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LIVE IT UP 1

VCE PHYSICAL EDUCATION UNITS 1 & 2

4TH EDITION

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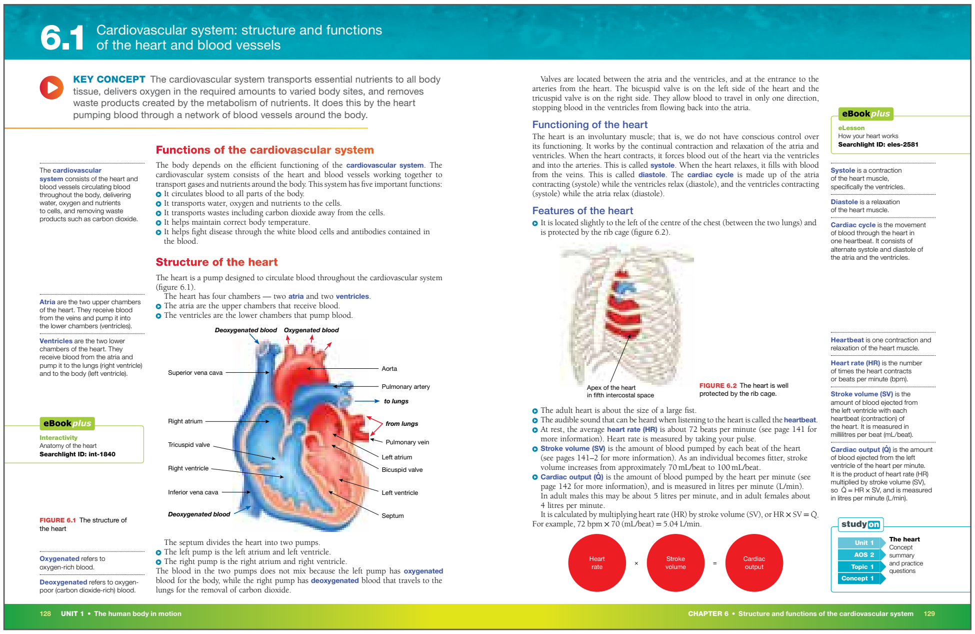

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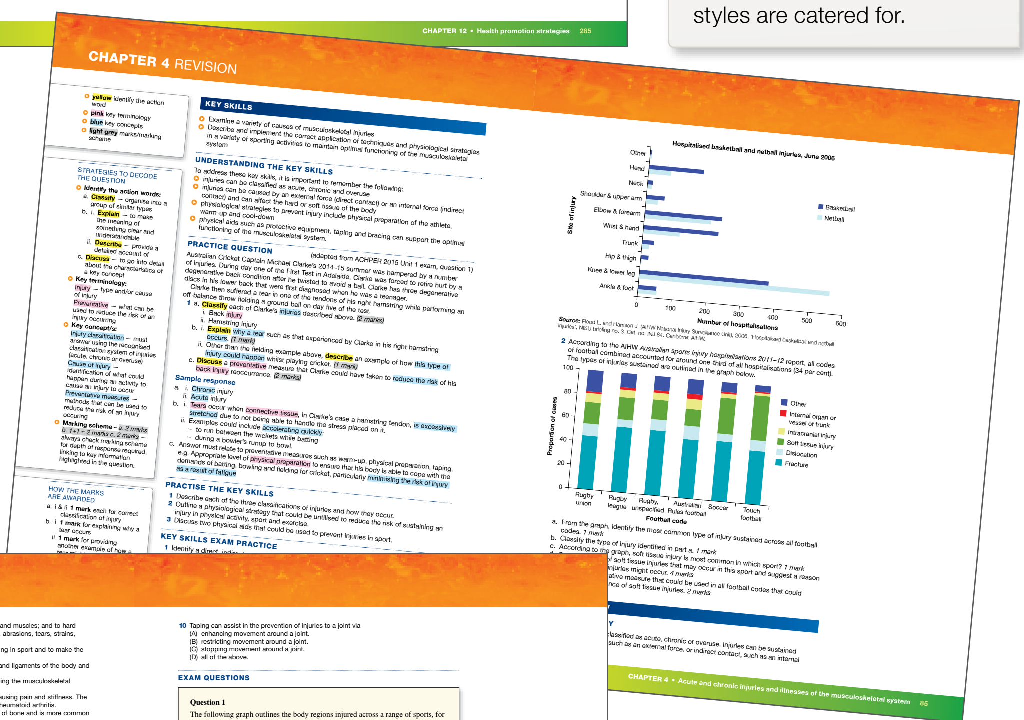

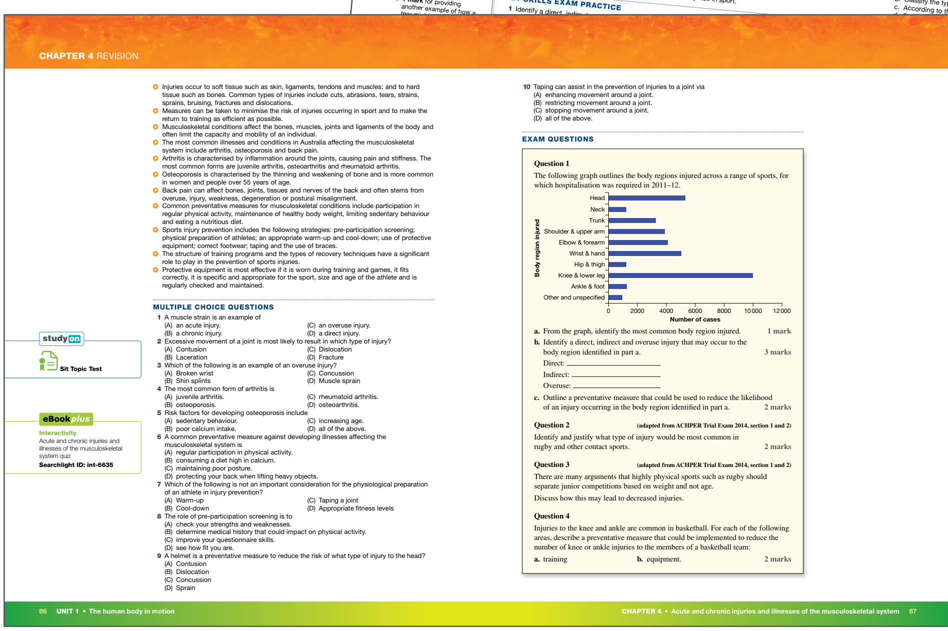

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PREFACE

Live It Up 1, Fourth Edition is an exciting and valuable resource for teachers of senior Physical Education. The student textbook and support material have been written for the re-accredited Victorian Certificate of Education Physical Education Study Design (2017–2021). This edition contains resources suitable for the modern educational environment. The supporting eBook uses the advantages of digital technologies to provide students and teachers with stimulating and engaging learning activities.

The author team of *Live It Up 1, Fourth Edition* is made up of highly experienced, practising teachers. The Australian Council for Health, Physical Education and Recreation (ACHPER) Victorian Branch acknowledges Michelle O'Keeffe, Kirsty Walsh, Vaughan Cleary, Sam Millar and Mark Quinlan for their outstanding contribution to the development of this learning resource.

ACHPER is the professional association for educators working in physical education, health education, sport and recreation. It supports educators in these areas in terms of professional learning, resources and other services, aiming to promote healthy lifestyles.

Trevor Robertson
President
ACHPER, Victorian Branch

Unit 1

The human body in motion

OUTCOME 1

Collect and analyse information from, and participate in, a variety of practical activities to explain how the musculoskeletal system functions, and its limiting conditions, and evaluate the ethical and performance implications of the use of practices and substances that enhance human movement.

OUTCOME 2

Collect and analyse information from, and participate in, a variety of practical activities to explain how the cardiovascular and respiratory systems function, and the limiting conditions of each system, and discuss the ethical and performance implications of the use of practices and substances to enhance the performance of these two systems.

INQUIRY QUESTION
Is this physical activity, sport or exercise?

CHAPTER 1

Introduction to the concepts of physical activity, sport and exercise

VCE Physical Education is the study of movement. Some topics relate to sports performance and others focus on factors that influence the participation in and outcomes of movement.

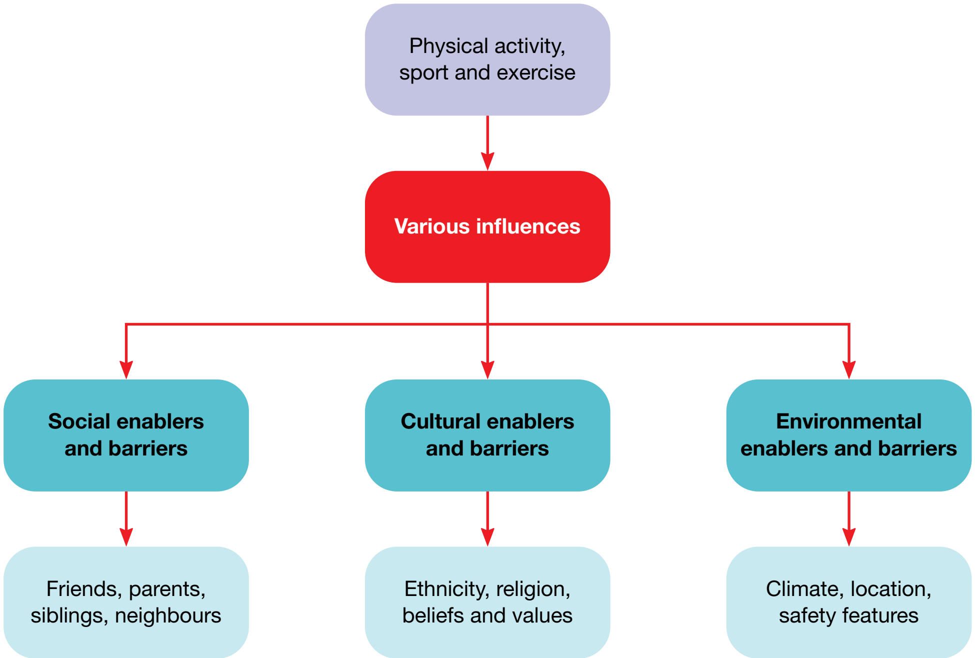
KEY KNOWLEDGE

- The concepts of physical activity, sport and exercise
- Social, cultural and environmental enablers and barriers to movement such as family, peers, socioeconomic status, level of education, cultural values, geographic location and access to facilities

KEY SKILLS

- Define and participate in a range of physical activities, sports and exercise
- Describe the social, cultural and environmental influences on movement

CHAPTER PREVIEW



1.1 Physical activity, sport and exercise

KEY CONCEPT Physical activity, sport and exercise refer to different types of movement. It's important to identify the influences that either enable people to exercise or prevent them from doing so.

Physical Education is the study of human movement. There are different reasons for studying this. We study the relationship between movement and health, and movement and performance. Some movements are performed to maintain good health and others are performed to gain a competitive advantage in sports. The emphasis of studying movement for health is different from the emphasis of studying movement for sports performance. For this reason, it is helpful to be able to categorise the types of movement. For example, physical activity is not the focus for an athlete; they are focused on sporting performance. A person training for a fun run is more focused on regular and planned exercise rather than increasing their general amount of physical activity.

studyon

Unit 1 | AOS 1 | Topic 1 | Concept 1

Physical activity, sport and exercise
Concept summary and practice questions

The terms physical activity, sport and exercise are often used interchangeably. While they all involve movement, they are different in their application. Sport is organised and competitive, exercise is often associated with activities people participate in to increase their fitness, and physical activity is a broad term relating to various forms of movement.

VCE Physical Education covers a range of topics related to maximising sports performance, the effects of exercise on the body and physical activity participation. Many of the content areas in VCE Physical Education will relate to all three: physical activity, sport and exercise. At times, the content will relate to only one of these areas.

Physical activity is any movement of the body produced by skeletal muscles, resulting in energy expenditure.

Physical activity is any activity that involves or requires some form of physical exertion. It includes sport, play, active transport, chores, games, fitness activities, recreation and some forms of work. Some examples of physical activity include children playing in the playground, adults walking to work or a family bike ride.

FIGURE 1.1 Bike riding is a form of physical activity.

Sport comprises a range of activities that are highly organised and involve rules, complex skills and tactics, physical exertion and competition between participants. Examples of sport include playing on a basketball or hockey team.

Sport is a range of activities that are highly organised and involve rules, complex skills and tactics, physical exertion and competition between participants.

FIGURE 1.2 Competitive sports such as basketball involve rules and skills that require training to master.

Exercise is physical activity that is planned or structured. It involves repetitive body movement done to improve or maintain one or more components of fitness. Participation in a Zumba class, going for a run or doing weight training are examples of exercise.

Exercise is defined as physical activity that is planned or structured, involving repetitive body movement done to improve or maintain one or more components of fitness.

FIGURE 1.3 A Zumba class is an example of exercise.

TABLE 1.1 Comparison of physical activity, exercise and sport

All	Physical activity	Sport	Exercise
Involve movement	Any body movement that results in energy expenditure	Highly organised Involves rules, complex skills, tactics and competition	Planned, structured, repetitive body movements Often aimed to improve fitness

TEST your understanding

1 Take a brief look at the other chapters in Unit 1 of this textbook. Create a table with three columns and two rows. Label the columns ‘physical activity’, ‘sport’ and ‘exercise’. In each column, list a chapter number and outline how a topic from that chapter may relate to each of these headings.
2 Use a Venn diagram to show the similarities and differences between physical activity, sport and exercise.
3 For each of the following, indicate whether it is an example of physical activity, sport or exercise.

Activity	Physical activity	Sport	Exercise
Gardening			
Walking to the shops			
Playing badminton			
Running laps of an oval			
Going for a ride along a bike path			
Using the stairs rather than the escalator			
Playing four-square			
Using the treadmill at the gym			
Swimming laps			
Digging holes			
Doing pushups			
Playing for a soccer club			
Climbing a tree			
Doing sprints			
Riding a horse			
Body-boarding			

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Interactivity
Sport, exercise, activity?
Searchlight ID: int-6615

1.2 Social, cultural and environmental enablers and barriers to movement

KEY CONCEPT The factors that affect movement are complex. For example, a person's physical activity behaviour is the result of a complex interaction between their personal beliefs, the influence of those around them and their environment. The determinants of movement in sports are also complex: the game score, position of other players, weather, and the player's confidence, genetics and training history are some of the factors that combine to produce movement.

There are many factors that influence a person's participation and success in physical activity, sport and exercise. These factors include two categories: 1) sociocultural factors and 2) environmental factors. Some of these factors are listed in table 1.2 below. **Sociocultural influences** are a combination of social and cultural factors. Social influences refers to power structures within society and social interactions and relationships, as well as political and economic factors. The cultural component relates to shared ways of thinking and acting (ideas, values, beliefs and behaviours) which differ from one culture to another or within cultures.

Environmental influences relate to the characteristics of the environment where people live and spend their time. Environmental influences could relate to policy or the built/natural environment. Examples of policy-related factors may be school policies about physical activity and active play. Policies related to road safety such as car speeds in built up areas could also influence physical activity. The built environment relates to human-made facilities such as recreation centres, bike paths, gyms and ovals. The natural environment includes factors such as the weather, oceans, rivers and proximity to outdoors.

Sociocultural and environmental influences can have a positive or negative effect on a person's movement. These are referred to as enablers and barriers.

An **enabler** is something or someone who makes it possible for a particular thing to be done. It has a positive effect on one's physical activity behaviour or outcome of movement.

A **barrier** is something that prevents progress or makes it difficult for someone to achieve something. It has a negative effect on one's physical activity behaviour or outcome of movement.

Sociocultural influences are the combination of social and cultural influences on an individual. Social influences include the interactions an individual has with family, peers and teachers. The cultural component relates to shared ways of thinking and acting (ideas, values, beliefs and behaviours).

Environmental influences are characteristics of the environment in which people live and spend their time that either enable exercise or create a barrier which can prevent people from exercising.

An **enabler** is something or someone that has a positive effect on one's physical activity behaviour.

A **barrier** is something or someone that has a negative effect on one's physical activity behaviour.

TABLE 1.2 Sociocultural and environmental factors that influence movement

Sociocultural factors	Environmental factors
Social Income Level of education Ethnicity/race Gender Socioeconomic status	Access to facilities Geographical location Distance to recreational facilities Safety Weather
Cultural Cultural norms Ethnicity National traditions	

studyon

Unit 1
AOS 1
Topic 1
Concept 2

Social and cultural enablers and barriers (physical activity)
Concept summary and practice questions

There are factors that are unique to each individual such as their physiology, genetics, maturation rates and physical ability/disability. These factors are not covered in detail in this chapter but are referred to in other chapters of books 1 and 2. For the purpose of this chapter, they are also classified as sociocultural influences.

studyon

Unit 1	**Environmental enablers and barriers (physical activity)** Concept summary and practice questions
AOS 1	
Topic 1	
Concept 3	

FIGURE 1.4 A skate park is a human-made facility that encourages physical activity.

Table 1.3 provides some examples of how sociocultural and environmental factors can be enablers or barriers to movement.

TABLE 1.3 Examples of sociocultural and environmental enablers and barriers

	Barrier example	Enabler example
	Social	
Income	Low family income may prevent a child from participating in swimming lessons. This will reduce the likelihood of the child swimming for exercise or activity.	High family income could enable a child to have regular coaching with expert coaches, providing an opportunity for the child to develop into an elite tennis player.
Education	A child who attends a school without a PE teacher may not learn the fundamental movement skills needed to play sport. This may reduce their participation because they don't have the skills or confidence to play sport.	Knowledge that weight-bearing exercise influences bone density may result in an older adult being more likely to be active.
Gender	Girls may be less likely to develop skills in a particular sport because boys are given more opportunities and receive better coaching in that sport; for example, Australian Rules football.	Males are more likely to develop skills in sports such as rugby because they have more opportunities and male role models in that sport.
Family	Children whose parents don't value the importance of physical activity may have fewer opportunities to be active.	Children who play a lot of sport with their siblings may be more likely to develop the skills needed to be active.
Peers	A lack of interest in sports and activity within a friendship group would provide fewer opportunities for an adolescent to be active.	Using a Fitbit to compare the number of steps with friends may encourage an individual to be active.
	Cultural	
Ethnicity	Some ethnic groups may value participating in sport, or particular sports, more than others. This may prevent them from developing skills in other sports or, if the sports that they are familiar with are not accessible, they may be inactive.	People of a particular ethnicity may be genetically suited to particular sports. Therefore, they may find it easy to participate in that sport. For example, people from Kenya are typically good at endurance sports, so excel at long-distance running.
Cultural norms	Girls may be placed at psychological and social risk in some sections of society if they choose to participate in certain sports, due to cultural norms.	Australia's pride in sporting achievement means that the government provides funding to programs that encourage physical activity, providing Australians with more opportunities to be active.
	Environmental	
Access to facilities	Living in a high-rise apartment could reduce opportunities to be active within the local environment.	A workplace with an onsite gym provides employees with more opportunities to be active.
Safety	Absence of street lights would discourage some from being active when it is dark.	Bike lanes on the road would make riding safer and increase the number of people cycling to work.
Weather	Rain will reduce the likelihood of people exercising, due to discomfort and increased inconvenience.	Mild sunny days can encourage activity because there is less risk of sunburn and people tend to be more motivated.

TEST your understanding

1 Explain the phrase ‘sociocultural influences on movement’.
2 Identify two sociocultural factors that are not listed in table 1.2.
3 Describe how these two factors can influence movement.
4 Define the terms ‘enablers’ and ‘barriers’.
5 Identify two possible subcategories that may exist under the heading of ‘environmental influences on movement’. Provide an example of each.

APPLY your understanding

6 (a) As a class or in groups, brainstorm a separate list of sports, physical activities and exercises that you could do at school.
(b) Form groups of six or eight students.
(c) From the list that you established during the brainstorm, choose at least one physical activity, one form of exercise and one sport in which your group will participate.
(d) Split your group into pairs. Each pair will then run a 15-minute group personal training session for the rest of the group. In preparation for your session, you will write up a lesson plan that includes key points of communication, details and timing of activities and considerations for safety. Please remember to stay true to your form of activity.
In your planning, please remember that your priority is to show an example of physical activity, sport or exercise so that the members of the group can discover the similarities and differences between these.
(e) After all groups have had their turn, head back to the classroom and make some notes about the similarities and differences between physical activity, sport and exercise.
(f) Following this task, an extension activity could be for the teacher to choose a group for each category (physical activity, sport and exercise) to run their session with the whole class. This will provide students with participation in a wider range of activities.

7 Draw up three tables, each with six rows and two columns.
(a) Label the three tables ‘Physical activity’, ‘Sport’ and ‘Exercise’.
(b) Label the columns ‘Equipment’ and ‘How it could be used’.
(c) Make a visit to the PE store room at your school. Identify equipment that could be used for physical activity, sport and exercise, and outline how it could be used. An example is provided below.

PHYSICAL ACTIVITY	
Equipment	**How it could be used**
Skipping ropes	Skipping ropes available for use at lunchtime

8 (a) Make a list of the physical activity, exercise and sport in which you have participated over the last three to five days.
(b) Put these activities into three categories — physical activity, exercise and sport.
(c) Create a table with three columns (an example is provided for you below). Think of the enablers and barriers to participation that influenced your activity over this period. Identify each factor, indicate whether it is sociocultural or environmental and explain how this factor influenced your behaviour.

Factor	**Sociocultural or environmental**	**Explanation**

1.3 Sociocultural influences throughout Units 1–4

KEY CONCEPT Understanding how to use the term 'sociocultural influences' is important in VCE Physical Education.

Throughout VCE Units 1–4 Physical Education you will be required to apply the term 'sociocultural influences' in various ways. Listed below are some examples of how you may be required to apply this terminology during your VCE studies.

FIGURE 1.5 Sociocultural influences were one of the factors that led to the drug scandals in cycling in the 1990s.

Unit 1 The human body in motion

- *Social, cultural and environmental enablers and barriers to movement*
  Refer to table 1.3 for examples.
- *Sociocultural influence on the use of legal and illegal practices*
  Example — consider the cyclists in the 1990s who were pressured to use illegal methods of performance enhancement because their peers were participating in these practices.

Unit 2 Physical activity, sport and society

- *Sociocultural influences on participation in physical activity across the lifespan*
  Example — teenagers may be more active than adults because more of their friends are active and the elderly may be active to increase social connections.
- *Identify contemporary issues associated with participation in physical activity and sport*
  Example — active transport and cultural diversity are examples of these contemporary issues. Active transport is a term used to describe when people use exercise as a form of transport. This is an issue in Australia because government and non-government organisations work together to make changes that encourage active transport. In relation to cultural diversity, what changes need to be made to better engage our culturally diverse community in physical activity?

Unit 3 Movement skills and energy for physical activity

- *Sociocultural factors that impact on skill development*
  Example — a child who grows up in some Australian communities may have access to only Australian Rules football and cricket, limiting his or her opportunities to develop skills in other sports. Children from some families or cultures may have fewer opportunities to develop skills because sport and fitness are regarded as being less important than academic success.

FIGURE 1.6 Today, there are many devices that trainers can use to help their clients achieve fitness goals.

Unit 4 Training to improve performance

- *The purpose of fitness testing from a sociocultural perspective*
  Example — athletes will participate in fitness testing for different reasons compared to individuals who are starting an exercise program at the local gym. Athletes will be measuring their fitness to improve their sporting performance, whereas the gym attendee may want to find out how their fitness compares to that of the population. A coach may use fitness testing to compare players whereas a personal trainer may use fitness testing to provide feedback to his/her clients about improvements to their fitness. For these and other reasons, the tests used and accuracy of methodology will vary.
- *Strategies to record and monitor sociological training data*
  Training data is collected to evaluate many aspects of training. Devices such as Fitbits provide people with an opportunity to compare physical activity and exercise participation. This can provide the users with performance comparisons, social benefits and motivation.

CHAPTER 1 REVISION

KEY SKILLS

- Define and participate in a range of physical activities, sports and exercise
- Describe the social, cultural and environmental influences on movement

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- social influences relate to relationships, role models and the influence of some policies and economic factors
- cultural influences relate to shared ways of thinking and acting
- environmental influences relate to the built and natural environment and policies related to the use of these environments
- physical activity, sport and exercise all refer to different types of movement.

PRACTICE QUESTION

Identify and **outline** one example for each of the following influences on movement: social, cultural and environmental. *(6 marks)*

Sample response

Social factor (peers) — A person is more likely to be active if their friends are active. The positive influence of a person's friends and the fact that they are also active will provide a person with greater opportunities to be active.

Cultural factor (cultural norms) — Generally, Australians value physical activity and sport. Therefore, if a person wants to be active they are encouraged to do so and will have more opportunities because there are fewer barriers to participation.

Environmental factor (weather) — A person may be less active in winter. The increased rainfall makes it more difficult to go for a bike ride or a run because of discomfort, inconvenience of changing clothes and lack of motivation. This will reduce the person's opportunities to be active and as a result the amount of physical activity that they participate in.

PRACTISE THE KEY SKILLS

1 Outline a social, cultural and environmental factor (one of each) that influences your participation in physical activity, sport and exercise.

2 Harry is 13 years of age and his family has moved from Melbourne to a rural Victorian town that has a population of 3000 people. The sports that are available in the town include squash, tennis, football, cricket, netball and basketball. When he lived in the city, Harry used to enjoy skateboarding and swimming. He used to catch public transport to school but he may be able to walk to school now because he lives only one kilometre from the school.

   Use your knowledge of the sociocultural and environmental influences on physical activity to explain how the move to the country may affect Harry's physical activity.

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:** **Identify** — determine the key characteristics or features **Outline** — general description but not in detail
- **Key terminology:** influences — factors that affect movement
- **Key concept:** there are multiple factors that affect movement, many of which are interrelated. These factors can be categorised into sociocultural and environmental factors.
- **Marking scheme:** *6 marks* — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

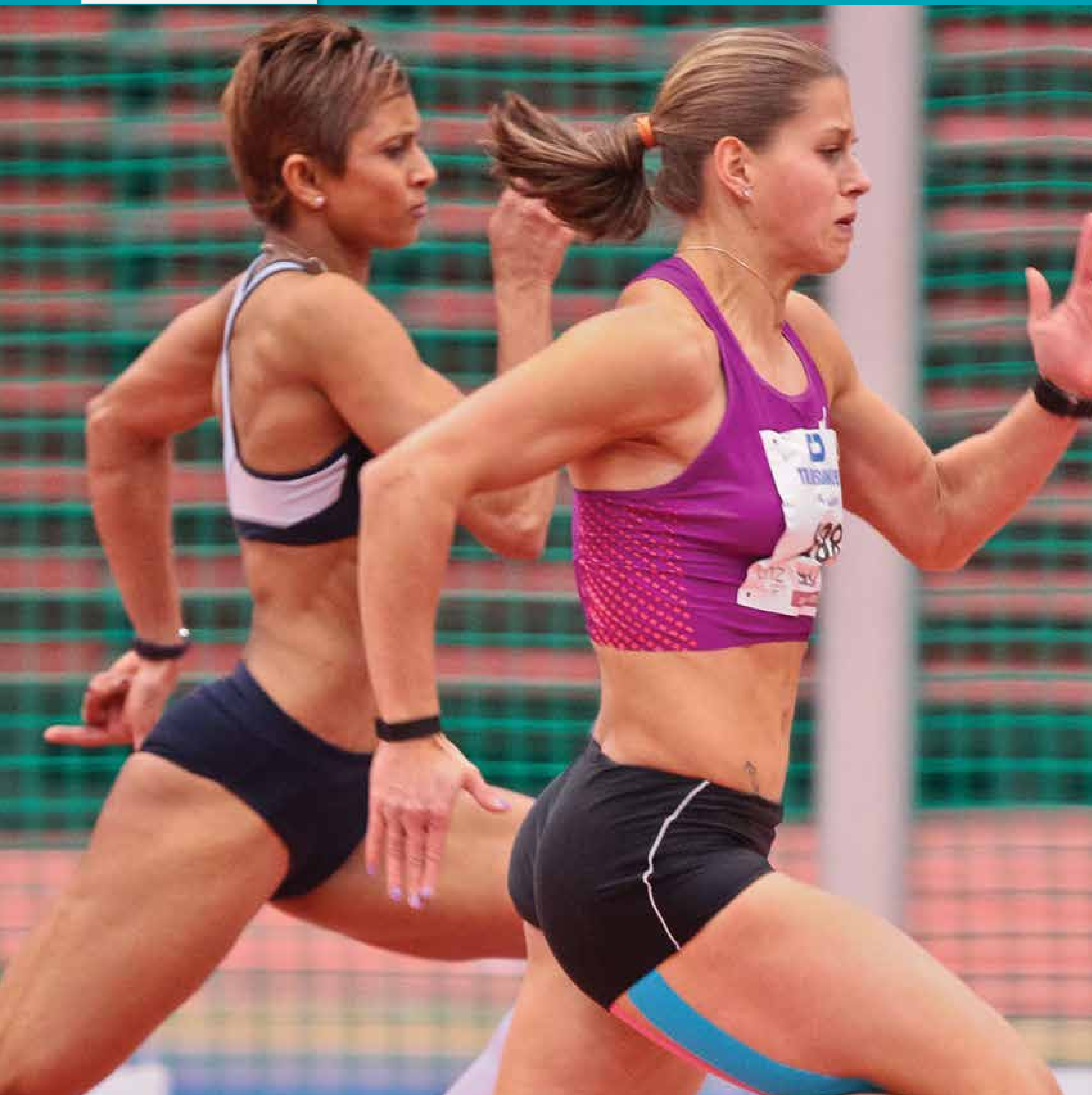
- 2 marks for each (social, cultural and environmental)
- **1 mark:** identify a correct example of each of the influences on movement
- **1 mark:** outline how it affects physical activity behaviour

CHAPTER REVIEW

CHAPTER SUMMARY

- There is a difference between physical activity, exercise and sport.
- There are numerous influences on movement. These influences can be classified as sociocultural or environmental.
- Sociocultural influences can be further separated into social and cultural influences.
- Environmental influences include the built and natural environment and the policies that can affect the use of the environment where people live or spend their time.
- Each influence is called a factor. These factors can be enablers or barriers to movement.
- Enablers are factors that encourage movement or enhance movement quality.
- Barriers are factors that reduce the likelihood or efficiency of movement.

INQUIRY QUESTION
How do bones and joints assist movement in sprinting?



CHAPTER

2 Structure and functions of the skeletal system

The skeletal and muscular systems work together to produce movement in physical activity, and one cannot function without the other. The different bones and joints have a number of functions and work together with muscles, creating the various anatomical movements.

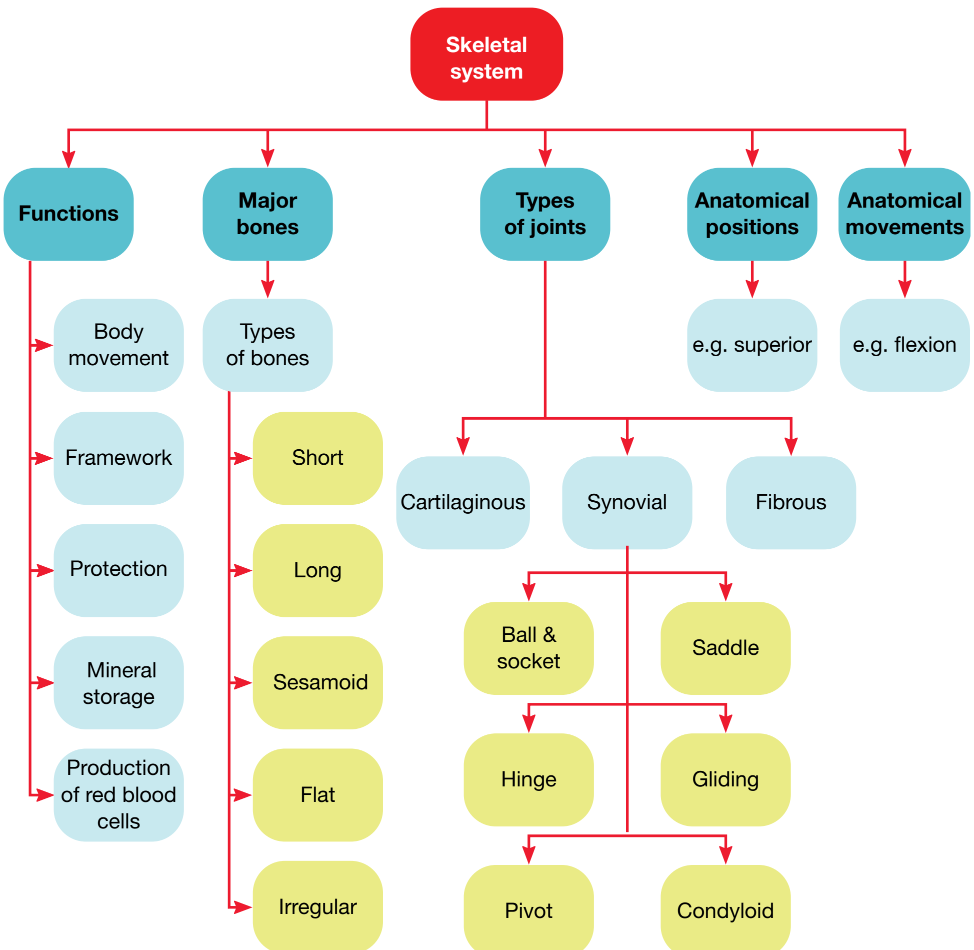
KEY KNOWLEDGE

- The structure and function of the skeletal system including bones of the human body, classification of joints and joint actions

KEY SKILLS

- Use and apply correct anatomical terminology to the working of the musculoskeletal system in producing human movement
- Perform, observe and analyse a variety of movements used in physical activity, sport and exercise to explain the interaction between bones, muscles, joints and joint actions responsible for movement

CHAPTER PREVIEW



2.1 The skeletal system: functions and structure of major bones

KEY CONCEPT The skeletal system is an essential body system for physical activity. It provides the framework for muscles to attach to so that movement can occur. It also interacts with other body systems providing protection, mineral storage and a site for blood cell formation.

The musculoskeletal system is made up of the skeletal system (bones, joints, ligaments and tendons) and muscular system (muscles). The skeletal system is made up of 206 bones and encompasses all of the bones, every joint and corresponding ligaments.

Functions of the skeletal system

The **skeletal system** is a rigid structure made of bones that provides support, protection and sites to which muscles attach to create movement.

The **skeletal system** has five main functions in bodily health:

- body movement (the most important function to understand in physical education)
- framework
- protection
- mineral storage
- production of red blood cells.

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Unit 1	**Functions of the skeletal system** Concept summary and practice questions
AOS 1	
Topic 2	
Concept 1	

Body movement

The human body has 206 bones, all of which provide sites for muscle attachment. The bones act as levers and work with the muscular system to create movement. When a muscle contracts, it pulls on the bone to which it is attached and thus movement occurs. Any irregularity on a bone's surface provides a possible site for a muscle attachment. Figure 2.1 illustrates the sites for the triceps muscle attachments.

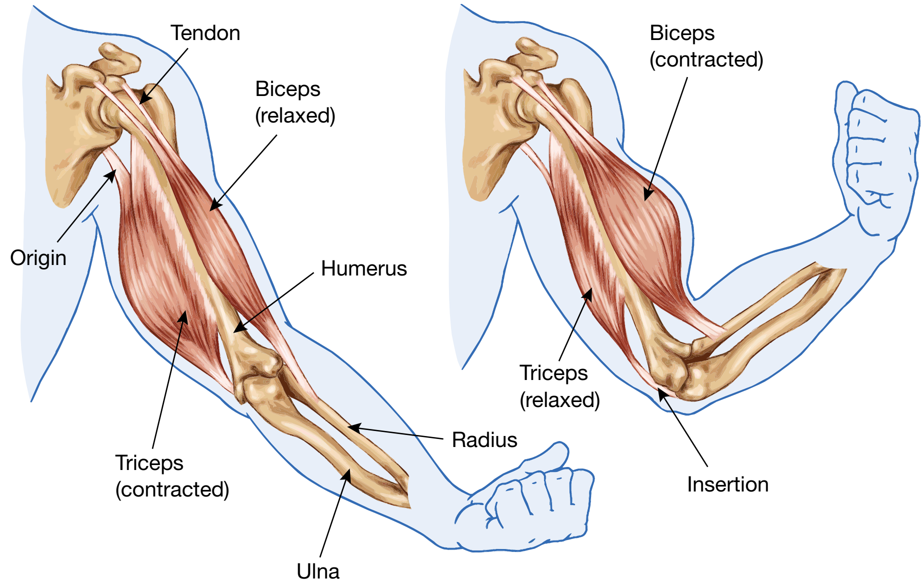

FIGURE 2.1 Bones offer ready attachments for muscle tendons.

Framework and protection

The skeleton provides a solid framework for the body and helps battle the forces of gravity. Everyone has a solid skeleton, but the differences in people's posture indicate the interdependence of the skeletal and muscular systems in maintaining correct posture.

The strong protective skeletal layer provides protection for many vital body organs. This is particularly evident when the rib cage is examined (figure 2.2). This naturally enclosing shell effectively protects the heart and lungs from all but the most traumatic of injuries.

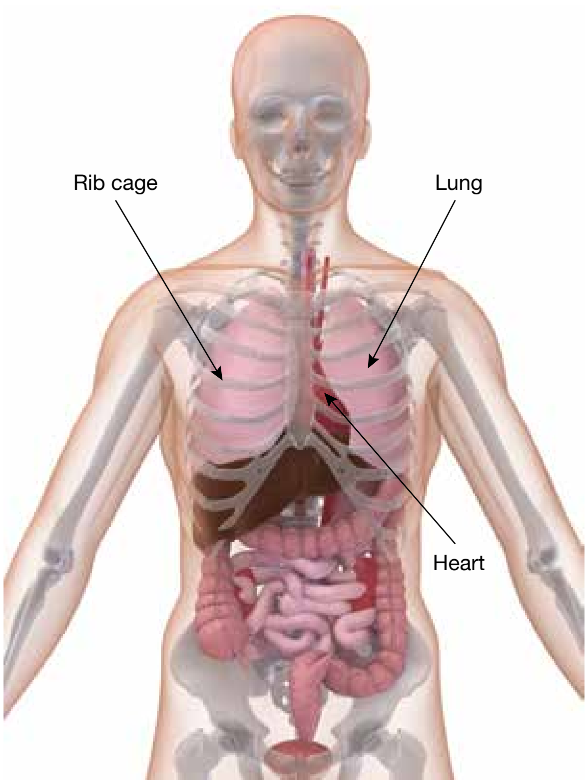

FIGURE 2.2 The ribs provide protection to the vital organs of the body.

There are two main types of bone tissue:

- Compact bone, which is found in the shaft or diaphysis of the long bone. This comparatively solid bone surrounds the cavity of the long bone (figure 2.3), offering an extremely strong structure that gives the body its rigid framework. Collagen is a central ingredient in providing compact bone rigidity and tensile strength (as it is with cancellous bone). In some ways the skeleton is stronger and more durable than concrete.
- Cancellous bone (also described as spongy bone, being less dense than compact bone), which provides some of the shock absorption required at the end of long bones or at the edges of more irregular bones.

Mineral storage

Bone tissue efficiently stores a number of minerals that are important for health. **Calcium**, phosphorus, sodium and potassium all contribute to the health and maintenance of bone tissue as well as carrying out other roles in the body. Calcium also assists with muscular activity.

Calcium is a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.

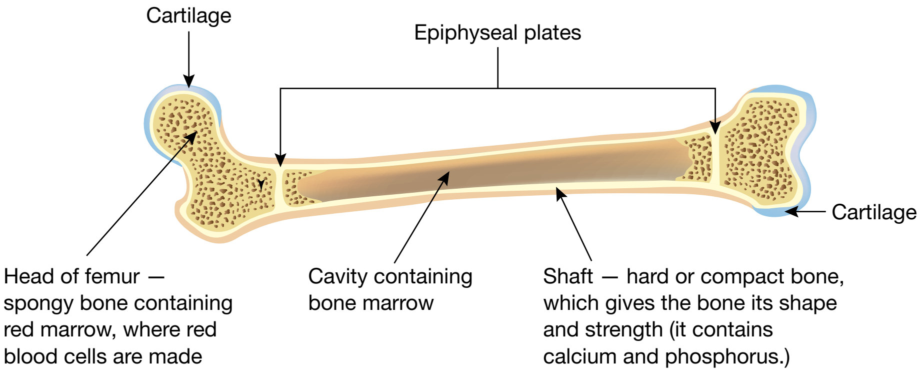

FIGURE 2.3 A long bone

Haemoglobin is a substance found in red blood cells that transports oxygen around the body.

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Interactivity
Major bones of the skeletal system
Searchlight ID: int-6616

Production of red blood cells

Essential production of new red blood cells occurs within the cavity of long bones. Production levels are high during growth years, diminishing as age increases and the need for high rates of red blood cells decreases. Such cells are essential for oxygen transportation throughout the body. **Haemoglobin**, a protein inside red blood cells, transports oxygen molecules from the lungs to the body. Much of an adult's bone cavity is filled with yellow bone marrow, which is a source of long-term energy (figure 2.3).

Major bones of the skeletal system

The major bones of the skeletal system are shown in figure 2.4.

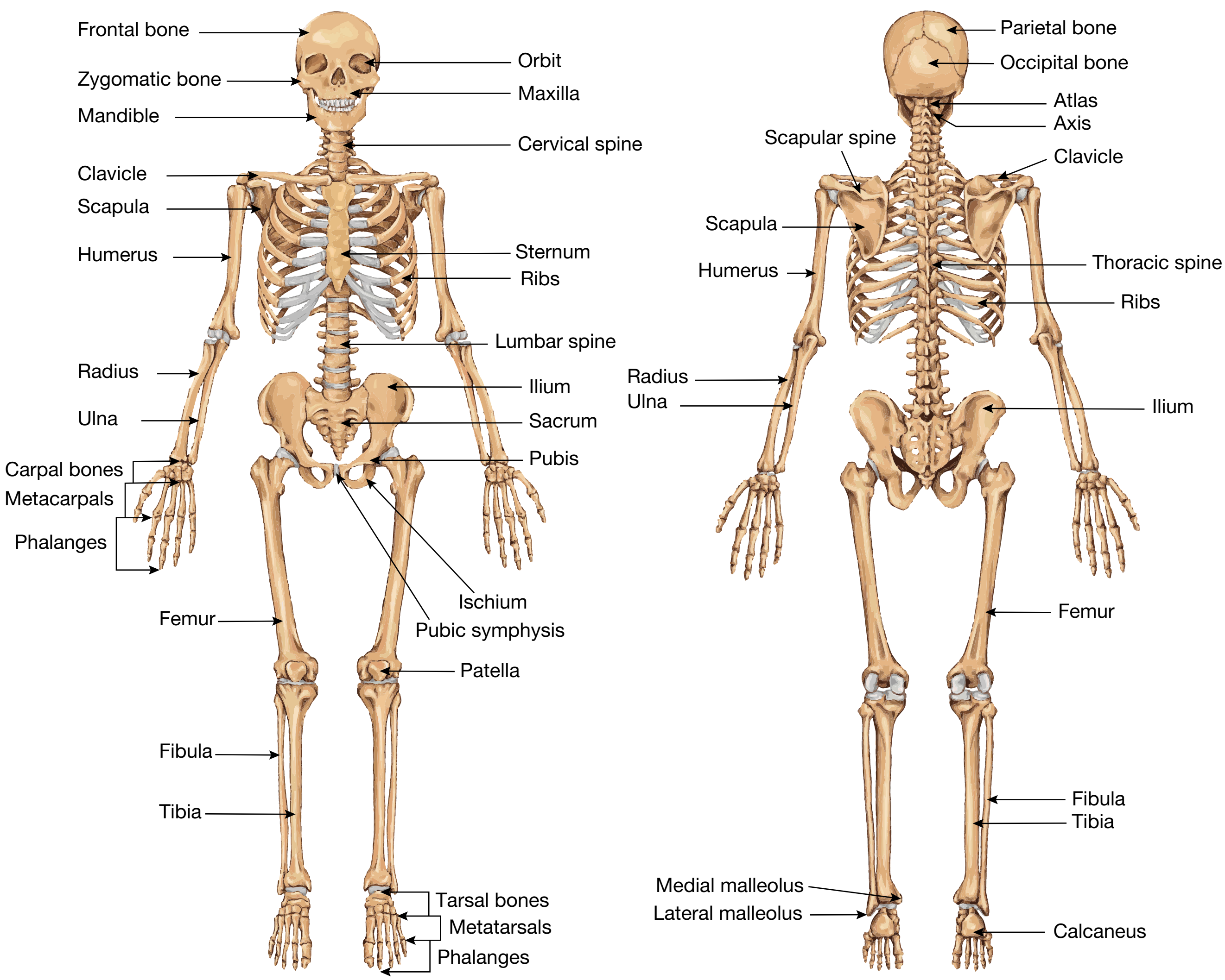

FIGURE 2.4 Skeletal bones from the anterior and posterior of the body

Types of bones

There are five types of bones in the human body, distinguished by their shape.

1. Short bones (figure 2.5a) are roughly cubical, with the same width and length; for example, the carpals of the wrist and the tarsals of the foot.
2. Long bones (figure 2.5b) are longer than they are wide, and they have a hollow shaft containing marrow (figure 2.3); for example, femur, phalanges and humerus.
3. Sesamoid bones (figure 2.5c) are small bones developed in tendons around some joints; for example, the patella at the knee joint.
4. Flat bones (figure 2.5d) provide flat areas for muscle attachment and usually enclose cavities for protecting organs; for example, scapula, ribs, sternum and skull.
5. Irregular bones (figure 2.5e) have no regular shape characteristics; for example, vertebrae and bones of the face.

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Weblink
Types of bone

studyon

Unit 1 | AOS 1 | Topic 2 | Concept 2

Structure of the skeletal system
Concept summary and practice questions

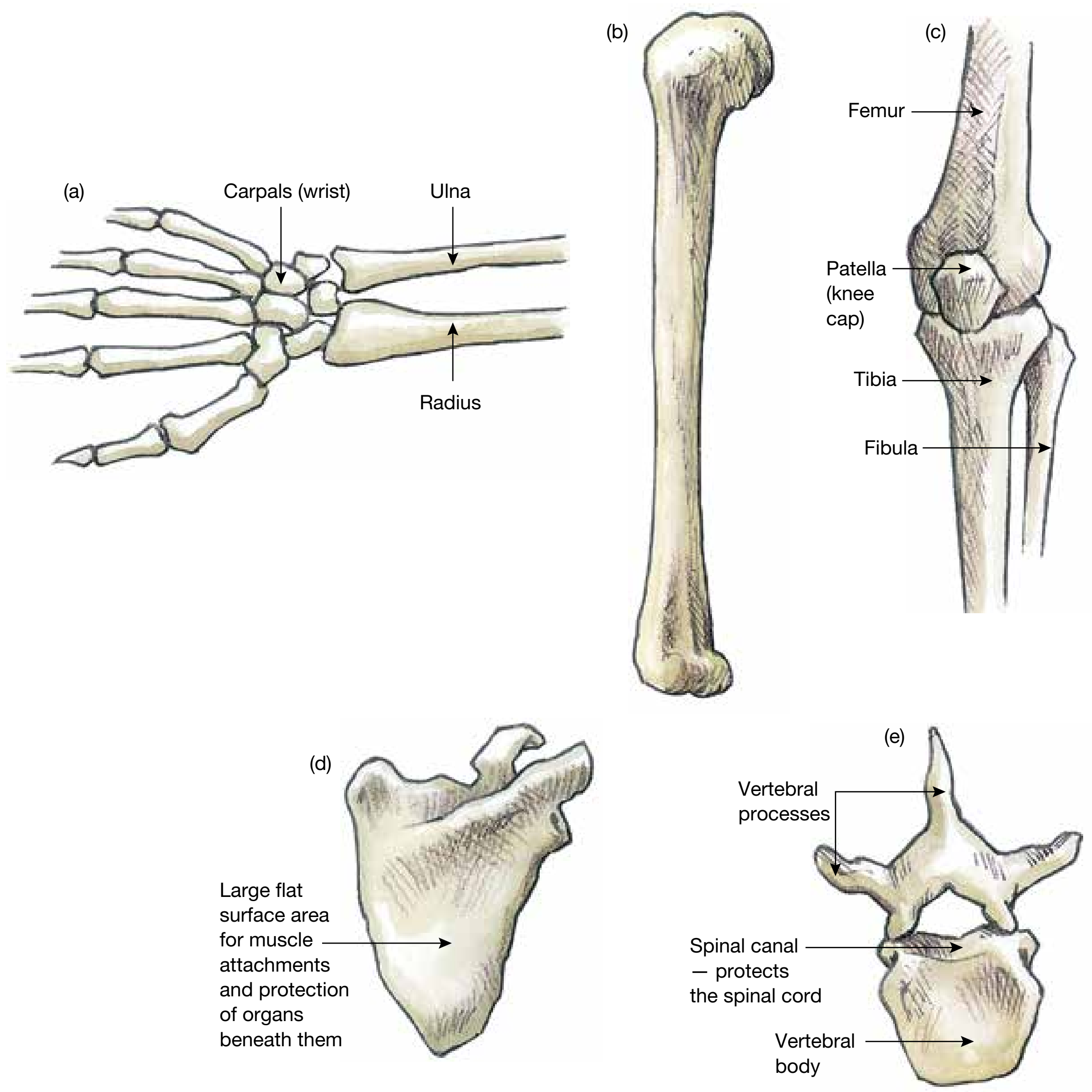

FIGURE 2.5 Examples of bone types: (a) short bones, (b) a long bone, (c) a sesamoid bone, (d) a flat bone, (e) an irregular bone

Vertebral column

The **vertebral column** (or spine) is the column of irregular bones comprised of three distinct curves that provides the body's central structure for the maintenance of good posture.

Vertebrae are the 33 moveable and immoveable bones that make up the vertebral column.

The **vertebral column** (also called the spine) provides the central structure for the maintenance of good posture. If a person maintains the correct levels of strength and flexibility in all the muscle groups that connect with the vertebral column, then they are likely to avoid postural problems.

The vertebral column has some special features:

- Each vertebra has a hollow centre through which travels the spinal cord that controls most conscious movement within the body. In this way the cord is protected (figure 2.5e).
- The **vertebrae** increase in size as they descend from the cervical to the lumbar region (figure 2.6). This helps them support the weight of the body.
- Movement between two vertebrae is very limited. But the range of movement of the vertebral column as a whole is great, allowing bending and twisting.
- Intervertebral discs separate each of the vertebrae in the cervical, thoracic and lumbar regions. They absorb shock caused by movement and allow the vertebral column to bend and twist.

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Interactivity
Sections of the spine
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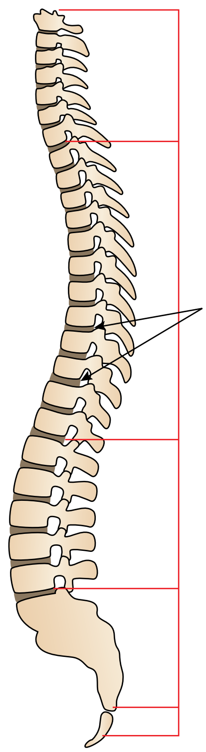

FIGURE 2.6 Side view of the vertebral column showing the five main sections

Bone growth and health

Epiphyseal plates (or growth plates) are the growth centre of developing bones.

Epiphyseal plates, also known as growth plates, are the centres for bone growth. Found at the ends of the diaphysis or shaft of the long bone, these plates are visible under x-ray and may be damaged in injury. The rate of growth of a leg, for example, may diminish if the leg is broken during growth years. However, following injury repair, the leg's rate of growth will usually accelerate until the legs are again growing equally. The majority of bone growth occurs during infancy and adolescence and has usually stopped by early adulthood.

TEST your understanding

1 Using the correct anatomical terminology, analyse the movement depicted in the image at the start of this chapter on page 12 by:
   (a) identifying the bones and joints utilised in this sprinting activity
   (b) identifying the joint actions required in the sprinting activity responsible for movement.
2 Download the 'Skeleton' document from your eBookPLUS. Label the major bones of the skeleton.
3 Discuss the five main functions of the skeletal system.
4 The function of some bones is to provide protection for vital organs. Identify these bones and the vital organs they protect.
5 Identify and describe the two types of bone tissue.
6 List the five types of bones in the skeletal system and provide one example of each.
7 Identify the bones that form each of the following joints:
   (a) shoulder
   (b) elbow
   (c) hip
   (d) knee
   (e) ankle.
8 Revise what you know about the vertebral column.
   (a) List the five main sections of the vertebral column.
   (b) Identify how many vertebrae are in each section.
   (c) Describe how the vertebrae change along the length of the vertebral column.
   (d) Provide some possible reasons for this change.
   (e) List the main functions of the vertebral column.
9 Copy and complete the table below.

Common name	Anatomical name	Type of bone
Shin bone	Tibia	Long
Jaw		
Breast bone		
Shoulder blade		
Hip bone		
Collar bone		
Thigh bone		
Knee cap		
Ankle bones		

APPLY your understanding

10 **Practical activity: participate in a game of tennis**
   (a) Identify all the skills/movements required in the activity you have participated in.
   (b) For each skill/movement, list the bones responsible for helping to create that movement.

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Skeleton
Searchlight ID: doc-1099

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Interactivity
Common and anatomical names of bones
Searchlight ID: int-6618

2.2 Joint classification and structure and anatomical movements

KEY CONCEPT A joint is the intersection of two or more bones. Joints and their actions are essential for human movement as movement occurs via muscles crossing joints, attaching to bones and pulling on them to allow contractions to occur.

study on

Unit 1	**Classification of joints**
AOS 1	Concept summary
Topic 2	and practice
Concept 3	questions

Classification of joints

The skeleton has three major joint types. These joints are classified by how the bones are joined together and by the movement that each joint permits.

- Fibrous (immoveable) joints offer no movement. Examples include the skull (figure 2.7), pelvis, sacrum and sternum.
- Cartilaginous (slightly moveable) joints are joined by cartilage and allow small movements. Examples include the vertebrae (figure 2.8) and where the ribs join the sternum.
- Synovial (freely moveable) joints offer a full range of movement and move freely in at least one direction. Examples include the knee or shoulder (figure 2.11 on page 22).

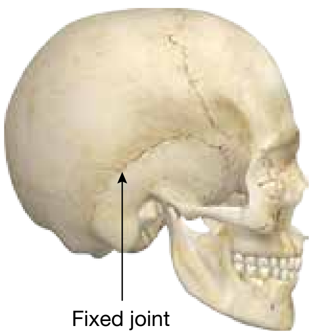

FIGURE 2.7 Immoveable fibrous joints form the skull.

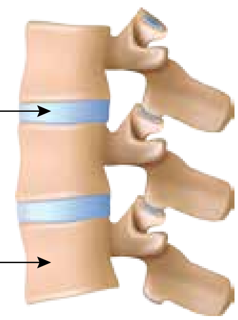

FIGURE 2.8 Slightly moveable (cartilaginous) joints in the spine

Connective tissue

Connective tissue plays an important role in the function of both the skeletal and muscular systems. It is classed as soft tissue because it does not have the rigidity of bone whereas it does have the flexibility of soft tissue along with the strength that collagen provides.

Cartilage

Cartilage is a tough, fibrous connective tissue located at the end of bones and between joints. It protects bones by absorbing the impact experienced in movements such as jumping.

Cartilage is a smooth, slightly elastic tissue found in various forms within the body:

- hyaline cartilage coats the ends of the bones in synovial joints
- discs of cartilage separate the vertebrae of the spine (figure 2.8)
- the ribs attach to the sternum via cartilage
- the hard part of the ear and the tip of the nose are also cartilage.

Ligaments

A **ligament** is a strong fibrous band of connective tissue that holds together two or more moveable bones or cartilage, or supports an organ.

Ligaments cross over joints, joining bone to bone. Their slight elasticity allows small movement from the bones of the joint. The main function of ligaments is to provide stability at the joint, preventing dislocation (figure 2.9). If ligaments are seriously damaged in an accident, they may not be able to repair themselves and may require surgery.

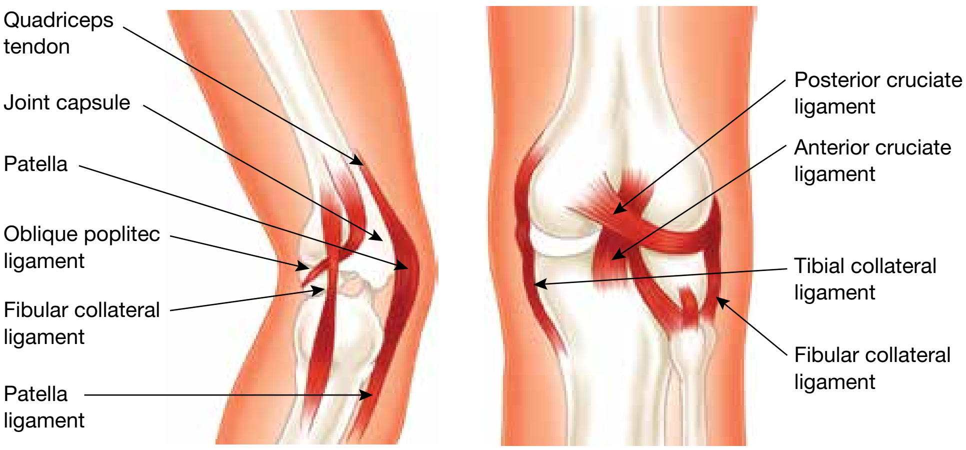

FIGURE 2.9 Ligaments of the knee joint (side and rear view)

Tendons

Tendons are inelastic and very strong, allowing movement by helping muscles pull through the joint and on the bones. The biceps muscle (figure 2.10) is an example of a muscle that works through two joints. It has two tendinous origins at the scapula (allowing the humerus to flex away from the body), and the tendinous insertion into the radius in the forearm allows the forearm to flex upwards towards the humerus.

A **tendon** is a fibrous connective tissue that attaches muscles to bones.

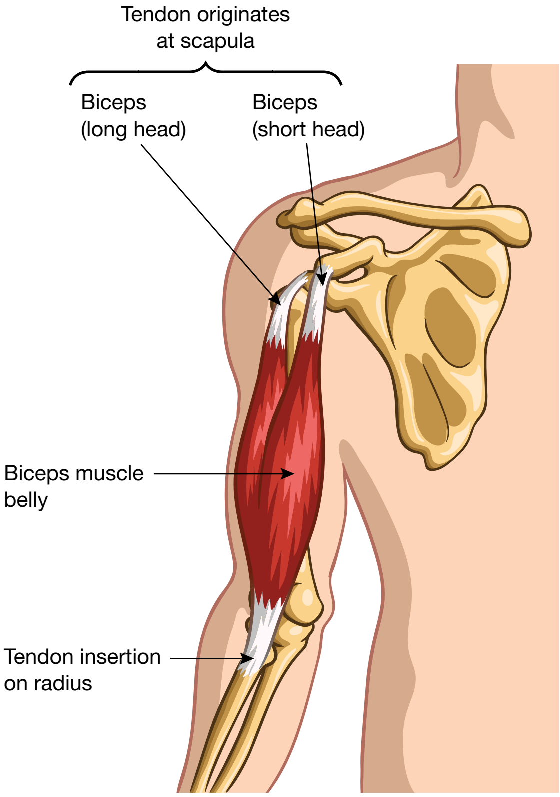

FIGURE 2.10 Tendons of the biceps muscle

Synovial joints

Synovial joints are the joints of most interest to physical activity as they are directly involved in producing skilled movement. They are classified by a number of qualities (figure 2.11):

- free movement in at least one direction
- cartilage that offers protection and cushioning at the ends of bones and reduces friction

A **synovial joint** is a specialised joint that allows more or less movement and has a joint capsule.

- ligaments that secure bones in place and allow controlled ranges of movement
- enclosure by a joint capsule (a layer of tissue that surrounds the joint and provides stability in the joint by holding it together)
- a synovial membrane that lines the inside of the joint capsule and secretes synovial fluid, promoting lubricated movement by the joint.

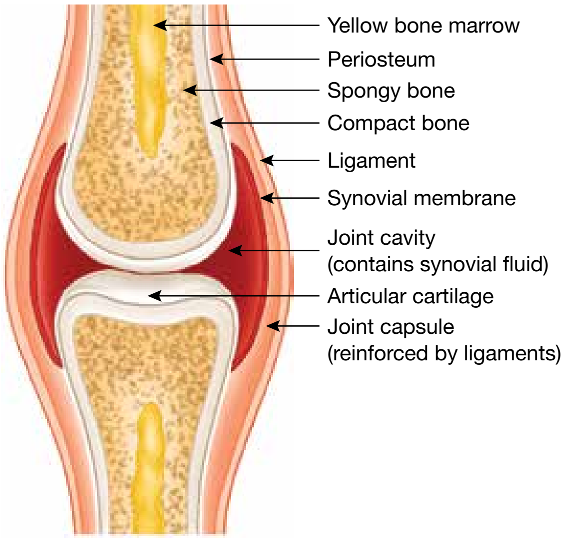

FIGURE 2.11 Basic structure of a synovial joint

Types of synovial joints

There are six types of synovial joints (figure 2.12). These joints are classified by the shape of the bones that articulate at the joint as well as the amount and type of movement possible at each joint.

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Animation of joint movements
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Six types of synovial joints

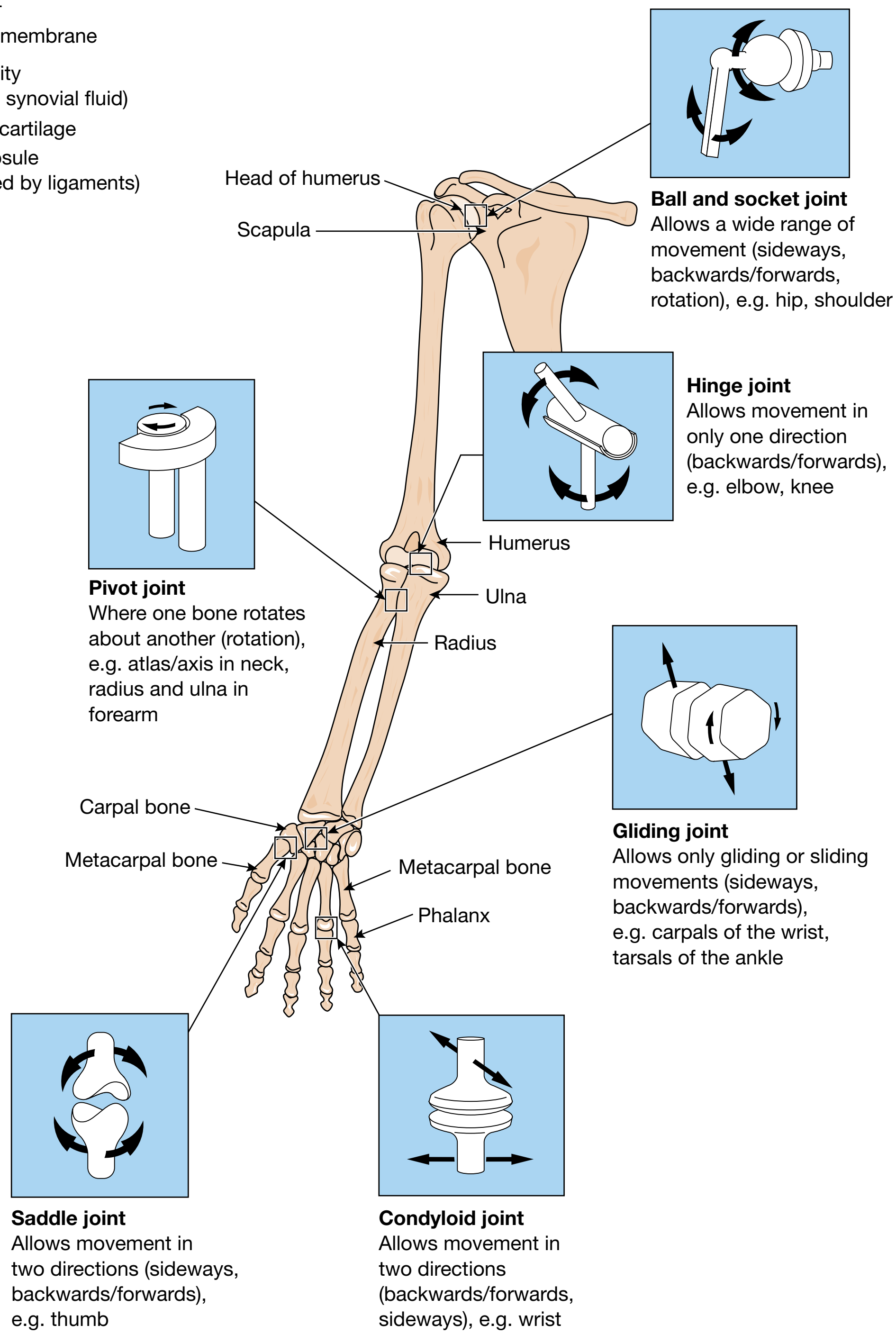


FIGURE 2.12 Six types of synovial joints

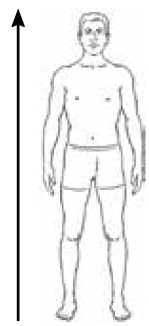
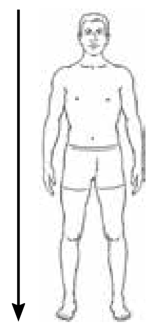
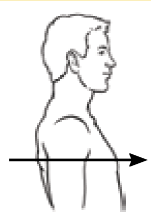
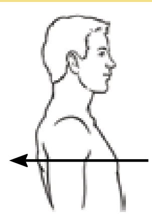
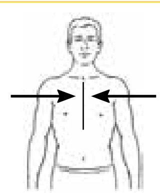
Anatomical position, terms of reference and movements

Anatomical position and terms of reference

When discussing synovial joints and the movements they create, it is also important to understand the anatomical position and common terms of reference. The **anatomical position** is defined as standing erect, facing forward with arms by the side and palms facing forward. The terms of reference shown in table 2.1 help to describe where a body part is in relation to another body part. For example, the patella is located on the anterior (front) aspect of the body.

Anatomical position refers to standing erect, facing forward with arms by the side and palms facing forward.

TABLE 2.1 Terms of reference

Term	Definition	Example	
Superior	Towards the head or upper part of the body	The cranium is superior to the sternum.	
Inferior	Towards the feet or lower part of the body	The tarsals are inferior to the femur.	
Anterior	Towards the front of the body	The patella is on the anterior side of the body.	
Posterior	Towards the back of the body	The scapula is posterior to the sternum.	
Medial	Towards the midline of the body	The sternum is medial to the rib cage.	

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Weblink
Anatomical terms of reference

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Interactivity
Orientation and directional terms
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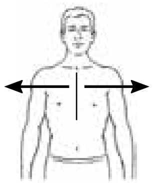
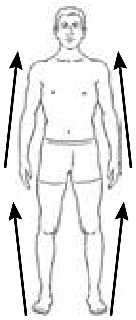
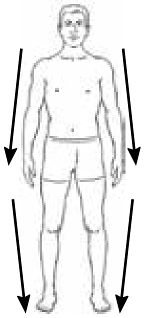
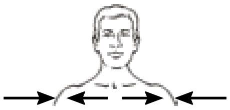
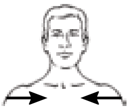
TABLE 2.1 Continued

Term	Definition	Example
Lateral	Towards the outer side of the body	The fibula is lateral to the tibia. 
Proximal	Closer to the trunk of the body	The femur is proximal to the patella. 
Distal	Further away from the trunk of the body	The phalanges are distal to the humerus. 
Superficial	Towards the surface of the body	The rib cage is superficial to the heart. 
Deep	Towards the inner part of the body	The liver is deep to the skin. 
Prone	Face down	Lying on the stomach 
Supine	Face up	Lying on the back 

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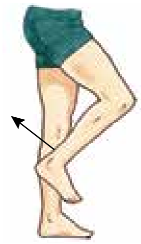
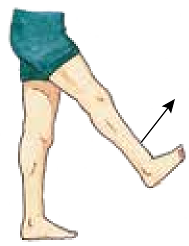
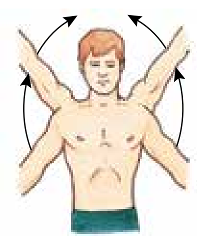
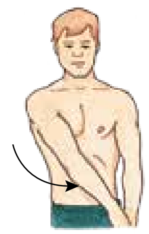
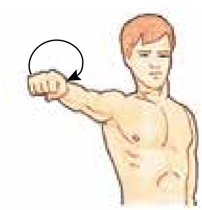
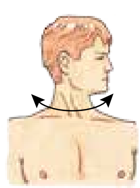
Unit 1
AOS 1
Topic 2
Concept 4

Joints actions Concept summary and practice questions

Anatomical movements

A variety of movements can occur at synovial joints. These are called anatomical movements, and there is a specific term to describe each movement (table 2.2).

TABLE 2.2 **Terms for anatomical movements in various activities**

Anatomical movement	Definition	Example	
Flexion	Decrease in the angle of the joint	Bending the elbow or knee	
Extension	Increase in the angle of the joint	Straightening the elbow or knee	
Abduction	Movement of a body part away from the midline of the body	Lifting arm out to side (*out* phase of star jump)	
Adduction	Movement of a body part back towards the midline of the body	Returning arm into body or towards midline of the body	
Circumduction	Movement of the end of the bone in a circular motion	Drawing a circle in the air with straight arm	
Rotation	Movement of a body part around a central axis	Turning head from side to side	

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Anatomical terms of movement

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Interactivity
Anatomical movement: image match
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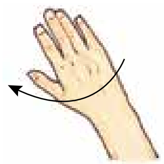
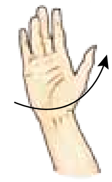
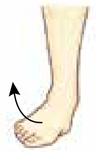
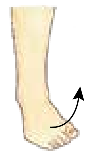
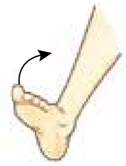
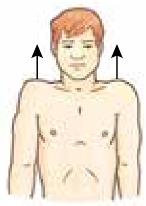
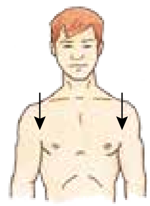
TABLE 2.2 Continued

Anatomical movement	Definition	Example
Pronation	Rotation of the hand so that the thumb moves in towards the body	Palm facing down 
Supination	Rotation of the hand so that the thumb moves away from the body	Palm facing up 
Eversion	Movement of the sole of the foot away from the midline	Twisting ankle out 
Inversion	Movement of the sole of the foot towards the midline	Twisting ankle in 
Dorsi flexion	Decrease in the angle of the joint between the foot and lower leg	Raising toes upwards 
Plantar flexion	Increase in the angle of the joint between the foot and the lower leg	Pointing toes to the ground 
Elevation	Movement of the shoulders towards the head	Shrugging shoulders 
Depression	Movement of the shoulders away from the head	Returning shoulders to normal position 

TEST your understanding

1 Discuss the three joint types and provide an example of each.
2 Outline the common features of synovial joints. Draw a picture to illustrate.
3 Copy and complete the table below in relation to synovial joints.

Joint	Type of synovial joint	Anatomical movement
Neck		
Shoulder		
Elbow		
Wrist		
Hip		
Knee		
Ankle		

4 Describe the anatomical position.
5 Using your knowledge of the anatomical terms of reference, select the correct option in relation to the bones of the human body.
  (a) The skull is (superior/inferior) to the sternum.
  (b) The scapula is found on the (anterior/posterior) side of the body.
  (c) Carpals are found at the (proximal/distal) end of the arm.
  (d) The fibula is on the (medial/ lateral) side of the body.
  (e) A situp is performed in the (prone/supine) position.

APPLY your understanding

6 **Practical activity:** Conduct the following activities, and identify and define the anatomical movement that is taking place.
  (a) The knee when kicking a football
  (b) The arm when performing a star jump
  (c) The shoulder during an underarm pitch
  (d) The shoulders during a volleyball dig
7 **Practical activity:** For each of the anatomical movements listed in table 2.2, demonstrate a sporting example that illustrates the movement.
8 **Practical activity: participating in a team sport such as netball or touch football**
  (a) List all the skills required to complete the activity successfully.
  (b) For each skill, identify:
    (i) the joints used and the type of each joint
    (ii) the anatomical movement performed.

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Interactivity
Joints
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CHAPTER 2 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:** **Discuss** — to go into detail about the characteristics of a key concept
- **Key terminology:** types of joints and anatomical movements (hinge, and ball and socket) and their anatomical movements (flexion, extension, adduction, abduction and rotation)
- **Key concept:** joints and anatomical movements — understanding the different types of joints (hinge, and ball and socket) and their anatomical movements (flexion, extension, adduction, abduction and rotation)
- **Marking scheme:** *4 marks* — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

- **1 mark:** similar — stated that both joints are freely moveable and synovial joints
- **1 mark:** difference — stated the difference between types of joints and anatomical movements
- **1 mark:** used key terminology — synovial joint, extension, flexion, rotation, abduction and adduction
- **1 mark:** demonstrated an understanding of the different types of joints and anatomical movement

KEY SKILLS

- Use and apply correct anatomical terminology to the working of the musculoskeletal system in producing human movement
- Perform, observe and analyse a variety of movements used in physical activity, sport and exercise to explain the interaction between bones, muscles, joints and joint actions responsible for movement

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- correct anatomical names for the major bones in the body
- understand how joints are classified
- understand, identify and explain the various types anatomical movements.

PRACTICE QUESTION

By referring to types of joints and anatomical movements, **discuss** the **similarities and differences** of the elbow and the shoulder joints *(4 marks)*.

Sample response

The elbow and shoulder joints are **similar as they are** both freely moveable and classified as synovial joints. The **differences are shown with the types of synovial joints and anatomical movements** as the hinge joint (elbow) only allows movement in one direction, flexion and extension, whereas the ball and socket (shoulder) joint allows a range of movements such as flexion, extension, abduction, adduction and rotation.

PRACTISE THE KEY SKILLS

1. Compare the gliding joint and condyloid joint.
2. State the name and type of bone in the:
   a. lower leg
   b. forearm.
3. Name the bones, joints and movements required to produce the body action of jumping.

KEY SKILLS EXAM PRACTICE

Complete the following table on types of synovial joints and anatomical movements.

Joint	Type of synovial joint	Anatomical movement/s
Shoulder		
Elbow	Hinge	Flexion, extension
Ankle		

4 marks

CHAPTER REVIEW

CHAPTER SUMMARY

Skeletal system

- The skeletal system has five main functions:
  - body movement
  - framework
  - protection
  - mineral storage
  - production of red blood cells.
- Bones act as levers and work with the muscular system to create movement.
- There are five types of bones: long bones, short bones, flat bones, irregular bones and sesamoid bones.
- The vertebral column provides the central structure for the maintenance of good posture.

Joints and anatomical movements

- The major joint types within the skeleton are:
  - fibrous (immoveable)
  - cartilaginous (slightly moveable)
  - synovial (freely moveable).
- Connective tissue includes cartilage, ligaments and tendons.
- Synovial joints are classified into six main types via the shape of the bones they articulate and the movements they allow:
  - ball and socket
  - hinge
  - pivot
  - saddle
  - gliding
  - condyloid.
- The anatomical position is standing erect, facing forward with arms by the sides and palms facing forward. Terms of reference help to describe where a body part is in relation to another body part.
- Anatomical movements include flexion, extension, abduction, adduction, circumduction, rotation, pronation, supination, eversion, inversion, dorsi flexion, plantar flexion, elevation and depression.

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Sit Topic Test

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Interactivity
Structure and functions of the skeletal system quiz
Searchlight ID: int-6622

MULTIPLE CHOICE QUESTIONS

1 From inferior to superior, the curvatures of the spine are the
(A) cervical, thoracic, lumbar, sacral, coccyx.
(B) coccyx, sacral, lumbar, thoracic, cervical.
(C) sacral, coccyx, lumbar, cervical, thoracic.
(D) cervical, thoracic, sacral, lumbar, coccyx.

2 The humerus joins with the radius and ulna to form a
(A) saddle joint.
(B) pivot joint.
(C) gliding joint.
(D) hinge joint.

3 Bones are attached to each other by
(A) ligaments.
(B) muscle.
(C) joints.
(D) cartilage.

4 Muscles are attached to bones by
(A) ligaments.
(B) tendons.
(C) connective tissue.
(D) joints.

5 Pushups are done in which position?
(A) Supine
(B) Lateral
(C) Superior
(D) Prone

6 The movement that causes the angle of the joint to decrease is
(A) abduction.
(B) flexion.
(C) extension.
(D) adduction.

7 The five main functions of the skeletal system are
(A) production of white blood cells, body movement, mineral storage, framework and protection.
(B) production of white blood cells, body movement, mineral production, framework and protection.
(C) production of blood cells, body posture, mineral production, framework and protection.
(D) production of red blood cells, body movement, mineral storage, framework and protection.

8 The tarsals of the foot are examples of a
(A) long bone.
(B) flat bone.
(C) short bone.
(D) sesamoid bone.

9 The two main types of bone tissue are
(A) hard bone and spongy bone.
(B) collagen bone and compact bone.
(C) compact bone and cancellous bone.
(D) spongy bone and solid bone.

10 The skeleton has three major joint types. They are classified as
(A) fibrous (freely movable), cartilaginous (slightly moveable) and synovial (immoveable).
(B) fibrous (slightly movable), cartilaginous (freely moveable) and synovial (immoveable).
(C) fibrous (immovable), cartilaginous (slightly moveable) and synovial (freely moveable).
(D) fibrous (freely movable), cartilaginous (immoveable) and synovial (slightly moveable).

EXAM QUESTIONS

Question 1

a. Name the anatomical movement responsible for raising the athlete up from the floor to the position shown in the picture. **1 mark**

b. Describe the type of anatomical movement required to raise the athlete up from the floor to the position shown in the picture. **1 mark**

Question 2

Discuss **one** function of the skeletal system. **2 marks**

Question 3

a. Describe the action of the elbow joint when the weight is lowered. **1 mark**

b. List the bones in the upper and lower arm that are involved in this movement. **2 marks**

Question 4

State the types of bones in the knee joint and upper leg. **2 marks**

Question 5

Use the diagram below of the skeletal system to answer the following questions.

a. Circle clearly and label an example of each of the following joint types. **4 marks**

i. saddle

ii. hinge

iii. ball and socket

iv. gliding

b. Select two of the above joint types and using arrows and words describe the types of movements possible at each joint. **2 marks**

Joint type 1: ______________________________

Movements possible: ______________________________

Joint type 2: ______________________________

Movements possible: ______________________________

INQUIRY QUESTION
How does the musculoskeletal system work together to produce movement such as in this chinup?

CHAPTER

3 Structure and functions of the muscular system

The skeletal and muscular systems work together to produce movement in physical activity, and one cannot function without the other. The different muscle fibre types, the range of muscle movements and how they are stimulated to move by the central nervous system are essential learning for the developing sportsperson.

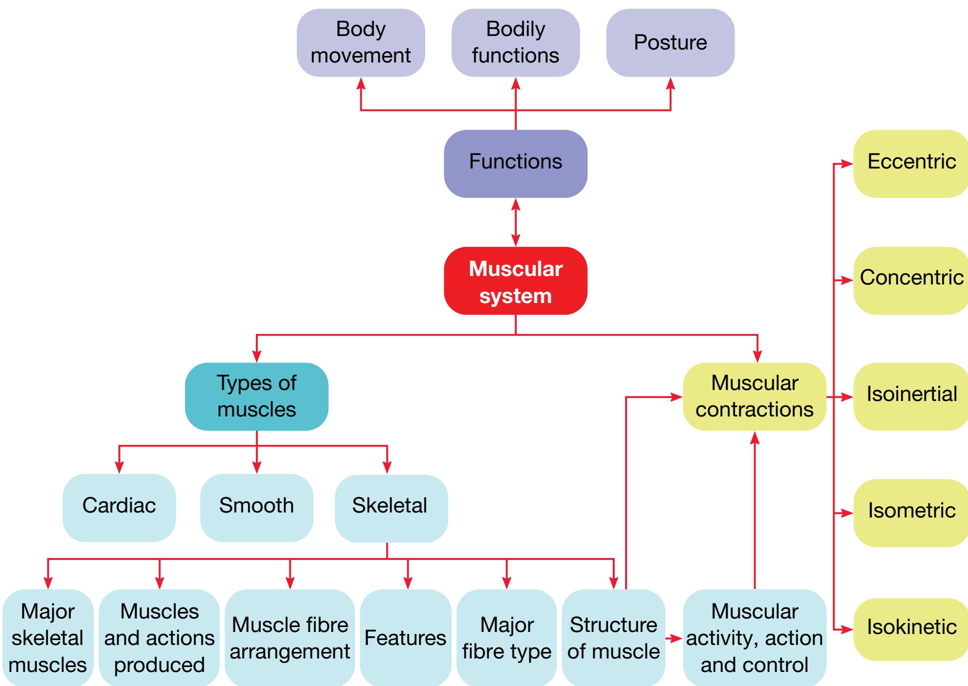
KEY KNOWLEDGE

- The major muscles of the human body
- Characteristics and functions of muscle fibres including fibre arrangement and type (fast-twitch and slow-twitch)
- Types of muscular actions (isoinertial, isometric and isokinetic)
- Agonists, antagonists and stabilisers, and the concept of reciprocal inhibition
- Control of muscles including the recruitment (size principle) and activation ('all or nothing' principle) of motor units in relation to force production
- Interactions of muscles and bones to produce movement in physical activity, sport and exercise

KEY SKILLS

- Use and apply correct anatomical terminology to the working of the musculoskeletal system in producing human movement
- Perform, observe and analyse a variety of movements used in physical activity, sport and exercise to explain the interaction between bones, muscles, joints and joint actions responsible for movement
- Describe the role of agonists, antagonists and stabilisers in movement
- Describe the relationship between motor unit recruitment, activation and force production

CHAPTER PREVIEW



3.1 The muscular system: functions, types and major muscle groups

KEY CONCEPT The muscular system allows a range of physical movements we can consciously or subconsciously control including body movement, posture and essential bodily functions. Each individual muscle has an important role and is responsible for assisting with everyday movements.

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Unit 1	**Types of muscle and their function** Concept summary and practice questions
AOS 1	
Topic 3	
Concept 1	

Functions of the muscular system

The human body has over 600 muscles. These muscles function to allow a range of physical movements that we either consciously or subconsciously control. These movements range from fine motor skills such as blinking an eye or writing, to gross body movements such as running or throwing a ball.

Body movement

All muscles that we can consciously control (**voluntary control**) are attached to bones. Such muscles are also known as voluntary muscles. The central nervous system sends a message to the relevant muscle, and then the muscle pulls the bones to allow the desired movement.

Voluntary control refers to conscious control of the muscle.

Adequate posture

Muscles are continually in a state of tone that affects their ability to help our body to maintain an upright posture when awake and to function safely during sleep. People with poor muscle tone generally have poor posture and resultant aches and pains because gravity is defeating the muscles' resistance. Muscles of the upper back — such as the trapezius, rhomboids and the latissimus dorsi — strongly influence posture maintenance. Regular exercise helps improve muscle tone, which allows resting muscles to resist being stretched and keeps them in constant readiness.

Essential bodily functions

Involuntary muscles are those over which we have little or no conscious control (**involuntary control**). They function continuously and preserve our ongoing body needs whether we are awake or not. The heart is a muscle over which we generally have little control, and muscular effort also controls our digestive and breathing demands.

Involuntary control refers to no conscious control of the muscle.

Types of muscle

Muscles can be classified into three main groups:

- smooth
- cardiac
- skeletal.

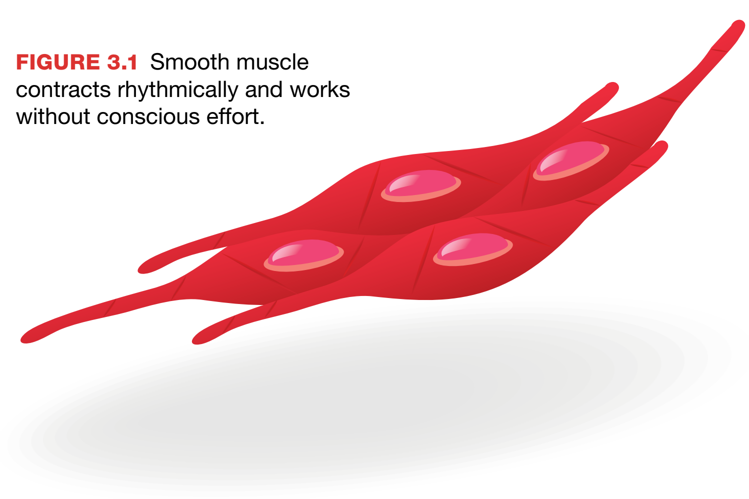

FIGURE 3.1 Smooth muscle contracts rhythmically and works without conscious effort.

Smooth muscle

Smooth muscle is found in hollow organs such as the walls of the digestive tract, the bladder and the blood vessels (figure 3.1). You have no conscious control over smooth muscle contractions (thus called 'involuntary'), which are slow, sustained and rhythmic. The contractions of the smooth muscle in the intestinal walls and stomach, for example, move food through the digestive tract. Such muscles fatigue more slowly than skeletal muscle.

Cardiac muscle

Cardiac muscle is found only in the heart. The muscle fibres are intertwined, which helps the heart push blood into arteries going to the lungs and other body tissues (figure 3.2). The heart is an involuntary muscle (although some people claim that they can make their heart beat faster or slower at will) and it is difficult to fatigue. When a nerve impulse arrives at the heart, the message is relayed from cell to cell, causing rhythmic contractions and relaxations.

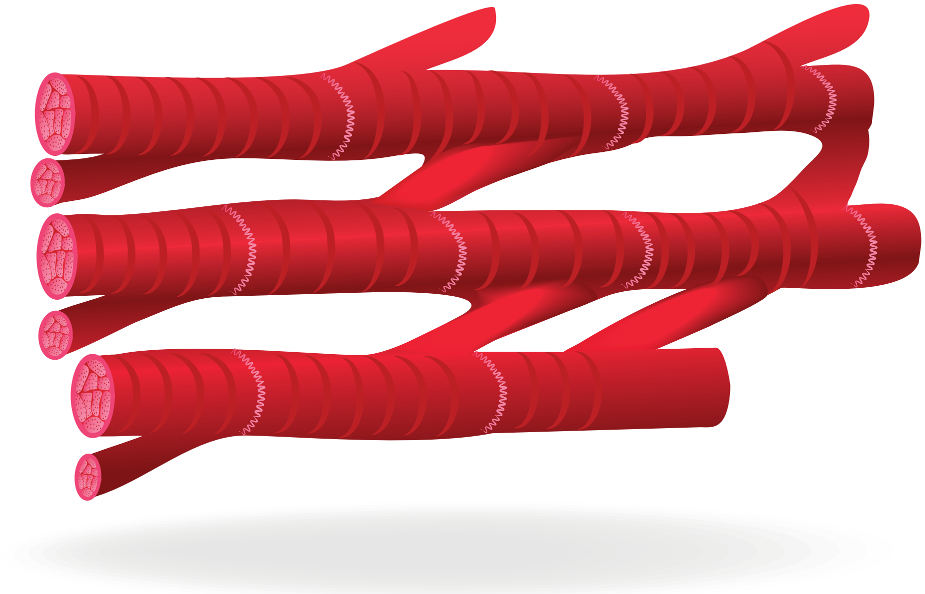

FIGURE 3.2 Cardiac muscle is a combination of the other two muscle types (smooth and skeletal).

Skeletal muscle

Skeletal muscle attaches to and causes movement of the skeleton. It is striated, meaning that it has a striped appearance (figure 3.3). Skeletal muscle is under voluntary control because you are consciously aware of the muscles and can control their contractions. The muscles may also take part in reflex actions, such as a knee-jerk reaction. If you want to throw a netball or kick a soccer ball, your brain sends a message to the muscles concerned and the required physical action results. As skeletal muscle is responsible for human movement, this muscle type will be the focus of the next section.

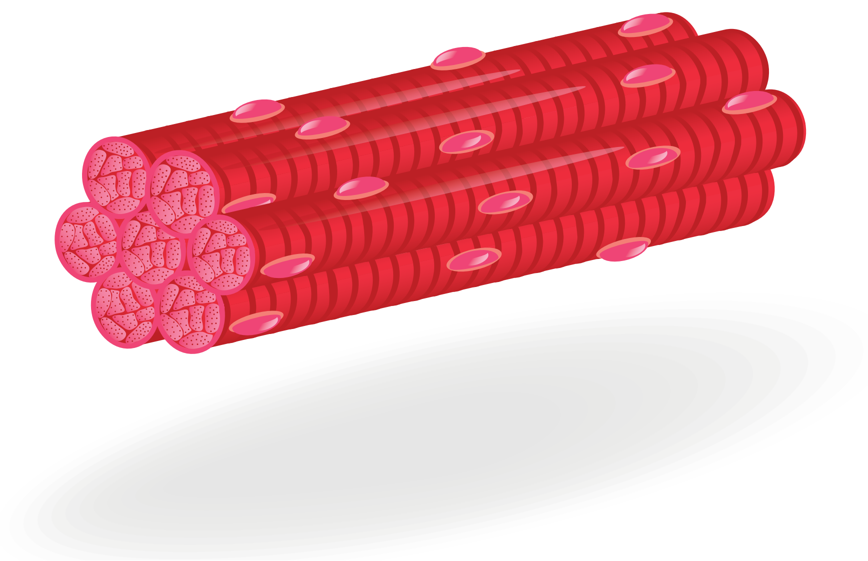

FIGURE 3.3 Skeletal muscle is under voluntary control, causing movement of the skeleton when activated.

Major skeletal muscles

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Interactivity
Muscles
Searchlight ID: int-6623

To be able to study body movements, it is important to identify the positions and actions of the major muscle groups of the body (figure 3.4 and table 3.1). Muscles are usually named according to their characteristics or locations. For example: the triceps, which has three points of origin; the pectoralis major, which is a large (major) muscle of the chest or pectoral region; and the quadriceps femoris, which consists of four separate muscles anterior to the femur.

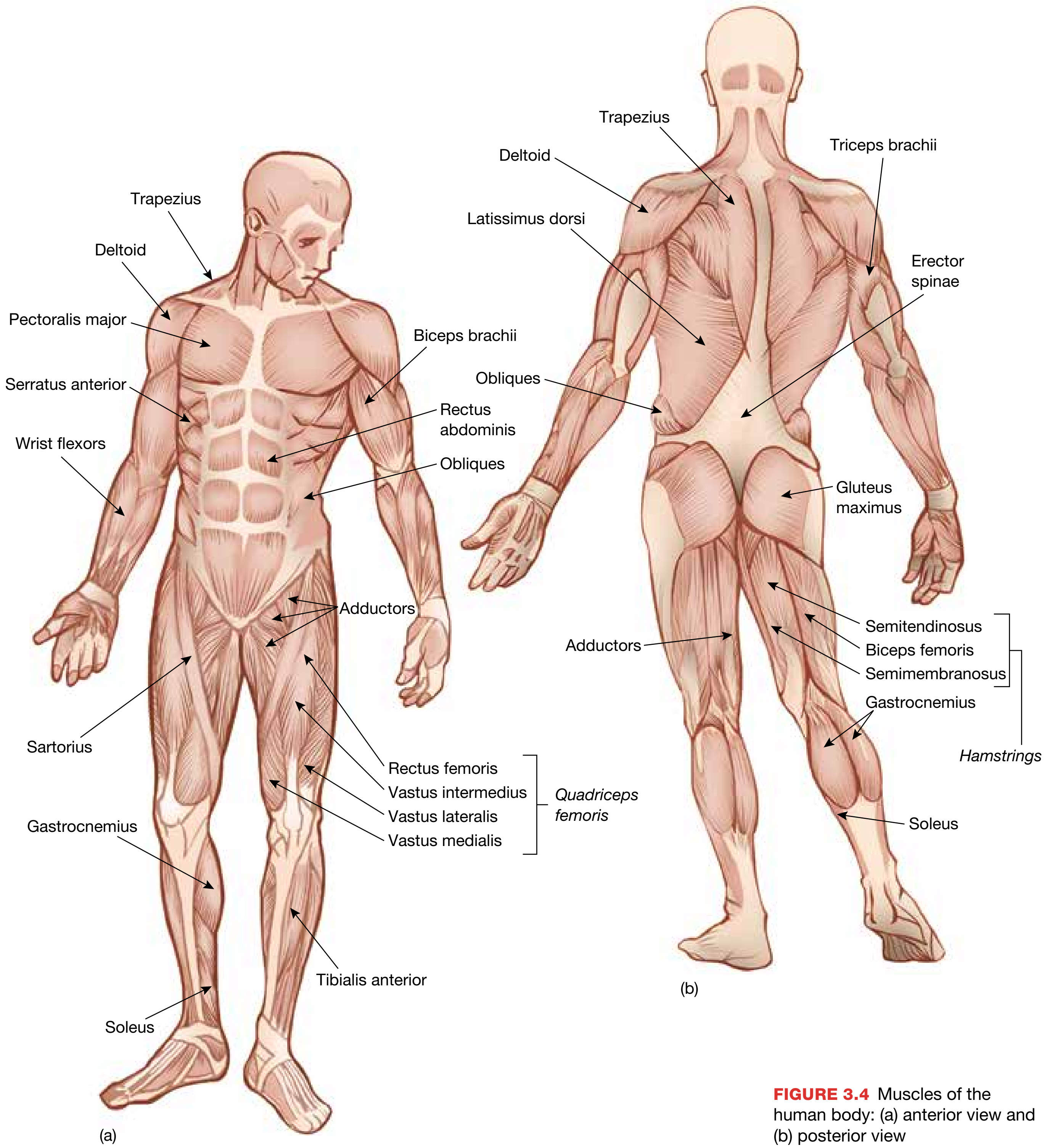

FIGURE 3.4 Muscles of the human body: (a) anterior view and (b) posterior view

TABLE 3.1 Major muscles and the actions they produce

Major muscle	Action	Example
Shoulder/chest — anterior		
Deltoid	Shoulder abduction Shoulder flexion Shoulder extension	Bowling in cricket
Pectoralis major	Shoulder flexion	Tennis forehand
Serratus anterior	Shoulder abduction	Boxing punch
Shoulder/back — posterior		
Trapezius	Scapula elevation	Shoulder shrug
Latissimus dorsi	Shoulder adduction	Butterfly stroke in swimming
Arm — anterior		
Biceps brachii	Elbow flexion	Pullup
Wrist flexors	Wrist flexion	Wrist curl
Arm — posterior		
Triceps brachii	Elbow extension	Throwing a javelin
Wrist extensors	Wrist extension	Squash backhand
Trunk		
Abdominals • Rectus abdominis • Obliques	 Trunk flexion Trunk flexion Trunk rotation	 Situp
Erector spinae	Trunk extension Trunk rotation	Gymnastics backflip
Pelvis — anterior/medial/posterior		
Sartorius	Hip flexion Knee flexion	Breaststroke kick
Adductors	Hip adduction	Riding a horse
Gluteus maximus	Hip extension Hip abduction	Running
Leg — anterior		
Quadriceps • Rectus femoris • Vastus lateralis • Vastus intermedius • Vastus medialis	 Hip flexion Knee extension Knee extension Knee extension	 Kicking/cycling Jumping Rock climbing
Tibialis anterior	Dorsi flexion	Freestyle kick
Leg — posterior		
Hamstrings • Biceps femoris • Semitendinosus • Semimembranosus	 All three muscles — hip extension and knee flexion	 Running
Gastrocnemius	Plantar flexion	Calf raises
Soleus	Plantar flexion	Ballet — toe point

TEST your understanding

1 Form a small group. Together, look closely at the image on page 32 at the start of this chapter and then:
   (a) make a list of the bones, muscles, joints and joint actions responsible for movement
   (b) explain how movement can occur using the musculoskeletal system.
2 Outline the three functions of the muscular system.
3 Name and describe the three types of muscle and identify if they are under voluntary or involuntary control.
4 Download the muscle chart from your eBookPLUS. Label the major muscles in the body.
5 List the major muscles of the following muscle groups:
   (a) hamstrings
   (b) quadriceps
   (c) abdominals.

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Digital document
Muscle chart
Searchlight ID: doc-1101

APPLY your understanding

6 **Practical activity: movements and muscles**
Complete the actions listed in the table below to determine the muscle responsible.

Movement created	Muscle responsible
Trunk flexion	
Shoulder adduction	
Elbow extension	
Hip flexion	
Shoulder elevation	
Trunk extension	
Ankle (dorsi) flexion	
Knee flexion	
Hip adduction	

7 **Practical activity: muscles creating movement**
With a partner, complete each movement/skill to determine the muscle involved.
   (a) wide-grip pushup (floor to straight arms)
   (b) situp
   (c) tennis serve
   (d) kicking a football
   (e) forward swing in baseball batting
8 **Practical activity: investigating the action of major muscles**
With a partner complete the following activities and record your results.
   (a) Jump upwards with a 60-centimetre take-off. What action occurs at the ankle joint?
   (b) Perform abduction of your arm. What is the major muscle moving your arm?
   (c) Complete ten situps. What muscles work hard during this action?
   (d) Perform horizontal flexion of your arms. What happens to your scapula?
   (e) Bend your elbow. What is the major moving muscle?
   (f) Extend your elbow. What is the major moving muscle?
   (g) Kick a ball. What action is performed by the quadriceps?

3.2 The muscular system: features, arrangement and microscopic structure

KEY CONCEPT Skeletal muscles all have features that distinguish what they can do; in particular, movements that they make and force they can generate. It is important to understand the microscopic structure of skeletal muscle and how these structures assist with creating movement.

Common features of muscles

Most muscles have certain common features:

- Nervous control — nerve stimuli control muscle action.
- Contractility — muscles contract and become thicker.
- Extensibility — muscles have the capacity to stretch when a force is applied.
- Elasticity — muscles can return to their original size and shape once stretched.
- Atrophy — muscles can decrease in size (waste) as a result of injury, illness or lack of exercise.
- Hypertrophy — muscles can increase in size (growth) with an increase in activity.

Muscle fibre arrangement

Muscle fibres are organised in different ways according to the shape (or arrangement) and function of the muscles (figure 3.5). The main arrangements of major skeletal muscles used in physical activity include fusiform, pennate and radiate muscles.

studyon
Unit 1
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Concept 2
Muscle fibre arrangement
Concept summary and practice questions

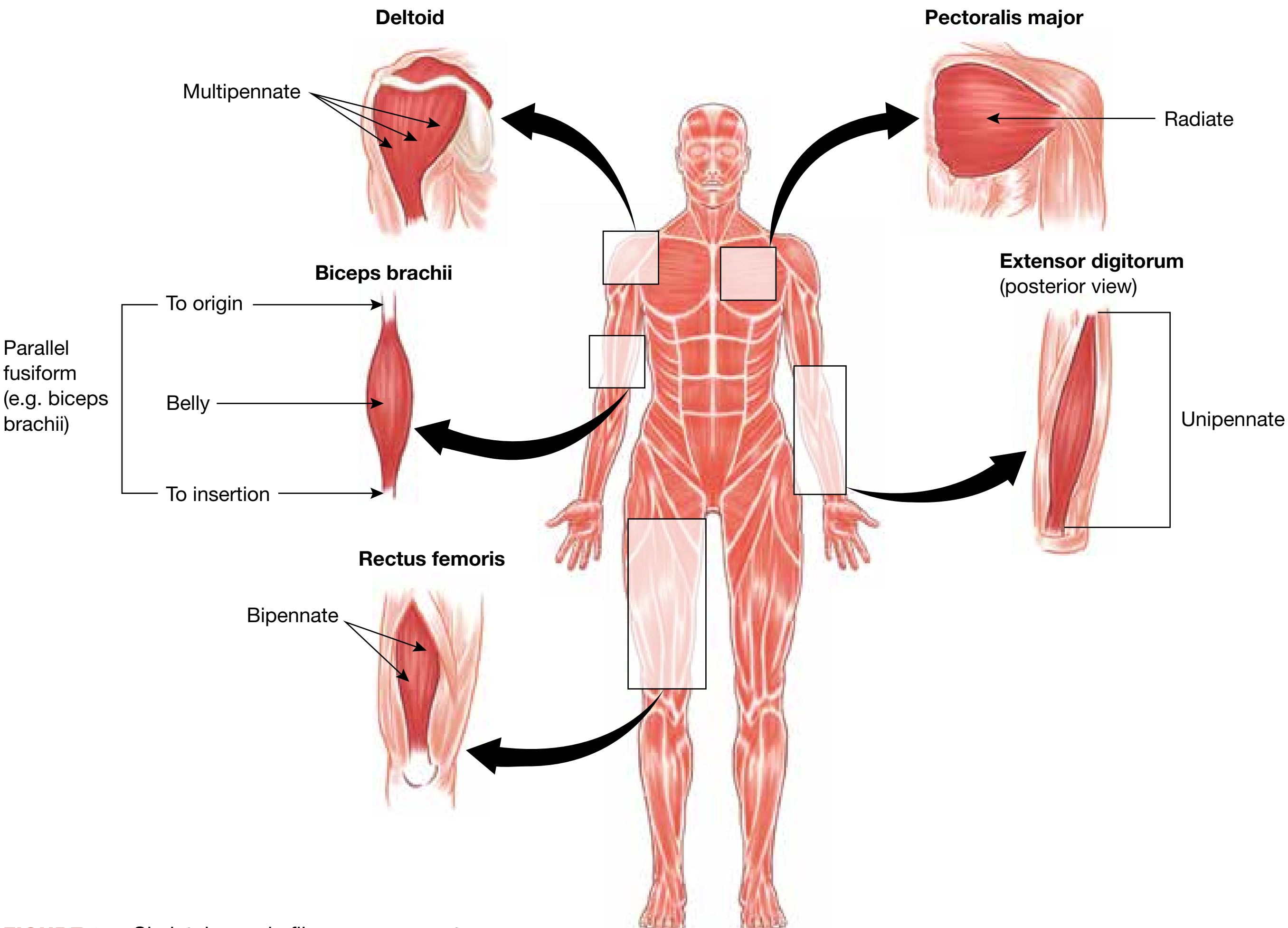

FIGURE 3.5 Skeletal muscle fibre arrangement

Fusiform muscles

Fusiform muscle fibres run the length of the muscle belly. They are designed for mobility because they produce contractions over a large range, yet they produce low force (e.g. sartorius and biceps).

Pennate muscles

Pennate muscle fibres run at angles to the tendons. These muscles do not provide as much mobility as do fusiform muscles because they are designed for strength and power. There are three categories of pennate muscles:

- unipennate muscles — fibres are only found on one side of a central tendon (e.g. the semimembranosus in the hamstrings and the tibialis anterior)
- bipennate muscles — fibres run off either side of a central tendon (e.g. the rectus femoris in the quadriceps)
- multipennate muscles — fibres branch out from several tendons (e.g. the deltoid). This arrangement enables the body to generate the greatest force.

Radiate muscles

Radiate muscle fibres radiate from the main tendon. These muscles are a compromise between fusiform and pennate muscles because they are capable of producing strength and power while retaining their mobility (e.g. the pectoralis major).

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Structure of skeletal muscles

Skeletal muscle is covered with a layer of connective tissue called the epimysium. The epimysium thickens as it reaches the ends of the muscle to form tendons that usually attach to bone.

Skeletal muscle consists of thousands of muscle fibres that run the length of the muscle and are arranged in bundles called fasciculi. (A single bundle is called a fasciculus.) Each individual muscle fibre is surrounded by connective tissue called the endomysium, which binds the fibres together to form the bundles. The fasciculi are surrounded by a layer of connective tissue called the perimysium, which helps bind the fasciculi together (figure 3.6).

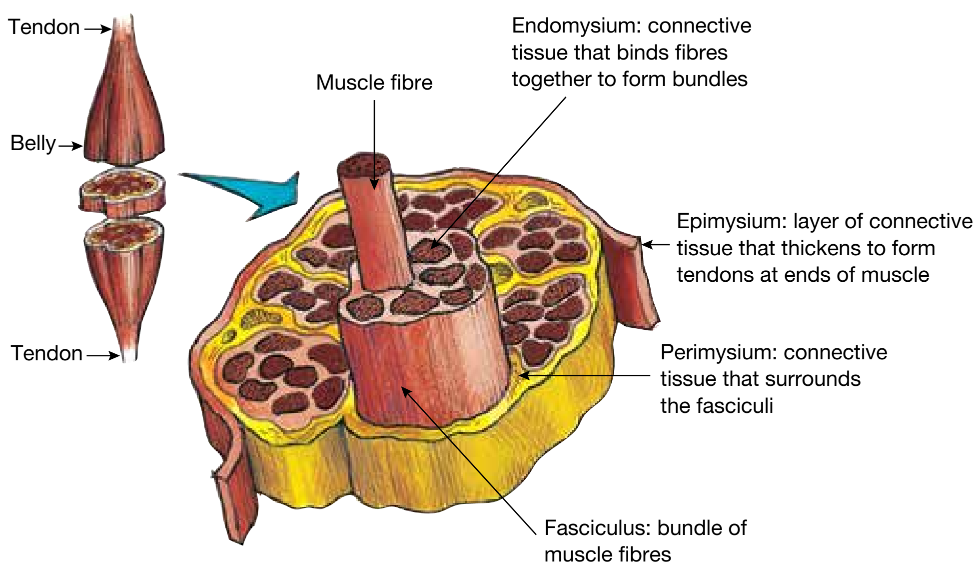


FIGURE 3.6 The muscle belly in cross-section

The muscle fibre

Each muscle fibre is surrounded by a cell membrane called the sarcolemma. Underlying the sarcolemma is a gel-like fluid called sarcoplasm. This fluid contains:

- mitochondria, which are the site of aerobic energy production
- myoglobin, which carries oxygen to the mitochondria
- fat, carbohydrate and protein (energy nutrients)
- adenosine triphosphate (an immediate energy source)
- enzymes, which are chemicals that speed up energy production
- actin and myosin myofilaments (contractile proteins).

Each muscle fibre is made up of long strands called myofibrils. Each myofibril consists of many individual units, called sarcomeres, which are responsible for contracting the muscle.

Sarcomeres

A **sarcomere** is a contractile unit, and each one is designated by a line at either end called a Z line. Each sarcomere consists of two protein myofilaments called actin and myosin. Actin is a thin filament that attaches to the Z line. Myosin is a thick filament situated between each of the actin filaments. Figure 3.7 illustrates the several bands and zones that help define the sarcomere:

- the I band, where only actin is found
- the A band, where both actin and myosin are found. It equates with the length of the myosin filaments.
- the H zone, where only myosin is found. It is the gap between the ends of the actin.

A **sarcomere** is the smallest unit of muscle contraction.

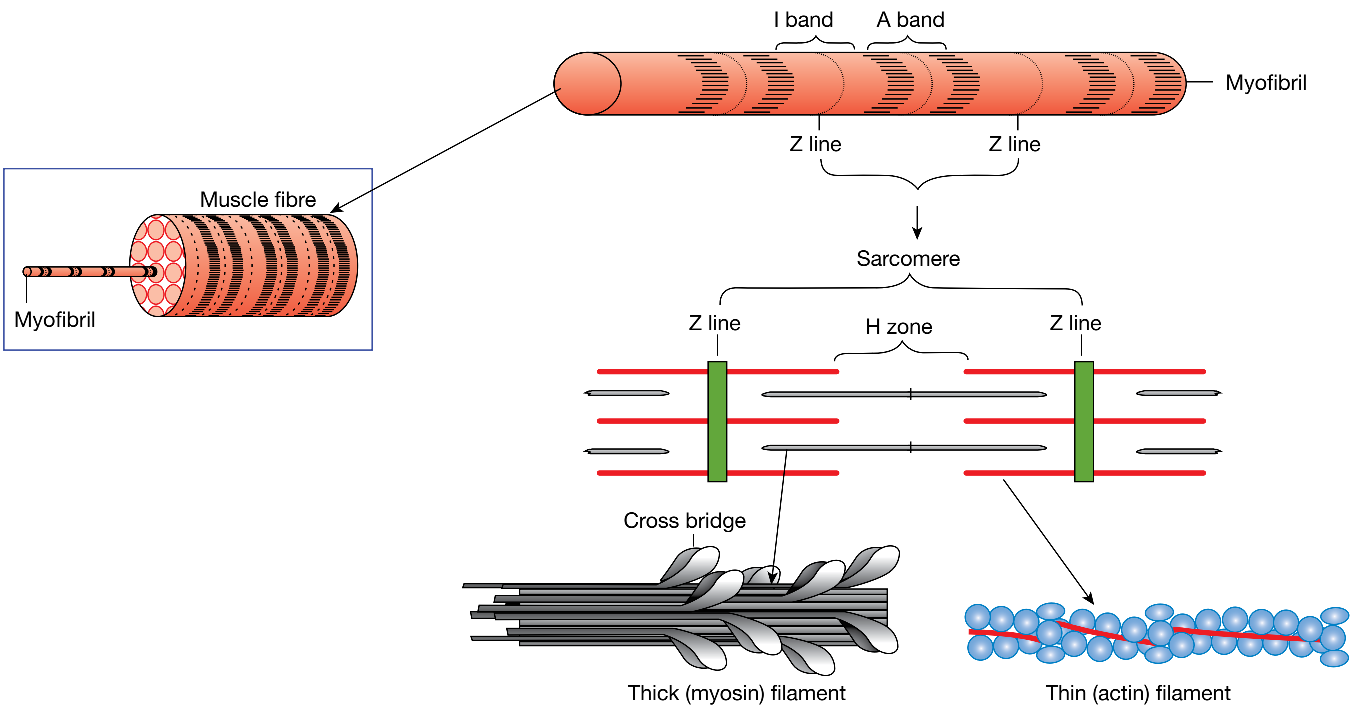


FIGURE 3.7 Arrangement of sarcomeres within the muscle fibre

Cross bridges

The myosin filaments have cross bridges (oar-like structures) that are attracted to the actin filaments (figure 3.7).

- At rest, there is little contact between the actin and the myosin.
- When a nerve impulse arrives at the neuromuscular junction, calcium is released.
- In the presence of calcium, the myosin filaments can now attach to the actin.

- The breakdown of ATP enables the cross bridges to attach to the actin filaments and pull them into the centre of the sarcomere in a 'rowing' action (figure 3.8) and the sarcomere contracts.
- The cross bridges continue to detach and reattach themselves from the actin filaments, shortening the sarcomere.
- The structural rearrangement of actin and myosin filaments change whereby Z lines move closer together, the I band reduces in width, the A band remains the same length and the H zone may disappear.
- Every sarcomere along the muscle fibre shortens, leading the whole muscle to contract.
- The muscle will relax when the actin and myosin filaments lose contact with each other — that is, when the cross bridges detach from the actin.

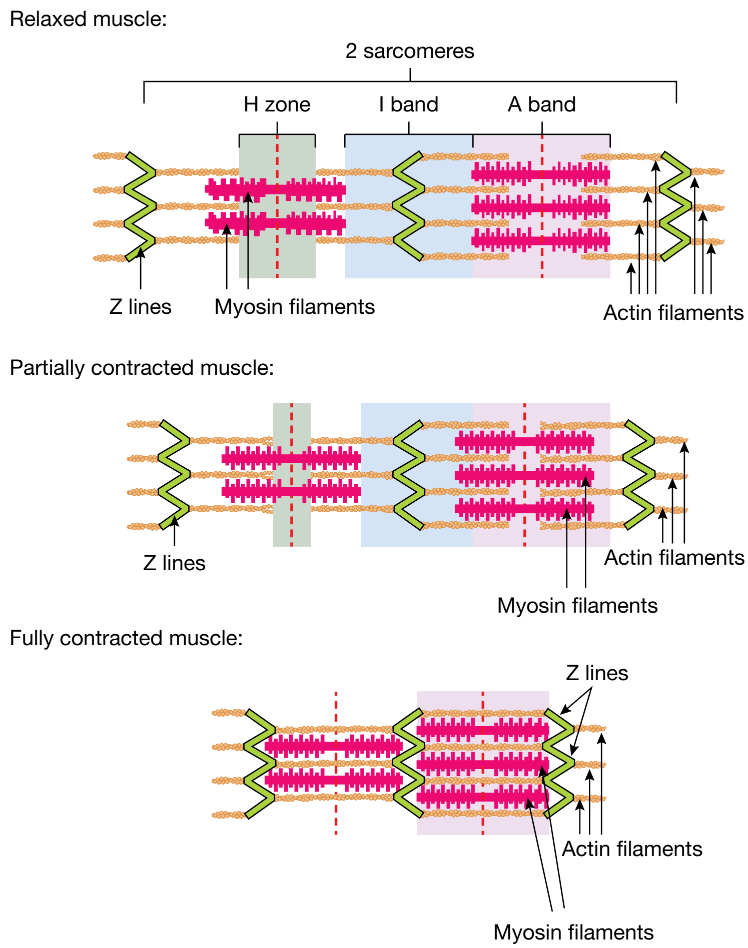


FIGURE 3.8 Structural rearrangement of actin and myosin filaments at rest and during contraction

Source: Adapted from Powers S & Howley, E 2004, *Theory and application to fitness and performance*, 5th edn, © McGraw-Hill Companies, Inc. and IvyRose Ltd, 2005, www.IvyRose.co.uk.

Muscle tone

Not all the myosin filaments detach themselves from the actin. Some may stay in contact, so the muscle is never completely relaxed — the muscle is then said to have 'tone'. The advantage of muscle tone is that the actin and myosin are already partly connected, so they can be activated quickly when a muscle contraction is ready to occur. It also helps us to maintain good posture and look good!

TEST your understanding

1 Outline the main features of all muscles.
2 The deltoid is an example of a muscle that displays a multipennate fibre arrangement. Explain why multipennate muscles produce greater force than fusiform muscles.
3 Name the two protein myofilaments, and identify where they are found and which filament attaches to the cross bridges.
4 Explain muscle tone and the advantage of having it.
5 Explain what happens to the following structures in a sarcomere during a muscle contraction. Draw a picture to illustrate your explanation.
   (a) Z lines
   (b) A band
   (c) I band
   (d) H zone

APPLY your understanding

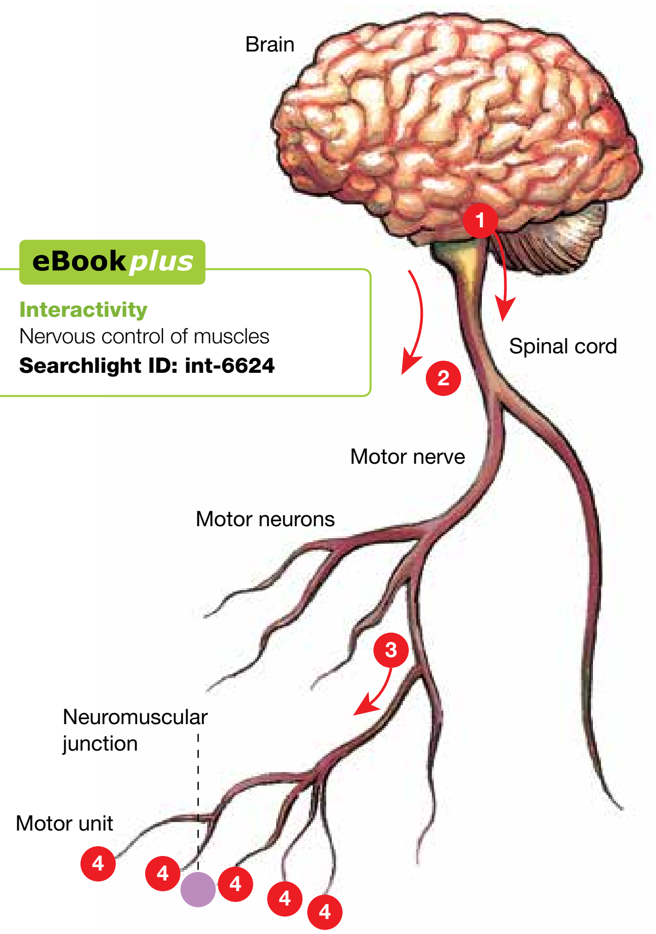
6 **Practical activity: participate in a weight-training session**
For each exercise you complete in your weight-training session, identify:
- the muscle being used
- the muscle fibre arrangement of that muscle
- the action performed by that muscle.

Write your results in a table similar to the one shown below.

Exercise	Muscle	Muscle fibre arrangement	Action
Bicep curl	Bicep	Fusiform	Flexion

3.3 The muscular system: initiation of muscular activity, action and control

KEY CONCEPT Muscles create movement by pulling on the bones to which they attach. In order to do this, messages are sent from the brain to the muscles to initiate movement. Muscles work in pairs to produce coordinated movements.



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Interactivity
Nervous control of muscles
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Stages of nervous control of muscle action

1. Brain initiates message.
2. Nervous impulse branches from spinal cord to motor nerve.
3. Message passes into motor neurons.
4. Message branches off to arrive at all muscle fibres controlled by that nerve; travels across gap at neuromuscular junction (aided by acetylcholine) and all connected muscle fibres contract.

FIGURE 3.9 Nervous control of muscular movement

A **motor unit** consists of one motor neuron and the muscle fibre it stimulates. (Each neuron may stimulate a number of muscle fibres.)

Nervous control of muscles: initiation of muscular activity

- To enable conscious control of muscles, the brain must send electrical nervous messages to the muscle.
- These messages or signals travel down the spinal cord to the motor nerves that branch from the spinal cord to the relevant muscles.
- Leaving the spinal cord, the motor nerve separates into smaller motor neurons that then divide a number of times to attach to individual muscle.
- Where the nerves meet the muscle fibres, there is a gap (called a neuromuscular junction or the synaptic cleft) across which the nerve impulse has to travel.
- A neurotransmitter, which is a chemical compound called acetylcholine, helps the nerve impulse make this jump.
- The muscle will continue to contract for as long as the brain sends messages and the relevant energy sources last (figure 3.9).

Motor units

The number of fibres within each **motor unit** varies according to the precision of the movement required. Generally, muscles (such as those in your hand) that perform precise, controlled movements such as writing, typing or throwing darts have small motor units, where one motor neuron may be responsible for stimulating only a few fibres. Muscles such as the quadriceps that perform gross movements such as running or kicking a ball have large motor units, where one motor neuron may stimulate thousands of fibres (figure 3.10).

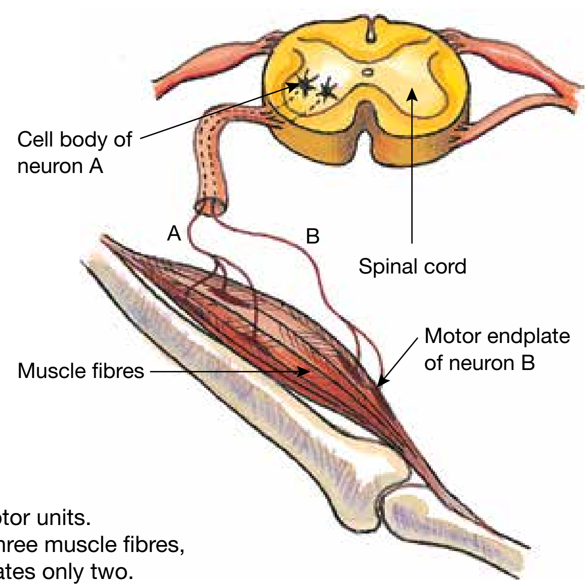

FIGURE 3.10 Two motor units. Neuron A stimulates three muscle fibres, while neuron B stimulates only two.

Henneman principle (size principle)

The **Henneman principle**, which is also known as the **size principle**, states that the recruitment of motor units within a skeletal muscle commences with small motor units to large motor units. Small motor units are recruited first at low muscle forces, for example walking. An increase in muscle force, from walking to sprinting, leads to an increase of larger motor units.

Characteristics of small motor units are:

- slow contracting
- easily excitable and recruited
- fatigue resistant
- utilised for prolonged activities (walking, posture control).

Characteristics of large motor units are:

- fast contracting
- less easily excitable and recruited
- rapidly fatigable
- utilised for high force activities (sprinting, hitting, jumping).

The **size (Henneman) principle** states that the recruitment of motor units in skeletal muscles starts with small motor units to large motor units.

Motor unit activation and force production

Each person's muscle strength reflects their ability to produce force to overcome a load or to produce a movement. The development of muscle force is dependent on a number of factors:

- number and type of motor units activated
- size of the muscle
- initial length of muscle that is being activated
- angle of the joint
- the muscle's speed of action.

More force can be generated with more motor units activated. Fast-twitch (FT) motor units produce more force due to each FT motor unit having a larger cell body and more axons and innervates from 300 to 800 muscle fibres. Conversely, a slow-twitch motor unit has a small cell body and innervates from 10 to 180 muscle fibres. Large muscles have more muscle fibres so can produce more force than smaller muscles.

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Initiation of muscle activity Concept summary and practice questions

Strength of muscular contraction

Skeletal muscles can generate a range of contractions varying from strong maximal contractions to complete relaxation. However, for a contraction to occur, there must be a strong enough nerve impulse to innervate (stimulate) the muscle fibres.

The 'all or nothing' principle

The **'all or nothing' principle** states that the nerve impulse will not stimulate the muscle fibres until it reaches a certain threshold level. Once the nerve impulse reaches this threshold, all fibres of the motor unit will contract at the same time and maximally. If the impulse is too weak, no fibres will contract at all. However, the intensity of muscular contractions can vary in two ways.

- By varying the number of motor units stimulated. Not all the motor units within a muscle need to be recruited at one time for a muscle contraction. If you require a large degree of strength (e.g. lifting a heavy weight), then more nerve impulses are sent, activating more motor units and therefore contracting more muscle fibres. If you require a minimal degree of strength (e.g. putting a golf ball), then fewer impulses are sent, contracting fewer fibres.
- By varying the frequency at which the impulses arrive at the motor unit. The greater the frequency of nerve impulses, the greater the contractions in the muscle. If you require a large degree of strength (e.g. for performing a vertical jump), then impulses will be sent at a faster rate to the muscles involved.

The **'all or nothing' principle** states that if the nerve impulse meets a certain threshold, maximal action occurs in the muscle fibre. If the stimulation is less than threshold, no muscle action occurs in the muscle fibre.

Skeletal muscle action and control

Muscle action

Skeletal muscles create movement by pulling on the bones to which they are attached. They have a more rigid attachment to a bone at one end, and they are attached across a joint to another bone that is usually more moveable.

The **origin** is the fixed point of attachment that is closer (or proximal) to the body's midline.

The **insertion** is usually attached to the bone that moves most when the muscle contracts. It is further (or distal) from the body's midline.

Muscle origin

- The muscle's point of attachment to the more stationary bone is called the **origin** (or the fixed end) and tends to be closer (or more proximal) to the main mass of the body. The origin of a muscle is often quite widespread because it helps 'anchor' the muscle.

Muscle insertion

- The muscle's more moveable point of attachment is called the **insertion** (the moving end) and tends to be located away (or more distal) from the mass of the body. It usually attaches to the bone near the joint that is to be moved by the muscle, and adheres in most cases by means of a strong non-elastic tendon (figure 3.11).

Muscle contraction

- When a muscle contracts, the origin and insertion are drawn together, shortening the muscle. The bones attached to the muscle produce movement in a specific direction. This movement is called the muscle's action. For example, the action of raising your arm by your side (abduction) is caused by the contraction of the deltoid muscle, where the insertion of the muscle at the humerus moves towards the muscle's origin at the scapula.

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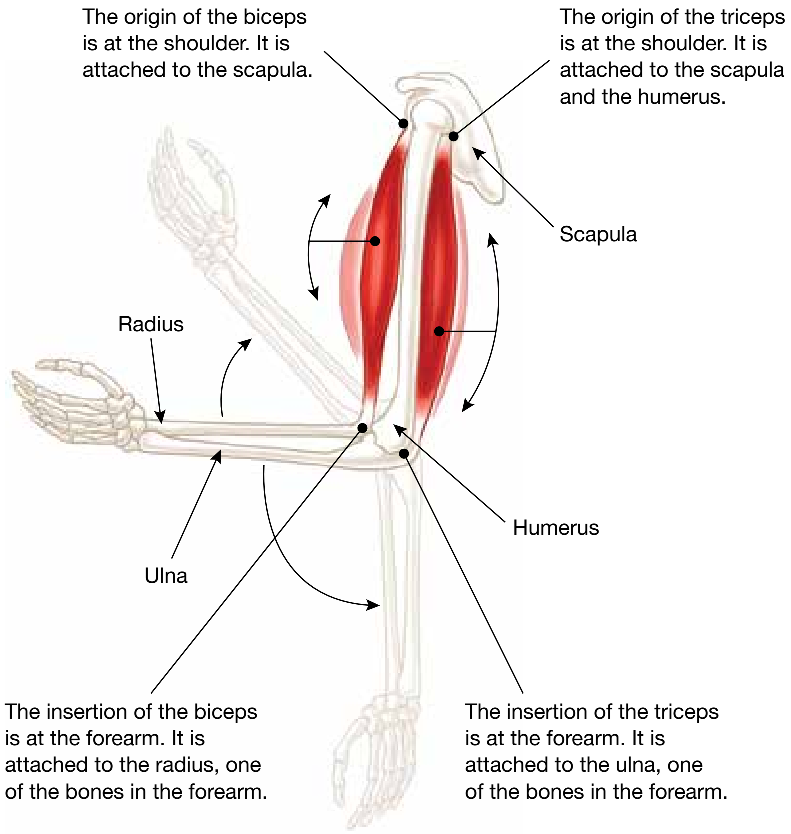

FIGURE 3.11 Skeletal muscles — insertions and origins

Muscle control

Skeletal muscles work in pairs or groups to produce movement — that is, as a muscle contracts on the front side of the body (anterior), usually the muscles at the back (posterior) with the opposite action relax. For example, when the quadriceps muscle group (anterior) contracts to kick a football or to push from the ground when acceleration is required during a team game, the hamstrings muscle group (posterior) must relax or stretch.

During a particular movement, a muscle performs one of the following four roles:

- **agonist** (or prime mover). This muscle causes the major action. There is usually more than one prime mover in a joint action, and there are prime mover muscles for all moveable joints.
- **antagonist**. This muscle must relax and lengthen to allow a movement to occur. It causes an opposite action to that caused by the agonist. Generally, muscle flexors and extensors work in an agonist–antagonist relationship. For example, when a person bends their elbow, the flexor (biceps) is the agonist while the extensor (triceps) is the antagonist. These roles can be reversed. For example, when a person straightens their elbow (as when serving in tennis), the extensor (triceps) is the agonist while the flexor (biceps) is the antagonist. This pairing of actions can also be seen with other movements such as adduction and abduction.
- **synergist** (or assistant). This muscle assists the agonist to produce the required movement to reduce any excessive or unnecessary movements. During elbow flexion, for example, the biceps is the agonist and it is assisted by the brachialis and brachioradialis.
- **stabiliser** (or fixator). These muscles ensure that the joint remains stable while the agonist and antagonists are working. The muscle will shorten just slightly during contraction, causing only minimal movement to allow the action to be performed more effectively. When someone shoots a goal in netball, for example, the abdominals and the erector spinae muscles contract to stabilise the body and to enable the arms and shoulders to perform the skill.

Coordinated movement

The process of the agonist muscle contracting and its opposing muscle, the antagonist, relaxing is called **reciprocal inhibition** (figure 3.12). Efficient movement involves a process of give and take on each side of the joint. When you perform major movements such as kicking a soccer ball, a coordinated sequence of these muscle actions must occur. This depends on the nervous system, because the muscles need to be stimulated to contract in the proper sequence with exact timing and with the most appropriate degree of force to provide a smooth, controlled movement. This is why beginners at a task often appear jerky — for example, either overhitting or underhitting a ball.

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How muscles work

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Muscle control roles
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The **agonist** is the muscle that causes the major action (prime mover).

The **antagonist** is the muscle that relaxes and lengthens to allow movement to occur.

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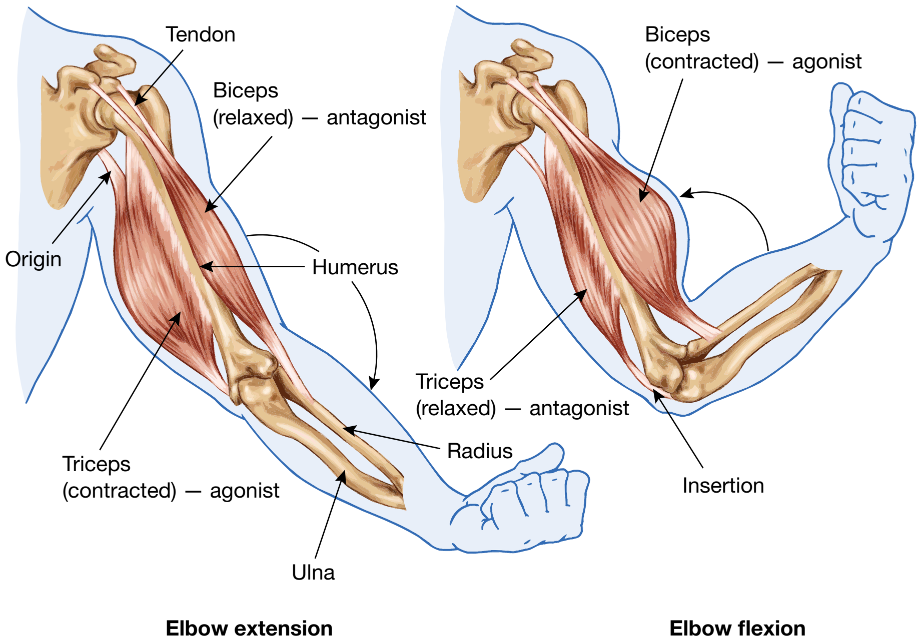
Interactivity
Muscle action: agonist and antagonist
Searchlight ID: int-6627

The **synergist** is the muscle that assists the agonist to produce the required movement.

The **stabiliser** is the group of muscles that ensure that the joint remains stable during movement.

Reciprocal inhibition is the process of one muscle contracting (agonist) while the other muscle relaxes (antagonist) to create movement.



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Interactivity
Flexion and extension
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FIGURE 3.12 Reciprocal inhibition: when one muscle is contracting, the opposite muscle in the pair is relaxing.

TEST your understanding

1 Describe how a nervous impulse moves from the brain to a muscle site to initiate a movement.

2 Define the term *motor unit*. Discuss the differences in amount of fibres of each motor unit.

3 Describe the following principles:
(a) 'all or nothing' principle
(b) Henneman (size) principle.

4 Explain the difference between origin and insertion. Provide an example.

5 Define the following terms:
(a) agonist
(b) antagonist
(c) synergist
(d) stabiliser.

6 Explain the process of reciprocal inhibition. Provide an example of a muscle pair that clearly demonstrates this process.

APPLY your understanding

7 Practical activity: reciprocal inhibition with movements
In pairs, conduct each movement and state the agonist and antagonist muscle in each exercise.
(a) a pushup
(b) a chinup with hands facing towards you
(c) a chinup with hands facing away from you
(d) a biceps curl in weight training
(e) a bench press in weight training
(f) a leg extension in weight training
(g) an upright row in weight training
(h) a half squat in weight training
(i) accelerating from the blocks in an athletic sprint
(j) the full rowing movement when rowing
(k) a forehand in tennis
(l) shooting for goal in netball
(m) a hockey penalty stroke
(n) moving from standing to sitting
(o) throwing a cricket ball from the boundary to the 'keeper'.

8 Practical activity: action muscles in sport
Participate in a sport or recreational activity of your choice.
(a) List four different body movements used in the activity.
(b) Sketch each movement. These may be your best artwork or simple but clear stick figures. Use one A4 page for each drawing.
(c) Identify the agonist muscles and the antagonist muscles for each movement.

9 Practical activity: free weights
(a) Working in pairs, select five exercises from the following list of free weight exercises: calf raise, leg curl, leg extension, squat, situp, lat pulldown, bench press, bicep curl, tricep extension.
(b) For each exercise you need to:
  (i) identify one joint that is moving
  (ii) identify the movement that is occurring at the joint in the first stage of the movement
  (iii) identify the agonist muscle contracting
  (iv) identify the antagonist muscle (opposing muscle that is relaxing).

3.4 The muscular system: muscle fibre types and muscular contractions

KEY CONCEPT Muscles consist of slow-twitch and fast-twitch fibres. These fibres are suited to certain types of physical activity and assist with an athlete's capacity to create forceful or sustained muscle contractions. Muscular contractions can be concentric, eccentric, isoinertial, isokinetic or isometric.

Muscle fibre types

There are two distinct types of muscle fibres within the body's muscular system: fast-twitch fibres, and slow-twitch fibres. The relative proportions of these fibre types are genetically determined, but on average most muscles contain about 50 per cent of each fibre type (i.e. 50 per cent fast-twitch and 50 per cent slow-twitch). Each fibre is better suited to a different intensity of physical activity.

Fast-twitch fibres can be further categorised into two types on the basis of various structural and functional characteristics, so that skeletal muscle fibres can now be classified into three types (table 3.2):

- type 1 slow-twitch oxidative fibres
- type 2A fast-twitch oxidative fibres
- type 2B fast-twitch glycolytic fibres.

FIGURE 3.13 Female body builders develop their fast-twitch muscle fibres to a high degree.

Type 1 muscle fibres

Characteristics of type 1 muscle fibres:

- slow-twitch oxidative
- contain large amounts of myoglobin, and large numbers of mitochondria and blood capillaries
- red, split ATP (adenosine triphosphate, the basic source of energy for muscle cell metabolism and movement) at a slow rate and have a slow contraction velocity
- are very resistant to fatigue, and have a high capacity to generate ATP by oxidative metabolic processes
- are suited to low-intensity, longer duration, aerobic work.

Athletes who have a larger proportion of slow-twitch fibres are suited to events such as marathons, triathlons, long-distance cycling and cross-country skiing.

Type 2A muscle fibres

Characteristics of type 2A muscle fibres:

- fast-twitch oxidative
- contain an large amount of myoglobin, and large numbers of mitochondria and blood capillaries
- pinkish in colour and have a very high capacity for generating ATP by oxidative metabolic processes
- split ATP at a very rapid rate, have a fast contraction velocity
- are relatively resistant to fatigue
- are classed as partially aerobic and are suited to events that require both aerobic and anaerobic elements.

Athletes who have a larger portion of type 2A fast-twitch fibres are suited to events such as middle-distance running and swimming.

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Muscle fibre types Concept summary and practice questions

Type 2B muscle fibres

Characteristics of type 2B muscle fibres:

- fast-twitch glycolytic
- contain a low myoglobin content, relatively few mitochondria and blood capillaries, and large amounts of glycogen
- white and are geared to generate ATP by anaerobic metabolic processes

- fatigue easily
- split ATP at a fast rate, and have a fast contraction velocity
- suited to high-intensity, short-duration, anaerobic work.

Athletes who have a larger proportion of type 2B fast-twitch fibres are suited to events that require explosiveness such as sprinting, throwing and weight-lifting.

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Interactivity
Characteristics of fast- and slow-twitch muscle fibres
Searchlight ID: int-6628

TABLE 3.2 Characteristics of fast- and slow-twitch muscle fibres

Characteristic	Slow-twitch	Fast-twitch oxidative	Fast-twitch glycolytic
Also known as	Type 1	Type 2A	Type 2B
Colour	Red	Pinkish	White
Used for	Aerobic	Anaerobic (long-term)	Anaerobic (short-term)
Fibre size	Small	Medium	Large
Motor neuron size	Small	Large	Very large
Resistance to fatigue	High	Medium	Low
Force production	Low	Medium	High
Speed of contraction	Slow	Fast	Very fast
Hypertrophy potential	Low	High	High
Mitochondrial density	High	High	Low
Capillary density	High	High	Low
Myoglobin content	High	High	Low
Oxidative capacity	High	Medium	Low
Glycolytic capacity	Low	High	High
Major fuel	Triglycerides	Creatine phosphate/glycogen	Creatine phosphate/glycogen

FIGURE 3.14 Rohan Dennis, time trial winner of the 2015 Tour de France and hour-record holder at the Velodrome Suisse, has a high percentage of slow-twitch fibres in his leg muscles. These help him to excel in endurance events.

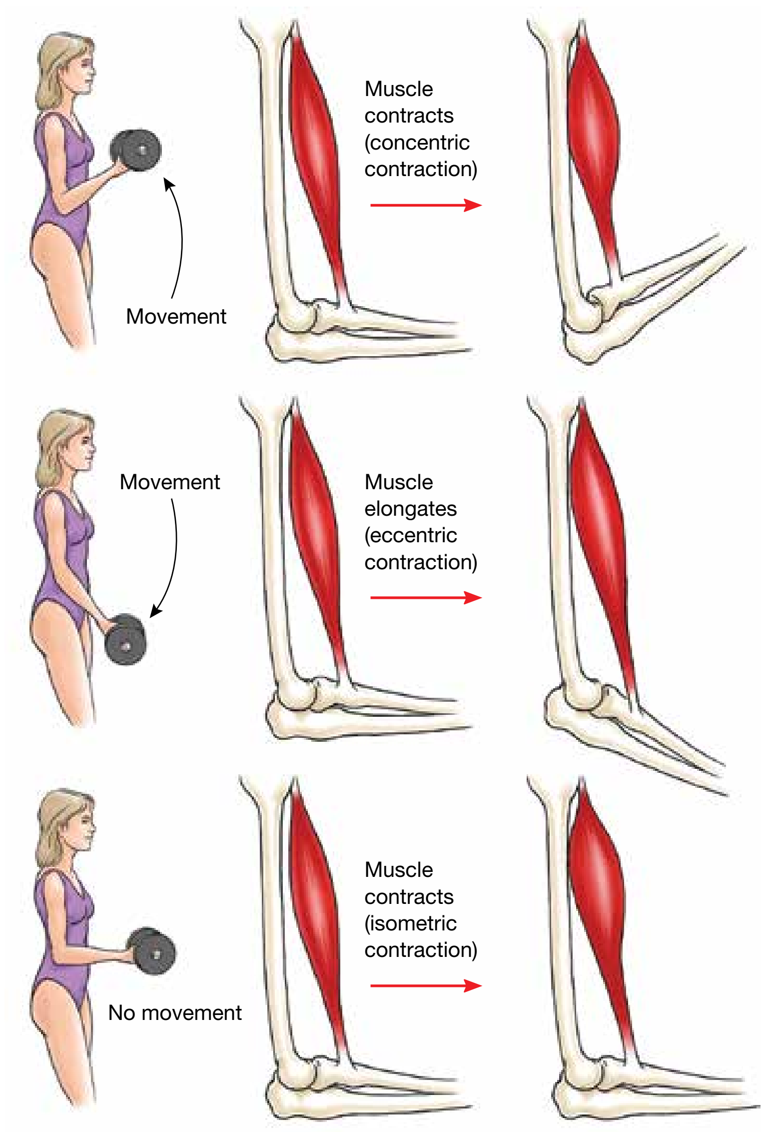
Types of muscular contraction

Muscle contractions are classified according to the movement they cause:

- dynamic — mechanical work is performed and joint movement is produced
- static — no mechanical work is performed and joint position is maintained.

There are five types of muscular contraction classified under the dynamic and static categories:

- Dynamic — concentric, eccentric, isoinertial and isokinetic
- Static — isometric.



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Types of muscular contraction Concept summary and practice questions

FIGURE 3.15 For flexion at the elbow, the weight of the dumbbell must be overcome (isoinertial), the biceps contracts (concentric) while the triceps stretches. For extension at the elbow, the triceps contracts while the biceps stretches (eccentric). When the weight is held, the muscles generate force and the length of the muscle (isometric) remains the same.

Dynamic work

Concentric contraction

Concentric contraction is when muscles develop sufficient tension to overcome the resistance of the body segment, the muscle length shortens and causes joint movement to create the contraction (concentric contraction) — for example, the biceps curl where the bicep muscle shortens to lift the dumbbell from the straight arm position.

Concentric contraction is when the muscle length shortens as the force is being produced.

Eccentric contraction

Eccentric contraction is when the muscle length lengthens as the force is being produced.

Eccentric contraction occurs when the muscle lengthens while the force is developed to decelerate the motion of a joint. This occurs in activities that resist gravity, and it will slow the limb or trunk movement to allow for controlled movement of the joint/s — for example, lowering the body during a situp, lowering the body during a squat or even gently setting down an object. The process is similar to a drawbridge, where the bridge must be lowered in control while working against the effect of gravity.

Isokinetic contraction

Isokinetic contraction is when force created by the muscle is maximal for all angles of the joint movement via use of a machine.

An **isokinetic contraction** allows the performer to work at a constant angular velocity against a weight or resistance that changes as the performer moves through the working muscle's possible range of movement (figure 3.17). Hence the velocity of the contracting muscle is constant so the muscle contracts concentrically and eccentrically with different directions of joint motion. These contractions are only possible with the use of expensive, specialised equipment. The amount of force applied by these machines always equals the amount of force applied by the muscle, so it is possible to develop strength through a muscle's entire range of motion. Thus isokinetic contractions are considered to be the most effective way to develop strength and endurance.

Isoinertial contraction

Isoinertial contraction is a type of dynamic muscle work where the muscle length can shorten, lengthen or remain the same as the resistance remains constant.

An **isoinertial contraction** is a type of dynamic muscle work where the resistance against which the muscle must contract remains constant. For example, when lifting the weight in a bicep curl, at the start of the exercise, the weight of the dumbbell must be overcome. Initially the involved muscles contract isometrically in order to produce enough tension to begin to overcome the load of the dumbbell. As soon as the force produced by the muscle is greater than the resistance, then the muscle contracts concentrically, and causes acceleration of the bicep curl exercise.

Static work

Isometric contraction

Isometric contraction is when force is developed but there is no change in the length of the muscle.

An **isometric contraction** produces the most amount of force of any type of muscular contraction, and therefore causes the muscle to tire more quickly. The muscle generates a force, but the muscle length remains unchanged. Many sports rely on performers using isometric contractions (figure 3.16). Examples include the rugby scrum, rock climbing, amateur wrestling holds, the position out on the trapeze in sailing, and the grip on a playing stick or racquet.

FIGURE 3.16 Isometric muscle contractions are important in many sports.

FIGURE 3.17 A Biodex machine allows the quadriceps muscle group to be both assessed and trained through its full range of motion.

TEST your understanding

1. Outline the differences between the three types of muscle fibres.
2. Download and view the table of muscle fibre types in your eBookPLUS. Complete this table.
3. Name and describe the five types of muscle contraction. Provide an example of each.
4. Consider the following sports and decide, giving reasons, whether fast-twitch fibres, slow-twitch fibres or a combination of both would be more important in them:
   (a) weight-lifting
   (b) athletics, a long jumper
   (c) Tour de France
   (d) athletics, a decathlete
   (e) soccer, a goal-keeper
   (f) tennis
   (g) hockey, inside right
   (h) sprint cycling
   (i) netball, wing attack
   (j) basketball, centre
   (k) AFL, centre half forward
   (l) water polo.

APPLY your understanding

5. **Practical activity: muscle movements**
   Work in a group of three to undertake the following tasks. Demonstrate the movements to the class.
   (a) Demonstrate three examples of how concentric and eccentric movements are used in sport. Outline the major muscle group(s) performing the contraction in each example, and nominate whether the contraction is eccentric or concentric.
   (b) Demonstrate three examples of how isometric movements are used in sport. Outline the major muscle group(s) performing the contraction in each example.
6. **Practical activity: muscle contractions in volleyball**
   Play a game of volleyball. Identify two activities in the game that involve performing the following contractions:
   (a) isometric contractions
   (b) concentric contractions
   (c) eccentric contractions
   (d) isoinertial contractions.

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Digital document
Muscle fibre types
Searchlight ID: doc-1102

CHAPTER 3 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

KEY SKILLS

- Use and apply correct anatomical terminology to the working of the musculoskeletal system in producing human movement
- Perform, observe and analyse a variety of movements used in physical activity, sport and exercise to explain the interaction between bones, muscles, joints and joint actions responsible for movement
- Describe the role of agonists, antagonists and stabilisers in movement
- Describe the relationship between motor unit recruitment, activation and force production

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- correct anatomical names for the major muscles and muscle fibres in the body
- understand how muscle contraction works and the link with motor unit recruitment
- understand and identify the various types of muscle contractions and the roles of agonists, antagonists and stabilisers.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action words:** **State** — to state the main points using precise terms **Describe** — provide a detailed account of
- **Key terminology:** type, muscle contraction, hamstring, flexion, agonist, extending
- **Key concept:** muscle contraction — understanding how muscle contraction occurs and the types of muscle contractions
- **Marking scheme:** *5 marks* — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

PRACTICE QUESTION

The above picture depicts a physiotherapist measuring the angle of movement during flexion of the left leg at the knee joint.

a. **State** what type of muscle contraction is occurring in the hamstring muscle group during flexion of the knee. *(1 mark)*
b. **State** the agonist muscle group which is mainly responsible for extending the knee. *(1 mark)*
c. **Describe** the role of the agonist and antagonist during flexion of the knee. Your response must refer to the muscle groups. *(3 marks)*

Sample response

a. Concentric muscle contraction
b. Quadriceps muscle group is the agonist muscle responsible for extending the knee.
c. During flexion of the knee, the hamstrings are the agonist (prime mover) muscle group that contract and enable flexion of the knee joint. The quadriceps act as the antagonist muscle group by relaxing and lengthening to allow flexion of the knee joint.

HOW THE MARKS ARE AWARDED

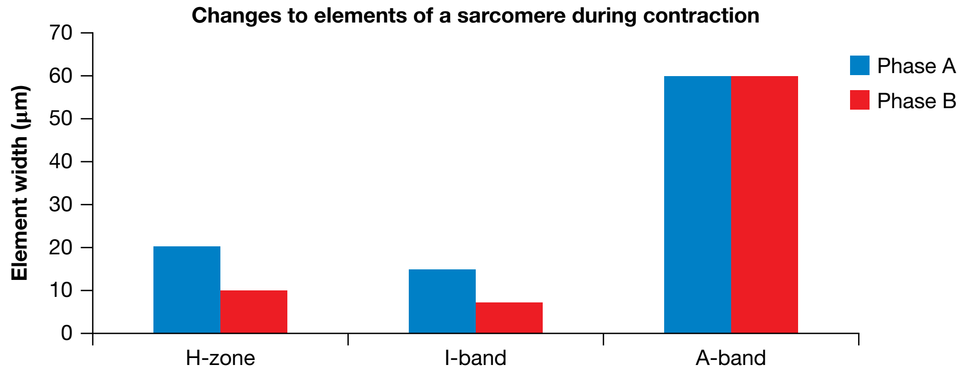
- **1 mark:** stating the correct muscle contraction type
- **1 mark:** stating the correct agonist muscle group to extend the knee
- **1 mark:** stating that the agonist is the prime mover for flexion of the knee joint
- **1 mark:** stating the antagonist allows flexion by relaxing and lengthening the muscle group
- **1 mark:** reference to the correct muscle groups hamstrings (agonist) and quadriceps (antagonist) and using correct terminology

PRACTISE THE KEY SKILLS

1 Discuss the differences between the characteristics of slow-twitch and fast-twitch muscle fibres.
2 Explain how skeletal muscles must work in pairs to produce movement.
3 State the muscles and anatomical movement to produce the body movement of jumping.

KEY SKILLS EXAM PRACTICE

1 (© ACHPER 2015, from the written exam paper, 2015, Q15)



Source: Ballarat and Clarendon College.

a. In terms of muscular contraction, describe what is happening during Phase B. *4 marks*

b. i. Describe the advantage of a pennate muscle arrangement compared to a fusiform muscle arrangement. *1 mark*

ii. Provide an example of a multipennate muscle. *1 mark*

c. Explain why muscle fibres don't simply contract at 50 per cent of their maximum in order to alter the strength of a contraction. *3 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

Muscular system

- The muscular system has three main functions:
  – to allow movement
  – to maintain adequate posture
  – to maintain essential bodily functions.
- The three types of muscle are smooth (involuntary), cardiac (involuntary) and skeletal (voluntary).
- Muscles are usually named from their various characteristics or locations.
- Muscle fibres are organised in different ways according to the shape (or arrangement) and function of the muscles. The main arrangements of major skeletal muscles used in physical activity are fusiform, pennate and radiate muscles.
- Skeletal muscle consists of thousands of muscle fibres that run the length of the muscle. Each muscle fibre is made up of myofibrils. Each myofibril consists of many individual units, called sarcomeres, which contain actin and myosin and are responsible for contracting the muscle.
- Messages are sent from the brain to the muscles to initiate movement. A motor unit consists of the motor neuron plus the muscle fibres it stimulates.

- Skeletal muscles create movement by pulling on the bones to which they are attached. During a particular movement, a muscle performs one of four roles: agonist (prime mover), antagonist (relaxing muscle), synergist or stabiliser.
- The process of the agonist muscle contracting and its opposing muscle, the antagonist, relaxing is called reciprocal inhibition.
- There are two different categories of muscle fibre:
  – fast-twitch fibres
  – slow-twitch fibres.
- Muscle contractions are classified according to the movement they cause, dynamic or static. The five types are concentric, eccentric, isoinertial, isokinetic and isometric.

MULTIPLE CHOICE QUESTIONS

1 Muscles move bones by
(A) lengthening.
(B) pulling.
(C) pushing.
(D) shortening.

2 Each myofibril is made up of tiny units called
(A) myofilaments.
(B) myosin.
(C) actin.
(D) sarcomeres.

3 The muscles mainly responsible for making movements are known as
(A) agonists.
(B) stabilisers.
(C) antagonists.
(D) fixators.

4 The paired movement of a muscle is called
(A) agonist.
(B) reciprocal inhibition.
(C) antagonist.
(D) all or nothing.

5 The muscle fibres responsible for explosive movements are called
(A) explosive twitch.
(B) fast-twitch oxidative.
(C) slow-twitch.
(D) fast-twitch glycolytic.

6 Pushing against an immoveable wall is an example of what type of muscular contraction?
(A) Concentric
(B) Isometric
(C) Eccentric
(D) Isoinertial

7 Muscles can be classified into three main groups:
(A) voluntary, involuntary and smooth.
(B) cardiac, voluntary and rough.
(C) skeletal, involuntary and smooth.
(D) smooth, cardiac and skeletal.

8 Muscle fibres that run at angles to the tendons are classified as
(A) radiate muscles.
(B) fusiform muscles.
(C) pennate muscles.
(D) elasticity muscles.

9 The major muscle involved in shoulder flexion is
(A) sartorius.
(B) serratus anterior.
(C) pectoralis major.
(D) soleus.

10 The cross bridges during muscle contractions continue to detach and reattach themselves from the
(A) myosin filaments.
(B) sarcomere filaments.
(C) actin filaments.
(D) muscle fibre filaments.

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Sit Topic Test

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Interactivity
Structure and functions of the muscular system quiz
Searchlight ID: int-6629

EXAM QUESTIONS

Question 1

a. Which agonist muscle group is mainly responsible for raising the athlete up from the floor to the position shown in the picture? **1 mark**

b. Describe the type of muscle contraction required to hold the position shown. **1 mark**

Question 2

Describe the differences between fast-twitch and slow-twitch muscles when considering the amount of triglycerides they store. **2 marks**

Question 3

a. Describe the action of the elbow joint when the biceps contracts eccentrically. **1 mark**

b. Describe the process of reciprocal inhibition referring to the bicep curl as an example. **2 marks**

Question 4

The 'all or nothing' principle states that when a muscle develops tension, its fibres will either fully contract or will not contract at all. Explain two ways in which the amount of tension developed in the muscle can be altered. **2 marks**

Question 5 **(adapted from ACHPER Trial Exam 2015, question 4)**

a. Discuss a similarity and difference within the agonist muscle during the concentric and eccentric phase of the bicep curl. **2 marks**

b. With reference to a chosen joint action, explain the concept of reciprocal inhibition. **3 marks**

INQUIRY QUESTION
What are the best methods for an individual to prevent injuries from occurring?

CHAPTER 4

Acute and chronic injuries and illnesses of the musculoskeletal system

An inherent risk of participation in physical activity is injury to muscles and bones. There are a number of ways that an athlete can minimise this risk. Being physically fit, training appropriately for the activity and wearing protective gear can all act to reduce the incidence of common injuries.

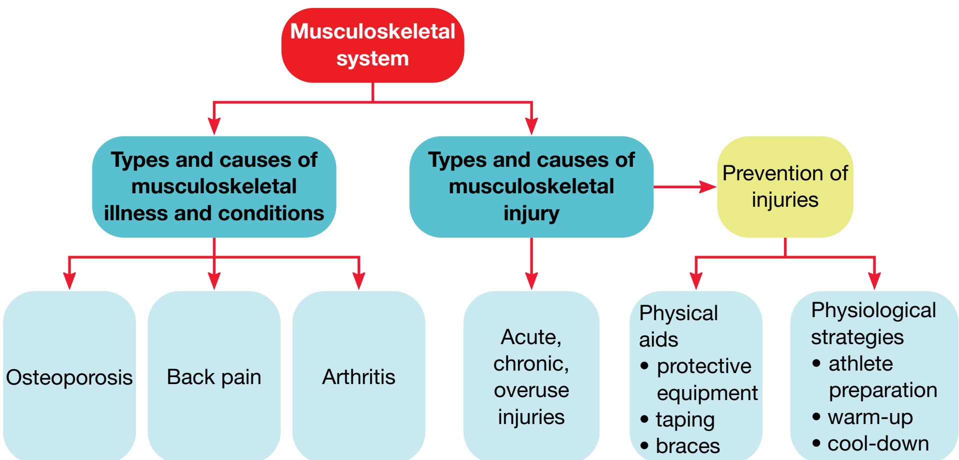
KEY KNOWLEDGE

- Causes of potential acute and chronic injuries and illness associated with the muscular and skeletal systems such as arthritis, osteoporosis and other musculoskeletal conditions
- Physiological strategies to prevent musculoskeletal injuries such as physical preparation of athletes, warm-ups and cool-downs
- The role of physical aids that support the musculoskeletal system such as protective equipment, taping and braces

KEY SKILLS

- Examine a variety of causes of musculoskeletal injuries
- Describe and implement the correct application of techniques and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system

CHAPTER PREVIEW



4.1 Classification and types of sports injuries

KEY CONCEPT Injuries can be classified as acute, chronic or overuse. The type of injury sustained varies according to the cause of the injury. Injuries can affect hard or soft tissue in the body.

Australians are encouraged to be physically active for good health. Current guidelines recommend that Australians be active on most, if not all, days of the week (see chapter 11).

People who lead sedentary lifestyles and do not engage in sufficient physical activity are at a greater risk of ill health and possible death from a range of chronic illnesses and diseases. According to the Australian Institute of Health and Welfare (AIHW), physical inactivity contributes to 13 500 deaths each year in Australia. But as people engage more in physical activity, sport and exercise, there is greater potential for them to develop a **musculoskeletal injury**.

A **musculoskeletal injury** is any damage that occurs to the structures of the muscular or skeletal systems of the body.

Injuries of the musculoskeletal system are a common occurrence during physical activity. Sports injuries can occur via accidents, poor training practices, improper equipment, clothing and footwear, as well as not being in the proper condition to participate in the selected physical activity. Once an injury is sustained, it impacts on the ability of the individual to effectively participate in sport or physical activity and can lead to further damage if not treated properly.

All areas of the body are at risk of suffering an acute injury. Injuries are largely preventable and a variety of measures can be taken to reduce this risk; these are discussed in sections 4.3 and 4.4. If not treated correctly, such injuries may become chronic or progress to a form of overuse injury.

Acute injury is an injury that occurs quickly and for which pain and loss of function is immediate.

Direct injury is caused by external force.

Indirect injury is caused by internal force.

Classification of injuries

Injuries can be classified into three types: acute, chronic and overuse.

An **acute injury** is one that occurs quickly and for which pain and loss of function is immediate. Acute injuries are classified according to how the injury occurred; either via a **direct** (external force) or **indirect** (internal force) mechanism.

FIGURE 4.1 Examples of direct and indirect injuries

Acute injuries can be further classified by the structure that is injured (e.g. bone, ligament, muscle, joint) and the nature of the injury (e.g. fracture, sprain, strain). For example, a netballer who changes direction suddenly may sprain their ankle.

TABLE 4.1 Types of acute injuries

Type of acute injury	Caused by	Possible mechanism	Likely injury
Direct	External force	Collisions between players Direct contact with equipment	Bruise Cork Fracture Cut
Indirect	Internal force	Overstretching connective tissue Losing balance	Sprain Strain Tear

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Interactivity
Injury types and definitions
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Specific examples of these injuries are presented in tables 4.2 and 4.3.

Chronic injuries tend to start out as acute in nature, and then recur as a result of re-injury through a prolonged weakness or insufficient rehabilitation following the previous injury. Recurring hamstring strains in AFL players are chronic injuries.

Overuse injuries are caused by excessive and repeated use of the same muscle, bone or joint, and are usually diagnosed by the presence of inflammation and pain. These injuries tend to be prolonged, taking a long time to recover (such as shin splints and stress fractures). Around 80 per cent of all overuse injuries occur in the lower body. Overuse injuries may occur via:

- Internal causes, e.g. muscle imbalance, anatomical problems such as poor posture
- External causes, e.g. training errors, incorrect technique, or uneven surfaces or hard running tracks.

(Overuse injuries are discussed further on page 63.)

Chronic injury is an injury that recurs due to weakness or insufficient rehabilitation.

Overuse injury is an injury caused by excessive and repeated use of the same muscle, bone or joint.

Acute injuries: soft and hard tissue

Soft tissue injuries are the most common in sports and include any damage to skin, muscles, tendons and ligaments.

- A tear occurs when connective tissue — such as muscles, tendons and ligaments — is excessively stretched or ruptured. A tear can be either a:
  strain: muscle or tendon, e.g. strained hamstring
  sprain: ligament, e.g. sprained ankle.

These injuries occur when the connective tissue fibres cannot cope with the stress being placed on them (e.g. when a muscle contracts too quickly during the sudden acceleration in a sprint take-off) or when a joint is overextended (e.g. during a side push on the knee during a football tackle). Strains and sprains are classified by the number of fibres torn and thus the severity of the injury (figure 4.3).

FIGURE 4.2 Ankle sprain

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Unit 1
AOS 1
Topic 4
Concept 1

Acute injuries Concept summary and practice questions

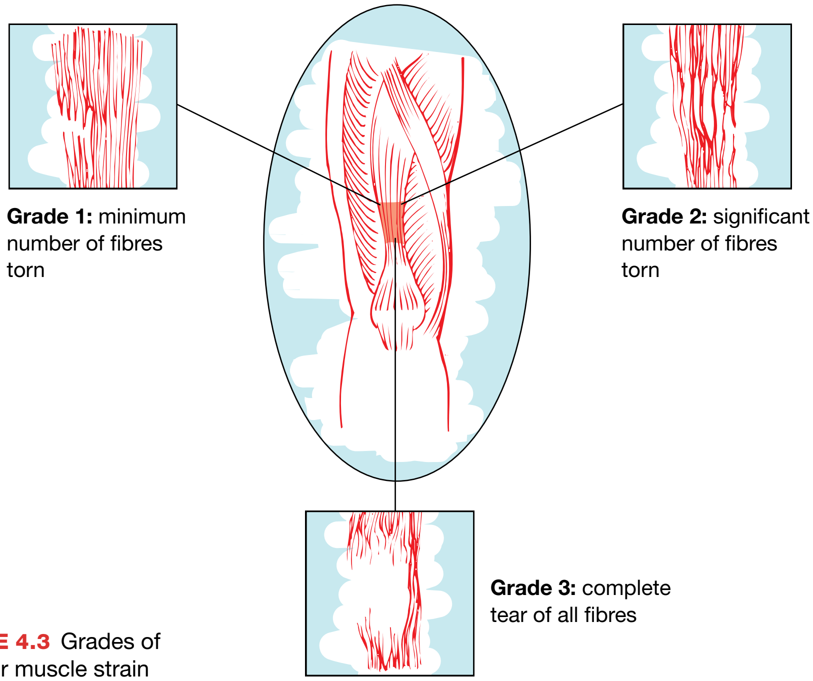

FIGURE 4.3 Grades of tears for muscle strain

- A contusion (or bruise) is caused by bleeding into the soft tissue. This generally results from a direct blow to the site via a collision with a player or piece of equipment (e.g. being hit by a cricket ball) or from a heavy fall.

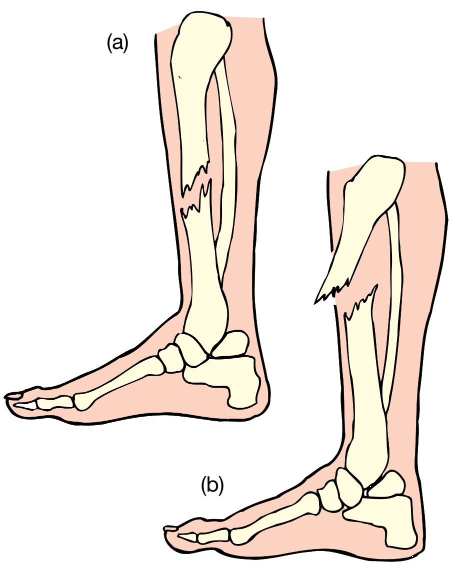

FIGURE 4.4 (a) A simple fracture (b) A compound fracture

TABLE 4.2 Types of soft tissue injuries

Type of injury	Structure injured	Possible cause
Sprain	Ligament	Excessive movement forcing the joint past its maximum range of motion, or external violence such as a side push on the knee during a football tackle
Strain	Muscle or tendon	Overstretching of muscle or tendon generally during sudden acceleration or deceleration
Contusion (bruise or haematoma) or a cork	Muscle, tendon, skin	Direct blow from a collision with a player or piece of equipment, or from a heavy fall
Open wound — cut, abrasion, laceration	Skin	Direct blow from a collision with a player or piece of equipment

Hard tissue injuries involve the bones of the skeleton. The most common injury to bones is a fracture.

- A fracture is a break to the bone and it can be closed or open (compound), where the bone has broken through the skin (figure 4.4). A fracture can be caused by direct trauma to the area such as a blow, or an indirect trauma such as falling on an outstretched hand. Signs and symptoms of a fracture can include pain, swelling, bruising, tenderness, difficulty in moving or deformity.
- Dislocations occur at a joint and involve the bones forming the joint being displaced. They damage both the hard tissue of bone and the surrounding connective tissue. Dislocations generally result from excessive movement of a joint; for example, falling awkwardly in the landing of a gymnastics routine. Signs

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Unit 1
AOS 1
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Concept 2

Chronic and overuse injuries Concept summary and practice questions and symptoms include pain, swelling, tenderness, deformity or loss of movement. A partial dislocation is known as a subluxation.

Tables 4.2 and 4.3 summarise the types of sporting injuries that may occur to different body structures and their possible causes.

TABLE 4.3 Types of hard tissue injuries

Type of injury	Structure injured	Possible cause
Fracture	Bone	Direct trauma such as a blow; indirect trauma such as falling on an outstretched hand
Dislocation/ subluxation	Joint	Excessive movement of the joint

Overuse injuries

Athletes can develop an overuse injury during periods of high workloads and low levels of rest. This is particularly relevant to younger athletes who are going through puberty and growth spurts. A strategy for reducing the impact of injuries on an athlete's function is to manage the pain cycle (figure 4.5).

The main examples of overuse injuries seen in athletes are summarised in table 4.4.

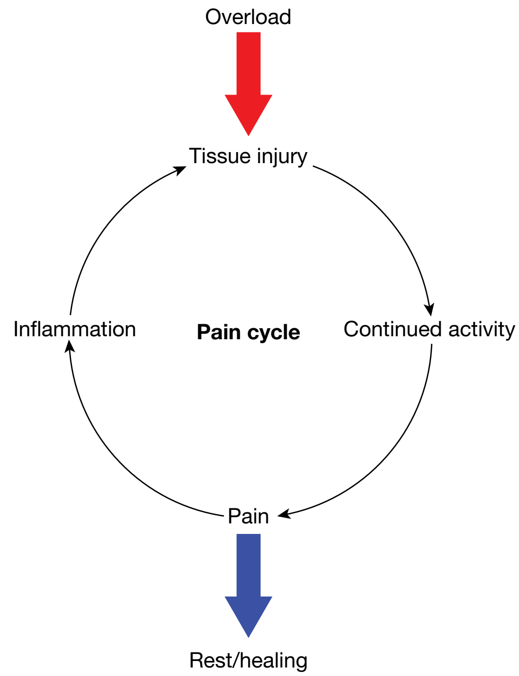

FIGURE 4.5 The pain cycle: incorrect overload leads to tissue injury; continued activity leads to pain, which results in inflammation. The only way out of the cycle is rest and healing.

TABLE 4.4 Types of overuse injuries

Overuse injury	Signs and symptoms	Possible causes
Shin splints	Initial pain may be caused by slight inflammation in the muscles; over time, pain can become constant and extremely uncomfortable.	• Poor posture • Excessive training during an adolescent growth spurt or the beginning of a training program • Fallen arches in the feet • Biomechanically incorrect gait • Muscle fatigue in the lower limbs • A strength imbalance between anterior and posterior muscles in the lower leg
Osteitis pubis: irritation and/or overuse of the joint between the pubic bones of the pelvis	• Gradual onset of groin pain with an increasing level of discomfort • Pain when kicking, running, twisting or completing turning movements • Pain when contracting abdominal muscles • Significant loss of kicking strength or length • Reduction in maximum running speeds	A combination of • high running loads • frequent changing of direction at pace • the kicking action • muscle imbalance (abdominals)
Patellar tendonitis	• Patellar tendon inflamed and tender • Pain often felt at the end of a session or when the athlete has cooled down	• Running, jumping or high-impact activities • Growth spurt
Tennis or golfer's elbow	• Recurring pain on the outside of the upper forearm just below the bend of the elbow; occasionally pain radiates down the arm towards the wrist • Difficulty extending the forearm fully because of inflamed muscles, tendons and ligaments • Pain caused by lifting or bending the arm or grasping even light objects such as a coffee cup	• Poor technique • Equipment • Sudden increase in training/activity

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Acute sports injuries
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Common sports injuries

An athlete can expect to suffer a number of different sports injuries during their career. The severity of each injury will vary greatly in terms of injury damage, recovery and rehabilitation. Some sports lend themselves to specific types of injuries. Table 4.5 shows the types of sporting injuries and their causes.

TABLE 4.5 Acute sports injuries

Area of body	Cause of injury	Signs of injury
Head		
Concussion	Blow to the head or heavy fall	Loss of consciousness; vomiting; loss of memory; headache or drowsiness
Chest		
Winded	Heavy blow to the chest or abdomen	Gasping for breath; pain; nausea
Abdomen		
Stitch	Possible causes: • air bubbles in the duodenum • spasm of the diaphragm	Pain in the side of the abdomen
Shoulder		
Dislocation	Falling on an outstretched arm	Shoulder and arm in abnormal frontal position; resultant damage to ligaments and joint capsule; severe pain at point of injury; swelling
Broken clavicle (collarbone)	Falling on an outstretched arm	Need to support the elbow of the broken side
Elbow		
Dislocation	Falling on an outstretched hand	Deformity at elbow causing loss of movement; swelling; extreme pain
Hand/finger		
Dislocated fingers	Direct blow to the hand/finger, usually caused by an object such as a ball or stick	Deformity; swelling; localised pain
Thigh		
Cork (haematoma)	Direct contact with an object or body	Weakness in strength and power of the muscle; reduced range of motion; localised pain and swelling
Strain in quadriceps/ hamstrings	Sudden over-stretching or contraction of muscle	Sudden and severe localised pain when muscle is contracted; reduced mobility, strength and power
Knee		
Patella dislocation	Forceful twist of knee while bearing weight	Deformity and loss of function of knee; extreme pain; swelling
Rupture of anterior cruciate or ligament sprain	Falling awkwardly and twisting knee	Sound of 'pop' or 'crack' in the knee; immediate pain in knee, which is sore to touch; some restricted movement
Torn cartilage (menisci)	As for sprain	Swelling may be evident or occur later; other signs as for sprain
Ankle		
Sprain	Twisting the ankle or playing on uneven surfaces	Immediate pain in ankle, which is sore to touch; restricted movement; swelling
Achilles tendon rupture	Extremely powerful contraction of the calf muscles	Deformity of the Achilles tendon; a lump in the middle of the calf muscle; loss of movement of foot; pain

TEST your understanding

1 Outline the three classifications of injuries.
2 Discuss the difference between direct and indirect injuries. Provide examples.
3 Outline the difference between a strain and a sprain.
4 Is a dislocation an injury to hard tissue or to soft tissue?

APPLY your understanding

5 Apply the following questions to cricket, netball and tennis.
   (a) Identify injuries that are most likely to occur in these sports.
   (b) Provide examples of how these injuries might occur.
   (c) Classify the injuries as direct/indirect and soft/hard tissue injuries.
6 Read the following scenarios and classify them according to the type of injury most likely to have occurred.
   (a) A 100-metre sprinter begins his race accelerating from the blocks and feels a sharp pain in his Achilles tendon.
   (b) A basketballer jumps for a rebound but lands heavily and twists her ankle.
   (c) A tennis player feels discomfort in the elbow during a five-set match.
   (d) A footballer hears a crack as his leg collides with an opposing player's leg while disposing of the football.
   (e) Two hockey players collide heads when going for the ball, and one complains of a headache.
   (f) A netballer trips over her opponent's feet in the goal circle, puts her arms out to slow her fall and hurts her shoulder.
7 **Learning activity: injury fact sheets**
   Sports Medicine Australia provides links to injury fact sheets that can be viewed using the **Sports Medicine Australia** weblink in your eBookPLUS.
   Read the list of injury fact sheets and complete the following tasks.
   (a) Select two different acute injuries and read through their fact sheets.
   (b) For each injury, summarise the important information and record any interesting aspects of each injury.
   (c) Compile a 3-minute oral presentation on the two injuries you selected.
8 **Practical activity: common sporting injuries**
   Choose a common team sport such as hockey or soccer to play as a class. While playing, consider all the injuries that could occur in the game.
   (a) The figure below shows the top ten most common injuries during sport. Suggest ways such injuries could occur in the sport you were playing.
   (b) Suggest ways of preventing or reducing these injuries.

Top ten most common injuries during sport

1. Sprain or strain	6. Dislocation
2. Fracture, excludes tooth	7. Intracranial injury
3. Open wound, excludes eye	8. Eye injury
4. Injury to muscle or tendon	9. Crushing injury
5. Superficial, excludes eye	10. Foreign body

Source: Victorian Injury Surveillance Unit, Monash University Accident Research Centre.

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Weblink
Sports Medicine Australia

4.2 Illnesses associated with the musculoskeletal system

KEY CONCEPT Musculoskeletal illnesses and conditions can reduce the mobility of an individual and their capacity to remain physically active. There are preventative measures that can be taken to limit the effect of these conditions.

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Unit 1 | AOS 1 | Topic 4 | Concept 3

Musculoskeletal illnesses and conditions
Concept summary and practice questions

As well as injuries to the musculoskeletal system during physical activity, sport and exercise, there are many illnesses and conditions affecting both the muscular and skeletal systems that can impact on the ability of an individual to engage in regular physical activity.

The Australian Institute of Health and Welfare (AIHW) estimates that in 2011–12, 6.1 million Australians (28 per cent of the population) had a musculoskeletal condition. These conditions affect bones, muscles, joints and ligaments and often limit the capacity and mobility of an individual via reduced joint function, pain and psychological distress.

The most common musculoskeletal conditions in Australia include:

- arthritis (including osteoarthritis, juvenile arthritis and rheumatoid arthritis)
- osteoporosis
- back pain and problems.

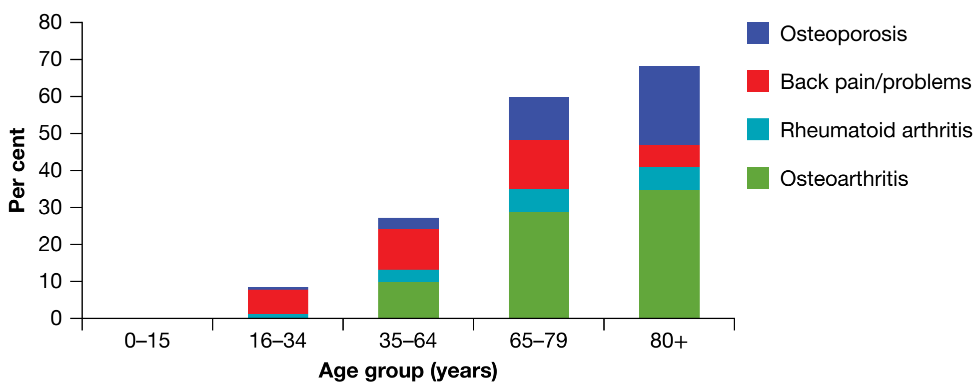

FIGURE 4.6 Prevalence in Australia of common musculoskeletal conditions according to age.

Source: Australian Institute of Health and Welfare 2014. *Arthritis and other musculoskeletal conditions across the life stages.* Arthritis series no. 18 PHE 173. Canberra: AIHW.

Arthritis

Arthritis is a condition characterised by inflammation of a joint, causing pain and stiffness.

Arthritis is characterised by inflammation of the joints in the body, causing pain and stiffness. It can impinge on the joint via weakness, instability and deformity around the joint structure. Arthritis is estimated to affect 3.5 million Australians (15.5 per cent), with more than half of those (58.9 per cent) suffering from osteoarthritis and 11.5 per cent with rheumatoid arthritis (AIHW, 2014). Arthritis more commonly affects females than males and prevalence increases with age, especially after 45 years. Arthritis can restrict the ability of an individual to engage in daily activities such walking, preparing food and general hygiene.

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Weblink
Arthritis Australia

There are over 100 forms of arthritis but the most significant ones affecting an individual's ability to participate in physical activity are discussed below.

Juvenile arthritis describes the type of arthritis that occurs in children under 16 years of age. It is relatively uncommon, affecting less than 1 per cent of Australian children. Juvenile arthritis can be very unpredictable, changing from one moment where an individual can be symptom-free through to severe swelling, tenderness, stiffness and pain in and around the affected joints. Mobility can be compromised, making participation in physical activity difficult due to the unpredictable nature and flare up of symptoms. The cause of juvenile arthritis is currently unknown.

Osteoarthritis is a degenerative condition resulting from overuse, or 'wear and tear', of a joint, mostly affecting the weight-bearing joints of the hip, knee or ankle but can also affect the hands and spine. Cartilage on the ends of bones wears away causing the bones to rub together, creating pain, swelling and restriction of range of motion in the affected joint. Risk factors for developing osteoarthritis include increasing age, physical inactivity, being overweight, joint trauma from previous injuries and repetitive stress on a joint.

Rheumatoid arthritis is a chronic disease resulting from an autoimmune response of the body. The immune system attacks the tissues lining the joints causing pain, swelling, stiffness, progressive and irreversible damage, and deformity. Rheumatoid arthritis is the most severe form of arthritis, generally affecting the smaller joints of the body, such as the hands and feet.

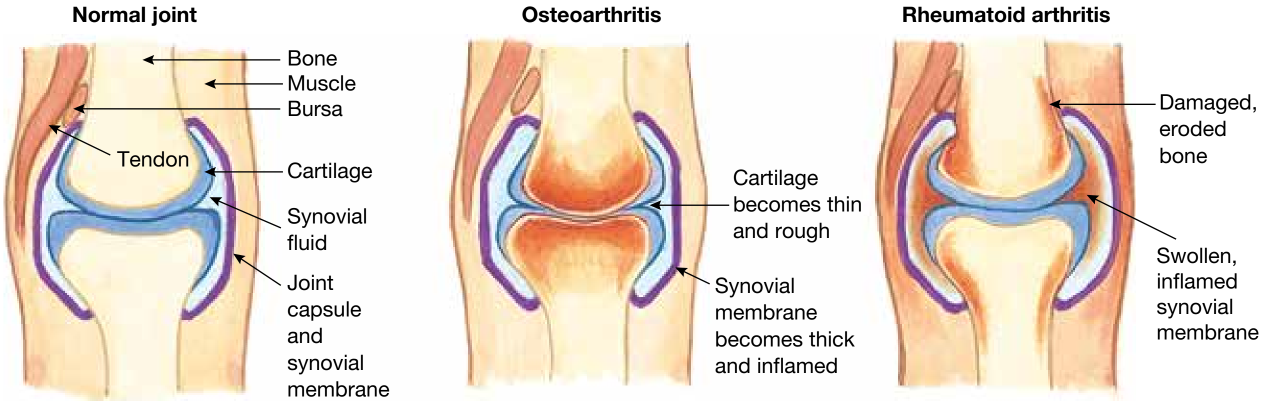

FIGURE 4.7 Normal and arthritic joints

For all forms of arthritis, regular physical activity has been found to improve the mobility and flexibility of joints, increase muscle strength and improve posture and balance as well as decrease pain, feelings of fatigue and tiredness, and muscle tension and stress. The added benefit of engaging in physical activity is also the improvement in overall health and maintenance of a healthy body weight. Excess body weight can contribute to symptoms of arthritis, especially in the weight-bearing joints of the body.

The type of physical activity should take into consideration the individual's condition and limitations. Lower-impact exercises are often more comfortable as less force is going through the joints. These exercises might include:

- flexibility exercises, e.g. stretches, to maintain or improve the mobility of joints and muscles
- muscle strengthening, e.g. resistance training with weights, to develop strong muscles to support the joints and connective tissue
- aerobic activities, e.g. brisk walking and swimming, to improve heart and lung health.

Osteoporosis

Osteoporosis is a musculoskeletal condition characterised by the thinning and weakening of a bone, making it very fragile. This occurs when the bone loses minerals, in particular calcium, quicker than the body can replace them. This loss impairs the density of the bone and increases the risk of fracture in comparison to a normal bone.

Osteoporosis affects 3.5 per cent of the Australian population. It is more common in women than men and has a higher incidence in people over the age of 55 (AIHW). It is often called the 'silent disease' as it has little to no symptoms and people may not know they have it until a fracture occurs. Once a fracture occurs, sufferers may have mobility concerns, especially if the fracture occurs in the spine, pelvis or lower limbs.

Osteoporosis is a largely preventable condition. Risk factors for developing osteoporosis include sedentary behaviour and lack of exercise, as well as nutritional concerns such as poor calcium intake and vitamin D deficiencies. Participation in

Osteoporosis is a condition in which the bones become weak and thin and therefore brittle.

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Weblink
Osteoporosis Australia

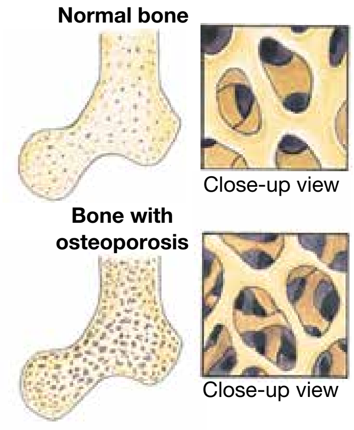

FIGURE 4.8 A normal bone compared with a bone affected by osteoporosis

regular physical activities (particularly those that place 'stress' on the bone, such as weight-bearing activities) helps to maintain and/or improve bone density and strengthen the muscles that attach to these bones. Stronger bones and muscles improve posture and balance, and reduce the likelihood of falls and subsequent breaks in the bones.

Osteoporosis Australia outlines the following effects of exercise at different stages of life for the prevention or management of osteoporosis.

TABLE 4.6 Exercise and its effects on osteoporosis

Age	Bone status	Exercise effect
Childhood/ adolescence	In girls and boys the major build-up of bone occurs in the pre-teen and adolescent years. Peak bone density is reached during mid to late 20s.	Can increase bone density and structure to maximise peak bone strength, which helps keep bones strong for longer in adulthood.
Early to mid adulthood	Bone density is maintained or starts to decrease very gradually when a person reaches their 30–40s although increases are still possible during middle adulthood.	Can maintain or increase (1–3%) bone density and improve cardiovascular health and fitness; resistance training can also improve muscle mass and strength.
Post menopausal women	In women from the age of 45 years, bone loss begins to increase to 1–2% per year. Bone loss accelerates up to 2–4% per year at the onset of menopause.	Can maintain bone strength by helping to slow the rate of bone loss following menopause. It is very difficult to increase bone density during or after menopause by exercise alone. Can effectively improve muscle function (balance) and reduce falls risk.
Men	Bone density tends to remain relatively stable until middle age, decreasing by about 0.5–1.0% per year from the age of 45–55 years. Low testosterone or hypogonadism can increase bone loss in men.	Can maintain or increase (1–2%) bone density, improve muscle mass, strength, balance and co-ordination to help prevent falls and maintain general health.
Older adults without osteoporosis	After 75 years of age, further increases in bone loss occur in both sexes, especially from the hip. The risk of fracture increases as bone loss increases.	Helps to maintain bone strength and increase muscle strength, balance and co-ordination, which in turn help to prevent falls.
Older adults with osteoporosis/ fractures	Bones are increasingly thin and fragile.	Exercises recommended by physiotherapists and exercise physiologists can improve general health, muscle strength, balance and posture to prevent falls and reduce the risk of further fractures.

Source: Osteoporosis Australia, www.osteoporosis.org.au.

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Weblink
Back pain

Back pain

Back pain and back problems can affect the bones, joints, tissues and nerves of the back. They can be caused by a variety of mechanisms, including soft tissue injury (e.g. muscle strain or sprains), displacement of intervertebral discs, postural stress, nerve irritations (e.g. sciatica) and structural problems. Back problems often stem from overuse, injury, weakness, degeneration or postural misalignment.

Back pain can be acute, but more often than not it can become chronic and long lasting. It is estimated that 2.8 million Australians (13.6 per cent) are affected by back pain (AIHW, 2011–12).

Risk factors for back pain include sedentary behaviour and physical inactivity, being overweight or obese, type of occupation (especially those that involve lifting, bending or twisting), poor posture and stress. Other musculoskeletal conditions, such as osteoarthritis and osteoporosis, can also be risk factors for and contribute to back pain.

Treatment to help prevent back pain includes:

- exercises to strengthen the back and core muscles, to assist with correct posture and support of the spine
- maintaining a healthy weight, as excess weight puts strain on the back and postural muscles
- staying active.

TABLE 4.7 **Summary of risk factors and preventative measures for a range of musculoskeletal conditions**

Musculoskeletal conditions	Description	Risk factors	Preventative measures
Rheumatoid arthritis	Chronic disease of the joints causing pain, swelling, stiffness, and irreversible damage and deformity	Age Gender (female) Family history Tobacco use	Regular participation in physical activity Not smoking Healthy diet
Osteoarthritis	Degenerative condition resulting from overuse of a joint where cartilage wears away, causing bones to rub together	Increasing age > 45 years Physical inactivity Overweight/ obesity Joint trauma from previous injury Repetitive stress on a joint	Regular participation in physical activity Maintenance of healthy body weight
Osteoporosis	Characterised by thinning and weakening of the bone, making it very fragile	Sedentary behaviour Physical inactivity Poor calcium intake Vitamin D deficiency Increasing age > 55 years Gender (female)	Regular participation in weight-bearing activities Nutritious diet, including calcium
Back pain	Pain affecting bones, joints, tissue and nerves of the back stemming from overuse, injury, weakness or degeneration	Sedentary behaviour Physical inactivity Overweight/obesity Poor posture Type of occupation	Limiting sedentary behaviour Regular participation in physical activity Maintenance of healthy body weight

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Digital document
Risk factors and preventative measures for musculoskeletal conditions
Searchlight ID: doc-18669

TEST your understanding

1 What is a musculoskeletal illness or condition?
2 List the common musculoskeletal illnesses or conditions and indicate the percentage of Australians affected by each of these conditions.
3 Outline the difference between the three most common types of arthritis.
4 Osteoporosis is largely a preventable condition. Discuss this statement.

APPLY your understanding

5 Outline the similarities and differences between the musculoskeletal illnesses and conditions discussed in this section.
6 For each of the musculoskeletal illnesses and conditions outlined in question 5, suggest ways to prevent these conditions occurring.
7 Create a fact sheet for one of the musculoskeletal illnesses, outlining:
   - what the condition is
   - how a person can develop the illness
   - how many Australians suffer from the illness
   - any preventative measures that can reduce the likelihood of developing the illness
   - health promotion programs that address the illness.

4.3 Physiological strategies to prevent musculoskeletal injuries

KEY CONCEPT: A range of strategies can be used to assist the athlete to be physiologically prepared for participation in physical activity, sport and exercise, and reduce the incidence of injury.

Sustaining an injury is one of the risks involved in participating in competitive sport, physical activity and exercise. Factors such as age, gender, health, physical fitness, skill level, sports equipment and the environment can all influence the potential for injury. It is estimated that up to 50 per cent of sporting injuries are preventable. A proactive approach to **sports injury prevention** will reduce the likelihood of injury occurring.

Sports injury prevention strategies refer to any processes completed by a coach, athlete or sports administrator to minimise the risk of injury.

There is a correlation between the characteristics of certain sports and the increased risk of injury to athletes. High-risk characteristics include:

- high levels of physical contact
- high impact activity
- heavy physical demands requiring maximal exertion
- high training volume, e.g. swimming and gymnastics which require six to nine sessions per week
- long seasons of competition or no breaks between seasons.

The physical preparation of an individual is the key to prevention of injury. Through appropriate preventative strategies, the individual is better placed to participate in their sport, physical activity or exercise, and reduce their risk of injury. Preventative actions include:

- performing pre-participation screening
- developing physical fitness appropriate to the activity
- developing correct skills and techniques
- completion of adequate warm-up, stretching and cool-down procedures.

Individuals need to be aware of these to ensure that they are in peak condition to participate in their chosen physical activity, sport or exercise.

FIGURE 4.9 Risk of injury is increased with high risk characteristics such as: high levels of physical contact, long seasons and high impact activity.

Pre-participation screening

Pre-participation screening should be undertaken by all individuals prior to commencing or increasing their physical activity, whether that is a health and fitness program or competitive sport. Pre-participation screening can take the form of questionnaires and/or physical examinations. Questionnaires are the most common form of screening and are designed to ask about the medical history of athletes and may include questions relating to current medical conditions, allergies, family histories and previous injuries. Physical examinations provide data on parameters such as height, weight and blood pressure.

Figure 4.9 is an example of an adult pre-participation screening questionnaire produced by Exercise and Sports Science Australia (ESSA), Fitness Australia and Sports Medicine Australia. This form is specifically designed to identify individuals with underlying health concerns or at high risk of something going wrong during exercise.

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Unit 1 | AOS 1 | Topic 4 | Concept 4

Strategies to prevent injuries Concept summary and practice questions

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Digital document SMA questionnaire
Searchlight ID: doc-1108

ADULT PRE-EXERCISE SCREENING TOOL

This screening tool does not provide advice on a particular matter, nor does it substitute for advice from an appropriately qualified medical professional. No warranty of safety should result from its use. The screening system in no way guarantees against injury or death. No responsibility or liability whatsoever can be accepted by Exercise and Sports Science Australia, Fitness Australia or Sports Medicine Australia for any loss, damage or injury that may arise from any person acting on any statement or information contained in this tool.

Name: ______________________________

Date of Birth: ____________________ Male: ☐ Female: ☐ Date: ____________________

STAGE 1 (COMPULSORY)

AIM: To identify those individuals with a known disease, or signs or symptoms of disease, who may be at a higher risk of an adverse event during physical activity/exercise. This stage is self administered and self evaluated.

Please circle response

1. Has your doctor ever told you that you have a heart condition or have you ever suffered a stroke?	Yes	No
2. Do you ever experience unexplained pains in your chest at rest or during physical activity/exercise?	Yes	No
3. Do you ever feel faint or have spells of dizziness during physical activity/exercise that causes you to lose balance?	Yes	No
4. Have you had an asthma attack requiring immediate medical attention at any time over the last 12 months?	Yes	No
5. If you have diabetes (type I or type II) have you had trouble controlling your blood glucose in the last 3 months?	Yes	No
6. Do you have any diagnosed muscle, bone or joint problems that you have been told could be made worse by participating in physical activity/exercise?	Yes	No
7. Do you have any other medical condition(s) that may make it dangerous for you to participate in physical activity/exercise?	Yes	No

IF YOU ANSWERED ‘YES’ to any of the 7 questions, please seek guidance from your GP or appropriate allied health professional prior to undertaking physical activity/exercise.

IF YOU ANSWERED ‘NO’ to all of the 7 questions, and you have no other concerns about your health, you may proceed to undertake light-moderate intensity physical activity/exercise.

I believe that to the best of my knowledge, all of the information I have supplied within this tool is correct.

Signature ______________________ Date ____________

ADULT PRE-EXERCISE SCREENING TOOL

STAGE 2 (OPTIONAL)

Name: ______________________________

Date of Birth: ______________ Date: ______________

AIM: To identify those individuals with risk factors or other conditions to assist with appropriate exercise prescription. This stage is to be administered by a qualified exercise professional.

		Risk factors
1. Age ________ Gender ________	≥45 yrs Males or ≥55 yrs Females +1 risk factor	
2. Family history of heart disease (e.g. stroke, heart attack) Relative / Age / Relative / Age ☐ Father ________ ☐ Mother ________ ☐ Brother ________ ☐ Sister ________ ☐ Son ________ ☐ Daughter ________	If male < 55 yrs = +1 risk factor If female < 65 yrs = +1 risk factor Maximum of 1 risk factor for this question	
3. Do you smoke cigaretes on a daily or weekly basis or have you quit smoking in the last 6 months? Yes No If currently smoking, how many per day or week? ________________________	If yes, (smoke regularly or given up within the past 6 months) = +1 risk factor	
4. Describe your current physical activity/exercise levels: Sedentary ☐ Light ☐ Moderate ☐ Vigorous ☐ Frequency sessions per week ________ ________ ________ Duration minutes per week ________ ________ ________	If physical activity level < 150 min/week = +1 risk factor If physical activity level ≥ 150 min/week = –1 risk factor (vigorous physical activity/ exercise weighted × 2)	
5. Please state your height (cm) ________ weight (kg) ________	BMI = ________ BMI ≥ 30 kg/m^2 = +1 risk factor	
6. Have you been told that you have high blood pressure? Yes No	If yes, = +1 risk factor	
7. Have you been told that you have high cholesterol? Yes No	If yes, = +1 risk factor	
8. Have you been told that you have high blood sugar? Yes No	If yes, = +1 risk factor	

STAGE 2 Total Risk Factors = ________________

FIGURE 4.10 Pre-participation screening tool

Source: essa.org.au

Physical preparation of athletes

Training should always ensure athletes achieve appropriate fitness levels that are specific to the sport. Athletes and coaches must correctly apply the principles of training — particularly those of specificity, appropriate progressive overload, intensity and frequency — during both the pre-season and in-season training. It is important that the athlete's preparation is thorough, but not so demanding as to cause **overtraining**. Adequate recovery between training sessions is vital for the athlete to benefit from the session as well as prevent injury from occurring. Fatigue is one of the most common causes of injury, but physically fit athletes do not fatigue as quickly. Fitness testing in the pre-season phase will allow the coach to identify the strengths and weaknesses of individual athletes, and prepare specialised training for each individual.

Overtraining refers to a physical condition characterised in its most severe form by decreased athletic performance, increased fatigue, persistent muscle soreness, mood disturbances, and a feeling of being 'burnt-out' or 'stale'.

Warm-up

A **warm-up** prepares the body for physical activity. Physiologically, a warm-up:

- increases heart rate and respiratory rate, resulting in increased delivery of oxygen to working muscles
- increases blood flow to muscles, resulting in an increase in muscle temperature and an increase in oxygen delivery to the muscle cells
- increases extensibility of the muscle fibres (and tendons) due to the increase in muscle temperature
- increases enzyme activity within the muscle cells due to increased muscle temperature, facilitating improved energy release within the muscle.

Psychologically, it prepares the mind for competition by increasing focus, attention and concentration.

The type of activity being undertaken should determine the type of warm-up conducted. All warm-ups include a general phase followed by a sport-specific phase.

- The general phase (beginning of the warm-up) should include low-impact aerobic activities, such as jogging, that are continuous in nature, as well as stretching.
- The sport-specific phase should include activities directly related to the muscles, joints and body parts about to be used in the activity. These activity-related movements should be dynamic movements and could involve activities such as:
  - run-throughs
  - high knee-lift running
  - horizontal ladder stepping
  - skill drills that replicate the specific movement patterns performed during the sport or activity; for example, kicking a football.

Warm-up refers to activities and exercise undertaken at the beginning of a training session with the aim of preparing the body both physiologically and psychologically for the training session that follows.

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Unit 1	**Physical preparation of athletes** Concept summary and practice questions
AOS 1	
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FIGURE 4.11 Activities that can be completed in a warm-up

By warming up the muscles, the risk of injury is reduced, particularly muscle strains and tears. This is due to the fact that there is an increased range of motion around the joint and decreased stiffness of the surrounding connective tissue.

There is no set duration for a warm-up; however, the athlete should be guided by how they feel. A general guideline is that the warm-up should produce mild sweating without fatigue. The length of the warm-up is related to weather temperature and, in warmer conditions, the time needed for an adequate warm-up is generally much less than in cooler conditions.

Cool-down refers to low-intensity activity completed at the end of a training session or competition that allows the body to recover by breaking down lactic acid and preventing venous pooling, gradually returning the body to its resting physiological state.

Cool-down

The **cool-down** assists the body to recover from exercise via completion of a low-intensity version of the activity just participated in. It is a gradual reduction in the intensity of the activity being performed, followed by a period of static and proprioceptive neuromuscular facilitation (PNF) stretching of the major muscles used in the activity.

The main aims of the cool-down are to:

- prevent venous pooling (accumulation of blood in the veins)
- ensure that waste products, such as lactic acid, are broken down and removed from the blood
- reduce the potential for muscle soreness
- allow the body to return to its resting physiological state.

The length of a cool-down can vary depending on the athlete and type of activity undertaken. It is the first stage in the recovery process.

FIGURE 4.12 Stretching is an important part of the cool-down procedure.

Fighting sporty kids' arthritis risk

BY CATHY JOHNSON

Sports injuries in kids can leave a lasting legacy: arthritis later in life. However, some simple exercises can dramatically reduce the risk.

There's no denying sport is an important part of a healthy childhood.

But when injuries strike, there's a hidden toll many parents are unaware of. Your child's pain can return years down the track in the form of osteoarthritis, or damaged joints. The disease makes joints stiff and sore and can reduce mobility — sometimes significantly.

In fact research has shown sporting injuries in childhood are responsible for around 20 per cent of osteoarthritis cases in adults, some of whom are as young as 30.

With osteoarthritis affecting two million Australians, that's close to half a million people who can link their condition to childhood sport.

According to research published in 2011, the sports with the greatest number of injuries predisposing to arthritis in later life are soccer, Australian football ('Aussie Rules') and netball. This is partly due to their popularity and the fact they involve sudden changes in direction that tend to create knee injuries. Players aged 15 to 24 are most commonly affected.

The good news is some simple workouts could help prevent the injuries occurring in the first place, says Sydney arthritis expert Professor David Hunter, a staff specialist at Sydney's Royal North Shore Hospital.

If a 10 to 20 minute injury prevention routine was part of training for all school and community sports, it could substantially reduce the number of injuries and therefore future arthritis sufferers, Hunter says.

In Norway, such a scheme produced a drop in injuries as high as 60 per cent and the effectiveness of programs has been documented in several scientific journals.

Prevention programs are rare in Australia but Hunter is part of a group pushing for them to become standard in sporting groups across the country.

Until that happens, he says parents can take the lead.

'Parents have a strong influence over what coaches ultimately do. Or they can just make sure their own kids do the right exercises at home. We want to encourage kids' involvement in sport, but we want to make sure it's done in a safe way.'

Right exercises cut risk

Ideally Hunter would like to see detailed injury prevention routines developed for specific sports. These could then be incorporated into coach education systems, with coaches ensuring the routines are performed correctly by players during training.

Soccer's international governing body, the Federation International Football Association (FIFA), has developed a program suitable for its players, although it hasn't been adopted widely by coaches in Australia.

However, Hunter says parents can help their children reduce their risk of injury by encouraging them to do five of the FIFA program's exercises, which are helpful for players of any sport. He suggests children do these exercises twice a week, ideally on a sporting field or park where there is plenty of space.

(continued)

Exercises

Walking lunges

Stand with your feet hip-width apart and lunge forward slowly at an even pace across a distance (approx. 10 times each leg) and then jog back.

Do this twice (i.e. 2 sets).

Correct	Incorrect
• Bend your leading knee to 90 degrees • Keep your upper body upright • Keep your pelvis horizontal	• Your bent knee should not extend beyond your toes • Do not let your leading knee buckle inwards • Do not bend your upper body forwards • Do not twist or tilt your pelvis to the side

Lateral jumps

Stand on one leg with your upper body bent slightly forwards from the waist, with knees and hips slightly bent. Jump approx. 1m sideways from the supporting leg on to the free leg, maintaining your balance. Repeat, changing legs each time.

Do 2 sets of 30 secs each.

Correct	Incorrect
• When viewed from the front, your hip, knee and foot should be in a straight line • Land gently on the balls of your foot, bend the hip, knee and ankle at the same time and lean your upper body forwards • Keep your upper body stable and facing forwards • Keep your pelvis horizontal	• Do not let your knee buckle inwards • Do not turn your upper body • Do not twist or tilt your pelvis to the side

Box jumps

Stand with your feet hip-width apart and imagine there is a cross marked on the ground and you are standing in the middle of it. Alternate between jumping forwards and backwards, from side to side, and diagonally across the cross. Jump as quickly and explosively as possible.

Do 2 sets of 30 secs each.

Correct	Incorrect
• When viewed from the front, the hip, knee and foot of both legs should be in two straight parallel lines • Jump off both feet and land on the balls of your feet with feet hip-width apart • Bend your hips, knees and ankles on landing • A cushioned landing and a powerful take-off are more important than how high you jump	• Never let your knees meet and do not let them buckle inwards • Do not land with extended knees or on your heels

Boundings

Take a few warm-up steps then take 6-8 bounding steps with a high knee lift before slowing to a jog. Use an exaggerated arm swing for each step (opposite arm and leg). Try not to let your leading leg cross the midline of your body. Jog back to recover.

Do this twice (i.e. 2 sets).

Correct	Incorrect
• Keep your upper body straight • Land on the ball of the leading foot with the knee bent and spring	• Do not let your knee buckle inwards

Plant cut

Jog 4-5 steps, then 'plant' on the right leg (i.e. firmly place your right foot on the ground) and 'cut' to change direction to the left and accelerate. Sprint for 5-7 steps (at 80–90% of maximum pace) before you decelerate and plant on the left foot to cut to change direction to the right. Repeat for a distance of about 70 metres or so then jog back.

Do this twice (i.e. 2 sets).

Correct	Incorrect
• Make sure you keep your upper body straight • Your hips, knees and feet should be aligned	• Do not let your knees buckle inwards

These descriptions are based on those outlined in FIFA's injury prevention program 11+.

The arthritis time bomb

A variety of injuries can predispose a child to arthritis later in life, including severe ankle sprains and tears to the menisci (discs of cartilage on either side of the knee). However, one injury that stands out as particularly problematic is a tear to a major ligament in the knee, the anterior cruciate ligament, Hunter says.

He recommends the five exercises with this in mind. They help sports players strengthen their ankles and learn to land with straight knees. This prevents sudden lurches to the side that impose forces up to 10 times your body weight.

'Of the 20,000 Australians who tear their cruciate ligament each year, about 70 per cent will get osteoarthritis in that knee within 10 to 20 years, irrespective of the treatment they undergo.'

While a torn anterior cruciate ligament can be repaired surgically with a recuperation period of six to 12 months, the initial injury changes the stability of the knee joint so that 'different parts of the joint that weren't previously in contact with each other are now touching,' Hunter says.

Over time, cartilage and other tissues in the joint start to be 'overwhelmed' and start to break down, causing the symptoms of pain and stiffness.

'If we use imaging techniques to follow people [who have injured their cruciate ligament], their joint basically never returns to normal,' Hunter says. 'Even though the ligament repairs, it doesn't necessarily make everything else get back to normal.'

'So a lot of people are getting osteoarthritis in their early and mid-30s as a result of an injury that might have happened in their teens. And most of those people do become quite disabled.'

Prevention is best

Unfortunately there's little you can do to prevent arthritis developing once you've had a cruciate ligament injury, Hunter says — hence the focus on prevention.

Some parents believe, incorrectly, if their child avoids sports involving heavy contact with other players, they will not be at risk.

'People are misled into thinking these injuries occur during heavy contact in violent sport. But the overwhelming majority of them aren't contact injuries, they're a person landing on the knee improperly with no-one even standing near them and the ligament just tears.'

But he urges parents not to let fear of injuries lead them to hold their child back from playing sport.

'Physical activity is healthy and we want kids to do it. And injury prevention is a tangible realistic goal.'

Source: www.abc.net.au, 23 May 2012.

TEST your understanding

1 List the factors that can contribute to an athlete sustaining an injury.
2 Outline the role of pre-participation screening.
3 Explain how the following can help prevent injury:
   (a) adequate fitness
   (b) warm-up
   (c) cool-down.

APPLY your understanding

4 **Practical activity: warm-up/cool-down**
   (a) Working in pairs, plan a warm-up or cool-down for a sport of your choice.
   (b) Conduct the session for the class.
   (c) Explain to the class how each activity completed will help reduce the risk of injury.
5 **Learning activity: injury prevention**
   The figure below shows the top ten most injury-prone sports. Choose three sports from this list.
   (a) List all the injuries that could occur in the three sports.
   (b) Identify all the risks that you think could contribute to injuries sustained in the three sports.
   (c) Outline injury prevention measures for each injury identified.

Top ten most injury-prone sports	
1. Australian Rules football	6. Bike/cyclist/BMX
2. Basketball	7. Hockey
3. Soccer	8. Motor/trail/mini bike
4. Netball	9. Rugby
5. Cricket	10. Tennis

Source: Victorian Injury Surveillance Unit, Monash University Accident Research Centre.

6 **Learning activity: 'Fighting sporty kids' arthritis risk'**
   Read the article on pages 75–7 and use your knowledge to answer the following questions.
   (a) Explain the link between sport, injury and osteoarthritis.
   (b) Identify and classify the types of injuries discussed in the article.
   (c) Outline preventative measures discussed in this article that could reduce the chance of injury occurring.

4.4 Physical aids to support the musculoskeletal system

KEY CONCEPT: Protective equipment, taping and braces are widely used by individuals to provide additional protection from sustaining an injury during physical activity, sport and exercise.

Protective equipment

Most sporting activities use protective equipment designed to reduce the risk of injury to participating athletes, especially the effect of impact and collisions. Some safety equipment is compulsory but much of it is used voluntarily. It is important that all protective equipment:

- is worn during training and games
- fits correctly
- is specific and appropriate for the sport, size and age of athlete
- is regularly checked and maintained.

Protective equipment can cover all parts of the body. It is designed to feel comfortable for the athlete and to not interfere with sporting activity. Protective equipment can be used as a preventative measure prior to an injury occurring or on return to sport where there may be risk of aggravating an old injury. Table 4.8 outlines a range of protective equipment that can be worn across a wide variety of sports.

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Unit 1
AOS 1
Topic 4
Concept 6

Protective equipment Concept summary and practice questions

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Interactivity
Protective equipment
Searchlight ID: int-6632

FIGURE 4.13 Protective equipment should be worn when there is a risk of injury from impact.

While protective equipment is designed to prevent injury, there are instances where this may not occur. In November 2014, Australian cricketer, Philip Hughes was struck by a cricket ball on the back of his neck just below his helmet during a Sheffield Shield match. The blow to his neck led to a haemorrhage, and, tragically, he died two days later in hospital. The Australian cricket community was in shock that such a tragedy could happen on the field and subsequently, many questions were asked about the safety of equipment used and emergency medical care on field.

Hughes was wearing a Masuri-branded helmet when the accident occurred. At that time there was no helmet that could have protected Hughes from the ball hitting an artery in his neck. Masuri has since released a new helmet with greater protection in an effort to prevent another tragic death. It features a clip-on 'StemGuard' made of plastic and foam to help protect the back of the neck. This year, players from Sri Lanka and Australia have been trialling the StemGuard attachment.

Correct footwear

Many sports require different types of footwear depending on the demands of the sport and the surface being played on. Specialised footwear can include running shoes, spikes and football boots. A good running shoe will help prevent injuries such as shin splints, overpronation and underpronation of the foot, and Achilles tendon problems. For example, running shoes should have the following characteristics:

- a good grip on the playing surface
- stability that allows quick changes of direction
- cushioning for shock absorption, such as gel pads or air bladders
- flexibility to allow the foot to flex
- comfort for the wearer
- correct fit.

Shoes should be laced properly before activity to allow a firm fit around the foot. A podiatrist may prescribe orthotics for athletes with congenital defects such as flat feet, high arches, unequal leg length, and overpronation or underpronation. Orthotics inserted into the shoe will prevent ongoing injury. Figure 4.15 describes how to choose sports shoes.

FIGURE 4.14 The new Masuri helmet, featuring the StemGuard attachment, which provides greater protection to the back of the head and neck.

Be specific
No single pair of shoes is right for all activities. Look for shoes designed to reduce and absorb the unique stresses and forces placed on your foot in your chosen activity.

Good cushioning
The importance of cushioning will depend on your injury history, and the type of surface you are exercising on, such as grass or concrete. Look for adequate forefoot and mid-foot cushioning for shock absorption.

Heel support
The structure at the back of the shoe that cups the heel should be firm and wide enough to provide a stable platform for the foot. This is especially important for sports that involve lateral motion, like tennis and basketball. The shoe should also have a notch at the top back of the shoe to prevent rubbing on your Achilles tendon.

Ask for help
Everybody's feet are different. Specialty shoe stores will have a variety of brands, features and styles to choose from, and have staff trained to help you select the right shoe for your activity and anatomy. If you have any injury concerns, it may help to see a podiatrist, who can assess your feet, and recommend the best shoes for you.

Replace old shoes
Shoe wear depends on your foot anatomy, body weight, type of exercise, frequency of training and the training surface. Don't wait till your shoes are completely worn out before buying another pair. They can look clean, but most shoes lose their cushioning after 12 months of use. Inner soles can also be replaced to help absorb your weight.

FIGURE 4.15 How to choose sports shoes

Source: Andrew Cate, exercise physiologist, from ABC Health & Wellbeing, www.abc.net.au.

Taping

Preventative **taping** (or strapping) and bandaging of joints before playing or training can reduce the chance of injury and the severity of a ligament injury or strain. Taping is used to restrict some potentially harmful movements while allowing the desired movement of a joint or muscle during activity.

Taping can be used as a preventative measure, especially in high-risk activities, such as ankles in netball, or in rehabilitation after an injury has occurred to protect the injured site during the healing phase and prevent further injury. It can also be used to enhance **proprioceptive** feedback from the affected site, especially when there has been previous injury to the site.

There are many types of tapes and bandages on the market to be used by athletes. Rigid strapping tape is used if the athlete is wanting to restrict movement and provide mechanical support and proprioception. Soft elastic bandages are used for initial injury, especially when wanting to compress soft tissue and reduce swelling to the affected area. Basic taping techniques include anchors, stirrups, figure of six and figure of eight (see **Taping techniques** weblink in your eBookPLUS for more information).

Whilst taping offers many benefits, potential harms can include irritation of the skin and reduced circulation if too tight. Tape does also lose elasticity over time, and therefore can become less effective than when initially applied. Taping can be applied by athlete but is often applied by medical professionals.

Taping refers to the use of strapping tape to limit the range of movement in a joint as part of an athlete's prevention or rehabilitation strategy.

Proprioception is the ability of the muscles, tendons and joints to receive and process stimuli about their position.

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Weblink
Taping techniques

FIGURE 4.16 Preventative taping can reduce the chance of injury.

FIGURE 4.17 Kinesiology taping allows an athlete a greater range of movement while still offering support to an injured muscle or joint.

Kinesiology taping

An alternative form of tape is kinesiology tape. This tape is thinner and more elastic than traditional rigid strapping tape. It is a less restrictive type of taping that allows muscle support while not compromising range of joint motion. The tape is not completely wrapped around the injured joint or muscle, but applied over or on the periphery of these areas. Benefits of this type of taping are thought to include pain relief, greater range of motion and the ability to be worn for longer than rigid strapping tape.

The tape is applied in different techniques to rigid strapping with three general shapes:

- an 'I' shape where the tape is applied linearly
- a 'Y' shape for larger muscles, such as the deltoid across the shoulder
- an 'X' shape for large and long muscles such as down the hamstring on the biceps femoris.

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Unit 1
AOS 1
Topic 4
Concept 7

Taping and bracing
Concept summary and practice questions

FIGURE 4.18 A knee brace provides extra support during physical activity.

Braces

Sports braces play a similar role to taping in the prevention of sports injuries, with the added advantage of the athlete being able to put on the brace themselves rather than relying on a professional to tape the affected joint. While they can be expensive, a good quality brace will last longer and may be cheaper in the long term if the athlete needs to repeatedly tape an area.

As well as being used for the prevention of sporting injuries, taping, bandages and braces can also be used for the musculoskeletal conditions outlined in section 4.2, especially for arthritic joints and back pain.

TABLE 4.8 Protective equipment used in a variety of sports

Protective equipment	Sports used in (examples)	Potential injury prevented
Mouthguard	Boxing Collision sports (e.g. hockey, netball, basketball) Football codes (AFL, soccer, rugby)	Dental injury • Teeth knocked out, chipped, broken, displaced • Mandible (jaw) injury
Goggles/glasses	Skiing Squash Swimming	Eye injury
Helmet/face shield	Baseball/softball Cycling Cricket (wicketkeeper, slips) Fencing Football codes (soft helmet) Gridiron Hockey (goalie) Horse racing (jockey) Ice hockey Snowboarding	Broken jaw, facial bones Skull fracture Facial lacerations Concussion
Lower leg/shin padding	Baseball/softball (catcher) Cricket Hockey Soccer Volleyball	Lower limb contusion Broken bones in lower leg/ankle
Upper body/chest padding	Baseball/softball (catcher) Cricket Fencing Gridiron Hockey (goalie)	Broken/fractured ribs Contusion
Gloves	Boxing Cricket Hockey (goalie)	Broken/fractured/dislocated fingers Contusion
Wrist/forearm guard	In-line skating Snowboarding	Broken/fractured wrist
Footwear	Athletics (spikes) Basketball Baseball Boxing Cricket Football codes (AFL, soccer, rugby) Golf	Shin splints Strains/sprains Stress fractures

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Interactivity
Protective equipment/likely injury
Searchlight ID: int-6633

eBook*plus*

Interactivity
Protective equipment: which sport?
Searchlight ID: int-6634

TEST your understanding

1 Discuss the important considerations for the use of protective equipment in sport.
2 Explain why correct footwear is important for the prevention of injury.
3 Outline the purpose of taping and braces.

APPLY your understanding

4 (a) Choose a sport and list all the protective equipment that is available for playing that sport.
(b) Outline why each piece of equipment has been introduced.
(c) Explain the potential injury prevented by each piece of equipment.
(d) Outline how each piece of equipment protects the athlete.
(e) Nominate whether the equipment is compulsory or optional.

5 **Practical activity: taping**
The aim of this activity is to teach students how to tape a sports injury.

Equipment

- rolls of thick (38 mm) and thin (12 mm) masking tape
- undertape (to protect skin and hair)

Method

Instructions on taping an ankle can be viewed using the 'How to tape' eLesson in your eBookPLUS.
Listen to the instructions and then complete the following.
(a) In pairs, discuss the main points concerning the taping of the ankle.
(b) Use the masking tape to tape your partner's ankle.
(c) Swap over so your partner can tape your ankle.

Results

Compare your taping efforts with other class members and have the teacher assess your efforts and give feedback.

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eLesson
How to tape
Searchlight ID: eles-2580

CHAPTER 4 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action words:**
  a. **Classify** — organise into a group of similar types
  b. i. **Explain** — to make the meaning of something clear and understandable
     ii. **Describe** — provide a detailed account of
  c. **Discuss** — to go into detail about the characteristics of a key concept
- **Key terminology:**
  Injury — type and/or cause of injury
  Preventative — what can be used to reduce the risk of an injury occurring
- **Key concept/s:**
  Injury classification — must answer using the recognised classification system of injuries (acute, chronic or overuse)
  Cause of injury — identification of what could happen during an activity to cause an injury to occur
  Preventative measures — methods that can be used to reduce the risk of an injury occuring
- **Marking scheme** – *a. 2 marks b. 1+1 = 2 marks c. 2 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

a. i & ii **1 mark** each for correct classification of injury
b. i **1 mark** for explaining why a tear occurs
   ii **1 mark** for providing another example of how a tear might occur in cricket
c. **1 mark** – identification of a preventative measure
   1 mark – discuss how the measure could reduce the risk of back injury reoccurrence.

KEY SKILLS

- Examine a variety of causes of musculoskeletal injuries
- Describe and implement the correct application of techniques and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- injuries can be classified as acute, chronic and overuse
- injuries can be caused by an external force (direct contact) or an internal force (indirect contact) and can affect the hard or soft tissue of the body
- physiological strategies to prevent injury include physical preparation of the athlete, warm-up and cool-down
- physical aids such as protective equipment, taping and bracing can support the optimal functioning of the musculoskeletal system.

PRACTICE QUESTION

(adapted from ACHPER 2015 Unit 1 exam, question 1)

Australian Cricket Captain Michael Clarke's 2014–15 summer was hampered by a number of injuries. During day one of the First Test in Adelaide, Clarke was forced to retire hurt by a degenerative back condition after he twisted to avoid a ball. Clarke has three degenerative discs in his lower back that were first diagnosed when he was a teenager.

Clarke then suffered a tear in one of the tendons of his right hamstring while performing an off-balance throw fielding a ground ball on day five of the test.

1 a. **Classify** each of Clarke's injuries described above. *(2 marks)*
   i. Back injury
   ii. Hamstring injury
  b. i. **Explain** why a tear such as that experienced by Clarke in his right hamstring occurs. *(1 mark)*
   ii. Other than the fielding example above, **describe** an example of how this type of injury could happen whilst playing cricket. *(1 mark)*
  c. **Discuss** a preventative measure that Clarke could have taken to reduce the risk of his back injury reoccurrence. *(2 marks)*

Sample response

a. i. Chronic injury
   ii. Acute injury
b. i. Tears occur when connective tissue, in Clarke's case a hamstring tendon, is excessively stretched due to not being able to handle the stress placed on it.
   ii. Examples could include accelerating quickly:
   – to run between the wickets while batting
   – during a bowler's runup to bowl.
c. Answer must relate to preventative measures such as warm-up, physical preparation, taping. e.g. Appropriate level of physical preparation to ensure that his body is able to cope with the demands of batting, bowling and fielding for cricket, particularly minimising the risk of injury as a result of fatigue

PRACTISE THE KEY SKILLS

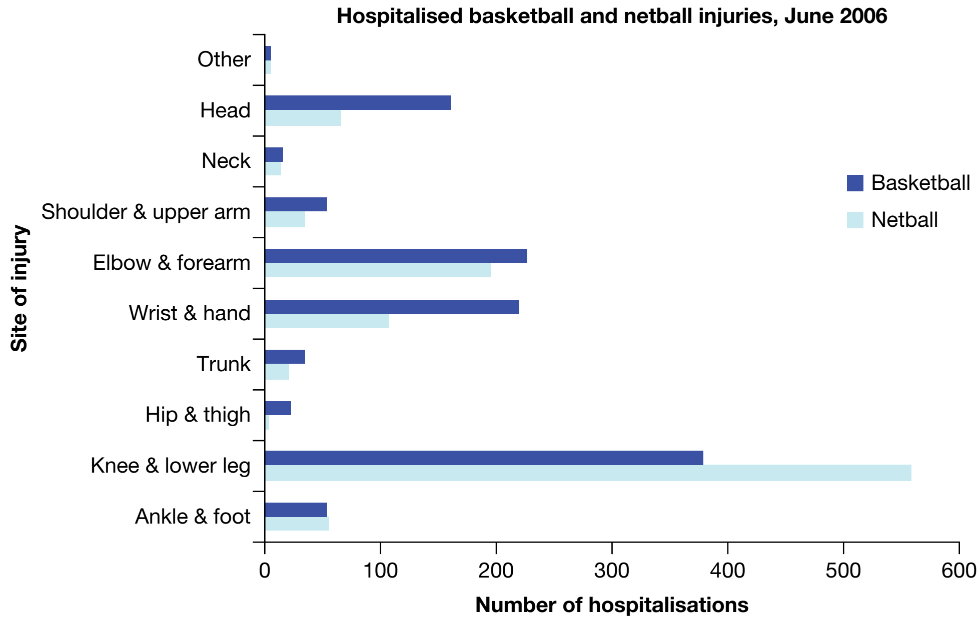
1 Describe each of the three classifications of injuries and how they occur.
2 Outline a physiological strategy that could be untilised to reduce the risk of sustaining an injury in physical activity, sport and exercise.
3 Discuss two physical aids that could be used to prevent injuries in sport.

KEY SKILLS EXAM PRACTICE

1 Identify a direct, indirect and overuse injury that may be included in the most common reasons for basketball hospitalisations shown in the following graph.

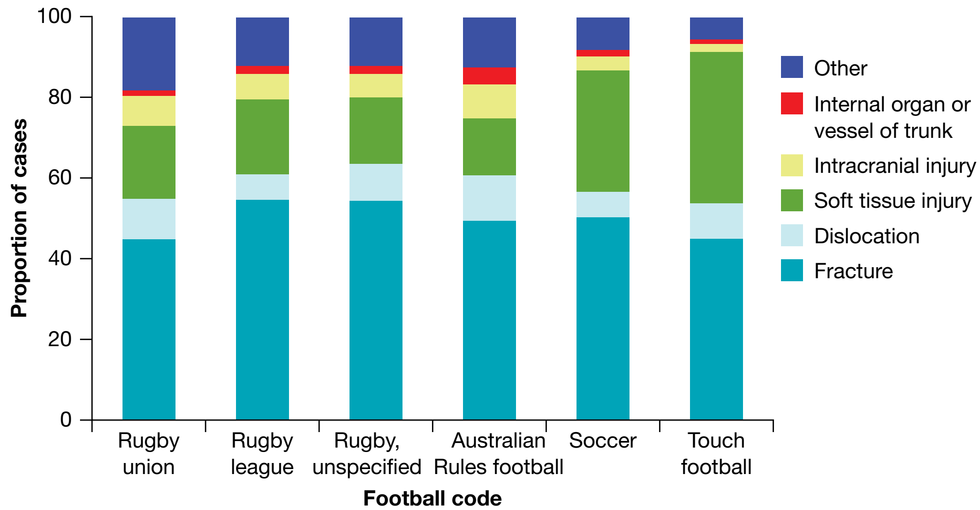
Direct	
Indirect	
Overuse	

3 marks



Source: Flood L. and Harrison J. (AIHW National Injury Surveillance Unit), 2006. 'Hospitalised basketball and netball injuries', NISU briefing no. 3. Cat. no. INJ 84. Canberra: AIHW.

2 According to the AIHW *Australian sports injury hospitalisations 2011–12* report, all codes of football combined accounted for around one-third of all hospitalisations (34 per cent). The types of injuries sustained are outlined in the graph below.



a. From the graph, identify the most common type of injury sustained across all football codes. *1 mark*
b. Classify the type of injury identified in part a. *1 mark*
c. According to the graph, soft tissue injury is most common in which sport? *1 mark*
d. State the types of soft tissue injuries that may occur in this sport and suggest a reason as to how these injuries might occur. *4 marks*
e. Outline a preventative measure that could be used in all football codes that could reduce the incidence of soft tissue injuries. *2 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

- Sports injuries can be classified as acute, chronic or overuse. Injuries can be sustained through direct contact, such as an external force, or indirect contact, such as an internal force.

- Injuries occur to soft tissue such as skin, ligaments, tendons and muscles; and to hard tissue such as bones. Common types of injuries include cuts, abrasions, tears, strains, sprains, bruising, fractures and dislocations.
- Measures can be taken to minimise the risk of injuries occurring in sport and to make the return to training as efficient as possible.
- Musculoskeletal conditions affect the bones, muscles, joints and ligaments of the body and often limit the capacity and mobility of an individual.
- The most common illnesses and conditions in Australia affecting the musculoskeletal system include arthritis, osteoporosis and back pain.
- Arthritis is characterised by inflammation around the joints, causing pain and stiffness. The most common forms are juvenile arthritis, osteoarthritis and rheumatoid arthritis.
- Osteoporosis is characterised by the thinning and weakening of bone and is more common in women and people over 55 years of age.
- Back pain can affect bones, joints, tissues and nerves of the back and often stems from overuse, injury, weakness, degeneration or postural misalignment.
- Common preventative measures for musculoskeletal conditions include participation in regular physical activity, maintenance of healthy body weight, limiting sedentary behaviour and eating a nutritious diet.
- Sports injury prevention includes the following strategies: pre-participation screening; physical preparation of athletes; an appropriate warm-up and cool-down; use of protective equipment; correct footwear; taping and the use of braces.
- The structure of training programs and the types of recovery techniques have a significant role to play in the prevention of sports injuries.
- Protective equipment is most effective if it is worn during training and games, it fits correctly, it is specific and appropriate for the sport, size and age of the athlete and is regularly checked and maintained.

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Sit Topic Test

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Interactivity
Acute and chronic injuries and illnesses of the musculoskeletal system quiz
Searchlight ID: int-6635

MULTIPLE CHOICE QUESTIONS

1 A muscle strain is an example of
(A) an acute injury.
(B) a chronic injury.
(C) an overuse injury.
(D) a direct injury.

2 Excessive movement of a joint is most likely to result in which type of injury?
(A) Contusion
(B) Laceration
(C) Dislocation
(D) Fracture

3 Which of the following is an example of an overuse injury?
(A) Broken wrist
(B) Shin splints
(C) Concussion
(D) Muscle sprain

4 The most common form of arthritis is
(A) juvenile arthritis.
(B) osteoporosis.
(C) rheumatoid arthritis.
(D) osteoarthritis.

5 Risk factors for developing osteoporosis include
(A) sedentary behaviour.
(B) poor calcium intake.
(C) increasing age.
(D) all of the above.

6 A common preventative measure against developing illnesses affecting the musculoskeletal system is
(A) regular participation in physical activity.
(B) consuming a diet high in calcium.
(C) maintaining poor posture.
(D) protecting your back when lifting heavy objects.

7 Which of the following is not an important consideration for the physiological preparation of an athlete in injury prevention?
(A) Warm-up
(B) Cool-down
(C) Taping a joint
(D) Appropriate fitness levels

8 The role of pre-participation screening is to
(A) check your strengths and weaknesses.
(B) determine medical history that could impact on physical activity.
(C) improve your questionnaire skills.
(D) see how fit you are.

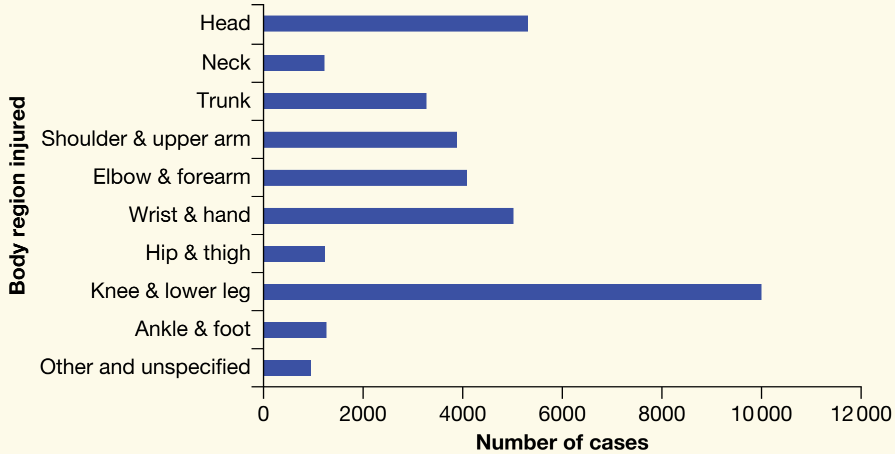
9 A helmet is a preventative measure to reduce the risk of what type of injury to the head?
(A) Contusion
(B) Dislocation
(C) Concussion
(D) Sprain

10 Taping can assist in the prevention of injuries to a joint via
(A) enhancing movement around a joint.
(B) restricting movement around a joint.
(C) stopping movement around a joint.
(D) all of the above.

EXAM QUESTIONS

Question 1

The following graph outlines the body regions injured across a range of sports, for which hospitalisation was required in 2011–12.



a. From the graph, identify the most common body region injured. **1 mark**

b. Identify a direct, indirect and overuse injury that may occur to the body region identified in part a. **3 marks**

Direct: ______________________________

Indirect: ____________________________

Overuse: ____________________________

c. Outline a preventative measure that could be used to reduce the likelihood of an injury occurring in the body region identified in part a. **2 marks**

Question 2

(adapted from ACHPER Trial Exam 2014, section 1 and 2)

Identify and justify what type of injury would be most common in rugby and other contact sports. **2 marks**

Question 3

(adapted from ACHPER Trial Exam 2014, section 1 and 2)

There are many arguments that highly physical sports such as rugby should separate junior competitions based on weight and not age.

Discuss how this may lead to decreased injuries.

Question 4

Injuries to the knee and ankle are common in basketball. For each of the following areas, describe a preventative measure that could be implemented to reduce the number of knee or ankle injuries to the members of a basketball team:

a. training **b.** equipment. **2 marks**

INQUIRY QUESTION
What legal and illegal substances and methods can be used to enhance the performance of the musculoskeletal system to improve the strength, power and speed of an athlete?

CHAPTER 5

Performance enhancement of the musculoskeletal system

Legal and illegal performance-enhancing substances and methods are used by many athletes to give them an advantage over the competition. As well as providing benefits to the athlete, they may also potentially harm the athlete.

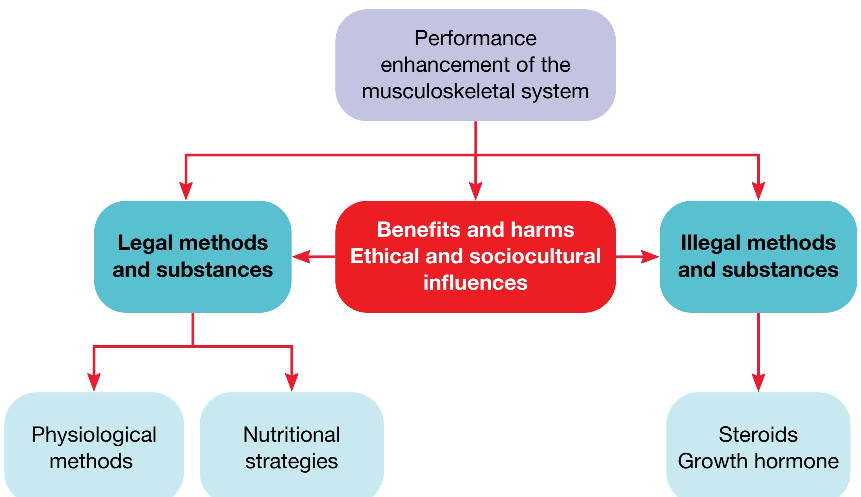
KEY KNOWLEDGE

- Actual and perceived benefits and potential harms of legal and illegal substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)
- The ethical and sociocultural considerations of legal and illegal practices associated with enhancing the performance of the musculoskeletal system in sport

KEY SKILLS

- Investigate, evaluate and critically analyse a range of performance-enhancing practices from a physiological perspective
- Discuss the ethical considerations and sociocultural influence on the use of legal and illegal practices associated with improving the function of the musculoskeletal system

CHAPTER PREVIEW



5.1 Performance-enhancing substances and methods

KEY CONCEPT Performance enhancement includes any method, device or substance that has the potential to improve athletic performance. These enhancements can be legal, such as training methods or naturally occurring food sources, or they can be illegal, such as synthetically manufactured hormones.

Performance enhancement includes methods, devices or substances that enhance athletic performance.

A number of practices are employed by athletes today to enhance their performance and assist with training and recovery. **Performance-enhancing** methods and substances are used by many athletes and are thought to improve performance by:

- influencing the physiological capacity of a particular body system (e.g. use of creatine supplementation to increase creatine stores in the muscle for replenishment of ATP)
- removing physiological constraints that impact on performance (e.g. use of diuretics to reduce body weight so the athlete is lighter or makes a weight category)
- increasing the speed of recovery (e.g. use of compression garments to increase blood flow and removal of wastes).

Performance-enhancement techniques can be categorised as mechanical, nutritional, pharmacological, physiological or psychological depending on what the substance or method does and how it interacts with the body to enhance performance. Examples for each of these categories include:

- mechanical — devices including heart rate monitors, weights, sports clothing and footwear, and equipment
- nutritional — food sources including caffeine, creatine and sports drinks
- pharmacological — synthetically produced drugs including anabolic steroids, beta blockers and amphetamines
- physiological — practices and use of naturally occurring products including blood doping, EPO, human growth hormone
- psychological — methods including imagery, meditation, music, relaxation.

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Unit 1	**Performance-enhancing substances and methods** Concept summary and practice questions
AOS 1	
Topic 5	
Concept 1	

FIGURE 5.1 Specially designed clothing can help athletes improve their performance.

TEST your understanding

1. Define the term *performance enhancement*.
2. List the five categories of performance-enhancement techniques and include three examples for each category.

APPLY your understanding

3. (a) Identify the ways performance-enhancement techniques are thought to improve performance.
   (b) For each way identified in part (a), suggest types of athletes who may use performance-enhancement techniques to gain these improvements.

5.2 Legal substances and methods: training methods and mechanical aids

KEY CONCEPT There are a variety of ways to legally enhance performance. One of the most obvious legal methods is through specific training methods and aids.

As previously discussed, the musculoskeletal system has an important role in body movement, as well as creating energy for movement. Muscles attach to bones to create movement and the reactions that take place with the muscle determine how hard, fast or long we can work. The musculoskeletal system contributes to both aerobic and anaerobic energy production.

A variety of training methods and aids can be used by athletes and coaches to enhance performance of the musculoskeletal system. By determining the relevant fitness components, energy systems and muscles used in each sport, athletes and coaches can decide on the best method to improve an athlete's performance.

Training methods that can specifically enhance performance of the musculoskeletal system include:

- anaerobic training methods such as resistance training, plyometric training and short, intermediate or high intensity interval training to develop power, strength and speed
- aerobic training methods such as continuous training, fartlek or long-interval training to develop endurance.

Through specific training a number of **chronic muscular adaptations** occur to enhance an athlete's performance. These are outlined in table 5.1.

Chronic adaptation consists of the long-term responses of body systems, developed over a period of time in response to a training program.

TABLE 5.1 Chronic muscular adaptations of anaerobic and aerobic training

	Chronic adaptation	Benefit to performance	Potential harms
Anaerobic training	Muscular hypertrophy Increased number and size of myofibrils Increased stores of ATP, CP and glycogen Increased glycolytic capacity Increased speed of contractions Increased tolerance to accumulation of metabolic by-products	**Increased strength, power and/or speed via:** Greater strength and force created by the muscle Greater capacity to produce energy quickly Faster speed of muscle contraction Greater ability to continue to work at higher intensities Increased capacity to tolerate by-products and delay the onset of fatigue	**Risk of injury due to:** Lack of adequate fitness Incorrect application of training principles Not enough recovery Too heavy resistance Incorrect technique Overtraining
Aerobic training	Increased size and number of mitochondria Increased myoglobin Increased stores of glycogen and triglycerides Increased capacity to oxidise glucose and fats Increase a-VO_2 difference Decreased use of the anaerobic glycolysis system	**Increased endurance via:** Greater capacity to produce energy due to more sites for aerobic energy production Greater capacity to work for longer due to greater fuel availability Ability to work aerobically at higher intensities for longer Delayed lactate inflection point (LIP) therefore decreased reliance on anaerobic energy systems	**Risk of injury due to:** Lack of adequate fitness Incorrect application of training principles Not enough recovery Incorrect technique Overtraining

FIGURE 5.2 A variety of methods can be used to train the musculoskeletal system, both anaerobic and aerobic training.

Anaerobic training methods

Resistance training

Resistance training aims to build muscle strength, muscle power or local muscular endurance by exercising muscles or a group of muscles against a resistance.

Resistance training involves exercising a muscle or group of muscles against a resistance. It is the most common training method used to develop muscular strength, power or endurance.

The main physiological effects of using resistance training to enhance the performance of the musculoskeletal system include:

- increased muscle size, mass and fuel stores
- increased bone density and strength.

These changes benefit the performance of the individual as they lead to an increased capacity to produce the greater strength and/or power required to run faster, throw or kick further, or jump higher in their chosen sport.

While resistance training is a very good way to develop the musculoskeletal system, athletes need to consider the potential harms from engaging in this type of training. Harms can include:

- overtraining — not allowing enough recovery between sessions for the muscles to repair and grow
- injury — lifting too heavy a weight or using incorrect technique, placing stress on muscles, bones and joints.

As discussed in chapter 3, muscle contractions are classified according to the movement they cause:

- dynamic (concentric, eccentric, isokinetic, isoinertial) and
- static (isometric).

Resistance training methods are based on each of these classifications and can involve the use of free weights, machine weights and body weight.

FIGURE 5.3 Resistance training methods involve different types of muscle contractions: (a) isoinertial free weight training (b) isometric training.


(a)


(b)

Mechanical aids to resistance training

In addition to the traditional use of dumbbells, barbells and weighted machines, resistance training can also incorporate a variety of mechanical aids. These aids can include tyres, parachutes, elastic cords and weighted vests. These aids aim to provide added resistance while completing sport-specific movement, such as running, to develop strength and power specific to the muscles used in the activity.

FIGURE 5.4 Mechanical aids such as parachutes, tyres and resistance cords can be used to assist resistance training.

Plyometric training

The aim of **plyometric training** is to increase muscular power by first stretching a muscle (eccentric contraction) and then contracting it (concentric contraction) in the shortest time possible.

Plyometric training aims to increase muscular power by first stretching a muscle then contracting it in the shortest time possible.

This training method takes advantage of the stretch-shortening cycle or the stretch reflex. This is where the body attempts to resist the sudden change in muscle length by calling on the stretched muscle to contract, and thus prevent the suddenly stretched muscle from tearing. Essentially, plyometrics trains this reflex to develop a more powerful contraction of the muscle. The benefit of this type of training is it allows the athlete to produce more explosive power when running, jumping, kicking or throwing, depending on the muscles focused on.

Because plyometric exercises can create so much muscular power, potential harms relate to the safety and appropriateness of the exercises being performed and specific guidelines should be followed. These exercises can place considerable stress on the body and joints and are not recommended for individuals with poor fitness levels. Individuals should start with low-impact activities before progressing to those which place greater stress on the body. If not completed correctly and without adequate fitness or recovery, plyometric training has the potential to cause injury through tearing of the muscles.

Examples of plyometric exercises are shown below.

Low impact drills, such as:

- skipping with and without a rope
- doing low hops, step and jumps
- throwing a light (2.5 kg) medicine ball (see figure 5.5a),

High impact drills, such as:

- bounding with alternate legs
- clap pushups (see figure 5.5b)
- jumping on, over and from benches that are 35 cm high
- throwing a heavy medicine ball (above 4 kg).

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Unit 1 | AOS 1 | Topic 5 | Concept 2

Anaerobic training
Concept summary and practice questions

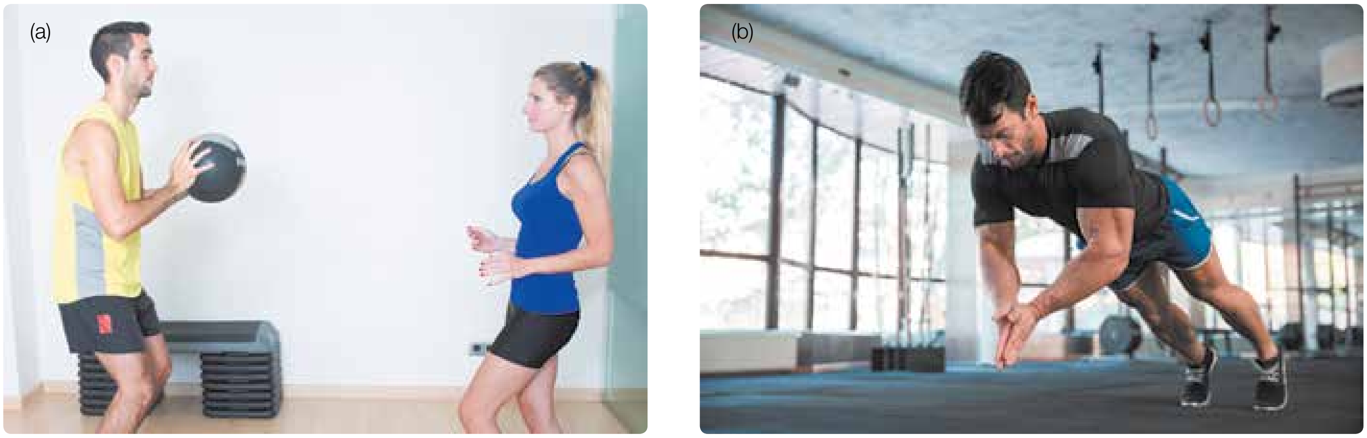

FIGURE 5.5 Plyometric training exercises: (a) Low impact medicine ball throw and (b) high impact clap pushup

Interval training: short, intermediate and high intensity interval training (HIIT)

Interval training consists of intervals of work followed by intervals of rest or recovery.

Interval training involves set periods of work followed by set periods of rest or recovery repeated several times in an exercise session. This type of training allows for repeated high-intensity work periods that improve speed, power, anaerobic capacity and agility. Interval training can be used to develop all three energy systems depending on the manipulation of the work and rest periods and the intensity the repetitions are performed at. The types of interval training specific to the anaerobic enhancement of the musculoskeletal system are outlined in table 5.2.

TABLE 5.2 Summary of interval training types

Interval type	Energy system	Work intensity	Work-to-rest ratio	Suitable sports
Short	ATP-PC	95%+ MHR	1 : 5	100-metre sprints, team sports
Intermediate	Anaerobic glycolysis	85%+ MHR	1 : 3	200-metre sprint, team sports
High intensity (HIIT)	Anaerobic and aerobic energy systems	80%+ MHR to maximal	Varied depending on aim of session 2 : 1, 1 : 1	Any

The benefit of short and intermediate interval training for the athlete is through the adaptations that occur at the muscular level allowing them to run faster through improved speed, power and anaerobic capacity. This type of training is useful for team sports where the work-to-rest ratio can resemble that of a game situation, with intense bursts of speed followed by periods of recovery.

High-intensity interval training (HIIT) involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity.

The addition of **high-intensity interval training (HIIT)** into training programs has increased in recent times. HIIT involves repeated bouts of high intensity efforts (90–95%+ HR max) followed by varying periods of complete rest or recovery at a lower intensity (40–50% HR max). HIIT can be adapted from traditional cardio activity to resistance training where the athlete will use explosive effort to move a resistance. These efforts range from 5 seconds to 30 seconds of work, with complete rest recovery in between.

Potential harms of these types of interval training include increased risk of injury due to inadequate fitness levels and incorrect application of training principles, including not allowing enough recovery for the body to adapt between sessions.

Aerobic training methods: benefits and harms

As identified in table 5.1, aerobic training produces a variety of chronic muscular adaptions to enhance performance. These adaptations allow for greater energy production, especially when working at higher intensities. However, the critical factor in improved performance relates to the efficient delivery of oxygen to the working muscles via the cardiorespiratory system. This aspect will be discussed in depth in chapter 9, 'Performance enhancement of the cardiorespiratory system'. Training methods most suited to aerobic energy production are briefly outlined in table 5.3.

TABLE 5.3 Summary of continuous training methods

Training type	Description	Example
Continuous	Continuous activity that lasts a minimum of 20 minutes at the required sub-maximal (70–85% HR max) intensity	Runners, swimmers or cyclists exercising continuously for 30 mins at 80% HR max
Fartlek	Continuous activity that involves surges of higher intensity throughout the session	Changes in intensity can be simply an increase in pace or running up a hill.
Long interval training	Intervals lasting between 1–6 minutes. Work periods sub-maximal intensity closer to 85% HR max. Rest periods passive or active at lower intensity. Work-to-rest ratio 1 : 1 or below	Middle distance runner — run 4 min 85% HR max, rest 4 min

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Unit 1
AOS 1
Topic 5
Concept 3

Aerobic training (musculoskeletal)
Concept summary and practice questions

FIGURE 5.6 Continuous training increases the number and size of mitochondria in the muscle to produce energy for aerobic activities.

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Interactivity
Anaerobic or aerobic
Searchlight ID: int-6636

TEST your understanding

1 Describe each of the legal training methods that can be used to enhance musculoskeletal performance.
2 Outline the actual and perceived benefits and potential harms from participating in a resistance training session.
3 Explain how plyometric training makes use of the stretch reflex to increase muscular power.
4 Discuss the ways aerobic training can enhance the performance of the musculoskeletal system.

APPLY your understanding

5 Explain why an athlete might use a mechanical aid in addition to normal training. Provide specific examples.
6 **Practical activity: plyometrics session**
Participate in the following plyometrics training session. Make sure you have completed a thorough warm-up prior to completing these exercises. For each exercise, perform at a low level with ten repetitions. Recovery of one minute between each exercise.
- Squat jumps
- Mountain climbers
- Alternate leg bounds
- Power skipping
- Lateral (side) jumps

(a) Discuss the way in which plyometrics can improve the performance of the musculoskeletal system.
(b) Outline potential harms of this type of training and link these harms to suggested safety considerations.
(c) Design your own plyometrics training session for a sport of your choice. Consider skills required and muscles used when choosing the activities.

5.3 Legal substances and methods: nutritional supplements

KEY CONCEPT: Nutritional supplements are commonly used by athletes to enhance performance, however an athlete needs to be aware of the potential doping risks associated with the ingestion of such products.

Nutritional supplements have been developed for athletes over the years in an effort to assist the athlete to gain an edge over their competitors. Unfortunately, a number of these supplements have no real scientific credibility and the long-term effects of using them have not yet been fully researched. In addition, any supplement may carry a drug or doping risk. It is the athlete's own responsibility to avoid breaking the anti-doping rules. On the other hand, nutritional supplements can play some part in assisting the athlete to reach their peak performance.

Nutritional supplements are food or preparations ingested in excess of those consumed in a normal diet to supplement or increase the amount of nutrients available.

FIGURE 5.7 Dietary supplements may be of benefit if specific nutrients are lacking in the diet.

Nutritional supplements can be divided into three broad groups:

1. *Specialised sports foods*. These address an athlete's specific nutritional needs and include sports drinks, sports bars or gels, and liquid-meal supplements. Athletes find that these products can be a useful addition to their specialised nutrition program, in that they are practical and convenient to incorporate into any training regime.
2. *Dietary supplements*. Even through the rigours of regular training and competing, the athlete should not require supplements, provided they have a well-chosen diet that addresses their daily energy intake. Supplements are really only required if a specific nutritional deficiency is identified. For example, calcium and iron supplements are sometimes advised for female endurance athletes.
3. *Performance supplements*. These benefit performance and/or recovery from exercise. Research has found that the benefits claimed by very few so-called nutritional performance supplements are actually supported by scientific evidence and as such these aids should be used with caution. There is some support, in certain circumstances, for the use of caffeine, creatine and bicarbonate being of benefit to the athlete.

The Australian Institute of Sport (AIS) provides information for athletes to inform them of the appropriate use of nutritional supplements. It also educates them in respect to anti-doping regulations as they apply to nutritional supplements.

The AIS uses the ABCD classification system to identify sports supplements and/or ergogenic aids that can be used by athletes, and categorises them according to the amount of scientific evidence available to support their use. Table 5.4 on page 98 gives a summary of these categories or groupings. Currently, only group A supplements have scientific backing and are supported by the AIS for use by its athletes.

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AIS nutrition

TABLE 5.4 A guide to sports supplement groupings

Supplement grouping	Definition of grouping	Subcategory	Examples
A	**Evidence:** Supported for use in specific situations using evidence-based protocols.	Sports foods	Electrolyte replacement Liquid meals Sports bars Sports confectionary Sport drinks Sports gels Whey protein
		Medical supplements	Calcium Iron Multivitamins/minerals Probiotics (gut/immune) Vitamin D
		Performance supplements	B-alanine Bicarbonate Beetroot juice Caffeine Creatine
B	**Evidence:** Deserving of further research and could be considered for provision to athletes under a research protocol or case-managed monitoring situation.	Food polyphenols	Curcumin Exotic berries (acai, goji etc.) Quercetin Tart (Montomorency) cherry
		Other	Antioxidants C and E Carnitine Fish oils Glucosamine Glutamine HMB
C	**Evidence:** Have little meaningful proof of beneficial effects. Not provided to athletes within supplement programs.	Category A and B products used outside approved protocols The rest — if you can't find an ingredient or product in groups A, B or D, it probably deserves to be here.	See lists for category A and B products.
D	**Evidence:** Banned or at high risk of contamination with substances that could lead to a positive drug test. Should not be used by athletes.	Stimulants	Ephedrine Strychnine Sibutramine Methylhexanamine (DMAA) Other herbal stimulants
		Prohormones and hormone boosters	DHEA Androstenedione 19-norandrostenione/ol Other prohormones
		GH releasers and peptides	
		Other	Glycerol – banned as a plasma expander Colostrum

Source: Adapted from The Australian Institute of Sport.

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Unit 1 | AOS 1 | Topic 5 | Concept 4

Nutritional supplements
Concept summary and practice questions

TEST your understanding

1 Define what constitutes a nutritional supplement.
2 Outline the Australian Institute of Sport (AIS) ABCD classification system and explain why it exists.

APPLY your understanding

3 Nutritional supplements can be divided into three broad groups. List and outline each of the groups, including examples. Suggest athletes or sports that might use these supplements.
4 Choose one of the supplements identified in table 5.4 and use the internet to research:
- what the supplement is
- the type of athlete/sport this supplement may be beneficial for
- the form the supplement comes in
- how to consume the supplement
- actual and perceived benefits of consuming the supplement
- potential harms related to the supplement
- any other relevant information.

5.4 Specialised sports foods, methods and dietary supplements

KEY CONCEPT Specialised sports foods and dietary supplements are useful in providing a practical alternative to food when food cannot be consumed or if a specific nutritional deficiency is identified.

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eLesson
Professor Louise Burke, Head of Nutrition, Australian Institute of Sport, discussing supplements
Searchlight ID: eles-2571

Nutritional supplements play an important role in fuel supply, delaying fatigue and assisting recovery. They can be consumed prior to, during or after a training bout or competition to aid the athlete. Specialised sports foods, methods and supplements that can enhance the performance of the musculoskeletal system are outlined below.

Carbohydrates

Carbohydrates are the major fuel required for activities of high intensity as well as sub-maximal, prolonged duration. The body can store only a certain amount in the liver and muscles, therefore it is important for an athlete to make sure they have adequate supplies and continue to consume enough carbohydrates to maintain availability for energy production. The following discusses methods as well as specialised sports food that may be used by athletes to meet the fuel needs and enhance the performance of the musculoskeletal system.

Application of the glycaemic index

The **glycaemic index** is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood-glucose levels after eating.

Glycaemic index (GI) is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood-glucose levels after eating. Foods that have a high glycaemic index (70 and above) are those that are rapidly digested and absorbed and result in a rapid increase in blood glucose levels. Foods with a low glycaemic index (55 or less) are slowly digested and absorbed and produce gradual rises in blood glucose and insulin levels (see fig 5.8).

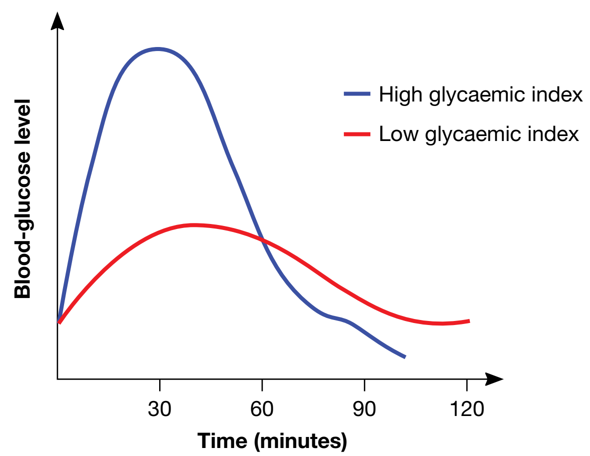

FIGURE 5.8 Rate of release of glucose for foods with a high and low glycaemic index

Knowledge of the glycaemic index allows athletes, coaches and sports dietitians to determine what carbohydrate foods to eat and when to eat them. This is particularly important for sub-maximal endurance athletes where glucose is the main fuel for replenishment of ATP.

Low-GI foods are suggested pre-event to maximise stores and provide a sustained release during activity, whereas high GI foods are recommended during activity to replace and top up stores, as well as after activity to replace depleted stores quickly. Manipulated correctly, application of the glycaemic index will benefit the athlete by optimising their carbohydrate availability for energy production and thereby optimally enhancing their performance and recovery. It is worth noting that not all athletes respond positively and may experience gastrointestinal upset or bloating in response to the consumption of carbohydrates.

Table 5.5 is a guide to the glycaemic index of many common carbohydrate foods.

TABLE 5.5 Average glycaemic index of some common carbohydrate-rich foods

	Food	Glycaemic index (glucose = 100)
High glycaemic index	Rice crackers	87
	Cornflakes	81
	Porridge, instant oats	79
	Potato, boiled	78
	Watermelon	76
	White bread	75
	White rice, boiled	73
Moderate glycaemic index	Popcorn	65
	Sweet potato, boiled	63
	Honey	61
	Soft drink	59
	Pineapple	59
	Muesli	57
	Porridge, rolled oats	55
Low glycaemic index	Sweetcorn	52
	Pasta, white	49
	Orange	43
	Chocolate	40
	Milk, full fat	39
	Apple	36
	Lentils	32

Source: Copyright ©2008 American Diabetes Association. From: 'Diabetes Care', December 2008 31:2281–2282. Reprinted with permission from The American Diabetes Association.

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Interactivity
Glycaemic index
Searchlight ID: int-6637

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Unit 1 | **AOS 1** | **Topic 5** | **Concept 5**

Glycaemic index and dietary supplements Concept summary and practice questions

Carbohydrate loading

Carbohydrate loading is a method typically used by endurance athletes competing in events lasting longer than 90 minutes (marathons, triathlons, cross-country skiing) to maximise carbohydrate (glycogen) stores in the muscle and liver. Additional carbohydrates are consumed prior to the event to increase stores by 50–100 per cent above normal resting levels.

Carbohydrate loading involves the manipulation of training and nutrition prior to endurance events to maximise muscle glycogen (carbohydrate) stores.

Consumption of 7–12 grams of carbohydrate per kilogram of body mass, along with tapering for 36–72 hours prior to the event, is the most successful strategy for increasing the muscle glycogen stores in endurance athletes. During the event, athletes are also recommended to consume small amounts of carbohydrates (30–60 g per hour) to delay the depletion of stores.

The benefit to the athlete from carbohydrate loading is that they are able to exercise at optimal pace for longer, due to increased availability of glycogen stores. However, this strategy does not work for all athletes and potential harms include bloating, weight gain and gastrointestinal discomfort. A sample carbohydrate loading suitable for a 70 kg athlete is outlined in table 5.6 on page 102.

TABLE 5.6 Sample carbohydrate loading meal plan

Breakfast	3 cups of low-fibre breakfast cereal with 1½ cups of reduced fat milk 1 medium banana 250 mL orange juice
Snack	toasted muffin with honey 500 mL sports drink
Lunch	2 sandwiches (4 slices of bread) with filling as desired 200 g tub of low-fat fruit yoghurt 375 mL can of soft drink
Snack	banana smoothie made with low-fat milk, banana and honey cereal bar
Dinner	1 cup of pasta sauce with 2 cups of cooked pasta 3 slices of garlic bread 2 glasses of cordial
Late snack	toasted muffin and jam 500 mL sports drink
This sample plan provides approximately 14 800 kJ, 630 g carbohydrate, 125 g protein and 60 g fat.	

Source: Written by the AIS Department of Sports Nutrition, last updated June 2009.

FIGURE 5.9 Specialised sports foods that address specific nutritional needs of the athlete

Sports gels

Sports gels are a compact, solid source of carbohydrate designed to provide a large boost of fuel in one serving. They are easily consumed and digested quickly, allowing a more concentrated intake of carbohydrate (60–70 per cent), which is beneficial both during and after activity to replenish depleted stores in the muscle. Sports gels can vary in flavour, consistency, type and amount of carbohydrates in the gel. Other ingredients such as electrolytes and caffeine may also be present in the sports gel. Due to their highly concentrated form, sports gels should be consumed with water or similar fluids to reduce the risk of gastrointestinal upset. Athletes are advised to experiment with gels during training sessions to assess tolerance prior to competition.

Sports bars

Like sports gels, **sports bars** provide a compact and practical source of carbohydrates to boost fuel levels pre-, during and post-activity and replenish fuel stores at the muscle site. As well as containing a high concentration of carbohydrates, sports bars often contain protein and micronutrients. They are similar to muesli or cereal bars, having a chewy consistency and can be coated with chocolate or include nuts and grains. A concern with sports bars is overuse and the replacement of nutritious whole food with the convenience of a bar. Again, athletes are advised to experiment with bars during training sessions to assess tolerance prior to competition.

Sports gels and bars are fortified foods containing a blend of carbohydrates and protein to provide a large boost of fuel in one serving.

Liquid-meal supplements

Liquid-meal supplements are supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder (or liquid) that can be mixed with water or milk. They often include additional sources of vitamins, minerals and essential amino acids. Liquid meal supplements can be purchased as ready-to-drink or in powder mix. They can vary in flavour, fat and fibre content and in the amount of protein, carbohydrates, vitamins and minerals present.

This compact form of energy is especially useful for athletes who are aiming to increase lean body mass, coping with demanding training programs or undergoing growth spurts. Liquid meal supplements are also useful as a post-exercise recovery

Liquid-meal supplements are supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder formula that can be mixed with water or milk.

snack to replace fuel and promote repair of muscle cells. A concern with liquid meal supplements is overuse and the replacement of nutritious whole food with the convenience of a drink, as well as overconsumption of kilojoules and unwanted weight gain.

Hydration

Adequate hydration is very important for an athlete to maintain and even enhance their performance. Depending on the type of fluid an athlete consumes, they have the potential to rehydrate as well as refuel. Hydration can assist the musculoskeletal system to function at optimal levels and reduce the potential for fatigue via dehydration and depletion of energy stores. Dehydration, via the loss of water and electrolytes, interferes with the ability of the muscles to contract, thus decreasing performance. Depletion of energy stores, specifically glycogen, limits the capacity of the muscles to produce energy for contraction and the intensity at which the athlete can perform will decrease.

Sports drinks

Sports drinks (carbohydrate–electrolyte drinks) provide both fluid and carbohydrate to allow an athlete to rehydrate and refuel at the same time. These drinks are ideal to consume before, during or after training and competition, and help delay the fatigue that can be caused by dehydration and depletion of energy stores.

Sports drinks typically containing 6–8 per cent carbohydrate and 10–25 mmol/L electrolyte (sodium and potassium) rapidly deliver both fluids and fuels when consumed. The taste of sports drinks encourages athletes to increase fluid intake. Electrolyte replacement, particularly sodium, helps to maintain the athlete's desire to drink, and can help to reduce further fluid loss through urination.

Concerns with the use of sports drinks relate to overconsumption and the additional carbohydrates impacting on energy balance and displacement of other nutrients. Sports drinks can also cause gastrointestinal discomfort for some athletes and they can contribute to dental erosion, therefore minimal contact time with teeth is recommended.

There are different types of sports drinks to meet the different needs of athletes. These are outlined below.

TABLE 5.7 Types of sports drinks

Type	Content	Absorption rate	Example	Suitable for
Isotonic	6–8 per cent CHO, 10–25 mmol/L electrolytes	Rapid	Gatorade Powerade	Widely used by most athletes
Hypotonic	Low level CHO (<4 per cent), 1–25 mmol/L electrolytes	Rapid	Water Mizone	Athletes that require fluid replenishment without CHO, e.g. jockeys (weight restriction sports)
Hypertonic	High level of CHO (>8 per cent)	Slow	PowerBar Isomax High5 Energy Source Fruit juice Soft drink	Prolonged endurance Ultra distance events *Note:* need to be consumed with water or isotonic drink for hydration

FIGURE 5.10 Sports drinks can be used to provide the athlete with both fluids and fuels.

TABLE 5.8 Specialised sports foods

Nutritional supplement	Form	Composition	Perceived benefit	Potential harm or disadvantages
Sports gels	Gel 30–40 g sachets or tubes	60–70 per cent CHO	High concentration of CHO to top up/refuel stores for energy production Reduce/delay the effects of fatigue due to fuel depletion	Expensive Concentrated CHO can cause gastrointestinal upset
Sports bars	Bar 50–60 g	40–50 g CHO 5–10 g protein	High concentration of CHO to top up/refuel stores for energy production Reduce/delay the effects of fatigue due to fuel depletion	As per sports gels Overconsumption can impact on energy balance
Liquid meal supplements	Powder (mix with water or milk) Liquid	1–1.5 kcal/mL 15–20 per cent protein 50–70 per cent CHO Vitamins/ minerals: can supply 50–100 per cent of RDI	Post exercise recovery snack to replenish fuel and promote repair of muscle cells	Overconsumption can impact on energy balance Unwanted weight gain May displace other whole foods
Sports drinks	Powder Liquid	Isotonic: 6–8 per cent CHO 10–25 mmol/L sodium	Rehydration Replenishment of fuel (glucose) stores	Overconsumption can impact on energy balance Gastrointestinal upset Dental erosion

Vitamin and mineral supplements

Vitamins, which assist chemical reactions in the body (and thus help to release energy from food), and **minerals**, which are important in muscle contraction, nerve transmission, fluid balance and enzyme activity, are a very important part of an athlete's diet.

Eating a balanced diet ensures an adequate vitamin and mineral intake; however, supplementation may be required to prevent or treat a dietary deficiency in some athletes. This may be caused from dieting, not consuming a certain food or food groups, or recovering from injury or illness. If there is no deficiency, use of supplements has been shown to have no effect on performance enhancement and excess consumption tends to be excreted by the body. Supplementation can take the form of a multivitamin/mineral that contains a variety of vitamins and minerals, for example Centrum, or a single-nutrient supplement such as calcium or iron.

Vitamins are essential components of a balanced diet; they allow normal body growth and maintenance by assisting chemical reactions in the body.

Minerals are inorganic substances in the body required for adequate functioning of the body; they are important components of bone, muscle, skin and blood.

Calcium

Calcium is important for muscle contraction, nerve transmission, enzyme activity and blood clotting. It is also an essential component of bones and teeth. Calcium requirements increase during childhood, adolescence, pregnancy and breastfeeding.

Calcium is a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.

Inadequate calcium intake may lead to low bone-mineral density and the risk of stress fractures. Calcium is important for athletes and those at risk include athletes with an insufficient intake of dairy in their diet, those with a poor calcium balance due to malabsorption from the small bowel, and females with impaired menstrual function. Supplementation is recommended for athletes who may require more or who are at risk of not consuming enough calcium in their diet and is only recommended under medical supervision.

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Unit 1 | AOS 1 | Topic 5 | Concept 6

Hydration, vitamin and mineral supplements Concept summary and practice questions

TEST your understanding

1 Outline how carbohydrate-based sports food can assist the performance of the musculoskeletal system.
2 Discuss how knowledge of the glycaemic index of foods can help an athlete optimise his or her performance.
3 Identify which specialised sports foods are suitable for post-exercise snacks. Link each to a specific sport and explain why.
4 Discuss whether or not it is necessary for an athlete to consume supplements. Provide specific examples.
5 Outline the differences between the three types of sports drinks.

APPLY your understanding

6 Compare and contrast sports gels, sports bars and liquid meal supplements.
7 Discuss the importance of hydration for an athlete and why an athlete would consume a sports drink in preference to water.
8 **Learning activity: sports supplements**
Visit a supermarket or health food shop. Look at the range of liquid-meal supplements, sports bars and sports gels and make a list of the available supplements. Choose a product from each of these categories (liquid-meal supplements, sports bars and sports gels) and answer the following questions.
(a) What are the main ingredients and nutrients (in contents per 100 grams)?
(b) What are the claimed benefits?
(c) What is the most appropriate time to consume the supplement?
(d) What is the recommended intake during exercise and how does this compare with the product content?

5.5 Performance supplements

KEY CONCEPT Performance supplements benefit performance and/or recovery from exercise. Research has found that the benefits of very few so-called performance supplements are actually supported by scientific evidence and as such these aids should be used with caution.

Protein supplements

Protein is a popular nutritional supplement used by many athletes, due to its function in the growth and repair of muscle tissue and cells. Protein can be found naturally in foods such as red meat, poultry, nuts, eggs and legumes as well as a formulated supplement in the form of a drink, bar or powder.

Protein supplements are nutritional supplements used by many athletes to aid in the growth and repair of muscle tissue and cells.

Protein supplements can assist performance of the musculoskeletal system through increased muscle protein synthesis and therefore an increased muscle cross-sectional area. This increase leads to a greater storage of fuels and a greater ability to produce strength and power. Training intensity and frequency can increase due to the increased repair of the muscle cells.

Timing of protein consumption is important and the most benefit is gained by consuming protein immediately after exercise. At this time, muscle uptake and retention of amino acids is enhanced and appears to continue to be enhanced for up to 24 hours.

Endurance athletes in heavy training, athletes wanting to gain muscle mass and strength athletes in initial stages of training have all been shown to have higher need for protein than other athletes, however this intake can be achieved through manipulation of diets.

Protein powders

The most common forms of supplementation are protein powders made into shakes and protein bars. The amount of protein is generally higher than can be achieved in consuming foods containing protein. They are classified according to the amount of protein and other nutrients they contain.

Whey protein is the most common supplement form as it is rapidly digested and rich in branched chain amino acids. It comes in three forms:

- whey protein isolate: highest amount of protein with all lactose and fat removed
- whey protein concentrate: high amount of protein with small amounts of lactose and fat present
- whey protein hydrolysate: a combination of the above forms.

It is interesting to note that current nutritional guidelines do not foresee the need for protein supplements for athletes, and research suggests that supplements offer no advantage over consuming protein-rich foods as part of a balanced diet. Protein consumption well above recommended intakes (>2 grams per kilogram BM) does not stimulate further muscle building or recovery and is not recommended by sports dietitians. In fact, extra consumption may displace other important nutrients from the diet. Some health risks might also be associated with excessive protein intake because of the extra demand placed on the kidneys to excrete any unused amino acids. Furthermore, excessive protein intake can compromise bone density and may also lead to weight gain if food choices are also high in fat.

However, athletes may require a supplement when consumption of food is difficult post-exercise and products such as liquid meal supplements offer convenience and a practical solution to consuming adequate protein.

FIGURE 5.11 Protein powders are a quick and convenient supplement that can be used to assist muscle growth and repair.

Caffeine supplementation

Caffeine was removed from the World Anti-Doping Agency (WADA) prohibited list on 1 January 2004. Since then, caffeine has been used by some athletes to enhance their performance. In terms of the effects of caffeine on the body, it has previously been believed that caffeine:

- mobilises fat from adipose tissue and muscle cells, resulting in glycogen sparing in endurance athletes
- alters the nervous system, creating a change in perception of effort and fatigue
- stimulates both the release and the action of adrenaline
- causes a diuretic effect, leading to dehydration.

Recent research now brings into question the ability of caffeine to enable glycogen sparing, as well as its diuretic effect on the athlete. There is, however, sound evidence that caffeine can enhance endurance and performance of:

- short-duration, high-intensity events of 1–5 minutes
- prolonged high-intensity events of 20–60 minutes
- endurance events of a minimum of 90 minutes
- prolonged intermittent, high-intensity team or racquet sports.

Any performance enhancement effect on strength, power or brief sprint activities is unclear. The reason for the enhancement is still unclear but seems to be linked to a decreased perception of effort and fatigue in the athlete.

Caffeine acts on the central nervous system (CNS) to stimulate the release of adrenalin and alters perception of effort and fatigue.

How much caffeine?

Caffeine doses of 1–3 milligrams per kilogram BM or 70–200 milligrams have proven to be beneficial in prolonged exercise lasting longer than 60 minutes. Caffeine can be consumed prior to or throughout the exercise. Furthermore, studies show that ingestion of more than 3 milligrams per kilogram BM of caffeine does not further increase performance, but may increase the risk of side-effects, including increased heart rate, impairment of technique and over-arousal. Athletes need to be conscious of the fact that there is great individual variability in the response to caffeine intake.

The AIS no longer provides caffeine to athletes for performance enhancement; however, it does educate about the use and potential benefits of low doses of caffeine as well as the risk of side-effects.

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Protein and caffeine supplements Concept summary and practice questions

TABLE 5.9 Typical content of caffeine in selected food and drink

Food or drink	Serve	Caffeine content (mg)
Instant coffee	250 mL cup	60 (12–169)*
Brewed coffee	250 mL cup	80 (40–110)*
Tea	250 mL cup	27 (9–51)*
Chocolate (milk)	60 g	5–15
Chocolate (dark)	60 g	10–50
Coca Cola	375 mL can	49
Red Bull energy drink	250 mL can	80
V energy drink	250 mL can	50
Mother energy drink	500 mL can	160
PowerBar caffeinated sports gel	40 g sachet	50
No-Doz	1 tablet — Australia 1 tablet — USA	100 200

*The caffeine content of tea and coffee varies widely, depending on the brand, the way that the individual makes their cup of tea or coffee, and the size of their mug or cup.

Caffeine: a legal performance-enhancing drug

BY KATE SCHLAG

If you were to rifle through almost any of my teammate's bags — or even mine, for that matter — there's a good chance you'd find performance-enhancing drugs. I promise we're not cheating, though: every other team uses (and, often, relies on) the same drug — caffeine.

Believe it or not, there's little scientific question that caffeine is an effective performance-enhancing drug. The first study to investigate the relationship between caffeine and exercise performance, published in 1978, reported that caffeine reduced cyclists' rating of perceived exertion by increasing fat oxidation; theoretically, those fatty acids were mobilised to be used by muscles early on, sparing glycogen for later use when your muscles are really exhausted.

Since then, several other theories have been proposed to explain caffeine's ergogenic capacity: caffeine stimulates the central nervous system, thereby enhancing mental alertness and reaction times (key in a sport that relies on mental acuity to make both offensive and defensive plays). It also increases calcium release and inhibits calcium re-uptake, two actions that play a role in muscle contraction. These effects result in increased muscle contraction force, allowing you to play longer and harder.

Initially, these studies focused on high amounts of caffeine (10–13 mg/kg body weight — for a 77 kg man, that's about 5–8 cups of coffee) in endurance events, but more recent studies have focused on low to moderate doses (≤3 mg/kg body weight, or 1–2 cups of coffee for a 77 kg man) in sustained high-intensity sports (like swimming and rowing) and stop-and-go sports. Researchers confirm that these lower doses can and do enhance performance. Here's what else you should know about caffeine and athletic performance.

All caffeine isn't created equal

There are over 60 sources of naturally occurring caffeine in nature, from coffee and cocoa beans to tea leaves and kola nuts. Because these plants and the foods and drinks they're turned into contain many other micronutrients, antioxidants and compounds in addition to caffeine, their effects on the body can vary widely. Tea, for example, contains higher amounts of theobromine and theophylline, which also stimulate the central nervous system. But it also contains L-theanine, an amino acid that increases the generation of alpha waves, which are associated with a more relaxed — but still alert — state of consciousness. The added sugar in a can of Coke — about 10 teaspoons — leads to a huge sugar spike immediately but often leaves you feeling even more lethargic (and in need of another caffeine boost) hours later.

The takeaway: If you're used to caffeinating with one type of caffeine before games and suddenly switch to another, be aware that it might not affect you in the same way. As with other tenets of sports nutrition, experiment with different forms of caffeine during practices and workouts and find out which type works best for you.

More isn't necessarily better

If two cups of caffeine can improve your performance, what can four cups do? It might make you incrementally faster, but it's likely that it will also make you jittery, shaky and anxious, which might not translate into success on the ultimate field. Too much caffeine might also hinder your decision making: one study found that while 200 mg of caffeine improved the accuracy and speed of problem solving, doubling the dose to 400 mg impaired problem-solving abilities. After 600 mg of caffeine, cognitive performance is said to decline rapidly. Experts seem to agree that the optimal range for exercise performance is 3–6 mg per kg of body weight. For that 170-lb man, that's between 1.5 and 3 cups of coffee.

It's also important to note that habitual coffee or tea drinkers can build a tolerance to caffeine, which means that if you regularly consume caffeine throughout the day, you may not feel the effects of one dose of caffeine on game day. If you're a regular consumer, try cutting out caffeine three or four days before a tournament and then reintroducing it Saturday morning.

The takeaway: The difference between 'alert and focused' and 'jittery and anxious' might be small; again, find your optimal range during practices and workouts. If you're really looking to improve performance from caffeine, you may want to consider saving it for when you really need it — which means decreasing your weekly caffeine intake.

It doesn't affect everyone the same way

Some people can drink coffee all day without feeling any negative side-effects; others have to take their last sip of a caffeinated beverage before 3 pm or they risk staying up all night. In general, women metabolise caffeine twice as fast as men, as do smokers compared to non-smokers (a faster caffeine metabolism means that you'll process caffeine faster, abating its effects more quickly).

Genetics play a pretty big role as well: an enzyme called CYP1A2 is responsible for metabolising caffeine, and multiple studies have shown a high inter-individual variation in its expression. Your nervous system could also account for some variation, as caffeine's effects partly depend on the percentage of receptors that bind to caffeine . . .

. . . Caffeine can cross the blood–brain barrier as soon as 15 minutes following ingestion, increasing alertness and wakefulness almost immediately (in fact, just smelling roasted beans or the aroma of a steaming pot can increase brain activity). Peak caffeine levels usually occur around 45–60 minutes, when lipid oxidation is also increased. From there, you — an average, non-smoking adult — will probably feel the effects for another three to four hours, although this can be highly variable as well.

The takeaway: By now, you should know whether you're more sensitive or more tolerant to caffeine. If you don't, look to your parents, as caffeine sensitivity is hereditary. Aim to get your caffeine 45–60 minutes before the first pull, although you can play around with this timeline at practice.

Some side-effects might hinder performance

While caffeine improves the immediate physical aspects of performance, it may have longer-term impacts that, ultimately, could lead to a net *decrease* in performance. The consumption of caffeine might interfere with sleep duration and quality, which has further implications when you consider that many important tournaments last three, or even four, days. Ingesting caffeine before a night game might improve performance, but it also might hinder your sleep, making you more tired and groggy for your morning game. In addition, no studies have looked at how taking caffeine multiple times a day affects performance — for example, once before quarters, semis and finals. If you're sensitive to the effects of caffeine, this begs the question: should you ingest caffeine before each and every game, or save the jolt for, hopefully, your appearance in finals?

With respect to other potential side-effects, some studies have shown that caffeine intake may affect hydration status and carbohydrate metabolism. However, these studies have found either inconsistent or statistically insignificant results on performance . . .

Source: www.ultiworld.com, 26 March 2015.

Creatine

A naturally occurring compound found in skeletal muscle, **creatine** is created through daily intake of foods such as fish, poultry and red meat. It is also manufactured in the kidneys through the intake of some amino acids. Creatine monohydrate is the commonly supplemented form of creatine.

Creatine is a naturally occurring compound found in skeletal muscles that assists in the regeneration of ATP in the muscle cells.

The use of creatine phosphate in the regeneration of adenosine triphosphate (ATP) for short-duration, high-intensity exercise is well known. Initial research cited a 25 per cent increase in stored creatine when taking a creatine supplement in comparison to not taking a supplement. However, subsequent research findings have varied considerably. What is agreed on is that creatine supplementation will enhance performance involving repeated sprints or bouts of high-intensity, short-duration activity separated by short recovery intervals of less than 1 minute. It is also recommended for developed, elite athletes who use resistance training to increase lean body mass, or for team athletes who participate in intermittent sports such as netball, football or racquet sports.

FIGURE 5.12 Creatine is a nutritional ergogenic aid.

There are two recognised creatine supplementation regimens used by the AIS:

1. *Rapid loading protocol* — 20 grams daily (4 × 5-gram doses) for a total of five days. This protocol is linked to weight gain, usually in the form of fluid retention.
2. *Slow loading protocol* — smaller doses (3 grams) ingested each day.

To enhance creatine uptake, it is suggested that creatine also be taken with a large amount of carbohydrates (50–100 grams). Once loaded, a maintenance dose of 3 grams daily is recommended. Extended loading protocols are not required.

Although no recognised findings have been reported on the possible side-effects of long-term use of creatine, there are anecdotal reports of weight gain due to fluid retention, cramps and harmful effects on the liver and kidney when creatine has been consumed in excess of recommended doses. If protocols such as those presented on page 109 are followed, creatine has not been seen to cause these side-effects in healthy people.

Bicarbonate

Bicarbonate is a source of sodium that neutralises acids; it is ingested orally as a capsule or effervescent powder.

Bicarbonate increases the body's ability to dispose of excess hydrogen ions that are produced during anaerobic glycolysis. Hydrogen ions are thought to have a significant fatiguing effect on the body when working anaerobically. Bicarbonate loading acts as a buffer within the muscle, reducing the fatiguing effect of hydrogen on the functioning of the muscle. It is relevant to high-intensity events lasting between 1 and 7 minutes.

Bicarbonate can be consumed as a capsule or effervescent powder. The AIS recommends the following two protocols for ingestion of bicarbonate:

1. *Acute bicarbonate loading* — 300 milligrams per kilogram BM dose ingested 1–2 hours prior to the session.
2. *Chronic bicarbonate loading* — 500 milligrams per kilogram BM dose ingested per day over five days and split into four doses over the day.

Studies have shown that acute bicarbonate loading has a moderate effect in enhancing the performance of anaerobic exercise or events, and chronic bicarbonate loading can increase buffering capacity, with effects lasting for at least 24 hours following the last dose. It should be noted that very few studies have been completed in a sports setting.

At this point, the only side-effects noted have been reports of gastrointestinal distress. It is recommended that athletes do not combine this supplement with other nutritional supplements such as caffeine and creatine.

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Unit 1 | AOS 1 | Topic 5 | Concept 8

Creatine and bicarbonate Concept summary and practice questions

TABLE 5.10 Performance supplements that enhance the musculoskeletal system

Performance supplement	Performance benefits	Potential harms
Protein	Used for muscle growth and repair Increases muscle cross-sectional area — increase power and strength Increases PC storage Allows increased training intensity and frequency Promotes glycogen resynthesis for increased fuel availability	May displace other foods Expensive Extra consumption may displace other important nutrients from the diet Health risks associated with excessive protein intake because of the extra demand placed on the kidneys to excrete any unused amino acids Can compromise bone density May lead to weight gain if food choices are also high in fat
Caffeine	Change in perception of effort and fatigue Stimulates release and action of adrenalin	Overuse can lead to dependence Excessive consumption can lead to: Increased heart rate Impairment of technique Overarousal Anxiety Insomnia

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Digital document
Performance supplements that enhance the musculoskeletal system
Searchlight ID: doc-18670

Performance supplement	Performance benefits	Potential harms
Creatine	Increased stores of creatine in muscle allows for: Increase in force and power produced in muscle contractions Train harder at higher intensities Delays CP depletion and fatigue Decreases reliance on anaerobic glycolysis, reduce lactate accumulation delaying fatigue	Weight gain due to fluid retention Possible side-effects: gastrointestinal upset, muscle cramps Excessive use may cause liver and kidney damage
Bicarbonate	Buffers hydrogen out of muscle at a faster rate allowing for more to be produced Delays fatigue	Gastrointestinal upset

TEST your understanding

1 Outline why nutritional ergogenic aids should be used with caution.
2 Define protein supplementation. Is it recommended for athletes?
3 Study table 5.9. Identify examples of caffeine products that you would consume in a normal day. Calculate your caffeine intake.
4 Define the term *creatine*. List food sources containing creatine.

APPLY your understanding

5 For each of the following sports, choose one nutritional ergogenic aid and outline how it may be beneficial for that sport.
   (a) 100-metre runner
   (b) 400-metre runner
   (c) team sportsperson (60–90 minutes duration)
   (d) ultra-distance athlete.
6 **Learning activity: caffeine and sports performance**
   Read the article 'Caffeine: a legal performance enhancing drug' on pages 108–9 and summarise the key elements of the article by answering the following questions.
   (a) How is caffeine thought to enhance performance?
   (b) For each of the benefits of caffeine listed in the article, suggest types of athletes for whom the benefit would be particularly relevant.
   (c) Identify reasons why athletes might choose not to use caffeine prior to an event.

5.6 Illegal substances and methods that enhance performance of the musculoskeletal system

KEY CONCEPT Illegal performance-enhancing substances and methods have been employed by coaches and athletes in order for the athlete to gain an advantage over their competitors. While they might bring about improved performance, the health and associated risks of doping to the athlete need to be taken into consideration prior to use.

Doping is the use by, or distribution to, an athlete of certain substances or methods that could have the effect of artificially improving the athlete's physical and/or mental condition and enhancing their performance.

Anti-doping codes are codes established to eradicate the use of drugs and other illegal performance-enhancing methods in sport.

Taking or using (illegal) performance-enhancing substances or methods is commonly referred to as '**doping**'. This issue has been, is and will continue to be the most dominant moral and ethical controversy in sport.

Recent high-profile cases, including the alleged drug use of the Essendon Football Club (Australian Football League) and the Cronulla Sharks (National Rugby League) in Australia, as well as the international scandals involving Lance Armstrong (cycling) and American sprinters Tyson Gay and Justin Gatlin (athletics), have all tainted sport and cast doubt over the legitimacy of individual and team performances.

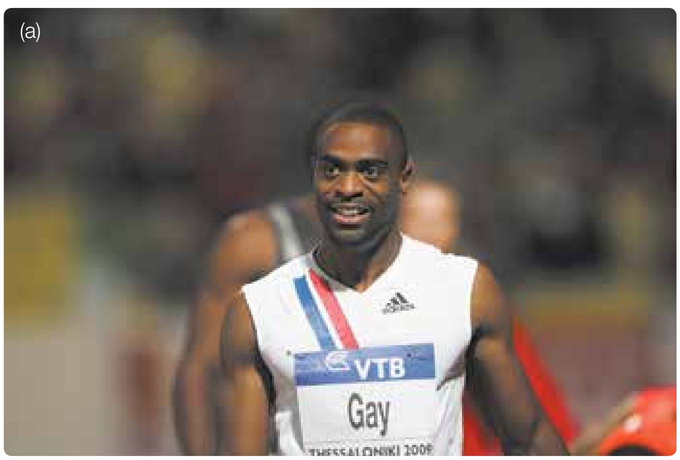
Indeed, the International Olympic Committee (IOC) has singled out doping as the greatest challenge to the integrity and future of world sport.

The World Anti-Doping Agency (WADA) was established in 1999 in response to the concerns of the IOC. WADA is an independent agency that is composed of and funded by governments and sporting movements of the world. The mission of WADA is to 'promote, coordinate and monitor the fight against doping in sport in all its forms'.

The introduction of **anti-doping codes** in sport has been an integral part of the fight to eradicate the use of drugs and other illegal performance-enhancing methods in sport. These practices are prohibited because they:

- artificially enhance the performance of an athlete
- are potentially harmful to the health of an athlete
- are contrary to the spirit of sport.

(a)



(b)

FIGURE 5.13 (a) American sprinter Tyson Gay has been recently involved in a drug scandal. (b) Concerns were raised about Essendon's supplements program in season 2012, which subsequently led to a full investigation into illegal use of drugs at the club.

Performance-enhancing substances and methods

Performance-enhancing substances and methods have been employed by athletes and coaches for a variety of reasons:

- to increase strength and muscle mass (anabolic agents, steroids)
- to counteract undesirable side-effects (hormones, anti-oestrogenic substances)
- to mask the presence of banned substances (diuretics)
- to increase alertness and/or aggressiveness (caffeine, amphetamines)

- to enhance oxygen transfer (blood doping)
- to alter samples provided for testing (urine substitution)
- to speed up the rehydration process (intravenous infusions)
- to reduce pain (narcotics).

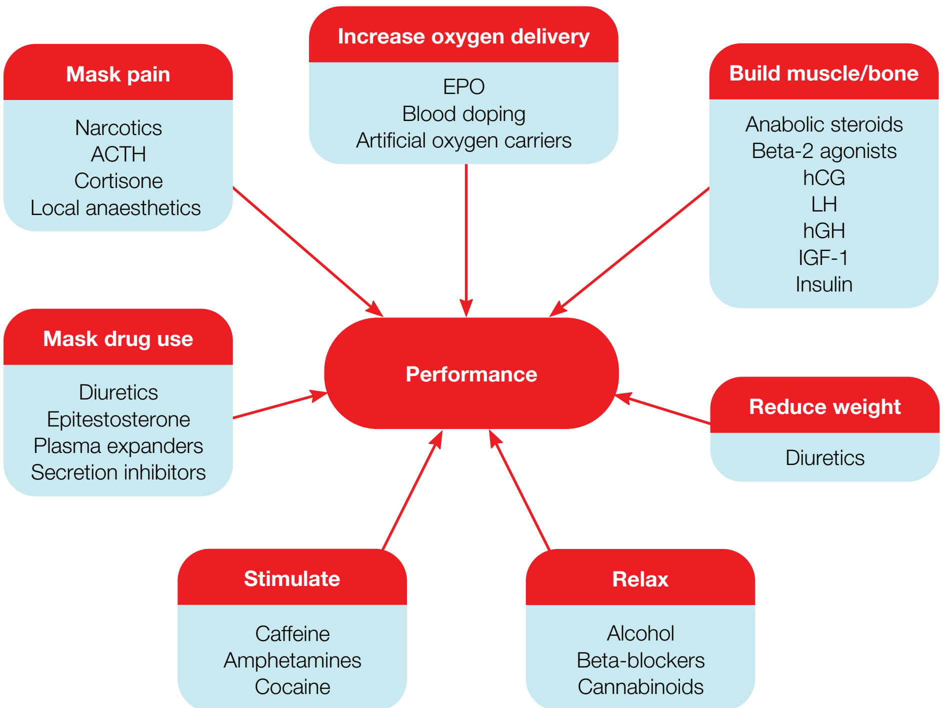


FIGURE 5.14 Performance-enhancing drugs can have a variety of effects on performance.

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Unit 1 | AOS 1 | Topic 5 | Concept 9

Illegal substances and methods (musculoskeletal) Concept summary and practice questions

Performance-enhancing drugs are currently banned or considered illegal in most sports. Furthermore, some performance-enhancing practices currently used in sport produce exactly the same results, but are neither banned nor illegal. For example, the illegal drug anabolic steroid increases lean muscle mass, thus enhancing the strength and power an athlete can generate. However, the same effect can be obtained legally by participating in a resistance training program, as discussed earlier in this chapter.

WADA produces a list of prohibited substances and methods annually. Many drugs are prohibited at all times, whereas others are prohibited only in competition. Some substances are banned only in certain sports. Athletes caught using these drugs have been stripped of their medals and records and banned from their sports, sometimes for years and, on occasions, for life.

The performance-enhancing drugs and methods most relevant to the development of the musculoskeletal system include those based on naturally occurring hormones in the human body, specifically anabolic steroids, and growth hormones and related substances. These substances are prohibited at all times.

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Weblinks
WADA prohibited drug list
Doping to win

Anabolic steroids

Steroids are synthetically produced drugs that mimic the effect of the hormone testosterone. Testosterone has both an anabolic effect and an androgenic effect on the human body. The anabolic effect promotes bone density, muscle growth and rapid recovery from injury, while the androgenic effect relates to the development and maintenance of male secondary sexual characteristics, such as growth of the male reproductive system and development of muscle mass, a deeper voice and facial hair.

Steroids are synthetically produced drugs that mimic the effect of the hormone testosterone.

Athletes may use steroids for their anabolic effects; that is, the building of bone and muscle to increase the amount of strength and power they can produce. With greater strength and power, athletes are able to produce more force to run quicker,

FIGURE 5.15 American baseballer Mark McGwire admitted to using both anabolic steroids and human growth hormone during his career.

Growth hormone is a synthetically produced drug that mimics the effect of the hormone human growth hormone (hGH).

jump higher and throw further. The other reason for athletes using steroids is an increased rate of recovery which allows an athlete to train more often and for longer periods of time. The use of anabolic steroids allows an athlete to increase muscle growth and strength quicker than through legal methods such as resistance training.

Potential harms related to the use of steroids can be different for males and females, due to the increased level of testosterone in the body. Males are at risk of possible infertility, increased libido, testicular atrophy, baldness and development of breast tissue. Females are at risk of menstrual problems, increased body and facial hair, an enlarged clitoris and deepening of the voice. Both genders are at equal risk of tendon injury, fluid retention, liver damage, tremors, mood swings and depression, hypertension, acne (face and back) and cancer.

A legal alternative to steroids to promote muscle growth is resistance, plyometric and short interval training and the use of protein supplementation to assist the growth and repair of muscle.

Human growth hormone

Human growth hormone (hGH) is a peptide hormone that is naturally produced by the pituitary gland. This hormone determines the height, bone and muscle growth of an individual.

Synthetic **growth hormone** may be taken by athletes in the belief that it will increase muscle strength, and hence athletic performance, through its capacity to build muscle. However, research indicates that the effects of hGH are inconclusive at best and any performance benefits to the athlete are most likely through taking a combination of steroids and hGH. Other growth factors such as Hexarelin, stimulate the release of growth hormone and have been linked to quicker recovery and healing times from injury. Similar to steroids, use of human growth hormone and related factors allows an athlete to increase muscle growth and strength quicker than through legal methods such as resistance training.

Potential harms of human growth hormone use include fluid retention, acromegaly, thickened skin, hypertension, hairiness, cardiac disease, osteoarthritis, and joint and bone pain.

Like steroids, a legal alternative to using human growth hormone to promote muscle growth and strength development is resistance, plyometric and short interval training, as well as the use of protein supplementation to assist the growth and repair of the muscles being exercised.

FIGURE 5.16 Resistance training is a legal way for an athlete to build strength.

TABLE 5.11 Illegal methods used to enhance the performance of the musculoskeletal system

WADA classification	Examples	Performance benefits	Potential harms (side-effects)	Legal alternative
S1 Anabolic agents	Anabolic steroids Nandrolone Stanozolol Tetrahydrogestrinone (THG)	Increased lean muscle mass and strength Reduced fatigue Increased rate of recovery Increased aggression	In males: Possible infertility Increased libido Testicular atrophy Baldness Development of breast tissue In females: Menstrual problems Increased body and facial hair Enlarged clitoris Deepening of the voice Both: Tendon injury Fluid retention Liver damage Tremors Mood swings and depression Hypertension Acne (face and back) Cancer	Resistance training Plyometric training Short interval training Protein supplementation
S2 Growth factors	Growth hormone releasing hormone (GHRH) Insulin-like growth factor-1 (IGF-1) Hexarelin	Enhanced muscle and bone development Increased muscle size and strength Reduced recovery time Increased healing time from injury	Acromegaly Thickened skin Hypertension Hairiness Cardiac disease Fluid retention Osteoarthritis Joint and bone pains	Resistance training Plyometric training Short interval training Protein supplementation

TEST your understanding

1. Define the term *doping*.
2. List some of the reasons why some athletes may use performance-enhancing drugs in sport.
3. What is WADA? Explain its role in anti-doping initiatives.

APPLY your understanding

4. Explain the difference between a performance-enhancing substance and a performance-enhancing method.
5. Discuss why some drugs are banned all the time but others are prohibited only in certain sports.
6. Outline how hormone-based drugs such as steroids and human growth hormone can physiologically enhance the performance of athletes.

5.7 Ethical and sociocultural considerations associated with performance enhancement in sport

KEY CONCEPT: The debate regarding the use of performance-enhancing substances and methods polarises opinions when considering the benefits that can be achieved versus the harms that they might inflict on an athlete.

The use of performance-enhancing substances and methods in sport, whether they are legal or illegal, remains a hotly debated topic within sport, media and society. Performance-enhancing practices have the potential for both positive and negative outcomes, providing physiological benefits as well as potential harms to the athlete.

The big question facing many athletes is whether or not to use performance-enhancing substances and methods and, if they choose to do so, which ones will be of most benefit to the athlete. As outlined in this chapter, there are a number of legal and illegal substances and methods available to improve the functioning of the musculoskeletal system. In addition to these, the area of performance enhancement is constantly developing. New products designed to assist athletes to develop their strength and power, enhance their energy stores and improve their recovery times in order to train at higher intensities more frequently are entering the market all the time.

FIGURE 5.17 US sprinter Justin Gatlin tested positive for a testosterone-based substance and served a four-year ban before returning to athletics in 2010.

Ethical considerations regarding the use of performance-enhancing practices

The debate surrounding the use of both legal and illegal performance-enhancing substances and methods is not as definitive as 'is it right or wrong to use them'.

Illegal performance enhancement incites many different opinions regarding whether or not a substance should be classified as illegal. The IOC and many professional and amateur sporting organisations subscribe to the WADA Anti-Doping Code classification, which states that if a substance has the capacity to artificially enhance the performance of the athlete, place the health of the athlete at risk or is contrary to the spirit of sport, it should be banned. Supporters of the code consider the use of any illegal substance or method is wrong and amounts to cheating as it provides an unfair advantage of one athlete over another. Athletes who have been implicated in the use of banned substances, such as anabolic steroids, to improve the functioning of the musculoskeletal system, have had their medals stripped and served bans from their chosen sport. Examples include the three track and field athletes, Ben Johnson, Marion Jones and Justin Gatlin.

There is also a school of thought that argues in favour of the use of some current illegal substances and methods. They argue that performance enhancers are so prevalent in sport that the right and only realistic option is to allow athletes to use what they want as long as they do it safely. Suggestions of scientifically backed, medically supervised doping programs are common. Such suggestions argue that administration of the naturally occurring substances within the body, such as testosterone, within safe limits should be allowed to enhance the performance of an athlete.

While most of the debate centres around the use of illegal substances and methods, there are also ethical considerations regarding the use of legal substances and methods. Because a substance is legal, is it right to use it? Should all legal substances be available to or given to all athletes? This is particularly pertinent for junior athletes in relation to nutritional supplements such as creatine, caffeine and protein powders. These substances have credible evidence for improving the functioning of the musculoskeletal system in well-trained, developed bodies but the safety of supplement use in juniors with developing bodies is unknown due to lack of studies in this demographic.

FIGURE 5.18 The effects of performance-enhancing substances on junior athletes have not been widely researched, therefore their safety is unknown.

The Australian Institute of Sport (AIS) does not recommend the use of nutritional supplements such as creatine and protein powders, instead they encourage a well-planned, balanced and varied diet, along with training practices such as resistance training, to meet muscle growth and repair demands. Consumption of liquid meal replacements and food sources such as yoghurt with high protein content are recommended for the developing athlete, rather than synthetically produced supplements.

Another consideration for legal performance enhancement relates to access to these substances and methods, and the concept of a fair and level playing field. Some athletes and teams have access to specialised support staff (medical professionals, nutritionists, physiologists) and an array of training equipment and expertise to focus their training on improvements in strength, power and speed. Many others do not. Financial support also plays a large role in the ability of an individual or team to achieve success. It has been widely documented that in 2012, the success of the UK team at the London Olympics was attributed to an increased amount of funding dedicated to its Olympic team to help them perform well on home soil. Does this gap in levels of professional support and funding mean there is a fair and level playing field for all athletes?

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Weblink
AIS: Supplements and junior athletes

Case study: Where does an athlete draw the line in terms of using performance-enhancing substances?

Associate Professor Craig Fry and Australian athlete Kimberley Crow put their cases forward for the use of legal and illegal performance-enhancing substances in sport.

Bring truth into play by saying yes to drugs in sport

BY CRAIG FRY

Bans on performance enhancers don't make elite competition fairer.

THE 2012 Tour de France starts this weekend under yet another drugs cloud. The US Anti-Doping Agency's recent announcement of "doping" charges against Lance Armstrong and others is no small matter.

If the case is proven, it will nullify Armstrong's record seven Tour de France wins between 1999 and 2005, and reverberate much more widely through international cycling. This being an Olympic year, it amplifies the relevance of this case for world sport generally.

It is a good time to reflect on our current thinking about performance enhancement in sport.

Most people are against performance enhancing drugs in elite sport based on the fairness and equity ideal of a level playing field, and a belief that 'doping' is unnatural and poses a health risk.

But what is the truth of performance enhancement in elite competition? Let's take the level playing field idea first.

These days, elite-level sportspeople have an increasing array of performance-enhancing options and technologies available — from lighter, smoother, stronger and more aerodynamic competition clothing and equipment to scientifically advanced skills and fitness training regimes. The list goes on.

Access to these resources is far from equal. Major equity gaps exist across and within countries as a function of national wealth, development and politics. Gaps also exist between certain sports due to differences in marketability and public profile, and related funding.

The genetic lottery of sporting ability is hardly fair either. The people who compete for Olympic medals, world championships and Tour de France jerseys are the genetic exceptions, not the rule.

We might all agree in principle that striving for greater equity in sporting competition is important. But belief in that ideal doesn't commit us to judging all examples of advantage or disadvantage as unfair or morally wrong. Like it or not, in sport there is difference and this is determined by more than natural abilities alone.

What about the argument that performance-enhancing drugs are problematic because they are unnatural, dangerous and risky?

In elite sport, no-one gets to be the fastest, strongest or most skilled through natural hard work alone. In addition to the performance technologies already highlighted above, a cornucopia of nutritional, medicinal and other aids for energy, recovery, pain and stress relief, and emotional and mental health is now available to athletes.

Use of these consumable performance enhancers is widespread in the highest levels of all sports, with government-funded scientific programs and large teams of health and other professionals devoted to maximising outcomes.

Why make a distinction between these accepted examples and performance enhancement through use of corticosteroids, testosterone, erythropoietin, clenbuterol and the like?

Many say such substances and other doping practices should be restricted because of risks to athlete health. There are indeed risks with the use of these banned substances.

But safe forms of most of these are in use in other areas of life. And legally obtained drugs and medicines have risks and side effects too if used inappropriately.

For many people, the fact that certain practices are defined as illegal or prohibited in the sporting context is reason enough to accept them as such. Regulations that aim to govern sporting conduct are necessary at all levels, but we should acknowledge there is no divine or universal truth to the rules of sporting competition. These are subjectively defined, and history confirms that these change over time as knowledge and attitudes evolve and societal expectations shift.

We may like to believe that our modern sporting rules and laws uphold the ideals of equity and natural risk-free achievement in elite sport. Yet current practices suggest that the true spirit of elite sporting competition is more consistent with the Athenian ideal of superhuman effort at any cost.

The truth is 'health risk' occupies a central place in sporting competition. We applaud our sporting heroes when they take risks and triumph through injury. Putting your body on the line, pushing physical limits, and courageous play are as much a part of the allure of elite sporting competition as any interest in fairness and upholding the rules.

There will always be athletes at the highest levels willing to use banned drugs and other substances. The allure of fame, money, power and position for the successful will see to that.

The inconvenient truth is that the current drugs and substances prohibited from elite sporting competition are not uniquely dangerous or risky, or inherently harmful. Nor are they the only or biggest sources of risk.

We have the knowledge to use such things safely in sport if we so choose. Instead, our approach encourages clandestine doping.

As we have seen with drugs and other substances regarded as dangerous, prohibition policies serve to create illicit markets of hidden, uninformed and unregulated consumption. The evidence confirms such conditions exacerbate a range of health and other harms to both individual and community.

The level playing field and natural, risk-free achievement in elite sport are sentimental myths. Using these ideals to argue against performance-enhancing drugs in sport makes little sense, and does not reflect the truth of elite sporting competition as it occurs today.

An alternative would be an open and regulated approach to performance-enhancing drugs in elite sport. This would be consistent with the range of other enhancement technologies and resources used now. It would also better enable us to prevent and or minimise the health risks to those athletes already using prohibited substances secretly.

Associate Professor Craig Fry is a principal fellow at the Centre for Health & Society and Centre for Applied Philosophy and Public Ethics, Melbourne University. He specialises in drugs in society, health ethics and policy.

Source: *The Age*, 29 June 2012.

Allow drugs in sport? I nearly choked on my (low-fat) Weeties

BY KIMBERLEY CROW

I can remember the moment when I choked. I was happily reading *The Age* online from the Australian Institute of Sport's training base in Northern Italy. I was shovelling down a pre-training bowl of muesli (natural) with milk (low-fat) when Craig Fry's opinion piece 'Bring truth into play by saying yes to drugs in sport' (29/6) sent my throat into oesophageal reflux.

Fry's contention was that "the level playing field and natural, risk-free achievement in elite sport are sentimental myths" and that, therefore, it is anomalous to ban performance-enhancing drugs.

A highly scientific vox-pop of the breakfast table uncovered a startling result. Of those surveyed (three), 100 per cent would not participate in sport if performance-enhancing drugs were required to become successful. We are not lab-rats, nor are we the pin-cushions of sports doctors. We are living, breathing, thinking, aspiring human beings.

What Fry fails to tackle is why people pursue elite sport in the first place.

From the outside looking in, I can understand why it appears that elite sport is about winning, fame and self-aggrandisement. That we do this for the Weeties boxes.

We don't. Motivations will differ markedly from person to person, but speaking for myself, I aspire to Olympic gold because I see it as an opportunity to test my limits, to challenge myself to be better, to grow as a person.

For me, the most important asset I will take with me to the start line of the Olympics is willpower. It is willpower, strengthened over years of refining technical skills under duress, of pushing my body to work harder when all it wants to do is stop, that will enable me to be the best I can be at the Olympics.

While it is easy to look at elite sportspeople and see genetic freak-ism, the truth is far removed. I was genetically blessed with long limbs and an above-average aerobic capacity. I was also genetically slammed with below-average strength and my fair share of dodgy bones. Like every rower, it was hard work, persistence and an unrelenting desire to get better that enabled me to improve.

With a few small exceptions in niche events — such as 100-metre sprinting, which requires a God-given gamut of fast-twitch fibres — the common thread among elite athletes is exceptional dedication, not exceptional genes.

An Olympics where willpower is displaced, and the competition becomes about who has taken the most or the best drugs, is an Olympics I never want to be a part of.

Elite sport would move from a test of personal strength, courage and commitment, to a giant game of chicken, where the winner is the one prepared to risk their health the most in order to win.

One need only look to the tragic deaths of riders before cycling got serious about stamping out doping, or the ruined lives from East Germany's doping regime, to see that the health ramifications far outweigh any theoretical imperfections cited by Fry in the 'level playing field' concept.

Certainly, some performance-enhancing substances and methods used to gain an 'edge', such as using ice baths for recovery, training at altitude or using biomechanical expertise, may be unfairly accessible to some but not all athletes.

But a line delineating the acceptable and unacceptable must be drawn somewhere.

The speed limit in school zones is set at 40 km/h, not because 39 is definitively 'safe' and 41 definitively 'unsafe', but because it is the most appropriate limit to balance the competing considerations of safety and the ability of cars to get from place to place in reasonable time.

The line between which drugs are permitted in sport and which are not is premised on a similar balancing act. Drugs that are clearly performance-enhancing and risky to athletes, such as steroids, are banned. Drugs that are used every day for common ailments and pose little risk to athletes' long-term health, such as paracetamol, are not.

There will always be grey areas. Should intravenous drips to administer permitted substances be allowed? Should caffeine, a performance-enhancing stimulant, yet one common in society, be banned?

These issues are constantly monitored by our anti-doping agencies, and change over time to reflect where best the line should be drawn.

Yet the presence of grey areas is no reason for failing to draw a line at all.

Beyond the consequences for elite athletes themselves, the trickle-down ramifications for grassroots sport is deeply concerning.

Nor should anyone assume that the fight against doping is failing. The artillery of detection mechanisms is greater than ever. We have to record our whereabouts for every single day of the year. We can be tested anywhere, any time.

We can be required to provide blood, urine or both. Our samples can be stored for up to eight years, and can be retested when tests for new drugs become available. Our blood samples can be compared against each other over the duration of our careers (the 'blood passport') and be monitored for changes that would not occur naturally. Australian Institute of Sport scholarship holders can have their rooms searched at any time.

Doping detection mechanisms and the 'level playing field' may be imperfect, but elite athletes should not have to play Russian roulette with their health in order to win.

Kimberley Crow is a member of the Australian rowing team.

Source: *The Age*, 2 July 2012.

Sociocultural influences on the use of performance-enhancing practices

All athletes strive to achieve their best but the pressure placed on athletes to succeed may greatly influence the decisions they make about the most effective way to achieve the goals they have set for themselves. While many would say it is the responsibility of the individual athlete to know what they are using — whether the substance is legal or illegal or if it has any side-effects — it is not always clear cut. Athletes are individuals but are also part of a wider support group which has the capacity to influence their behaviour and the choices they make, especially in relation to their performance. A variety of sociocultural reasons may influence an athlete to use performance-enhancing substances and methods to gain an edge over their fellow competitors.

Sociocultural influences come from the power structures and relationships within society and the culture that creates shared ways of thinking and doing things. In sport, these sociocultural influences include:

- income
- education
- influence of self, family, peers
- influence of coaches and sporting organisations
- cultural norms in the society or the particular sporting culture
- national and political ideology.

These may all have an impact on whether athletes choose to use legal or illegal performance-enhancing substances. Some examples are highlighted below.

Income: The financial and material rewards of success can be a major influence on athletes. The need to earn an income to support training and travel, and the celebrity status that may come with product endorsements or sponsorship can influence choices made. The fame and prestige associated with being the 'fastest person in the world' are often cited as the reason why athletes, in particular sprinters, have been linked with illegal substance use. The opportunity to move out of poverty may also be a strong influence for an athlete. In many of the African nations, where being an elite athlete provides you with an avenue to change the course of your life, there is incentive to use a performance-enhancing substance to win races, get noticed by talent scouts and make national teams.

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Unit 1	**Ethical and sociocultural considerations (musculoskeletal)** Concept summary and practice questions
AOS 1	
Topic 5	
Concept 10	

Influence of self, family, peers: Pressure can be derived from the expectations of family members, or of the individual themselves, to win and be successful. Individual pressure is often derived from the want to improve performance, receive the accolades that go with winning and be a sporting hero. Peers can also be a significant source of pressure, whether that be through encouragement to use, or from the belief that other athletes around them are using substances to enhance their performance. Youth are often faced with pressure from their peers to take legal substances such as creatine or protein powders to increase muscle bulk, strength and power. This extends to recreational and amateur sportspeople, as well as those hoping to make it professional in their sports. The risk with this revolves around level of education and understanding of the benefits and harms of using these substances, as the advice is often not from an informed individual.

FIGURE 5.19 Cyclist Lance Armstrong is a high-profile example of an athlete who succumbed to the lure of performance-enhancing substances.

Influence of coaches and sporting organisations: The Essendon football club supplements saga has highlighted the strong influence a coach, their support personel and the sporting organisation can have on an athlete. In 2016, 34 players received WADA bans for alleged use of the performance-enhancing substance thymosin beta 4, a banned peptide that can enhance healing via production of new cells. The introduction of this drug, along with other supplements in 2012, was part of a program to assist the football club to gain an edge over fellow teams and bring them closer to a premiership. The players were told by the club that the supplements were legal and there was no risk of infringing the WADA anti-doping code. The blind faith and possibly misplaced trust of the players highlights the pressure that an athlete can face, especially in a team sport, to win at all costs.

FIGURE 5.20 James Hird, former coach of Essendon football club, who received a 12-month suspension for his role in the illegal drug use by players under his leadership

TEST your understanding

1 Outline some of the specific pressures that athletes face, which may influence the use of performance-enhancing substances or methods.

APPLY your understanding

2 **Case study:** Read the articles written by Craig Fry and Kimberley Crow and answer the following questions.
   (a) Craig Fry questions whether or not sport really is a 'level playing field'. Outline his concerns.
   (b) What motivations did Kimberley Crow suggest as the reasons people pursue elite sport?
   (c) Fry and Crow both mention 'grey areas' of performance enhancement. List some of these.
   (d) Who do you agree with? Write a brief paragraph comparing the two articles and provide a personal summation of whether you think there is a place for all forms of performance enhancement in sport.

CHAPTER 5 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:**
  a. **Name** — identify or state
  Provide — give or state
  b. **Outline** — general description but not in detail
- **Key terminology:**
  Physiological benefit — changes that occur within the body to enhance the performance of the muscuoskeletal system
  Side-effects — harm or risk associated with the use of the substance or method
- **Key concept/s:**
  Illegal substance — method or substance that is banned by WADA
  Legal substance — method or substance that can be used by an athlete
  Performance enhancement — increases the functioning of the musculoskeletal system
- **Marking scheme:** *a. 2 marks + b. 2 marks*
  Always check marking scheme for depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

a. **1 mark** — naming an illegal ergogenic aid relevant to improving performance to compete in the 100 m hurdles
1 mark — naming a legal ergogenic aid relevant to improving performance to compete in 100 m hurdles

b. **1 mark** — outlining a perceived physiological benefit of the illegal ergogenic aid identified
1 mark — outlining a harmful side-effect of the illegal ergogenic aid identified

KEY SKILLS

- Investigate, evaluate and critically analyse a range of performance-enhancing practices from a physiological perspective
- Discuss the ethical considerations and sociocultural influence on the use of legal and illegal practices associated with improving the function of the musculoskeletal system

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- understand the potential benefits and perceived harms of a range of legal and illegal strategies that can be used by an athlete to enhance the functioning of the musculoskeletal system
- physiological refers to changes that occur within the body, specifically to the skeletal or muscular system
- performance enhancement relates to improvements in the functioning of the musculoskeletal system
- provide a clear link between the musculoskeletal physiological adaptation and how it can enhance performance
- there are a range of ethical and sociocultural influences on an athlete when making the choice to use or not use performance-enhancing substances and methods.

PRACTICE QUESTION (adapted from ACHPER Trial Exam 2014, question 1)

Australian athlete, Sally Pearson, is the current Olympic champion in the women's 100 m hurdle event. In winning this event in the 2012 London Olympics, her time was 12.35 seconds. As an elite athlete, Sally has been drug tested numerous times in her career.

a. **Name one** illegal ergogenic aid that an athlete may use in order to enhance performance in the 100 m hurdles and **provide one** legal alternative that could be used to give similar performance improvement. *2 marks*

b. **Outline one** perceived **physiological** benefit and **one** harmful side-effect (other than heart attack or death) of the illegal ergogenic aid given in **part a**. *2 marks*

Sample response

a. Illegal ergogenic aid — one of anabolic steroids or growth hormone
Legal ergogenic aid — training (resistance, plyometrics, short interval)

b. Physiological benefit
Anabolic steroid — can include increased muscle bulk, increased aggression, faster recovery rates after training
Human growth hormone — can include enhanced muscle/bone development, anti-inflammatory effects
Potential side effect
Anabolic steroid — can include cancer, hypertension, fluid retention, acne, testicular atrophy, breast atrophy, anger issues
Human growth hormone — can include fluid retention, cancer, infertility, hypertension

PRACTISE THE KEY SKILLS

1. Choose either caffeine, creatine or bicarbonate. Outline perceived benefits and possible harms for an athlete who might consume these supplements.
2. Identify one legal and one illegal method that athletes might use to build muscle strength and power. Discuss performance benefits and potential harms of these methods.
3. Discuss some of the specific pressures athletes experience that may influence them to use performance-enhancing drugs and/or methods to improve the musculoskeletal system.

KEY SKILLS EXAM PRACTICE (ACHPER Trial Exam 2008, question 9)

Creatine supplementation is a dietary enhancement practice thought to enhance performance.

a. Outline the major perceived benefit to performance from the use of creatine supplementation. *2 marks*

b. What type of athletes would most benefit from the use of creatine supplementation? *1 mark*

c. Outline one other possible effect that creatine supplementation may have on an athlete. *2 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

Performance enhancement

- Performance enhancement includes any methods, devices or substances that have the potential to improve athletic performance. They can be legal or illegal and are categorised as mechanical, nutritional, pharmacological, physiological or psychological aids to enhance performance.
- Performance-enhancing substances and methods improve performance by influencing the physiological capacity of a particular body system, removing physiological constraints that impact on performance or increasing the speed of recovery.

Legal substances and methods

- Legal substances and methods to enhance performance of the musculoskeletal system include training methods such as resistance training, plyometric training, and short and intermediate interval training.
- Training methods and mechanical devices can improve an athlete's performance by increasing the strength, power and speed generated by the muscles to run faster, jump higher and throw further.
- Nutritional supplements can also benefit the athlete. There are myriads of nutritional supplements on the market, although many of them have no scientific backing to support their performance-enhancement claims. While specialised sports foods or drinks are very popular and can be a useful addition to a specialised program, nutritional performance supplements should be used with caution. Only a few so-called nutritional performance supplements actually offer benefits supported by scientific evidence.
- The AIS provides an information program for its athletes, which categorises sports supplements and/or ergogenic aids. Currently, only those supplements found in group A have scientific backing and are supported by the AIS for use by its athletes. Examples of these supplements include sports drinks, electrolyte replacement supplements, sports bars or gels, liquid-meal supplements, orally ingested vitamin or mineral supplements, protein supplements, caffeine, creatine and bicarbonate.

Illegal substances and methods

- Doping is the use of certain substances or methods that could artificially improve an athlete's physical and/or mental condition, thus enhancing their performance. Performance-enhancing drugs are currently banned or considered illegal in most sports.
- Performance-enhancing drugs may be taken by athletes to increase their strength and muscle mass, counteract undesirable side-effects, mask the presence of other banned substances, increase alertness or aggressiveness, or reduce pain.
- The World Anti-Doping Authority (WADA) produces a list of banned substances and methods annually that athletes and sporting organisations must abide by. Drugs can be prohibited at all times, only in competition or only in certain sports depending on their classification and effects on the body.
- Performance-enhancing drugs most relevant to the development of the musculoskeletal system include those based on naturally occurring hormones in the human body, including anabolic steroids and growth hormones and related substances.
- There are a variety of reasons why athletes take drugs. These can include dissatisfaction with performance and progress; belief that others are using drugs; being easily influenced by others; lack of knowledge about side-effects; culture of the sport; pressure to win from coach, parents, public, media; and financial reward.

MULTIPLE CHOICE QUESTIONS

1 The most relevant anaerobic training methods to enhance performance of the musculoskeletal system are
(A) resistance training, fartlek training, flexibility training.
(B) plyometric training, continuous training, circuit training.
(C) resistance training, plyometric training, short-interval training.
(D) plyometric training, flexibility training, long-interval training.

2 Plyometrics aims to increase muscular power by which of the following methods of contraction?
(A) A rapid isokinetic contraction followed by a rapid concentric contraction
(B) A rapid eccentric contraction followed by a rapid concentric contraction
(C) A rapid concentric contraction followed by a rapid eccentric contraction
(D) Holding an isometric contraction

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Sit Topic Test

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Interactivity
Performance enhancement of the musculoskeletal system quiz
Searchlight ID: int-6638

3 Which of the following is not a legal supplement that can be used by an athlete to enhance performance?
(A) Creatine
(B) Protein
(C) Caffeine
(D) Steroids

4 Sports gels are commonly used by athletes to increase fuel supply of which nutrient?
(A) Protein
(B) Carbohydrates
(C) Fats
(D) Vitamins and minerals

5 Sports drinks can limit the fatigue of an athlete during an event, as they can
(A) hydrate an athlete.
(B) hydrate and refuel an athlete.
(C) refuel an athlete.
(D) stop hunger.

6 Caffeine is commonly used by athletes to enhance their performance as it is thought to
(A) decrease perception of fatigue and effort.
(B) decrease glycogen-sparing capacity.
(C) increase heart rate.
(D) increase fuel stores.

7 Illegal performance-enhancing drugs most relevant to the musculoskeletal system include
(A) steroids and stimulants.
(B) steroids and blood doping.
(C) steroids and growth hormone.
(D) steroids and beta blockers.

8 WADA have prohibited the use of a number of substances and methods by athletes, as they have the potential to
(A) artificially enhance the performance of an athlete.
(B) be potentially harmful to the health of an athlete.
(C) be contrary to the spirit of sport.
(D) All of the above.

9 Power athletes may use human growth hormone (hGH) in an attempt to increase their muscle bulk. A potential harm of taking this drug could be
(A) increased blood viscosity.
(B) hypertension.
(C) decreased libido.
(D) increased heart rate.

10 A legal alternative to using steroids that could induce the same physiological changes to enhance performance would be
(A) creatine supplementation.
(B) human growth hormone injections.
(C) resistance training.
(D) continuous training.

EXAM QUESTIONS

Question 1 **(ACHPER Trial Exam 2013, question 12)**

In January 2013 Lance Armstrong, winner of seven Tour De France titles, admitted that he had used numerous performance-enhancing drugs and/or practices to help him secure these wins.

List one perceived benefit and one side-effect that Armstrong would have experienced by consuming the substance anabolic steroid.

Benefit:

Side-effect:

Question 2 **(ACHPER Trial Exam 2015, question 10)**

Michael Clarke is an Australian cricketer who hit a score of 128 off 163 balls in two days of play during a five-day test match against India. In the same summer season Peter Handscomb hit a score of 103 off 64 balls in a Twenty20 game that was completed in three hours.

a. Michael Clarke was advised to consume caffeine during the five-day test match.

Evaluate the perceived benefits of caffeine supplementation as a nutritional strategy for Michael Clarke during a five-day test match. **4 marks**

b. List and explain **one** hydration technique, other than drinking water, that Michael Clarke could utilise during a five-day test match to enhance performance. **2 marks**

Question 3 **(ACHPER Trial Exam 2011, question 6)**

Samuel Wanjiru of Kenya won the Olympic Marathon in Beijing 2008 in an Olympic record time of 2 hours, 6 minutes and 32 seconds. The event was held in hot and humid conditions. In preparation for the event Samuel regularly trained over 160 kilometres per week.

a. Elite endurance athletes like Samuel Wanjiru will carbohydrate (CHO) load before their event. Outline the dietary and training strategies that should be used in conjunction with CHO loading. **2 marks**

b. i. Other than the associated benefits of increasing muscle and liver glycogen stores, describe one advantage of CHO loading and how it assists performance. **3 marks**

ii. Outline two disadvantages that may be associated with CHO loading. **2 marks**

Question 4 **(ACHPER Trial Exam 2012, question 12)**

Protein is a vital component in an athlete's diet.

a. Name two foods that are a **high** source of protein. **2 marks**

b. Outline two roles that protein plays in exercise **recovery**. **2 marks**

Question 5 **(ACHPER Trial Exam 2008, question 19)**

During 2005, the media ran a number of stories relating to the use of caffeine supplements as a performance-enhancing practice for elite athletes.

a. Outline **two** supposed performance benefits associated with the use of caffeine. **2 marks**

b. Outline **two** potential side-effects associated with the use of caffeine as a performance-enhancing substance. **2 marks**

INQUIRY QUESTION
How do the structures of the cardiovascular system work together to meet the demands of the body during rest and exercise?

CHAPTER 6 Structure and functions of the cardiovascular system

The cardiovascular system plays an important role in the delivery of oxygen and fuels for energy production, as well as the removal of waste products during physical activity.

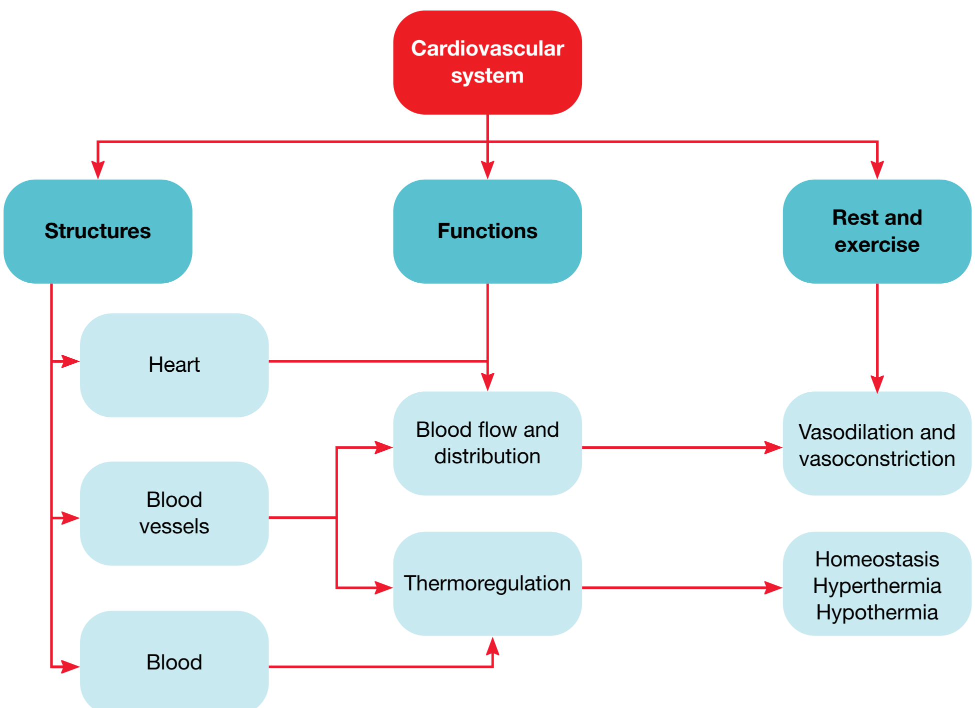
KEY KNOWLEDGE

- The structure and function of the cardiovascular system, including the structure and function of the heart and blood vessels, and blood flow around the body at rest and during exercise
- Components of blood, including red blood cells, white blood cells, platelets and plasma, and their function at rest and during exercise
- The role of the cardiovascular system in thermoregulation: homeostasis, hyperthermia and hypothermia
- Vasodilation and vasoconstriction of the blood vessels to regulate blood distribution at rest and during exercise
- The relationship between stroke volume, heart rate and cardiac output at rest and during submaximal and maximal exercise

KEY SKILLS

- Use and apply correct anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- Describe the role and function of the blood
- Examine the role of the cardiovascular system in thermoregulation
- Analyse the relationship between stroke volume, heart rate and cardiac output at rest and during submaximal and maximal exercise
- Perform, measure and report on changes to the cardiovascular and respiratory systems at rest compared with exercise

CHAPTER PREVIEW



6.1 Cardiovascular system: structure and functions of the heart and blood vessels

KEY CONCEPT The cardiovascular system transports essential nutrients to all body tissue, delivers oxygen in the required amounts to varied body sites, and removes waste products created by the metabolism of nutrients. It does this by the heart pumping blood through a network of blood vessels around the body.

Functions of the cardiovascular system

The body depends on the efficient functioning of the **cardiovascular system**. The cardiovascular system consists of the heart and blood vessels working together to transport gases and nutrients around the body. This system has five important functions:

- It circulates blood to all parts of the body.
- It transports water, oxygen and nutrients to the cells.
- It transports wastes including carbon dioxide away from the cells.
- It helps maintain correct body temperature.
- It helps fight disease through the white blood cells and antibodies contained in the blood.

The **cardiovascular system** consists of the heart and blood vessels circulating blood throughout the body, delivering water, oxygen and nutrients to cells, and removing waste products such as carbon dioxide.

Structure of the heart

The heart is a pump designed to circulate blood throughout the cardiovascular system (figure 6.1).

The heart has four chambers — two **atria** and two **ventricles**.

- The atria are the upper chambers that receive blood.
- The ventricles are the lower chambers that pump blood.

Atria are the two upper chambers of the heart. They receive blood from the veins and pump it into the lower chambers (ventricles).

Ventricles are the two lower chambers of the heart. They receive blood from the atria and pump it to the lungs (right ventricle) and to the body (left ventricle).

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Interactivity
Anatomy of the heart
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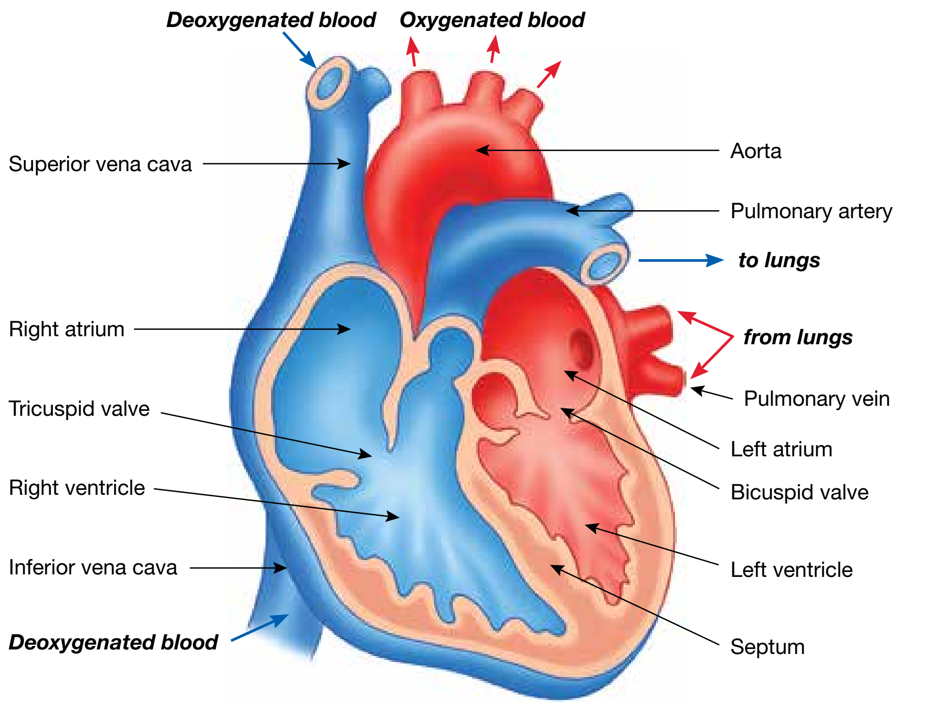

FIGURE 6.1 The structure of the heart

The septum divides the heart into two pumps.

- The left pump is the left atrium and left ventricle.
- The right pump is the right atrium and right ventricle.

The blood in the two pumps does not mix because the left pump has **oxygenated** blood for the body, while the right pump has **deoxygenated** blood that travels to the lungs for the removal of carbon dioxide.

Oxygenated refers to oxygen-rich blood.

Deoxygenated refers to oxygen-poor (carbon dioxide-rich) blood.

Valves are located between the atria and the ventricles, and at the entrance to the arteries from the heart. The bicuspid valve is on the left side of the heart and the tricuspid valve is on the right side. They allow blood to travel in only one direction, stopping blood in the ventricles from flowing back into the atria.

Functioning of the heart

The heart is an involuntary muscle; that is, we do not have conscious control over its functioning. It works by the continual contraction and relaxation of the atria and ventricles. When the heart contracts, it forces blood out of the heart via the ventricles and into the arteries. This is called **systole**. When the heart relaxes, it fills with blood from the veins. This is called **diastole**. The **cardiac cycle** is made up of the atria contracting (systole) while the ventricles relax (diastole), and the ventricles contracting (systole) while the atria relax (diastole).

Features of the heart

- It is located slightly to the left of the centre of the chest (between the two lungs) and is protected by the rib cage (figure 6.2).

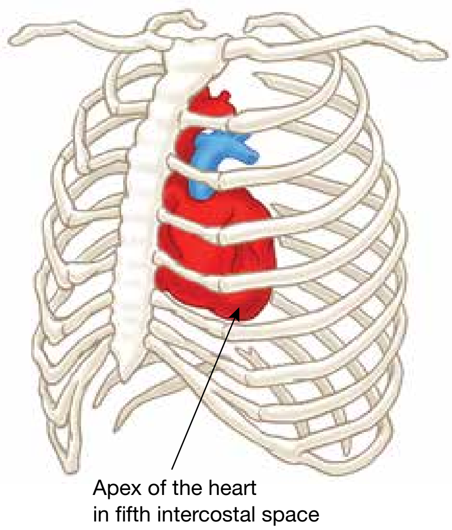

FIGURE 6.2 The heart is well protected by the rib cage.

- The adult heart is about the size of a large fist.
- The audible sound that can be heard when listening to the heart is called the **heartbeat**.
- At rest, the average **heart rate (HR)** is about 72 beats per minute (see page 141 for more information). Heart rate is measured by taking your pulse.
- **Stroke volume (SV)** is the amount of blood pumped by each beat of the heart (see pages 141–2 for more information). As an individual becomes fitter, stroke volume increases from approximately 70 mL/beat to 100 mL/beat.
- **Cardiac output ($\dot{Q}$)** is the amount of blood pumped by the heart per minute (see page 142 for more information), and is measured in litres per minute (L/min). In adult males this may be about 5 litres per minute, and in adult females about 4 litres per minute.

It is calculated by multiplying heart rate (HR) by stroke volume (SV), or HR × SV = $\dot{Q}$. For example, 72 bpm × 70 (mL/beat) = 5.04 L/min.

Heart rate × Stroke volume = Cardiac output

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How your heart works
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Systole is a contraction of the heart muscle, specifically the ventricles.

Diastole is a relaxation of the heart muscle.

Cardiac cycle is the movement of blood through the heart in one heartbeat. It consists of alternate systole and diastole of the atria and the ventricles.

Heartbeat is one contraction and relaxation of the heart muscle.

Heart rate (HR) is the number of times the heart contracts or beats per minute (bpm).

Stroke volume (SV) is the amount of blood ejected from the left ventricle with each heartbeat (contraction) of the heart. It is measured in millilitres per beat (mL/beat).

Cardiac output ($\dot{Q}$) is the amount of blood ejected from the left ventricle of the heart per minute. It is the product of heart rate (HR) multiplied by stroke volume (SV), so $\dot{Q}$ = HR × SV, and is measured in litres per minute (L/min).

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Unit 1 | AOS 2 | Topic 1 | Concept 1

The heart
Concept summary and practice questions

Blood vessels

Blood vessels are a transport network of arteries, capillaries and veins that carry nutrients and waste around the body.

In addition to the heart, the cardiovascular system has three types of **blood vessels** that control the direction and volume of the blood flow around the body:

- arteries (figure 6.3)
- veins (figure 6.4)
- capillaries (figure 6.5).

This network is also referred to as the vascular system.

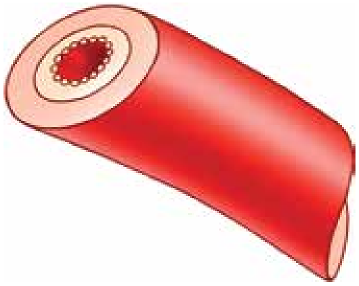

FIGURE 6.3 An artery has a thick, elastic, muscular wall.

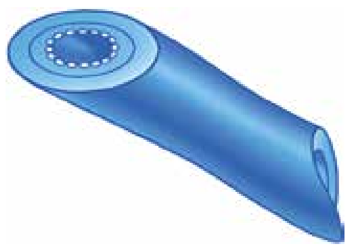

FIGURE 6.4 A vein has a thinner, less elastic wall than an artery wall.

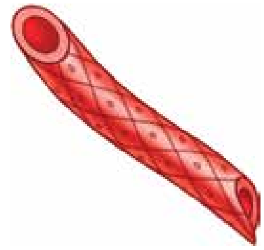

FIGURE 6.5 A capillary has a very thin wall that allows oxygen, carbon dioxide and nutrients to pass into the cells.

Arteries

Arteries are large, thick-walled blood vessels that carry blood away from the heart.

Arteries always carry oxygen-rich blood from the heart to the body. The aorta is the largest artery in the body (figures 6.1 and 6.7). The left ventricle pushes the blood into the aorta and on to the rest of the body. The volume of blood pumped into the arteries with each beat is quite large. The artery walls are elastic so they can expand with each heartbeat to accommodate this volume.

When you take your heart rate, you are recording the number of beats of the heart by feeling the pressure of the blood being pushed into the arterial system. The two most common points for recording a heart rate are the carotid (neck) and radial (wrist) pulse. You should always take your heart rate at only one point on the body, using a fingertip and not a thumb. A quick method of calculating your heart rate is to take it for 10 seconds, then multiply that number by six to find the beats per minute.

Figure 6.6 shows the location of the major pulse sites on the body. These may also be emergency pressure-control points to stem blood flow after accidents that have caused high blood loss. Bleeding from an artery can be recognised by the blood spurting out with each heartbeat and by the bright red colour of this oxygen-rich blood. Factors that affect resting heart rate include:

- gender, with males usually having a lower resting heart rate than females
- temperature, with heart rate increasing as air temperature increases
- eating, which increases heart rate
- laughing, which increases heart rate
- smoking, which increases heart rate
- body position, with heart rate being higher when standing than when sitting, and higher when sitting than when lying down
- exercise, which increases heart rate in order to deliver more oxygen and nutrients around the body and to the working muscles.

Arteries reduce in size to become arterioles as the network of blood vessels works its way into the depths of the body.

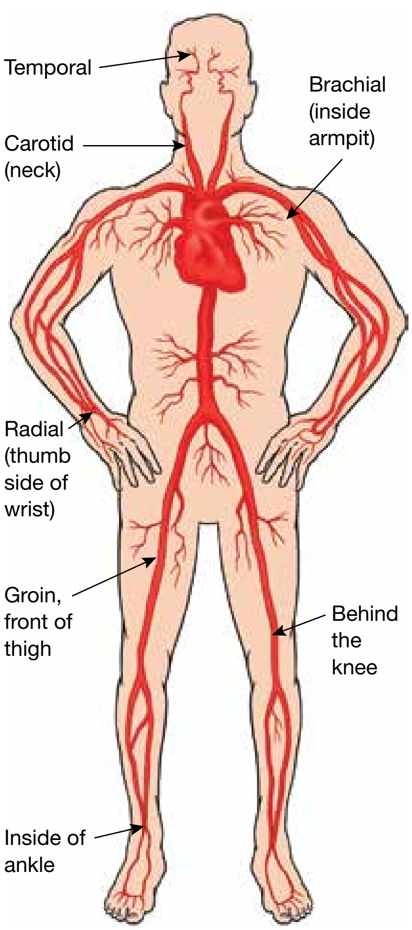

FIGURE 6.6 Major pulse sites in the body

Like other muscles, the heart needs a supply of oxygen and nutrients which are delivered by the cardiovascular system. There are two **coronary arteries** (figure 6.7), both of which branch from the aorta and spread across the heart muscle to feed all the chamber walls with nutrients. One of the most common causes of heart attack is the blockage of one or both of the coronary arteries with fatty deposits, resulting from a poor lifestyle. This reduces the blood supply to the heart muscle, causing severe pain in the chest and possibly death of part of the heart muscle or of the individual.

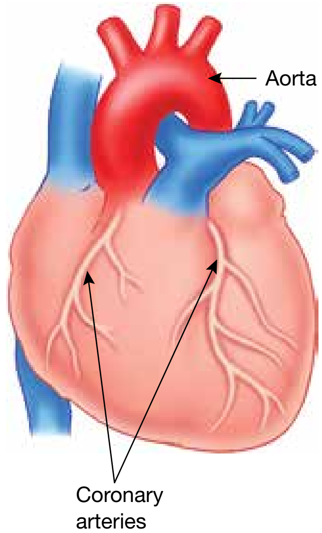

FIGURE 6.7 The two coronary arteries supply oxygen and nutrients to the cardiac muscle.

Coronary arteries supply oxygen and nutrients to the cardiac muscle (heart).

Capillaries

Capillaries are the smallest blood vessels, and they form the next stage of the blood vessel network after the arterioles (figure 6.8). The exchange of nutrients and waste between the blood and the body cells occurs in the capillaries. Heat from the cells is also absorbed by the blood in the capillaries. This exchange of materials and heat is easy because the thin walls of the capillaries are only one cell thick.

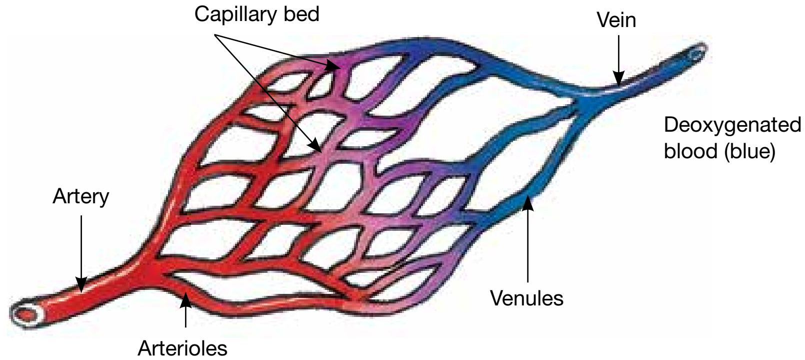

FIGURE 6.8 The capillaries are the smallest division in the blood circulation network. Gases and nutrients are exchanged in the capillaries.

Capillaries are tiny blood vessels in the cardiovascular system between the ends of the arterioles and the venules. They are the site for the exchange of gases between the cells and the cardiovascular system.

When you begin to exercise, the capillaries dilate (increase in diameter) to allow the increased blood flow required during exercise. Other capillaries feeding the working muscles also come into use by 'gateways' or **precapillary sphincters**, opening up and allowing more blood to the muscles. The cardiovascular system uses these sphincters to channel blood to various body sites depending on prevailing conditions (figure 6.9).

Precapillary sphincters are one-way valves that control blood flow within capillaries.

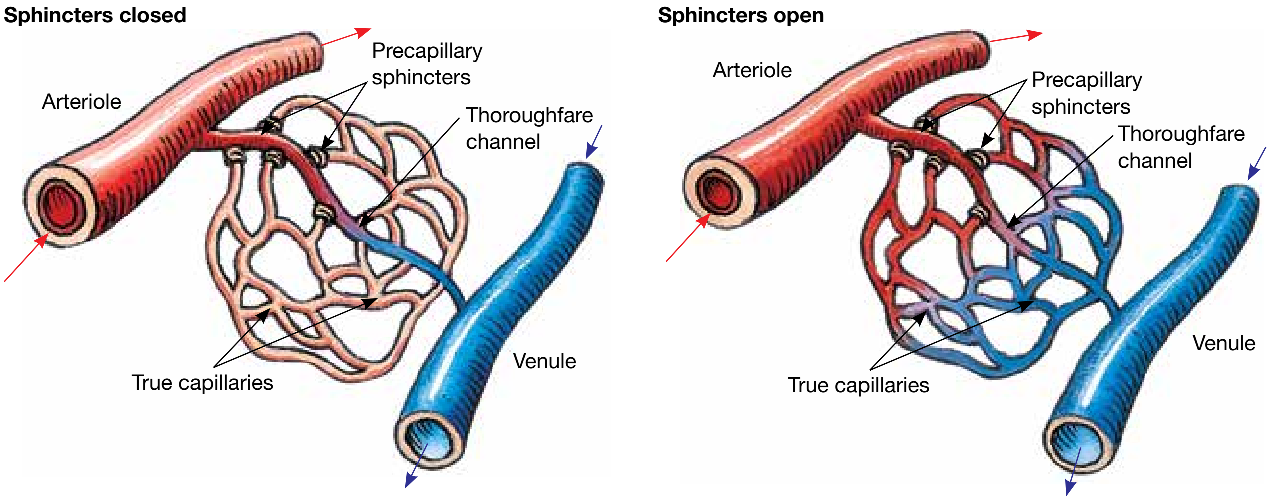

FIGURE 6.9 When whole body sections require increased blood flow (such as muscles during exercise), precapillary sphincters open to allow a greater volume of blood.

A long-term exercise program may increase the number of capillaries supplying blood to muscles (including the heart). This allows an increased supply of oxygen and other nutrients to the muscles and a more rapid removal of wastes. The capillaries eventually carry these wastes to the venules, which then carry them into the veins.

Veins

When blood reaches the veins, it is no longer surging or pulsing under the influence of the heartbeat. Instead, the flow is steady and consistent. The walls of the veins are quite thin and not as elastic as the walls of the arteries.

Veins are blood vessels that carry deoxygenated blood and waste products from the body's cells back to the heart.

Veins carry blood with lower oxygen content and a high carbon dioxide content because the muscles and cells have extracted oxygen to produce energy. The return of blood to the heart in the veins depends on the contraction of skeletal muscles. Veins running alongside muscles are squashed or squeezed when the muscles contract. One-way valves force blood in the veins upwards towards the heart (figure 6.10), against the force of gravity.

Blood pooling refers to a collection of blood in the leg veins when high intensity activity stops too suddenly.

Blood pooling after exercise is a problem if you do not gradually cool down. Given the increased blood flow during exercise (from around 5 litres per minute to possibly over 30 litres per minute), a gradual return to rest conditions is paramount. During a cool-down, the muscle pump system continues to move the gradually diminishing excess blood flow around the body until it has reached resting level. Without this process, the combination of high blood flow and gravity creates an increase (or 'pooling') of blood in the legs.

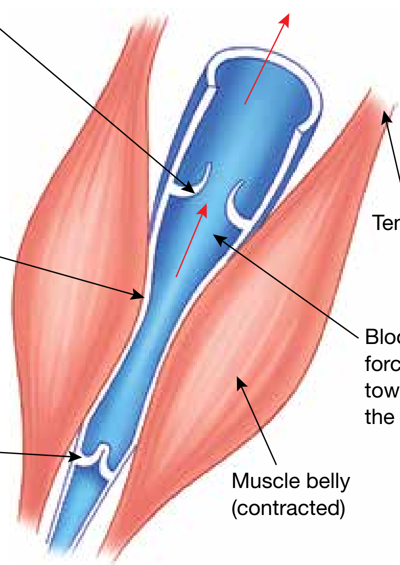

FIGURE 6.10 The contracting muscles squeeze the vein, forcing the blood against gravity towards the heart.

TABLE 6.1 Summary of structure and function of blood vessels

Blood vessel	Structure	Function
Artery	Large, thick, elastic wall	Carries blood away from the heart
Capillary	Small, thin wall Only one cell thick	Site of exchange for nutrients and wastes between cells and cardiovascular system
Vein	Thin, large diameter One-way valves	Carries blood back to heart

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Interactivity
Blood vessel structure and functions
Searchlight ID: int-6641

TEST your understanding

1 Download the diagram of the heart in your eBookPLUS. Label the structures of the heart. Indicate the direction of blood flow through the heart.
2 List the five functions of the cardiovascular system.
3 Outline the cardiac cycle. Explain the difference between systole and diastole.
4 Compare the differences between the three types of blood vessels — arteries, veins and capillaries.
5 Define heart rate. Discuss the factors that can affect heart rate.

APPLY your understanding

6 Define cardiac output. Calculate the cardiac output ($\dot{Q}$) of an individual who has a heart rate of 75 bpm and a stroke volume of 70 mL/beat.
7 Define stroke volume. Calculate the stroke volume (SV) of an individual participating in moderate exercise who has a heart rate of 100 bpm and a cardiac output of 8 L/min.
8 Explain the importance of capillaries in physical activity.
9 Describe what the body does to lessen the problems caused by venous pooling.
10 Detail the path that blood flows through the heart, outlining all structures. Begin at the vena cava.
11 **Learning activity: sheep's heart dissection**
   (a) In pairs or groups of three, dissect a sheep's heart, locating chambers, valves, main entrance and exit blood vessels.
   (b) Write a report of the dissection that includes a labelled diagram you have drawn.
12 **Practical activity: heart rate and exercise**
   (a) Before you begin the physical activities, sit down quietly and manually measure your resting heart rate.
   (b) Perform each of the following activities, taking your pulse for 10 seconds immediately after you complete each activity. Rest until heart rate has returned to resting heart rate between each activity.
   – Walking for 2 minutes
   – Jogging for 2 minutes
   – Situps for 30 seconds
   – Stepups on a bench for 2 minutes
   – Seated toe-touches for 30 seconds
   – Running for 3 minutes as fast as possible
   (c) Record and graph your results. Multiply by six to determine your heart rate.
   (d) Identify which activity caused the highest heart rate. Suggest reasons for this.
   (e) Discuss the relationship between your heart rate and the intensity of the activity. Provide examples.

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Interactivity
Blood flow in the heart
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Unit 1
AOS 2
Topic 1
Concept 2

Blood vessels
Concept summary and practice questions

6.2 Cardiovascular system: blood and blood circulation

KEY CONCEPT Blood circulates around the body to deliver oxygen and nutrients to cells while removing waste products. Blood travels around two major circuits: the systemic circuit (the body), and the pulmonary circuit (the lungs).

Blood

Blood is the only body tissue that is a liquid. Blood cells make up 45 per cent of the blood volume, while plasma makes up the other 55 per cent. Blood transports materials required for energy production, including oxygen and glucose, and byproducts of energy production such as carbon dioxide and lactate, around the body. Blood also plays a very important role in the thermoregulation of the body. Each individual has approximately 4–5 litres of blood in their body, and it takes around one minute to circulate around the body at rest. Exercise improves the quality and quantity of the body's blood supply. The three types of blood cell are described below.

Blood is the fluid circulated by the heart around the body. It consists of plasma, red and white blood cells, and platelets.

Red blood cells

- Make up 99 per cent of all blood cells
- Transport oxygen to, and carbon dioxide from, the cells and muscles
- Contain **haemoglobin** (the substance that carries oxygen through the bloodstream)
- Are continuously produced in the bone marrow in the cavities of bones (see chapter 2, page 16)
- Are continually removed by the liver and spleen when worn out
- Have a lifespan of about four months

Haemoglobin is a substance found in red blood cells that transports oxygen around the body.

White blood cells

- Exist in the body in a ratio of 1 to every 700 red blood cells
- Come in a variety of shapes and sizes
- Are generally larger than red blood cells
- Can pass through capillary walls into the body cells to fight disease-causing organisms by absorbing and digesting them
- Have a lifespan of a few days

Platelets

- Cause blood to clot when a blood vessel is damaged
- Are smaller than red blood cells
- Are produced in the bone marrow

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Unit 1	**Blood components** Concept summary and practice questions
AOS 2	
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Plasma

Plasma is a clear yellowish fluid of which over 90 per cent is water. It carries the blood cells, continually passing through the capillary walls and into the cells. Plasma provides the cells with proteins, salts, glucose, fats, antibodies and some oxygen. It also removes waste products. In emergencies, plasma is the first substance fed into the injured body to replace any lost fluids. Any blood transfusions are normally given later.

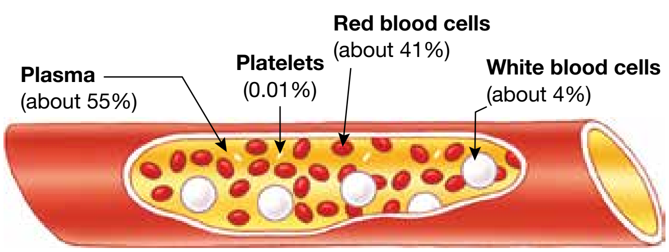

FIGURE 6.11 The components of blood

TABLE 6.2 Summary of the role and function of blood components

Blood component	Function
Red blood cell	Transports oxygen around the body
White blood cell	Protects against disease
Platelet	Causes blood to clot
Plasma	Carries blood cells around body

Blood circulation

Circulation of blood throughout the body is divided into two closed circuits:

- **systemic circulation**, when oxygenated (oxygen-rich) blood is transported from the heart via the left ventricle and aorta and circulated into the arteries around the body (except for the lungs), and deoxygenated (oxygen-poor) blood returns to the heart via the vena cava and into the right atrium
- **pulmonary circulation**, when deoxygenated blood is transported away from the heart and circulated to the lungs via the right ventricle and pulmonary artery, and oxygenated blood returns to the heart via the pulmonary vein and into the left atrium.

The following sequence shows how blood is circulated through the body (figure 6.12):

1. The right atrium receives blood (low in oxygen and high in carbon dioxide) from the body via the vena cava.
2. The right ventricle receives blood from the right atrium via the tricuspid valve and pumps this blood to the lungs via the pulmonary artery.
3. Blood gives up carbon dioxide and takes up oxygen while in the lungs.
4. Oxygenated blood returns via the pulmonary vein to the left atrium.
5. Blood enters the left ventricle via the bicuspid valve and is pumped through the aorta into the arterial system.
6. Blood flows to all extremities of the body through the arterioles.
7. Blood enters capillaries, where oxygen and nutrients are fed to the cells, and carbon dioxide, water and other wastes are removed from the cells.
8. Capillaries carry blood to the venules, then to the veins.
9. Veins return oxygen-poor blood to the right atrium.

Systemic circulation describes the arteries and veins that feed blood from the heart to the whole body and back to the heart again for reoxygenation.

Pulmonary circulation describes the arteries and veins that feed blood from the heart to and from the lungs where blood is oxygenated.

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Circulation of blood throughout the body
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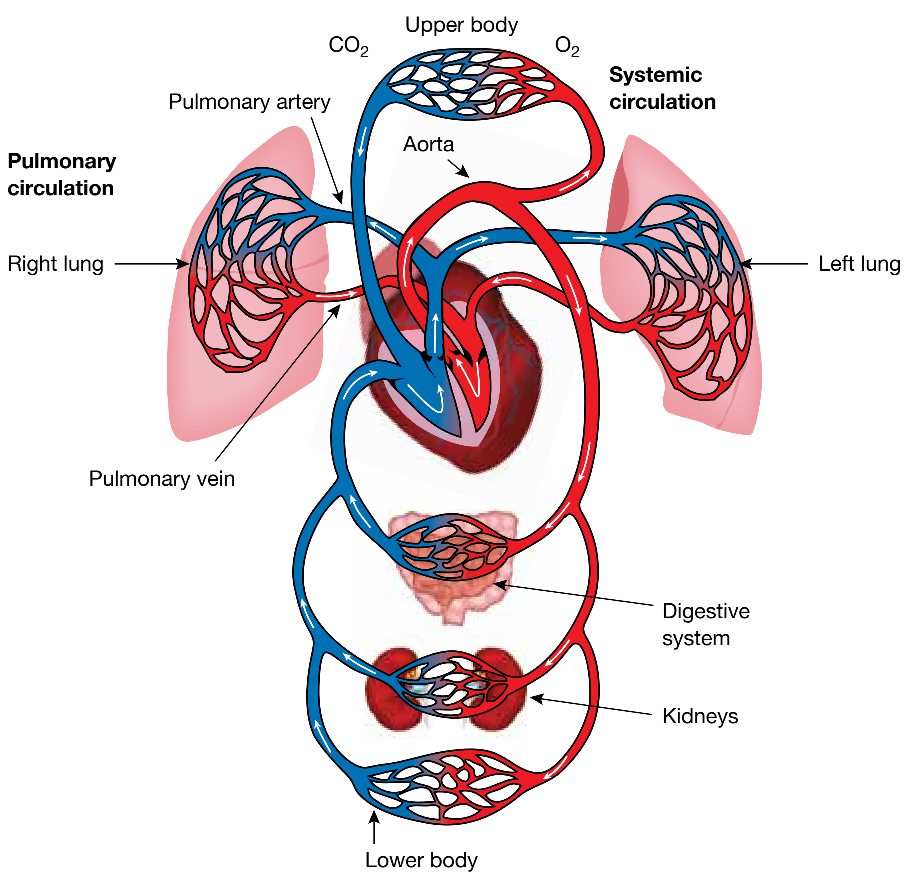

FIGURE 6.12 The circulation of blood: systemic and pulmonary

Blood pressure is the pressure exerted by the arterial blood against vessel walls as it is forced through the cardiovascular system by the beating or relaxing of the system.

Systolic blood pressure is the blood pressure recorded as blood is ejected during the contraction phase of the heart cycle. It is the higher of the two blood-pressure values.

Diastolic blood pressure is the blood pressure recorded during the relaxation phase of the heart cycle. It is the lower of the two blood-pressure values.

Features of the cardiovascular system

Blood pressure

Blood pressure is an indicator of the body's health. It shows:

- how hard the heart has to work to push the blood through the arteries, capillaries and veins
- the health of the arteries and capillaries.

Blood pressure has two measurements: an upper reading called the **systolic blood pressure**, and a lower reading called the **diastolic blood pressure**.

- Systolic blood pressure is a measure of the pressure that the blood exerts against the artery walls during the contractile (emptying) stage of the heart's pumping.
- Diastolic blood pressure is a measure of the same pressure against the artery walls, but during the relaxation (filling) phase of the heart's pumping action. A typical blood pressure reading is 120/80 mm Hg. (The measurement 'mm Hg' means millimetres of mercury, referring to the mercury-based device that measures blood pressure — a sphygmomanometer.) Figure 6.13 illustrates how to use a sphygmomanometer to measure blood pressure.

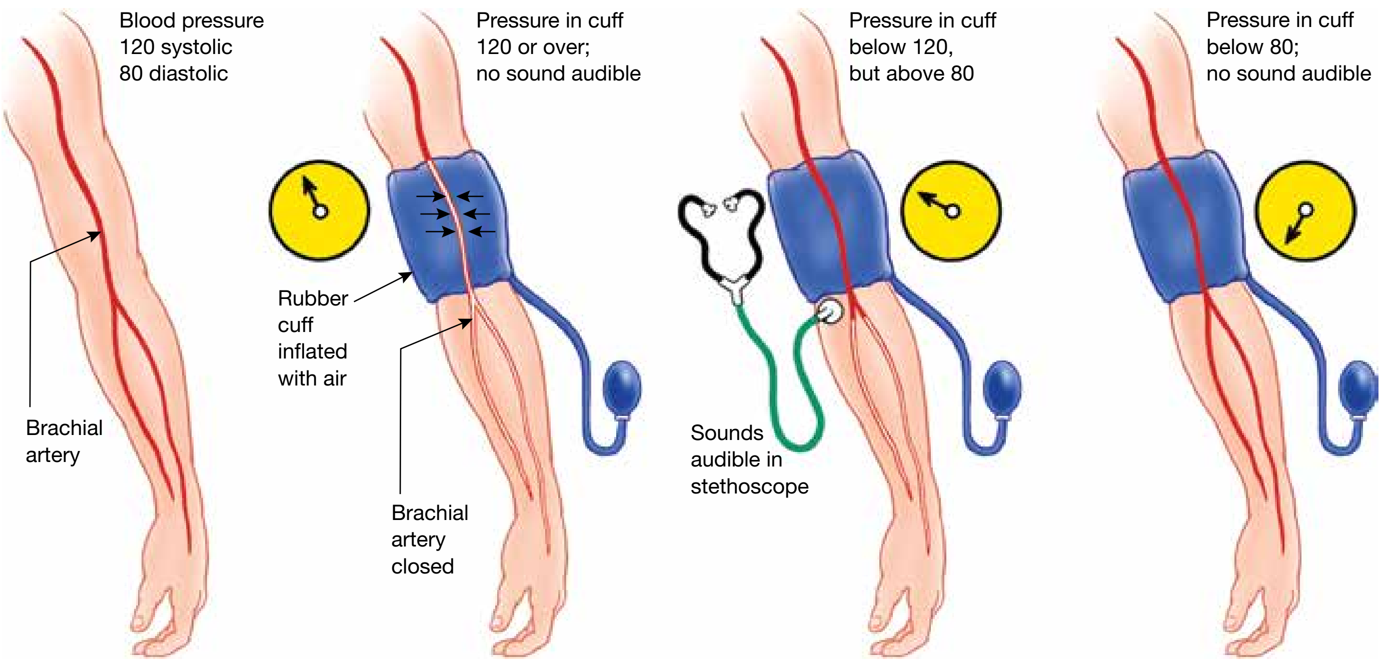

FIGURE 6.13 Learning how to place and read a sphygmomanometer will help you understand the importance of blood pressure in health.

Many factors affect systolic blood pressure. As a general rule, it should not be more than 140 mm Hg while at rest. Values above 140 mm Hg signify hypertension or high blood pressure. This is of concern as the heart has to work harder to pump blood around the body due to the increased pressure in the vessel walls. People with hypertension are at greater risk of developing cardiovascular diseases (see chapter 8). A guideline for predicting healthy systolic blood pressure is 100 plus your age, with a recommended maximum of 140–50 (table 6.3). However, with a healthy and active lifestyle, older people could sustain a systolic blood pressure of around 120 mm Hg. Regular exercise usually helps keep systolic blood pressure below the averages for 40–60 year olds.

TABLE 6.3 Average arterial blood pressures from birth to 60 years (mm Hg)

Age	Systolic	Diastolic
Newborn	40	20
1 month	75	50
2 years	85	60
4 years	90	65
10 years	105	70
15 years	110	70
20 years	120	80
30 years	130	85
40 years	140	90
50 years	145	90
60 years	150	90

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Unit 1
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Blood circulation and blood pressure
Concept summary and practice questions

TEST your understanding

1 Name the four components of blood and describe the function of each.
2 Define haemoglobin. Outline its importance in physical activity.
3 Identify the two closed circulatory systems of the body and describe their function.
4 Create a flowchart of the circulation of blood throughout the body, beginning at the right atrium.
5 Define blood pressure. Identify and discuss the two reading measurements.

APPLY your understanding

6 Imagine you are a red blood cell. Describe your path around the body, making sure to include anything that you may do along the way.
7 **Practical activity: blood pressure readings**
   (a) In pairs or groups of three, with one sphygmomanometer or digital blood-pressure reader per group, measure each other's heart rate and systolic and diastolic blood pressure when:
   – lying down
   – standing
   – sitting
   – riding an exercise bike.
   (b) Explain the differences in your blood pressure readings under the four conditions.
   (c) Compare and explain the similarities between the heart rate and blood pressure readings.
   (d) Did these results match what should have happened?

6.3 Role of the cardiovascular system in thermoregulation

KEY CONCEPT The cardiovascular system plays an important role in balancing heat gain or heat loss through the redirection of blood flow to dissipate or conserve heat for optimal functioning of the body.

Thermoregulation is the maintenance of core body temperature with a narrow range.

Homeostasis is a constant internal environment for optimal functioning of the body and its systems.

Vasodilation is a process whereby blood vessels increase their diameter causing an increase in blood flow.

Vasoconstriction is a process whereby blood vessels narrow or constrict causing a decrease in blood flow.

Thermoregulation relates to the maintenance of body temperature and the heat exchange that occurs between the body and the environment. Core temperature has a narrow range (36.5–37.5 °C) and any alterations can have an impact on the functioning of the individual.

Core temperature increases in response to exercise due to increased blood flow around the body, muscle use and energy production, as well as the environmental conditions that an individual may exercise in, such as heat and humidity.

The body has a number of mechanisms to address changes in body temperature such as heat loss, heat gain or the need for heat balance. The cardiovascular system plays an important role in thermoregulation and maintaining **homeostasis** of the body; that is, maintaining a constant internal environment for the optimal functioning of the body and its systems.

Optimal functioning of the body occurs when body temperature is approximately 37 °C. Body temperature is monitored by the brain, specifically the hypothalamus, and the mechanisms to control it include:

- sweating
- shivering
- controlling blood flow to the skin and around the body.

It is in this last mechanism that the cardiovascular system plays the greatest role.

When the body is too hot and there is need for heat loss, the cardiovascular system will automatically direct more blood flow through the vessels to the skin surface in an attempt to cool the body via increased sweating and heat loss to the external environment. The blood vessels expand or dilate to allow this increased blood flow and this process is known as **vasodilation**.

When the body is too cold and there is need for heat retention, the cardiovascular system will restrict blood flow to the skin and redirect it to the internal organs, decreasing heat loss. The blood vessels reduce in size or contract and this process is known as **vasoconstriction**.

FIGURE 6.14 Thermoregulation is important in different environmental conditions to keep the body at its optimal functioning.

Thermoregulation is essential to maintain optimal body temperature.

During exercise, both vasodilation and vasoconstriction can reduce blood flow to working muscles, either through redirection of blood to the skin for heat loss or internal organs to maintain heat, and ultimately impact on the energy production of the athlete. This often results in the athlete being unable to perform at their desired level, or at all, in order to maintain the homeostasis of the body.

Hyperthermia and exercise in the heat

During exercise, energy expended during muscular contraction results in heat production, which in turn brings about an increase in both muscle and core body temperature. Although an increased temperature of the skeletal muscles enhances the ability of the muscles to contract, performance becomes markedly impaired when the body's core temperature rises significantly. A rise in core temperature greater than 37.5–38.3 degrees is referred to as **hyperthermia**.

Hyperthermia is a rise in the body's core temperature above 37.5–38.3 degrees Celsius.

When the body's core temperature begins to rise, the body's thermoregulation mechanisms, such as sweat production, operate to ensure that any increase remains within a safe range. This is essential since core temperature rises of more than about three degrees Celsius can result in the impairment of bodily and mental functions, and the development of heat stroke, which can be fatal.

Exercising in the heat imposes additional stress on the body's thermoregulation mechanisms, and the cardiovascular system must work harder to maintain homeostasis to stop core temperature rising towards critical levels.

The cardiovascular system assists in the removal of body heat via redirection of blood flow and increased sweating rates. There is an increase in blood flow to the skin (vasodilation) in an attempt to increase the rate of the body cooling through the evaporation of sweat from the surface of the skin.

The redirection of blood flow and increased sweating can lead to impaired performance, as less blood flows to the working muscles than would normally in cooler conditions. Fluid loss through sweating causes a decrease in blood plasma volumes, so it is important that the athlete drinks plenty of water to help counteract this.

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Thermoregulation
Concept summary and practice questions

FIGURE 6.15 Cooling the body while exercising in the heat is important to limit the effects of hyperthermia.

Hypothermia and exercise in the cold

Hypothermia is a reduced core body temperature below 35 degrees Celsius.

Hypothermia is a thermal risk associated with exercising in cold environmental conditions. It occurs when the body's core temperature falls below 35 degrees Celsius. The body will respond to heat loss via shivering and the redirection of blood flow in order to generate heat and maintain core temperature.

The cardiovascular system attempts to reduce this heat loss by redirecting blood flow away from the extremities and towards the major organs in order to sustain their function. The vasoconstriction of the blood vessels close to the skin assists in reducing the heat lost to the external environment.

Once again, performance in physical activity will be impaired as blood flow to working muscles will also be reduced in an attempt to maintain homeostasis.

FIGURE 6.16 Hypothermia is a risk for all who venture into cold environments, and it can result in fatigue-like symptoms developing.

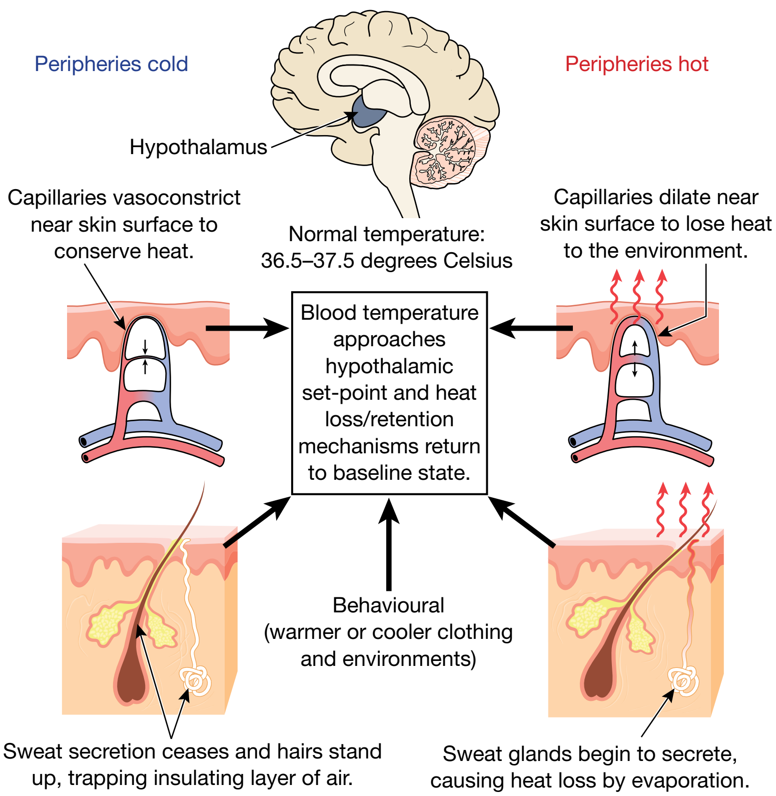

FIGURE 6.17 Thermoregulation mechanisms to control body temperature

TEST your understanding

1 Explain the relationship between thermoregulation and homeostasis.
2 Discuss the role of vasodilation and vasoconstriction in thermoregulation.
3 Outline the differences between hyperthermia and hypothermia.

APPLY your understanding

4 Participating in physical activity on a hot day can stress the body. Discuss the role of the cardiovascular system in the removal of heat from the body.

6.4 Responses of the cardiovascular system to physical activity

KEY CONCEPT Under exercise conditions, certain changes occur to the cardiovascular system to allow the body to meet the new demands placed on it. These responses last only for the duration of the training or exercise session and a short time afterwards (recovery).

The cardiovascular system and physical activity

When you begin to exercise, a number of changes occur within the cardiovascular system to meet the requirements of the body. These immediate, short-term responses are commonly called **acute responses** to exercise. They revolve around the greater demand for and more efficient delivery of oxygen and fuels to the working muscles to create energy and remove waste products.

Acute responses are the body's immediate, short-term responses that last only for the duration of the activity and for a short time afterwards (recovery).

Increased heart rate (HR)

- During exercise, HR quickly increases above resting levels to assist with the greater requirements of the muscles for oxygen to create energy and the associated removal of wastes.
- Generally, HR increases linearly with exercise intensity (figures 6.18 and 6.19). That is, as exercise intensity increases, so too does HR.
- Average resting HR is approximately 72 bpm, reaching up to and beyond 200 bpm during maximal exercise.
- HR will return to resting levels once physical activity is ceased.
- An approximate calculation of your maximum HR is 220 minus your age. For example, maximum HR for an 18-year-old is:
  220 – age = maximum HR
  220 – 18 = 202 advisable maximum HR.

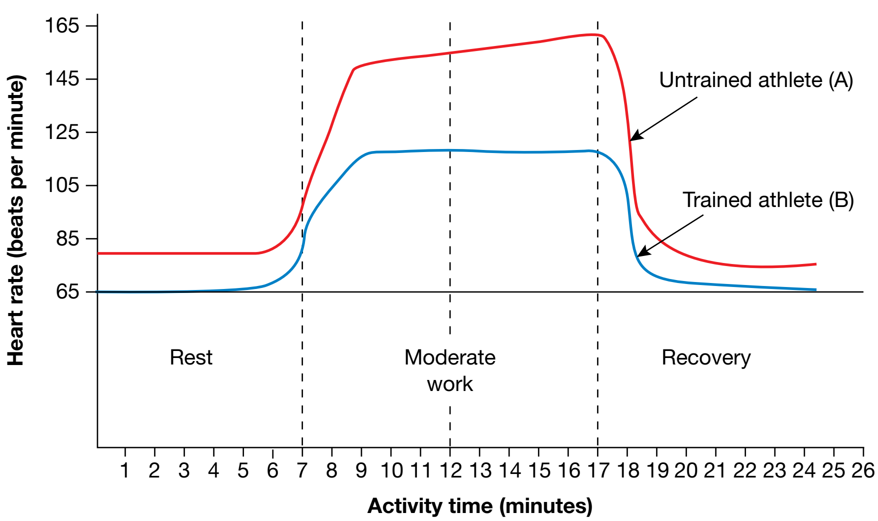

FIGURE 6.18 Heart rate responses before, during and after exercise for a trained athlete and an untrained athlete

Increased stroke volume (SV)

- The amount of blood pumped from the heart into the arterial system with each contraction of the left ventricle (stroke volume) increases to allow more oxygen to be delivered to the working muscles to create energy.
- Like heart rate, stroke volume increases with exercise intensity, but only to a certain point. The shorter filling time of the ventricles when the heart is beating

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Cardiac responses to physical activity Concept summary and practice questions

rapidly means the stroke volume will plateau at approximately 40–60 per cent of an individual's maximal exercise capacity and remain unchanged until exhaustion (figure 6.19).

- Stroke volume for the average adult female and male at rest may be about 60 mL/beat and 80 mL/beat, respectively. These values can increase to 110–130 mL/beat during maximal exercise. For a trained athlete, these values will be higher.

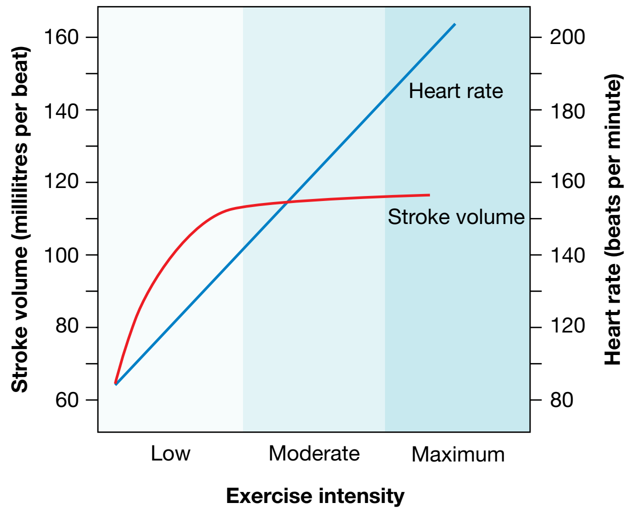

FIGURE 6.19 Heart rate and stroke volume responses to exercise

Increased cardiac output ($\dot{Q}$)

- The amount of blood pumped from the heart into the arterial system over 1 minute (cardiac output, $\dot{Q}$) increases due to the increase in both heart rate and stroke volume to deliver more blood and oxygen to the working muscles ($\dot{Q}$ = HR × SV). This is shown in table 6.4.
- Like heart rate and stroke volume, cardiac output increases proportionally with exercise intensity.
- At rest, cardiac output for the average adult male is approximately 5–6 litres per minute (L/min). It may rise to about 20 L/min for an untrained male during maximal exercise. Figures for females are slightly lower for a number of physiological reasons, about 15 L/min for an untrained female during exercise.

Integrated cardiac response to exercise

As previously discussed, cardiac output is directly affected by the responses of heart rate and stroke volume to the increased demand for oxygen and fuel to working muscles for energy production.

$$\dot{Q} = \text{HR} \times \text{SV}$$

The contribution of all three varies as an individual transitions from rest to exercise of increasing intensities.

At rest, the average heart rate is 70 beats per minute and stroke volume is approximately 70 millilitres per beat. This gives a cardiac output ($\dot{Q}$ = HR × SV) of roughly 5 litres per minute.

$$70 \text{ bpm} \times 70 \text{ mL/beat} = 4.9 \text{ L/min}$$

As the individual transitions from rest to exercise, both heart rate and stroke volume will increase to increase the cardiac output of the heart and meet the new energy demands required by the body. Depending on the intensity required, the contributions will vary.

During submaximal exercise, such as moderate-paced jogging, heart rate will increase until it meets the demands of the body, plateauing when it reaches **steady state**. Steady state occurs during submaximal activity where the oxygen demands of the body are being met by the supply of the cardiorespiratory system. Heart rate may increase to approximately 140 bpm, with stroke volume peaking at about 120 mL/beat, giving a cardiac output of approximately 16–17 litres per minute.

$$140 \text{ bpm} \times 120 \text{ mL/beat} = 16.8 \text{ L/min}$$

Steady state is the state in which oxygen supply equals oxygen demand and energy is being supplied aerobically.

As exercise intensity continues to increase beyond steady state, such as fast-paced running, heart rate will also increase linearly until it reaches maximum heart rate of values near 200 beats per minute. This in turn will increase the cardiac output of an individual.

At high to maximal intensities, any increase in cardiac output is due to this increase in heart rate, not stroke volume. Stroke volume tends to plateau when exercise intensity reaches around 40–60 per cent of the individual's maximal exercise capacity.

$$200 \text{ bpm} \times 120 \text{ mL/beat} = 24 \text{ L/min}$$

TABLE 6.4 Heart rate and stroke volume responses to various exercise intensities

Intensity	Heart rate (beats per minute)	Stroke volume (millilitres per beat)	Cardiac output (litres/minute)
Rest	70	70	4.9
Submaximal	140	120	16.8
Maximal	200	120	24

Increased systolic blood pressure (BP)

- Average BP at rest is $\frac{120}{80}$ mm Hg.
- During exercise, the systolic reading usually rises. This is due to increases in heart rate, stroke volume and cardiac output, and the fact that blood is being pumped more forcefully into the arteries.
- Under maximal intensity, systolic BP can reach around 200 mm Hg.
- The diastolic reading remains largely unchanged.

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Blood responses to physical activity
Concept summary and practice questions

Increased blood flow and blood vessel diameter

- Speed of blood flow increases due to the increases in heart rate, stroke volume and cardiac output.
- Blood vessels will increase their diameter to accommodate the increase in blood flow (vasodilation). As depicted in figure 6.10 on page 132, one-way valves in veins work to accommodate the increased blood flow's return to the heart.

Blood flow redistribution

- During exercise, blood flow is redistributed to the working muscles and away from those areas of the body that are less needed for the activity, such as the gut and kidneys (figure 6.20).
- At rest, blood flow to the muscles is approximately 15 to 20 per cent, or 1.5 L/min.
- As the intensity of physical activity and the demand for oxygen increase, blood flow to the muscles increases to 80 to 90 per cent, or about 10 L/min. This is achieved by the capillaries supplying the working muscles expanding in diameter (vasodilation) and blood flow to the organs is reduced by the narrowing (vasoconstriction) of the capillaries that supply them with blood.
- Removal of heat is also a reason for the redistribution of blood flow from the internal organs to the extremities (skin) shown in figure 6.20.

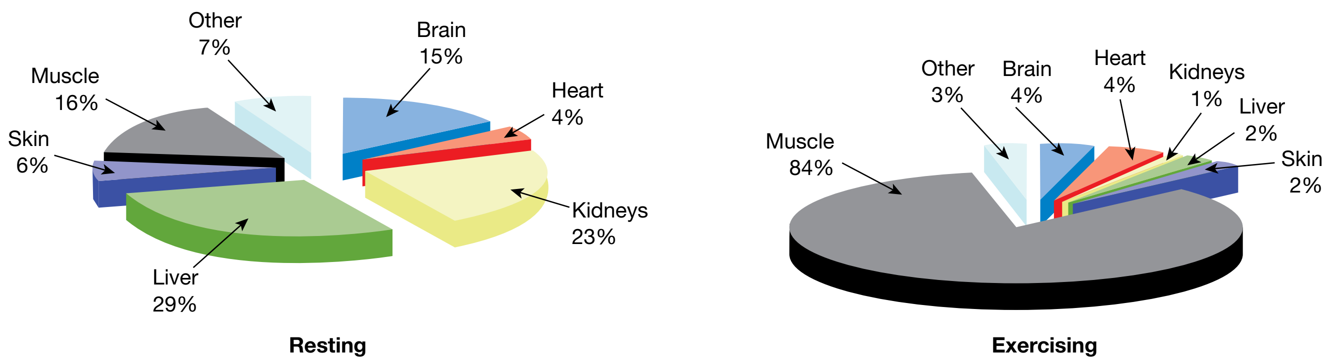

FIGURE 6.20 Blood flow redistribution during exercise
Source: Reprinted with permission, Hoffman J 2002.

Decreased blood volume

During exercise, blood volumes decrease due to the decrease in blood plasma levels. This is caused by the loss of fluid through the thermoregulatory processes of sweat and evaporation, as well as the removal of metabolic by-products associated with energy production. The size of the decrease depends on the intensity and duration of the exercise, the hydration level of the individual and environment conditions, such as temperature and humidity.

Increased arteriovenous oxygen difference (a-VO_2 diff.)

Arteriovenous oxygen difference (a-VO_2 diff.) is the difference between the concentration of oxygen in the arterial blood and the concentration of oxygen in the blood in the veins. This is measured in mL/100 mL of blood.

- The **arteriovenous oxygen difference (a-VO_2 diff.)** is a comparison of the amount of oxygen in the arteries with the amount of oxygen in the veins.
- It is measured in millilitres per 100 millilitres of blood.
- At rest, the arteries have an oxygen concentration of about 20 mL/100 mL of blood and veins about 13 mL/100 mL, a difference of 7 mL/100 mL.
- During exercise, the working muscles demand more oxygen for energy production, so the arterial blood will have more oxygen extracted by the working muscles than when they are at rest.
- The arterial blood entering the working muscle area during exercise will still have an oxygen concentration of 20 mL/100 mL, but the venous blood leaving the working muscles will have been drained of more oxygen and may have an oxygen concentration of about 5 mL/100 mL.
- Under exercise conditions, the a-VO_2 diff. could therefore be 15 mL/100 mL (figure 6.21).

	Oxygen concentration in blood (mL/100 mL)	
	At rest	During exercise
In arteries	20	20
In veins	13	5
a-VO_2 diff.	7	15

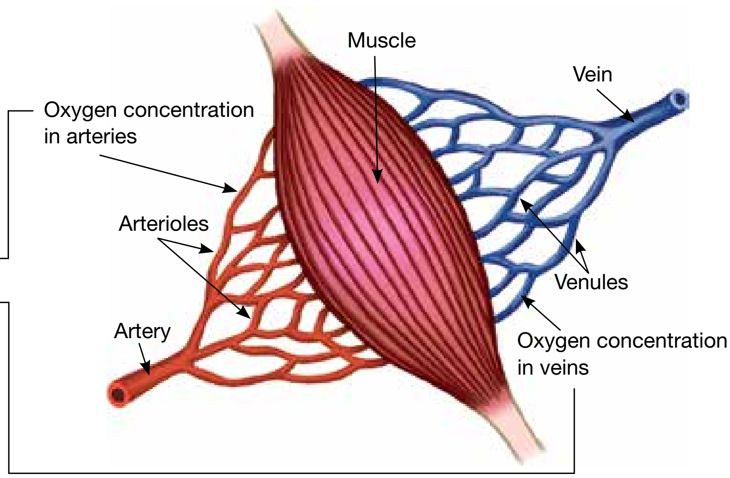

FIGURE 6.21 The arteriovenous oxygen difference during exercise

TEST your understanding

1. Define acute response to exercise.
2. Complete the table below by indicating whether the physiological parameter has increased, decreased or remained unchanged as a result of participating in exercise. Include the measurement values for rest and exercise.

Physiological parameter	Acute response	Measurement at rest	Measurement during submaximal exercise	Measurement during maximal exercise
Heart rate				
Stroke volume				
Cardiac output				
Blood pressure				
Blood flow and redistribution				
Body temperature				
Arteriovenous difference				

APPLY your understanding

3. Explain the relationship between the following factors and how they are affected by physical activity:
   - heart rate
   - stroke volume
   - cardiac output.
4. Outline the changes in blood flow that occur as a result of participating in physical activity.
5. Discuss the changes in the arteriovenous oxygen difference between rest and exercise. Explain why this occurs.
6. **Practical activity: acute responses of the cardiovascular system to exercise**
   Participate in two different activities for approximately 20 minutes each (e.g. basketball and aerobics class).
   For each activity, follow this procedure:
   Step 1 Record your resting heart rate prior to beginning the activity (manually or via a heart rate monitor).
   Step 2 Record your heart rate at the following intervals in each activity: 5 minutes, 10 minutes, 15 minutes, the end of the activity.
   Step 3 At the completion of the activity, sit quietly and record your heart rate at the following intervals after completion: 1 minute, 3 minutes, 5 minutes.
   Step 4 Record and graph your results. Answer the following questions:
   (a) At which stage did your heart rate rise the most? Suggest reasons for this.
   (b) At which stage did your heart rate rise the least? Suggest reasons for this.
   (c) Explain why heart rate increases as exercise begins.
   (d) Describe the relationship between heart rate and intensity of activity.
   (e) Outline other acute responses of the cardiovascular system that would have occurred during this activity.

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Physiological parameter
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CHAPTER 6 REVISION

- yellow identify the action word
- pink key terminology
- blue key concepts
- light grey marks/marking scheme

KEY SKILLS

- Use and apply correct anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- Describe the role and function of the blood components
- Examine the role of the cardiovascular system in thermoregulation
- Analyse the relationship between stroke volume, heart rate and cardiac output at rest and during submaximal and maximal exercise
- Perform, measure and report on changes to the cardiovascular and respiratory systems at rest compared with exercise

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:**
  Outline — general description but not in detail
  Identify — determine the key characteristics or features
  Justify — explain why the option you chose is the best option
- **Key terminology:**
  Physiological changes — what changes occur within the body?
- **Key concept/s:**
  Features of the cardiovascular system — cardiac output, blood flow to skeletal muscles, restribution of blood flow
- **Marking scheme:** *a. 1 mark, b. 2 marks, c. 2 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

UNDERSTANDING THE KEY SKILLS

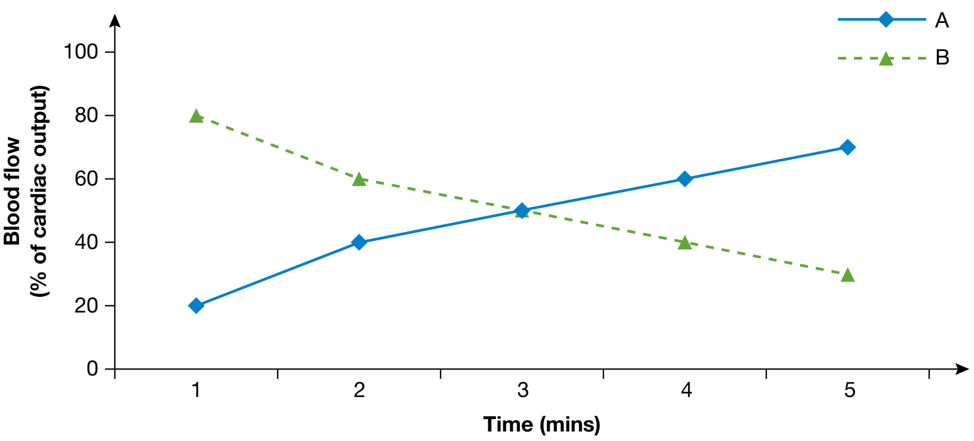
To address these key skills, it is important to remember the following:

- correct anatomical names for the structures of the cardiorespiratory system
- understand the functions of all structures in the cardiovascular system including the heart, blood vessels and components of blood
- understand the concepts of thermoregulation, homeostasis, hyperthermia and hypothermia and the role of the cardiovascular system in maintaining these
- heart rate, stroke volume and cardiac output are interrelated and their contribution to exercise is dependent of the intensity of exercise.

PRACTICE QUESTION

(adapted from ACHPER Unit 1 Exam 2011, question 2)

The graph below shows the blood flow to the major organs and skeletal muscles during submaximal exercise.



a. **Outline** what is meant by cardiac output. *1 mark*
b. **Identify** and **justify** which line, A or B, is most likely to represent blood flow to skeletal muscles. *2 marks*
c. **Outline** what physiological changes occur to allow the redistribution of blood flow during exercise. *2 marks*

Sample response

a. Cardiac output is the amount of blood pumped around the body per minute (L/min).
b. **Line A**. As exercise time increases, there is an increased need for blood carrying oxygen at the muscles.
c. Vasoconstriction, decrease in blood vessel diameter therefore decreased blood flow to the major organs, and vasodilation, increase in blood vessel diameter therefore increased blood flow to the skeletal muscles.

HOW THE MARKS ARE AWARDED

a. **1 mark** — correct definition of cardiac output
b. **1 mark** — identifying A as the line that represents blood flow to working muscles
   1 mark for linking Line A to the information on the graph, increase in time and increase in blood flow required by muscles during exercise
c. **1 mark** each for naming and describing the physiological adaptions of vasoconstriction and vasodilation and how they contribute to the redistribution of blood flow.

PRACTISE THE KEY SKILLS

1 Explain the role of the following physiological parameters in ensuring oxygen delivery to working muscles during exercise or physical activity.
   a. Heart rate
   b. Stroke volume
2 Describe the function of each of the four components of blood.
3 Explain how the cardiovascular system assists in thermoregulation.

KEY SKILLS EXAM PRACTICE

(ACHPER Trial Exam 2015, question 7)

1 a. Describe systemic circulation, beginning at the left atrium. Include references to structures of the heart and blood vessels. *6 marks*
   b. Other than valves, outline another mechanism that assists in the return of venous blood back to the heart. *2 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

Cardiovascular system

- The cardiovascular system has five main functions:
  - to circulate blood
  - to transport water, oxygen and nutrients
  - to transport wastes
  - to help maintain body temperature
  - to help fight disease.
- The heart is an involuntary muscle that pumps blood throughout the cardiovascular system. It has four chambers, two atria and two ventricles, a septum that divides the heart into two pumps, and valves at the entrances of structures to allow only a one-way flow of blood.
- The heart works via contraction and relaxation of the atria and ventricles. This is known as the cardiac cycle.
- The three types of blood vessels are arteries, capillaries and veins.
  - Arteries carry blood away from the heart.
  - Capillaries are the site of exchange of gases between the cells and the cardiovascular system.
  - Veins return blood to the heart.
- Blood is made up of blood cells and plasma. There are also three types of blood cell:
  - red blood cells
  - white blood cells
  - platelets.
- Blood circulation occurs via two main circuits:
  - the systemic circuit (the body)
  - the pulmonary circuit (the lungs).
- Blood pressure has two measurements:
  - systolic
  - diastolic.
- Thermoregulation is the maintenance of body temperature and heat exchange that occurs between the body and the environment.
- The cardiovascular system assists thermoregulation through the redirection of blood flow via the expanding of blood vessels (vasodilation) to increase heat loss or the reduction in size of blood vessels (vasoconstriction) to reduce heat loss.
- If thermoregulation is impaired, the individual risks developing:
  - hyperthermia where heat gain is greater than heat loss and the body's core temperature rises above 37.5 degrees Celsius
  - hypothermia where heat loss is greater than the heat that can be produced and core temperature falls below 35 degrees Celsius.
- There is a direct relationship between heart rate, stroke volume and cardiac output in response to increased demands to produce energy during exercise across a range of varying intensities.
- The cardiovascular system adapts to the onset of exercise via increases in heart rate, stroke volume, cardiac output, systolic blood pressure, arteriovenous difference (a-VO_2 diff.), blood flow and redistribution of blood flow.

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Sit Topic Test

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Interactivity
Structure and functions of the cardiovascular system quiz
Searchlight ID: int-6642

MULTIPLE CHOICE QUESTIONS

1 The heart is divided into four chambers called atria and ventricles. Atria are the
(A) upper chambers that eject the blood from the heart.
(B) upper chambers that receive the blood into the heart.
(C) lower chambers that eject the blood from the heart.
(D) lower chambers that receive the blood into the heart.

2 One-way valves allow blood flow to travel from the
(A) aorta to the ventricles.
(B) atria to the aorta.
(C) atria to the ventricles.
(D) aorta to the atria.

3 Arteries carry blood
(A) away from the heart.
(B) to the heart.
(C) away from the capillaries.
(D) to the veins.

4 Deoxygenated blood travels via which structure of the heart to the lungs to be oxygenated?
(A) Vena cava
(B) Pulmonary vein
(C) Aorta
(D) Pulmonary artery

5 The function of the red blood cells is to
(A) fight infection.
(B) clot the blood.
(C) carrying oxygen to the working muscles.
(D) carry the blood cells around the body.

6 The main role of the cardiovascular system in thermoregulation is
(A) increasing the volume of blood.
(B) warming the muscles.
(C) reducing heart rate.
(D) redirection of blood flow.

7 Exercising in the heat requires the body to work harder to keep the core temperature within a safe zone. Individuals are at risk of developing which condition when heat production exceeds heat loss?
(A) Hypothermia
(B) Hyperthermia
(C) Homeostasis
(D) Hyperthalamus

8 Blood vessels increase in diameter to accommodate increased blood flow during exercise. This is known as
(A) vasodilation.
(B) vasoconstriction.
(C) vasovagal.
(D) valsalva.

9 To facilitate the removal of heat, the body redistributes blood flow
(A) from the heart to the lungs.
(B) from the vital organs to the skin.
(C) from the skin to the muscles.
(D) from the vital organs to the head.

10 At high intensities, any increase in cardiac output is due to the linear increase in
(A) heart rate.
(B) stroke volume.
(C) heart rate and stroke volume.
(D) blood pressure.

EXAM QUESTIONS

Question 1 **(ACHPER Trial Exam 2013, question 4a)**

When comparing arteries to veins, the following differences can be observed. Use the table to fill in the relevant statements. The first one has been completed for you.

Arteries:	**Parameter**	**Veins:**
is oxygenated	Blood (is oxygenated/is de-oxygenated)	is de-oxygenated
	Transports blood (away from heart/towards the heart)	
	Valves (have them/don't have them)	
	Wall thickness (are thicker/are thinner)	

3 marks

Question 2 **(ACHPER Trial exam 2013, question 3)**

During an ironman event, an athlete's body temperature will increase significantly. Explain how the cardiovascular system assists in maintaining body temperature during exercise, such as an ironman competition. **2 marks**

Question 3

Outline the relationship between heart rate, stroke volume and cardiac output, and explain how they respond to increases in exercise intensity from submaximal to maximal exercise. **2 marks**

Question 4 **(ACHPER Trial Exam 2014, question 1e)**

Explain the relationship between the cardiovascular and respiratory systems in response to exercise. **3 marks**

INQUIRY QUESTION

How does the respiratory system contribute to energy production for movement?

CHAPTER

7 Structure and functions of the respiratory system

The respiratory system is the starting point for oxygen delivery to working muscles and the end point for removal of wastes such as carbon dioxide as a result of energy production.

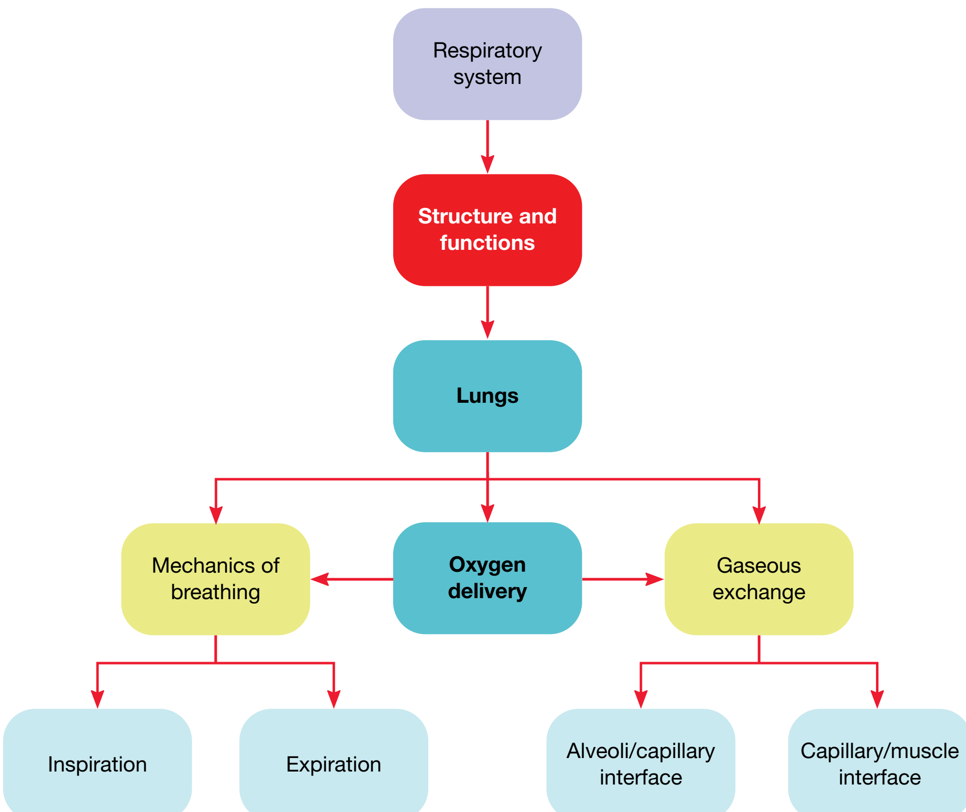
KEY KNOWLEDGE

- The structure and function of the respiratory system, including the structure and function of the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interface
- The interrelationship of the cardiovascular and respiratory systems to transport oxygen around the body at rest and during exercise

KEY SKILLS

- Use and apply correct anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- Describe the process of gaseous exchange
- Perform, measure and report on changes to the cardiovascular and respiratory systems at rest compared with exercise

CHAPTER PREVIEW



7.1 The respiratory system: structure and functions

KEY CONCEPT The respiratory system allows the body to breathe, bringing oxygen into the body and removing carbon dioxide. It is able to carry out this essential function during varying activity levels, from unconscious sleep to conscious levels of maximal exertion.

Functions of the respiratory system

The **respiratory system** consists of the lungs and associated structures responsible for gas exchange in the body, bringing air into the body and removing waste products.

The **respiratory system** has five important functions. It:
- brings air from the atmosphere into the lungs
- transfers oxygen into the blood
- removes carbon dioxide from the blood
- expels heat and water vapour in the air breathed out
- allows the vocal cords to create speech as air is breathed out.

Structure of the respiratory system

Figure 7.1 shows the basic structure of the respiratory system. The lungs are the major organs of the respiratory system. Located in the chest cavity behind the ribs, they consist of three main parts:
- the conducting system
- the pleura
- the diaphragm.

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Interactivity
Respiratory system
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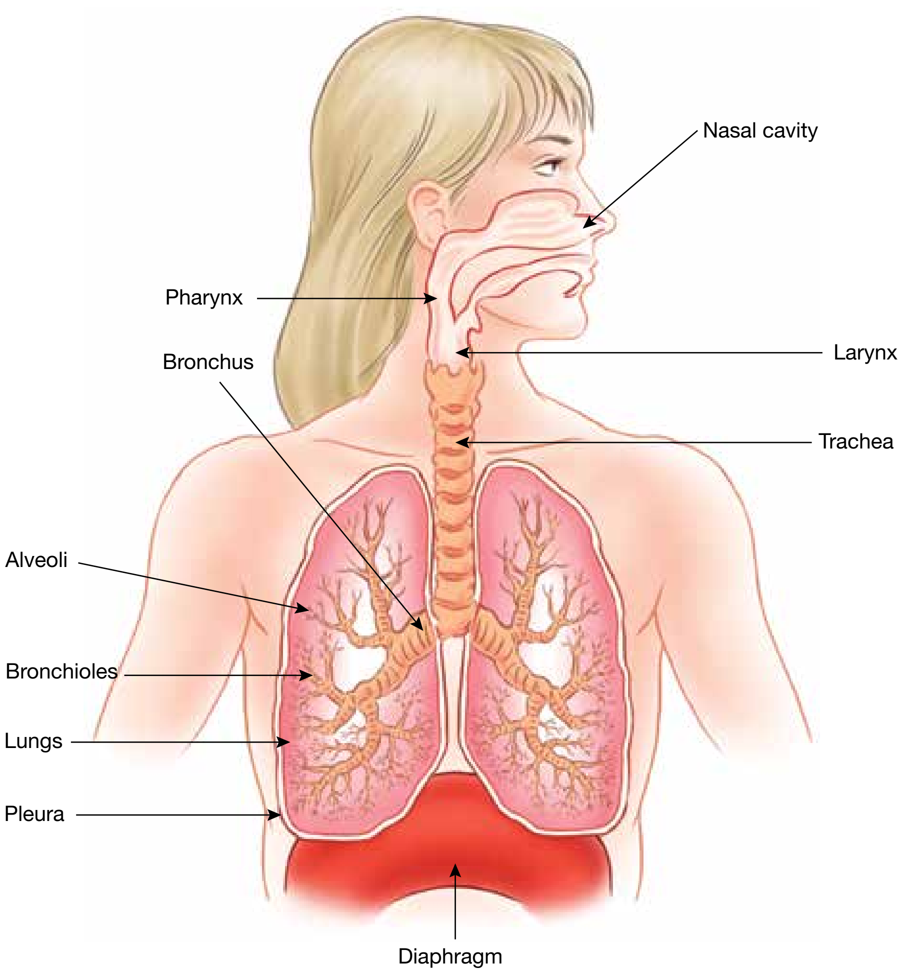

FIGURE 7.1 The respiratory system

The conducting system

The conducting system involves more than just the lungs. Its main elements are:

- The **nasal cavity**. The nose is the initial pathway for air from outside the body. Air is warmed and moistened in the nose to be more readily used by the body's interior. This is especially important in cold climates. The nose has layers of tissue called septa that are covered with cilia, which are small hair-like fibres that filter foreign particles from the air as it enters the respiratory tracts. These cilia cover the respiratory passage down to the pharynx, ensuring your lungs do not become clogged with foreign matter. Smoking destroys cilia, and their absence is the beginning of serious problems for the lungs of smokers.
- The **pharynx**. This section of the throat is where the backs of the mouth and the nose combine. The food is channelled into the oesophagus, while the air moves into the larynx. The air is further warmed here using similar methods as in the nose.
- The **larynx**. This structure is more evident in males with their 'Adam's apple'. The larynx contains the vocal cords that create the voice as air passes through them.
- The **trachea**. Often referred to as the windpipe, the trachea is constructed of rings of hyaline cartilage enclosed by other cartilage and tissue. It sits mostly behind the sternum, so it provides a well-protected medium for the passage of air into the lungs.
- The **bronchi**. The trachea divides into two bronchi, with each bronchus having the same characteristics as the trachea. Each bronchus feeds one of the lungs.
- The **bronchioles**. Each bronchus sub-divides into a series of further sub-dividing bronchioles. This system of the lungs' gradually diminishing series of air passages is similar to an inverted tree, with its main trunk moving to a series of ever-diminishing branches, then to the leaves.
- The **alveoli**. These 'leaves' of the lungs are microscopic cup-shaped sacs at the ends of the smallest bronchiole. Each alveolus is only one cell thick and surrounded by a rich network of capillaries that continually exchange oxygen for carbon dioxide and water (see figure 7.2 for the breakdown of the lung anatomy).

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Unit 1	**Structure and function of the respiratory system**
AOS 2	Concept summary and practice questions
Topic 2	
Concept 1	

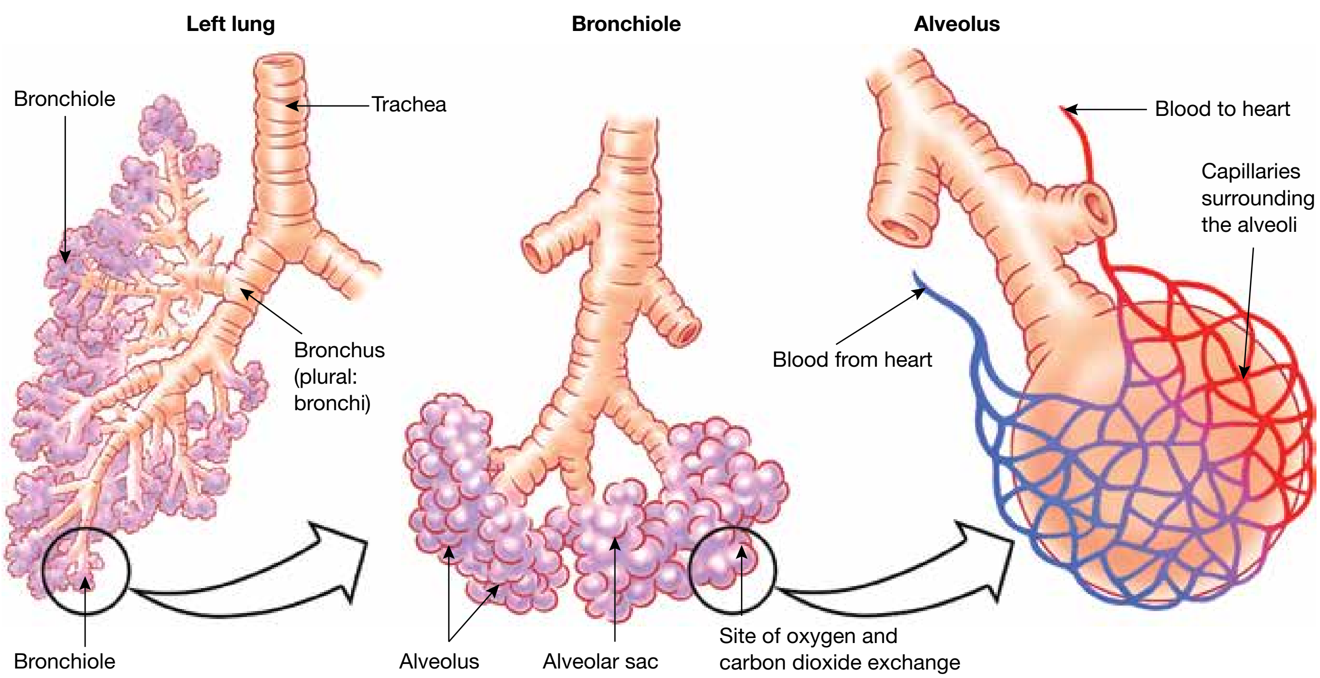

FIGURE 7.2 The structure of the lung

The pleura

The pleura covers each lung. The gap between the membrane and each lung is filled with a fluid that allows the lung to expand and contract with each breath, with minimal friction between the lung and its surrounding body tissue. The pleura is attached to the inside of the chest cavity and to the top of the diaphragm.

The diaphragm

This involuntary or smooth muscle contracts and relaxes to aid breathing, whether during sleep or consciousness. As the diaphragm moves up and down, the chest cavity decreases and increases in size, causing breathing (inspiration and expiration; see figure 7.3). A blow to the midriff during sport may hit the diaphragm, causing it to spasm. The individual in this case is 'winded' and may have difficulty breathing. The individual has to be encouraged to relax and wait for the muscle spasm to subside, which will happen in a short time and allow normal breathing.

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Digital document
Anatomy of the respiratory system
Searchlight ID: doc-1104

TEST your understanding

1. Download the 'Anatomy of the respiratory system' document from your eBookPLUS. Label the parts of the respiratory system.
2. List the five functions of the respiratory system.
3. Discuss how the diaphragm assists with breathing.
4. Outline the function of alveoli and where they can be found.

APPLY your understanding

5. Describe the path that air travels from outside the body to the lungs. Discuss the role of each of the structures it passes.
6. **Practical activity: respiratory rate and exercise**
   (a) Work in pairs. Before you begin the physical activities, sit down quietly and have your partner measure your resting respiratory rate.
   (b) Perform each of the following activities. Get your partner to count your respiratory (breathing) rate for one minute immediately after you complete each activity. Rest until respiratory rate returns to resting levels between each activity.
   - Walking for 2 minutes
   - Jogging for 2 minutes
   - Situps for 30 seconds
   - Stepups on a bench for 2 minutes
   - Seated toe-touches for 30 seconds
   - Running for 3 minutes as fast as possible

   (c) Record and graph your results.
   (d) Identify which activity caused the highest respiratory rate. Suggest reasons for this.
   (e) Discuss the relationship between your respiratory rate and the intensity of the activity. Provide examples.

7.2 The respiratory system: mechanics of breathing and gaseous exchange

KEY CONCEPT Gas exchange of oxygen and carbon dioxide occurs in the alveoli in the lungs. In order for this to happen, it is important to understand the mechanics of breathing; that is how air, and in particular oxygen, enters the lungs and wastes are removed.

Ventilation

Ventilation (V) is the amount of air breathed in (inspiration) and out (expiration) during 1 minute. It is calculated by multiplying **tidal volume (TV)** and **respiratory rate (RR)**. That is, the amount of air per breath multiplied by the amount of breaths per minute, or

$V = TV \times RR.$

For example, at rest ventilation could be

$TV \times RR = V$
$0.5 \times 12 = 6\ \text{L/min}$

Ventilation will differ depending on whether the individual is at rest or is exercising.

Ventilation (V) is the amount of air that is inspired and expired during 1 minute.

Tidal volume (TV) is the amount of air breathed in and out in one breath.

Respiratory rate (RR) is the amount of breaths per minute.

Inspiration

The diaphragm initiates **inspiration**. When the diaphragm contracts, it pulls downwards on the rib cage, thereby expanding the volume of the chest cavity. The intercostal muscles between each pair of ribs contract to help pull the rib cage outwards, also increasing the size of the chest cavity. The widening chest cavity decreases the air pressure inside the lungs, causing air from outside the body to be sucked into the chest cavity (figure 7.3). This occurs because air, like any gas, always travels from high pressure gradients towards low pressure gradients.

A normal intake of a breath for an adult is about 500 millilitres; this is called the tidal volume. During heavy exercise, inspiration may increase about eight times to around 4 litres for each breath. Also during exercise, extra muscles will work to help increase the size of the chest cavity even more, to accommodate the need for a more forceful exchange of a greater volume of air. These muscles include those of the neck and upper chest area.

Inspiration is the movement of air from the external environment into the lungs (breathing in).

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eLesson
Inspiration and expiration
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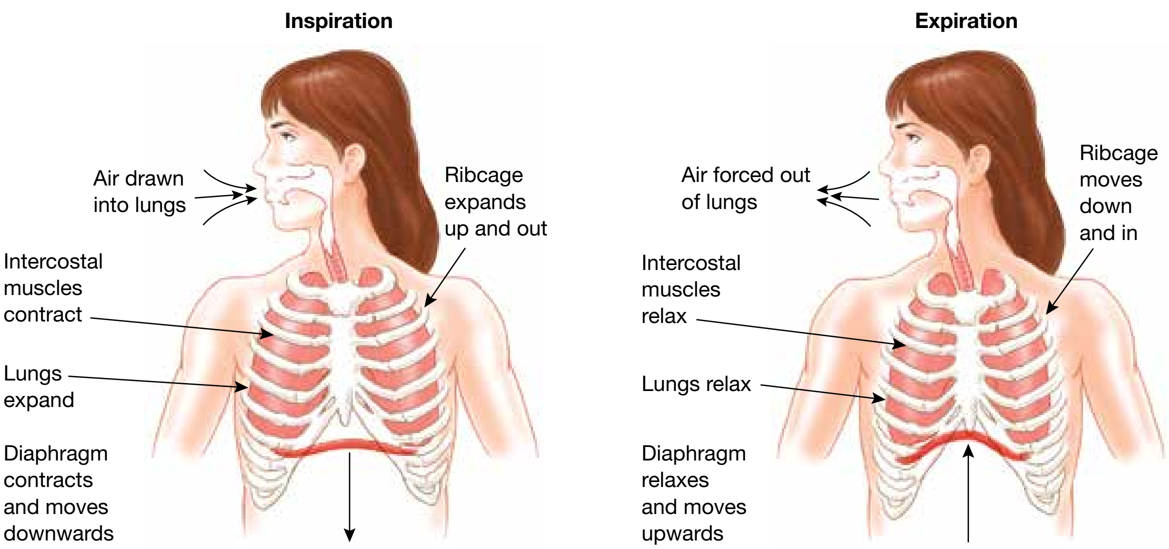

FIGURE 7.3 Inspiration and expiration of the lungs

Expiration

Expiration is the movement of air out of the lungs to the external environment (breathing out).

Expiration occurs when the diaphragm and intercostal muscles relax; that is, the diaphragm pushes up and creates a dome shape. This relaxation, along with the natural elasticity of the thorax (or chest area) is enough to squeeze the air within the chest cavity, create a higher pressure inside than out, and force the air to leave the lungs (figure 7.3).

Again, during exercise more muscles will work to help magnify the change in chest cavity volume to promote higher rates and levels of air exchange. Thus the abdominal muscles will contract to aid the speed and force of the chest restriction.

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Interactivity
Inspiration and expiration: structure and function
Searchlight ID: int-6645

TABLE 7.1 Comparison of inspiration and expiration

Structure and/or function	Inspiration	Expiration
Air	Drawn into lungs	Forced out of lungs
Pressure inside lungs	Low	High
Ribcage	Expands up and out	Moves down and in
Intercostal muscles	Contract	Relax
Chest cavity and lungs	Expand	Relax
Diaphragm	Contracts, moves downwards	Relaxes, moves upwards

Lung volumes

The lungs have different levels of capacity (or lung volumes) for holding air from inspiration and for expelling air by expiration. Capacity varies according to the state of health, fitness and activity level of an individual.

- Total lung capacity is the volume of air that can be held in the lungs after maximum inspiration. It is approximately 6 litres for males and 4.2 litres for females.
- **Vital capacity** is the maximum amount of air that can be expired (breathed out) after a maximum inspiration. It consists of the inspiratory reserve capacity, the tidal volume and the expiratory reserve capacity. Table 7.2 shows the vital capacity for students in Australian schools. Generally, the larger the person, the higher their vital capacity. Large rib cages and chest cavities lead to larger lungs. Males generally have higher vital capacity readings than females because males usually have larger frames.

Vital capacity is the maximum amount of air that can be expired after a maximal inspiration.

TABLE 7.2 Vital capacity readings for adolescent male and female students

	Boys (litres)		Girls (litres)	
Ranking	12 years	15 years	12 years	15 years
Top 10 per cent	3.65	5.5	3.6	4.25
Mid-range	3.0	4.5	2.9	3.6
Lowest	2.15	3.15	2.05	2.6

- Tidal volume is the amount of air inspired and expired with each breath. It is approximately 500 millilitres at rest, but can increase dramatically during exercise (figure 7.4).
- Residual volume is the amount of air left in the lungs at the end of a conscious, maximal expiration. This is the same amount whether the individual is at rest or during maximal exertion (figure 7.4). Sometimes when there has been a blow or trauma to the chest

study on

Unit 1 | AOS 2 | Topic 2 | Concept 2

Mechanics of breathing
Concept summary and practice questions

area, this residual volume may be expelled to some extent and may add to the sensation of being 'winded' when the diaphragm goes into spasm (see page 154).

- Inspiratory reserve capacity is the maximal amount of air that can be inspired after a normal inspiration (figure 7.4).
- Expiratory reserve capacity is the maximal amount of air that can be expired after a normal expiration (see figure 7.4).

Maximum oxygen uptake

- **Maximum oxygen uptake (VO_2 max)** is the maximum amount of oxygen per minute that can be taken in, transported to, and used by the working muscles to produce ATP. This reading reflects aerobic power (or the body's ability to use oxygen). It is the usual measure for comparing different sports' or individuals' aerobic power levels. VO_2 max is different for males and females due to lung capacity differences; that is, males generally have a greater VO_2 max than females due to larger heart and lung capacity. VO_2 max tests are the best way to measure the efficiency of the cardiovascular, respiratory and muscular systems under exercise conditions.

Maximum oxygen uptake (VO_2 max) is the maximum amount of oxygen per minute that can be taken in, transported to, and used by the working muscles to produce ATP.

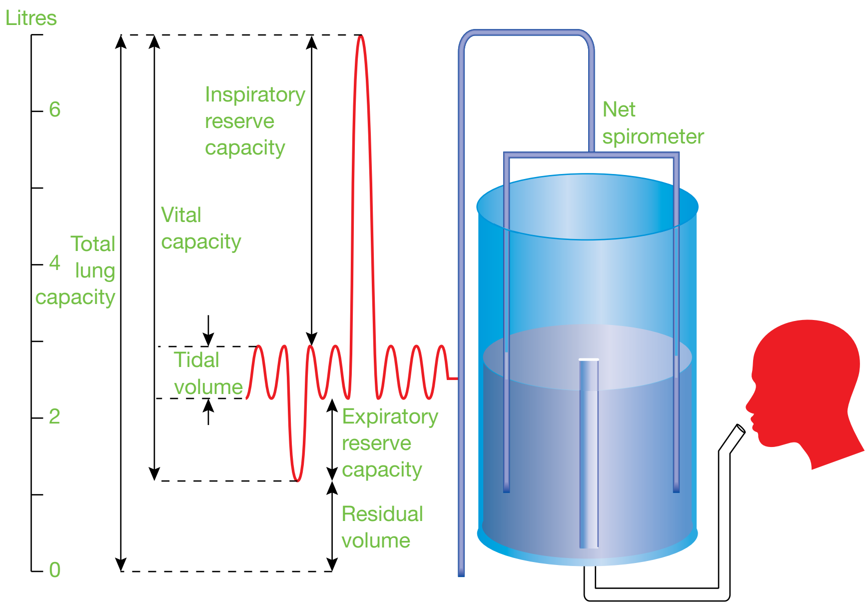

FIGURE 7.4 The relative amounts for each of the main lung volumes

Gaseous exchange

The respiratory and the cardiovascular system work together to transfer and transport gas molecules, in particular oxygen and carbon dioxide, around the body. In order to do this, gases are exchanged through the process of **diffusion**. Diffusion involves the movement of a molecule from a higher concentration to a lower concentration across a thin membrane. The sites of exchange important for the delivery of oxygen for energy production and the removal of waste occur at the alveoli/capillary interface in the lungs and the capillary/muscle interface at the cell site.

Diffusion is the movement from a higher concentration to a lower concentration.

Exchange of gases in the lungs

Pulmonary diffusion is the process to describe the exchange of gases in the lungs.

Inspiration involves air entering the lungs and travelling into the alveoli. Capillaries surround the alveoli. Both structures have very thin walls, only one cell thick, that allow the oxygen just breathed in to move from the higher concentration in the alveoli to the lower concentration of the surrounding capillaries. Once in the capillaries, the

Pulmonary diffusion is the process to describe the exchange of gases in the lungs.

oxygen attaches to the haemoglobin in the red blood cells to be transported to the muscles and other cells in the body.

During expiration, the carbon dioxide in the capillaries is under higher concentration than the air in the alveoli. The carbon dioxide diffuses into the alveoli and is expelled on outward breaths.

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eLesson
Diffusion between the alveoli and capillary interface
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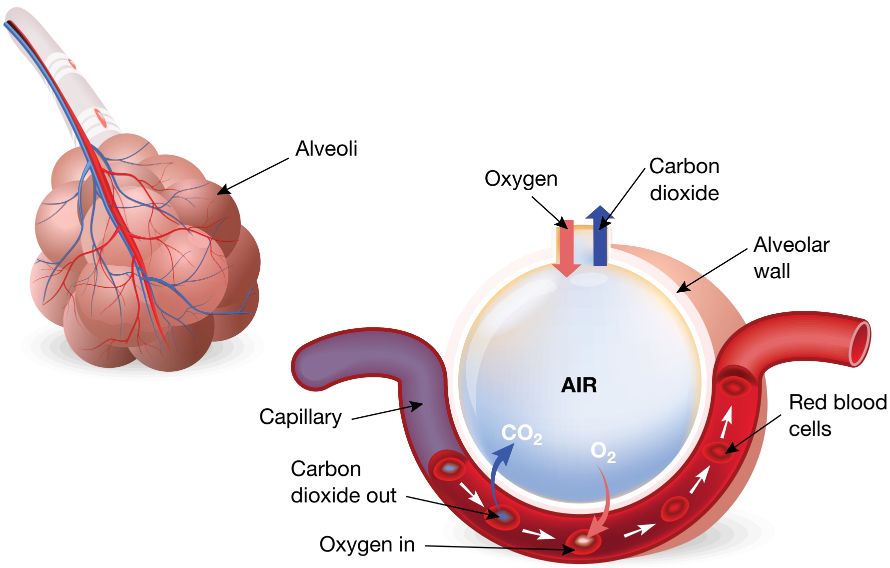

FIGURE 7.5 Gas exchange at the alveoli and capillary interface

Exchange of gases at the muscle (cell) site

At the muscle (cell) site, the concentration of the gases inside and outside the capillaries is the reverse of those within the lungs (figure 7.6). Oxygen-rich blood is transported to the muscles in response to the increased demand for energy production. The low levels of oxygen within the muscles attract the higher concentration oxygen from within the capillaries through the thin capillary wall. The opposite situation affects the movement of the high levels of carbon dioxide produced as a by-product from energy production from the muscle into the capillary to be transported to the alveoli and expired.

study on

Unit 1	**Gaseous exchange**
AOS 2	Concept summary and practice questions
Topic 2	
Concept 3	

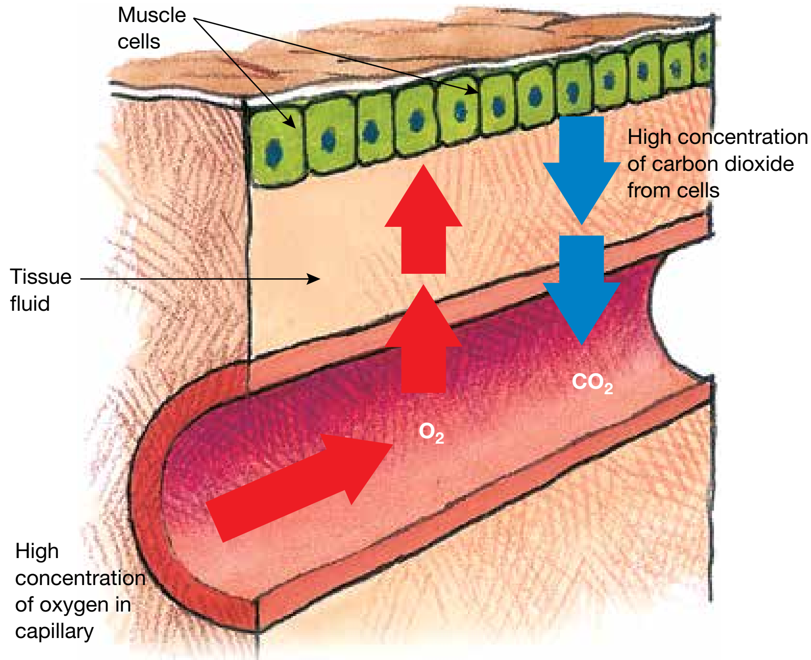

FIGURE 7.6 Exchange of gases at the muscle cell/capillary junction

Table 7.3 depicts the approximate composition of inhaled and exhaled air in the lungs.

TABLE 7.3 Approximate percentage composition of inhaled and exhaled air of the lungs

	Inhaled air	Exhaled air
Oxygen	21	16
Nitrogen	79	79
Carbon dioxide	0.03	4

TEST your understanding

1 Define ventilation.
2 Outline the major differences in the gas content of inspired air compared to that of expired air.
3 Download the diagram of lung volumes in your eBookPLUS. Label and define each of the types of lung volumes.
4 Define maximum oxygen uptake (VO_2 max).

APPLY your understanding

5 Describe the process of inspiration and expiration. Include the role of the diaphragm, intercostal muscles, air movements and air pressure both within and outside the lungs. Use a diagram to assist.
6 Explain how gas exchange occurs at the lungs.
7 Calculate the ventilation (V) of an individual who has a respiratory rate of 15 breaths per minute and a tidal volume of 0.5 litres per breath.
8 **Practical activity: measurement of lung capacity**
You will need a spirometer to complete this activity.
– Pinch your nose with your fingertips to prevent air escaping.
– Take a deep breath until you cannot take in any more air.
– Place your mouth around the spirometer and exhale until you cannot exhale any more.
(a) Record your vital capacity.
(b) Compare it to the values for adolescent male and female students in table 7.2.

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Digital document
Diagram of lung volumes
Searchlight ID: doc-1105

7.3 Responses of the respiratory system to physical activity

KEY CONCEPT Under exercise conditions, certain changes occur to the respiratory system to allow the body to meet the new demands placed on it. These responses last only for the duration of the activity and for a short period afterwards (recovery).

The respiratory system and physical activity

As an individual begins to exercise, a number of changes occur within the respiratory system to meet the requirements of the body. As with the cardiovascular system, these changes revolve around the greater demand for oxygen to be delivered to the working muscles to create energy, and the associated removal of waste products. Figure 7.7 summarises these changes.

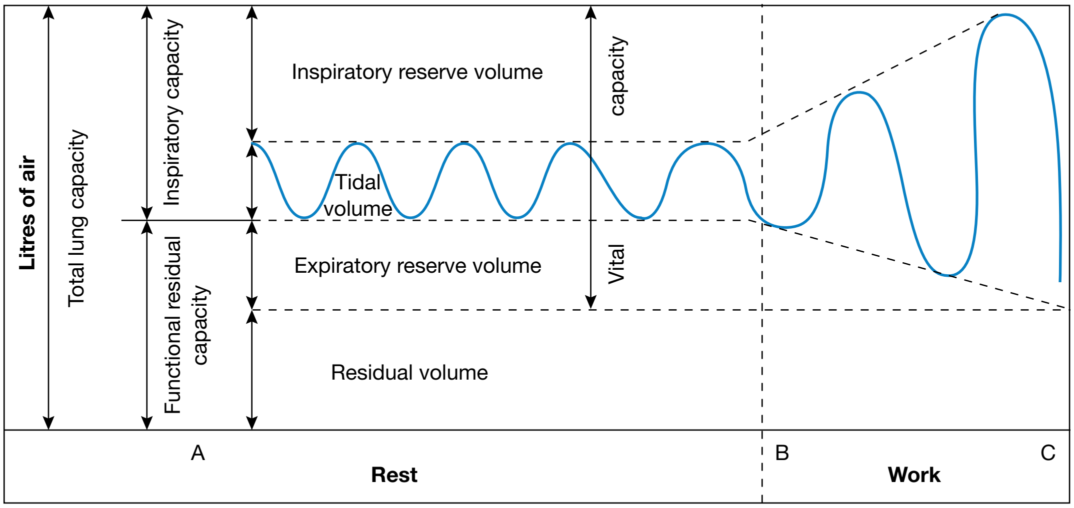

FIGURE 7.7 The change in lung volumes and function from rest to working levels

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Unit 1 | AOS 2 | Topic 2 | Concept 4

The respiratory system and physical activity
Concept summary and practice questions

Increased respiratory (breathing) rate (RR)

- At rest, adult respiration rate is 12–15 breaths per minute.
- Under high intensity exercise, RR can reach 35–45 breaths per minute due to the increased demand for oxygen and the need for removal of carbon dioxide.

Increased tidal volume (TV)

- Depth of breathing (tidal volume) at rest is approximately 0.5 litres per breath.
- This can increase to 4–5 litres per breath at maximal workloads in order to supply more oxygen to the blood to deliver to working muscles.

Increased ventilation (V)

- Due to the increases in respiratory rate (RR) and tidal volume (TV), ventilation (V) will also increase.
- At rest, ventilation is approximately 6.0 L/min.
- During maximal exercise, this value can increase dramatically. For example,

$$RR \times TV = V$$
$$45 \times 4 = 180 \text{ L/min}$$

TABLE 7.4 Comparison of respiratory rate, tidal volume and ventilation at rest and during exercise

	Respiratory rate (breaths/minute)	Tidal volume (L/breath)	Ventilation (L/min)
Rest	12	0.5	6
Submaximal exercise	30	2.5	75
Maximal exercise	45	4.0	180

Increased diffusion

During physical activity, the diffusion capacity at the alveoli/capillary and muscle/capillary interface is increased to allow greater amounts of oxygen and carbon dioxide to be exchanged at these sites.

Increased oxygen uptake (VO_2)

- Oxygen uptake increases due to the greater demand for oxygen by the muscles. This increase is linear, but will not increase further once maximum levels of oxygen uptake are achieved (i.e. VO_2 max, see figure 7.8).
- At rest, the average amount of oxygen that an individual can take into the body is about 0.35 L/min.
- During submaximal exercise, this can increase to around 2.0–3.5 L/min.
- Under maximal exercise, depending on the individual's aerobic fitness levels, this can reach 4–6 L/min.

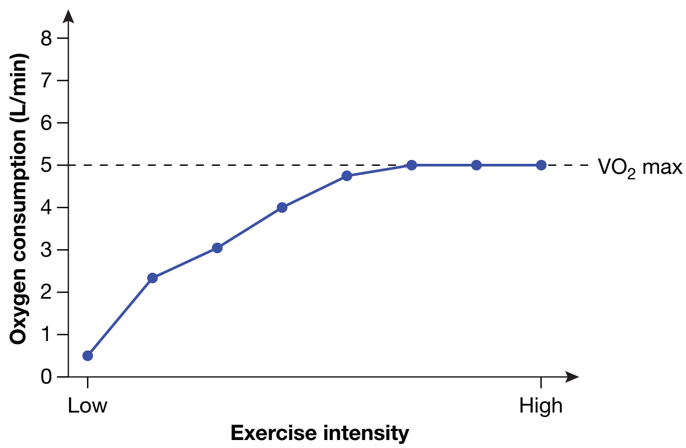

FIGURE 7.8 Oxygen consumption relative to exercise intensity

Source: Adapted from sportfitnessadvisor.com and sciencebasedrunning.com.

Increased efforts from ribcage muscles and diaphragm

- During physical activity, the external and internal intercostal muscles as well as the diaphragm will all work harder to enable increased expansion and contraction of the thoracic cavity.
- This increased movement of the cavity will accommodate the increased air volumes that are being demanded by the working muscles in order to gain their extra oxygen.

TEST your understanding

1 Copy and complete the table below by indicating whether the physiological parameter has increased, decreased or remained unchanged as a result of participating in exercise. Include the measurement values for rest and exercise.

Physiological parameter	Acute response	Measurement at rest	Measurement during submaximal exercise	Measurement during maximal exercise
Respiratory rate				
Tidal volume				
Ventilation				
Oxygen uptake				

APPLY your understanding

2 Explain the relationship between respiratory rate (RR) and tidal volume (TV) during exercise.

3 Refer to figure 7.7 and describe what happens to the following measures of lung volume from points B to C:
- (a) tidal volume
- (b) inspiratory reserve volume
- (c) expiratory reserve volume
- (d) vital capacity
- (e) total lung capacity.

4 **Practical activity: circuit**
- (a) Before you begin the physical activities, sit down quietly and record your resting respiratory rate.
- (b) Complete the following circuit. Spend 2 minutes at each station and record your respiratory rate for 10 seconds at the end of each station. Rest for 1 minute between each station.
  - Skipping
  - Situps
  - Shuttle run
  - Pushups
  - Agility run
  - Bicep curls
  - Star jumps
  - Lunges
- (c) Describe your respiratory rate responses to the circuit.
- (d) Identify the station that had the highest RR.
- (e) Identify the station that had the lowest RR.
- (f) Suggest reasons for this difference.

7.4 Summary of interactions of the cardiovascular and respiratory systems during physical activity

KEY CONCEPT The cardiovascular and respiratory systems work together to deliver oxygen to the working muscles during physical activity. For the oxygen to reach the muscles, it must be inhaled efficiently through the respiratory system and then carried efficiently through the cardiovascular system to the muscle sites.

Figure 7.9 below and the description that follows summarise the interaction of the cardiovascular and respiratory systems.

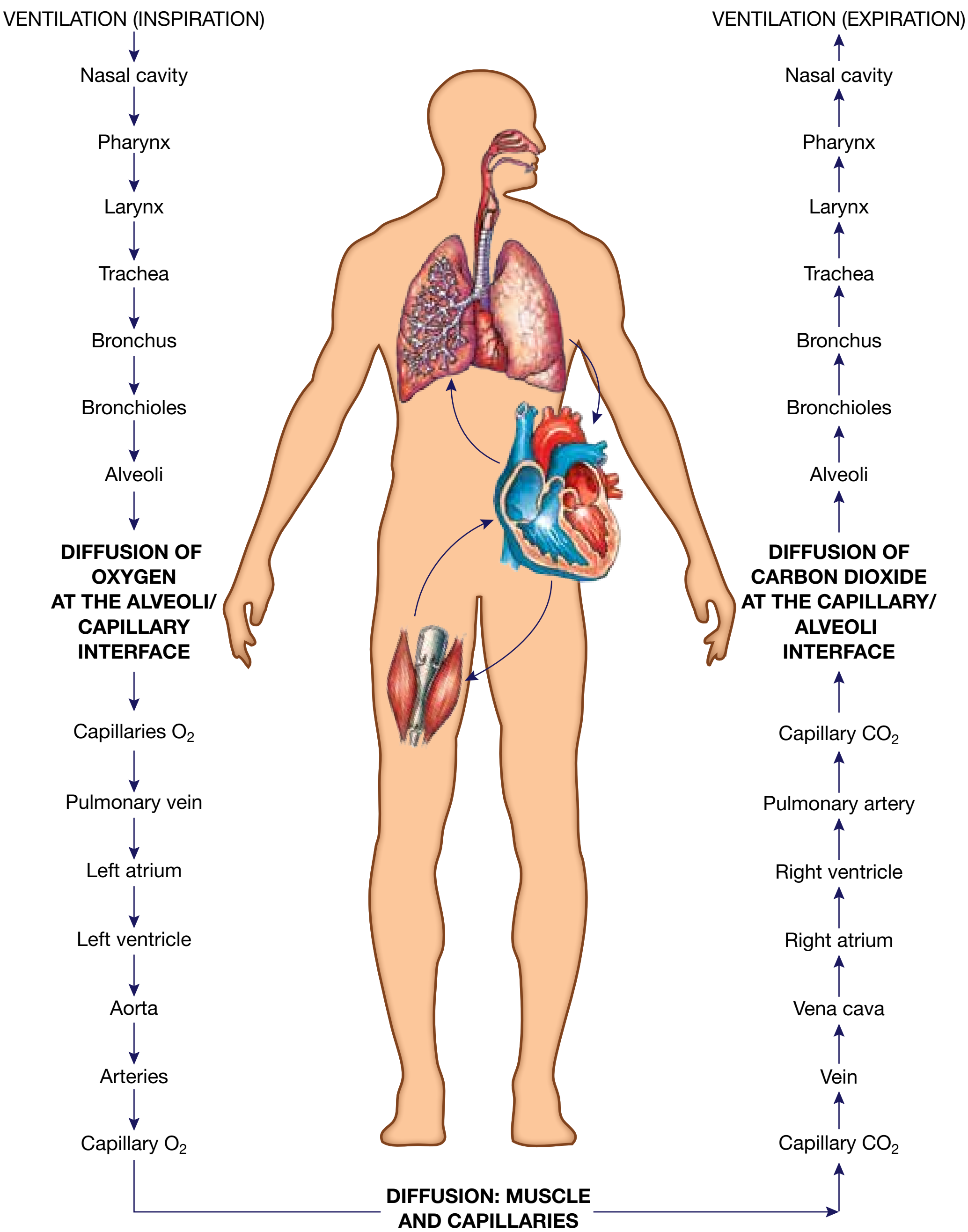

FIGURE 7.9 Interaction of the cardiovascular and respiratory systems

7.4 Summary of interactions of the cardiovascular and respiratory systems during physical activity

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Interactivity
Diffusion
Searchlight ID: int-1830

The cardiovascular system and the respiratory system work together to deliver oxygen to working muscles in the following way.

- The respiratory system transfers oxygen to and from the lungs from the atmosphere via the mechanisms of breathing — inspiration and expiration. This ventilation of air into and out of the lungs occurs at an average rate of 4 L/min during rest, increasing to 15–35 L/min during exercise and increasing intensities.
- Gaseous exchange (or diffusion) occurs at the alveoli and capillary interface where oxygen breathed in is in a higher concentration in the alveoli and diffuses across the thin membrane wall into the capillaries. This is the point of entry into the cardiovascular system where the oxygen will be transported via the blood, blood vessels and heart around the body.
- Oxygen combines with haemoglobin on the red blood cells to be transported via the arteries and heart to the muscles. At rest, cardiac output of the heart is 5 L/min, increasing to 20–30 L/min during exercise at increasing intensities.
- Oxygen enters the muscles at the capillary/muscle interface via diffusion where the concentration of oxygen is higher in the capillaries. Oxygen is used for energy production and carbon dioxide is produced as a result of this process. At this point, the carbon dioxide is in a higher concentration in the muscle than the capillary and also diffuses across the thin membrane into the capillaries to be transported away. Greater amounts of oxygen and carbon dioxide are used and produced during exercise in comparison to rest.
- Carbon dioxide travels via the veins and the heart back to the lungs where it is diffused into the alveoli and expired via the respiratory system.

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Unit 1	**The systems working together** Concept summary and practice questions
AOS 2	
Topic 2	
Concept 5	

TEST your understanding

1. Discuss the importance of the relationship between the cardiovascular and respiratory systems during physical activity.
2. Explain how gaseous exchange occurs between the cardiovascular and respiratory systems.

APPLY your understanding

3. Outline the pathway a molecule of oxygen takes through the body — from entering the nose until it reaches the muscle fibre.
4. Outline the pathway a molecule of carbon dioxide takes through the body — from the muscle fibre until it is expelled into the atmosphere via the nose.
5. **Practical activity: conduct and report on an exhaustive aerobic test**
   Undertake the following tests in a laboratory working as a class.
   (a) Measure individual students' vital capacity (VC) using dry spirometers.
   (b) Select two to three of the more aerobically fit students in the class. The number depends on your class size and how many exercise bikes you have. As a class, decide how to organise work increments for a 15–20 minute exercise bike aerobic test. Observe the subjects exercising at gradually increasing work increments over the exercise period.
   (c) Organise groups and individuals within the groups to be responsible for the following measurements. Everyone will be expected to make some form of oral report to the class on their area of responsibility:
   – respiration rates at rest and after each 5-minute increment
   – heart rates at rest and after each 5-minute increment
   – blood pressure readings at rest and after each 5-minute increment
   – any observable amounts and patterns of perspiration at rest and after each 5-minute increment
   – any observable signs of fatigue or discomfort at rest and after each 5-minute increment
   – production of data gathering sheets.
   (d) After taking time to prepare the results, all class members are to make oral reports to the class on each of the parameters observed.

CHAPTER 7 REVISION

KEY SKILLS

- Use and apply correct anatomical terminology to identify the structures and function of the cardiovascular and respiratory systems
- Describe the process of gaseous exchange
- Perform, measure and report on changes to the cardiovascular and respiratory systems at rest compared with exercise

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:
- correct anatomical names for the structures and functions of the cardiorespiratory system
- understand how gaseous exchange occurs and the structures where gaseous exchange can occur.

PRACTICE QUESTION

(ACHPER Trial exam 2015, question 6)

1 a. **List** the two structures between which gaseous exchange of oxygen and carbon dioxide takes place in the lungs. *2 marks*

b. Using the above example, **explain** gaseous exchange in terms of the concentration levels of each gas and the resultant movement. *3 marks*

Sample response

a. Alveoli and capillaries

b. Gaseous exchange is the movement of gas from an area of high concentration to an area of low concentration (1). In the lungs after inspiration, the alveoli are high in oxygen and low in carbon dioxide compared to the blood in the surrounding capillaries which is high in carbon dioxide and low in oxygen (1). As a result, the oxygen diffuses into the blood and the carbon dioxide diffuses into the lungs (1).

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:**
  List — enter in a list with others
  Explain — to make the meaning of something clear and understandable
- **Key terminology:**
  Oxygen
  Carbon dioxide
  Lungs — the site where the gaseous exchange occurs in this example
- **Key concept/s:** Structures of the cardiovascular and respiratory system — be able to identify the different structures within these systems where gaseous exchange occurs
  Gaseous exchange — understand what it is, the gases that are being exchanged and their concentration levels in the relevant structures of the cardiorespiratory system
- **Marking scheme:** *a. 2 marks b. 3 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

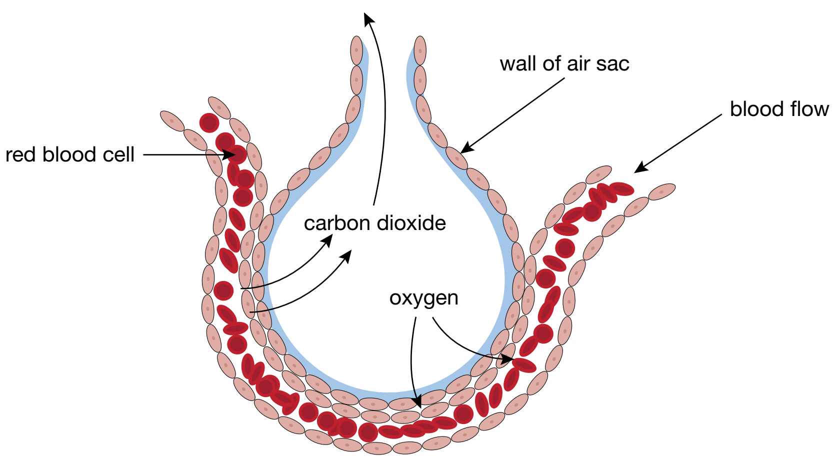
PRACTISE THE KEY SKILLS

1 Identify all the structures of the respiratory system that an oxygen molecule will pass during inspiration prior to entering the cardiovascular system.

2 Describe what is meant by gaseous exchange and identify two areas in the body where this may occur.

KEY SKILLS EXAM PRACTICE

(adapted from ACHPER Trial Exam 2012, question 1b)



1 Gaseous exchange occurs at the lungs, as outlined in the diagram above, to allow increased oxygen into the blood. Gaseous exchange also occurs at the muscles. Explain this process at the muscle. *3 marks*

HOW THE MARKS ARE AWARDED

- **1 mark** for each correct structure listed
- **1 mark** for explaining what gaseous exchange is
- **1 mark** for identifying the concentration levels of the gases (oxygen and carbon dioxide) within the structures
- **1 mark** for discussing the movement of the gases between the structures

CHAPTER REVIEW

CHAPTER SUMMARY

Respiratory system

- The respiratory system brings oxygen into the body and removes carbon dioxide.
- The conducting system of the respiratory system includes the nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles and alveoli.
- The diaphragm contracts and relaxes to aid breathing.
- Inspiration is when the lungs take in air, while expiration is when air is forced out of the lungs.
- Gas exchange occurs at the alveoli and capillaries, and at the capillaries and muscles, and involves the movement of oxygen and carbon dioxide from areas of high concentration to areas of low concentration.
- Everyone has different lung volumes and this affects their capacity for holding and expelling air.
- Vital capacity measures the maximum amount of air that you can breathe out after a maximum inhalation.
- Maximum oxygen uptake (VO_2 max) is the maximal amount of oxygen that can be utilised by the body in 1 minute.
- The respiratory system adapts to the onset of exercise via increases in respiratory rate, tidal volume, ventilation, diffusion and oxygen uptake by the muscles.

Interaction of the cardiovascular and respiratory systems

- Figure 7.9 (page 163) summarises the interaction of both the cardiovascular and respiratory systems to efficiently deliver oxygen to working muscles.

MULTIPLE CHOICE QUESTIONS

1 Which is not a function of the respiratory system?
(A) Bring air from the atmosphere to the lungs
(B) Transfer oxygen into the blood
(C) Transport oxygen to the muscles
(D) Remove carbon dioxide from the blood

2 The diaphragm contracts and moves downwards during
(A) inspiration.
(B) expiration.
(C) ventilation.
(D) diffusion.

3 The site of gaseous exchange in the respiratory system is the
(A) trachea.
(B) bronchus.
(C) alveoli.
(D) diaphragm.

4 Ventilation is calculated by multiplying
(A) heart rate and respiratory rate.
(B) respiratory rate and vital capacity.
(C) tidal volume and vital capacity.
(D) respiratory rate and tidal volume.

5 Diffusion is when gas molecules move from
(A) an area of high concentration to low concentration.
(B) an area of low concentration to high concentration.
(C) an area of equal concentration.
(D) one capillary to another.

6 The amount of air that can be inspired and expired with each breath is called
(A) total lung capacity.
(B) vital capacity.
(C) tidal capacity.
(D) tidal volume.

7 During exercise, which muscles work harder to enable increased expansion and contraction of the chest cavity?
(A) Sternum and ribcage
(B) Heart and lungs
(C) Intercostals and diaphragm
(D) Abdominals and deltoids

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Sit Topic Test

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Interactivity
Structure and functions of the respiratory system quiz
Searchlight ID: int-6646

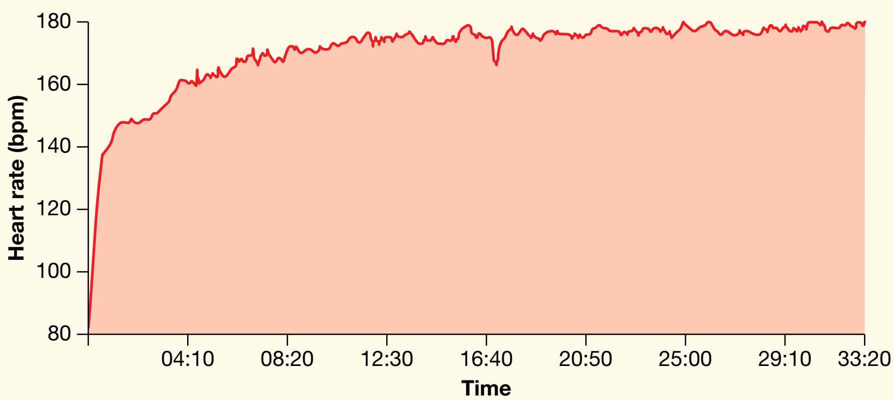
8 The gas that diffuses across the capillary/muscle interface to be expelled from the body after energy production is
(A) oxygen.
(B) carbon dioxide.
(C) lactic acid.
(D) myoglobin.

9 Respiratory rate increases during exercise due to the increased demand for
(A) food fuels.
(B) haemoglobin.
(C) oxygen.
(D) All of the above.

10 The main function of the nasal cavity is to
(A) warm and moisten the air.
(B) cool and moisten the air.
(C) protect the air.
(D) exchange air and carbon dioxide.

EXAM QUESTIONS

Question 1 **(adapted from ACHPER Trial Exam 2013, question 4)**



To allow the above to occur, the cardiovascular system will make a number of changes.

a. Describe how the respiratory system would change in response to the exercise shown in the graph above. **2 marks**

b. Outline how these changes are made possible by referring to the following respiratory system structures: diaphragm and intercostals. **2 marks**

c. Explain why the above changes occur using your understanding of the relationship between the cardiovascular and respiratory systems.

Question 2 **(adapted from ACHPER Trial Exam 2012, question 1)**

a. Complete the following table outlining the acute respiratory responses to increasing exercise intensities.

Exercise condition	Respiratory rate (breaths/min)	Tidal volume (L/breath)	Ventilation (L/min)
Rest		0.5	6
60% Max HR	20	2	
100% Max HR	40		160

3 marks

b. Explain why the above responses occur. **2 marks**

c. Explain how the cardiovascular system and respiratory system work together to allow the body to work aerobically. **3 marks**

INQUIRY QUESTION
What factors might influence the cardiovascular and respiratory health of these individuals?

CHAPTER

8 Factors that influence cardiorespiratory health

Good cardiorespiratory health is important for the efficient functioning of the cardiovascular and respiratory systems. Maintaining a healthy lifestyle and participating in regular physical activity has an important role in reducing the risk factors that may lead to chronic illnesses associated with these body systems.

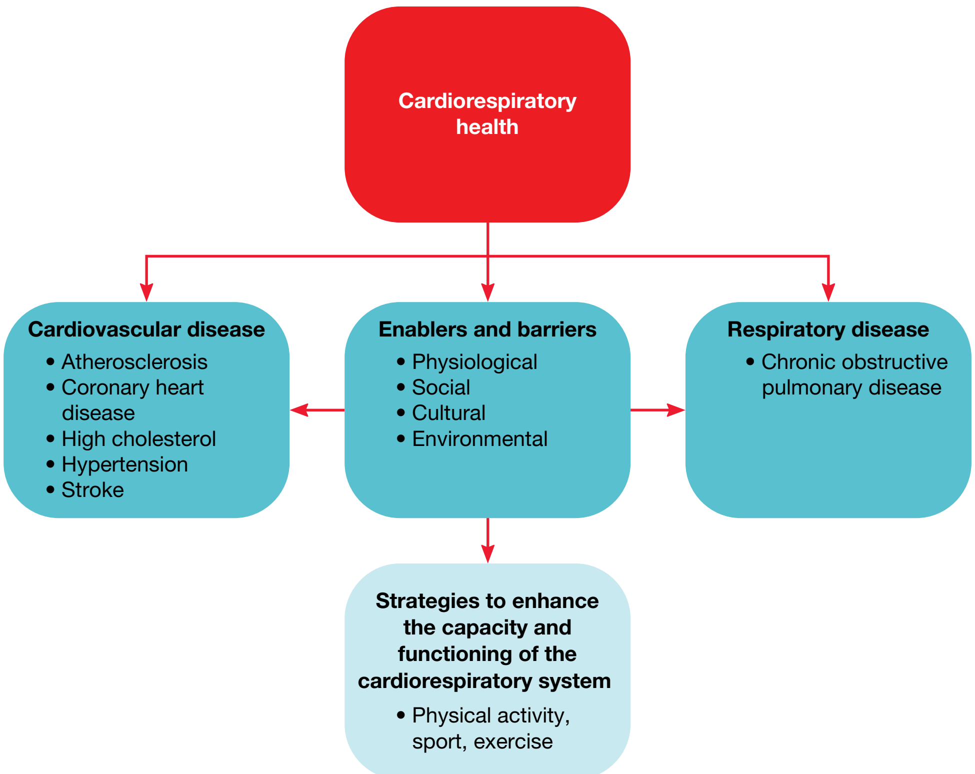
KEY KNOWLEDGE

- Physiological, social, cultural and environmental enablers and barriers of cardiovascular health (such as atherosclerosis, coronary heart disease, high cholesterol levels, hypertension and stroke) and respiratory health (such as chronic obstructive pulmonary disease)
- The role of physical activity, sport and exercise to enhance the capacity and functioning of the cardiovascular and respiratory systems

KEY SKILLS

- Assess enablers and barriers to cardiorespiratory health and investigate strategies to enhance the capacity and functioning of the cardiorespiratory system

CHAPTER PREVIEW



8.1 Cardiorespiratory health

KEY CONCEPT The health of the cardiovascular and respiratory systems is important for the efficient functioning of the body. When the functioning of these systems is compromised, it is much more difficult for the individual to deliver oxygen required for daily activities to cells.

Cardiovascular health

Cardiovascular health refers to the efficient functioning of the heart and blood vessels to transport oxygen, nutrients and waste products around the body. A number of factors can influence the health of the cardiovascular system, either positively or negatively. The maintenance of a healthy lifestyle is well known to be important for maintaining good cardiovascular health and preventing and managing cardiovascular disease.

Cardiovascular disease describes a number of conditions that affect the heart and blood vessels, including atherosclerosis, coronary heart disease, high cholesterol levels, hypertension, stroke and heart attacks.

Cardiovascular disease is the leading cause of death worldwide and is one of the biggest killers in Australia. In 2012 approximately 30 per cent of deaths recorded in Australia attributed cardiovascular disease as the underlying cause. Furthermore, an estimated 3.7 million Australians, or 1 in 5 adults, are living with a cardiovascular disease (AIHW, 2011–12).

Cardiovascular disease refers to a group of conditions that affect the functioning of the heart and blood vessels.

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Interactivity
Types of cardiorespiratory disease
Searchlight ID: int-6647

TABLE 8.1 How cardiovascular disease affects Australian adults

Cardiovascular disease	
1 in 5 Australian adults (22%) — approximately 3.7 million people in 2011–12 — had cardiovascular disease, based on self-reported data.	
1.1 million Hospitalisations — 11% of all hospitalisations in 2013–14 — where cardiovascular disease was the principal and/or additional diagnosis.	
30% or 43 946 Australian deaths in 2012, recorded cardiovascular disease as the underlying cause.	
2 times as high Cardiovascular disease hospitalisation rates for Aboriginal and Torres Strait Islander Australians compared to other Australians. Cardiovascular disease death rates were 30% higher than for non-Indigenous Australians.	
50% higher Cardiovascular disease death rates in the lowest socioeconomic group compared with the highest group. Similarly, 20% higher for CVD hospitalisation rates.	

This information was last updated in August 2015.

Source: Australian Institute of Health and Welfare, www.aihw.gov.au.

Cardiovascular diseases

Atherosclerosis

Atherosclerosis is a condition where the arterial walls become clogged up with fatty deposits known as plaque or atheroma (see figure 8.1). This build-up of deposits narrows the vessels and restricts blood flow in the arteries, meaning the heart has to work harder to pump blood around the body. This build-up can occur in any artery in the body.

Atherosclerosis is the underlying cause of many cardiovascular diseases and can lead to heart attack or stroke due to the blockage created by the deposits in the arteries. Atherosclerosis can be caused by lifestyle habits such as smoking, poor nutrition and physical inactivity, as well as other factors such as high cholesterol, high blood pressure, diabetes and family history.

Atherosclerosis is the narrowing and hardening of the arteries due to deposits on the walls of the arteries that slow down blood flow.

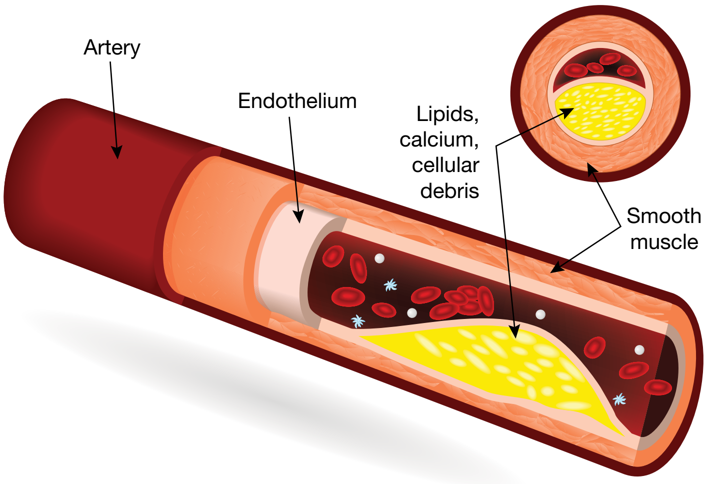

FIGURE 8.1 Atherosclerosis is the underlying cause of many other cardiovascular diseases.

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Unit 1	**Cardiovascular disease**
AOS 2	Concept summary and practice questions
Topic 3	
Concept 1	

Coronary heart disease

Coronary heart disease (CHD) is also called ischaemic heart disease. It occurs when plaque builds up in the coronary arteries causing them to narrow and thus reducing blood flow to the heart (atherosclerosis). It can lead to heart attack (blood supply to the heart blocked) and angina (chest pain or discomfort due to reduced blood flow to the heart).

CHD is the most common form of heart disease, affecting 1.2 million Australians (5.2 per cent). It is also the leading cause of death in Australia, accounting for 13.4 per cent of all deaths registered in 2013 (ABS).

The major risk factors for CHD are the same as those for atherosclerosis.

Coronary heart disease (CHD) is a build-up of plaque in the coronary arteries causing insufficient blood supply to the heart.

High cholesterol levels

Cholesterol is a waxy, fat-like substance found in body cells. There are three forms of cholesterol in the body:

- *High density lipoproteins* (HDL). These carry cholesterol in the blood to the liver for removal from the body. HDL helps protect against coronary heart disease by removing the cholesterol.
- *Low density lipoproteins* (LDL). These carry most of the cholesterol in the blood and can cause fatty deposits to build up in the artery walls. High levels of LDL lead to increased risk of coronary heart disease.

High cholesterol is when a person has greater amounts of cholesterol in the blood than required, which can increase the risk of cardiovascular disease.

- *Triglycerides*. These are found in the blood and stored in fat cells, and they can increase the risk of coronary heart disease. A high level of triglycerides in the bloodstream can be caused by eating too much food high in animal fat.

In 2014–15, 1.6 million Australians (7.1 per cent) reported having **high cholesterol** levels (ABS).

FIGURE 8.2 Foods high in saturated and trans fats contribute to the development of high cholesterol levels.

High cholesterol is caused by eating foods high in saturated and trans fats. It is one of the major causes of heart disease as it deposits on and narrows arteries, making the heart work harder to pump blood around the body. Individuals should aim to raise their HDL levels and lower their LDL levels for good health. This can be achieved through adopting a healthy lifestyle such as making healthy eating choices, incorporating regular physical activity and not smoking.

Hypertension

As outlined in chapter 6, blood pressure indicates how hard the body has to work to push blood out of the heart and through the arteries. A typical blood pressure reading is 120/80 mm Hg, where 120 is the systolic pressure (contractile phase of the heart cycle) and 80 is the diastolic pressure (relaxing phase of the heart cycle).

Hypertension is also known as high blood pressure.

Hypertension (high blood pressure) is when the systolic and/or diastolic pressure is elevated above normal levels. Hypertension is classed as having a reading higher than 140/90 mm Hg (individually or together). A high blood pressure reading means that the heart has to work harder to pump blood through the arteries and blood flow may be restricted due to the pressure applied. This places an individual at increased risk of coronary heart disease, stroke, heart attack and renal disease.

In 2014–15, 1 in 3 adults (32 per cent) over 25 years of age reported or were measured as having hypertension. Men are more likely to have high blood pressure than women and it generally increases with age (see figure 8.3).

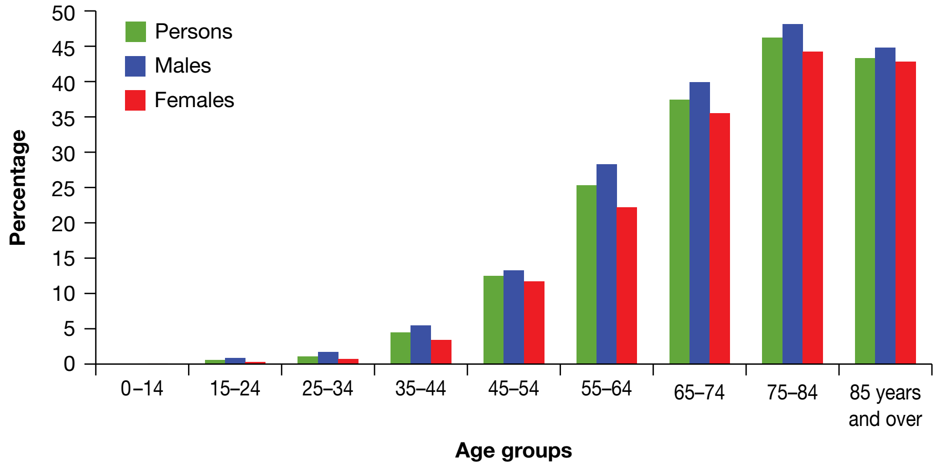

FIGURE 8.3 Percentage of people with hypertension, by age and gender

Source: Australian Bureau of Statistics (ABS), 2016.

Individuals with a family history of hypertension are at increased risk of developing it, along people who are overweight or obese, physically inactive, smoke tobacco, drink excessive alcohol or have a poor diet, particularly one that is high in salt. Hypertension requires life-long treatment that may include medication as well as adopting a healthy lifestyle.

FIGURE 8.4 A high blood pressure reading signifies increased risk of coronary heart disease, stroke and heart attack.

Stroke

A **stroke** occurs when blood supply to the brain is disrupted. When blood flow doesn't get to the brain, there is lack of oxygen and cells may die, causing permanent damage. The two main types of stroke are:

- *ischaemic stroke,* where a blood clot blocks a vessel
- *haemorrhagic stroke,* or rupture and bleeding of a blood vessel.

Ischaemic stroke is the most common, accounting for 80 per cent of all strokes, and the remaining 20 per cent are caused by haemorrhagic stroke. One in six Australians will have a stroke and it is one of the leading causes of disability (AIHW, 2013).

Strokes can be fatal and are the third most common cause of death, accounting for 7 per cent of all deaths in Australia. Strokes are more likely to occur with increasing age, especially over 65 years.

Hypertension (high blood pressure) is the most important risk factor for having a stroke. Other risk factors include age, gender and family history, as well as high cholesterol, overweight and obesity, physical inactivity, poor diet, smoking and excessive alcohol consumption.

Like all other diseases affecting the cardiovascular system, strokes can be prevented through a healthy lifestyle.

Stroke is a condition caused by lack of blood flow to the brain.

FIGURE 8.5 Strokes can be fatal and acting quickly to help a person suffering from a stroke is vital.

Risk factors for cardiovascular disease

Cardiovascular disease can largely be prevented. There are many factors that can contribute to the development of these diseases, some within our control and others that aren't. Factors that are not modifiable and can't be controlled include:

- age — older age increases risk
- gender — males are more likely to have a cardiovascular disease
- genetic influence — family history has a strong link to the development of cardiovascular disease

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Unit 1 | AOS 2 | Topic 3 | Concept 2

Risk factors for cardiovascular disease Concept summary and practice questions

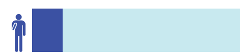
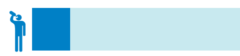
- ethnicity
- other medical conditions — high blood pressure, high cholesterol and diabetes increase risk.

Factors that are modifiable and can be controlled by the individual include health behaviours such as:

- tobacco use
- poor nutrition
- physical inactivity
- harmful use of alcohol.

These influences will be explored further in section 8.2.

TABLE 8.2 Cardiovascular disease risk factors

Behavioural risk factors	
Tobacco smoking Rates of daily smoking have continued to drop, to 14.5% of adults (2.6 million) smoking in 2014–15, compared with 16.1% in 2011–12 and 22.4% in 2001.	
Excessive alcohol consumption In 2014–15, 17.4% of adults consumed more than the recommended two standard drinks per day on average (exceeding the National Health and Medical Research Council lifetime risk guidelines).	
Inadequate fruit and vegetable consumption Over 1 in 2 Australian adults (52%) do not eat enough fruit. Over 9 in 10 Australian adults (92%) do not eat enough vegetables.	
Insufficient physical activity In 2014–15, 55.5% of 18–64 year olds participated in sufficient physical activity in the last week (more than 150 minutes of moderate physical activity or more than 75 minutes of vigorous physical activity, or an equivalent combination of both, including walking). Nearly one in three (29.7%) were insufficiently active (less than 150 minutes in the last week) while 14.8% were inactive (no exercise in the last week).	
Biomedical risk factors	
Overweight and obesity In 2014–15, 63.4% of Australian adults were overweight or obese (11.2 million people).	
High blood pressure In 2014–15, 23% of adults (4.1 million people) had measured high blood pressure.	

Source: Australian Institute of Health and Welfare, www.aihw.gov.au.

Respiratory health

Respiratory health relates to the efficient functioning of the lungs. On average, we breathe 23 000 times a day and as this is an involuntary process we tend not to notice it. It is only when our breathing may be compromised, such as during a cold or when exercising, that we do notice it. Many factors can influence the health of our lungs and it is important that we take steps to make sure that they remain healthy and are not at risk of disease.

Chronic obstructive pulmonary disease (COPD)

Chronic obstructive pulmonary disease (COPD) is a condition that limits airflow into the lungs.

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory condition that limits airflow in the lungs. It is caused by damaged air passages in the lungs. Symptoms can include shortness of breath, coughing, excessive phlegm production, chest tightness and wheezing. COPD is a broad term that also includes the conditions of emphysema (damaged lung tissue) and chronic bronchitis (frequent cough caused by excessive phlegm production).

According to AIHW, in 2011–12 530 000 Australians had COPD. It mainly affects older adults and an estimated 5.7 per cent of Australians 55 and over reported having the condition. COPD was the fifth leading cause of death, accounting for 4 per cent of all deaths in Australia. Mortality rates are higher for those living in more remote areas and in areas of low socioeconomic status (SES).

People who have COPD continue to lose lung function over their lifetime. There is no cure for COPD, however steps can be taken to manage the condition. Maintaining lung function and quality of life for people who have COPD is important as it can affect daily activity, sleep patterns and the ability to exercise. Interventions such as quitting smoking, use of specific medication, oxygen therapy and participating in pulmonary rehabilitation programs where education on the benefits of exercise and healthy nutrition are the focus, all help people with COPD manage their respiratory health.

COPD has shared risk factors with cardiovascular conditions such as advancing age and tobacco use but also has specific risk factors relevant to the functioning of the respiratory system such as long-term exposure to lung irritants including fumes, dust and smoke.

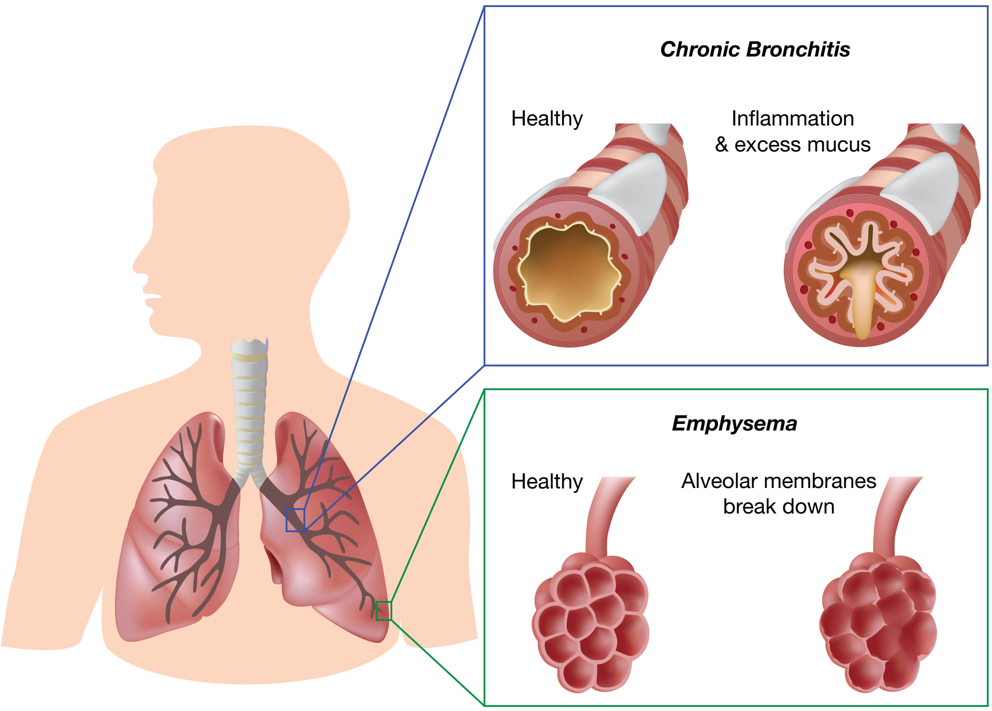


FIGURE 8.6 COPD limits the amount of airflow into the lungs.

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Weblink
ABS Health Survey

TEST your understanding

1. Define cardiovascular and respiratory health.
2. List the common risk factors that can contribute to both cardiovascular and respiratory disease.
3. Name and describe the cardiovascular disease that is the underlying cause of many other cardiovascular diseases.
4. Describe chronic obstructive pulmonary disease and identify a risk factor specific to the respiratory system.

APPLY your understanding

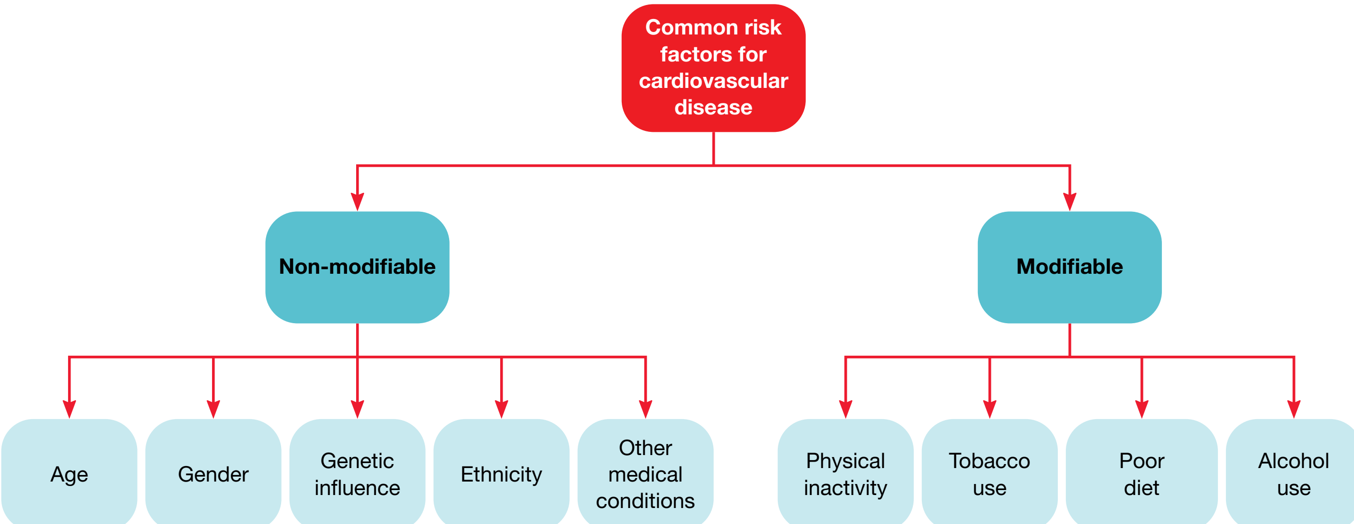
5. Cardiovascular and respiratory diseases can largely be prevented. Explain this statement using examples to support your explanation.
6. Using figure 8.3, answer the following questions.
   (a) Outline one trend evident on the graph.
   (b) Compare the difference in hypertension rates between males and females.
   (c) Explain why hypertension is a risk factor for developing other cardiovascular diseases.
7. Access the *ABS National Health Survey 2014–15 First Results* using the **ABS Health Survey** weblink in your eBookPLUS.
   Choose one of the following sections related to cardiovascular health and outline how the statistics for people affected by these diseases has changed over time.
   - High cholesterol
   - Heart, stroke and vascular disease
   - Hypertension and blood pressure

8.2 Enablers and barriers to cardiovascular and respiratory health

KEY CONCEPT There are many influences on an individual's ability to maintain good cardiovascular and respiratory health. Some of these influences can be positive (enablers) whereas others can be negative (barriers), leading to poor health outcomes.

A number of common risk factors have been identified that can compromise cardiovascular and respiratory health. Some of these factors cannot be modified, such as age, however others are modifiable, such as engaging in physical activity.

FIGURE 8.7 Cardiorespiratory disease risk factors



An **enabler** is something or someone who makes it possible for a particular thing to be done.

A **barrier** something that prevents progress or makes it difficult for someone to achieve something.

The ability to address these risk factors can be influenced by individual physiology, and the social, cultural and physical environments surrounding the individual. Each area has the potential to be an **enabler** or a **barrier** to maintaining good cardiovascular and respiratory health. These areas of influence have been outlined below, including their role as an enabler and/or barrier to health.

Physiological enablers and barriers

Age

Advancing age can act as a barrier to cardiovascular and respiratory health as the body gradually loses efficiency in its functions over time. The heart and lungs become less efficient and this can contribute to the development of cardiorespiratory diseases. Basal metabolic rate also slows with advancing age, making it more difficult to manage weight and therefore increasing the chance of weight gain.

FIGURE 8.8 Advancing age is a non-modifiable risk factor for cardiorespiratory diseases.

Gender

Being male can act as a barrier to cardiorespiratory health. Males tend to be more prone to cardiorespiratory diseases and are less likely than females to seek regular medical checkups to monitor their health. Physiologically, males have a higher propensity to store fat around the abdomen, as well as being more likely to be overweight (70.8 per cent compared to 56.3 per cent) and have hypertension (24.4 per cent compared to 21.7 per cent) than females.

Family history

Family history can act as an enabler to good cardiorespiratory health. Although family history is not modifiable, if an individual is aware of the increased risk of developing cardiorespiratory disease due to family history, they may choose to lead a healthy lifestyle and seek regular medical assistance to monitor their blood pressure and cholesterol levels.

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Unit 1
AOS 2
Topic 3
Concept 3

Physiological enablers and barriers (cardiorespiratory)
Concept summary and practice questions

Body weight

Maintaining a healthy body weight can act as an enabler to good cardiorespiratory health. Engaging in physical activity and eating a well-balanced diet low in saturated fats contribute to energy balance and reduce the chance of developing cardiorespiratory diseases.

Being overweight or obese can act as a barrier to cardiorespiratory health, as having excess body weight makes it harder for the heart and the lungs to effectively deliver oxygen into and around the body. This increases the risk of hypertension and high cholesterol levels in the blood.

Other cardiovascular diseases

Atherosclerosis, high blood pressure and high cholesterol all act as barriers to good cardiovascular health. The build-up of plaque in the blood vessels makes the heart work harder and can lead to the development of coronary heart disease, heart attack or stroke. Reducing salt and saturated and trans fat intake through a healthy diet can help an individual reduce the risk of cardiovascular disease.

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Unit 1
AOS 2
Topic 3
Concept 4

Social enablers and barriers (cardiorespiratory)
Concept summary and practice questions

Social enablers and barriers

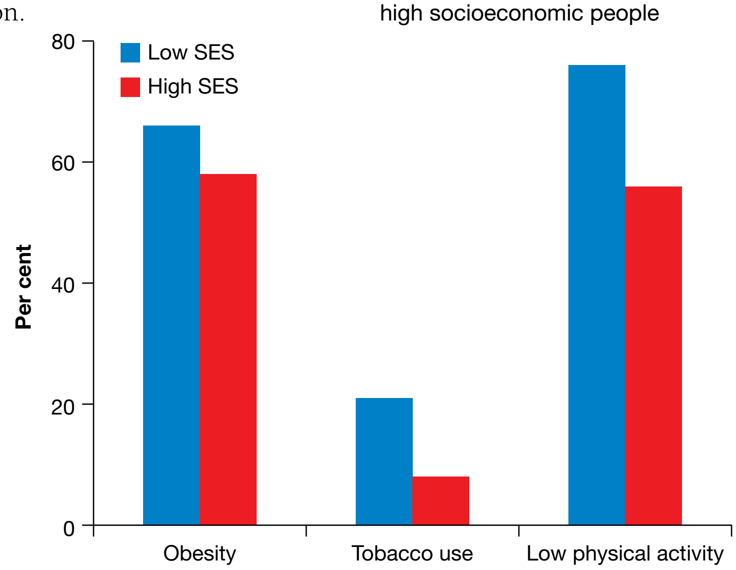
Socioeconomic status

Socioeconomic status refers to an individual's position in society in comparison to others, based on their income, education and occupation.

High socioeconomic status can act as an enabler for cardiorespiratory health as people with a higher income and level of education are more likely to have greater knowledge, choices and resources available to them to engage in a healthy lifestyle. This can include being able to purchase healthier food, such as fresh fruit and vegetables, as well as having gym memberships to be physically active.

Conversely, low socioeconomic status can be seen as a barrier as it is often associated with increased risk factors, leading to poor cardiorespiratory health. People in low socioeconomic groups are more likely to be obese, and have higher rates of smoking and lower levels of physical activity, which are all significant risk factors for developing cardiovascular and respiratory disease (see figure 8.9).

FIGURE 8.9 Comparison of risk factors for low socioeconomic and high socioeconomic people



People who are unemployed or in low-paid jobs have less money to purchase healthy food, participate in physical activity and pay for medical visits to reduce the effect of the common risk factors for developing cardiorespiratory diseases.

According to AIHW, cardiovascular disease death rates are 50 per cent higher in the lowest socioeconomic group compared with the highest socioeconomic group (table 8.1).

FIGURE 8.10 Exercising with others is a strong motivator for participating in physical activity.

Education

Knowledge about the health benefits of engaging in physical activity, eating a nutritious diet, limiting salt, saturated and trans fat and alcohol intake, and not smoking, acts as an enabler to cardiovascular and respiratory health. Health literacy, or the understanding of health information, is an important part of knowing how to lead a healthy life and where to access healthcare.

Social support

Social support of family, friends and health professionals can act as an enabler to cardiorespiratory health. The support of others can assist an individual through encouragement to engage in healthy behaviours, such as participating in physical activity together or sharing healthy meals. Social support can also assist with reducing risky behaviours that may lead to cardiorespiratory diseases, such as encouragement to quit smoking.

Cultural enablers and barriers

Ethnicity

Ethnicity is a non-modifiable risk factor for development of cardiorespiratory disease. Australia is a multicultural country and many cultures have different knowledge, beliefs and attitudes to health and the behaviours that can promote good cardiorespiratory health.

Culturally and linguistically diverse communities are at greater risk of developing cardiorespiratory disease. Barriers such as language, access to healthcare providers, and the absence of culturally appropriate programs and services may all contribute to poor cardiorespiratory health. For example, Muslim women who may not be able to access female healthcare professionals may go undiagnosed with cardiorespiratory health conditions.

Indigenous Australians have higher rates of many of the risk factors for cardiorespiratory disease compared to non-Indigenous Australians. This includes obesity, hypertension, tobacco and alcohol use, lower levels of physical activity and poor diet. Cardiovascular disease death rates are 30 per cent higher than for non-Indigenous Australians (AIHW) (table 8.1).

Both these community groups often have lower socioeconomic status (less education, income, employment) and often reside in rural and remote areas. These multiple barriers to health can predispose them to cardiovascular and respiratory dieseases.

FIGURE 8.11 Indigenous Australians are at greater risk of suffering from a cardiovascular disease than non-Indigenous Australians.

Environmental enablers and barriers

Geographic location

Living in remote and rural areas can act as a barrier to health, due to lack of access to services that are more readily available in major towns and cities. This can include access to fresh fruit and vegetables. If there is not a regular delivery, people may eat processed foods that are high in salt and saturated fat, placing them at increased risk of atherosclerosis and weight gain.

Healthcare facilities may be limited and the inability to access a variety of healthcare specialists may limit the opportunities those in rural and remote communities have to seek medical advice. Long waiting times and lack of prescreening, such as regular blood pressure and cholesterol checks, can be barriers to cardiorespiratory health.

Access to transport can also be a barrier as individuals may have greater distances to travel for services such as purchasing of food, participation in physical activity and seeking medical assistance. Travel can be expensive and this is a significant issue as in some communities there is higher than average unemployment and lower levels of income.

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Unit 1 | AOS 2 | Topic 3 | Concept 5

Cultural and environmental enablers and barriers (cardiorespiratory) Concept summary and practice questions

FIGURE 8.12 Infrastructure, such as walking and cycling tracks, allows opportunities for people to be physically active.

Access to recreation facilities

Areas such as parks, ovals, cycling and walking paths, as well as indoor sports and recreation facilities can act as enablers to good cardiorespiratory health. They provide an opportunity for people to be active and engage in physical activity which can assist in the maintenance of a healthy body weight and efficient functioning of the cardiovascular and respiratory systems. Urban environments are more likely to have such infrastructure than rural and remote environments.

Air quality

Good indoor and outdoor air quality is particularly important for the health of the respiratory system. Working in an environment where the individual may be exposed to irritants and fumes, such as being a painter, can act as a barrier to good health. Likewise, exposure to tobacco smoke, whether actively or passively inhaled, is a serious risk to both systems, contributing to chronic obstructive pulmonary disease.

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Weblink
Heart Foundation 'Map of Victoria'

TEST your understanding

1 Discuss the difference between enablers and barriers to cardiovascular and respiratory health.
2 Explain how socioeconomic status can be both an enabler and barrier to good health.
3 People who live in rural and remote areas are more likely to have a cardiorespiratory disease. Discuss why this is the case.

APPLY your understanding

4 Choose one of the barriers to cardiovascular health and provide suggestions of how this could be overcome to become an enabler of good cardiovascular health.
5 Indigenous communities, low socioeconomic groups, and those in rural and remote areas all have higher incidences of cardiovascular and respiratory conditions. Choose one of these groups and create a fact sheet about the importance of cardiorespiratory health. Include the enablers and barriers that may impact on an individual maintaining good health.
6 Access the Heart Foundation 'Heart Map of Victoria' using the **Heart Foundation 'Map of Victoria'** weblink in your eBookPLUS.
   Choose five different Victorian shires and compare their incidence of the following risk factors:
   - current smoking
   - overweight or obese
   - insufficient fruit and vegetable consumption
   - insufficient exercise.

   Suggest reasons why there may be different percentages of people in different shires exhibiting these risk factors for cardiovascular health.

8.3 Role of physical activity, sport and exercise to enhance the capacity and functioning of the cardiovascular and respiratory system

KEY CONCEPT There are clear links between being physically active and the prevention of cardiovascular and respiratory conditions.

Regular physical activity can improve health and wellbeing, and reduce the risk of premature death, illness and disability. Studies have shown that participation in regular physical activity can decrease cardiovascular-related deaths by up to 35 per cent. The physical benefits of regular activity specific to the cardiorespiratory system include reducing the risk of developing:

- cardiovascular disease
- high blood pressure
- type 2 diabetes
- chronic obstructive pulmonary disease (COPD).

Regular physical activity has the capacity to reduce risk factors, as well as assist the functioning of these systems through:

- maintenance of a healthy body weight
- lowering total blood cholesterol and triglycerides, and increasing HDL (good cholesterol) to transport fat to the liver for processing, reducing the risk of plaque depositing in arteries
- reducing blood pressure, placing less strain on the heart and blood vessels.

Physiological adaptations to exercise

Participation in physical activity, sport and exercise contributes to the efficient functioning of the body. This is particularly important for the heart and lungs. Moderate to vigorous activity improves the ability of the cardiovascular and respiratory systems to deliver oxygen around the body for energy production. The most common method to enhance the efficiency of these systems is engaging in aerobic-type activities such as walking, running, swimming, fitness classes and team sports.

FIGURE 8.13 A variety of aerobic-type activities are recommended for cardiovascular and respiratory health.

Physiological adaptions that occur through regular participation in physical activity, sport and exercise include:

- cardiac hypertrophy — an increase in the size and strength of the left ventricle of the heart, which leads to improved contractility of the heart allowing more blood to be pumped around the body
- increased capacity for blood flow — blood vessels increase in diameter and have greater elasticity, allowing for smoother flow of blood through the arteries to deliver oxygen to the body
- increased diffusion of oxygen at the lungs — greater capacity for oxygen and carbon dioxide to diffuse between the alveoli and capillaries.

These and other adaptations are explored further in chapter 9, 'Performance enhancement of the cardiorespiratory system'.

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Unit 1 | AOS 2 | Topic 3 | Concept 6

Enhancing the cardiorespiratory system
Concept summary and practice questions

Strategies to enhance the capacity and functioning of the cardiorespiratory systems

Several studies have found that engaging in low levels of physical activity provides considerable improvement in the functioning of the cardiovascular and respiratory systems. Furthermore, increases in exercise intensity are associated with a greater benefit and reduction of the risk of developing cardiorespiratory diseases.

With this in mind, many government and non-government organisations provide a variety of guidelines, strategies and interventions to motivate and assist individuals to engage in physical activity, sport and exercise.

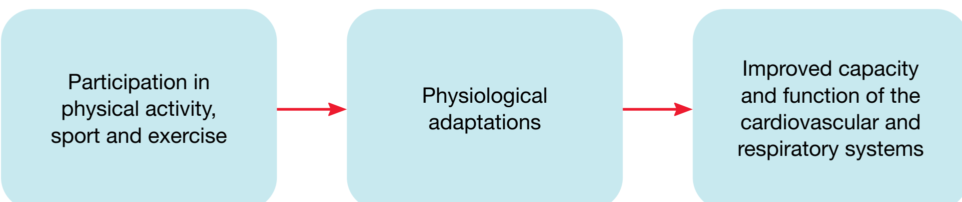

FIGURE 8.14 Regular participation in physical activity leads to improvements in the cardiorespiratory system.

Australia's Physical Activity and Sedentary Behaviour guidelines

The current Australian Physical Activity and Sedentary Behaviour guidelines have been designed to provide individuals with information regarding the optimal intensity, frequency, duration and type of physical activity required to improve health.

For youth aged 13–17, the guidelines state that for health benefits they should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day. For additional health benefits, young people should engage in even more activity.

For adults aged 18–64 the guidelines suggest that doing any physical activity is better than doing none. Individuals are encouraged to be active on most, preferably all, days every week. Participation in 150 to 300 minutes (2½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous intensity physical activity (or an equivalent combination of both moderate and vigorous activities) each week is associated with better health outcomes.

These and other guidelines are discussed further in chapter 11, 'Physical activity and sedentary behaviour'.

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Heart Foundation

National Heart Foundation: in focus

The National Heart Foundation provides a range of programs targeting involvement in physical activity across a variety of age groups. Each program revolves around participation in aerobic exercise of varying intensities to improve cardiorespiratory health. Some of these programs are briefly outlined below.

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Weblink
Jump Rope for Heart

Jump Rope for Heart

Program aimed at school-aged children to increase physical fitness and heart health. The program provides skills and resources to learn to skip in a supportive environment.

FIGURE 8.15 Programs such as Jump Rope for Heart allow people of all ages to have fun engaging in physical activity.

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Weblink
Heart Foundation Walking

Heart Foundation Walking

This program is a free, community-based program targeted at people of all ages and fitness levels. Walking is an accessible activity that can be done almost anywhere.

Heart moves

This program is a low to moderate physical activity program incorporating aerobic, weight-bearing and stretching exercises. It is targeted at adults who have risk factors or medical conditions that may limit their capacity to engage in physical activity.

In Unit 2 we will further investigate strategies and interventions to assist individuals to engage in physical activity for overall health.

FIGURE 8.16 Low impact physical activity can be beneficial for the elderly if their ability to exercise is limited.

TEST your understanding

1 Outline the physical benefits of participation in regular exercise, in relation to cardiorespiratory health.
2 Explain why physical activity is prescribed for people with cardiovascular disease.
3 List the physiological adaptations of the cardiovascular and respiratory systems that occur through participation in regular exercise.

APPLY your understanding

4 Use the **Better Health** weblink in your eBookPLUS to watch the video clip produced by the Better Health Channel, 'Exercise in your local surroundings'. Create a list of all the places in your local community that people could use to engage in physical activity. Explain the types of activities people could do in these spaces to improve their cardiorespiratory health.
5 **Practical activity**
The National Heart Foundation's 'Heart Moves' program is designed to assist people who may have difficulty participating in physical activity to make a start.
Use the **Heart Moves** weblink in your eBookPLUS to participate in the Heart Moves video session.
(a) Discuss how the exercises completed during this session can help someone who has not participated in physical activity recently begin to increase their activity levels.
(b) Outline other activities that could be incorporated into this session to increase cardiovascular and respiratory health.
(c) Choose one of the other programs offered by the National Heart Foundation and create an information sheet outlining the program, its target audience and how it can contribute to improving cardiorespiratory health.

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Weblink
Better Health

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Weblink
Heart Moves

CHAPTER 8 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:** **Outline** — general description but not in detail
- **Key terminology:** Enabler — allows something to be done
  Barrier — stops or hinders something from being done
- **Key concept/s:** Cardiorespiratory health — the efficient functioning of the heart and lungs to deliver oxygen around the body for energy production
  Influences — can be physiological, social, cultural and environmental
- **Marking scheme:** *8 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

- **8 marks** total — 2 marks allocated per influence
- **1 mark** for correctly identifying a factor relevant to the influence, e.g. physiological — body weight
- **1 mark** for explaining how this factor could either be an enabler or barrier to cardiorespiratory health

KEY SKILLS

- Assess enablers and barriers to cardiorespiratory health and investigate strategies to enhance the capacity and functioning of the cardiorespiratory system

UNDERSTANDING THE KEY SKILLS

To address this key skill, it is important to remember the following:

- cardiorespiratory health is affected by a number of modifiable and non-modifiable risk factors
- there are a number of physiological, social, cultural and environmental influences on an individual's cardiorespiratory health and each of these has the potential to be an enabler or barrier to good health
- physical activity, sport and exercise all play an important role in the efficient functioning of the cardiovascular and respiratory systems, as well as the reduction of risk factors associated with diseases of these systems.

PRACTICE QUESTION

There are a variety of influences on an individual to maintain good cardiovascular and respiratory health. These influences can be physiological, social, cultural and environmental.

For each of these influences, choose one factor relevant to it and **outline** how this factor can be an enabler or a barrier to cardiorespiratory health. *2 + 2 + 2 + 2 = 8 marks*

Sample response

Physiological: Age — advancing age is a barrier to cardiorespiratory health as the body systems no longer function as efficiently as in younger years.

Social: Socioeconomic status — High socioeconomic status can act as an enabler, as people with a higher income and level of education are more likely to have greater knowledge, choices and resources available to them to engage in a healthy lifestyle, reducing the risk of cardiorespiratory diseases.

Cultural: Ethnicity — Language can act as a barrier for culturally and linguistically diverse communities as people may not be able to understand the recommendations for cardiorespiratory health, such as living a healthy lifestyle and accessing healthcare providers to monitor health.

Environmental: Geographic location — Living in urban areas can act as an enabler due to increased range of and access to services, such as health professionals, to monitor cardiorespiratory health. These are not as readily available in rural and remote areas.

PRACTISE THE KEY SKILLS

1. Explain how the capacity and functioning of the cardiovascular and respiratory system can be reduced when an individual suffers from a chronic diease such as coronary heart disease.
2. Discuss how the geographic location in which you live can be both an enabler and a barrier to cardiorespiratory health.
3. Outline a physical activity strategy that targets cardiorespiratory health.

KEY SKILLS EXAM PRACTICE

1. Socioeconomic status can influence an individual's ability to maintain good cardiovascular and respiratory health. Outline how socioeconomic status can be a barrier and provide a strategy that may assist an individual to overcome this barrier. *2 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

- Cardiovascular disease is the leading cause of death in Australia and 1 in 5 adults live with some form of cardiovascular disease.
- Risk factors for poor cardiovascular and respiratory health include non-modifiable factors such as age, gender, ethnicity and family history, as well as modifiable factors such as physical inactivity, poor nutrition, tobacco use and excessive alcohol use.
- Cardiovascular diseases include atherosclerosis, coronary heart disease, high cholesterol, hypertension and stroke. Respiratory diseases include chronic obstructive pulmonary disease, which also includes the conditions of emphysema and chronic bronchitis.

- There are a number of factors that can influence cardiorespiratory health including individual physiology, and social, cultural and physical environment factors.
- These factors can act as enablers or barriers to achieving good cardiorespiratory health.
- Regular physical activity can reduce the risk of premature death, illness and disability in relation to the development of cardiorespiratory disease.

MULTIPLE CHOICE QUESTIONS

1 One of the leading causes of death in Australia is
(A) brain injury.
(B) cardiovascular disease.
(C) obesity.
(D) cancer.

2 Risk factors within an individual's control to reduce the incidence of cardiorespiratory disease include
(A) tobacco use, age, physical inactivity, high blood pressure.
(B) age, gender, family history, ethnicity.
(C) high cholesterol levels, poor nutrition, physical inactivity, age.
(D) tobacco use, poor nutrition, physical inactivity, harmful use of alcohol.

3 The underlying cause of many cardiovascular diseases is
(A) atherosclerosis.
(B) obesity.
(C) high blood pressure.
(D) blood clots.

4 Chronic obstructive pulmonary disease (COPD) is caused by
(A) reduced air flow to the heart.
(B) hardening and narrowing of the arteries.
(C) damaged air passages in the lungs.
(D) coughing and wheezing.

5 Hypertension is
(A) low blood pressure.
(B) high blood pressure.
(C) high cholesterol.
(D) atherosclerosis.

6 Social enablers of good cardiorespiratory health include
(A) high socioeconomic status and social support.
(B) high socioeconomic status and ethnicity.
(C) low socioeconomic status and education.
(D) low socioeconomic status and family history.

7 The environment in which an individual lives can have a significant impact on maintaining cardiorespiratory health. Which of the following is not a factor related to environment?
(A) Geographic location
(B) Access to health care
(C) Air quality
(D) Income

8 A barrier to good cardiorespiratory health is
(A) participating in regular physical activity.
(B) being overweight or obese.
(C) eating a diet low in salt.
(D) being female.

9 Regular physical activity has been shown to assist the functioning of the cardiovascular and respiratory systems. Which of the following is not a benefit of physical activity related to the cardiorespiratory systems?
(A) Increased capacity for blood flow
(B) Increased lung diffusion
(C) Increased muscle mass and bone density
(D) Increased contractility of the heart

10 Physical activity can reduce risk factors associated with coronary heart disease such as
(A) blood cholesterol levels.
(B) body weight.
(C) hypertension.
(D) All of the above.

EXAM QUESTION

Question 1 (adapted from ACHPER Trial Exam 2013, section b, question 1c)

'Inactivity is one of four leading risk factors for cardiovascular disease'.
Explain the link between physical inactivity and cardiovascular disease. **2 marks**

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Sit Topic Test

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Interactivity
Factors that influence cardiorespiratory health quiz
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INQUIRY QUESTION

How can an athlete maximise their oxygen-carrying capacity and the efficiency of their cardiorespiratory system to improve their performance in endurance-based events?

CHAPTER

9

Performance enhancement of the cardiorespiratory system

There are many legal and illegal substances and methods that can be used to enhance the performance of the cardiorespiratory system. The perceived benefit must be considered against potential harms when deciding on a method to use.

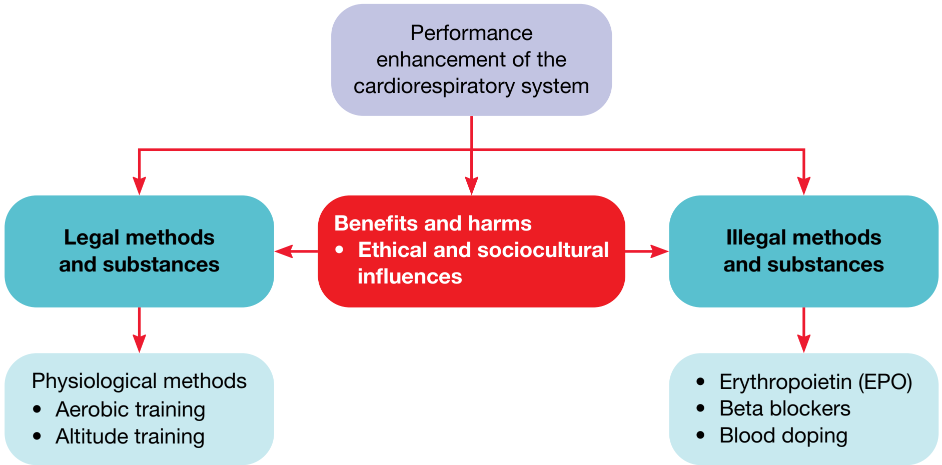
KEY KNOWLEDGE

- Actual and perceived benefits and potential harms to the athlete of legal and illegal substances and methods that enhance performance of the cardiorespiratory system, such as altitude training, erythropoietin (EPO), beta blockers and blood doping
- Ethical and sociocultural considerations associated with the use of illegal practices associated with improving the function of the cardiorespiratory system

KEY SKILLS

- Critically analyse the physiological effects of legal and illegal strategies that enhance the performance of the cardiorespiratory system on the individual
- Discuss the ethical, social and cultural considerations associated with the use of legal and illegal practices associated with improving the function of the cardiorespiratory system

CHAPTER PREVIEW



9.1 Legal substances and methods: training methods and mechanical aids

KEY CONCEPT Legal performance enhancement of the cardiorespiratory system can include the use of aerobic training methods and altitude training to increase the oxygen delivery to working muscles.

As previously discussed, the cardiorespiratory system has an important role in delivering oxygen to muscles to create energy for movement. The respiratory system brings air from the atmosphere into the lungs and transfers oxygen into the blood, while the cardiovascular system transports the oxygen around the body to the working muscles. The cardiorespiratory system primarily contributes to aerobic energy production.

A variety of training methods can be used by athletes and coaches to enhance performance of the cardiorespiratory system. Training methods that can specifically enhance this system include:

- aerobic training methods such as continuous training, fartlek, long-interval or high-intensity interval training to develop endurance
- altitude training to increase the production of red blood cells to allow for greater oxygen-carrying capacity.

Through specific training, a number of chronic cardiovascular and respiratory adaptations occur to enhance an athlete's performance. These are outlined in table 9.1.

TABLE 9.1 Chronic cardiorespiratory adaptations of aerobic training

Chronic adaptation	Benefit to performance	Potential harms
Cardiovascular: Increased left ventricle size and volume Increased stroke volume Decreased heart rate at rest and submaximal workloads Increased cardiac output during maximal exercise Increased arterio-venous difference (a-VO_2 diff) Increased blood and plasma volume Increased red blood cell and haemoglobin levels	**Increased endurance and VO_2 max via:** Increased blood flow and delivery of oxygen to working muscles Increased oxygen-carrying capacity and waste removal Increased diffusion from bloodstream into muscle resulting in greater uptake of oxygen by muscle to produce energy	**Risk of injury due to:** Lack of adequate fitness Incorrect application of training principles Not enough recovery Incorrect technique Overtraining
Respiratory: Increased pulmonary diffusion Increased lung ventilation during maximal exercise Increased maximum oxygen uptake (VO_2 max)	Increased oxygen available for diffusion Increased diffusion from alveoli into bloodstream	

Aerobic training methods

FIGURE 9.1 Aerobic training improves the endurance of an athlete, allowing them to work for longer periods of time.

Aerobic training methods can include continuous, fartlek and long-interval training. Each of these methods aims to improve the delivery of oxygen to working muscles as well as increase oxygen consumption (VO_2 max) for energy production. The performance benefits of a more efficient cardiorespiratory system mean that during aerobic activity, athletes will not have to work as hard at the same intensity or they will be able to work at a higher intensity for longer while still using the aerobic system and therefore delaying fatigue. An athlete can reach steady state faster, accumulate lactate more slowly and recover more quickly.

As with all training, there are potential harms associated with aerobic training. The athlete needs to develop a solid base relative to their level of fitness before working at higher intensities or increasing training distances. Overtraining or incorrect application of training principles, such as inadequate recovery between sessions, can increase the risk of injury.

Continuous training

Continuous training involves continuous activity that lasts a minimum of twenty minutes at the required submaximal (70–85 per cent max HR) intensity. It leads to an improvement in aerobic power and hence the delivery of oxygen to working muscles. Commonly used by runners, swimmers and cyclists, as well as in team sports as a pre-season training method to establish a sound aerobic base. An example of a continuous training session is a 30-minute cycle working at 80 per cent of HR max.

Continuous training is continuous, submaximal (70–85 per cent HR max) activity lasting longer than 20 minutes.

Fartlek training

Fartlek training is a variation of continuous training that involves changes of intensity throughout the session. Continuous submaximal efforts interspersed with high-intensity efforts allow the athlete to work both the aerobic and anaerobic energy systems, simulating the interplay that may be required in many individual and team sports. This benefits the athlete through improvements in anaerobic capacity and speed, as well as aerobic power and endurance. Examples of changes in intensity can be simply an increase in pace or running up a hill to increase the contribution of the anaerobic glycolysis energy system.

Fartlek training is continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems.

Interval training

Long-interval training

Long-interval training involves set periods of work followed by set periods of rest or recovery, repeated several times in an exercise session. Unlike the shorter distance interval training methods, long-interval training involves working at a submaximal intensity for longer distances with a work-to-rest ratio of 1 : 1. It is important to note that the athlete can work at a higher intensity, closer to 85 per cent HR max, due to the longer rest period, generally involving an active recovery at a lower submaximal intensity. A sample long-interval session for a middle-distance runner might be completing three sets of running for four minutes at 85 per cent + HR max followed by rest recovery for four minutes.

Long-interval training consists of intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system.

High-intensity interval training (HIIT)

High-intensity interval training (HIIT) involves repeated bouts of high intensity efforts (90–95+ per cent HR max) followed by varying periods of recovery at a lower intensity (40–50 per cent HR max). These efforts can be manipulated to suit endurance athletes, with work periods ranging from 30 seconds to eight minutes. Overall sessions can last from 20 to 60 minutes. The benefit of including HIIT as part of a training program is that similar cardiovascular adaptations to participating in continuous training can be achieved, but in a shorter time frame with fewer sessions.

Athletes may include HIIT as part of their training but due to the demanding nature of working at very high intensities, adequate recovery must be factored in. It is suggested that two to three sessions per week is sufficient to achieve the necessary cardiorespiratory adaptions to increase VO_2 max.

High-intensity interval training (HIIT) involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity.

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Unit 1	**Aerobic training methods (cardiorespiratory)** Concept summary and practice questions
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FIGURE 9.2 Changing intensity by running up a hill is a way to work the anaerobic energy system during fartlek training

Mechanical aids to aerobic training

Athletes can use a variety of movement- and intensity-tracking devices to assist traditional aerobic training methods and enhance the performance of the cardiorespiratory system. Devices include heart-rate monitors, GPS/activity trackers and cycling power metres.

These devices can provide instantaneous feedback, allowing the athlete to monitor and track the work being completed and ensure they are meeting proposed training aims. In particular, when athletes monitor the intensity at which they are working, they can establish if they are training in the correct aerobic training zone to gain maximal benefit from their training sessions.

FIGURE 9.3 Heart rate monitors can be used during aerobic training to help an athlete train at the correct intensity.

Altitude training

Altitude training is a legal training method that involves training at levels greater than 1500 metres above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood. The physiological adaptations that occur at altitude are thought to benefit performance at sea level. While this method is practised by a variety of athletes, research into the benefits for athletes performing at sea level is inconclusive.

As there is a lower level of oxygen present in the air at altitude, the body must adapt (acclimatise) to this reduced oxygen level. Physiological changes that occur with acclimatisation include:

- increase in the number of capillaries
- increase in the production of the naturally occurring hormone **erythropoietin (EPO)**
- increase in the production of red blood cells (RBC)
- increase in buffering capacity (especially waste removal)
- changes in the microscopic structure and function of muscles, including an increase in the number of mitochondria, the amount of myoglobin and the activity of oxidative enzymes.

These changes contribute to improvements in the oxygen-carrying capacity of the blood, increasing the delivery to and use of oxygen by the muscles. This benefits the performance of the athlete via improved maximal oxygen uptake (VO_2 max), thus enhancing their endurance capacity.

A variety of techniques have been developed for training at altitude, however the 'Live high – train low' technique is the most common and involves the athlete living in a low-oxygen environment and training in a normal oxygen environment. This allows the body to acclimatise to low levels of oxygen by living at altitude, while not compromising training intensity. The recommended minimum time spent living at altitude is at least three weeks for more than 12 hours per day to gain benefits.

Training can occur at actual altitude (greater than 1500 metres elevation) or, in more recent times, in altitude or **hypoxic** chambers which can be rooms, houses or tents. These are specifically designed spaces that simulate altitude. Athletes can train or sleep in these artificially induced low-oxygen environments. As training at altitude

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eLesson
Altitude training
Searchlight ID: eles-2575

Altitude training involves training at levels greater than 1500 m above sea level to induce physiological changes that enhance the oxygen-carrying capacity of the blood.

Erythropoietin (EPO) is a naturally occurring hormone secreted by the kidneys that stimulates the production of red blood cells. Can also be produced synthetically.

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Unit 1
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Altitude training
Concept summary and practice questions

Hypoxic means that a low level of oxygen is available.

is often costly and inconvenient, organisations such as the Australian Institute of Sport (AIS) and many Australian Rules Football (AFL) clubs have their own simulated altitude rooms in their training facilities.

These rooms are designed for a number of athletes and can be used for:

- preparation for competition at high altitude
- maintaining the benefits of altitude training camps
- using the 'live high – train low' training technique (athletes can sleep at simulated altitude).

While altitude training has many actual and perceived benefits, there are also potential harms from altitude exposure that an athlete must take into consideration.

- The increase in red blood cells increases blood viscosity; that is, it makes blood thicker, reducing the speed of flow and making it harder to pump blood around the body, ultimately decreasing the delivery of oxygen to muscles.
- At very high altitudes (greater than 5000 m elevation) weight loss occurs, the immune system can weaken and due to the lower level of oxygen, the body cannot exercise as intensely as at sea level.
- Due to the reduced amount of oxygen, athletes find it difficult to maintain their intensity of training and their aerobic fitness may decrease.
- There is a risk of developing altitude sickness.

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Weblink
Altitude training

FIGURE 9.4 Athletes train at altitude or in altitude rooms in an attempt to increase the oxygen-carrying capacity of their blood.

TEST your understanding

1. Outline the legal training methods that can be used to enhance cardiorespiratory performance.
2. Define the term 'altitude training'.
3. Explain the perceived benefits and potential harms of altitude training for an athlete.

APPLY your understanding

4. Discuss why an athlete may use a mechanical aid in addition to normal training. Provide specific examples.
5. Discuss the physiological benefits an athlete can gain from participating in a continuous training program.
6. **Practical activity: participate in a fartlek training session**
   Participate in the following fartlek training session, based on the Gerschler Fartlek method.
   - Five minute warm-up
   - Repeat three times: Stride hard for 30 seconds, jog 90 seconds. Repeat with 15-second decreases in recovery jog, e.g. 30–90, 30–75, 30–60, 30–45, 30–30 and 30–15.
   - Five minute cool-down

   (a) Outline the physiological benefits of participating in a fartlek training program.
   (b) Explain how fartlek training differs from continuous and long-interval training.
   (c) Identify sports that would be suited to fartlek training. Choose one and design a fartlek training session specific to the requirements of that sport.

9.2 Illegal substances and methods that enhance performance of the cardiorespiratory system

KEY CONCEPT Illegal substances and methods that enhance the cardiorespiratory system can appeal to endurance athletes due to their ability to improve the delivery of oxygen to working muscles.

As outlined in chapter 5, performance-enhancing drugs are currently banned or considered illegal in most sports. Illegal substances and methods that athletes may use to enhance the cardiorespiratory system are quite different to those used to enhance the musculoskeletal system. The focus of these methods primarily revolves around the enhanced delivery of oxygen to the working muscles, improving and/or altering the function of the cardiorespiratory system.

Substances and methods that increase the amount of red blood cells in the body, such as erythropoietin (EPO) and blood doping, are prohibited at all times under the WADA code. The use of substances to manipulate the functioning of the cardiorespiratory system, such as beta blockers, are prohibited in certain sports where they offer a competitive advantage.

Famous doping cases involving these types of substances and methods have been linked to endurance sports, such as the now infamous case of Lance Armstrong who was stripped of seven Tour de France titles due to doping violations, or those sports requiring accuracy and precision, such as pistol shooting where North Korean athlete Kim Jong-Su returned a positive test to beta blockers at the 2008 Beijing Olympics and was stripped of both a silver and bronze medal.

For most illegal practices, there are safer legal alternatives that can produce exactly the same results but are neither banned nor illegal. For example, the illegal drug erythropoietin (EPO) can create an increase in red blood cell levels; however, the same effect can be obtained legally by living and training at altitude, or by spending time (usually while asleep) inside an altitude chamber or tent, as discussed earlier in this chapter.

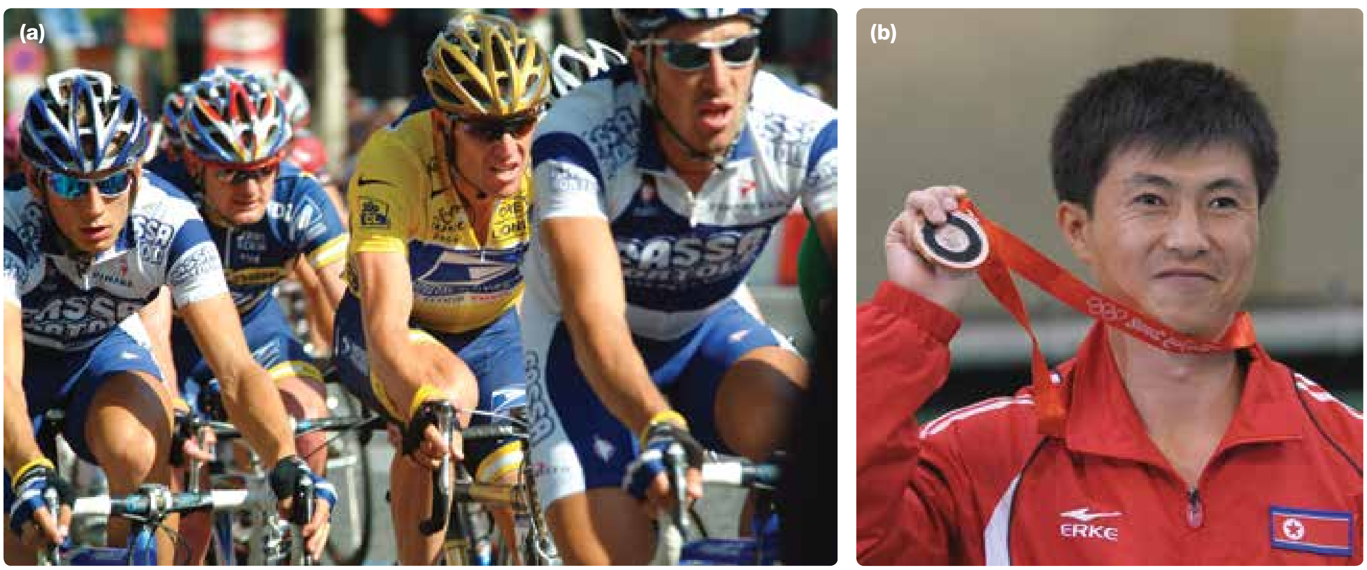

FIGURE 9.5 Athletes banned from their sports for using performance-enhancing substances include (a) Lance Armstrong and (b) North Korean athlete Kim Jong-Su.

Erythropoietin (EPO)

EPO is a naturally occurring hormone, secreted by the kidneys. This hormone stimulates the production of red blood cells. Athletes may use a synthetic version of EPO in order to gain an advantage over others, particularly in endurance-based sports.

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Weblink
EPO and blood doping

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Unit 1	**Illegal substances and methods (cardiorespiratory)** Concept summary and practice questions
AOS 2	
Topic 10	
Concept 3	

As the role of EPO is to stimulate an increase in red blood cell production (RBC), there is more haemoglobin available for oxygen to attach to and be delivered to working muscles. This increase results in better oxygen transportation and a higher rate of aerobic energy production. The performance benefit of EPO use is greater aerobic endurance and VO_2 max, as athletes can produce more energy aerobically at a higher level before relying on the anaerobic energy systems.

As the use of EPO increases the amount of red blood cells beyond normal level, this poses risks to the health of the athlete. Potential harms include increased viscosity (thickening) of the blood, blood clots, increased risk of heart attack and stroke, and dehydration. Synthetic EPO is administered by a series of injections over a period of time so there is also the risk of infection and blood-borne disease if not administered correctly.

Legal alternatives to the use of EPO in order to increase the amount of red blood cells and their oxygen-carrying capacity include training methods such as aerobic or altitude training.

Blood doping

Blood doping is the process of infusing extra human blood (red blood cells) into an athlete's body prior to performance.

Blood doping involves the process of infusing extra human blood (red blood cells) into the body prior to performance. It can be an athlete's own blood or that of someone else of same blood type. If using their own blood, the athlete will remove some blood, then concentrate, freeze and store the blood to be reinfused at a later date. In the meantime, the body replaces removed red blood cells with new red blood cells. WADA prohibits this method at all times.

As with EPO, the increased amount of red blood cells leads to improved oxygen delivery to the muscles via the increased amount of haemoglobin in the blood. This has the potential to increase endurance via enhancement of the VO_2 max and aerobic capacity of the athlete.

Potential harms associated with blood doping are similar to those of EPO including increased viscosity (thickening) of the blood, blood clots, increased risk of heart attack and stroke, and dehydration. In addition to these, there is the associated risk with blood transfusions such as infectious diseases or the blood being toxic due to incorrect storage.

Legal alternatives that produce the same effect as blood doping, albeit not as fast, include aerobic and/or altitude training.

FIGURE 9.6 Blood doping involves the removal and reinfusion of an athlete's blood to increase the red blood cell count.

Beta blockers

Beta blockers are medical drugs that block adrenalin hormones from binding to receptors on nerves, thus reducing the effect these hormones have on the heart and blood vessels. Legally they are prescribed for people who have medical conditions such as high blood pressure, angina and cardiac arrhythmias.

Illegally they are used by athletes to control and reduce blood pressure, slow the heart rate and reduce body tremor. They can also reduce pre-competition tension by relaxing the body. Sports that benefit from beta blockers are those requiring precision, accuracy and a steady hand. WADA prohibits the use of beta blockers during competition in the following sports: archery, billiards, darts, golf, shooting, some skiing and snowboarding events, and some underwater sports. The use of beta blockers is also prohibited out of competition in archery and shooting.

Potential harms of using beta blockers include hypotension (low blood pressure), decreased heart rate, hypoglycaemia, cardiac failure, tiredness and decreased capacity in endurance sports.

A legal alternative to the use of beta blockers to manipulate the functioning of the cardiorespiratory system is the use of psychological methods such as breathing techniques and mental rehearsal to reduce arousal and aid concentration and relaxation.

Beta blockers are drugs that block adrenalin hormones from binding to receptors on nerves, reducing the effect they have on the heart and blood vessels.

FIGURE 9.7 The sports of archery and shooting ban the use of beta blockers at all times.

TABLE 9.2 Illegal methods used to enhance the performance of the cardiorespiratory system

WADA classification	Examples	Performance benefits	Potential harm (side-effects)	Legal alternative
S2: Peptide hormones	Erythropoietin (EPO)	**Increased endurance and VO_2 max via:** increased red blood cell production, and thus oxygen-carrying capacity to working muscles	Increased viscosity (thickening) of blood Blood clots Increased risk of stroke and heart attack Dehydration Cardiac failure	Aerobic training methods Altitude training
M1: Manipulation of blood and blood components	Blood doping	**Increased endurance and VO_2 max via:** increased red blood cell mass, thus improved oxygen delivery to muscles	Increased viscosity (thickening) of blood Blood clots Increased risk of stroke and heart attack Dehydration Cardiac failure	Aerobic training methods Altitude training

(continued)

TABLE 9.2 *(continued)*

WADA classification	Examples	Performance benefits	Potential harm (side-effects)	Legal alternative
P2: Beta blockers	Lopressor Propranolol	Accuracy and a steady hand via reduced heart rate, tension, body tremors. Helps stop the hands from shaking	Lowered blood pressure Decreased heart rate Tiredness Decreased capacity in endurance sports Cardiac failure	Psychological methods (breathing, mental rehearsal) to reduce arousal, aid concentration and relaxation

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Interactivity
Illegal methods used to enhance the performance of the cardiorespiratory system
Searchlight ID: int-6649

TEST your understanding

1 Outline the performance benefits of illegal substances and methods that can be used to enhance the cardiorespiratory system.
2 Explain the term 'enhancement of oxygen transfer'.
3 Suggest legal methods that can be used to enhance the performance of the cardiorespiratory system.

APPLY your understanding

4 Discuss the similarities and differences in potential benefits and harms of EPO use and blood doping for an athlete.
5 Using examples of illegal substances that can enhance the performance of the cardiorespiratory system, explain why some drugs are banned all the time but others are only prohibited in certain sports.
6 **Practical activity**
Participate in an activity that requires accuracy and precision such as archery, darts or golf putting.
Prior to completing the actual skill (e.g. shooting at the archery target) each student should complete the following scenarios.
(i) Sitting down quietly for one minute visualising the task you are about to complete.
(ii) High intensity exercise, such as sprinting, for one minute prior to completing the task.
- Take your heart rate immediately before executing your shot. Record your heart rate.
- Perform the skill.
- Record your result.

(a) Discuss your heart rate in relation to the results you achieved.
(b) Identify one legal and one illegal substance or method that an athlete might use to assist their performance in the activity you participated in.
(c) Outline the benefits and harms an athlete needs to be aware of if using the substance or method identified in part (b).

9.3 Ethical and sociocultural considerations associated with performance enhancement in sport

KEY CONCEPT The use of performance-enhancing substances and methods is a complicated issue requiring serious consideration of the impact they can have on the individual, the sport and the wider sporting community.

In chapter 5 we explored the ethical concerns and sociocultural influences regarding the use and misuse of performance-enhancing substances and methods relevant to the musculoskeletal system. Our focus now changes to consider the impact of these on the functioning of the cardiorespiratory system.

As outlined in this chapter, there are a number of legal and illegal substances and methods available to improve the functioning of the cardiorespiratory system. All focus on increasing endurance by improving the delivery of oxygen to working muscles. This allows an athlete to not have to work as hard at the same intensity or to allow them to work at a higher intensity for longer, while still using the aerobic system and therefore delaying fatigue.

Ethical considerations of the use of performance-enhancing practices

The zero tolerance approach to the use of illegal substances and methods, and the opposing argument of allowing the use of performance-enhancing substances are similarly applied to the substances and methods that can be used by endurance-based athletes to gain that winning edge over their fellow competitors.

Illegal substances and methods such as the use of EPO and blood doping are banned at all times not only because they have the capacity to enhance the performance of the athlete but also because of the significant health risks they pose to athletes. The harms from engaging in these illegal practices, such as increased viscosity (thickening) of the blood and the formation of blood clots leading to an increased risk of heart attack and stroke and possible death, do not seem to be a deterrent to some athletes and the chance of winning overrides the fear of these potential outcomes.

A number of endurance athletes in the sports of road cycling, cross-country skiing, triathlon, and 20-km and 50-km race walking have been implicated in the use of banned substances such as EPO to improve the functioning of the cardiorespiratory system. The consequence of use has been titles being rescinded, medals stripped and bans served, some lifetime, from their chosen disciplines.

FIGURE 9.8 Some cross-country skiers have been implicated in the use of EPO and blood doping to enhance the delivery of oxygen to working muscles.

The assumption of widespread use of EPO in these events has led to the suggestion to allow all athletes to use this substance at a medically safe, determined level to create a level playing field and reduce the risk of misuse and possible future deaths. Ethicist Julian Savulescu contends that 'we should allow doping within safe, measurable physiological parameters. For example, if an athlete's haematocrit is under say 50 per cent, we should not worry about whether she reached that level by altitude training, hypoxic tent use, genetic good luck, or EPO. We should focus resources on drugs which are unreasonably risky for athletes, or which are against the spirit of the individual sport (by which I mean they substantially remove the human component of a given sport). The doping we allow should be supervised by a medical professional, within prescribed safe ranges, and tested by independent accredited and monitored laboratories.'

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Weblink
Julian Savulescu: Ethics and performance-enhancing drugs

Legal methods available to improve the functioning of the cardiorespiratory system spark debate regarding access and equity, and whether or not there is in fact a 'fair and level playing field' for all athletes to begin with. The practice of altitude training and use of altitude chambers involves significant cost to attend training camps or use facilities to gain the benefits of training at high altitude. Athletes from less privileged backgrounds or those who don't have the financial support of clubs or sporting organisations may not have the resources to partake in this type of training. When a legal method is not accessible to all athletes, it brings into question the ideal of a fair and level playing field.

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Unit 1 | **AOS 2** | **Topic 10** | **Concept 4**

Ethical and sociocultural considerations (cardiorespiratory) Concept summary and practice questions

FIGURE 9.9 The Sydney Swans AFL team in their $260 000 altitude room at the SCG, which simulates low-oxygen environments. Facilities such as this one are not available to many athletes.

Sociocultural influences on the use of performance-enhancing practices

While improved sporting performance is one of the most commonly cited motivators for an athlete using a performance-enhancing substance or method, there are a number of influences that sway the decision of an athlete to take additional steps to enhance their performance. As previously mentioned in this text, sociocultural influences are numerous and can have a varied impact on an individual. They include:

- income
- education
- influence of self, family, peers
- influence of coaches and sporting organisations

- cultural norms in the society or the particular sporting culture
- national and political ideology.

Recent examples of athletes using performance-enhancing substances and methods to improve the functioning of the cardiorespiratory system reveal how influences outside the individual have an impact on their decision making.

Cultural norms in the society or the particular sporting culture

The ‘culture of cycling’ is a term often used to describe the long history of performance enhancement use and misuse in this sport. The alleged use of amphetamines during the 1960s followed by the use of blood doping and EPO from the late 1980s until now has constantly dogged the sport. As Chris Froome discovered during his success in the 2015 Tour de France, in which he was accused by the media of taking illegal substances, the level of trust in cyclists to be competing without some form of illegal enhancement has diminished and they are constantly questioned about the authenticity of their success.

FIGURE 9.10 2015 Tour de France winner Chris Froome was constantly questioned by the media about performance enhancement.

This public doubt has arisen because of a number of doping scandals. The highest profile was the scandal surrounding Lance Armstrong and his subsequent admissions to a variety of doping offences during his time as a professional cyclist. The fallout of this investigation involved a number of cyclists admitting to using performance-enhancing substances, particularly EPO. The pressure of team expectations and the knowledge and/or belief that others were using illegal substances have often been cited as major influences on their decisions. In a tough, demanding and often gruelling event such as the Tour de France, it is conceivable that athletes would agree to almost anything to give them a competitive advantage and a chance to wear the yellow jersey.

National and political ideology

Sport is important to the culture and identity of many countries around the globe. The medal tally at Olympic Games and success in World Championships allow a country to prove its sporting prowess on the global stage. For this reason, many governments and their national sporting organisations contribute to the pressure placed on athletes to perform at their best and possibly use performance-enhancing substances to uphold the reputation of the country.

At the end of 2015, the Russian athletics team made headlines around the world. Medals won by Russian athletes at the 2012 London Olympics and the methods by which they were able to achieve their successes were questioned. A number of endurance athletes, particularly those competing in the 20-km and 50-km walk races, had returned abnormal samples with elevated haemoglobin values, suggesting the use of EPO or blood doping prior to the Olympics, but were still allowed to compete. A WADA investigation into both the Russian Athletics Federation and the IAAF has suggested a culture of 'state-sanctioned doping' where athletes were administered with banned substances and authorities overlooked the problem. Life bans have been announced for individual athletes and the Russian Athletics Federation has been warned that they will be unable to compete in the 2016 Rio Olympics unless they review their operations and adhere to the WADA anti-doping code, especially rigorous testing of athletes for use of illegal performance-enhancing substances.

With such pressure as this, it raises the question: Did these athletes have an opportunity to *not* use illegal performance-enhancing substances or was it an expectation that as part of the team and when representing your country you would do whatever it took to be successful?

FIGURE 9.11 Russian race walk athletes implicated in the 'state-sanctioned doping'.

TEST your understanding

1. The 'culture of a sport' is often cited as a reason for accepting or dismissing the behaviours that may occur within a sport. Discuss the sociocultural influences that may be present within the 'culture of a sport' to influence an athlete to use performance-enhancing substances and methods.
2. Explain the phrase 'state-sanctioned doping'. Discuss how this may influence an athlete in relation to performance enhancement.

APPLY your understanding

3. Using the **Swans' altitude room** weblink in your eBookPLUS, read the article and answer the following questions.
   (a) Outline the advantage to an athlete or team of having unlimited access to an altitude room, as does the Sydney Swans football team.
   (b) Access and equity are cited as factors that may have an impact on a level playing field for all athletes. Discuss this in relation to the use of legal performance-enhancing methods such as altitude training.
4. **Class debate: Should all performance enhancement practice be legal?** Ethicist Julian Savulescu contends that "we should allow doping within safe, measurable physiological parameters". Conduct a class debate arguing whether or not some illegal performance-enhancement substances and methods should be legal.

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Weblink
Swans' altitude room

CHAPTER 9 REVISION

KEY SKILLS

- Critically analyse the physiological effects of legal and illegal strategies that enhance the performance of the cardiorespiratory system on the individual
- Discuss the ethical, social and cultural considerations associated with the use of legal and illegal practices associated with improving the function of the cardiorespiratory system

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- understand the potential benefits and perceived harms of a range of legal and illegal strategies that can be used by an athlete to enhance the functioning of the cardiorespiratory system
- physiological refers to changes that occur within the body, specifically to the cardiovascular or respiratory system
- performance enhancement relates to improvements in the functioning of the cardiorespiratory system
- provide a clear link between the cardiorespiratory physiological adaptation and how it can enhance performance
- there are a range of ethical and sociocultural influences on an athlete when making the choice to use or not use performance-enhancing substances and methods.

PRACTICE QUESTION (adapted from ACHPER 2013 Trial Exam, Unit 3 and 4, question 12)

In January 2013 Lance Armstrong, winner of seven Tour de France titles, admitted that he had used numerous performance-enhancing drugs and/or practices to help him secure these wins.

Armstrong also admitted to 'blood doping' and using erythropoietin (EPO). Both blood doping and the use of EPO are believed to enhance an athlete's VO_2 maximum.

Critically **evaluate** how these different methods lead to improvement in an athlete's VO_2 maximum.

(4 marks)

Sample response

EPO is a hormone produced naturally in the kidneys. Artificial EPO stimulates the production of red blood cells and thus enhances the oxygen-carrying capacity of the athlete, enabling an improved VO_2 maximum.

Blood doping, however, requires blood transfusion where an athlete's own blood, or that of another person, is transfused into the athlete.

The extra blood cells are infused into the athlete's body, increasing the red blood cells and therefore the VO_2 maximum of the athlete.

PRACTISE THE KEY SKILLS

1. Identify legal and illegal methods that athletes might use to enhance oxygen transfer. Discuss performance benefits and potential harms of these methods.
2. Describe the changes that occur in the body when undertaking altitude training and why they might improve performance.
3. Discuss some of the specific pressures athletes experience that may influence them to use performance-enhancing drugs and/or methods to improve the cardiorespiratory system.

KEY SKILLS EXAM PRACTICE

Question 1 (ACHPER Trial Exam 2011, question 1)

Australian athlete Sarah Jamison won a silver medal for the 1500 metre running event at the 2006 Commonwealth Games in a time of 4:06:64. The ability of the body to transport oxygen to the working muscles is important during this event.

a. i. Name the structure responsible for transporting oxygen in the blood.

1 mark

ii Describe one legal and one illegal method an athlete may use to increase the amount of the structure named.

2 marks

iii Other than cardiac problems or death, outline one physiological side effect of using this illegal method.

1 mark

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:** **Evaluate** — suggest reasons for the effectiveness of something
- **Key terminology:** Enhance — increase the functioning of VO_2 maximum — maximum amount of oxygen per minute that can be taken in, transported to and used by the working muscles to produce ATP
- **Key concept/s:** Illegal substance — EPO and blood doping
  Performance enhancement — increases the functioning of the cardiorespiratory system
- **Marking scheme:** *4 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

- **1 mark** — describing EPO and the physiological change caused though using EPO
- **1 mark** — linking the physiological change to improved VO_2 maximum
- **1 mark** — describing blood doping and the physiological change caused though using blood doping
- **1 mark** — linking the physiological change to improved VO_2 maximum

CHAPTER REVIEW

CHAPTER SUMMARY

Legal substances and methods

- Training methods to enhance the functioning of the cardiorespiratory system include aerobic training methods such as continuous training, fartlek training, long-interval and high-intensity interval training, as well as altitude training.
- Altitude training is a legal training method that induces physiological changes to enhance the oxygen-carrying capacity of the blood, thus increasing the delivery of oxygen to the muscles. This training can occur at actual altitude (greater than 1500 metres above sea-level) or in specifically designed chambers or rooms that simulate altitude.
- Performance benefits of a more efficient cardiorespiratory system are that during aerobic activity, athletes will not have to work as hard at the same intensity or they will be able to work at a higher intensity for longer while still using the aerobic system and therefore delaying fatigue.

Illegal substances and methods

- Illegal methods that can be used by athletes to enhance performance include EPO, blood doping and beta blockers.
- EPO and blood doping increase the red blood cell count, therefore creating more sites to carry oxygen, resulting in better oxygen transportation and a higher rate of aerobic energy production.
- Beta blockers may be used illegally by athletes in precision sports such as archery and shooting to increase their accuracy and steadiness, and reduce body tremor and pre-competition anxiety.

Ethical and sociocultural influences

- There are a variety of influences on athletes to use performance-enhancing substances. These can include sociocultural reasons such as income, education, influence of self, family and peers, the influence of coaches and sporting organisations, cultural norms in society or the particular sporting culture, and national and political ideology.

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Sit Topic Test

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Interactivity
Performance enhancement of the cardiorespiratory system quiz
Searchlight ID: int-6650

MULTIPLE CHOICE QUESTIONS

1 Training methods to best enhance the performance of the cardiorespiratory system include
(A) continuous training, resistance training, flexibility training.
(B) continuous training, speed training, fartlek training.
(C) continuous training, fartlek training, plyometrics.
(D) continuous training, fartlek training, long-interval training.

2 Altitude training causes which of the following physiological adaptations to occur in the body?
(A) Increased muscle mass
(B) Increased blood plasma, red blood cells and white blood cells
(C) Increased production of erythropoietin (EPO) and increased red blood cells
(D) Decreased heart rate

3 Activity trackers are aids that can be used to assist training of the cardiorespiratory system. The most relevant information to address training goals of this system would be
(A) movement patterns and intensity of effort.
(B) movement patterns and amount of sleep.
(C) calories burned.
(D) power output.

4 Aerobic training is likely to result in which of the following chronic adaptations to improve performance of the cardiorespiratory system?
(A) Increased left ventricle size, increased fast-twitch fibres, increased haemoglobin levels
(B) Increased pulmonary diffusion, decreased heart rate during submaximal loads, increased stroke volume
(C) Increased muscle mass, increased stroke volume, increased red blood cells
(D) Increased haemoglobin, decreased maximal oxygen uptake, increased left ventricle size

5 A continuous training method that includes changes of intensity to work both the aerobic and anaerobic energy systems is called
(A) aerobic training.
(B) long-interval training.
(C) fartlek training.
(D) flexibility training.

6 In recent years some endurance athletes have been found guilty of using the illegal drug erythropoietin (EPO) to gain an edge over their competitors. A potential harm of using this drug is
(A) low blood pressure.
(B) increased risk of blood clots.
(C) male infertility.
(D) decreased muscle mass.

7 Beta blockers have been used in sports that require precision and accuracy such as archery, shooting and golf. They are banned by WADA as they have the potential to
(A) reduce body tremors.
(B) reduce perception of effort and fatigue.
(C) increase focus and attention.
(D) increase heart rate.

8 A legal alternative to blood doping is
(A) using a heart-rate monitor.
(B) psychological training.
(C) altitude training.
(D) consuming high amounts of iron in your diet.

9 A perceived benefit and potential harm of blood doping is
(A) increased maximal oxygen uptake and decreased heart rate.
(B) increased haemoglobin levels and decreased tremor.
(C) increased endurance and increased infertility.
(D) increased amount of red blood cells and increased risk of stroke.

10 Illegal methods used to enhance the transfer of oxygen include
(A) EPO and beta blockers.
(B) EPO and blood doping.
(C) EPO and altitude training.
(D) blood doping and beta blockers.

EXAM QUESTIONS

Question 1 **(ACHPER Trial Exam 2015, question 11)**

Biological Passports have been introduced by the World Anti-Doping Authority (WADA) in order to monitor physiological parameters of athletes to determine whether athletes are adhering to the WADA Code. In 2015, five Russian female race walkers, including three Olympic champions and one World Champion, were banned by the Russian Anti-Doping Agency for irregularities in their Biological Passports. The irregularities were deemed to indicate the use of performance-enhancing drugs.

a. With reference to the WADA code, explain why these athletes received sanctions by the Russian equivalent to the Australian Sports Anti-Doping Authority (ASADA). **2 marks**

b. Elite female race walking is a 20 km endurance event averaging 90 minutes duration. One of the parameters monitored in a Biological Passport is an athlete's haematocrit which indicates the concentrations of red blood cells in their blood.

Provide **one** legal and **one** illegal strategy that may result in an athlete's haematocrit increasing. **2 marks**

Unit 2

Physical activity, sport and society

OUTCOME 1

Collect and analyse data related to individual and population levels of participation in physical activity and sedentary behaviour to create, undertake and evaluate an activity plan that meets the physical activity and sedentary behaviour guidelines for an individual or specific group.

OUTCOME 2

Apply a social-ecological framework to research, analyse and evaluate a contemporary issue associated with participation in physical activity and/or sport in a local, national or global setting.

INQUIRY QUESTION
What determines if you are physically active or sedentary? Is it possible to be both?

CHAPTER

10 Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers

It's important to understand what physical activity, physical inactivity and sedentary behaviour are so that we can make healthy decisions and changes to our behaviour.

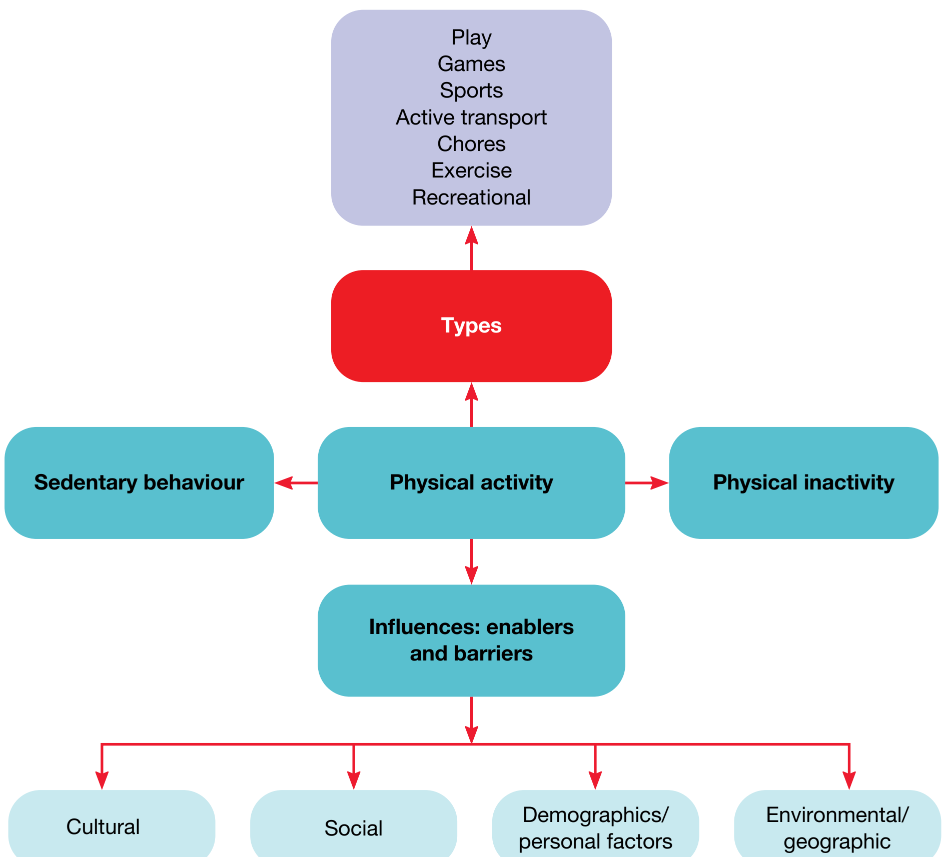
KEY KNOWLEDGE

- Forms of physical activity such as play, games, sports, transportation, chores, exercise and recreational activities
- The concepts of physical activity, physical inactivity and sedentary behaviour
- Sociocultural influences on participation in physical activity across the lifespan such as historical, social, cultural, environmental, geographic and personal factors
- Enablers and barriers of physical activity behaviours including demographic, social, cultural and environmental factors

KEY SKILLS

- Participate in and reflect on a variety of different forms of physical activity, including a variety of culturally diverse physical activities
- Define and identify forms of physical activity, physical inactivity and sedentary behaviour
- Analyse sociocultural influences on physical activity participation across the lifespan
- Investigate and determine factors that influence an individual's participation in physical activity across the lifespan

CHAPTER PREVIEW



10.1 Forms of physical activity

KEY CONCEPT Physical activity involves movement that expends energy and can be done in many ways. Generally it doesn't matter what type of physical activity you participate in, as any physical activity is better than none.

Physical activity is any movement of the body produced by skeletal muscles, resulting in energy expenditure.

There many ways to move and expend energy and, therefore, there are many different ways to be physically active. Most **physical activities** can be categorised as one of the following forms: play, games, sports, transportation, chores, exercise and recreational activities.

TABLE 10.1 Types of physical activity

Type of activity	Description	Example
Play	Activities engaged in for enjoyment and recreation rather than a serious or practical purpose	
Games	Activities that one engages in for amusement	
Sports	Activities involving physical exertion and skill, in which an individual or team competes against another or others for entertainment	
Transportation (active)	Travel between destinations by walking, cycling or other non-motorised modes	

Type of activity	Description	Example
Chores	Routine tasks, for example, jobs done around the home	
Exercise	Activities requiring physical effort, carried out to sustain or improve health and fitness	
Recreational activities	Leisure activities. Leisure is discretionary time, which is time outside of work and study commitments.	

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Unit 1
AOS 2
Topic 10
Concept 1

Forms of physical activity
Concept summary and practice questions

The type of physical activity people predominately engage in generally changes as they move through different stages of their lives. For example, it is likely that young children will be physically active through play and games and rarely through exercise or organised sport. This is because their physical and cognitive capabilities are still developing.

Primary school children are likely to engage in some play and games. Many also have plenty of opportunities to try sports through PE classes and modified sports, and some children possibly engage in active transport, but most probably don't engage in much structured exercise. By the end of primary school many children are engaged in team sports such as netball, football, soccer and tennis.

Teenagers are likely to engage in less play and games, preferring to participate in sport, active transport, exercise, recreational activities and, hopefully, some chores around the house.

FIGURE 10.1 Recreational activities such as surfing have more appeal than play as teenagers get older.

TABLE 10.2 **Children participating in organised sport 2012**

	NUMBER			PARTICIPATION RATE		
	Males '000	Females '000	Persons '000	Males %	Females %	Persons %
Age group (years)						
5–8	354.7	273.8	628.5	61.4	50.1	55.9
9–11	309.5	237.3	546.9	73.3	59.0	66.4
12–14	284.8	215.9	500.7	66.3	52.9	59.8

Source: Australian Bureau of Statistics, 2012.

Adults are unlikely to engage in play and games, and are likely to be most active through sport, active transport, exercise, recreational activities and chores, which may include physical activity in the workplace such as walking as a waitress or strength work as a builder. The elderly (65+ years) are most likely to be active through active transport (mainly walking), recreational activities and chores, such as gardening.

The Australian Bureau of Statistics has identified that participation in sport and physical recreation generally decreases with age. People aged 15 to 17 years report the highest participation rate in sport and physical recreation (74 per cent), while people aged 65 years and over have the lowest (47 per cent). Male and female participation rates were similar, except in the 25–34 age group, where participation rates were higher for males (67 per cent) than females (61 per cent).

eBook*plus*

Interactivity
Forms and concepts of physical activity
Searchlight ID: int-6651

TEST your understanding

1 Describe what is meant by recreational activity and provide two examples.
2 List six different examples of games.
3 List four different forms of active transportation.
4 List the most common types of physical activity for each stage across the lifespan: children, youth, adults and the elderly.
5 Use the information in table 10.2 to answer the following questions:
   (a) What are some of the trends in the data?
   (b) Why are there differences between males and females?
   (c) Why does participation in organised sport peak between 9 and 11 years of age?
   (d) Suggest how the data would differ as age increases.

APPLY your understanding

6 Set up and observe a play space. Supply a variety of equipment (skipping rope and balls) in a set space (e.g. gym/oval). Invite students (preferably younger) to enter the space. Observe who uses the equipment and how they use it. Join in with students.
   (a) What is play and when did you see this occurring?
   (b) Who was most active and how?
   (c) Did you observe any sedentary behaviour? If so, by whom and where?
   (d) Based on your observations, outline three enablers and three barriers.
7 Set up and play a variety of games. In groups, choose a game to teach your classmates (e.g. Octopus tag, hopscotch, duck duck goose). Explain the rules of the game and then run the game for your classmates for 5–10 minutes.
   (a) How are games different to sport and play?
   (b) What are two advantages and two disadvantages of play?
   (c) Identify when throughout the lifespan you would be most likely to engage in games. Justify your answer.
8 Research and peer teach/participate in a game that originates in a different culture from your own. Some examples are listed below. Use the **Games** weblinks in your eBookPLUS to find out more information and rules.
   - Baseball
   - Bocce

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Weblinks
Games

- Sepak takraw
- Korfball
- Lacrosse
- European handball

(a) Suggest reasons why these sports are not as high profile in Australia as they are in other countries.
(b) Outline three barriers for people wanting to participate in these sports and suggest ways they can be overcome.
(c) How were these activities different from your usual physical activity, if at all. How did these differences make you feel?

9 Using pedometers, walk around the school campus for your daily timetable for a week. Graph your results and compare with a partner and then with your class.
(a) Discuss the similarities and differences between you and your partner, and your class.
(b) Using your knowledge of barriers and enablers, give reasons for these differences.
(c) Suggest two ways you could increase your use of active transportation.

10 Participate in a group fitness class (e.g. cycle/RPM, aerobics, body step, boot camp), preferably off campus. Monitor your intensity throughout the practical (heart rate, METs, talk test).
(a) Describe the class. What did you do? How did you feel? Who was part of the class?
(b) Discuss how this activity is different from playing a sport.
(c) Identify and justify at what stage of the lifespan these types of activities would be commonly used as the predominant form of physical activity.
(d) Outline a barrier and enabler for you to engage in these types of activities.
(e) Compare this activity with going on a run or bike ride. What are the advantages and disadvantages of each?
(f) Explain how these activities are exercise rather than sport.

11 Participate in a number of different dances. Go to your eBookPLUS to find the **Fit for Feast** weblink.
(a) Describe the different dances you participated in.
(b) Explain why these dances are most likely to be described as recreational activities and not exercise or sport.

eBook*plus*

Weblink
Fit for Feast

10.2 Physical inactivity and sedentary behaviour

KEY CONCEPT Physical activity and inactivity were traditionally seen as being on opposite ends of the same continuum — a person could be either physically active or inactive. However, more recent studies indicate that a person can be both physically active and sedentary at different times of the day.

FIGURE 10.2 Watching TV does not always have to be sedentary.

The relationship between physical inactivity and sedentary behaviour

Physical inactivity refers to lack of involvement in physical activity during an individual's leisure time.

Sedentary behaviour is behaviour associated with sitting or lying down, including activities such as watching television, working or playing on the computer, driving or sitting in a car, bus or train. It also includes homework, studying or reading. MET of 1–2.

METs (metabolic equivalents) are commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3–6.

There is a relationship between physical inactivity and sedentary behaviour. Generally, the greater the sedentary behaviour, the higher the levels of physical inactivity and vice versa. However, it is important we understand the difference between these two concepts.

Physical inactivity is used to describe lack of involvement in any form of physical activity during an individual's leisure time, whereas **sedentary behaviour** is associated with sitting and lying down where energy expenditure is very low.

In the past we have often depicted physical activity and sedentary behaviour as being at opposite ends of the continuum of activity, implying that a person cannot be active and sedentary. More recent research has found that, on the contrary, a person may be both physically active and engage in sedentary behaviour. For example, consider an office worker who sits at work all day, jogs 30 minutes to and from work and then relaxes in front of the television for the rest of the evening at home. Is this person active because they spend an hour each day jogging? Or are they sedentary because they spend the majority of their day sitting down?

Researchers are now beginning to acknowledge that being active does not necessarily displace sedentary behaviour. People may engage in both types of behaviour at different times of the day. This has led to the recent modification of the National Physical Activity Guidelines to also include sedentary behaviour guidelines. They have now become the Australian Physical Activity and Sedentary Behaviour Guidelines (see also chapter 11). For maximal health benefits, including maintaining a healthy weight, we need to ensure we are seeking to be physically active and limiting sedentary behaviour.

When discussing physical activity, inactivity and sedentary behaviour, we must determine the parameters in which the concepts will be used. For the purpose of this discussion, sedentary behaviour is deemed to be a level of physical activity that falls below the level necessary to produce a health effect on the body. We will use the term *inactivity* to encompass sedentary behaviour. The term *physical activity* will imply sufficient physical activity to produce a health benefit for an individual. In the case of a person being both physically active and sedentary, if their level of physical activity is sufficient to induce a health benefit then they will be deemed to be physically active.

studyon
Unit 1
AOS 2
Topic 10
Concept 2
Inactivity and sedentary behaviour
Concept summary and practice questions

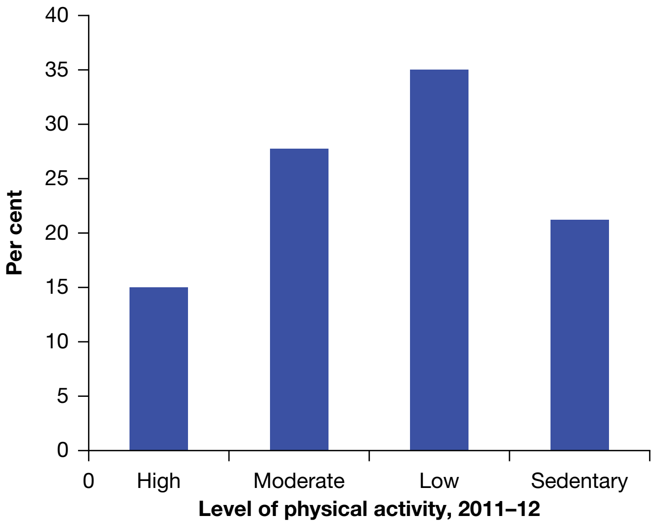

FIGURE 10.3 More Australians report low and sedentary levels of physical activity than moderate and high levels.
Source: www.abs.gov.au

Australia is often referred to as the sporting capital of the world, yet we are also one of the highest ranked countries in the world for obesity. Our physical activity levels are decreasing and our obesity rates are increasing. Figure 10.3 shows that the majority of Australians are not active enough and this is a problem that is contributing to our rising obesity levels.

FIGURE 10.4 Aware that office workers' jobs are sedentary and therefore contributing to unhealthy lifestyles, some companies have introduced standing meetings and other methods to get their employees moving more.

TEST your understanding

1 Define sedentary behaviour.
2 Discuss the relationship between sedentary behaviour and physical inactivity.
3 List five examples of common sedentary behaviours for the following age groups:
   Children
   Adults
4 Why are physical activity and sedentary behaviour no longer considered to be at opposite ends of the continuum of activity?
5 Using the graph in figure 10.3 answer the following questions.
   (a) Describe what would be considered sedentary levels of physical activity.
   (b) What does the graph suggest about the typical Australian's physical activity levels?
   (c) An individual's physical activity levels were categorised into either High, Moderate, Low or Sedentary. Discuss the implications of this.

APPLY your understanding

6 Go to the **Baker IDI Heart and Diabetes Institute** weblink in your eBookPLUS to read the article 'Get up, Stand up'.
   (a) Outline the sedentary behaviour guidelines for adults.
   (b) According to the article, what are the health implications of prolonged sitting?
   (c) Explain how someone can be physically active yet still be sedentary.
   (d) Other than the suggestion in the article, outline three practical ways sedentary behaviour could be limited in the office and at school.
7 Explain how it is possible to meet the recommended guidelines for physical activity but not for sedentary behaviour and suggest two changes to behaviour that could be made to ensure both are met.
8 Analyse your own and one other person's regular daily physical activity and sedentary behaviour patterns for a week using the table below. Evaluate your levels against the relevant guidelines (see chapter 11). Explain what changes could be made to your daily routine to improve the patterns.

Day	Physical activity	Sedentary behaviour	Met physical activity guidelines	Met sedentary behaviour guidelines
Monday	• 30 mins walking to and from school • 60 mins soccer training	• School • 2 hours of homework no breaks	Yes	No. Too much time sitting without breaks.
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				

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Weblink
Baker IDI Heart and Diabetes Institute

10.3 Influences on physical activity and sedentary behaviour (enablers and barriers)

KEY CONCEPT While physical activity and sedentary behaviour are very different concepts, the factors that influence how much we participate in both of them are similar.

Research has identified that those least likely to be physically active are women, people with lower socioeconomic status, older adults, people born overseas, people with a disability and Indigenous Australians. However, it is important that we understand why this is the case, what influences behaviour and what the **enablers** and **barriers** are. Only when we understand these can we begin to plan for change.

An **enabler** is something or someone who makes it possible for a particular thing to be done.

A **barrier** is something that prevents progress or makes it difficult for someone to achieve something.

Individual factors: demographics and personal factors

Individual factors include personal factors and **demographics**, such as age and gender. As we age, most of our personal factors will also change. This can have a significant impact on how we value physical activity and sedentary behaviour.

Demographic refers to the physical characteristics of a population, such as age, gender, ethnicity, family size, job status and education.

Common barriers to individual participation in physical activity

Australians who are physically inactive report lack of time (40 per cent) and injury or disability (20 per cent) as individual barriers to physical activity. Other factors that have an impact on participating in physical activity include:

- a lack of enjoyment
- having health problems
- feeling self-conscious/lacking confidence.

studyon

Unit 1 | AOS 2 | Topic 10 | Concept 3

Individual factors Concept summary and practice questions

Individual attitudes: enablers and barriers

As people pass through the different phases of physical development, they are influenced by different groups of people, take on different commitments and develop individual identities and attitudes. This process plays an important role in determining a person's attitude towards participation in physical activity.

Childhood (5–12 years)

Children participate in play (experimentation), modified games and competitive activities. They learn basic skills and have many opportunities to participate at home or at school. Having the skills to be active, for example, riding a bike, can act as an enabler; however, a lack of skill can be a barrier.

FIGURE 10.5 Having increased skills, like riding a bike, can increase opportunities to be active.

Adolescence (12–18 years)

Experiences for boys and girls differ greatly at this stage, as both groups experience intense physical development and are developing their own identities and personalities. Attitudes towards physical activity and sedentary behaviour can be heavily influenced by a person's knowledge of the benefits and consequences. Valuing health can act as an enabler, whereas not knowing or caring about the consequences of sedentary behaviour and inactivity can be a barrier to physical activity.

Adults (18–64 years)

Adult access to physical activity is related to individual priorities and motivations that are the result of lifestyle and experiences gained in adolescence. Opportunities for physical activity are based on time available, education, money and the influence of peer groups, all of which can act as either a barrier or enabler to physical activity.

For example, someone who works 40 hours a week in an office may struggle to find time to be physically active and therefore time can be a barrier. Whereas for someone who has more flexible hours, including later starts and earlier finishes, time can be an enabler as they can be physically active before and/or after work during daylight hours.

FIGURE 10.6 While many older adults have more time for exercise, some are not able to due to failing health. Swimming is an excellent type of exercise at any age.

Older adults (65+ years)

The time available for physical activity increases greatly among older adults, mainly due to retirement. However, safety fears can be a significant barrier to physical activity for older people, as well as health issues and problems, such as poor eyesight or hearing,

Social factors: enablers and barriers

studyon

Unit 1	**Social factors** Concept summary and practice questions
AOS 2	
Topic 10	
Concept 4	

As discussed in chapter 1, social influences include power structures within society and social interactions and relationships, as well as political and economic factors. Put simply, social factors generally involve the influence of other people. Social factors include:

- *socioeconomic status (SES)*. Opportunities and access to physical activity are often dictated by available money, time, facilities and equipment.
- *friends and family*. The people around you can have a major influence on your participation in physical activity. Parents and other adults can encourage participation by showing interest, providing money, transport, coaching and knowledge as well as serving as role models. As much of our time as children is spent in schools and much of our adult life in workplaces, other people in these environments can influence our behaviours.
- *the media*. The media can influence people to participate in physical activity by:
  - providing exposure to activities and so increasing people's knowledge of opportunities for participation (e.g. competitions, venues)
  - depicting role models
  - advertising lifestyle campaigns (e.g. Get set 4 life).

The media can be powerful in promoting physical activity and limiting sedentary behaviour by the positive promotion of active role models and events.

Childhood (5–12 years)

Research has shown that children of parents who are physically active are more likely to be physically active themselves. If your siblings are active you are also more likely to be active, as you are exposed to physical activity through their participation. During childhood parents are important role models and provide transport, money and access to facilities. Active parents and siblings create greater opportunities; however, a lack of role models and support from parents can be a barrier for children.

FIGURE 10.7 As a child, your parents and siblings have a great influence on how active you are.

Adolescence (12–18 years)

Schools provide meaningful physical education and sports programs, along with access to activity facilities throughout the school day. This gives students both the motivation and opportunity to experience a wide variety of activities and become involved in physical activity. A peer group's favourable attitude to participation in physical activity will be an enabling influence on individual members of the group, and a peer group's negative attitude to participation will be just as powerful a barrier.

Adults (18–64 years)

One of the most significant social influences for adults is the workplace. Some employers recognise the benefits of having a healthy workforce and develop strategies in the workplace to help employees maintain or work on their fitness (e.g. by providing free gym memberships and promoting corporate fun runs). Your colleagues, not unlike your peers at school, also influence your behaviour. Having workmates who walk or ride to work or during lunch breaks can be an enabler of physical activity. Having workmates who prefer to engage in sedentary behaviour during lunch breaks or who drive to work can act as a barrier.

Older adults (65+ years)

While older adults may have more time to be active once they have retired, they can often also experience financial limitations. Lower SES can be a barrier to physical activity, as many activities require equipment and the use of facilities which can cost money.

Cultural factors: enablers and barriers

Cultural factors include ethnicity and cultural norms that affect physical activity and sedentary behaviour. Australia is a multicultural country and, therefore, cultural factors can impact significantly on participation in physical activity and sedentary behaviour. For many groups there may be barriers, such as racial discrimination, limited opportunities for sports of cultural importance, a lack of affordable activities and a lack of transport.

It is challenging for sports and activities to cater for all cultures; however, attempts are being made to ensure that programs and services are culturally appropriate, particularly for women. Common enablers include:

- providing information about programs in multiple languages, and ensuring that they are accessible for different types of groups; for example, Netball Australia's One Netball program
- allowing flexibility in programs so that people can still respect their cultural beliefs and traditions while being active; for example, Muslim AFL player Bachar Houli being allowed to pray during training

- providing role models and multicultural awareness programs; for example, the AFL's multicultural round.

FIGURE 10.8 The AFL multicultural round celebrates diversity in sport.

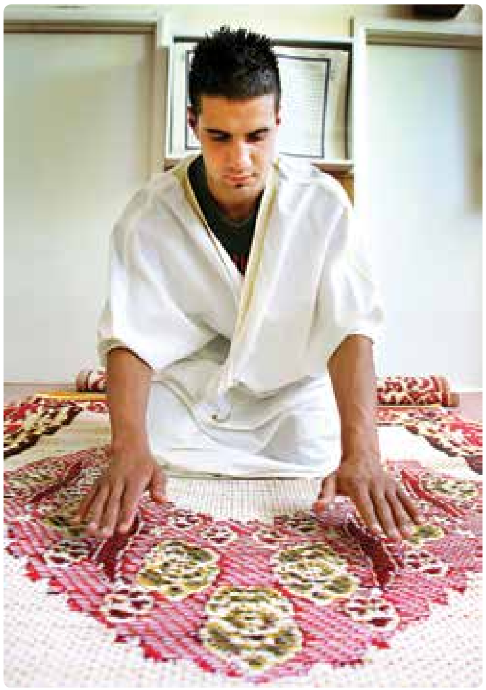

FIGURE 10.9 Richmond player Bachar Houli successfully combines his faith with his passion for AFL.

Influence of cultural factors across the lifespan

The impact of culture can change across the lifespan. Generally, when a person is younger, the impact of culture will depend on parents and their beliefs. As a person grows up and gains more independence they may have more choice in how culture can influence their lives.

FIGURE 10.10 Your culture has an influence on how active you are and the types of activity you do.

Environmental (including geographic) factors: enablers and barriers

The environment can either facilitate or discourage physical activity. Research has shown that the characteristics of a neighbourhood can influence a person's participation in physical activity. People are influenced by environmental factors such as:

- access to facilities (e.g. opening times, gender restrictions)
- proximity to facilities (the distance that people have to travel to the facilities)
- safety of facilities and nearby surroundings (e.g. the safety of the equipment or the adequacy of the lighting)
- environmental changes (e.g. the creation of traffic-free zones, or safe streets with footpaths and cycle lanes, helps increase physical activity in children).
- climate and weather (e.g. wet or humid).

A lack of parks, footpaths, bicycle trails or safe walking paths close to home will reduce the chance of participation in physical activity. Similarly, if people live in an area that has a high crime rate, hills or heavy traffic, they will be less likely to participate in activities close to home. Many people use facilities such as health clubs, swimming pools, bike lanes and parks, so it is important to consider the convenience of these facilities. Having somewhere pleasant to walk or exercise has also been found to influence participation.

FIGURE 10.11 Environmental factors such as weather and facilities influence our activity levels.

Influence of environmental factors across the lifespan

During childhood, youth and in older age, we are heavily dependent on others for transport, so the proximity and accessibility of facilities, and opportunities to be active, are vital to facilitating physical activity. Safety of surroundings can also heavily influence parents' approval of physical activity. As we gain independence this can be less of a barrier as we have increased options. Proximity to facilities can not only influence how much physical activity we participate in but also in many cases what type. For example, Australia has a high participation rate in swimming. Our geographic location, with easy access to beaches, many inland waterways and warm weather, contributes positively to this.

Environmental factors play a significant role in influencing how much sedentary behaviour we engage in; for example, desks in our schools and workplaces. If we have access to standing desks then this could help decrease sedentary behaviour; if we only have access to sitting desks this may increase sedentary behaviour.

The proximity and safety of paths and roads can determine whether we use active transportation or if we drive, thus influencing our physical activity and sedentary behaviour levels.

FIGURE 10.12 Standing desks are one environmental factor in schools and workplaces that can increase our physical activity.

FIGURE 10.13 Many people living in towns and cities on Australia's coastline experience agreeable weather throughout the year, allowing plenty of opportunities for them to participate in outdoor physical activities.

Historical factors: enablers and barriers

One of the most significant changes in recent times has been an increase in access to technology. This has coincided with an increase in sedentary behaviour and a decrease in physical activity. For children and youth there is increased access to digital media for entertainment. Now children can use games and apps to build cubby houses and play sports online instead of actually engaging in the physical activity.

For adults, increased technology in many cases has increased sedentary behaviour in the workplace and home as the manual jobs such as raking the leaves and going to see a colleague on another floor have been replaced by motorised leaf blowers and emails. But technology can also act as an enabler. We now have a multitude of apps and tracking devices that act as great motivational tools for physical activity. We also have greater access to resources, such as exercise plans and log books, which can help facilitate physical activity.

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Unit 1	**Environmental and historical factors**
AOS 2	Concept summary and practice questions
Topic 10	
Concept 5	

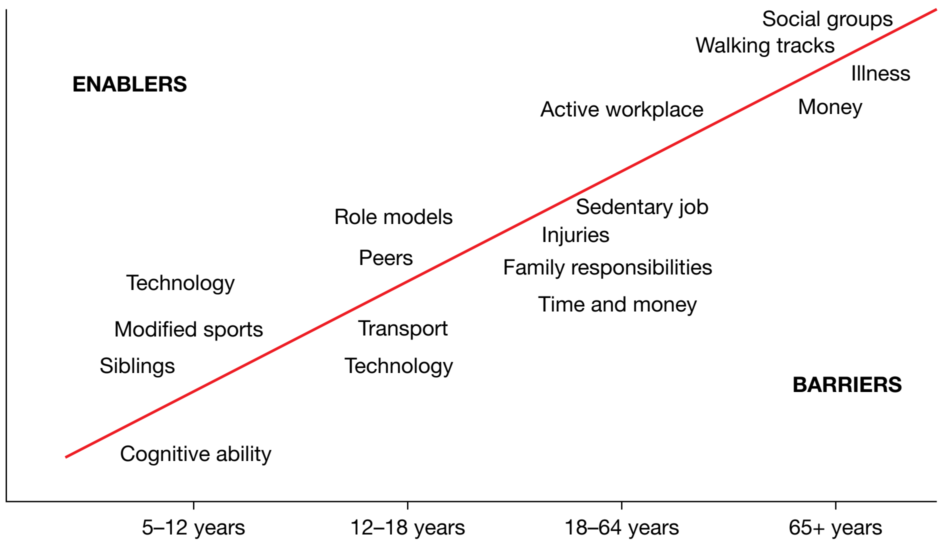

FIGURE 10.14 Common enablers and barriers to activity across the lifespan

TEST your understanding

1. Parents are an important influence on the activity patterns of their children during childhood and adolescence. Explain why.
2. Evaluate how the media can influence activity patterns.
3. List four barriers to physical activity.
4. Suggest four barriers to limiting sedentary behaviour.
5. Outline three barriers and three enablers for physical activity, specific to older adults.
6. Discuss the influence of technology on physical activity and sedentary behaviour for young people.
7. Outline how technology can be seen as a barrier and an enabler for physical activity.
8. Explain how chores can be considered a form of physical activity.

APPLY your understanding

9. Discuss how including a variety of forms of physical activity, as opposed to just one or two, in your daily life is more likely to lead to healthy lifelong habits.

10 The environment in which we live influences our activity patterns. Examine your own immediate neighbourhood. Suggest what could be done to make the area more conducive to engaging in physical activity and decreasing sedentary behaviour.

11 Research your local physical activity facility (e.g. gym, oval, swimming pool). What programs/strategies, if any, do they offer to encourage people from other cultures to be active?

12 Consider a non-English speaking mother of two. Devise a program to help encourage her to be more physically active. When devising your program, consider what could facilitate and what could discourage involvement in physical activity.

13 Draw a timeline of your life so far and clearly label all barriers and enablers for physical activity. Now predict at least two possible barriers and enablers you may experience in your adult and older years.

14 Look at the graph in figure 10.15.

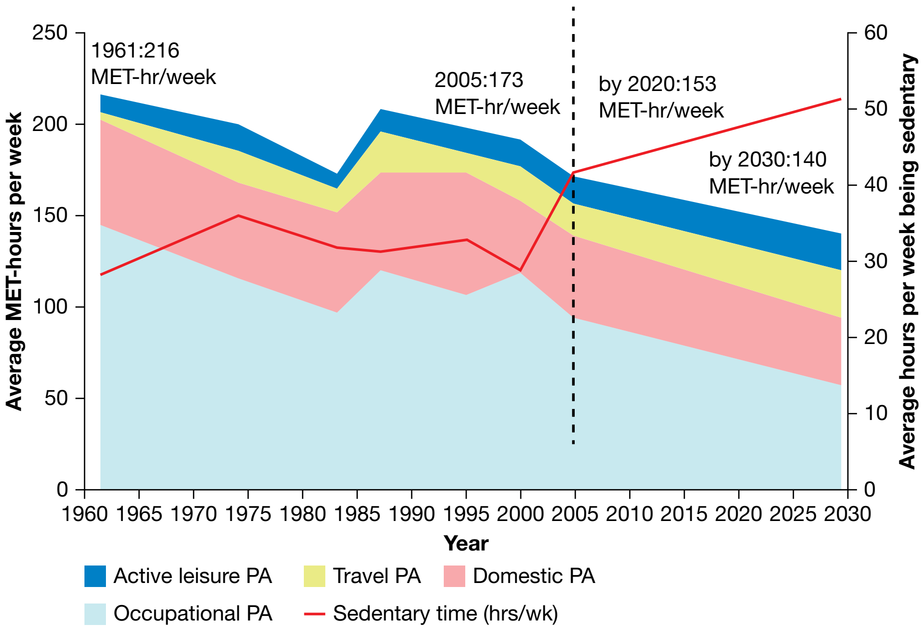

FIGURE 10.15 Trends in physical activity (PA) and sedentary behaviour over time

Source: www.eufic.org.

(a) Identify three trends in the graph.
(b) Suggest a reason for each of the trends you identified.
(c) These statistics were taken from the UK. Discuss how you think the information would be similar and different for Australian adults.
(d) Suggest a reason for your answer above based on social and environmental influences.
(e) Summarise the predictions for the future and justify them using an individual influence.

15 Choose a stage in the lifespan (children, youth, adult or older people). Consider the barriers and enablers in your local community and devise a program to help decrease sedentary behaviour. Look at figure 10.14 to help you identify barriers and enablers across the lifespan.

16 Interview an older person (65+yrs) and draw a timeline of their physical activity and sedentary behaviour across their lifespan. Investigate the factors that influenced these behaviours. Determine the most significant enabler and barrier for physical activity and sedentary behaviour for each stage of their lifespan.

17 Watch the video found at the **Piano stairs** weblink in your eBookPLUS. Devise an activity for your school population that would be fun and lead to an increase in physical activity during free time.

eBook*plus*

Weblink
Piano stairs

CHAPTER 10 REVISION

- yellow identify the action word
- pink key terminology
- blue key concepts
- light grey marks/marking scheme

KEY SKILLS

- Participate in and reflect on a variety of different forms of physical activity, including a variety of culturally diverse physical activities
- Define and identify forms of physical activity, physical inactivity and sedentary behaviour
- Analyse sociocultural influences on physical activity participation across the lifespan
- Investigate and determine factors that influence an individual's participation in physical activity across the lifespan

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- enablers and barriers for physical activity across the lifespan.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:** **Explain** — to make the meaning of something clear and understandable
- **Key terminology:** Physical environment — natural or human-made surroundings
- **Key concepts:** Results in table — refer back to table
- **Marking scheme:** *4 marks* — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

PRACTICE QUESTION

A major aim of ABS surveys about sport and physical recreation participation is to find out about the wide range of physical recreation activities in which people take part. Table 10.3 presents summary information for the top ten sports and physical recreation activities participated in by men and women aged 15 years and over.

The physical environment can often be a key determinant as to whether a person participates in physical activity. **Explain** how the physical environment may have influenced at least two of the results in the table below. *4 marks*

TABLE 10.3 Participants [a] in selected sports and physical recreation activities [b] by sex 2011–12

	Number '000	Participation rate %
Males		
Walking for exercise	1474.1	16.5
Fitness/gym	1343.6	15.1
Cycling/BMXing	875.5	9.8
Jogging/running	775.3	8.7
Golf	732.5	8.2
Swimming/diving	671.9	7.5
Tennis	436.1	4.9
Soccer (outdoor)	368.6	4.1
Cricket (outdoor)	268.3	3.0
Basketball	245.6	2.8
Females		
Walking for exercise	2784.7	30.4
Fitness/gym	1745.7	19.1
Swimming/diving	729.2	8.0
Jogging/running	585.4	6.4
Cycling/BMXing	490.6	5.4
Netball	410.5	4.5
Tennis	314.2	3.4
Yoga	298.9	3.3
Dancing/ballet	229.1	2.5
Bush walking	216.8	2.4

(a) Relates to persons aged 15 years and over who participated in physical activities for recreation, exercise or sport as players during the 12 months prior to interview.
(b) The top 10 activities for males and females in terms of total participation in a playing role in 2011–12.

Source: ABS. Participation in Sport and Physical Recreation, Australia, 2011–12 (cat. no. 4177.0).

Sample response

The presence of safe walking tracks (e.g. paved and shady) could result in more people walking; therefore, walking is ranked highly.

Going to the gym is indoors and can be done in any type of weather and at any time of day at some gyms, so this removes the barrier of weather and this could explain why fitness/gym is ranked so highly.

HOW THE MARKS ARE AWARDED

- **1 mark** — for showing an understanding of physical environment: safe walking tracks, paved and shady
- **1 mark** — for making a link to data: could result in more people walking so highly ranked
- **1 mark** — for showing an understanding of physical environment: exercising indoors can be done in any weather
- **1 mark** — for showing link to data through linking this to high ranking of gym

PRACTISE THE KEY SKILLS

1. Outline how socioeconomic status could act as a barrier to physical activity for older people.
2. Outline how peer support can act as an enabler to physical activity for youth.
3. Explain how the physical environment, especially at school and in the workplace, can impact sedentary behaviour levels.
4. Explain why the factors affecting behaviour change throughout the lifespan.

KEY SKILLS EXAM PRACTICE

In 2011–12, while most Australians aged 15 years and over had undertaken exercise in the last week, the overall level of this activity was low. Taking into account the intensity, duration and frequency of individuals' physical activity, 66.9 per cent of Australians were either sedentary or had low levels of exercise in the week prior to interview (comprised of 35.4 per cent sedentary and 31.5 per cent low levels of exercise). However, this is a decrease from 2007–08 when the proportion of people who were sedentary or had low levels of exercise was 71.6 per cent.

1. After reading the information above, describe what is meant by the term 'sedentary behaviour' and give an example of this concept. *2 marks*
2. Outline the sedentary behaviour guidelines for 15-year-olds. *1 mark*
3. Suggest why there was a decrease in the proportion of people who were sedentary from 2007–08 compared to 2011–12. Use an example to support your response. *2 marks*
4. Discuss the relationship between sedentary behaviour and physical activity. *1 mark*

CHAPTER REVIEW

CHAPTER SUMMARY

- Physical activity is any activity that involves or requires some form of physical exertion. Physical inactivity refers to no involvement in physical activity during an individual's leisure time.
- Sedentary behaviour involves activities requiring little to no movement.
- Recent research has found that a person may be *both* physically active and engage in sedentary behaviour.
- There are many types of physical activity, such as play, games, sports, transportation, chores, exercise and recreational activities.
- The type of physical activity generally engaged in changes across the lifespan.
- There are many factors — demographic, social, cultural and environmental — that affect a person's participation in physical activity and sedentary behaviour. They can generally be categorised as barriers or enablers. They include:
  - gender
  - age
  - socioeconomic status
  - ethnicity
  - parents
  - schools/workplaces
  - peers
  - the media
  - the physical environment.
- The barriers and enablers of physical activity and sedentary behaviour can differ greatly from person to person and across the lifespan.

MULTIPLE CHOICE QUESTIONS

1 Which of the following would be most likely to be categorised as an organised sport?
(A) Chasey
(B) Skipping
(C) Park runs
(D) Cross-country running

2 Going for a 5 km jog around a park with a friend would be considered
(A) recreational activity.
(B) sport.
(C) exercise.
(D) leisure.

3 Which of the following is considered sedentary behaviour?
(A) Sitting
(B) Sleeping
(C) Standing still
(D) All of the above

4 Which of the following types of physical activity are older adults most likely to engage in?
(A) Games
(B) Sport
(C) Exercise
(D) Leisure

5 Family responsibilities are most likely to be a barrier to physical activity for which group?
(A) Children
(B) Youth
(C) Adults
(D) Elderly

6 Which of the following is most accurate about participation in physical activity across the lifespan?
(A) As age increases participation in physical activity increases.
(B) As age increases participation in physical activity decreases.
(C) As age decreases participation in physical activity increases.
(D) Participation in physical activity increases and then decreases.

7 A social enabler for physical activity for adults is
(A) lack of income.
(B) family responsibilities.
(C) active workmates.
(D) access to facilities.

8 An environmental factor that could help reduce sedentary behaviour for the elderly is
(A) access to walking tracks.
(B) subsidised bus travel.
(C) stand up desks.
(D) water aerobics classes.

9 What types of physical activity are young children (aged 2–4) most likely to participate in?
(A) Games and active transport
(B) Organised sport and chores
(C) Exercise and organised sport
(D) Chores and exercise

10 Which of the following statements is true?
(A) Increasing physical activity will also result in decreased sedentary behaviour.
(B) Decreasing physical activity will also result in increased sedentary behaviour.
(C) Increasing physical activity will result in decreased physical inactivity and sedentary behaviour.
(D) You can increase physical activity but still be too sedentary, so you need to increase physical activity and decrease sedentary behaviour.

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Sit Topic Test

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Interactivity
Physical activity and sedentary behaviour: sociocultural influences, enablers and barriers quiz
Searchlight ID: int-6652

EXAM QUESTIONS

(ACHPER 2013 Unit 2 question 1 detailed study)

The costs of physical inactivity

There is work in progress updating the costs of physical inactivity to the healthcare system. However, current evidence from the Be Active Australia Framework for Health Sector Action suggests:

- The direct healthcare costs due to physical inactivity, based on mid-1990s costings, are around $400 million per year.
- Physical inactivity causes more than 8000 deaths annually, including 77 000 potential years of life lost.
- The true costs of obesity have been estimated as $1.3 billion and are rising fast; physical inactivity is a major cause of obesity.
- Physical inactivity is responsible for about 6 per cent of the total burden of disease in males and 8 per cent in females and is a major contributor to high blood pressure (5 per cent of burden) and obesity (4 per cent of burden).

1. Explain how the below factors can positively impact the physical activity of children and young people. **(2 marks)**
Parents:
Media:

2. Think of two reasons commonly given by young people who do not exercise or participate in physical activity. Use the table below to list one strategy for each reason that could be used to overcome this barrier. **(4 marks)**

Reasons for not participating in physical activity	Strategies/solutions
1.	
2.	

3. Suggest a reason for the above trends. **(1 mark)**

INQUIRY QUESTION
Are these typical Australians, engaging in plenty of sport and recreation?

CHAPTER 11

Physical activity and sedentary behaviour: trends, benefits, risks, guidelines and assessment

Many people are well aware of the benefits of increasing physical activity and decreasing sedentary behaviour; however, the message doesn't seem to be sinking in. Recent statistics reveal an alarming increase in health problems due to inactivity and unhealthy lifestyles. There are many barriers to people engaging in physical activity, ranging from geographical location and access to facilities, age, gender, socioeconomic status to cultural influences. The key is for our government to provide more enablers to physical activity and raise awareness of the importance of being physically active so that the health of our nation can improve.

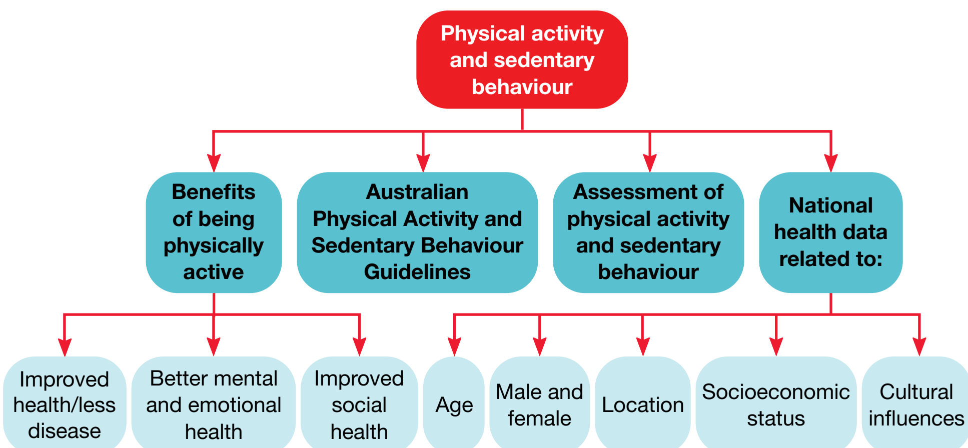
KEY KNOWLEDGE

- Prevalence and trends of physical activity, sport and sedentary behaviour in the population
- Physical, social, mental and emotional benefits of regular participation in physical activity
- The increased health risks associated with being physically inactive, including type 2 diabetes and obesity
- Physical activity and sedentary behaviour guidelines for different age groups and population groups
- Subjective and objective methods of assessing physical activity and sedentary behaviour, such as recall surveys or diaries, pedometry, accelerometry, inclinometry, observation tools (including digital tools such as smart phone and tablet apps) and personal activity trackers

KEY SKILLS

- Participate in physical activity, and collect, analyse and reflect on information related to the physical, social, mental and emotional health benefits of physical activity
- Explain the health consequences of physical inactivity and sedentary behaviour
- Describe the physical activity and sedentary behaviour guidelines for different stages across the lifespan
- Use appropriate methods to measure and analyse physical activity and sedentary behaviour levels at the individual and population levels
- Collect, analyse and interpret primary and secondary data related to trends in participation in physical activity

CHAPTER PREVIEW



11.1 Australia: a healthy nation?

KEY CONCEPT High levels of physical activity and low levels of sedentary behaviour positively influence the health of individuals.

Australians like to think of themselves as a healthy and active nation of people. In many respects Australia excels in the health and wellbeing of its population; however, there are alarming trends indicating that many people are engaging in less physical activity and being inactive for longer periods of time. This unhealthy combination increases the risk of ill health, with clear links to conditions such as cardiovascular disease, osteoporosis, obesity and diabetes mellitus type 2.

In addition, there is growing awareness of the link between physical activity and the promotion of mental and social health. Being active improves one's mood and reduces the impact of conditions such as anxiety, stress and depression. Not only does physical activity improve quality of life but it can also increase life expectancy. Due to the significant impact that inactivity can have on a community, it makes sense that stakeholders in health promotion have an accurate understanding of the physical activity and inactivity levels of the population.

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Benefits of physical activity Concept summary and practice questions

FIGURE 11.1 There are clear links between physical activity and health.

Benefits of being physically active

There is a growing awareness in the community about the positive effects that movement has on the health of individuals and populations. This extends beyond the physical health benefits of being physically active to include social, mental and emotional health.

Physical activity can be defined as any form of movement that expends energy. This includes incidental activity that occurs throughout the day, such as chores around the home, moving from one classroom to another at school or getting up out of bed and having a shower. In addition to incidental activity, people expend energy via other activities such as gardening, playing sport, active transport and involvement in other recreational activities.

Physical activity is any movement of the body produced by skeletal muscles, resulting in energy expenditure.

FIGURE 11.2 Physical activity encompasses all forms of sport and recreational activities.

Benefits of regular physical activity on physical health

Physical health, like the other dimensions of health, can benefit from regular physical activity. Physical health is not just the absence of illness or disease but takes into consideration the efficient functioning of the body. This includes the capacity of a person to undertake desired activities on a daily basis without undue stress or fatigue occurring. From a physical perspective, engaging in regular activity has multiple benefits for the human body.

Physical health is the efficient functioning of the body, free from disease and illness.

These benefits include **weight management**, building and maintaining healthy bones, muscles and joints and a reduction in the risk of suffering from chronic and life-threatening conditions such as diabetes mellitus, obesity, cardiovascular disease, osteoporosis, hypertension and some cancers.

Weight management is the ability to maintain a balance between energy intake and energy expenditure, resulting in a relatively stable weight.

FIGURE 11.3 An activity such as running increases daily energy expenditure and helps assist in managing weight.

The risks of not being physically active

Chronic health conditions have a significant impact on the community. Not only are there implications for physical health at both an individual and population level, but there are also negative impacts on the social, emotional and economic health of the nation.

Diabetes

Type 2 diabetes is a growing health concern in many countries, including Australia, with close to a million adults diagnosed with the condition. It is a disease characterised by the inability of the pancreas to properly control blood sugar levels in the body. It usually develops in people over the age of 45, but due to poor lifestyle habits there are increasing numbers of younger people and children at risk of developing type 2 diabetes. To combat the increasing prevalence of this condition within the Australian community there are lifestyle choices that people can make, including eating more nutritious foods, reducing kilojoule intake and engaging in more physical activity.

The other two types of diabetes are gestational diabetes, which develops during pregnancy, and type 1 diabetes. Type 1 diabetes is an autoimmune condition that may be genetic, but has no known cause and is not linked to lifestyle factors. Mainly children and adolescents are diagnosed with type 1 diabetes, and it has nothing to do with weight, diet or exercise, although in order to manage the disease, these factors become important.

Obesity

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The risks of being inactive
Concept summary and practice questions

Weight management is an important aspect of maintaining a healthy weight. There needs to be an appropriate balance between the energy expended per day compared to the energy taken in via food and drink. If there is a balance between energy in and out, then a person will maintain a stable body weight. If there is an imbalance, then weight can be lost or gained. For many Australians weight gain occurs because energy intake via food and drinks is higher than the energy expended by the body. In fact, more than two out of three Australian adults are overweight or obese.

What determines energy expended? It is a combination of the energy expended by the body during normal rest periods in addition to any movement. The quantity of energy used while moving depends on, in particular, the duration and intensity of activity. For example, walking for 40 minutes instead of 15 minutes will expend far more energy, as would running at 12 kilometres per hour instead of at 8 kilometres per hour.

FIGURE 11.4 Obesity is a condition where excess fat is carried by an individual due to an imbalance between energy intake and energy expenditure.

Cardiovascular disease

A leading cause of death in Australia is cardiovascular disease. This is a collective term that covers diseases of the cardiac muscle (heart) and the vessels that transport blood around the body.

TABLE 11.1 Two common examples of cardiovascular disease

Type	Description
Coronary heart disease	This is the most common form of heart disease in Australia and kills more Australians per annum than any other single cause. The coronary artery becomes blocked and prevents blood being pumped back to the heart. When not enough blood is delivered to the heart muscle, temporary chest pain, known as angina, occurs. Angina is associated with an increased risk of a myocardial infarction, the technical term for a 'heart attack'.
Cerebrovascular disease	The second most predominant cause of death in Australia includes blockages and bleeding within the brain, often referred to as 'strokes'.

There are many risk factors for cardiovascular disease, some controllable and some not. The uncontrollable factors include age, ethnicity and genetic influences (there is a strong family link). There is, however, a range of lifestyle choices that individuals can make to decrease the risk of cardiovascular disease, such as not using tobacco products and consuming a healthy diet, which is low in saturated fats. Physical inactivity is also a major risk factor for cardiovascular disease. By making healthy lifestyle choices, such as eating well and exercising, other risk factors for cardiovascular disease can be controlled, including hypertension (high blood pressure), obesity, diabetes mellitus and high blood cholesterol levels.

FIGURE 11.5 Angina is a sign that heart disease is present. The blood flow to the heart is restricted, leading to pain in the chest and often the neck, face, shoulder and arm regions.

Osteoporosis

Osteoporosis is a condition suffered by many Australians. Older people are at most risk of suffering from osteoporosis. Data from the Australian Bureau of Statistics (ABS) indicates that over 650 000 Australians aged over 50 have been diagnosed with the condition, with women accounting for approximately 80 per cent of all cases.

Osteoporosis is characterised by a reduction in bone density. Healthy bone tissue is constantly being broken down and replaced, but for people with osteoporosis, this process of repair does not keep up with the deterioration of the bone tissue, causing bones to become weak and brittle. This thinning of the bones leads to a higher risk of bone fractures. There is a range of risk factors associated with osteoporosis, the most significant being the inadequate consumption of calcium, a lack of vitamin D absorption and physical inactivity.

To minimise the chances of suffering from osteoporosis, children and adolescents are strongly encouraged to develop the largest bone density possible by ensuring sufficient calcium intake through ingestion of foods which are calcium rich, such as dairy foods, and exposure to vitamin D from the sun. In addition, bones become strengthened when exposed to weight-bearing activities such as soccer, running and netball. High impact actions such as jumping (e.g. in gymnastics or dance) and jumping rope develop bone growth. Although non weight-bearing activities are beneficial for health, they do not promote bone density. This includes activities such as cycling and swimming, where there are no direct gravitational forces acting on the bones.

FIGURE 11.6 Gymnastics incorporates weight-bearing activities that are great for strengthening bones and muscles.

Cancer

Cancer is a term to describe the abnormal growth and multiplication of the body's cells. This can occur in any of the cells of the body but is most common in the skin, lungs, breasts, prostate and bowel. There are a range of causes of cancer including exposure to chemical, physical or biological factors. Exposure to excessive ultraviolet light and smoking are two significant risk factors for Australians. There is also a link between being overweight or obese and suffering from cancer of the breast, bowel and kidneys among other types.

Due to the link between excessive body weight and the risk of some cancers, physical inactivity is therefore a risk factor. By engaging in regular physical activity and limiting sedentary behaviour, body weight can be better maintained at a healthy level and therefore decrease the risk of cancer.

FIGURE 11.7 Smoking has been proven to be a significant risk factor for many cancers.

Benefits of regular physical activity on mental and emotional health

Although mental and emotional health are often linked, they are different. **Mental health** relates to the brain having the capacity to work well. This can also be referred to as having good cognitive functioning. A person with good mental health would display proper reasoning ability, have good memory, remain focused and be capable of acquiring new knowledge (i.e. be a good learner). **Emotional health**, on the other hand, relates to the capacity to appropriately display and control emotions. Being anxious or depressed would be signs of poor emotional health.

Mental health is the capacity of the brain to function well.

Emotional health is the capacity to appropriately display and control one's emotions.

Being physically active has been shown to promote both mental and emotional health. There is evidence linking the following with physical exercise:

- improved mood and energy levels
- improved body image and self-esteem
- decreased anxiety
- decreased depression (exercise has been proven to be a potent antidepressant)
- increased mental clarity
- improved brain functioning, including improved attention and learning with significant benefits in middle aged and elderly people.

There is increasing evidence that shows participation in of physical activity can improve brain function and subsequent learning. Schools that have more regular Physical Education (PE) classes have proven academic gains over those schools with less PE time.

FIGURE 11.8 Many people believe that yoga practice is beneficial to both the mind and body, with its focus on mindfulness and meditation as well as building strength in the muscles.

FIGURE 11.9 There are a variety of ways to help cope with the effects of poor mental health, including being active.

Benefits of regular physical activity on social health

Social health is the capacity to get on well with others.

There are strong links between being physically active and improved social health, particularly for people who use physical activity as a tool for engaging with others. **Social health** can be described as the capacity to get on well with others. It includes the ability to adapt to new people and environments, form healthy and satisfying relationships, appropriately deal with conflict and behave in a socially acceptable manner. Improved social health can occur via engagement in physical activity, either as a member of a sports team or club, exercising with others or even meeting people on walks. The positive effects of physical activity on social health include:

- improved communication skills
- decreased feeling of isolation and loneliness
- increased interactions and collaboration with others
- wider exposure to new people and places
- increased rapport and friendship with others
- increased empathy and trust for others.

The relationship between emotional, mental, social and physical health

Although it is easy to look at the different dimensions of health in isolation, they are interrelated and can affect each other in both positive and negative ways. A negative example is the impact of a broken leg on a player in a sports team. As a result of this decline in physical health, not playing sport may cause emotional disturbance, such as feelings of anxiety and moodiness. If poor mood causes conflict with others this may reduce the social health of the individual. If the individual spends time worrying about their situation, their mental health may be negatively affected, leading to decreased cognitive functioning.

A positive example of how the dimensions of health can have an impact each other would be a retired worker joining a golf club. The retiree would experience improved physical health from walking around the golf course. Walking around the course

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Mental, emotional and social health
Concept summary and practice questions

would also provide opportunities to promote social health via meeting new people. This would improve emotional health by making the retiree happier.

FIGURE 11.10 Participation in recreational activities, such as golf, enables social benefits in addition to physical benefits.

TEST your understanding

1. Outline the four dimensions of health discussed in this chapter.
2. Obesity is prevalent in the Australian population. Discuss the link between this condition and ill health.
3. Describe the difference between mental health and emotional health.
4. Make a list of the social benefits of being involved in a sports or recreational club.

APPLY your understanding

5. You overhear a family member saying that they don’t need to exercise to be healthy. Describe in detail the many benefits of being physically active.
6. An elderly neighbour has just been diagnosed with diabetes mellitus. The neighbour asks you for advice. What is diabetes mellitus? What are the lifestyle changes that can be made to reduce the symptoms or side effects of this condition?
7. The dimensions of health are interrelated. Use an example to explain what this means.
8. **Practical activity:** Participate in a class engaged in a recreational activity such as lawn bowls, bocce, archery or any other selected by the teacher. After participating in the class, outline the potential benefits across the physical, social, emotional and mental dimensions of health.

11.2 How much is enough?

KEY CONCEPT: The Australian Physical Activity and Sedentary Behaviour Guidelines have been developed to provide health advice for the Australian population.

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Guidelines for children and young people
Concept summary and practice questions

The Australian Physical Activity and Sedentary Behaviour Guidelines were developed by the Australian government and are advertised via many avenues, including the Department of Health website. This website provides a variety of resources to help people make informed decisions about their health. This includes specific recommendations for different population groups to promote physical activity and discourage inactivity. These recommendations are mapped to the following population groups:

- children from birth to 5 years of age
- children between the ages of 5 and 12
- young people between the ages of 13 and 17
- adults aged 18 to 64 years
- older adults aged 65 years old and above.

FIGURE 11.11 Too much screen time is associated with poor health outcomes.

For each of these groups, the recommendations have been based on evidence that links the intensity, frequency, duration and type of physical activity to specific health outcomes, such as a reduction in obesity, cardiovascular disease, diabetes mellitus and other chronic diseases. Similar evidence has linked increased sedentary behaviour with these same conditions. Following the Australian Physical Activity and Sedentary Behaviour Guidelines is strongly correlated with significantly improved health outcomes. The Australian Physical Activity and Sedentary Behaviour Guidelines for each age group are listed in the following sections.

Physical Activity Recommendations for children aged 0–5

Physical activity recommendations

- For healthy development in infants (birth to 1 year) physical activity — particularly supervised floor-based play in safe environments — should be encouraged from birth.
- Toddlers (1–3 years) and preschoolers (3–5 years) should be physically active every day for at least three hours, spread throughout the day.

Sedentary behaviour recommendations

- Children younger than 2 years should not spend any time watching television or using other electronic media (DVDs, computer and other electronic games).
- For children aged 2 to 5 years, sitting and watching television and the use of other electronic media (DVDs, computer and other electronic games) should be limited to less than one hour per day.
- Infants, toddlers and preschoolers (all children aged 0–5 years) should not be sedentary, restrained, or kept inactive for more than one hour at a time, with the exception of sleeping.

Physical Activity and Sedentary Behaviour Guidelines for children aged 5–12

Physical activity recommendations

- For health benefits, children aged 5–12 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.
- Children's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.
- On at least three days per week, children should engage in activities that strengthen muscle and bone.
- To achieve additional health benefits, children should engage in more activity — up to several hours per day.

Sedentary behaviour recommendations

- To reduce health risks, children aged 5–12 years should minimise the time they spend being sedentary every day.
- To achieve this, limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day — lower levels are associated with reduced health risks.
- Break up long periods of sitting as often as possible.

Physical Activity and Sedentary Behaviour Guidelines for young people aged 13–17

Physical activity guidelines

- For health benefits, young people aged 13 to 17 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.
- Young people's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.
- On at least three days per week, young people should engage in activities that strengthen muscle and bone.
- To achieve additional health benefits, young people should engage in more activity — up to several hours per day.

FIGURE 11.12 Vigorous activities provide additional health benefits.

Sedentary behaviour guidelines

- To reduce health risks, young people aged 13–17 years should minimise the time they spend being sedentary every day.
- To achieve this, limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day — lower levels are associated with reduced health risks.
- Break up long periods of sitting as often as possible.

FIGURE 11.13 Most school students spend long periods of time sitting during the school day. Teachers should find ways to get students to be more active during classes.

Physical Activity and Sedentary Behaviour Guidelines for adults aged 18–64

Physical activity guidelines

- Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 minutes (2½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous intensity physical activity — or an equivalent combination of both moderate and vigorous activities — each week.
- Do muscle strengthening activities on at least 2 days each week.

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Guidelines for adults Concept summary and practice questions

Sedentary behaviour guidelines

- Minimise the amount of time spent in prolonged sitting.
- Break up long periods of sitting as often as possible.

Physical Activity Recommendations for older Australians aged 65 and over

Physical activity guidelines

- Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities.

- Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility.
- Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days.
- Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity.
- Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.

FIGURE 11.14 There are many opportunities for older Australians to engage in low impact activities that promote health, such as water aerobics.

TEST your understanding

1. Explain the correlation between sedentary behaviour and health outcomes.
2. Provide advice to a 15 year old about the Australian Physical Activity and Sedentary Behaviour Guidelines that they should be following.
3. You overhear one of your parents saying they are too busy to exercise every day. Describe the duration and intensity recommended for your parent each week.
4. What type of activities are recommended for older Australians as described in the physical activity guidelines?

APPLY your understanding

5. A 9-year-old child is swimming for at least an hour per day at the appropriate intensity for health gains. They do no other type of activity. Recommend another activity for this child to add to their weekly schedule. Justify your selection with reference to the Australian Physical Activity Guidelines for children.
6. An adult who has been sedentary is not expected to start exercising and meet the Australian Physical Activity Guidelines immediately. With reference to the guidelines, provide advice to this adult.
7. Compare the types of physical activities recommended for adults versus older adults (over 65 years of age).

11.3 Assessment of physical activity and sedentary behaviour

KEY CONCEPT There are a variety of subjective and objective assessment tools available to measure physical activity and sedentary behaviour.

There are many reasons why assessment of physical activity and sedentary behaviour at the population level is desired. These include the following:
- to provide an evidence base for the behavioural determinants of health
- to help understand the key issues relating to physical activity and inactivity
- to track progress or lack of progress over time at a population level
- to highlight disadvantaged groups so that specific interventions can be developed
- to ensure appropriate interventions can be designed, implemented and assessed.

In addition to assessing physical activity and inactivity for populations, there is value in assessing them at an individual level. Some benefits of assessing an individual's physical activity and sedentary behaviour include the following:
- to gather specific information about an individual
- to provide more accurate data for an individual, so appropriate strategies can be tailored to that person
- to provide information to enable an individual to highlight strengths and weaknesses of their daily movement patterns
- to use the information as a motivational tool to encourage increased physical activity
- to use the information as a motivational tool to discourage sedentary behaviour
- to track an individual's level of activity over time to highlight patterns of behaviour (e.g. increased levels of sedentary behaviour over winter) so that trends can be identified and appropriate interventions put in place.

There are a range of assessment tools. These are often categorised as either **subjective** or **objective**.

Subjective assessment is information obtained from a person's perception, understanding and interpretation of an event.

Objective assessment is information obtained via measurable or observable means.

FIGURE 11.15 A personal trainer can record and track a client's level of physical activity and tailor a program to suit their needs.

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Unit 2 | AOS 1 | Topic 11 | Concept 6

Recall surveys and diaries
Concept summary and practice questions

Using recall surveys

Recall surveys are a commonly used subjective measurement tool for assessing the physical activity and sedentary behaviour levels of a population, due to their ease of administration and cost-effectiveness. Depending on the purposes of the survey, there are a variety of types of recall surveys, ranging from very brief surveys right through to significantly more detailed versions.

As a subjective method, recall surveys typically ask an individual to recall their levels of physical activity or sedentary behaviour over a given time frame. Short recall surveys are the quickest and easiest to undertake. This type of survey provides a swift assessment of both the domains and dimensions of physical activity, providing a basic overview of the physical activity and inactivity levels of population groups.

Surveys like this would typically use a smaller number of questions and either be completed by an individual (known as a self-administered survey) or by an interviewer. Longer self-recall surveys can be used and generally capture broad information. For example, a survey of an adult who is asked to recall the amount of sport and exercise they did as a child will have limited scope to record accurately the dimensions of health. An estimation of the type and frequency of sport might be all the researcher asks in such a survey.

Examples of surveys include:

- the Adolescent Physical Activity Recall Questionnaire
- the Adolescent Sedentary Activity Questionnaire
- the Children's Leisure Activities Survey
- the Australian Health Survey.

The main advantages of recall surveys are:

- they are a cost-effective way of collecting large quantities of data
- they are easy to administer and complete
- they can be used in a variety of formats including digital and paper
- they can be used to collect a broad range of data
- they can take into consideration the context of physical activity and sedentary behaviour.

The main disadvantages include:

- an increased likelihood of lower accuracy of data due to poor recall and a lack of understanding of the survey's requirements
- **social desirability bias**, when respondents exaggerate their physical activity levels and underestimate their level of sedentary behaviour
- the difficulty of accurately recalling details of past events, particularly over a longer period of time
- they are not suitable for children under 10 years of age and older adults due to cognitive limitations of these respondents.

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Social desirability bias is the tendency of individuals to respond to questions in a survey in a way that they think will be viewed favourably by others, which often results in overreporting 'good behaviour' and underreporting 'bad behaviour'.

Using diaries

Diaries are another subjective method of assessing levels of physical activity and sedentary behaviour. They share similar advantages to that of recall surveys, with both ease of administration and low cost as reasons why they are considered as a method of data collection. In comparison to recall surveys, diaries can be used to record information whenever it is desired by those administering the test. For example, information may be recorded hourly or daily. As the person filling out the diary doesn't have to recall information over a prolonged period, the accuracy of information is likely to be better.

Some disadvantages include the following:

- The diary may become a burden to the person as they have to to input information regularly.
- Respondents become **reactive** to the presence of the assessment tool and therefore temporarily increase their physical activity levels, which reduces the chances of an accurate reflection of typical physical activity and inactivity levels.
- Diaries are prone to social desirability bias.
- Compared to surveys (which tend to make comparisons based on set questions), diaries tend to have less prescriptive questions and it is therefore harder to compare responses from different people.

Reactivity is the change in the behaviour of an individual who is aware they are being assessed.

For both recall surveys and diaries there is an option to have an adult take a survey or fill in a diary on behalf of somebody else. Known as a proxy survey or proxy diary, these are used to collect data on behalf of those with limited cognitive ability, including children under 10, the elderly over 80 and those with mental disabilities. A proxy report would typically be carried out by a parent, guardian, primary carer or a teacher.

FIGURE 11.16 Children under 10 have limited capacity to accurately recall their levels of physical activity and inactivity.

Using pedometry as an assessment tool

A pedometer is a tiny device that clips onto a person's belt or clothing to measure the quantity of steps taken (usually daily steps). It collects data and, depending on the type of model, can estimate the total distance covered during a day as well as the energy expenditure as a result of those steps. Due to its capacity to collect data it is categorised as an objective assessment tool when collecting information regarding physical activity levels.

The advantages of pedometers for assessing levels of activity include the following:

- They are a cheap tool (can be purchased from as little as a few dollars).
- There are a range of types with different functions including steps taken, distance covered and energy expended.
- Some can be synced to other digital devices for recording of data collection.
- They are easy to use.
- They can record incidental exercise that occurs as a normal part of a person's day — activity that is often overlooked in surveys or diaries.

The disadvantages of using pedometers to assess levels of activity include the following:

- The limited dimensions that they can record; there is no scope to measure intensity and context.
- They have no capacity to record upper body movement, nor can they measure swimming, cycling or gymnasium activity.
- They can be quite inaccurate for distance covered, particularly if users alter their usual stride length; this includes going up and down hills and stairs or engaging in physical activity such as running or playing sport.
- Users often experience reactivity when wearing a pedometer; this reduces the accuracy of data collected if used to measure the activity levels of an individual for the purposes of a population assessment of physical activity and sedentary behaviour.
- They do not record sedentary behaviour.

FIGURE 11.17 Pedometers are a popular method of measuring steps taken daily.

Using accelerometry as an assessment tool

Similar to pedometers, accelerometers use motion sensors to detect movement and are also classified as an objective tool. Accelerometers record movement recorded by tiny transmitters inside the unit. There are various types of accelerometers, from single transmitters that sense acceleration in one plane (known as a uni-axial accelerometer) through to three transmitters (tri-axial transmitters) that can measure acceleration in all three planes and therefore provide more accurate information about movement. Accelerometers should generally be worn over a 7-day period to reflect physical activity and inactivity during a typical week. They can be worn on the hip, ankle or wrist.

Contemporary models of accelerometers are incorporating the use of inclinometry to record more accurate data, particularly sedentary behaviour. Inclinometers are mechanical or electronic devices that are used as an objective form of data collection. Inclinometers measure the angle of slope of an object including the angle of incline of a human body, and hence can determine whether or not a person is lying, sitting or standing. There are various names for inclinometers, including tilt or slope meters.

FIGURE 11.18 Modern accelerometers are embedded into easy-to-wear devices such as watches and smartphones.

Some advantages of using accelerometers include:

- their small size
- their ability to be worn continuously over an extended period of time (not including showering, sleeping etc.)
- the recording of both physical activity levels and sedentary behaviour
- the lack of visual feedback to the wearer, which decreases reactivity
- their ability to record frequency, intensity, duration and estimated energy expenditure
- their ability to be combined with inclinometers to increase accuracy with which sedentary behaviour is recorded.

Some disadvantages include the following:

- They can still cause some reactivity (although less than other modes of observation tools such as pedometers).
- Each accelerometer needs to be calibrated to each individual.
- They are not accurate at measuring sedentary behaviour (e.g. they will often record static physical activity as inactivity), although when combined with inclinometers the accuracy can be improved.
- They cannot record context and type of physical activity.

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Unit 2
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Concept 7

Pedometers and accelerometers
Concept summary and practice questions

Direct observation as an assessment tool

The aim of direct observation is to collect data that measure a participant's physical activity by type, duration, intensity and context of physical activity and inactivity. It offers an advantage over many other subjective and objective methods, such as decreasing the burden on people being assessed and improved accuracy. A trained observer is used to describe what the participant does in a particular setting. The trained observer would typically use a computer software program or application to record the information. Two common examples are SOFIT and SOPLAY; however, there are other digital direct observation tools which are increasingly being used.

SOFIT

SOFIT (System for Observing Fitness Instruction Time) is designed to measure student physical activity, lesson context and teacher behaviour during physical education classes. It will generally assess four students' levels of physical activity per class.

TABLE 11.2 What SOFIT measures

Measures	Examples
Student activity levels	Including lying, sitting, standing, moderate (including walking) or vigorous activity
Lesson context	Analyses time spent in general content time (where students are not intended to be active during a physical education class), knowledge content time (where the prime focus is on student acquisition of knowledge) and PE motor content (including fitness, skill practice, game play and other free play)
Teacher behaviour	Collects information as to whether the teacher's behaviour or involvement promotes student physical activity

SOPLAY

SOPLAY (System for Observing Play and Leisure Activity in Youth) is used to directly assess physical activity in free-play settings, such as during recess and lunch, in school students. It uses a trained observer to collect data either manually or digitally on the behaviour of groups of people in particular settings. This is done via a series of regular scans within the targeted setting. This includes:

- the number of students being active
- the type of activity
- the frequency of activity
- context, such as time of day, environmental conditions, temperature, presence of supervisors, area usability and availability of equipment
- behaviour comparisons of males versus females
- intensity of activity (either sedentary, walking or very active).

A similar program called SOPARC (System for Observing Play and Recreation Activity in Communities) is used in other community settings.

FIGURE 11.19 Organisations such as Active Living Research use observation tools such as SOFIT, SOPLAY and SOPARC to measure levels of physical activity and sedentary behaviour.

Other digital tools for direct observation

In contemporary times the increased use of digital tools to observe physical activity and sedentary behaviour is evident. Many of these are available as smart phone and/or tablet apps, making direct observational tools more accessible and easy to use for the general population. Some examples of such digital applications include:

- TimeMotion, which allows the recording of an individual's activity during an activity (even via recorded video footage). These can be specifically tailored to particular sports.
- ISOPARC, which is a new digital application that is designed to work in conjunction with both SOPARC and SOPLAY. In addition to all of the data collected via SOPLAY and SOPARC, it permits the collection and exportation of photos, and enables the identification, mapping, and spatial area calculation of target areas using the GPS technology of a compatible tablet or phone.

Some of the advantages of direct observation include the following:

- It is useful for assessing the activity levels of children in a range of settings.
- The use of trained observers increases the accuracy of data collected.
- There are free online guides for teachers and other data collectors who are interested in using assessment tools such as SOFIT and SOPLAY.
- It has the capacity to be used in conjunction with other methods, such as accelerometry, to provide a more accurate description of physical activity levels.

Some of the disadvantages include the following:

- It can be time consuming to collect and analyse data.
- It can be costly if trained professionals need to be used to increase accuracy.
- An awareness of the observer may increase reactivity.
- There is decreased accuracy when group size increases.

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Unit 2 | AOS 1 | Topic 11 | Concept 8

Direct observation
Concept summary and practice questions

Using personal activity trackers

For many years digital activity trackers, such as accelerometers, have been used extensively in research settings to assess the overall levels of physical activity, sedentary behaviour, sleep patterns and daily energy expenditure. They were expensive but tracked physical activity levels accurately. Due to advances in technology, there have been significant improvements in the design of digital activity trackers, minimising the need for accelerometers.

The new forms of digital activity trackers use similar technology to accelerometers (and most incorporate an accelerometer), but have become significantly smaller, cheaper and accessible to both researchers and the general public. They have also become more personal, as users can easily input personal information that helps improve the accuracy of data collected. Some examples of the use of digital activity trackers include a range of applications on smartphones and computers. There is also a growing market of wearable technology being used to measure physical activity, such as watches and wristbands.

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Unit 2 | AOS 1 | Topic 11 | Concept 9

Activity assessment tools and trackers
Concept summary and practice questions

FIGURE 11.20 Personal activity trackers come in all shapes and sizes.

Personal activity trackers use some or all of the following sensors: accelerometers; thermometers, ambient light sensors and UV sensors; inclinometers; optical heart rate monitors and GPS (global positioning system). There is a variety of types available for use. They can measure a range of dimensions in any of the following combinations:

- steps taken
- distance travelled
- speed of movement
- sedentary behaviour, including sleep time
- energy expenditure (using algorithms to estimate this dimension based on body weight, duration and intensity of movement)
- intensity via heart rate (through the skin via watch or bracelet)
- different modes of activity such as running, walking or cycling.

FIGURE 11.21 Many athletes rely on digital technology to support their training.

Some of the main advantages of digital activity trackers are that they:

- can potentially measure any dimension with some degree of accuracy
- have the capacity to record physical activity and sedentary behaviour
- have the capacity to be used in different environments, including in the water
- are easy and comfortable to wear
- have settings that can be personalised for the individual wearer.

Some of the main disadvantages of digital activity trackers are that they:

- are costly for some people
- have reduced accuracy for certain types of physical activity, such as free play, and activities that involve movement without leaving a position in space (e.g. wearing a GPS watch will not record movement on a treadmill or stationary bike).

FIGURE 11.22 Fitness trackers are useful for people who are trying to increase their level of physical activity and want to quantify their progress.

Selection of an assessment tool is dependent on a range of factors. There is generally an inverse relationship between accuracy and practicality in the collection of physical activity and sedentary behaviour data. In other words, the higher the accuracy the lower the practicality and the lower the accuracy the higher the practicality.

TEST your understanding

1. List three reasons why assessment of physical activity and sedentary behaviour at the population level is necessary.
2. List three reasons why assessment of physical activity and sedentary behaviour at the individual level is necessary.
3. Explain the difference between a recall survey and a recall survey by proxy. In what circumstances should a proxy recall survey be used as a physical activity assessment tool?
4. Describe the difference between an accelerometer and an inclinometer.

APPLY your understanding

5. Describe why direct observation offers an advantage over other subjective and objective physical activity and sedentary behaviour assessment tools.
6. You are a primary school PE teacher. You are trying to encourage students to increase their level of movement during the school day. You have heard that pedometers cause reactivity. Explain what the term reactivity means. Outline two advantages and disadvantages of using pedometers in such as school context.
7. Research the latest digital physical activity trackers. Select one that would suit your lifestyle and describe what this tool can measure.
8. **Practical activity:** Select a digital physical activity tracker for use during a practical class. Compare the data collected with data from other students in the class. Discuss the advantages and disadvantages of your choice compared with others.

11.4 National health data

KEY CONCEPT The federal government routinely collects data on the habits of Australians, including physical activity and inactivity and the many factors that influence such behaviour.

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Australian Health Survey

Periodically the federal government commissions surveys of the population to identify current trends in Australian society. The 2011–2013 Australian Health Survey is the largest and most detailed health survey ever to be undertaken in Australia, and allowed the federal government to collect broad data from a large sample size. A group of healthcare professionals was gathered from a wide range of sectors to oversee the survey process, including government and non-government organisations. The Australian Health Survey comprised the following three components:

- the National Health Survey (NHS)
- the National Nutrition and Physical Activity Survey (NNPAS)
- the National Health Measures Survey (NHMS).

These surveys were conducted on behalf of the federal government by the Australian Bureau of Statistics (ABS). This data is helpful for healthcare professionals because it not only identifies current trends in health status, but it also highlights potentially disadvantaged groups and individuals.

FIGURE 11.23 The logo of the Australian Bureau of Statistics

study on

Unit 2	National health data
AOS 1	Concept summary
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Physical activity and sedentary behaviour

As part of the Australian Health Survey an investigation was made into the physical activity and sedentary levels of Australians. To fully comprehend the data presented in this chapter, an understanding of the Australian Bureau of Statistics definitions is essential. See table 11.3 below for an outline of these definitions.

TABLE 11.3 Definitions of physical activity corresponding to different age groups

Children 2–4	Children 5–17	Adults 18+
		
Includes any active indoor or outdoor play	Any moderate/vigorous physical activity that increases heart and respiratory rate to a point where a person feels out of breath for some of the time. This includes active transport.	Any moderate/vigorous physical activity that increases heart and respiratory rate to a point where a person feels out of breath for some of the time. This includes active transport.

Sedentary behaviour includes time spent sitting or lying down for various activities over the last week. This includes waiting for transport, sitting while in transit, playing computer games, using the internet, watching television, talking or texting on a phone and leisure activities that are low in intensity. This includes playing chess, reading a book, going to the movies or having a barbeque.

FIGURE 11.24 The Australian Institute of Health and Welfare regularly publishes statistics about the health of the Australian population.

Children's physical activity and sedentary behaviour guidelines

The Australian Physical Activity Guidelines for children highlight the importance of play and being active throughout each day. For children under 5 years of age the guidelines encourage at least three hours of physical activity per day while for children and adolescents aged 5 to 17 at least 60 minutes up to several hours per day is recommended, with an emphasis on aerobic activities and those that strengthen muscle and bone.

In regards to Australia's Sedentary Behaviour Guidelines, children age 2 to 5 years are recommended to not be sitting, watching television or using other forms of electronic media, for any more than one hour per day. For children and adolescents aged between 5 and 17, sedentary behaviour should be limited to two hours per day, excluding for school-based purposes.

So how are Australian children and adolescents doing in regards to both the sedentary behaviour and physical activity guidelines? There is significant room for improvement. The results show that:

- only one in five Australian children aged between 2 and 4 currently meets both physical activity and screen-time guidelines, dropping to about one in ten children and adolescents aged between 5 and 17 years.
- three out of four children aged between 2 and 4 did not meet both the physical activity and screen-time guidelines, rising to 9 out of 10 children and adolescents aged between 5 and 17.

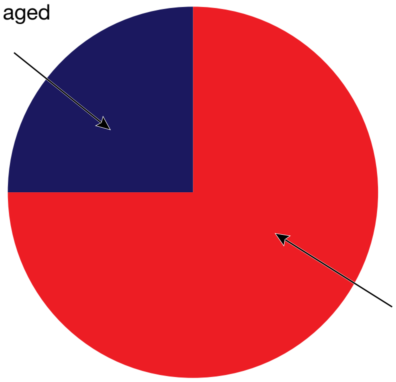
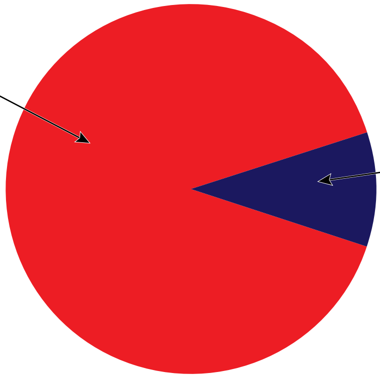


FIGURE 11.25 According to the Australian Institute of Health and Welfare, three out of four children aged between 2 and 4 years do not meet both physical activity and sedentary behaviour guidelines.



Australian children and teenagers need to do less of this…

….and more of this.

FIGURE 11.26 According to the Australian Institute of Health and Welfare, an alarming eight out of ten children and adolescents aged between 5 and 17 do not meet the physical activity and sedentary behaviour guidelines.

For this age group (2 to 4) there were some other interesting findings from the Australian Health Survey. Overall they indicate that the major issue is with children spending too much time in front of a screen, with the data highlighting that most young children are active enough. The data shows that for children between 2 and 4 years of age approximately:

- seven out of ten children meet the physical activity guidelines
- seven out of ten children spend excessive time using electronic media, the bulk of this time watching television and DVDs
- children are active on average for 6 hours per day, with close to half indoor play and half outdoor play
- children engage in sedentary behaviour using electronic media for 83 minutes per day
- all data for both boys and girls are similar with variations not being statistically significant.

For 5- to 17-year-olds, the data indicates that approximately:

- two in ten meet the physical activity guidelines
- three in ten meet the screen time guidelines
- 90 minutes of physical activity is undertaken per day, comprising of mainly non-organised activities such as walking, play and other games
- 136 minutes are spent a day on sedentary screen-based activities, with 84 minutes dedicated to watching television and DVDs, 21 minutes playing electronic games and an additional 25 minutes using the internet for non-homework purposes
- all data for both boys and girls are similar with variations not being statistically significant

Relationship between age and physical activity and sedentary behaviour

Table 11.4 outlines the relationship between age and the levels of physical activity and sedentary behaviour in the Australian population (aged 15 and over). The data indicates some clear patterns.

TABLE 11.4 Level of exercise[a], proportion of persons

	Age group (years)									
	15–17	18–24	25–34	35–44	45–54	55–64	65–74	75 years and over	Total 15 years and over	Total 18 years and over
	Proportion of persons (%)									
Persons										
Sedentary	21.4	29.4	31.2	34.3	36.0	37.1	40.3	56.9	35.4	36.0
Low	30.9	30.0	31.1	32.8	32.7	33.5	31.1	25.8	31.5	31.5
Moderate	25.7	21.6	21.0	19.9	19.9	23.0	24.6	15.6	21.2	21.0
High	21.8	19.0	16.7	12.9	11.2	6.2	4.1	*1.5	11.9	11.4
Total[b]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Estimate has a relative standard error of 25 to 50 per cent and should be used with caution.

(a) Level of exercise undertaken for fitness, recreation or sport in the last week.

(b) Includes level of exercise not stated.

Source: Australian Bureau of Statistics, Australian Health Survey: First results 2011–2012.

There is a direct relationship between ageing and an increase in sedentary behaviour. This is a concern as there are clear links between inactivity and poorer health outcomes.

There is a relatively consistent pattern of low-intensity physical activity undertaken across all age groups up until the 65–74 age bracket. For most aged people 15 or over, about one in three people (close to 33 per cent) engage in low intensity physical activity at least once per week.

Similar to low-intensity exercise there is a relatively consistent level of medium-intensity exercise undertaken at least once per week, averaging out to approximately 20–25 per cent across the age groups.

The most significant changes seen in the data involve the decline of high-intensity exercise across all age groups, with about one in five people engaging in this type of activity at least once a week in the 15–19 age bracket, compared to only about one in 20 (4 per cent) in the oldest age group surveyed, the 65–74 age group.

The data from the Australian Health Survey shows that as people get older they are likely to maintain similar levels of low and moderate physical activity but experience a decline in high-intensity exercise. There is also a clear relationship between ageing and an increase in sedentary behaviour. The reduction of high-intensity exercise combined with increased sedentary behaviour will have a significant impact on the physical, social and emotional health of older Australians.

Comparison of male and female physical activity and sedentary behaviour

The data comparing physical activity and sedentary behaviour for males and females shows some similarities and differences. The similarities include:

- an increase in the quantity of sedentary behaviour as both males and females age
- a significant drop in high-intensity exercise in both males and females as they get older
- a relatively stable quantity of low and moderate physical activity conducted per week.

Although there are similarities between the physical activity and sedentary behaviours of males and females there are also some significant differences. The major disparities between males and females include the following:

- Males are more likely to engage in medium- and high-intensity exercise while females are more likely to engage in behaviour that is categorised as sedentary, as well as low intensity activity.
- Sedentary behaviour in females between 15 and 18 years of age is double that of males, with sedentary behaviour exhibited in approximately 28 per cent of females in this age group compared to only 14 per cent in males.
- A rapid increase in sedentary behaviour occurs in males as they enter adulthood (ages 18–24). Sedentary behaviour almost doubles during this time (14.5 per cent to 27.4 per cent), while for females only a small increase in sedentary behaviour is shown from 28.7 per cent to 31.5 per cent.
- In people aged from 35 to 74 the level of sedentary behaviour in both males and females remains very similar. In the oldest age group surveyed, however, there is a marked increase in sedentary behaviour and a decrease in low-intensity physical activity in females. For males there is a much smaller increase in sedentary behaviour and decrease in low-intensity physical activity.

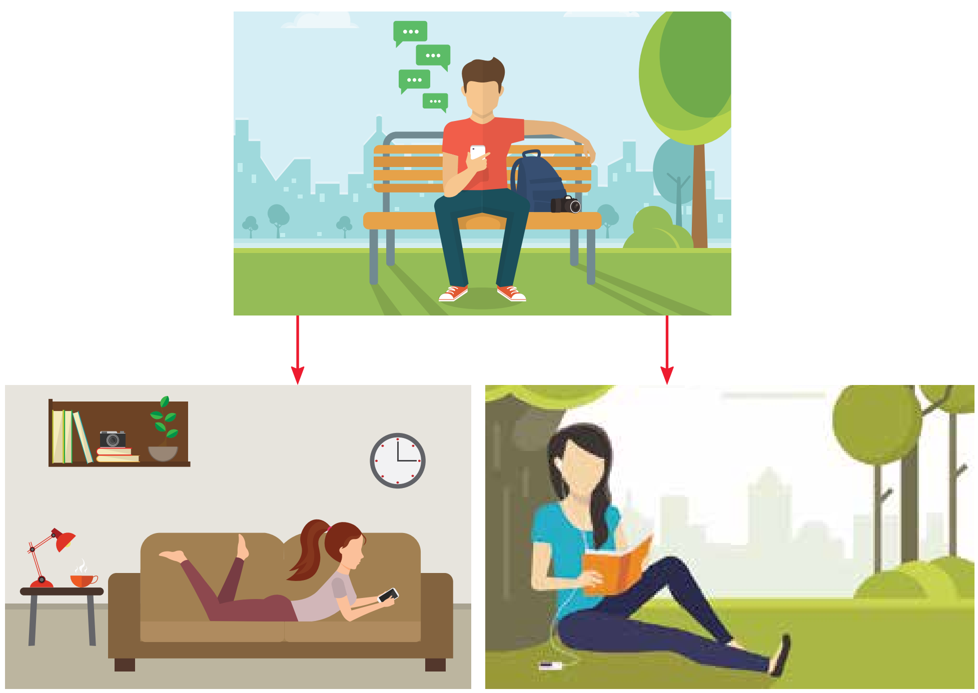


FIGURE 11.27 For every sedentary male aged 15–17, there are two sedentary females aged 15–17.

Making sense of the data

As discussed previously in this chapter, the Australian Physical Activity and Sedentary Behaviour Guidelines have been devised to educate people about the link between being physically active and good health. These guidelines can be used to measure whether people are being active enough to result in health gains, both in terms of the frequency, duration, type and intensity of activity in addition to sedentary behaviour.

The data in table 11.5 shows whether people are meeting these guidelines. The guidelines for adults advise 150 to 300 minutes (2½ to 5 hours) of moderate-intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous-intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week. The insufficiently active group indicates that there are approximately one in three Australians who do some activity but not enough to result in health benefits. The trend across the age groups indicates that as people age they are more likely to become inactive and less likely to be sufficiently active for health gains.

Australian adults spent only 3.8 hours per week engaged in physical activity. This is compared to 28.9 hours being sedentary during their leisure time. In other words, for every hour an Australian adult is active they spend 9 hours being inactive!

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The Australian Physical Activity and Sedentary Behaviour Guidelines

TABLE 11.5 Summary activity indicators by age in persons aged 18 years and over

		Age group (years)						
		18–24	25–34	35–44	45–54	55–64	65–74	75 years and over
Proportion of persons with sufficient physical activity in last week								
Inactive	%	10.5	15.0	19.2	23.1	21.9	23.3	40.4
Insufficiently active	%	35.8	36.1	35.7	31.9	38.3	38.4	34.0
Sufficiently active for health	%	53.4	47.0	44.0	44.0	38.9	37.7	25.2
Total [(a)]	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(a) Includes time not known.

Source: Australian Bureau of Statistics, Australian Health Survey, 2013.

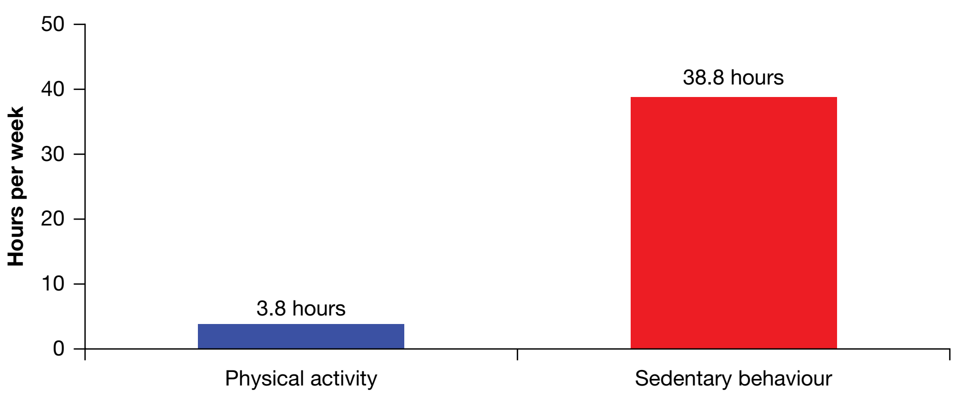

FIGURE 11.28 Australian adults spend on average only 3.8 hours per week being active and a staggering 38.8 hours per week engaging in sedentary behaviour.

Relationship between location and levels of physical activity and sedentary behaviour

There is a wide range of influences on how active and inactive Australians are. One influence is where people live. The data from the Australian Health Survey show a trend between healthy behaviour and how close people live to a major city. People who live in major cities have a lower rate of inactivity and a higher rate of being physically active enough for health gains. The rate of inactivity in adults living in major cities is 18 per cent, but climbs to 25 per cent in people who live in regional and remote areas. For physical activity for health benefits 45 per cent of Australian adults meet the guidelines, but this drops below 40 per cent for people living in regional and remote areas.

There are not only differences in the health-related behaviours of people living in city or regional areas, the Australian Bureau of Statistics data highlights that there are differences in the levels of physical activity and inactivity between the states and territories.

The most active people reside in the ACT, with only 16 per cent of the people inactive in the week leading up to the survey, 33 per cent were active but not at a level that would benefit health, and approximately half of the population were sufficiently active for health. People living in the Northern Territory were the least active, with only 37 per cent of the population sufficiently active according to the Australian Physical Activity Guidelines.

Percentage of the Australian population who participate in sufficient physical activity, by state

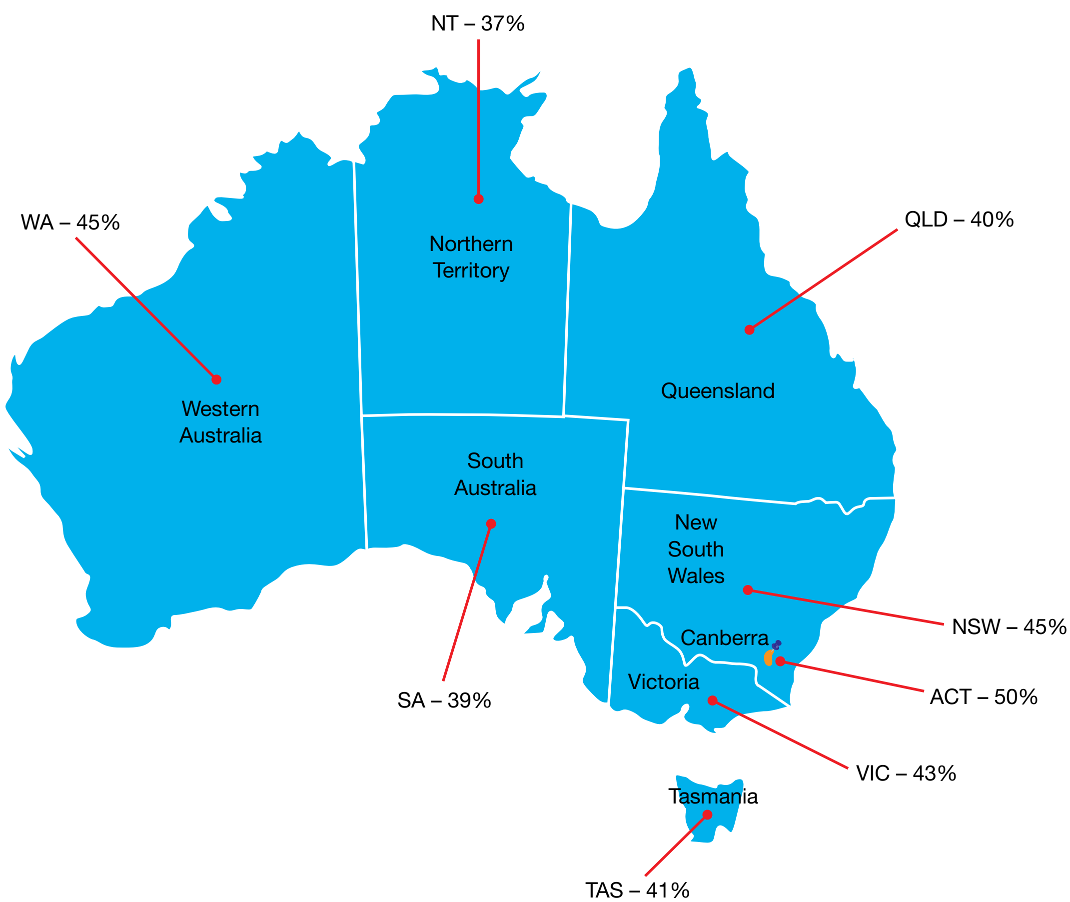

FIGURE 11.29 According to ABS data, ACT residents are the most active in Australia with 50 per cent of the ACT's population engaging in adequate physical activity for good health.

Relationship between socioeconomic status, education, culture and levels of physical activity and sedentary behaviour

Socioeconomic status

There are clear links between a person's socioeconomic status and their engagement in health-related behaviours, including physical activity. The term socioeconomic status refers to an individual or group's social and economic standing, taking into consideration a range of factors that include education levels, employment status and income. The Australian Bureau of Statistics uses a variety of ways to link socioeconomic status to health-related behaviour, including the link between socioeconomic disadvantage and physical activity and inactivity.

Table 11.6 demonstrates the relationship between socioeconomic disadvantage and higher levels of inactivity and lower levels of physical activity sufficient for health gains. It uses a measurement called the Index of Relative Socioeconomic Disadvantage. This measurement stems from a range of variables. These variables include:

- level of income
- level of education
- level of employment
- skilled versus unskilled occupations.

This information is used to highlight areas of advantage which score highly on the index and areas of disadvantage that score low on the index. Areas are then ranked and placed within quintiles, (defined as any of five equal groups into which a population can be divided). The data clearly demonstrates the correlation between socioeconomic disadvantage and lower levels of physical activity for health purposes. This correlation is the same regarding levels of inactivity: highest in the first quintile (most disadvantaged population group) and lowest on the fifth quintile (most advantaged population group).

TABLE 11.6 **Sufficient physical activity measured by selected population characteristics, persons aged 18 years and over**

	Participation in sufficient physical activity in last week			
	Inactive	Insufficiently active	Suffiiciently active for health	Total 18 years and over
	Proportion of persons (%)			
Index of Relative Socioeconomic Disadvantage				
First quintile (most disadvantaged)	26.5	38.3	34.0	100.0
Second quintile	23.0	36.7	39.2	100.0
Third quintile	20.4	35.5	42.5	100.0
Fourth quintile	18.9	34.4	46.1	100.0
Fifth quintile (most advantaged)	13.8	33.7	52.1	100.0
Total (across the whole population)	20.3	35.7	43.0	100.0

Source: ABS, Australian Health Survey: Physical Activity, 2011–12.

The results of the Australian Health Survey also show the relationship between equivalised household income and the levels of physical activity and inactivity. Equivalised household income is estimated from the income of a household and their relative wellbeing. As in the index of socioeconomic disadvantage, there are clear relationships between the most advantaged subset of a population and healthy behaviour.

The data reflects a distinct relationship between increased household income and increased level of physical activity for health gains and lower rates of inactivity. The results signal a massive difference between the most advantaged and disadvantaged. Economically disadvantaged households are approximately 2.5 times more likely to be inactive (27 per cent compared to 11.5 per cent).

FIGURE 11.30 The higher a person's socioeconomic status, the more likely they will be physically active.

Education

There is a clear relationship between a person's level of education and the likelihood they will engage in lower levels of inactivity and higher levels of activity sufficient enough for health benefits. Approximately 25 per cent of Australian adults who leave school without a qualification are categorised as inactive compared to only approximately 8 per cent of holders of postgraduate degrees. Early school leavers are three times more likely to be categorised as sedentary. The data also highlights that the most educated are the most active, with six in ten postgraduate degree holders active enough for health benefits.

FIGURE 11.31 The more highly educated a person is, the more likely they are to engage in physical activity.

Cultural influences

For Australians born here and overseas, there are few differences in both the levels of inactivity and levels of physical activity sufficient for health gains. There are, however, some major differences between people from different parts of the world.

Residents in Australia born in the United Kingdom and other North-west European countries (e.g. Belgium, Ireland, the Netherlands, Sweden, Denmark and Norway) show the highest rate of physical activity for health purposes, significantly higher than other parts of Europe, Asia, Africa and the Middle East.

Residents in Australia born in Southern and Eastern Europe (e.g. Albania, Cyprus, Greece, Bulgaria, Croatia, Serbia), North Africa and the Middle East show high levels of inactivity, with approximately one in four adults not exercising at all in the week leading up to the survey.

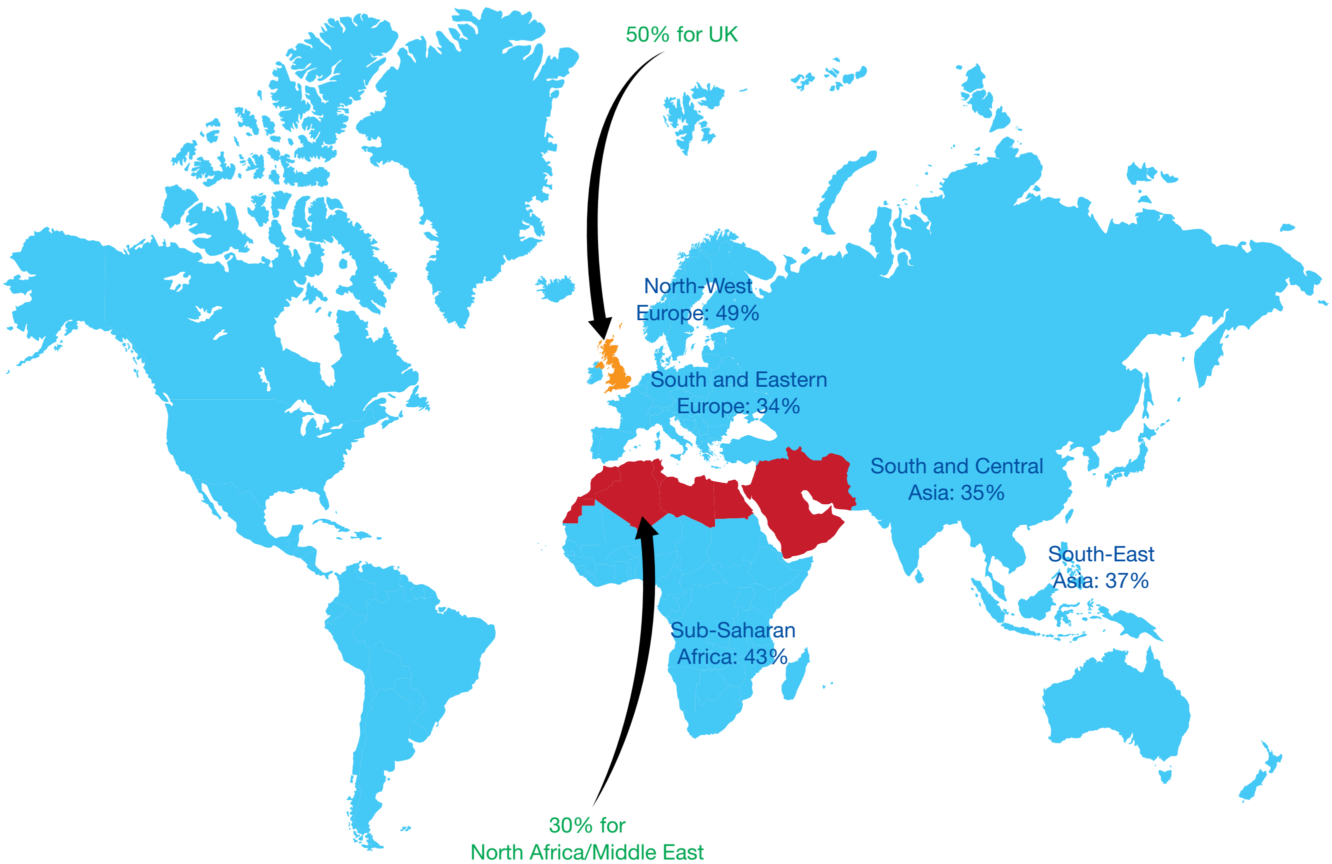

FIGURE 11.32 This map shows the percentages of overseas-born Australians who are sufficiently active for health. Overall, Australians born in Europe are most active; Australians born in Africa are least active.

TEST your understanding

1. Why does the government collect health data from surveys?
2. Provide four examples of sedentary behaviour as outlined in the Australian Health Survey.
3. What percentage of Australian children aged between 5 and 17 met both the physical activity and screen-based activity recommendations?
4. What is meant by the term 'Index of Relative Socioeconomic Disadvantage'? Discuss the relationship between this index and levels of physical activity measured in the Australian population.

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APPLY your understanding

5 A friend of yours is looking at the relationship between income and level of physical activity. Your friend says that the fifth quintile according to income has the highest level of physical activity while the first quintile has the lowest level of physical activity. Your friend asks you to clarify this statement to help him/her understand what this means.

6 View the following data comparing people who live in major cities, inner regional areas and outer regional/remote areas of Australia. What trends can be identified from this data?

	Participation in sufficient physical activity in last week		
	Inactive	Insufficiently active	Suffiiciently active for health
	Proportion of persons (%)		
Major cities of Australia	18.3	35.3	45.4
Inner regional Australia	25.4	37.3	36.0
Outer regional and remote Australia	25.2	34.6	39.0
Total	20.3	35.7	43.0

Source: ABS, Australian Health Survey, 2012.

7 The following data compares the proportion of people (%) mapped to their level of exercise. Describe the relationship between exercise intensity and ageing using data from the table. For each level of exercise give an example of an activity that would fit into each category.

	Age group (years)				
	15–17	18–24	25–34	35–44	45–54
	Proportion of persons (%)				
Level of exercise					
Sedentary	21.4	29.4	31.2	34.3	36.0
Low	30.9	30.0	31.1	32.8	32.7
Moderate	25.7	21.6	21.0	19.9	19.9
High	21.8	19.0	16.7	12.9	11.2
Total	100.0	100.0	100.0	100.0	100.0

Source: ABS, Australian Health Survey, 2012.

8 Design your own physical activity and sedentary behaviour questionnaire with the aim of recording these behaviours over a week. Compare this data with the data collected for a person your age and gender in the Australian Healthy Survey.

CHAPTER 11 REVISION

KEY SKILLS

- Participate in physical activity, and collect, analyse and reflect on information related to the physical, social, mental and emotional health benefits of physical activity
- Explain the health consequences of physical inactivity and sedentary behaviour
- Describe the physical activity and sedentary behaviour guidelines for different stages across the lifespan
- Use appropriate methods to measure and analyse physical activity and sedentary behaviour levels at the individual and population level
- Collect, analyse and interpret primary and secondary data related to trends in participation in physical activity

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- involvement in and analysis of involvement in physical activity
- link healthy behaviour with promotion of all the dimensions of health
- the Physical Activity and Sedentary Behaviour Guidelines need to be mapped to the appropriate age classification
- select appropriate assessment methods when asked to measure and analyse both physical activity and sedentary behaviour levels, for either an individual or for a large population group
- when selecting the appropriate method, students need to go through the advantages and disadvantages of the assessment methods in order to justify their selection
- during the data collection period, students may need to collect their own data (primary data) or work with data collected from other people or researchers (secondary data).

PRACTICE QUESTION

Sally, a 15-year-old secondary-school student engaged in the following physical activity during one week.

Frequency of activity = 7 days
Intensity of activity = moderate
Total duration over the week = 120 minutes
Type = Aerobic activities including running and swimming

(a) Using the information above, **describe** the area of weakness for Sally, an adolescent, in relation to one of the four dimensions of the Australian Physical Activity Guidelines. *2 marks*
(b) Using your knowledge of the guidelines, **recommend** to Sally what she needs to do to meet all four of the dimensions listed above. *1 mark*
(c) **Name** and **describe** two chronic health conditions that could be a consequence of limited physical activity. *4 marks*

Sample response

(a) The area of weakness for Sally is the total duration of activity over the week. According to the guidelines, being active every day for at least 60 minutes per day means that at least seven hours of physical activity should be completed over the week whereas Sally has only accumulated 120 minutes (2 hours).
(b) To meet the guidelines, she needs to participate in an extra five hours per week of exercise at the appropriate intensity.
(c) If she doesn't then she is at a higher risk of suffering from chronic health conditions such as diabetes mellitus and obesity. Diabetes mellitus is a condition where blood sugar levels are difficult to maintain due to problems with production of or response to insulin secretion. Obesity is a condition where excessive body fat is carried by an individual.

PRACTISE THE KEY SKILLS

1 Describe the Australian Physical Activity and Sedentary Behaviour Guidelines for children.
2 Explain the health benefits of increased physical activity.
3 Discuss the advantages and disadvantages of direct observation.

KEY SKILLS EXAM PRACTICE

1 Your Physical Education teacher wanted to track the amount of walking done by students during the school day. This task was completed using pedometers, an objective assessment tool.
(a) Describe the difference between subjective and objective assessment tools. *2 marks*
(b) Describe two advantages and two disadvantages of using pedometers as an assessment tool. *4 marks*

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:**
  Describe — provide a detailed account of
  Recommend — to make a suggestion of one option appropriate to the issue covered in the stimulus material
  Name — identify or state
- **Key terminology:** The Australian Physical Activity Guidelines are distinct from the Australian Sedentary Behaviour Guidelines that together make up the Australian Physical Activity Guidelines. This question specifically asks you to respond to the physical activity component. The term adolescent indicates that the answer must respond to the recommendations for this age bracket relating to the dimensions that are clearly included in the stem.
- **Key concept/s:** Chronic health conditions need to be mapped to the course content with conditions such as obesity and diabetes mellitus correct.

HOW THE MARKS ARE AWARDED

- **1 mark** — highlighting that duration is the issue
- **1 mark** — highlighting that Sally only completes 2 hours per week
- **1 mark** — highlighting that Sally should be completing 7 hours per week to meet the guidelines
- **2 marks** — one for each of two named chronic conditions such as diabetes mellitus, obesity, osteoporosis, some cancers or cardiovascular disease
- **2 marks** — one for each of two descriptions of chronic conditions such as diabetes mellitus, obesity, osteoporosis, some cancers or cardiovascular disease

The use of recall surveys was proposed but the teacher decided this would not be very accurate. The two reasons cited for making this decision were that the children had cognitive limitations and students may be prone to social desirability bias.

(c) Describe the link between cognitive limitations and recall ability. *1 mark*

(d) In regards to social desirability bias, what is likely to happen if students are asked to list the amount of physical activity and sedentary behaviour per day? *2 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

- Physical activity is associated with promotion of emotional, mental, social and physical health.
- One dimension of health can have an impact on the other dimensions.
- Chronic health conditions such as diabetes mellitus, some cancers, obesity, cardiovascular disease and osteoporosis are associated with low levels of physical activity and high levels of sedentary behaviour.
- The Australian Physical Activity and Sedentary Behaviour Guidelines have been developed to educate people about the benefits of being active and the dangers of being inactive.
- The Australian Physical Activity and Sedentary Behaviour Guidelines have been developed for children, adolescents, adults and older Australians.
- Assessment of the physical activity and sedentary behaviours of individuals and population groups can be done by using assessment tools, categorised as objective or subjective.
- Subjective assessment tools include recall surveys, proxy reports and diaries.
- Objective assessment tools include pedometers, accelerometers, inclinometers and other digital observation tools.
- There are advantages and disadvantages for each assessment tool.
- Often two or more assessment tools are used to increase the accuracy of the information collected.
- Assessment tools are becoming more accurate due to advances in information communications technology.
- Generally, the higher the accuracy of an assessment tool, the lower the practicality (and vice versa).
- On average, children in Australia spend too much time in front of a screen, not being active.
- There are trends that can be identified via collection of data; for example males are more active than females, and as adults get older they are less likely to engage in vigorous physical activity.
- There is a clear relationship between SES and increased physical activity.
- People in major cities are more active than those in rural and remote areas.
- Cultural influences play a role in determining how much value is placed on physical activity.
- Data collected by government and non-government agencies helps identify at-risk groups of the population due to high levels of inactivity.

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Sit Topic Test

eBookplus

Interactivity
Physical activity and sedentary behaviour: trends, benefits, risks, guidelines and assessment quiz
Searchlight ID: int-6654

MULTIPLE CHOICE QUESTIONS

1 Physical activity has been shown to
(A) increase the chance of illness.
(B) promote mental illness.
(C) increase the chance of diabetes mellitus.
(D) decrease the risk of osteoporosis.

2 Being active improves mental health and reduces the chance of mental illnesses such as
(A) stress, diabetes mellitus and anxiety.
(B) anxiety, depression and stress.
(C) cardiovascular disease and obesity.
(D) obesity, stress and depression.

3 Which of the following is the correct definition of social health?
(A) The ability to be happy
(B) The capacity to get on well with others
(C) The ability to run a marathon
(D) The ability to communicate effectively

4 The recommendations for Australians about appropriate levels of activity and sedentary behaviour are called
(A) Australia's Physical Activity Guidelines.
(B) National Guidelines.
(C) Australia's Physical Activity and Sedentary Behaviour Guidelines.
(D) Australia's Sedentary Behaviour Guidelines.

5 Which of the following statements is correct?
(A) Subjective assessment refers to information obtained from a stopwatch or other measuring device.
(B) Objective assessment refers to information obtained from a person's ideas.
(C) Objective assessment refers to information obtained from a person's perception, understanding and interpretation of an event.
(D) Subjective assessment refers to information obtained from a person's perception, understanding and interpretation of an event.

6 Respondents to surveys exaggerate their physical activity levels and underestimate their level of sedentary behaviour. This is known as
(A) reactivity.
(B) social desirability bias.
(C) cognitive limitations.
(D) reflexivity.

7 Devices that measure steps taken during a day are called
(A) inclinometers.
(B) heart-rate monitors.
(C) accelerometers.
(D) pedometers.

8 SOFIT, a software program used to assess physical activity is used in conjunction with which of the following methods?
(A) Direct observation
(B) Recall survey
(C) Proxy report
(D) Diary

9 The following is a common trend in Australia.
(A) As adults age, their levels of vigorous activity decrease.
(B) Females become more active as they get older.
(C) The older you get, the more active you become.
(D) The less you work, the more physical activity is done.

10 SES is a significant indicator of healthy behaviour. SES is an acronym for
(A) social and economic standards.
(B) student education services.
(C) socioeconomic status.
(D) stable economic situation.

EXAM QUESTION

Question 1

Bill is a 45-year-old man who wants to improve his health. His doctor recommends that he joins a lawn bowls club.

a. Outline the dimensions of the Australian Physical Activity Guidelines for Bill's age group. **(4 marks)**

b. Explain the health benefits of involvement in such a sports club.

Social benefits **(2 marks)**

Emotional benefits **(2 marks)**

Mental benefits **(2 marks)**

Physical benefits **(2 marks)**

INQUIRY QUESTION
What are the key factors that promote an active lifestyle?

CHAPTER

12 Health promotion strategies

In this chapter we take a look at the social-ecological model and the Youth Physical Activity Promotion Model in order to analyse physical activity initiatives in a range of settings.

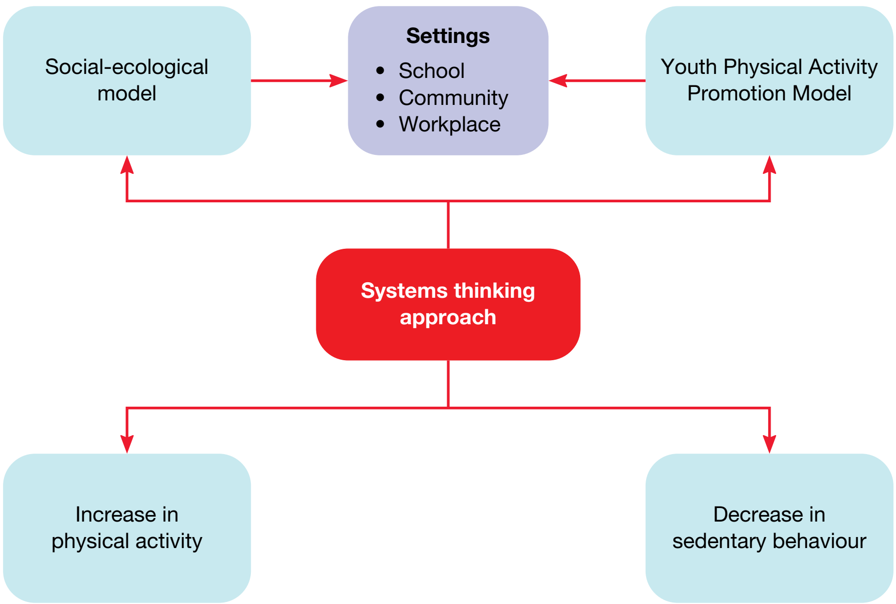
KEY KNOWLEDGE

- Components of the social-ecological model (individual, social environment, physical environment and policy) and/or the Youth Physical Activity Promotion Model
- Settings (schools, workplaces and community) based approaches to reducing sedentary behaviour and promoting physical activity
- A range of physical activity promotion and sedentary behaviour reduction initiatives and strategies that target different populations based on factors such as age, sex, gender, people with disabilities, cultural and indigenous groups

KEY SKILLS

- Apply a social-ecological model and/or the Youth Physical Activity Promotion Model to critique physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour for a range of populations in a variety of settings

CHAPTER PREVIEW



12.1 The social-ecological model

KEY CONCEPT There are many factors that impact on the physical activity and sedentary behaviour of people.

Systems thinking is a way of viewing things where the entities within a system influence one another.

In recent times experts have started to use a **systems thinking** approach to comprehend the complex nature of many things, including human behaviour. A system can be described as something that consists of elements that:

- interact
- are interrelated
- are interdependent.

This way of looking at systems has led to a field of study known as social ecology, which explores and tries to understand complex and ever-changing interrelations between people and their environment. Since the 1970s, experts in many fields including education, psychology and health have developed theoretical models and frameworks that attempt to explain such interrelationships and their impact on behaviour. Such models and frameworks have evolved and been adapted in line with understanding of the multiple factors that influence behaviour. Consequently, there are a variety of models and frameworks used. For the purposes of VCE Physical Education, the Victorian Curriculum and Assessment Authority (VCAA), in conjunction with Dr Helen Brown, Professor Jo Salmon and Associate Professor Amanda Telford, has advised that the social-ecological model can be used and applied to physical activity.

Components of the social-ecological model

The **social-ecological model** is a framework used to develop, implement and critique health-promotion strategies aimed at improving the health of people by promoting physical activity and limiting sedentary behaviour.

There are four components of the **social-ecological model**. The individual is at the centre, followed by the social environment, the physical environment and policy. The social-ecological model is seen as a series of circles that overlap and interrelate, with each circle representing a different component or layer of the model.

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Unit 2 | AOS 1 | Topic 12 | Concept 1

Individuals Concept summary and practice questions

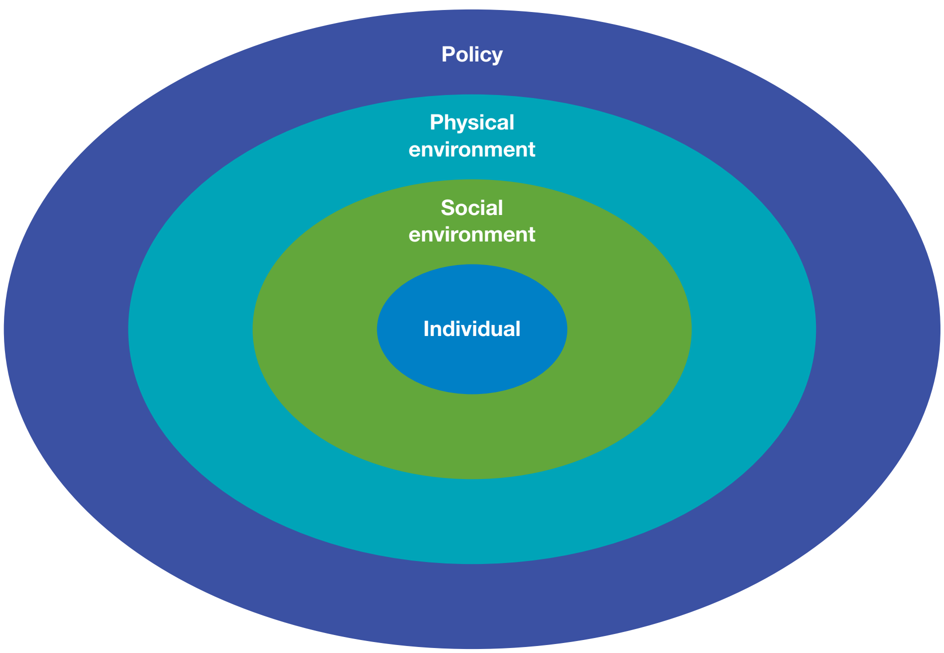

FIGURE 12.1 The social-ecological model is used to design, implement and critique strategies and programs aimed at promoting physical activity and discouraging sedentary behaviour.

The individual

Right at the centre of the model is the individual component. It incorporates all the personal factors that influence physical activity and sedentary behaviour. Some of the factors within the individual layer are described in the next section.

Knowledge and level of education

Having knowledge about the benefits of being physically active and the consequences of inactivity is a powerful force in influencing an individual's behaviour. There is a strong correlation between the level of formal education and activity levels: those with a high level of education are more likely to be involved in physical activity.

Attitudes and beliefs

People's attitudes and beliefs shape their view of being active. Many people have a positive view of physical activity and believe that it is an important part of being healthy. These attitudes and beliefs can shape behaviour.

Perceived barriers

There are many perceived barriers that affect whether or not a person is active. Commonly cited perceived barriers include lack of time, money or resources, and being too tired to exercise. Other barriers include too much time consumed by school, family, homework and lack of interest. The term 'perceived' means that it is the view of the person. It doesn't necessarily correlate to reality, as many people's perceptions are incorrect and can be used as an easy excuse not to be active.

Motivation and enjoyment

Many people have a natural desire to move and be active. This innate drive is a powerful influence on whether people incorporate physical activity into their daily lives. This internal drive is also known as **intrinsic motivation**, which is a desire to do something for its internal rewards such as learning and exploring, rather than a desire to do something due to an external reward or to please another person. Intrinsic motivation to be active is strongly associated with higher levels of activity over a person's lifetime.

Intrinsic motivation is an individual's inner drive to perform a certain action or behave in a specific way. Examples include doing something for pleasure or believing a specific action is the correct thing to do.

Motor skills

An individual's motor skills are linked to increased levels of success and higher levels of physical activity. It is natural for people to enjoy things that they are good at; hence the acquisition of motor skills is vital for young people so that they are more likely to continue pursuing sports and recreational activities as they enjoy experiencing success.

FIGURE 12.2 Development of motor skills is the key to successful experiences when engaged in physical activity.

Age and gender

Age and gender are both influences on an individual. For both of these influences, there are factors that increase the likelihood of being active or inactive. For example, adolescent males are more likely to be active than adolescent girls, perhaps due to greater intrinsic motivation and encouragement from others.

Socioeconomic status

Socioeconomic status (SES) is a term used to describe the social and economic situation of an individual. It incorporates level of education, employment status and income.

There is a strong relationship with increased SES and increased healthy behaviour choices, such as being physically active. For example, a university trained full-time worker on a high income is more likely to engage in physical activity than a school graduate who works part time and earns a small income.

Self-efficacy

Self-efficacy is an individual's belief that they can execute behaviours that can achieve a certain attainment of success.

Self-efficacy is a term used to describe an individual's belief that they can perform at a level where specific tasks can be achieved and goals attained. Individuals with high degrees of self-efficacy are likely to show more resilience when completing a task, particularly when overcoming barriers, leading to persistence and success.

Injuries and disabilities

Short-term injuries and long-term or permanent disabilities often impact negatively on the opportunities individuals have to be active. Injuries restrict the types of activity possible for an individual and can make it more difficult to engage in sufficient activity levels to meet the Australian Physical Activity and Sedentary Behaviour Guidelines (see chapter 11).

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Unit 2 | AOS 1 | Topic 12 | Concept 2

Social environment Concept summary and practice questions

Social environment

The next layer in the social-ecological model is the social environment, which has a significant influence on the individual. Many of the social environment factors that influence an individual's level of physical activity are discussed in the following sections.

Family

The family is a strong influence on an individual's physical activity level, particularly for children and adolescents. If adults in the family are inactive, this behaviour is observed by their children as they serve as role models. Their children's exposure to a variety of activity opportunities, as well as an understanding of the enjoyment of participating in activity, is limited.' Similarly, siblings play an important role in influencing each other to be active.

Family support is another influence on physical activity. Parents who pay membership fees, provide sports equipment and uniforms and transport their children to these sporting and leisure time commitments are demonstrating high levels of support for physical activity.

FIGURE 12.3 A strong social influence on physical activity levels is family.

Spouse or partner

Couples spend a lot of their leisure time together. If both of the individuals in the relationship enjoy being active, they can not only encourage each other to keep fit and healthy but they can also spend time together being active. Many couples walk, ride and go to the gym together, having a healthy and reciprocal impact on each other.

Peers

Peers are those people around you of similar age and include friends. Peers influence each other positively and negatively in relation to their behaviour. Examples include an individual deciding to take on a new sport because their friends have encouraged them to join, and another who drops out of a sport because their friends have left.

Institutions and organisations

Common institutions and organisations are schools, workplaces and communities. For many younger people, school plays a significant role in influencing children and adolescents' activity levels. Workplaces can have a similar impact on adults' physical activity behaviour. Examples of community organisations include local sports centres and local sports teams and clubs.

FIGURE 12.4 Professionals, such as teachers, can have a positive impact on levels of physical activity in students.

Social support

Individuals living in areas where there are strong social support networks are more likely to engage in greater levels of physical activity. This includes social support from local residents through to more organised social support networks, such as rotary groups. For many who live in social isolation, their lack of social support is a barrier to engaging in healthy levels of physical activity.

Healthcare professionals and educators

Healthcare professionals and educators, such as doctors, coaches and teachers, have the capacity to influence an individual's behaviour. Examples include a doctor who advises a patient of the benefits of being active, a teacher who encourages a student to pursue a sport outside of school hours, and a coach who supports the skill development of players.

Community norms and cultural background

Community norms are the behaviours and views that are considered normal within a given community. For example, a community that embraces sport and physical activity as a normal behaviour is likely to be a powerful influence on an individual's behaviour. For many communities, there are strong cultural influences that may have a positive or negative impact on its members' levels of physical activity. In some cultures, women are discouraged from engaging in physical activity. For girls and women in those communities it can be difficult to be active.

Socioeconomic status of a community

The socioeconomic (SES) status of a community relates to the levels of income, education and employment. Similar to the SES of individuals, there is a direct correlation between higher community SES and higher levels of physical activity.

Physical environment

The physical environment is the natural and human-made environment in which physical activity can take place. Like other factors, it can have either a negative or positive impact on an individual's physical activity levels. The physical environment can determine the type and duration of activities that an individual undertakes.

FIGURE 12.5 Having an attractive physical environment for recreational purposes is an important factor in promoting healthy behaviours.

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Unit 2	**Physical environment**
AOS 1	Concept summary and practice questions
Topic 12	
Concept 3	

Natural factors

Natural factors, such as the weather and geography, provide environments conducive to some sports and activities and not others. Increased sunlight is correlated with increased exercise. People who live in places where it is warmer and sunnier for more hours of the day are more active, due to increased opportunity and accessibility. Conversely people who live in places where it is cold, windy and there is less daylight are less likely to engage in healthy levels of activity.

People who live near the beach have the opportunity for more water-based activity while those living in cold, mountainous areas have easier access to snow skiing and other snow-based activities.

FIGURE 12.6 Australia's coastline provides a natural environment that promotes physical activity.

Availability and access to sport and recreation facilities

Parks, playgrounds, bicycle and walking tracks, gymnasiums and specific sports facilities, such as soccer fields, all provide an incentive for individuals to be active. In urban areas there is greater access to sport and recreation facilities and therefore a greater range of activities is available to the community. In rural areas facilities can be limited, which decreases opportunities to be active.

FIGURE 12.7 Provision of sports fields enables participation in sporting teams as an avenue for physical activity.

Aesthetics

Aesthetics refers to the perceived qualities of a particular facility or environment. An aesthetically appealing running track would be one that looks and feels attractive. A flat walking track surrounded by flowers and trees that provide shelter from sun and wind is likely to increase physical activity levels.

FIGURE 12.8 Research shows a link between aesthetically appealing physical environments and greater physical activity levels. Which of these environments would you rather exercise in?

Safety

Safety encompasses a range of factors such as crime rates, traffic and terrain. People are discouraged to be active in areas deemed to be unsafe, such as dark and unlit areas. The volume and speed of traffic can be a barrier to people engaging in physical activity, particularly active transport such as riding or walking to work or school. Making street environments safer by introducing signs that display a reduced speed limit and other traffic control measures such as traffic lights, speed humps and roundabouts can encourage more physical activity.

Community design and public transport

How certain communities are designed can promote or deter physical activity. When there is easy access to shops, public transport and sports facilities, people can find it easier to incorporate walking and riding into their everyday life instead of using their cars. Designing urban spaces with physical activity in mind can enable and motivate individuals and enhance the likelihood of participation. In areas where there are foot and bike paths that are well lit and properly maintained for easy access, people will be more likely to use them.

Policy

This layer of the social-ecological model includes all recommendations, procedures, regulations and legislation that have the potential to affect physical activity. These can include informal local policies or rules, or formal legislation and policies developed by governments (local, state or federal).

Urban planning policies

Many local and state governments legislate that a portion of land be reserved for parks and gardens. Having these policies increases the recreational facilities available to communities and the likelihood that people will use them. Other urban planning schemes include providing footpaths for pedestrians, bike paths for cyclists and designing built environments that encourage physical activity.

FIGURE 12.9 Designated bike paths are increasingly being used by local councils to promote active transport.

FIGURE 12.10 Schools are encouraged to adopt policies to support physical activity, such as providing bike racks to promote students riding to and from school.

Education policies

Each school has its own rules and policies that can promote or deter physical activity. Those that promote movement include compulsory PE class time, provision of sports equipment and access to bike racks and lockers to store equipment. Conversely policies which prevent students wearing their sports uniform to and from school, making certain grounds out of bounds and denying students access to a weights room for safety reasons can deter physical activity.

Workplace policies

Similar to schools, workplaces have their own policies that can impact on employees' physical activity levels. Some workplaces encourage the use of walk and talk meetings, discourage the use of elevators and provide standing desks — all of which reduce sedentary behaviour.

Funding policies

In any government or non-government sector, funding policies play a significant role in whether physical activity initiatives are successful. For example, if a local government wants more people to walk, then funding must be available to provide safe and inviting walking conditions. A state government spending significant money on developing bike lanes is another example of how funding policies can encourage a community to be active.

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Unit 2 | AOS 1 | Topic 12 | Concept 4

Policies Concept summary and practice questions

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Weblink Safe cycling

TEST your understanding

1 Name the four components of the social-ecological model.
2 Discuss the link between an individual's socioeconomic status and their level of physical activity and sedentary behaviour.
3 Define self-efficacy.
4 Provide an example of the influence of parents on children's physical activity levels. Identify the layer of the social-ecological model that the family is part of.

APPLY your understanding

5 The social-ecological model has been designed as a framework for explaining the complex nature of human behaviour, in which many elements interact, are interrelated and interdependent. What do the terms 'interact', 'interrelated' and 'interdependent' mean?
6 Investigate each component of the social-ecological model. Select the five most significant positive influences from the model that promote physical activity for you.
7 Investigate each component of the social-ecological model. Select the five most significant negative influences from the model that act as barriers to physical activity for you.

12.2 Core concepts of the social-ecological model

KEY CONCEPT There are four core principles that guide the use of the social-ecological model.

The social-ecological model provides a framework for understanding the many factors that influence physical activity and sedentary behaviour. These factors may act as either enablers or barriers. The model helps to comprehend a specific problem in a certain context, situation or setting. The social-ecological model can be used to:

- inform strategies or programs aimed to have a positive influence on physical activity levels (these are often referred to as strategies)
- support the implementation of such interventions
- guide the evaluation of these strategies or programs.

The social-ecological model is based on four core principles, each of which is discussed in the following sections.

Core principle 1: multiple factors influence behaviour

The first core principle acknowledges that behaviour is influenced by a wide range of factors. Attempts to change physical activity behaviour must therefore be wide ranging and target all four levels of the social-ecological model. Interrelationships exist between the four layers of the model: each of the four layers (individual, social environment, physical environment and policy) all have an impact on each other.

There is evidence to suggest that interventions to promote physical activity are more successful when multiple components of the model are targeted. For example, a program that includes education about the benefits of an activity (individual level), encourages peers to exercise together (social environment level), promotes physical activity that can be done in any location (physical environment level) and provides equipment as part of a government funding program (policy level) is more likely to be successful than one that is missing one or more of these levels.

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Unit 2 | AOS 1 | Topic 12 | Concept 5

Core principles Concept summary and practice questions

Core principle 2: environments are multidimensional and complex

This core principle highlights that both the social and physical environments contain a vast array of features and characteristics. This includes attributes such as size, temperature, facilities, safety, community norms, cultural backgrounds and accessibility.

As a consequence of these variables, environments are unique and include features that can both encourage physical activity or act as a deterrent. For example, planting attractive flowers and trees may increase the appeal of using a walking track for some, while for others the pollen may trigger hay fever, and hence be a deterrent.

FIGURE 12.11 Help or hindrance?

Core principle 3: human–environment interactions can be described at varying levels of organisation

The social-ecological model recognises that human interaction with the environment occurs at many levels. This includes interactions between individuals, small groups, community groups and larger populations. Consequently, interventions can be targeted towards these different levels. For example, physical activity strategies could include targeting individuals to be more active, encouraging workplaces and schools to promote healthy behaviour and population-based programs. The effectiveness of such programs is enhanced when targeting different levels of human–environment interaction.

Core principle 4: interrelationships between people and their environment are dynamic

FIGURE 12.12 Provision of footbridges and running tracks can promote engagement in physical activity.

There is a dynamic relationship between people and their social, physical and policy environments. Individuals can have an impact on the health of these environments and these environments can have an impact on the behaviour of individuals, groups and populations. The environment can determine, help or hinder the type and amount of physical activity people undertake. Changes in the environment can enhance the opportunity for movement and physical activity. Some examples of such interrelationships between people and their environment include the following:

- A physical environment that is regularly cold, wet and windy reduces people's capacity to engage in activities such as swimming and walking (environment affecting behaviour)
- If many people are walking to and from the town centre this behaviour could encourage a local council to build safe, flat and well-lit walking paths (behaviour affecting the physical environment)
- A social environment that encourages people to ride to work or school is likely to influence more people to use active transport (environment affecting behaviour)
- Role models, such as sports stars, health professionals and educators, engaging in physical activity is likely to promote a culture in which sport and recreation are seen as positive and desired (behaviour affecting the environment)

- A school policy environment that allows students to wear their runners at lunch time and recess to play sport may increase the level of activity among the students (environment affecting behaviour)
- The presence of many school students playing downball at school may influence school leaders to build more downball courts for the students (behaviour affecting environment).

FIGURE 12.13 A physical environment that encourages opportunities for safe experiences when being active can have a powerful influence on reducing sedentary behaviour.

There is much evidence to suggest that if the physical environmental is conducive to physical activity then other strategies and programs aimed at increasing physical activity are likely to be more successful. Conversely, there have been many examples of theoretically good interventions adopted which ultimately end up unsuccessful due to poor physical environmental conditions.

Understanding the core principles of the model is an important part of appropriately applying the social-ecological model to design, implement and critique interventions aimed at promoting physical activity and reducing sedentary behaviour.

TEST your understanding

1. The social-ecological model provides a framework for understanding the many factors that influence physical activity and sedentary behaviour. These factors may act as either enablers or barriers. Make a list of three enablers of and three barriers to physical activity.
2. How many core principles guide the social-ecological model? Name each principle.
3. Describe why multiple components of the social-ecological model are targeted when designing physical activity and sedentary behaviour interventions.
4. Core principle 2 highlights that both the social and physical environments contain a vast array of features and characteristics. List three examples of these.

APPLY your understanding

5. Provide an example in which a physical-activity intervention may act as a barrier to physical activity.
6. The social-ecological model recognises that human–environment interactions can be described at varying levels of organisation. Provide two examples of such human–environment interaction.
7. Discuss the link between physical environment interventions and physical activity. Provide an example at your school of such a relationship.

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Interactivity
Enabler or barrier
Searchlight ID: int-6655

12.3 Applying the social-ecological model: a settings-based approach

KEY CONCEPT A settings-based approach is a common way that physical activity and sedentary behaviour interventions are implemented.

The social-ecological model is used by health-promotion educators and experts to design strategies and programs to promote healthy lifestyle choices, such as increasing the level of physical activity and decreasing inactivity within individuals, populations and sub-population groups. Examples of subpopulation groups include those based on gender, ethnicity, indigenous status, people with disabilities and age.

A popular method of targeting interventions to enhance physical activity is via a **settings-based approach**. A setting can be defined as a place within which physical activity can occur and a strategy can be targeted. The three most common and relevant settings for physical-activity promotion initiatives are schools, workplaces and communities.

A **settings-based approach** involves strategies aimed to encourage healthy behaviour in specific environments known as settings, such as school, work and community settings.

FIGURE 12.14 Playground equipment provides an opportunity for children to engage in active play within school and community settings.

There are many **stakeholders** interested in promoting healthy behaviours. These include schools, workplaces and specific community groups and organisations. In addition, there is a range of local, state and national organisations that implement a settings-based approach. Examples include government-funded organisations such as VicHealth and local councils and non-government organisations including the National Heart Foundation and Women's Health Victoria.

Stakeholders are individuals or groups of people who have a vested interest in a particular issue.

There is an increased understanding within the community that an inter-sectorial approach is more effective than organisations working in isolation. The term inter-sectorial refers to different sectors (distinct groups, organisations and people) working together for the same purpose of increasing physical activity and decreasing sedentary behaviour.

A settings-based approach: schools

Schools are a great setting to be targeted for physical activity interventions because they reach most children. There are many organisations that provide advice, curriculum resources and a range of programs designed to promote increased physical activity and decrease sedentary behaviour. Schools often select a range of strategies to promote these healthy behaviours. Schools themselves are a powerful influence on students and therefore can implement not only other organisations' ideas but their own. When doing so, the core principles of the social-ecological model need to be adhered to in order to have the greatest chance of behaviour change. In particular, targeting multiple layers of influence is essential to ensure that the environment is conducive for physical activity.

Individual interventions

In the following list are some of the school-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the individual.

- Providing education programs aimed to promote an understanding of the physical, social, emotional and mental benefits of being active
- Providing education programs aimed at helping students to understand the poor health outcomes associated with sedentary behaviour
- Providing fundamental motor skill programs to enhance all-round physical ability
- Giving sport-specific skill training
- Implementing mentoring programs that focus on improving an individual's skills as well as their beliefs and attitudes about physical activity
- Providing a Physical Education curriculum that creates enjoyment and engagement for students
- Offering activities that develop self-efficacy and motivation
- Offering activities that have an appropriate degree of modification to enable injured or disabled students to participate in sports and recreational activities. For example, a student who is injured and cannot run may still be able to play as a goalkeeper in European handball, while a visually impaired student may participate in cricket using modified rules and equipment.

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Applying the model to schools
Concept summary and practice questions

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Weblink
Disability and sport

Social environment interventions

Some of the school-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the social environment include the following:

- Providing community education programs that educate students' families about the benefits of increasing physical activity and reducing sedentary behaviour
- Engaging community groups to promote healthy behaviours, such as working with local sports clubs
- Developing peer programs, such as older students working with younger students in Physical Education classes and other intra-school activities
- Developing social marketing campaigns, such as promoting ride to school day via the school website, Facebook page or Twitter feed
- Teachers role-modelling healthy physical activity behaviour by riding to and from work and walking around at lunch time
- Teachers using active learning strategies to minimise students sitting and promoting movement during class time
- Using guest speakers such as local healthcare professionals or athletes to increase student motivation

FIGURE 12.15 Organised sporting competitions provide a strong social influence in local communities.

Physical environment interventions

Some of the school-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the physical environment include the following:

- Providing bike racks and shower facilities to encourage active transport to and from school
- Distributing sports equipment at recess and lunch

- Providing safe, age appropriate and attractive sports grounds and facilities for use during the school day
- Reducing seats available during recess and lunch to discourage sedentary behaviour
- Providing standing desks in classrooms and maximising learning areas to encourage movement during class
- Providing large lockers for students to enable them to bring in sports equipment for storage while in class

eBook*plus*

Weblink
Jump Rope for Heart

FIGURE 12.16 Providing lockers supports students who need storage space for sporting equipment and clothing.

Policy interventions

Some of the school-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the physical environment appear in the following list.

- Implementing school policies that allow students to wear their PE uniform to and from school have been shown to not only increase physical activity levels to and from school, but also at school and at home after school
- Opening up sports facilities such as ovals, gymnasiums and weights room for students to use during breaks
- Increasing break time for unstructured play during school hours
- Funding for provision of sports equipment and safe facilities for use
- Mandating more PE and sport time during the school week
- Providing timetables that promote student movement between classes rather than remaining in the same room for the entire day

FIGURE 12.17 Jump Rope for Heart encourages school-aged children to get active through skipping.

Outside organisations

There are many examples of outside organisations supporting schools by providing access to specific programs that aim to promote physical activity and reduce sedentary behaviour. Following are two examples of such programs operating in Victoria.

National Heart Foundation's Jump Rope for Heart

Jump Rope for Heart is a program developed by non-government, not-for-profit organisation the National Heart Foundation (NHF). It has been a highly successful program. Since its inception in 1983, over 8 million students and 90 per cent of all Australian schools have participated. Approximately 280 000 students and 1400 schools participate annually.

Jump Rope for Heart has mutually beneficial outcomes for both schools and the NHF. Jump Rope for Heart supports students to get fit and learn new skills; it teaches students about community and compassion and raises funds for schools to purchase sports equipment. At the same time the NHF raises funds to further its ability to deliver heart health messages to the Australian population.

This physical-activity intervention targets the multiple layers of influence in the social-ecological model in the following ways:

- Individual
  - Jump Rope for Heart provides awareness and education about the link between exercise and improved health outcomes.
  - Jump Rope for Heart teaches students how to skip, increasing their skill level, self-efficacy and motivation.
- Social environment
  - Skipping with peers is used as a motivational tool to get more students involved.
  - Teachers are used to provide encouragement and support for students.
- Physical environment
  - Skipping can be done any time of the year, indoors or outdoors, on virtually any surface.
  - The school provides the facilities for the students.
- Policy
  - The NHF fully funds the provision of skipping ropes and resources, ensuring there is no cost to the school.
  - The NHF donate some of the funds back to the school, making it more attractive for schools to get involved.

VicHealth's Walk to School

VicHealth is an organisation fully funded by the Victorian government. The VicHealth Walk to School program is an annual event that has been in existence since 2006. It provides awareness to students about the physical, social and environmental benefits of active transport via walking. It encourages students to walk to and from school more often.

The program takes place each October, encouraging students to walk to school from the first day of term 4 to the end of October. It is hoped that the experiences of walking during this time encourage students to continue walking throughout the remaining school months. In addition to this program, VicHealth has developed a range of walk-to-school programs and funds Victoria Walks.

FIGURE 12.18 VicHealth is a government organisation that promotes good health and disease prevention in the community.

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Weblink
VicHealth Walk to School

FIGURE 12.19 An annual program since 2006, the VicHealth Walk to School program has been successful in encouraging walking to and from school.

FIGURE 12.20 Traffic control measures such as signs increase the degree of safety around schools.

This physical-activity intervention targets the multiple layers of influence in social-ecological model in the following ways:

- Individual
  - The program provides awareness of the physical health benefits of walking to and from school and links the program to the National Physical Activity and Sedentary Behaviour Guidelines.
  - Walk to School increases awareness of the other benefits of walking, including the better social and environmental outcomes of walking instead of driving.
- Social environment
  - Walk to School encourages students to walk together.
  - VicHealth uses local councils to provide support, education and funding for schools, increasing the use of the community in encouraging walking.
- Physical environment
  - Some local councils have made changes such as increased lighting on walking paths and tracks to enhance perceived safety when walking to and from school.
  - Less traffic leads to decreased congestion and reduced environmental impact.
- Policy
  - VicHealth provides $10 000 of funding to local councils to increase the opportunities for schools to get involved with the program.
  - VicHealth provides free resources, such as stickers, pamphlets and an app, that schools and students can use to enhance the awareness and opportunities for students to walk to and from school.

A settings-based approach: workplaces

There is an alarming trend as people enter the workforce; their overall physical activity levels reduce, leading to increased chances of poor health outcomes that not only have an negative impact on the individual, but also on society.

There are many workplaces that encourage their employees to be active, while many believe that they have no responsibility or reason to do so. There is, however, ample evidence that promoting physical activity and reducing sedentary behaviour can significantly benefit the employer. Some examples include:

- reduced staff illness
- decreased staff turnover (people leaving and having to be replaced)
- increased productivity
- fewer injuries
- increased happiness
- speedier recovery from illness
- a better image for the company.

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Individual interventions

Some examples of workplace-based initiatives to promote physical activity and reduce sedentary behaviour at the individual level appear in the following list.

- Providing education programs aimed to promote an understanding of the physical, social, emotional and mental benefits of being active
- Providing education programs aimed to get employees to understand the poor health outcomes associated with sedentary behaviour
- Providing information about safe walking or cycling routes to and from work
- Asking staff about what strategies could be adopted to make the workplace a healthier and safer place to be

Social environment interventions

Some examples of workplace-based initiatives to promote physical activity and reduce sedentary behaviour at the social environment level appear in the following list.

- Using guest speakers such as local health care professionals or athletes to increase employee motivation

- Providing walk and talk opportunities, so that people can exercise during meeting time instead of being sedentary, e.g. sitting
- Encouraging staff to exercise together during breaks
- Encouraging team sports to take place at lunch breaks as an alternative to sitting down
- Allowing employees to bring their dogs into work

FIGURE 12.21 Some workplaces encourage employees to bring their dogs to work to promote extra physical activity.

Physical environment interventions

Some examples of workplace-based initiatives to promote physical activity and reduce sedentary behaviour at the physical environment level appear in the following list.

- Providing bike racks and shower facilities to encourage active transport to and from work
- Having sports equipment available for use during breaks
- Providing safe facilities for use by staff, such as a gym
- Giving access to standing work stations
- Making lockers available for staff to store work clothes
- Having safe and well-lit floor plans to encourage movement around the workplace

Policy interventions

Some examples of workplace-based initiatives to promote physical activity and reduce sedentary behaviour at the policy level appear in the following list.

- Subsidising or paying for work-based sports teams such as Futsal or Volleyball
- Supporting staff to enter a corporate challenge triathlon
- Allowing more flexible work times for staff to accommodate physical activity, including longer lunch breaks and later starting times to allow for active transport time
- Discouraging the use of emails as an internal communication tool while encouraging people to walk to each other to communicate

Outside organisations

There are many examples of outside organisations supporting workplaces by providing access to specific programs that aim to promote physical activity and reduce sedentary behaviour.

eBook*plus*

Weblink
Heart Foundation Active Workplaces

Heart Foundation Walking @ Work

An initiative by the National Heart Foundation, Heart Foundation Walking @ Work is one of many walk-promotion initiatives as part of the Heart Foundation Walking program. It is specifically tailored to promote increased levels of walking in workplace settings. It offers workplaces the opportunity to work in collaboration with the Heart Foundation to promote walking as an alternative to sedentary behaviour, e.g. sitting, at work. Some examples of how this program is mapped to the social-ecological model are described.

FIGURE 12.22 The Heart Foundation encourages active workplaces through its Walking @ Work program.

- Individual strategies
  - Distribution of regular e-newsletters educates participants about the health benefits of walking.
  - Access is provided to the 'walker recognition scheme' which gives incentives and rewards for individuals.
- Social environment strategies
  - Collaboration between individual workplaces and the Heart Foundation ensures there is internal and external support for staff.
  - Encouragement to walk together as part of the program aims to promote both physical and social health.
- Physical environment interventions
  - Workplaces are encouraged to be physical environments that are conducive to movement via walking.
- Policy interventions
  - After a small donation from a workplace, the Heart Foundation funds access to a range of human and digital support.

A settings-based approach: community

In addition to work and school-based interventions, there are many community-based strategies and programs that aim to get people more active. These are initiated by a wide variety of stakeholders including government and non-government organisations, private companies, sports clubs, and formal and informal groups.

Local councils, in particular, play a significant role in supporting communities to be more physically active, and have a vested interest in the health and wellbeing of their constituents. Largely funded by local taxpayers, councils provide a range of services, many of these aiming to promote a healthy lifestyle. Some examples of how local councils use the social-ecological model to promote physical activity and reduce sedentary behaviour are listed in the following sections.

Individual interventions

Below are some of the community-based interventions to promote physical activity and reduce sedentary behaviour that focus on the individual.

- Delivering education programs through council-funded healthcare centres
- Using physical activity behavioural prompts, such as street signs promoting walking and bike riding as an alternative to driving

FIGURE 12.23 Walking signs are often a prompt to get people thinking about being more active.

Social environment interventions

Some of the community-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the social environment appear in the following list.

- Using local healthcare professionals to engage the community in promoting physical activity
- Working with local businesses and sports clubs to promote sport and recreation activities
- Providing fun runs and other events that promote physical activity

Physical environment interventions

Some of the community-based initiatives to promote physical activity and reduce sedentary behaviour that focus on the physical environment include the following:

- Maintaining safe and aesthetically appealing grounds, parks, walking and bike paths
- Providing many different types of physical activity facilities to cater for subpopulation groups, such as a skateboard rink for children and adolescents and lawn bowls for older people
- Designing urban spaces that enable people to easily move around from place to place via walking, running, cycling or riding scooters
- Making council halls and gymnasiums available for use by locals

Policy interventions

Some of the community-based initiatives to promote physical activity and reduce sedentary behaviour that focus on policy appear in the following list.

- Funding initiatives that invest money into sports facilities
- Enforcement of speed control measures such as 40 km speed limits, roundabouts and speed humps that increases perceptions of safety and use of active transport
- Providing subsidies for concession card holders, such as pensioners, at local government-funded gymnasiums and recreation centres

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VicHealth as an example of community-based interventions

VicHealth uses a variety of different community-based interventions that operate alongside each other to engage more people in sport and recreation. VicHealth targets all layers of the social-ecological model. In addition, multiple components within each layer increase the likelihood of positive outcomes across all dimensions of health.

VicHealth's Active Club Grants

VicHealth's Active Club Grants offer community-based groups, such as recreational and sports clubs, funding to purchase equipment, sports uniforms or injury-prevention items such as padding for goal posts or shin guards. Clubs are selected on their capacity to provide opportunities to engage more people in safe and enjoyable physical activity. There are two tiers of funding for sports and recreation clubs, with Vic Health currently offering grants of either $3000 or $10 000.

FIGURE 12.24 VicHealth's Active Club Grants support the growth of community sports clubs.

FIGURE 12.25 The AFL's Change the Game has been highly successful, resulting in a significant increase in females playing Australian Rules football.

VicHealth's Changing the Game: Increasing Female Participation in Sport Initiative

VicHealth is funding six sporting codes to work alongside women and girls who are not normally involved with traditional sports clubs and competitions. The program features high-profile sports people who were interviewed about their views on female participation, with the aim of raising the awareness and profile of female sport.

AFL Victoria (AFL)

AFL Active is an activity-based program that aims to develop fitness components using a total body workout that is aimed to appeal to females. It can be delivered anywhere using AFL-specific non-contact skills over a designated time frame.

Cycling Victoria

Cycling Victoria has developed a Social Spin program providing female-only spin classes in aesthetically appealing locations such as local parks. Pitched to promote enjoyment, skill and confidence, normal bikes are put onto wind trainers (a machine that enables a cyclist to pedal without the bike moving) before progressing to short-distance bike rides as the program develops.

FIGURE 12.26 Social Spin classes operate in various locations across the state.

Gymnastics Victoria

Gymnastics Victoria aims to motivate women to develop dominant movement patterns to enhance their strength, flexibility and overall health and wellbeing. Short videos have been produced so that women can learn fundamental movement skills in their own time, at their own pace, in their own home or even via a social club program. The program is called Move My Way.

FIGURE 12.27 Move My Way is a VicHealth and Gymnastics Victoria initiative to promote physical activity in the community.

Netball Victoria

Netball Victoria has developed Rock Up Netball, which is a 'pay as you go' program aimed at girls and women over 15. It aims to engage females of all abilities under the supervision of skilled coaches who conduct skill drills and game play.

FIGURE 12.28 Rock Up Netball encourages people to get involved in community-based netball games.

Surfing Victoria

Coasting is a beginners' program that delivers Stand Up Paddleboarding (SUP) sessions for both women and girls of school age. The focus is on the fun and social aspects of water-based activities. Surfing Victoria's introductory program Coasting delivers SUP sessions for women in beach, bay and inland locations across the summer. Sessions are tailored for women who may be trying SUP for the first time. Both the introductory sessions and the SUP school sessions have a focus on having a fun, enjoyable and social experience out on the water.

FIGURE 12.29 Stand Up Paddleboarding provides the opportunity for individuals to learn new skills through this aquatic-based activity.

Tennis Victoria (Tennis Australia)

Get into Cardio Tennis is a program targeting women who are sedentary or have low levels of physical activity. The program incorporates low impact movement patterns using tennis racquets and balls in a fun, social environment. It can be delivered to large groups and run in a variety of settings such as workplaces and local parks.

FIGURE 12.30 The aim of cardio tennis is to get fit while having fun.

FIGURE 12.31 TeamUp is a program that encourages people to exercise together.

VicHealth's TeamUp

TeamUp is a free app that promotes structured physical activity and recreational opportunities to the community. It aims to make physical activity enjoyable, accessible and social. TeamUp aims to remove many of the barriers that prevent people being active, including cost, transport, time and social connections. Both individuals and sporting organisations can use the app.

FIGURE 12.32 The TeamUp application is free.

How VicHealth's initiatives target the social-ecological model

Some ways that VicHealth's community-based physical activity interventions target the different layers of the social-ecological model appear in the following list.

- Individual interventions
  - VicHealth's programs target a wide range of activities to motivate a broad group of individuals as well as removing individual barriers, such as cost, time and lack of education about the benefits of exercising.
  - Motor skills and self-efficacy are promoted.
- Social environment interventions
  - The programs work alongside a wide variety of community groups and sporting organisations in an inter-sectorial approach to promote safe physical activity.
  - The social aspect of engaging in physical activity is fostered in formal and informal sports and recreational activities.

- Physical environment interventions
  – Many programs are implemented in any physical environment, increasing the access to appropriate places to exercise in all communities.
  – Sports clubs are given funding to purchase safe and functional sports equipment, and training and playing facilities for the community to enjoy.
- Policy interventions
  – Money is provided for the funding of free apps that promote physical activity.
  – Funding is spread across a wide variety of interventions, increasing the likelihood of more people responding positively to one or more of these strategies.

TEST your understanding

1 List the three most common settings used for physical activity programs.
2 For each of the settings listed in the first question, give an example of an external program that is offered to schools to support movement and physical activity.
3 In what type of setting do local councils predominately aim to promote healthy levels of activity?
4 Describe how policies can have an impact on the level of physical activity in a setting of your choice.

APPLY your understanding

5 You are a principal of a primary school. Use the social-ecological model to describe two strategies for each layer of the model that will promote greater levels of moderate to vigorous exercise at the school.
6 You are a principal of a primary school. Use the social-ecological model to describe two strategies per layer of the model that will reduce levels of sedentary behaviour in the classroom.
7 You join a new company as an employee and notice that many of your colleagues are engaging in unhealthy behaviour, such as sitting down most of the day and driving to and from work. List the benefits your employer may gain if people are more active and less sedentary.
8 You are the president of a local sports or recreation club and want to offer members of the community who are disabled a chance to play at your club. Your task is to:
   - select the type of sports or recreation club
   - visit the **Disability and sport** weblink in your eBookPLUS
   - select a category of disability you would like to target (e.g. visually impaired, hearing impaired, paraplegics, intellectual impairment)
   - visit the **Play by the Rules** weblink in your eBookPLUS
   - use the seven pillars of inclusion to help you plan how you are going to include your target group into your club
   - present your findings to the class using an appropriate presentation tool.
9 Indigenous Australians are often less active than non-Indigenous Australians. Use the **Closing the Gap** weblink in your eBookPLUS to research an existing program that aims to promote physical activity within this disadvantaged population group. Explain how the program works.
10 Use the **Sports Without Borders** weblink in your eBookPLUS to answer the following questions in your own words.
   - What is the aim of this non-profit organisation?
   - Describe one initiative this organisation has implemented to encourage people from culturally diverse backgrounds to be physically active. Explain what benefits the initiative brings to the participants and the wider community.
   - Devise a sports program for your community that could encourage people from culturally diverse backgrounds to participate.

eBook*plus*

Weblinks
Disability and sport
Play by the Rules
Closing the Gap
Sports Without Borders

For more information on programs for culturally and linguistically diverse communities see chapter 16.

12.4 Youth Physical Activity Promotion Model

KEY CONCEPT The Youth Physical Activity Promotion Model is a framework for promoting physical activity in youth, and highlights the many personal, social and environmental factors that influence physical activity behaviour. It can be used as an alternative to the social-ecological model.

In recent years, health promotion experts have increasingly used an alternative model when tracking the physical activity levels of younger people. Youth are motivated and influenced in different ways to adults and as such, a separate model is used in an attempt to explain and influence their behaviour. This model is called the Youth Physical Activity Promotion Model (YPAP). The YPAP is similar to the social-ecological model in many ways, highlighting the many personal, social and environmental factors that influence physical activity behaviour. Other similarities between the social-ecological model and the YPAP include the following:

- There are multiple influences on behaviour.
- Both models support and embed a range of alternative theories.
- Both models recognise the complexity of human behaviour.
- Both models acknowledge there are direct and indirect factors that influence behaviour.
- Both models recognise that the relationship between an individual and the environment is a reciprocal one (i.e. an individual can affect the environment and the environment can influence an individual's behaviour).

The YPAP is a simpler model than the social-ecological model, which is why it appeals to researchers and other groups who aim to improve the physical activity levels of younger people. The term youth in this model relates to any child or adolescent of primary or secondary school age. The YPAP acknowledges the unique characteristics of children in relation to their physical, mental and emotional development. The YPAP Model is constructed using three broad factors that collectively affect children and adolescents' physical activity behaviour. These include:

- predisposing factors that reflect the desire and interest to be active
- enabling factors that allow young people to be active
- reinforcing factors that support a child or adolescent to be active.

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The YPAP Model Concept summary and practice questions

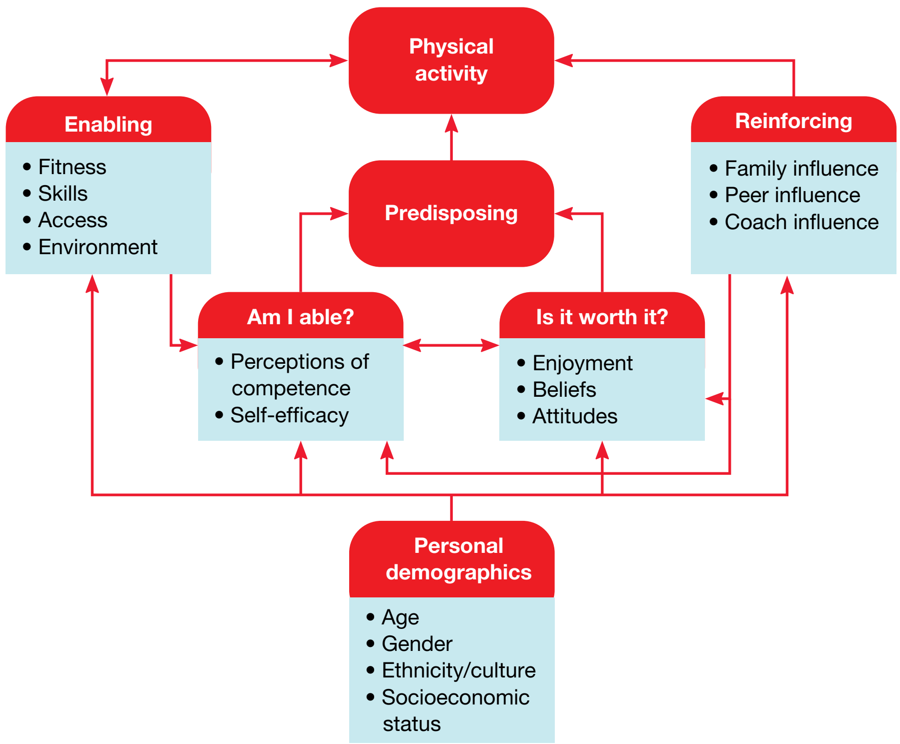

FIGURE 12.33 The YPAP is a conceptual framework designed to support the design, implementation and critique of physical-activity promotion initiatives and strategies for youths.

Predisposing factors

Predisposing factors are viewed as the predominant influence on youth physical activity levels. The YPAP Model focuses primarily on two key questions: *Am I able?* and *Is it worth it?*

Am I able?
This question focuses on the perceived competence of an individual to engage in physical activity. Perceived competence is the individual's own opinion of how good they are at a particular activity. This question also covers variables such as self-efficacy and how an individual values their own physical self-worth.
Is it worth it?
This question focuses on the benefits and costs to the individual. These include both cognitive and affective factors. Cognitive factors include perceived benefits, attitudes and beliefs about the value of physical activity. Affective factors include how individuals feel about being active. This includes enjoyment and interest in being physically active.

There are many people who understand the importance of being active and value it. Many, however, do not actually engage in physical activity. The question *Am I able?* is a vital link between thought and action.

Children and adolescents who believe that they are able to participate in sport and other forms of physical activity are far more likely to persist. This persistence will increase the likelihood of improved skill, enjoyment and success (that can be measured in a variety of ways) and subsequent continuation of physical activity into adulthood. Youths who can answer *yes* to both questions are therefore far more likely to be physically active for life.

Enabling factors

Enabling factors by themselves are not sufficient to ensure higher levels of physical activity. They do, however, provide the opportunity for physical activity and are therefore an important aspect of the YPAP Model. Enabling factors can be broadly classified as either biological or environmental.

TABLE 12.1 Enabling factors of the YPAP Model

Biological enablers	Environmental enablers
Physical fitness	Parks
Healthy body fat level	Gardens
Skill level	Walking tracks
	Programs that promote physical activity
	Availability of spaces to play
	Good weather
	Presence of safe footpaths
	Access to equipment

FIGURE 12.34 Physically fit individuals are more likely to participate in regular physical activity.

Youths that possess the biological enablers such as being physically fit, having a healthy level of body fat and good skill levels are more likely to have a positive body image. These youths are more likely to pursue opportunities to be active, are more likely to persist in activity for longer durations and be more successful in the activity.

Environmental enablers are an important part of any initiative to promote physical activity. Some climates are much more conducive to physical activity. There is evidence indicating that the more sunshine there is, the more likely children and adolescents will pursue physical activity opportunities outdoors. Two significant environmental enablers are access to safe and user-friendly spaces in which to be active and access to community-based programs, particularly in rural areas. This includes programs that promote awareness of the benefits of being active, and sports and recreation clubs.

Reinforcing factors

Reinforcing factors are predominantly social variables that have a direct influence on youth physical activity levels. The prime reinforcers are family, peers and coaches, but could extend to other role models such as teachers. Along with other factors there are direct and indirect influences on behaviour.

Direct reinforcement includes parents driving children to sports training and games, families exercising together, parents paying registration fees and encouraging physical activity. This encouragement is also seen in peer and coach interactions.

Although encouragement is a direct reinforcement tool, it often results in indirect promotion of physical activity via a youth's perception of their competence (more important than the actual level of competence). Studies show a clear link between perceived competence and increased physical activity levels. Although role modelling of physical activity by parents can influence behaviour, children are more likely to be physically active if their parents encourage them to see being active as part of their own identity.

Personal demographics

Demographics are at the base of the YPAP Model as they lay the foundation for how the various influences combine to impact on physical-activity behaviour. Personal demographics included in the model include age, gender, ethnic/cultural background and socioeconomic status. There are considerable cultural factors in addition to differences between development levels that influence physical activity.

All other factors being equal there is inequality in the levels of physical activity in young people, with males more likely to be active than females. This is linked to an increased intrinsic motivation in boys (predisposition) and more consistent encouragement to be active (reinforcement).

Strategies to promote physical activity in boys should therefore continue to be linked with reinforcement that promotes intrinsic motivation. Girls, on the other hand, tend to be more active through consistent reinforcement (from families, peers and coaches) and react more positively than boys to extrinsic rewards (e.g. encouragement, recognition, certificates and medals).

FIGURE 12.35 Activities that promote enjoyment and success are likely to encourage ongoing participation in sport and physical activity.

Using the Youth Physical Activity Promotion Model

The YPAP Model can be used to design, implement or evaluate programs aimed to increase youth physical activity levels. Promotional strategies include direct and indirect influences that:

- improve perceptions of competence (*I am able*)
- improve attraction to physical activity (*It is worth it*)
- strengthen enabling factors
- strengthen reinforcement factors
- cater for the personal demographics within a population.

Schools play a valuable role by ensuring that PE classes promote skill and fitness development (*I am able*) via a wide variety of activities in an engaging and fun environment (*It is worth it*). Other initiatives to promote activity during the school day should also be embraced.

Community programs reach large sections of the community, including children, in a cost-effective way. These programs increase access to both facilities and programs. Facilities include bike parks, sports halls and ovals, recreation centres, walking tracks and playgrounds. Programs that focus on improvement and self-mastery are key aspects of initiatives aimed to promote development and enjoyment in children. Many sports organisations, for example, understand the positive impact that modified rules have on children — minimising competition while maximising opportunities for children to have successful and fun sporting experiences. This increases the probability of ongoing participation in sports and other physical activities.

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An example of applying the YPAP Model in a primary school setting

Schools provide an ideal setting for use of the YPAP Model. The following is an example of how a primary school could adopt a school-wide approach of increasing physical activity.

1. **Improve levels of competence (*I am able*) by:**
   - employing appropriately trained PE teachers and coaches who aim to promote skill acquisition
   - focusing on what students can do rather than what they cannot
   - providing an environment via modified games and activities where success can be achieved by all (focusing on other ways that success can be measured instead of winning)
   - setting achievable targets and encouraging students to show persistence and patience throughout their learning journey
   - providing a range of activities to enable a breadth of skills to be developed.
2. **Improve attraction to physical activity (*It is worth it*) by:**
   - developing a culture in which engagement in physical activity is associated with enjoyment rather than competition
   - educating students about the links between movement and all dimensions of health
   - providing education about the potential consequences of sedentary behaviour.
3. **Strengthen enabling factors by:**
   - developing aerobic fitness in PE and Sport classes
   - promoting skill acquisition in PE and Sport classes
   - ensuring students have access to equipment and facilities during breaks
   - providing access to equipment and facilities during before- and after-school programs
   - providing safe and appealing play spaces.
4. **Strengthen reinforcement factors by:**
   - educating parents about the links between physical activity and health
   - encouraging walk or ride to school programs that encourage families to engage in active transport together

- using peers to encourage greater levels of physical activity in those likely to be sedentary during free time
- teacher modelling of healthy behaviour by organising staff versus student sports games, joining in a game at break time or walking around during yard duty supervision instead of remaining in a stationary position
- PE teachers encouraging students to be active by joining sports or recreational groups at school or in the community
- Principals or other teachers celebrating sports achievements and involvements at assemblies and in newsletters.

5. **Cater for the personal demographics within a population by:**
   - offering a wide range of sport and physical activity opportunities that appeal to both genders
   - selecting activities that not only appeal to children but are also appropriate for the relevant year levels
   - understanding the socioeconomic status of the community and mapping activities that are accessible for the student population and their families
   - offering programs to potentially disadvantaged students, such as the disabled or those from different ethnic backgrounds
   - considering the given population's specific needs prior to initiation of a program.

These suggestions provide examples of how the YPAP Model could be used as a framework to promote physical activity within a particular setting. Via the predisposing, enabling and reinforcing factors, children are more likely to engage in healthy levels of physical activity and sedentary behaviour if they feel that *Yes, I am able* and *Yes, it is worth it*!

FIGURE 12.36 PE classes at school need to be fun, engaging and accessible.

CHAPTER 12 REVISION

KEY SKILLS

- Apply a social-ecological model and/or the Youth Physical Activity Promotion Model to critique physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour for a range of populations in a variety of settings

UNDERSTANDING THE KEY SKILLS

To address this key skill, it is important to remember the following:

- when applying the social-ecological (SE) model or the Youth Physical Activity Promotion Model (YPAP) a critique of how effective specific initiatives and strategies have been in increasing physical activity and/or reducing sedentary behaviour is required
- the term 'critique' is used when asked to evaluate a practice in a detailed and analytical manner
- a stem will provide clues to what has been done to promote physical activity — reading this carefully is vital.

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

PRACTICE QUESTION

Jump Rope for Heart is a program developed by non-government, not for profit organisation the National Heart Foundation (NHF). It has been a highly successful program. Since its inception in 1983, over 8 million students and 90 per cent of all Australian schools have participated. Approximately 280 000 students and 1400 schools participate annually.

Jump Rope for Heart has mutually beneficial outcomes for both schools and the NHF. The school supports students to get fit and learn new skills, and it teaches students about community and compassion while raising funds for the school to purchase sports equipment. It provides free resources to get the program started. The program can be delivered at any time of the year in any venue that the school chooses. It uses teachers to encourage students to join.

Use the social-ecological model to **critique** why the NHF's Jump Rope for Heart program has been successful. In your critique, explain **why** this program has been successful, using examples from the information provided above. *5 marks*

Sample response

This program has been successful as it has targeted all layers of the social-ecological model. (NB: *This sentence also answers why this program has been successful*). It has targeted the individual by promoting new skills. It has used teachers as a source of encouragement, therefore using the social environment. By running a program that can delivered at any time of the year in any venue that the school chooses, it can be done in any physical environment. From a policy perspective it provides free resources for schools, enabling all to participate as cost is no barrier.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action words**: **Critique** — requires an explanation of **why** this program has been successful
- **Key terminology** — Social-ecological model must be used for this question. Information provided above indicates that the response must only relate to what is written in the stem using examples found in this text.
- **Key concept/s** — Targeting all layers of the social-ecological model is vital for successful programs.
- **Marking scheme** — 5 marks — always check marking scheme for the depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

- **1 mark** — for identifying that this program has been successful as it has targeted all layers of the social-ecological model
- **1 mark** — for highlighting that it targeted the individual by promoting new skills
- **1 mark** — for highlighting that it targeted the social environment by using teachers as a source of encouragement
- **1 mark** — for highlighting that it targeted the physical environment by using a program that can be delivered at any time of the year in any venue
- **1 mark** — for highlighting that it targeted the policy environment by providing free resources for schools

PRACTISE THE KEY SKILLS

1. Select any VicHealth program aimed at promoting physical activity in the community. Use the social-ecological model to critique the chosen program.
2. Select any National Heart Foundation program aimed at promoting physical activity in the community. Use the social-ecological model to critique the chosen program.
3. Select a setting (school, work, community). For your chosen setting design a physical-activity promotion or sedentary behaviour reduction strategy. Use either the social-ecological model or the Youth Physical Activity Promotion Model to support the proposed design and implementation of your strategy.

KEY SKILLS EXAM PRACTICE

1. Healthy Primary School Principal Mrs Smith is always looking for opportunities to improve the health and wellbeing of the students that attend this school. There are terrific before- and after-school activity programs and great opportunities for the students to be active during lunch. Mrs Smith, however, is concerned about the levels of sedentary behaviour within class time during the day.
   (a) Give an example of a type of sedentary behaviour likely to be seen within class time. *1 mark*
   (b) With reference to Australia's Sedentary Behaviour Guidelines, explain what the aim of Mrs Smith should be regarding reducing sedentary behaviour. *2 marks*
   (c) Using the social-ecological model as a guide, come up with four strategies (one for each layer of the model) that may reduce sedentary behaviour in the students. *4 marks*

CHAPTER REVIEW

CHAPTER SUMMARY

- A systems-thinking approach to behavioural change, such as decreasing sedentary behaviour and increasing physical activity levels is adopted, with support from models and used across a range of disciplines.
- Two models are used in VCE Physical Education: The social-ecological model and the Youth Physical Activity Promotion (YPAP) Model.
- The social-ecological and YPAP models are used to design, implement and analyse (critique) strategies and programs aimed at promoting physical activity and discouraging inactivity.
- There are four components of the social-ecological model: individual, social environment, physical environment and policy.
- The first of four core principles of the social-ecological model is that multiple factors influence behaviour.
- The second of the four core principles of the social-ecological model is that environments are multidimensional and complex.
- The third of the four core principles of the social-ecological model is that human–environment interactions can be described at varying levels of interaction.
- The last of the four core principles of the social-ecological model is that the interrelationships between people and their environment are dynamic.
- A settings-based approach is a common way that physical-activity and sedentary-behaviour interventions are implemented.
- The three most common settings are the school, workplace and community.
- The YPAP Model is a simple one and is particularly relevant when used for school-aged children, who are referred to as 'youths'
- The YPAP Model is constructed using three broad factors that collectively have an impact on children and adolescents, grouped as predisposing, enabling and reinforcing factors.
- There are two prime questions within the YPAP Model: *Am I able?* and *Is it worth it?*
- If the answers to the two prime questions are *Yes!* then physical activity levels are likely to be higher.
- Enablers include biological and environmental factors.
- Reinforcers include family, peers and coaches, who encourage and support physical activity.
- Demographics are at the base of the YPAP Model as they lay the foundation for how the various influences combine to impact on physical-activity behaviour.
- Promotional strategies to increase physical activity levels include direct and indirect influences.
- When using the YPAP Model perceptions of competence must be improved; physical activity must be made attractive for participants, enabling and reinforcing factors must be strengthened while catering for the needs of the targeted population.

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Sit Topic Test

eBookplus

Interactivity
Health promotion strategies quiz
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MULTIPLE CHOICE QUESTIONS

1 There are four components of the social-ecological model. Which component is at the centre of the model?
(A) Policy
(B) Social environment
(C) Physical environment
(D) Individual

2 Being encouraged by a PE teacher to join a sports team is an influence from what level of influence within the social-ecological model?
(A) Social environment
(B) Policy
(C) Physical environment
(D) Individual

3 There is a strong relationship between increased socioeconomic status (SES) and increased healthy behaviour choices, such as being physically active. SES incorporates
(A) level of income, assets including money in the bank and house etc.
(B) level of education, income and employment status.
(C) level of intelligence, level of education, employment status.
(D) level of education, level of intelligence, income.

4 Out of the following options what is the first priority if the aim is to promote physical activity?
(A) Educate people about the side effects of sedentary behaviour.
(B) Get friends to persuade each other to be active.

(C) Provide safe and attractive physical environments for activity.
(D) Create rules and regulations that let people use parks and gardens for recreation.

5 School rules can have a negative influence on students' levels of physical activity, such as not allowing them to wear runners during breaks. This is an example of a barrier imposed by
(A) social environment decisions.
(B) policy decisions.
(C) physical environment decisions.
(D) individual decisions.

6 The first core principle of the social-ecological model acknowledges that
(A) behaviour is influenced by a wide range of factors and not simply a few.
(B) the relationship between humans and the environment is reciprocal.
(C) the environment impacts on people's behaviour.
(D) intrinsic motivation is the main influence on the success of programs.

7 Programs that target schools, communities and workplaces to promote physical activity take a
(A) holistic-based approach to health promotion.
(B) targeted approach to health promotion.
(C) individual-based approach to health promotion.
(D) settings-based approach to health promotion.

8 The state government funds a range of health promotion strategies via
(A) National Heart Foundation.
(B) YMCA Victoria.
(C) Local councils.
(D) VicHealth.

9 The YPAP Model is specifically designed for use when designing, implementing or evaluating programs for
(A) school-aged students.
(B) 0 to 18-year-olds.
(C) children.
(D) adolescents.

10 The YPAP Model highlights predisposing factors that can influence behaviour, such as
(A) encouragement from family.
(B) skill level.
(C) a desire and interest to be active.
(D) fitness.

EXAM QUESTION

Question 1

You are a school teacher who is worried about the lack of physical activity of your students during class. You want to improve their health by reducing sedentary behaviour.

a. Describe what sedentary behaviour is. **(1 mark)**

b. Apply the Youth Physical Activity Promotion Model to your aim of reducing sedentary behaviour during scheduled class time. Two examples are required for each section.

- Improve perceptions of competence (*I am able*) **(2 marks)**
- Improve attraction to physical activity (*It is worth it*) **(2 marks)**
- Strengthen enabling factors **(2 marks)**
- Strengthen reinforcement factors **(2 marks)**
- Cater for the personal demographics within a population **(2 marks)**

Total: 11 marks

INQUIRY QUESTION
Can everyone improve their health by following the same plan?

CHAPTER

13 Principles of an activity plan

While most people have good intentions to be more active, for most getting started requires a plan. An individualised and well-prepared plan can be the difference between just thinking about being active and physical activity becoming part of a person's daily routine.

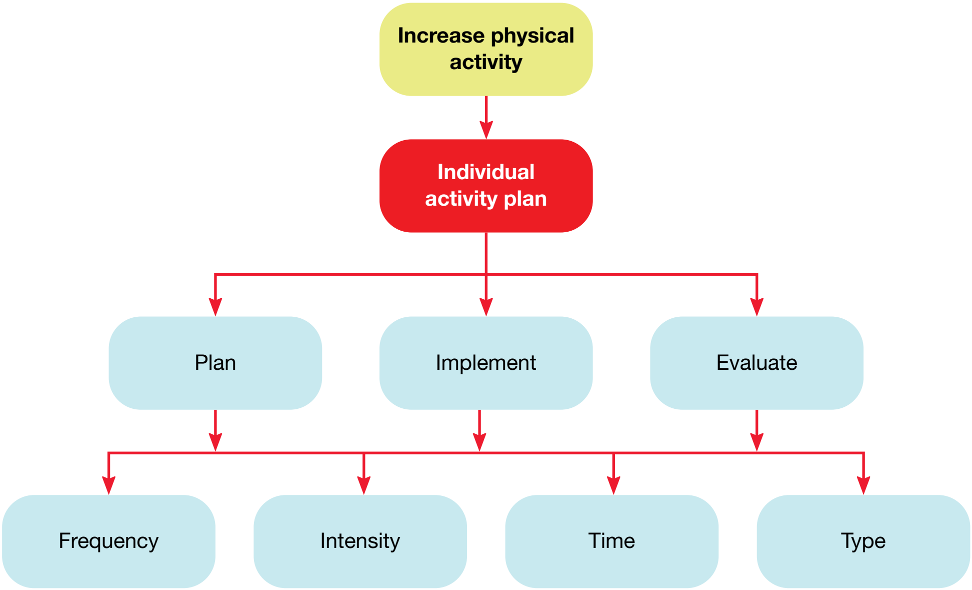
KEY KNOWLEDGE

- Principles of an individual activity plan including frequency, intensity, time and type of activity (FITT)

KEY SKILLS

- Apply the principles of frequency, intensity, time and type appropriately to an individual activity plan
- Create, implement and evaluate an activity plan for an individual or a specific group to increase physical activity and decrease sedentary behaviour in relation to the guidelines

CHAPTER PREVIEW



13.1 Gathering information

KEY CONCEPT Understanding the current levels of physical activity and sedentary behaviour for an individual and comparing them to the recommendations are the first and most important steps of any individual activity plan.

An individual physical activity plan is different to a training program. While increasing activity may lead to increased fitness, physical activity plans generally focus on improving behaviour to match the Australian Physical Activity and Sedentary Behaviour Guidelines (see chapter 11). The details of each of the guidelines appear in figure 13.1.

Physical activity
For health benefits, children aged 5–12 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.

Physical activity
Children's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.

Children 5–12

Sedentary behaviour
To reduce health risks, children aged 5–12 years should minimise the time they spend being sedentary every day. To achieve this:

- Limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day—lower levels are associated with reduced health risks.
- Break up long periods of sitting as often as possible.

Physical activity
On at least three days per week, children should engage in activities that strengthen muscle and bone.

Physical activity
To achieve additional health benefits, children should engage in more activity—up to several hours per day.

Physical activity
For health benefits, young people aged 13–17 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.

Physical activity
Young people's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.

Young people 13–17

Sedentary behaviour
To reduce health risks, young people aged 13–17 years should minimise the time they spend being sedentary every day. To achieve this:

- Limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day—lower levels are associated with reduced health risks.
- Break up long periods of sitting as often as possible.

Physical activity
On at least three days per week, young people should engage in activities that strengthen muscle and bone.

Physical activity
To achieve additional health benefits, young people should engage in more activity—up to several hours per day.

FIGURE 13.1 The Australian Physical Activity and Sedentary Behaviour Guidelines for each age group

To ensure the greatest chance of success, a physical activity for health plan should be tailored to the individual, in a similar manner to a training program. In order to do this, the plan should consider the following:

- Current levels of physical activity
  - Adherence to relevant Australian Physical Activity Guidelines
- Current levels of sedentary behaviour
  - Adherence to relevant Australian Physical Activity and Sedentary Behaviour Guidelines
- Influences on behaviour including enablers and barriers (as discussed in chapter 10)
  - Demographic, cultural, social and environmental influences that can encourage or discourage physical activity and sedentary behaviour.

FIGURE 13.1 *(continued)*

Sedentary behaviour
- Minimise the amount of time spent in prolonged sitting.
- Break up long periods of sitting as often as possible.

Physical activity
Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.

Physical activity
Be active on most, preferably all, days every week.

Adults 18–64

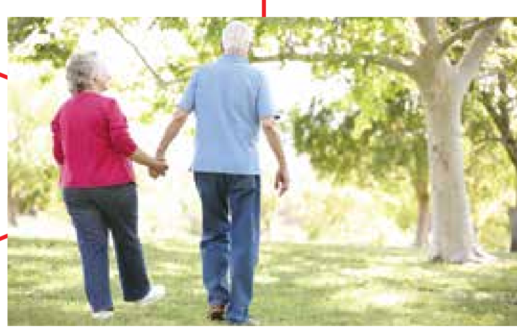
Physical activity
Accumulate 150 to 300 minutes (2½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous intensity physical activity or an equivalent combination of both moderate and vigorous activities, each week.

Physical activity
Do muscle strengthening activities on at least two days each week.

Physical activity
Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility.

Physical activity
Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity.

Physical activity
Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days.



Older Australians 65+

Physical activity
Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.

Physical activity
Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities.

These can be determined by talking to the individual and discussing the common factors present when they are active (e.g. social support through another person) and their reasons for not being active or for engaging in sedentary behaviour (e.g. perceived lack of time due to employment and family commitments). This process of talking to the individual is called a 'needs analysis'.

- Medical conditions
  - Chronic illness or injury that may impact on the ability of the individual to participate in some types of physical activity (e.g. heart and respiratory conditions)
- Physical activity goals
  - The goals the individual would like to achieve using the SMARTER goal setting framework

Goal setting is an effective motivational technique. However, to be a successful tool, goals should be SMARTER (see figure 13.2). Once SMARTER goals have been established you can begin to create the individual physical activity plan.

studyon
Unit 2
AOS 1
Topic 13
Concept 1
Gathering information
Concept summary and practice questions

S **Specific** — make your goals as specific and detailed as possible.

M **Measurable** — your goals should be measurable and assessed against a standard of previous performance, otherwise there is no way of determining whether or not you have achieved them.

A **Accepted** — all of the parties involved in the setting of the goals (e.g. the individual, trainer, coach) should accept them.

R **Realistic** — your goals need to be challenging, but also achievable. Goals should be framed in a positive manner and focused most importantly on improvement.

T **Time-framed** — short-term and long-term goals should be set and there should be a specific date for when they will be achieved.

E **Exciting** — the goals set should challenge, excite and inspire the individual.

R **Recorded** — the agreed goals should be recorded by the individual and trainer/coach so as to provide a constant reminder and to act as a source of motivation.

FIGURE 13.2 SMARTER goal setting can help increase the success of a program

FIGURE 13.3 Some people like to have a big fitness goal to train for, such as participating in an ocean swim like the annual Pier to Pub swim in Lorne.

TEST your understanding

1 Identify the Australian Physical Activity Guidelines for young people.
2 List four important pieces of information required before writing an individual physical activity plan.
3 Suggest two common barriers and enablers for adults.
4 Outline what is meant by SMARTER goals.
5 Outline the purpose of an individual physical activity plan.
6 Identify three medical conditions that may significantly affect an individual physical activity plan.
7 Briefly discuss how increased physical activity can help limit sedentary behaviour.

APPLY your understanding

8 (a) Create a needs analysis questionnaire of at least ten questions to collect the following information. When you have written your questionnaire, test it by interviewing two people then answer questions (b) and (c) below.
   - Current physical activity levels and behaviours (in order to compare to Australian Physical Activity and Sedentary Behaviour Guidelines)
   - Current sedentary behaviour levels and patterns (in order to compare to Australian Physical Activity and Sedentary Behaviour Guidelines)
   - Enablers and barriers influencing the individual's behaviour
   - Any pre-existing medical conditions
   - Physical activity and sedentary behaviour goals

   (b) Compare your two subjects' current physical activity and sedentary behaviour levels to the relevant guidelines. Do they meet them? Why not?
   (c) Suggest two ways your subjects could increase their physical activity and suggest two ways they could limit their sedentary behaviour.

9 Outline three enablers of and barriers to physical activity for a 16-year-old male and a 36-year-old female. Suggest a way to overcome each barrier.

13.2 Creating the activity plan

KEY CONCEPT The level of intensity at which an individual performs physical activity has an impact on the long-term health benefits they obtain from such activity. The intensity level of the activity will be affected by the duration and type of activity, and the benefits to the individual's health will be affected by the frequency of the activity.

After gathering preliminary information about current levels of physical activity and sedentary behaviour as well as enablers and barriers to physical activity, it is possible to create an individual physical activity plan.

To be most effective an individual physical activity plan should be prescribed considering the following training principles. The most important **training principles** for an individual activity plan are Frequency, Intensity, Time and Type (FITT), which are described in each of the following sections.

Training principles are rules that must be adhered to in order to benefit from any form of activity plan for health.

FIGURE 13.4 Plan and keep track of how many sessions a week you complete.

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Unit 2 | AOS 1 | Topic 13 | Concept 2

Creating the plan: FITT
Concept summary and practice questions

Frequency

Frequency is the number of sessions participated in a week. For example, completing a boot camp session and going for one bike ride once a week equals two sessions per week.

Frequency should replicate the relevant Australian Physical Activity and Sedentary Behaviour Guidelines. For all ages the minimum recommended frequency of sessions is most, preferably all, days of the week.

Intensity

Intensity is how hard you work. This can be measured in a number of ways. The first is as a percentage of maximum heart rate where maximum heart rate can be approximated by subtracting the person's age from 220.

The second is through METs (metabolic equivalent). One MET equals the energy (oxygen) used by the body as you sit quietly at rest, perhaps while talking on the phone or reading a book. The harder your body works during the activity, the greater the oxygen consumption and the higher the MET level.

However, for the purpose of an individual physical activity plan and compliance with the Australian Physical Activity Guidelines it is most important to know what is considered moderate and vigorous intensity.

Low intensity

A person should be able to sing while doing the activity. A heart rate lower than 50 per cent of maximum heart rate (MHR). Examples include walking the dog and household chores.

Moderate intensity

A person should be able to carry on a conversation comfortably while doing the activity. A person's target heart rate should be 50–70 per cent of maximum heart rate (MHR). Moderate-intensity activity is an activity that burns three to six METS. Examples include jogging, dancing, rollerblading, swimming at the beach and bike riding.

Vigorous intensity

A person becomes too out of breath to carry on a conversation. A person's target heart rate should be 70–85 per cent of maximum heart rate. Vigorous intensity activity is an activity that burns over six METS. Examples include running, rowing and burpees.

TABLE 13.1 Moderate exercise versus vigorous exercise

Moderate exercise	Vigorous exercise
Hiking	Jogging, running
Gardening or household chores	Heavy household chores
Dancing	Aerobics
Golfing (carrying clubs)	Basketball
Cycling <16 km/h	Cycling >16 km/h
Walking 5.5 km/h	Walking 7 km/h
	Swimming laps
	Weight-lifting (vigorous)

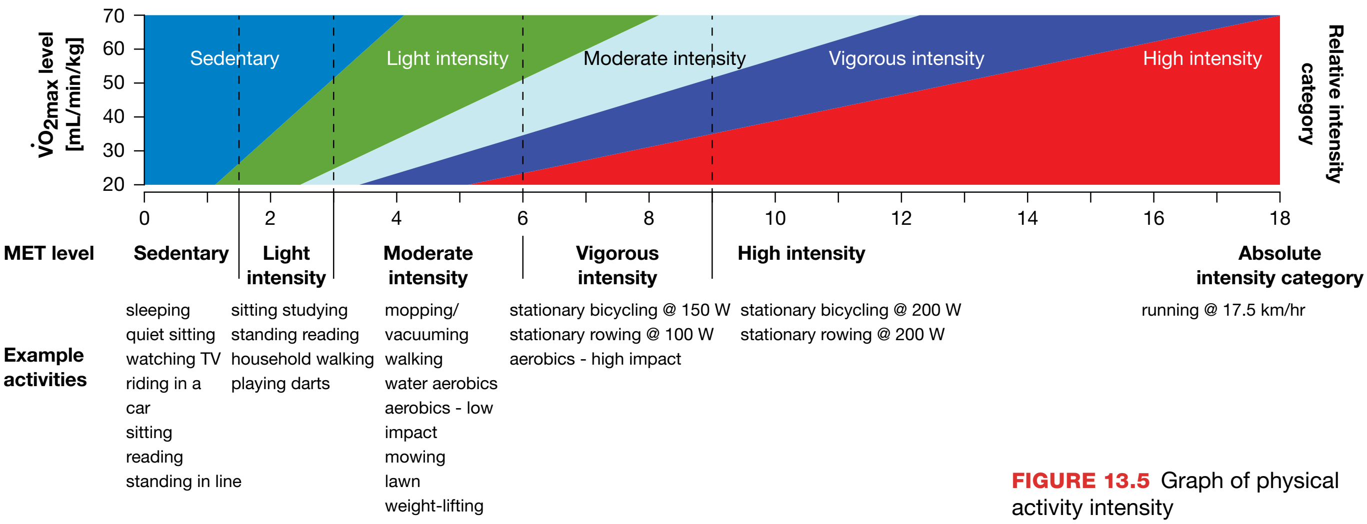

FIGURE 13.5 Graph of physical activity intensity

Time

Time is how long you are active for and is generally measured in minutes. An example is going for a 35-minute swim. While this generally refers to how long each session lasts, the Australian Physical Activity and Sedentary Behaviour Guidelines recommendations are an accumulation of daily and weekly time.

In order to fit physical activity into a busy lifestyle many people will accumulate time spent being active over various parts of the day and week. For example, 15 minutes riding bike to work, 20 minutes workout at gym at lunch and 15 minutes riding bike home from work is equal to 50 minutes for the day in total.

FIGURE 13.6 Physical activity trackers have become a vital tool for measuring and recording time spent being active.

Type

Type refers to the mode of activity being undertaken. Generally any physical activity is considered beneficial for your health; however, some guidelines do have specific recommendations regarding type. For example, the current Australian Physical Activity Guidelines suggest that adults do muscle strengthening activities on at least two days of the week.

Different types of activity most relevant to the current guidelines are listed in the following sections.

Aerobic activities

Aerobic activities include any activity that generally involves large muscle groups or most of the body and increases heart rate to 50 to 70 per cent maximum heart rate (MHR) for moderate physical activity and 70 to 85 per cent maximum heart rate for improved fitness. Examples include jogging, swimming, cycling and rowing.

FIGURE 13.7 Rowing is an example of an aerobic activity.

Strength activities

Strength activities generally target a muscle or muscle group and cause 'stress' to the muscle or muscle group because it needs to contract against a resistance or weight. These can be done using body weight as resistance (e.g. push ups and squats) or with free weights (e.g. example bicep curls).

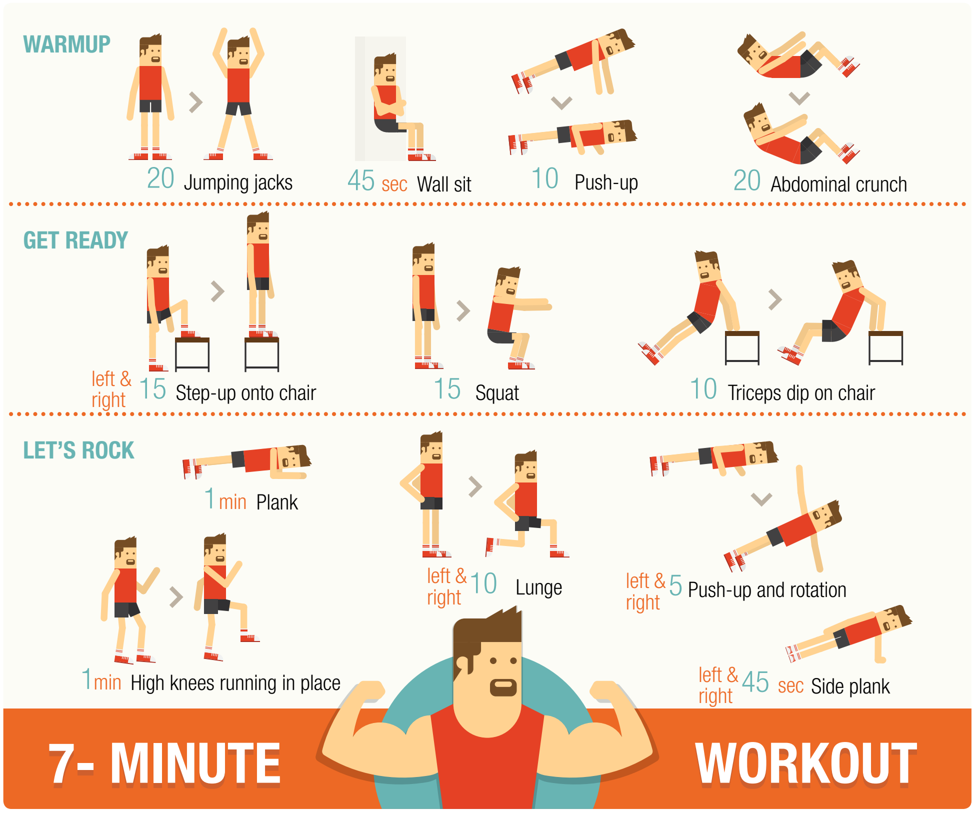

FIGURE 13.8 A 7-minute body weight circuit that can be done anywhere, anytime

Balance

Core strength and balance can be improved by using a Swiss ball or using body weight as resistance.

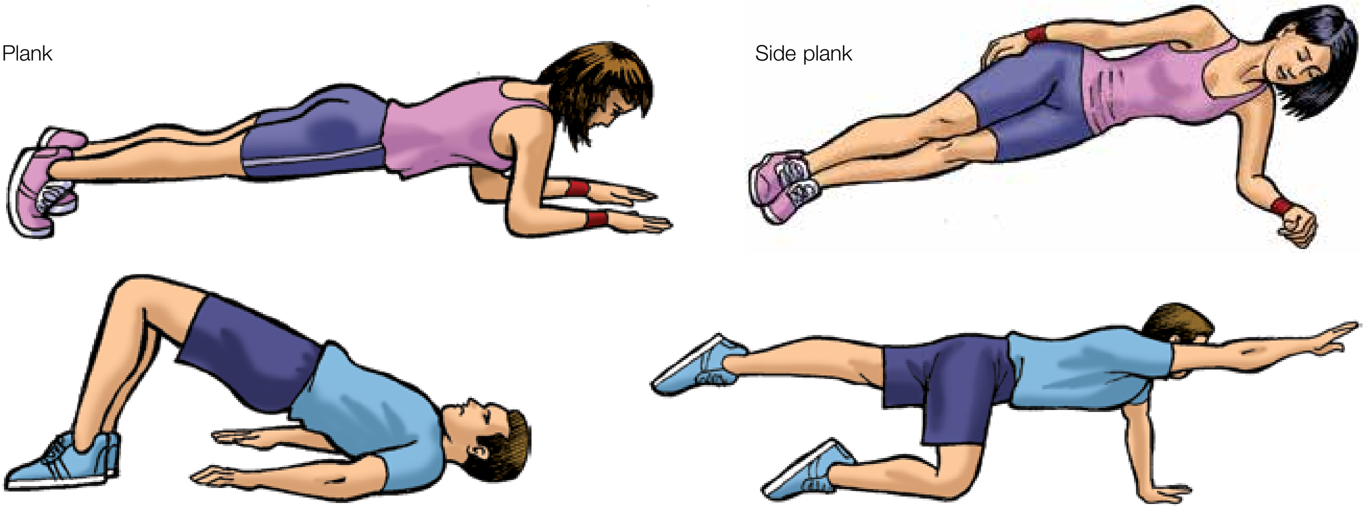

FIGURE 13.9 Core-stability exercises can be done solo and with minimal equipment.

Flexibility

Flexibility activities require the muscles to be stretched and encourage the joints to complete their full range of motion. This can help with maintaining everyday mobility. In an individual physical activity plan this could include Yoga and Pilates classes or stretching as part of a daily routine.

FIGURE 13.10 Working on flexibility is important for maintaining mobility in day-to-day activities.

Table 13.2 summarises the FITT training principles applied to the relevant Australian Physical Activity Guidelines.

TABLE 13.2 **FITT training principles applied to the Australian Physical Activity Guidelines for each age group**

Age group	Frequency	Intensity	Time	Type
Children 5–12	Every day	Moderate to vigorous intensity physical activity	Accumulate at least 60 minutes a day	• Variety of aerobic • strength at least three times a week
Young people 13–17	Every day	Moderate to vigorous intensity physical activity	Accumulate at least 60 minutes a day (420 minutes a week)	• Variety of aerobic • strength at least three times a week
Adults 18–64	Most, preferably all, days every week	Moderate or vigorous intensity depending on time	Accumulate 150 to 300 minutes (2½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1¼ to 2½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week. Broken down: 30 mins to 1 hour of moderate activity five days a week *or* 20 to 42 mins a day every day of the week	Muscle strengthening at least twice a week
Older Australians 65+	Every day	Moderate (vigorous if can)	At least 30 mins	A range of physical activities that incorporate fitness, strength, balance and flexibility

Sedentary behaviour

While increasing physical activity is associated with decreased sedentary behaviour, an active person can still be highly sedentary; the behaviours occur independently of each other. A good physical activity plan will create opportunities to be active while also decreasing sedentary behaviour. This, however, is not always possible.

For some people a separate plan that aims to decrease sedentary behaviour may be required. A decreasing sedentary behaviour plan should be created in a similar way to the physical activity plan. Assess the current levels, compare to the relevant guidelines, consider the enablers and barriers and create the program.

One of the easiest ways to increase physical activity and decrease sedentary behaviour is through active transportation. Even if you live a great distance from work, by parking further away or taking public transport you can decrease the sedentary behaviour of sitting and increase your physical activity through walking or riding part of the journey.

An individual physical activity plan should last for at least six weeks in order to see any health benefits. The plan should also be modified regularly to ensure long-term physical activity and health benefits.

FIGURE 13.11 Cycling to work is one way to engage in active transportation.

Sample activity plan

Below is an example of an individual physical activity plan.

Description of subject: 17-year-old female. Studying PE, HHD, English, Maths, Biology and Indonesian. Part-time job as a waitress. Plays tennis and volleyball for her school.

TABLE 13.3 Relevant Australian Physical Activity and Sedentary Behaviour Guidelines for subject

Frequency	Intensity	Time	Type
Every day	Moderate to vigorous intensity physical activity	Accumulate at least 60 minutes a day (420 minutes a week)	Variety of aerobic and strength at least three times a week

Task 1: Measure subject's current activity and sedentary behaviour levels

TABLE 13.4 Subject's current activity levels

Day	Intensity	Time	Type	Contextual notes (where, when, why)
Sunday	Low–mod Low–mod	45 mins 360 mins	Walk: aerobic Walk	Walking the dog Waitressing
Monday	Low–mod	60 mins	Volleyball training	After school sport
Tuesday	Mod–vig	50 mins	Circuit	PE practical class
Wednesday	Mod–vig	60 mins	Tennis training	After school sport
Thursday	Low–mid	65 mins	Volleyball game	After school sport
Friday	Low	120 mins	Walk: aerobic	Shopping
Saturday	Mod–vig	70 mins	Tennis game	School tennis game

TABLE 13.5 Subject's current sedentary behaviour

Day	Time	Type	Contextual notes (where, when, why)
Sunday	120 mins 20 mins 200 mins	Watching movie Driving Reading/texting	In bed on laptop To friend's place On couch, cold outside
Monday	6 × 50 mins 20 mins 30 mins 100 mins 45 mins	At desk At table In car At desk In bed	Classes Lunch To and from school Homework Watching TV series on laptop/phone
Tuesday	5 × 50 mins 20 mins 30 mins 100 mins 45 mins	At desk At table In car At desk In bed	Classes Lunch To and from school Homework Watching TV series on laptop/phone
Wednesday	6 × 50 mins 20 mins 30 mins 100 mins 45 mins	At desk At table In car At desk In bed	Classes Lunch To and from school Homework Watching TV series on laptop/phone
Thursday	6 × 50 mins 20 mins 30 mins 20 mins 100 mins 45 mins	At desk At table In car On bus At desk In bed	Classes Lunch To and from school Travel to sport Homework Watching TV series on laptop/phone
Friday	6 × 50 mins 20 mins 30 mins 100 mins 45 mins	At desk At table In car At desk In bed	Classes Lunch To and from school Homework Watching TV series on laptop/phone
Saturday	120 mins in morning 420 mins	In bus Sitting on couch	Travelling to tennis Watching TV/texting

Task 2: Evaluate current levels with relevant Australian Physical Activity and Sedentary Behaviour Guidelines

The subject does not meet the guidelines, despite being quite active and completing some physical activity on all days. The duration of the activity is not always long enough (needs to be at least 60+ mins) and is not always at the required intensity (needs to be moderate to vigorous). She is also sitting for prolonged periods of time and is therefore not meeting the sedentary behaviour guidelines.

By comparing your data to the relevant guidelines you can create a starting benchmark for the program and also determine specific areas to target (e.g. duration and intensity).

Task 3: Interview the subject about enablers and barriers to physical activity and sedentary behaviour

Hint: Use the questionnaire created in the Apply your Understanding questions in section 13.1.

By collecting information about what helps and what hinders behaviours it can help ensure the program is specific to the individual.

Enablers	Barriers
Sport with friends (social support)	School commitments
School sport	Family responsibilities
Active transport, doing two things at once	Time
Getting up and completing activity in the morning	

How will you overcome the barriers?

Use active transportation
Try group classes at local gym/part of school sport
Have a bad weather/indoor option
Reduce sedentary time; for example, set a reminder to move about the house every 20 minutes when completing homework

Make realistic suggestions about how to overcome barriers.

How can you use the enablers?

Organise sessions with others

Task 4: Set some goals for your subject using the SMARTER goal-setting model

Daily goals	Monthly goals	End of plan goals
Limit sedentary behaviour to 20 mins when not in classes. Have a reminder on phone when doing homework.	To be able to complete more repetitions of circuit in 30 mins	To meet the guidelines consistently
60 mins of moderate–vigorous activity per day	To attend a cycle class once a week	To be able to cycle to work and back without needing to stop (30 km)
	To complete a body weight circuit (as many reps as you can in 30 mins) twice a week	

Task 5: Create the plan (you may need a separate one for physical activity and sedentary behaviour)

Sedentary behaviour plan: break up sitting by setting a timer when doing homework. Do some exercises in ads of TV shows. Don't watch TV or movies in bed.

Day	Intensity	Time	Type	Contextual notes (where, when, why)
Sunday	Mod–vig Mod–vig Low–mod	30 mins 30 mins 360 mins	Run: aerobic Circuit Walk	With the dog Before work Waitressing
Monday	Mod–vig Low–mod	30 mins 60 mins	Cycle Volleyball training	To and from school After school sport
Tuesday	Mod–vig Mod–vig	30 mins 30 mins	Circuit Cycle	Before/after school To and from school
Wednesday	Mod–vig	60 mins	Tennis training	After school sport
Thursday	Low–mid Mod–vig	65 mins 30 mins	Volleyball game Cycle	After school sport To and from school
Friday	Mod–vig Mod–vig	30 mins 30 mins	Circuit Cycle	Before/after school To and from school
Saturday	Mod–vig	70 mins	Tennis game	School tennis game

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Interactivity
Analysing an activity plan
Searchlight ID: int-6657

eBook*plus*

Weblink
7-minute workout

eBook*plus*

Digital document
Sample physical activity plan
Searchlight ID: doc-18673

eBook*plus*

Digital document
Template for evaluating the program
Searchlight ID: doc-18674

TEST your understanding

1. List and briefly outline the four training principles.
2. Provide an example of each of the training principles.
3. Describe what is meant by moderate and vigorous activity.
4. Identify four different 'types' of physical activity as outlined by the Australian Physical Activity Guidelines and provide an example of each.
5. Using the sample activity plan above, answer the following questions:
   (a) Evaluate the subject's pre-plan physical activity and sedentary behaviour.
   (b) Discuss a limitation of only collecting one week of pre-plan information.
   (c) Explain, using specific examples, how the plan aims to overcome the barriers.
   (d) Explain how the plan, if followed correctly, adheres to the relevant guidelines.
   (e) Give the plan a score out of 10 based on its likelihood of success — 10 being highly likely to be successful. Justify your score.

APPLY your understanding

6. Create a flowchart to show the steps in creating an individual physical activity plan and justify the role of each step.
7. Participate in the 7-minute workout. Go to the **7-minute workout** weblink in your eBookPLUS.
   (a) Identify the activities in the 7-minute workout as aerobic or strength.
   (b) Discuss at what intensity each activity was completed, using a rate of perceived exertion or the talk test.
   (c) Explain how the time of this workout may help adults adhere to the relevant physical activity guidelines.
   (d) Discuss how you could apply the principle of frequency to this workout, to help meet the relevant physical activity guidelines.

13.3 Evaluating the plan

KEY CONCEPT Following a plan for a long period will only result in desired outcomes if the plan continues to meet the needs of the individual. Individuals change; therefore, so must physical activity plans. It is also important to recognise what isn't working and find something that does.

FIGURE 13.12 Some people need to vary their exercise routine to keep motivated.

Once you have created and implemented the plan it is vital, for long-term effectiveness, to evaluate it regularly. In order to evaluate your plan you will need to:

1. Record current levels of physical activity (adherence to relevant Australian Physical Activity and Sedentary Behaviour Guidelines) and current levels of sedentary behaviour (adherence to relevant Australian Physical Activity and Sedentary Behaviour Guidelines) preferably in the same way initial levels were recorded.
2. Compare the current levels to the initial levels.
3. If the plan has been successful, consider slight modifications to ensure continual progress and continued motivation and enjoyment. For example, the subject may be getting bored of walking the same route, so a fitness class or bike ride may be an easy alternative. The subject may be finding the 20 minutes jog easy so intensity or time could be increased for extra health benefits.
4. If the plan has not been successful then modifications are required. In order to make effective modifications the barriers to achieving the plan must be identified and considered. If the same barriers from the start of the program are still present, then a different method of overcoming them must be put in place.

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Unit 2	**Evaluating the plan**
AOS 1	Concept
Topic 13	summary
Concept 3	and practice questions

TEST your understanding

1. Identify when evaluations of physical activity plans should be completed.
2. Outline the role of evaluation in a physical activity plan.
3. Identify and justify which age group is most likely to have time as a barrier to meeting the relevant physical activity guidelines.

APPLY your understanding

4. Create a flowchart to show the steps in creating an individual physical activity plan and justify the role of each step.
5. Not all physical activity plans will automatically decrease sedentary behaviour. Suggest two ways you can increase physical activity whilst decreasing sedentary behaviour.

6 Using the template in your eBookPLUS, devise a physical activity plan for yourself and discuss how it could be modified if you were to go on holidays.
7 Using the template in your eBookPLUS, devise an individual physical activity plan for two family members and discuss how they differ and explain why.

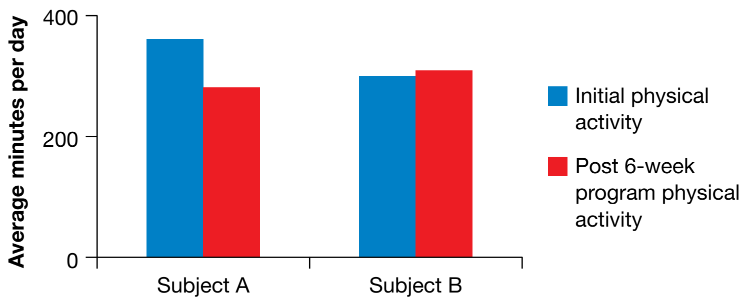

FIGURE 13.13 **Sedentary behaviour** levels pre- and post-individual physical activity plan

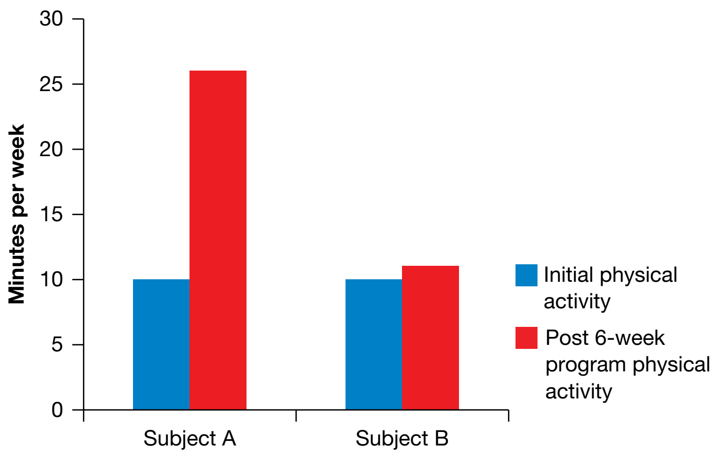

FIGURE 13.14 **Physical activity** levels pre- and post-individual physical activity plan

8 Based on the information provided in the graphs above, answer the following questions:
(a) Which subject experienced the most significant change in behaviour?
(b) What other information would be helpful in order to complete an accurate evaluation of the subjects?
(c) Based on the data above, evaluate the effectiveness of the physical activity plans for Subject A and B.

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Digital document
Sample physical activity plan
Searchlight ID: doc-18673

CHAPTER 13 REVISION

KEY SKILLS

- Apply the principles of frequency, intensity, time and type appropriately to an individual activity plan
- Create, implement and evaluate an individual activity plan to increase physical activity and decrease sedentary behaviour in relation to the guidelines.

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- the principles applied in an individual activity plan need to reflect the relevant Australian Physical Activity and Sedentary Behaviour Guidelines and the FITT principles.

PRACTICE QUESTION

Dave is a 39-year-old father of two who runs his own electrical business. In his youth, Dave was very active and participated in a range of physical activities. As his work and family commitments have increased, he has found it much more difficult to undertake the same amount of activity as he once did. Dave lacks time, and weather is often an obstacle for regular participation in physical activity. Dave has a good network of friends and enjoys exercising with them when he can. As an early riser, he has time available in the morning, and on the weekends he likes to spend time with his children by going to the park.

In a typical week, Dave's current participation in physical activity is as follows:

- Two 45-minute runs of moderate intensity.
- One 15-minute walk of low intensity to the park with the children, pushing a pram.

a. **Evaluate** Dave's current physical activity levels in relation to the Australian Physical Activity and Sedentary Behaviour Guidelines. *(4 marks)*

b. **Identify** any enablers and barriers that may assist or hinder Dave in meeting the relevant guidelines. *(2 marks)*

c. Based on the information provided, use the following table to design an individual activity plan for Dave to help him adhere to relevant guidelines. Make sure you correctly apply the FITT training principles. *(4 marks)*

Day	Intensity	Time	Type	Contextual notes (where, when, why)
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				

Sample response

a. While Dave completes some physical activity at the required intensity of moderate to vigorous (90 mins moderate intensity), he does not meet the recommended frequency (on most days), time (150 mins per week) or the type (muscle strengthening two days a week); therefore, he does not currently meet the guidelines.

b. Barrier: family responsibilities. Enabler: social support.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action word:**
  Evaluate — suggest reasons for the effectiveness of something.
  Identify — determine the key characteristics or features.
- **Key terminology**
  Enablers and Barriers
  Training principles — FITT
- **Key concept/s**
  Australian Physical Activity and Sedentary Behaviour Guidelines
  Training principles, FITT
  Individual activity plan
- **Marking scheme:**
  4+2+4 marks — always check marking scheme for depth of response required, linking to key information highlighted in the question.

HOW THE MARKS ARE AWARDED

a. **4 marks** — 1 mark each for identifying frequency, intensity, time and type compared against adult guidelines

b. **2 marks** — 1 mark each for identifying an enabler and barrier

c. **4 marks** — 1 mark each for correct application of frequency, intensity, time, type in the individual activity plan

c. Sedentary behaviour — break up sitting by setting a timer every day. Walk to get paper.

Day	Intensity	Time	Type	Contextual notes (where, when, why)
Monday				
Tuesday	Mod–vig	6.00–6.30 am	Run — aerobic	With running group. If raining cycle class at gym.
Wednesday	Mod–vig	6.00–6.30 am	Swim — aerobic	Swim with local swim club
Thursday	Mod–vig	6.00–6.30 am	Run — aerobic	With running group. If raining cycle class at gym.
Friday	Mod–vig	6.00–6.30 am	Cycle — aerobic	Cycle with Simon. If raining go to the gym and do weights circuit.
Saturday	Low–mod	20 mins 30 mins	Walking — aerobic Strength — weights circuit at home	To get paper At home in garage with family

PRACTISE THE KEY SKILLS

1 Based on the Australian Physical Activity Guidelines, outline the FITT principles a 17 year old should follow for good health.
2 Outline four common barriers to and enablers of physical activity. Outline four common barriers to and enablers of limiting sedentary behaviour.
3 Using the FITT principles, describe how you could use active transportation to help meet the physical activity guidelines and decrease sedentary behaviour.

KEY SKILLS EXAM PRACTICE

Ebony is a mother of three. Her eldest boy has just started primary school. She has two girls at home and works part time as an accountant. She currently attends a boot camp session once a week. She enjoys walking with the girls in the pram when weather permits. She lives out of town so her car is her primary mode of transportation.

1 Identify three likely barriers to physical activity for Ebony. *(3 marks)*
2 Suggest how you could overcome each of these barriers. *(3 marks)*
3 Outline an example of a physical activity plan for Ebony. This plan should clearly show how she could meet the relevant guidelines and correct application of the FITT principles. *(5 marks)*

CHAPTER REVIEW

CHAPTER SUMMARY

- For an individual physical activity plan to be effective it needs to be tailored to the individual's needs, a one-size-fits-all approach is unlikely to be effective long term.
- To create a plan you need to assess the current physical activity levels, compare them to the relevant guidelines, consider the enablers and barriers and create a program.
- The training principles Frequency, Intensity, Time and Type (FITT) are vital to an effective plan.
- The Australian Physical Activity and Sedentary Behaviour Guidelines provide recommendations for Frequency, Intensity, Time and Type according to age groups.
- A physical activity plan should try to increase physical activity while also aiming to decrease sedentary behaviour.
- All individual physical activity plans should be regularly evaluated and modified for long-term success.

MULTIPLE CHOICE QUESTIONS

With reference to the following sample activity plan, answer questions 1–4

Variable 1	Variable 2	Variable 3	Variable 4
Run	Mon, Wed, Fri	6 km	70–85% MHR
Walk	Tues and Sat	30 mins	4 METS

1 Which variable best represents time?
(A) Variable 1 (B) Variable 2 (C) Variable 3 (D) Variable 4

2 Which variable represents intensity?
(A) Variable 1 (B) Variable 2 (C) Variable 3 (D) Variable 4

3 What type of activity is being done in the above sessions?
(A) Anaerobic
(B) Aerobic
(C) Anaerobic and aerobic
(D) Flexibility

4 The above plan aligns most closely with the suggested guidelines for which subject?
(A) 15-year-old male
(B) 25-year-old female
(C) 70-year-old male
(D) All of the above

5 Which of the following need to be taken into account before developing an individual physical activity program?
(A) Current adherence to relevant National Physical Activity Guidelines
(B) Physical activity goal
(C) Family responsibilities
(D) All of the above

6 Which of the following is the least accurate measure of intensity?
(A) Heart rate (B) METS (C) Talk test (D) Observation

7 Which population group, according to the Australian Physical Activity Guidelines, does not require the frequency of every day?
(A) Children (B) Youth (C) Adults (D) Elderly

8 Which of the following is not an example of a strength type of activity?
(A) Push ups (B) Jogging (C) Squats (D) Plank

9 Which of the following activity types are recommended for an elderly person's individual physical activity plan?
(A) Flexibility (B) Balance (C) Strength (D) All of the above

10 A good physical activity plan will work for anyone. This statement is
(A) False — every plan needs to be specific to the individual's enablers and barriers.
(B) True — as long as they have the motivation to follow it.
(C) True — as long as it goes for six weeks.
(D) True — as long as it adheres to the training principles.

EXAM QUESTION

Question 1 **(from 2013 unit 2 ACHPER exam)**

Young people are generally more active than other age groups; however, as for all age groups, this has declined over time.

a. Outline the youth guidelines for physical activity according to frequency, intensity, time and type. **4 marks**

b. List two reasons commonly given by young people (who do not exercise or participate in physical activity) for not exercising or participating in physical activity. Use the table below to outline one strategy for each reason you listed that could be used to overcome this barrier. **4 marks**

Reason for not participating in physical activity	Strategy/Solution
1.	
2.	

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Sit Topic Test

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Interactivity
Principles of an activity plan quiz
Searchlight ID: int-6658

INQUIRY QUESTION
What influences participation in physical activity and sport?

CHAPTER

14 Contemporary issues and sport: overview

A person's level of physical activity can fluctuate according to their age and stage of life. In this chapter, the issue of declining levels of physical activity across the lifespan, and the reasons for it, will be examined. Various factors contribute to a lack of physical activity: gender inequality, issues of access to facilities and programs, and concern about safety and risk management.

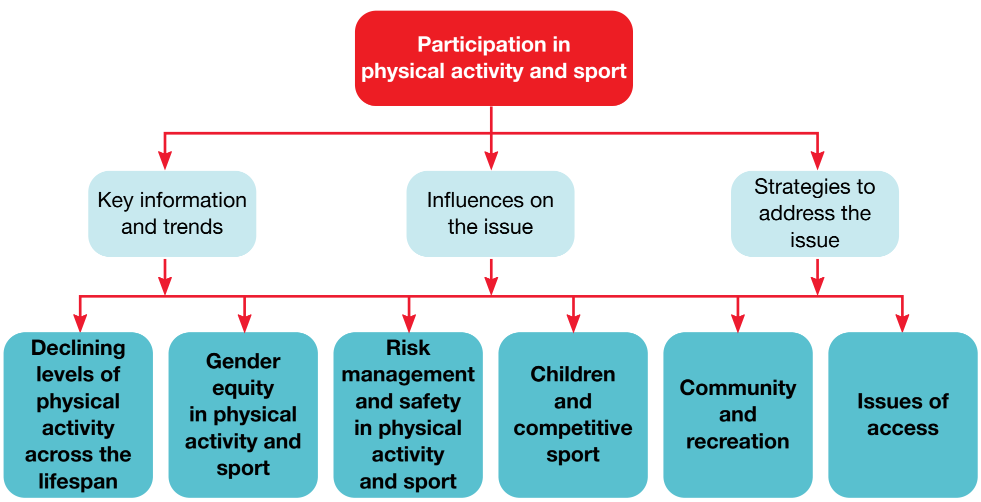
KEY KNOWLEDGE

- The role of the social-ecological model and/or the Youth Physical Activity Promotion Model in evaluating physical activity promotion and sedentary behaviour reduction initiatives and strategies
- The key concepts associated with the selected contemporary issue associated with participation in physical activity and/or sport in society
- Individual, social, policy and environmental influences on participation in physical activity and/or sport in reference to the selected issue
- Local, national and/or global perspectives of the selected issue
- Historical, current and future implications of the selected issue
- Government, community and/or personal strategies or programs designed to promote participation in physical activity and/or sport

KEY SKILLS

- Identify contemporary issues associated with participation in physical activity and sport
- Participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue
- Collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, and print and electronic material
- Analyse the historical, current and future implications on the issue identified
- Apply the social-ecological model or Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue
- Draw informed conclusions and report in a suitable format on the socio-cultural and environmental influences that impact on participation in physical activity and/or sport, based on research findings

CHAPTER PREVIEW



14.1 Declining levels of physical activity across the lifespan

KEY CONCEPT As we age, we generally participate in less physical activity, which can cause physical and mental health problems.

Declining physical activity across the lifespan

As age increases, participation in sport and physical activity generally decreases. Recent Australian statistics show that participation in sport and physical recreation peaks at 15 to 17 years of age, with 74 per cent of this age group involved. The lowest rates, 47 per cent, are recorded by people aged 65 years and over.

There are many factors that impact our participation in sport and physical activity (see chapter 10). Many studies suggest the greater variety of physical activity you participate in when you are young, the more likely you are to be sufficiently active as you age. As people age, their interests, needs and physical ability can change, so the more ways in which one can be active, the greater the ability to overcome these barriers.

It is a widely believed myth that as people get older, their bodies become too frail and weak to participate in physical activity, and that the body doesn't need as much activity as we age. However, there are many health benefits of physical activity at any age and, importantly, if older people can remain active, they are more likely to maintain their independence.

In Australia we have an ageing population, so it is vital that physical activity across the whole lifespan can be maintained, ensuring the benefits of fitness (see chapter 11) can be experienced for longer.

FIGURE 14.1 An active lifestyle is important for good health, no matter what your age.

study on

Unit 2
AOS 2
Topic 14
Concept 1

Physical activity across the lifespan
Concept summary and practice questions

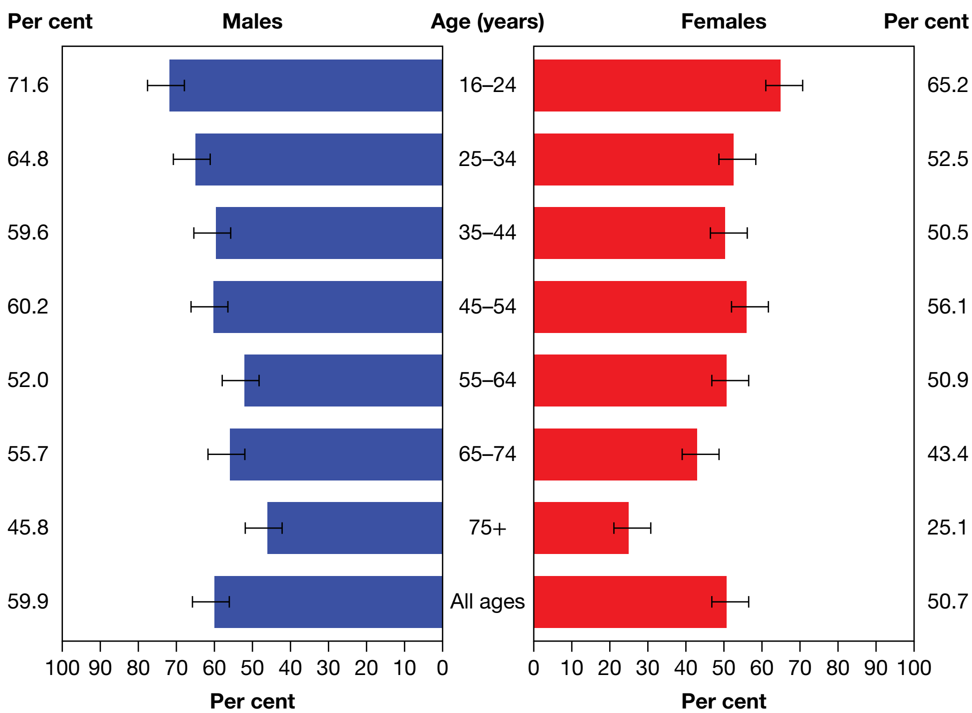
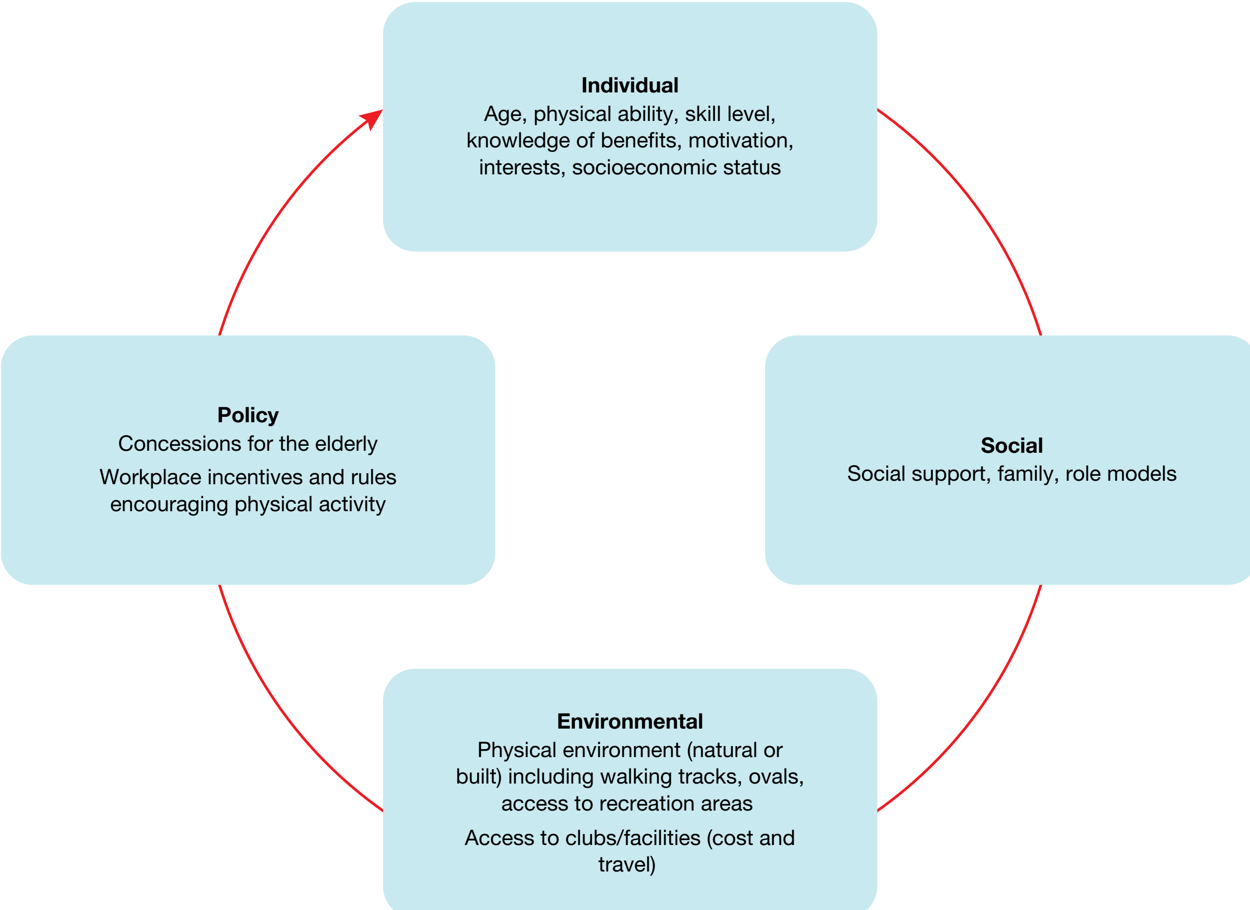


FIGURE 14.2 Adequate physical activity by age and sex, 16 years and over, NSW 2014

Influences on activity across the lifespan



Individual

Once people retire, while they may have more time to be involved in physical activity, they often lack the finances and motivation to do so. If an individual's confidence in their physical ability and skill remains high, they will be more likely to engage in physical activity.

Social

As there are fewer active older people, there is less social support for those who seek to be active. Unlike for young people, there are fewer teams and groups for older people to join and feel comfortable in. If older people are surrounded by others who are active, they will be more likely to engage in physical activity as well.

Policy

While some sports have age restrictions for their competitions, many organisations provide subsidised memberships or benefits (for example, free morning tea) for older people who are actively involved.

Environmental

Many older people have less access to physical activity and recreation facilities. Many older people become less able to travel independently, which can limit their physical activity opportunities. However, if there are safe and kinesthetically pleasing recreation areas nearby, older people may be more likely to use them for physical activity.

Strategies to address the decline in physical activity across the lifespan

The following strategies have been put in place to target particular age groups.

Adults

- Active workplace challenge: a program that runs for 10 weeks encouraging colleagues to be involved in groups of five
- TeamUp (VicHealth): an app that encourages adults to join others easily for a variety of physical activities
- Mums United (Heart Foundation): lots of ideas for ways the family can be active together and a fun family tracker to encourage the whole family to be involved

Older adults (65+ years)

- Masters games: a variety of sports for anyone over 35 years of age. Encourages older people to remain in competitive sport for longer.
- Walking groups (Heart Foundation and local councils): older people meet and walk local routes
- Warm Water exercise classes: water aerobics classes that cater for older adults in particular those suffering from arthritis and musculoskeletal conditions

TEST your understanding

1. Identify and justify at what stage in the lifespan physical activity levels are the highest.
2. Outline two physical environment barriers to activity for children and older adults.
3. Outline two social environment barriers to activity for adults and suggest how these could be overcome.
4. Based on figure 14.2 on page 316, identify the age group most likely to achieve adequate physical activity.
5. Outline the general trend relating to age in the graph.

APPLY your understanding

6. Suggest three reasons for the trend shown in figure 14.2.
7. The 45–54 age group is an anomaly. Suggest reasons for this.
8. The data has been collected from NSW. Predict if the data for Victoria would be similar or different and justify your response.
9. **Practical activity:** Participate in one of the following activities, which are often enjoyed by older people: lawn bowls, golf, dancing.
   (a) Reflect on why the activity you participated in might appeal to older people. In your discussion, you should consider common barriers and enablers for this age group.
   (b) You have been asked to promote the activity you participated in to older people, but also those in other age groups. Create a promotional piece (poster, advertisement, short film) for the activity.
   (c) Research what other physical activities in your local area target older people.

14.2 Gender equity in physical activity and sport

KEY CONCEPT Why is there a difference in opportunities and participation in physical activity and sport for different genders?

Gender equity in physical activity and sport

Recent research by the Australian Bureau of Statistics suggests that females are more likely to walk for exercise than males (25 per cent and 14 per cent respectively). Fitness and gym are the next most popular activities for females (17 per cent). Males are more likely than females to play golf (6.6 per cent and 1.4 per cent respectively) or participate in cycling and BMX riding (8.5 per cent and 4.0 per cent respectively).

Traditionally sports were classified as 'male' or 'female' sports, and whilst some are still heavily dominated by one sex there have been significant gains made in ensuring all people, no matter their sex or **gender**, have opportunities in all sports and physical activity.

Gender refers to the state of being male or female (typically used with reference to social and cultural differences rather than biological ones).

In the past there have been many stereotypes regarding the roles of males and females; for example, females shouldn't sweat and should wear respectable clothing (not bathers or shorts), females are to maintain the primary role in the house, and sport is too dangerous for females.

Thankfully some of the stereotypes have been broken down, increasing acceptance and opportunities for all people.

Some of the most significant gains have been seen in the following sports.

- AFL: now one of the fastest growing sports for females, with the AFL aiming for a national competition in the near future
- Cricket: during the 2015/16 season the Big Bash League included a female competition that was also broadcast live on TV.
- Tennis: male and female Australian Open winners receive equal prize money.

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Unit 2 | AOS 2 | Topic 14 | Concept 2

Gender equity
Concept summary and practice questions

FIGURE 14.3 Meg Lanning, captain of the Australian Women's cricket team, is a world-record holder and superstar cricketer. Despite receiving many accolades for her performance, her pay as a female cricketer is well below the pay of her male counterparts. The best female cricketers in Australia are paid a maximum of $85 000, while the best male cricketers are paid more than two million dollars per year.

It has also become more acceptable for males to participate in what have been seen as traditionally female-dominated sports and physical activity.

- Dance: there are now many role models and opportunities for males to participate in a variety of styles of dance.
- Netball: there is an increase in mixed and male-only competitions. This includes a national competition.

However, there is still much to be done to achieve equality as men's sport is still much more highly paid and more commonly televised than women's. Female athletes often have to maintain a day job as well as playing professional sport, as they cannot earn enough through their sport alone.

National AFL Women's League needs proper pay and resources to succeed, say players

BY DAMIEN MCIVER

Prospective footballers in the new national women's AFL next year insist they need to be looked after financially for the competition to succeed.

The AFL is pushing ahead with plans to establish a national women's league in 2017.

Western Bulldogs player Lauren Arnell, who represented the club in the last two years in exhibition games against Melbourne, said if the league wants elite athletes the players need to be treated as such.

'They want elite athletes so we need to make sure the resources are there for female athletes and female footballers to do the job properly,' Arnell said.

Details of the league are still being discussed, but one model being mooted involves up to eight teams playing a competition in the weeks before the men's league beginning in late March.

FIGURE 14.4 Pay for play. Lauren Arnell says if the new women's national AFL league wants elite athletes, they have to treat players as elite.

'We'll start from a base where the girls should be no worse off for playing football,' said AFL General Manager of Game Development Simon Lethlean.

'As it (the league) becomes more viable, more popular and more commercial realities become available, we'll look to reward the players,' he said.

Brisbane teenager Tayla Harris says players understand there will be some trade-offs to get the competition up and running.

'I could be a little bit negative and say I'm going to miss out on getting paid, but then I really want to be in the position where I can trail blaze . . . and be in the first group which I think is pretty significant,' she said.

Queensland leading the charge in women's AFL

Harris is one of the standout players from the Queensland system, which has become a stronghold in the women's game.

Last year, 71 293 women and girls in Queensland played or participated in AFL programs, compared to 42 260 in Victoria.

'We punch well above our weight compared to the traditional football states,' says AFL Queensland's Craig Starcevich.

'It's quite exciting for the years to come because we've got a number of good girls to choose from,' he said.

The AFL is currently running women's football academies in each state, designed to accelerate the development of talented players.

There is an urgency to the project, with the AFL keen to ensure the standard of the new competition is of a high quality.

'We won't get everything right first up,' says Lethlean.

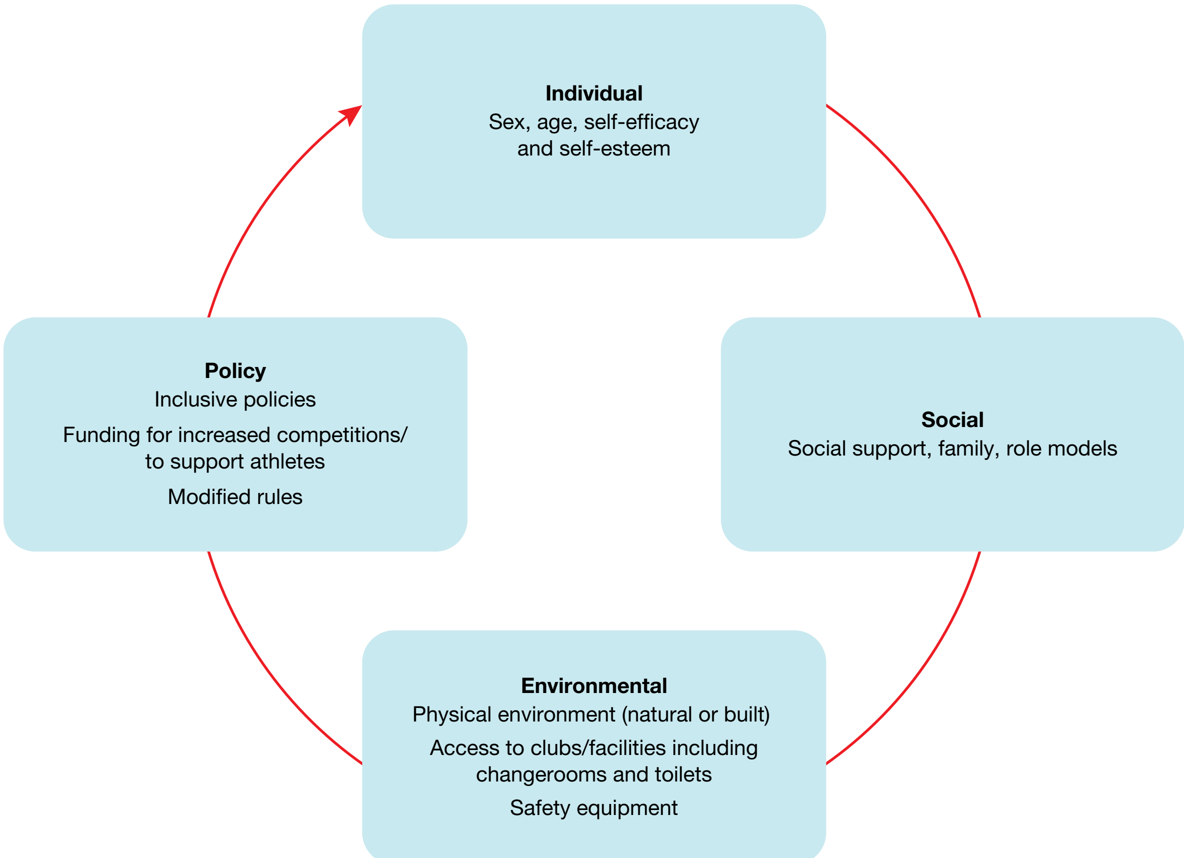
'We want to have a sustainable and viable competition for the elite girls to play in . . . year two might be different to year three, we saw with the Big Bash League (cricket) how they started, year one compared to year five.'

Lauren Arnell said many people were already surprised by the standard of the women's game.

'Whether they come and watch a training session or they see it on the TV or they come and watch a game . . . they see that women can really play a decent brand of footy and it's worth watching.'

Source: abc.net.au, 9 February 2016.

Influences on gender equity



Individual

Individual mindset can play a large part in combatting gender stereotypes. If you have high self-esteem it can help you tackle any stereotypes involved with the sport or physical activity of your choice.

Social

In some sports, due to traditional stereotypes, there can be a lack of participants of a particular gender and this can act as a barrier to social support; for example, males dancing or playing netball. However, if there are a variety of positive role models, such as the female AFL players through the draft, it can encourage more people to join in and challenge the stereotypes.

Policy

Some sports and physical activities, for safety reasons, do have rules and guidelines regarding who can play in what competitions; for example, in junior sport where children can play in mixed teams until a certain age. Having alternate competitions or changing these rules can help keep people involved in the sport for longer.

Environmental

The accessibility and maintenance of change rooms for both males and females at sporting and recreation venues can act as a barrier or enabler for physical activity. All participants in physical activity should have access to suitable toilets and changing areas.

Strategies to address gender equity in sport

The following strategies, in addition to those previously mentioned, have been put in place to target the particular genders.

Females

- Women-only gyms (e.g. Curves and Fernwood): these gyms only allow female members to ensure a female-friendly gym environment
- Mums United (Heart Foundation): a variety of programs aimed at mums to help them include physical activity in with family time

Males

- Men's netball league: a state and national competition for males to play netball at the highest level
- Men's dance classes (local): classes where males are welcome to join, or male-only classes are held

Transgender

- The Gay Games/World Outgames: an organised event that involves a variety of sports and targets the gay, lesbian and transgender community

TEST your understanding

1 Discuss some common stereotypes about physical activity and sport for each gender.
2 Outline how policies can help break down gender stereotypes.
3 Read the article 'National AFL women's league needs proper pay and resources to succeed, say players' on page 320 then answer the following questions.
   (a) Outline how the AFL are providing increased opportunities for females.
   (b) Outline the barriers for females wanting to play AFL and how the AFL could overcome these.
   (c) Explain the benefits for increasing the opportunities for females at the AFL level.

APPLY your understanding

4 **Media analysis**
   (a) Complete a media analysis of sport and physical activity coverage and/or promotion. This should include at least one newspaper and a sports reports on the news. This may include local, state or national levels.
   (b) Count the number of mentions for males and females and other (both or transgender).

	Male	Female	Other
Newspaper			
TV sports report			

   (c) Graph your results and compare your results with those of another student. Are they similar or different? Why?
   (d) Answer the following questions.
      i Discuss the similarities and differences between female and male sport/physical activity coverage.
      ii Explain three reasons for the differences.
      iii 'The media accurately reflects the physical activity and sporting trends in our society.'
      Compare your results with the current participation rates for males and females and debate the above statement.
      iv Suggest ways in which the media could change to ensure gender equality in its presentation of sport and physical activity.

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Weblink
Girls playing in boys teams

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Unit 2 | AOS 2 | Topic 14 | Concept 3

Influences on gender equity
Concept summary and practice questions

14.3 Risk management and safety in physical activity and sport

KEY CONCEPT Playing sport and being involved in physical activity comes with risks but many risks can and should be managed to ensure optimal safety and therefore enjoyment for all involved.

Risk management and safety in physical activity and sport

Unfortunately, people get injured when playing sport or participating in physical activity; there is always risk. However, most risks can and should be minimised so that the benefits of participating outweigh the possibility of suffering an injury.

AFL has the highest recorded injuries of 3186 out of 222 641 adults listed as playing AFL per year. Soccer has more participants (over 535 278) and fewer injuries (2962) which is not surprising, given soccer involves less contact than AFL.

FIGURE 14.5 Mouthguards help prevent injury to the teeth when playing contact sports.

FIGURE 14.6 Injuries and hospitalisations due to sport in Australia per year

An **overuse injury** is an injury caused by excessive and repeated use of the same muscle, bone or joint.

Injuries have always been a part of sport but interestingly, despite our increased use of technology and better understanding of how to prevent injuries, there has been an increase in hospitalisations of children due to sport-related injuries. No one sport can be blamed for this increase. Experts suspect that the increase in children choosing to play one sport all the time, or playing several sports all at once, are factors leading to what are called **overuse injuries**.

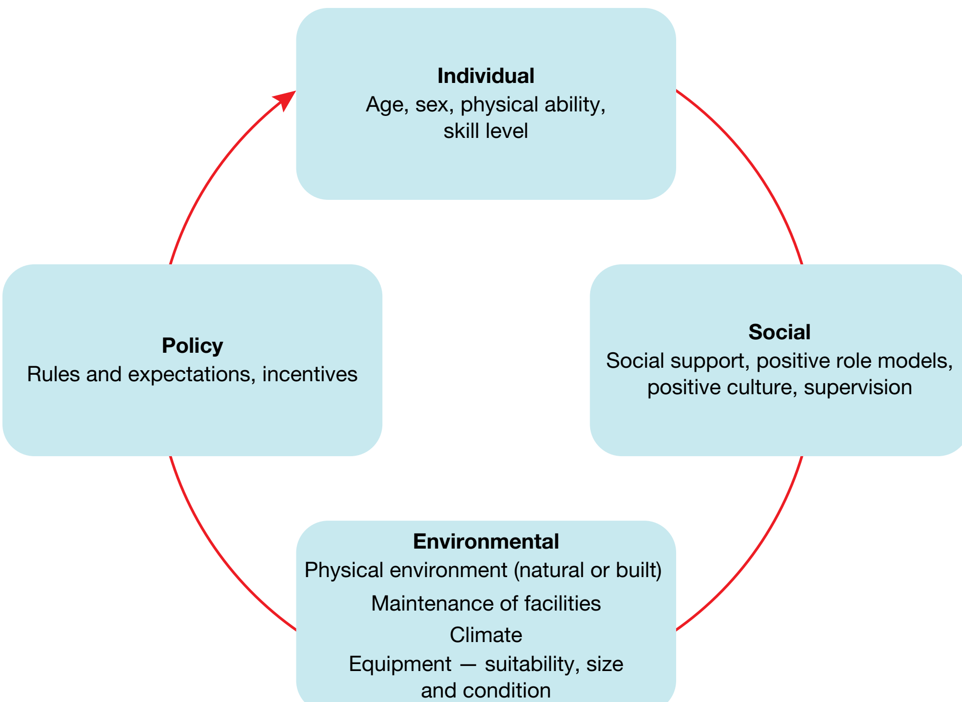
Risk management has now become a very important part of sport. It is important not just for sporting organisations but also coaches and players. Most sports and organisations involved in physical activity, e.g. gyms, will have very clear and thorough risk-management policies that are designed to not only keep participants safe but also protect all involved; for example, spectators, coaches and administrators. These include, but are not limited to:

- checking the condition of grounds and equipment (e.g. no debris on oval, goal posts fixed safely)
- ensuring appropriate training and qualifications of personnel (e.g. working with children checks, first aid)
- having and enforcing rules around weather conditions (e.g. extreme heat policies at the Australian Open tennis tournament)
- having appropriate facilities to cater for participants (e.g. drink stations in marathons)
- clear procedures and policies to manage and report injuries (e.g. an incident report).

Influences on risk management and safety in physical activity and sport

studyon

Unit 2	**Influences on risk management and safety**
AOS 2	Concept summary and practice questions
Topic 14	
Concept 4	



Individual

A lower level of skill can put someone at higher risk of injury, not just in sport but any physical activity. For example, using gym equipment incorrectly can result in injury. An appropriate level of skill can help prevent injury, not only for the participant but others around them.

Social

Appropriate supervision is a vital component of risk management and injury prevention. This includes supervision for equipment that poses a higher risk, such as gymnastic and weight equipment, but also referees and umpires in sport. Having a positive culture at a sports club that promotes safe and fair play can help decrease risk of injury.

Policy

Having very clear regulations regarding use of equipment and maintenance of facilities can help reduce the risk of injury. Maintenance checks should be completed regularly. By identifying and removing impediments, injuries can be avoided. A lack of guidelines and procedures, or failure to follow these, can leave many people at increased risk.

Environmental

Too many injuries are caused by inadequate equipment and facilities. In all physical activity, some equipment is required and, in order to reduce risk, this equipment must be carefully fitted, and regularly checked and maintained. Modified equipment is an important part of reducing risk involved in junior sport and physical activity.

Strategies to address risk management and safety in physical activity and sport

There are many strategies focused on increasing the safety of physical activity and sport.

- Play by the Rules: includes a comprehensive website with free resources about risk management and safety for everyone involved in sport
- Good Sports: provides a program with resources for sporting clubs to create a healthy and safe culture
- Kids Alive — Do the Five: provides free resources for everyone to ensure safety around water

Many local clubs and councils also have programs in place specific to the needs of the sport and the local community.

eBook*plus*

Weblink
Play by the Rules

TEST your understanding

1. Describe what is meant by risk management in sport.
2. Discuss the purpose of risk management in sport and physical activity.

APPLY your understanding

3. Use the **AIS Risk Management** weblink in your eBookPLUS and read the risk management documents you find there.
   (a) Create a risk management template and complete a risk management for a local facility for the sport/physical activity of your choice.
   (b) Considering the risks identified, create a program to encourage safer participation in the sport/physical activity of your choice.

eBook*plus*

Weblink
AIS Risk Management

14.4 Children and competitive sport

KEY CONCEPT Is the competitive nature of sport turning children away from sport and physical activity?

FIGURE 14.7 Too much of a good thing: is competitive sport always a positive for children?

Sport is defined as a range of activities that are highly organised and involve rules, complex skills and tactics, physical exertion and competition between participants (chapter 10). Competitive sport suggests that scores are kept and teams play against each other in a regular competition.

There has been much debate about the impact, positive and negative, of competitive sport on children in particular. There have been concerns that too much competitive sport can discourage future involvement in sport and other physical activity. A counter argument is that competitive sport is an important part of a child's physical and mental development. Learning to lose is an important life lesson, as we can't all be winners all the time.

Either way, considerable efforts have been made to ensure that competitive sport is managed well, safe and enjoyable for all.

Many sports now have modified sport programs for children. These programs focus on enjoyment and allowing children to develop skills in a modified environment. Common modifications include:

- no scoring or different scoring
- lighter/shorter equipment
- no contact
- smaller playing fields
- shorter game durations.

Examples of these programs include: Auskick (AFL), Netta (netball), OzHoops basketball, Milo in2Cricket, futsal soccer, Hot Shots tennis, tee-ball and Aussie Hockey.

Another debate that surrounds children in competitive sport is the way in which sports are graded. While most sports grade children based on age, there are often significant differences in the size of children of the same age. In contact sports, this can increase the risk of injury.

Use the **Juniors graded by size** weblink in your eBookPLUS to read an article on this topic for more information.

eBook*plus*

Weblink
Juniors graded by size

Influences on children and competitive sport

Individual

If children are placed in teams based on age, but are big or small for their age, it can have a negative impact on their enjoyment of the sport. If children don't enjoy their sport, not only are they less likely to keep playing, but it can also decrease their involvement in physical activity all together. If students understand the benefits of being active, beyond just winning or losing, they are more likely to enjoy their sport.

Social

Competitive sport can be enjoyable for children if they have positive people around them. 'Ugly parent syndrome', in which parents behave aggressively and too competitively, can result in many negative experiences for children and ultimately cause them to drop out of competitive sport.

Policy

Club costs can be a significant barrier for families who have children involved in competitive sport; for example club fees, uniform fees, insurances etc. Sports and clubs also have varying rules on selection criteria and expectations. If these are considered achievable, it can help maintain involvement.

Environmental

Most children rely on others for travel to and from sporting venues. If the clubs and facilities are close by, it can make it easier for children to be involved in competitive sport. As children age, there can be more travel involved; for example, bigger competitions or a need to move to other competitions. This can make being involved more challenging for children.

Strategies to address children's involvement in competitive sport

As previously mentioned, many sports offer modified versions for children to ensure enjoyment and safety.

Other programs and strategies include:

- Good Sports: provides guidelines for supporters at sporting clubs to ensure a positive role model behaviour
- Play by the Rules: provides tips and resources for clubs to ensure a positive club culture
- Play for Life — Join a Sporting Club: linked with the active after-school sport communities, it encourages involvement in up to 70 different sports and 20 different physical activities.

study on

Unit 2	**Children and competitive sport**
AOS 1	Concept summary and practice questions
Topic 14	
Concept 5	

TEST your understanding

1 Describe what is meant by competitive sport.
2 Discuss the issues involved with competitive sport for children.
3 Use the **Juniors graded by size** weblink in your eBookPLUS to read the article and then answer the following questions.
   (a) Outline why rugby league would have a greater need to grade players by weight than other sports such as soccer.
   (b) List some other sports that may benefit from grading players by weight or size instead of age.

APPLY your understanding

4 **Practical activity:** Participate in a modified sport (Auskick (AFL), Netta netball, OzHoops basketball, Milo in2Cricket, futsal soccer, Hot Shots tennis, tee-ball or Aussie Hockey) then answer the following questions.
   (a) Describe the differences between the modified version and competitive version of the sport played.
   (b) Discuss the advantages and disadvantages of having modified versions of the sport.
   (c) Explain how the modified sport may lead to greater and longer participation in the sport.
   (d) Choose another sport and discuss how and why it could be modified.
5 Complete a pros and cons table about grading players based on weight instead of age.

Pros	Cons

eBook*plus*

Weblink
Juniors graded by size

14.5 Community and recreation

KEY CONCEPT The community environment is a significant influence on physical activity. There is much to be gained for the community by ensuring the environment enables physical activity.

FIGURE 14.8 Access to outdoor exercise equipment such as this plays an important role in keeping people active.

The community and recreation

Recent research shows that walking for exercise is the most common form of physical activity for Australians (23 per cent). This was followed by aerobics, fitness or gym group (14 per cent), swimming (7.4 per cent), cycling (6.5 per cent) and jogging or running (6.5 per cent). These activities were the only activities that were participated in by more than one in twenty Australians.

All of the above physical activities rely heavily on access to local facilities such as walking tracks, public pools, gyms and safe bike lanes. These are generally the responsibility of the local council and/or the state government.

While there are significant costs in building, maintaining and staffing these facilities, the costs can be heavily outweighed by the benefits. If these facilities are used correctly and frequently by the community, they can increase physical activity levels. Increased physical activity levels can lead to many health, economic and social benefits for the community (see chapter 11).

As our population increases and our cities become more densely populated, urban planning that provides open spaces and facilities to encourage physical activity has become a necessity. This helps to ensure our communities are conducive to recreation and physical activity.

Influences on the community and recreation

Individual
Age, gender, physical ability, skill level, knowledge of benefits, socioeconomic status

Social
Social support, family, role models, community support

Environmental
Physical environment (natural or built)
Access to clubs/facilities (cost and travel)
Safety of environment (general upkeep, lighting)

Policy
Urban planning, rules (e.g. speed limits)

study on

Unit 2
AOS 2
Topic 14
Concept 6

Community and recreation
Concept summary and practice questions

Individual

Community recreation areas will be more likely to be used if people know the benefits of being active and where the physical activity and recreation facilities are. Without understanding the purpose of the spaces or equipment, it is unlikely that there will be much interest in them.

Social

Recreation spaces such as ovals and parks can encourage physical activity but it is often harder if you are on your own. If large numbers of people use the recreation spaces and facilities, it not only provides positive role models but also social support for others.

Policy

Rules and regulations about the use of community recreation areas are vital in ensuring these spaces encourage physical activity. Unfortunately, some spaces have curfew times, which can restrict their use and therefore people's physical activity. However, there are also many rules in place that increase the perception of safety, such as slower speed limits near parks and bicycle lanes, which help encourage the use of these areas.

Environmental

Having the space and equipment is important but maintaining these is just as crucial to ensure long-term use for physical activity. If equipment is not maintained, it can become unsafe which will reduce its appeal to the community. Continual checks and upgrades are important to ensure the safety and interest of the community.

FIGURE 14.9 Councils have a responsibility to ensure that public amenities are well maintained and safe for members of the public to use.

Strategies to address the issue

There are a number of strategies at the local community level aimed at increasing spaces and places for physical activity. Some of these include:

- walking tracks
- outdoor gym equipment
- ovals
- bike racks
- water taps
- skate parks
- playgrounds (with shade cover).

Programs to assist local governments with this include the following.

- Healthy Spaces & Places: a national guide to help communities plan for appropriate places of recreation
- VicHealth's Community Activation program (active until July 2015). Grants were given to councils to help create more opportunities for communities to be active. One example of this is by Manningham City Council, where changes are planned for an existing space in the plaza forecourt of City Square in Doncaster. The money provided by the grant will allow the space to be transformed to include a vertical green wall, exercise stations and dedicated spaces for fitness and sporting activity, as well as yoga and dance. A grassed area, sandpit and sporting equipment are also planned to help encourage physical activity. It is hoped that local providers will use this new space to organise physical activity opportunities for the community.

TEST your understanding

1. List ten ways in which the community environment can encourage physical activity.
2. List five barriers that may exist in the community environment.

APPLY your understanding

3. Consider your local community (preferably using a current map).
   (a) Outline the barriers to physical activity within your community.
   (b) Suggest ways to overcome the barriers identified.
   (c) Outline the enablers to physical activity within your community.
   (d) Focusing on the enablers within your local community, create an advertisement (poster, brochure, short film) encouraging the use of the community recreation facilities.

14.6 Issues of access

KEY CONCEPT Money, roads, schools, parenting, safety and ability are some of the many factors that determine access to programs, education and facilities in relation to physical activity. The movement of children, rural and remote communities, people with disabilities, Aboriginal and Torres Strait Islander people and others in Australia are affected by factors related to access.

Access

People are most likely to be active if they live in walkable neighbourhoods and have easy access to green space and sporting facilities. Access to coaching and instruction about skills and fitness can also be enablers of movement. People with disabilities may need modified ramps and other alterations to the built environment to make it easy for them to access facilities.

There is anecdotal and indirect evidence that suggests modern-day children are less active than children in previous decades.

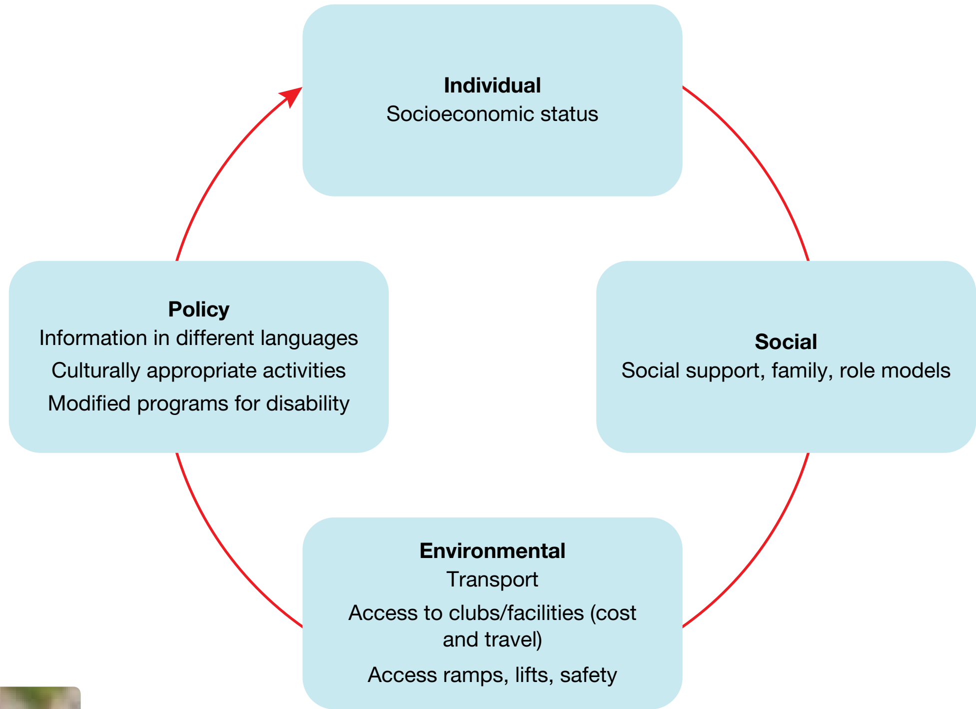
The ABS statistics (2013) show that 38 per cent of ATSI adults in non-remote areas participated in sufficient physical activity to maintain good health. This is compared to 43 per cent of the adult population in Australia.

A study conducted at the University of South Australia showed that 47 per cent of the South Australian population was classified as inactive, compared to 57 per cent in some regional areas.

The ABS *Perspectives on Sport* report (2012) shows the participation in sport and physical recreation activities of people with and without a disability. The results showed that 68 per cent of males with a disability participated, compared to 82 per cent of males without a disability.

For some communities in Australia, these factors are present and are therefore enablers to physical activity. For others, such as some children, rural and remote communities, Aboriginal and Torres Strait Islanders (ATSI) and people with disabilities, conditions are not ideal and can be barriers to physical activity participation.

Influences on access



Individual

Cost

Cost is a barrier for some people with disabilities due to limited employment opportunities. The increased cost of travel can be a barrier for people who live in rural and remote communities.

Cognitive ability

Low literacy or computer skills among people with a disability can be a barrier to movement because they are unable to follow instructions, understand promotional material or register for programs.

Social

Sociocultural factors such as social capital and children's preferences are the greatest enablers of movement for children. Socioeconomic status can influence access to physical activity, sport and exercise. Family income can be a barrier or an enabler for children because it can determine the opportunities that they have to access a variety of sports and quality instruction.

Policy

Access to modified exercise and sports programs such as wheelchair basketball is an enabler of movement for people with disabilities.

FIGURE 14.10 Factors such as family income and ease of travel can affect whether children are able to participate in sporting activity.

Programs that meet the cultural needs of Aboriginal and Torres Strait Islander people are enablers of movement. The amount and type of programs available in rural and remote areas may be a barrier to movement for people who reside in these areas.

Environmental

Environmental factors such as the distance from home and school also influence movement. Access to parks and playgrounds can encourage participation. Neighbourhood safety, the condition of parks and playgrounds, and the amount of traffic can be barriers to physical activity, sport and exercise for children.

FIGURE 14.11 The Aboriginal Family Holiday Program was designed to nurture the health and wellbeing of young Indigenous Australians in country Victoria.

Transport

The city of Whitehorse in Melbourne released a report based on their Sport and Physical Activity project. In this report, people with disabilities indicated that transport was a major barrier to physical activity participation.

Talented children or youth from remote or rural areas may have limited access to elite training and/or competition. People in remote communities and some Aboriginal and Torres Strait Islander communities may not have facilities within a commutable distance.

Facilities/services

Factors that determine access to facilities are interrelated. Access to facilities such as indoor playing areas, grass areas, gyms, aquatic facilities and tennis courts is dependent on many factors. People with disabilities may have difficulty accessing facilities due to their mobility, cost may make it prohibitive, the physical environment may make it difficult for them to enter the premises or they may not feel that their individual needs, such as privacy in the change rooms, are catered for. Children may not be able to access facilities such as gyms because of their age, lack of transport, cost or safety. Facilities and services may not exist in rural and remote communities.

Built environment

The built environment can include the density of housing in the area we live in, or it can relate to modifications to buildings that encourage access. For example, the presence of ramps, handrails and lifts would be enablers to movement for people with physical disabilities.

FIGURE 14.12 Wheelchair ramps like this one help those with disabilities to access public pools.

FIGURE 14.13 Ahmed Kelly overcame many obstacles in his life to swim for Australia at the 2012 London Paralympic Games and at the 2016 Paralympic Games in Rio de Janeiro. Social influences on Ahmed, such as the love and support from his adoptive mother and his siblings, as well as the policies of Swimming Australia, have enabled him to participate in swimming at an elite level.

studyon

Unit 2 | AOS 2 | Topic 14 | Concept 7

Issues of access Concept summary and practice questions

Strategies to address the issue of access

Below is a list of programs and organisations that are making access an enabler rather than a barrier for people with disabilities, people in rural and remote communities, children and Aboriginal and Torres Strait Islander (ATSI) communities.

- Swimming Australia: have developed a framework for inclusion
- VicHealth: 'Active for Life' resource is aimed at increasing the activity levels of children
- Playing Out: an organisation in the UK that aims to transform neighbourhoods to encourage active play
- Sporting Schools: physical activity programs that are conducted before, during and after school
- Inclusive Play Space: landscape architects who provide advice about how to enhance the inclusiveness of recreation facilities and playgrounds
- Aboriginal Family Holiday Program: a holiday program that provides opportunities for Aboriginal and Torres Strait Islander people to access physical activity
- Regional Sport and Recreation program, Sport and Recreation Victoria
- Pop-Up-Park: a temporary park set up on vacant land in suburban Melbourne

TEST your understanding

1 Watch the videos that are included in the **Vic Swimming** weblink in your eBookPLUS. Outline the strategies that are included in their framework for inclusion. Choose one of the groups discussed in this chapter and provide an explanation of how this framework may be an enabler of movement for a person within this group.

APPLY your understanding

2 In relation to neighbourhood spaces, there are some innovative solutions being developed in other countries. In the UK, the Playing Out organisation provides support for residents of a neighbourhood who want to make some changes that encourage physical activity of children.

Use the **Playing Out** weblink in your eBookPLUS to access their website. Taking the information you find there as a stimulus, develop five ways in which access to physical activity could be improved where you live.

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Weblink
Vic Swimming

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Weblink
Playing Out

CHAPTER 14 REVISION

CHAPTER REVIEW

CHAPTER SUMMARY

- There are many issues that impact participation in sport and physical activity.
- The issues have changed and will change over time.
- There are many programs and strategies in place to combat some of the issues negatively impacting on physical activity levels.
- Multiple factors influence physical activity behaviour including individual, social environment, physical environment and policy.
- The social-ecological model and Youth Physical Activity Promotion Model can be used to help create, evaluate and modify programs designed to increase participation in physical activity and sport.

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Digital document
Issue report template
Searchlight ID: doc-18675

INQUIRY QUESTION
Why are active transport levels declining?

CHAPTER

15 Contemporary issues and sport: active transport

The increasing rate of sedentary behaviour in Australians is a major health concern. Not only are we becoming more sedentary, our physical activity levels are also declining.

One way to decrease sedentary behaviour and increase physical activity levels at the same time is through active transportation.

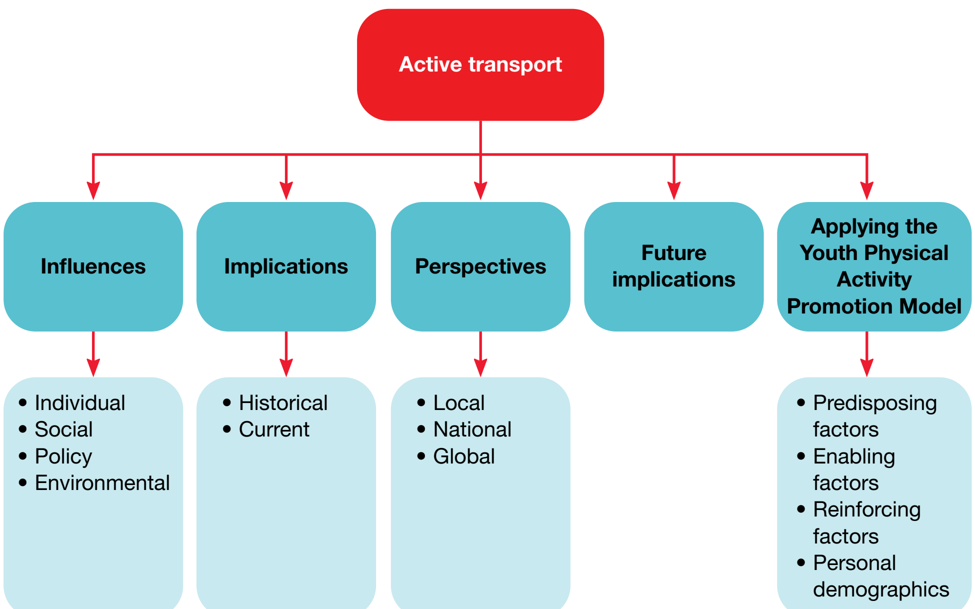
KEY KNOWLEDGE

- The role of the social-ecological model and/or the Youth Physical Activity Promotion Model in evaluating physical activity promotion and sedentary behaviour reduction initiatives and strategies
- The key concepts associated with the selected contemporary issue associated with participation in physical activity and/or sport in society
- Individual, social, policy and environmental influences on participation in physical activity and/or sport in reference to the selected issue
- Local, national and/or global perspectives of the selected issue
- Historical, current and future implications of the selected issue
- Government, community and/or personal strategies or programs designed to promote participation in physical activity and/or sport.

KEY SKILLS

- Identify contemporary issues associated with participation in physical activity and sport
- Participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue
- Collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, print and electronic material
- Analyse the historical, current and future implications on the issue identified
- Apply the social-ecological or Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue
- Draw informed conclusions and report in a suitable format on the socio-cultural and environmental influences that impact on participation in physical activity and/or sport based on research findings

CHAPTER PREVIEW



15.1 Active transportation

KEY CONCEPT Active transport refers to the way we travel using our bodies, rather than using passive forms of transport, such as being a passenger in a car or bus. The more we participate in active, not passive, transport, the greater our likelihood of good health.

The issue

Active transport is defined as physical activity undertaken as a means of transport and not purely as a form of recreation. Common examples include walking, cycling and, for younger people, skateboarding or using a scooter. High levels of active transportation are linked to positive physical, economic and social outcomes. Active transport has also been found to be one of the most effective means of increasing levels of physical activity within a community.

According to the National Heart Foundation of Australia, the number of children walking to school has halved over the past 40 years. There has also been a significant rise in the rate of childhood overweight and obesity, and a decline in the average fitness level of children.

FIGURE 15.1 Walking or cycling to work or school has many health benefits.

studyon

Unit 2
AOS 2
Topic 15
Concept 1

The issue with active transportation Concept summary and practice questions

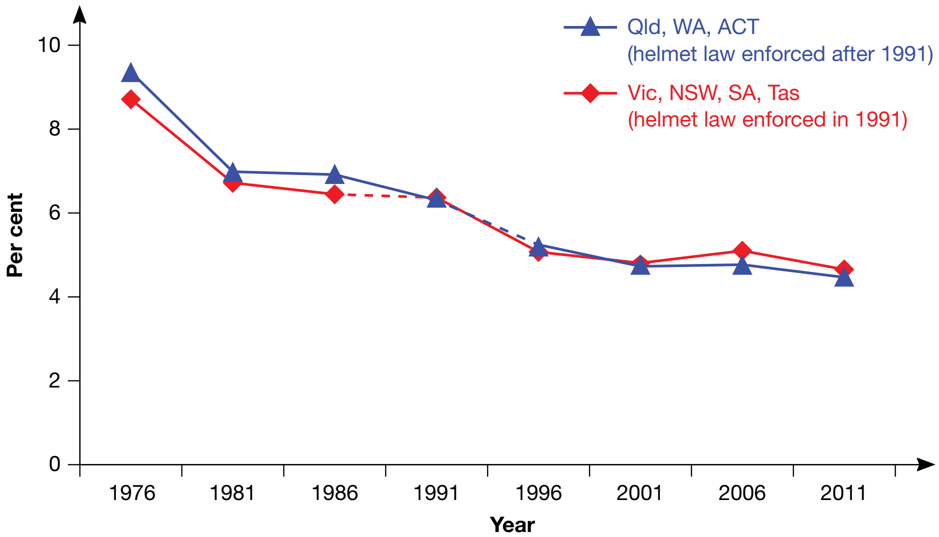


FIGURE 15.2 National percentage of people walking to work, 1976–2011

Source: cyclehelmets.org

Among adults, walking is the most commonly reported form of recreational activity in Australia, and this is also the case worldwide. Although the physical and psychological benefits of walking are well known, many surveys indicate a decline in the frequency and amount of walking done by both children and adults in many countries, including Australia.

FIGURE 15.3 Urban sprawl in Australia's major cities has contributed to people having to catch public transport to work and school, rather than walk or cycle, due to long distances being travelled.

TEST your understanding

Use figure 15.2 to answer the following questions.

1 Outline a trend from the graph.
2 Justify the trend.
3 Suggest the most popular mode of transport to work and how it may have changed over time, based on the trend above.
4 Outline the impact helmet laws had on the percentage of people walking to work and suggest a reason for this.
5 In what year/s were there more Victorians walking to work than Western Australians?

APPLY your understanding

6 Would you expect a similar trend in the percentage of people riding to work? Explain why or why not.
7 Research what percentage of people walk to work in London, Beijing or New York. Compare this data to the graph above. Suggest reasons for any similarities or differences.

15.2 Factors influencing active transport

KEY CONCEPT Individual, social, policy and physical environmental factors can enable active transport or can act as a barrier to it. It is important that all factors are understood and considered if we are to increase the number of people regularly using active transport.

Individual factors

Cost

Money is often a barrier for participation in physical activity; however, 'cost' can help encourage people to use active transport to and from school and work, acting as an enabler. Walking and cycling come at a very low cost and can have financial benefits due to the money saved on fuel, parking and public transport.

Knowledge and skills

If there is a lack of knowledge about the benefits of cycling and/or a lack of cycling skills, it can act as a barrier for active transportation.

Social factors

Role models

Many schools and local communities use role models to strongly encourage walking to school. Most walk-to-school programs, such as the Walking School Bus, include a supervisor, usually a parent or teacher, to accompany the children on their journey.

Cultural norms and family dynamics

Over the past 30 to 50 years, our family and home dynamics have changed significantly. There are fewer children in families, which means fewer people with whom to walk or cycle to school. Most families now also rely heavily on car travel, as it is perceived to be more convenient. Many parents incorporate school drop-offs with their commute to and from work.

FIGURE 15.4 Bike-share initiatives make active transport more accessible.

Policy factors

Funding

Increased funding from the government for safe bike paths and bike storage, or for public bike-share initiatives, assists in making active transportation more accessible and therefore easier. On a smaller scale, employers can provide incentives for employees who use active transport; for example, more flexible hours to ensure safe travel in daylight.

Physical environmental factors

Safety

Safety is one of the most influential factors on active transportation. Safe routes for walking and cycling can strongly encourage people to use active transportation. This includes the provision of bike lanes, well-lit walking paths and signage to indicate reduced speed limits. A perception of increased stranger danger has also become a barrier for many people who consider active transport.

Access to equipment

While cycling to work does not require much equipment, Australian law requires that a helmet is worn when riding a bike. Australia was the first country to make this mandatory between 1990 and 1993, and this coincided with a significant drop in the number of people using cycling as their primary mode of transport. While the laws increased safety, it was seen by some as a barrier to cycling. More recently, Australians are still riding to work less than pre-helmet days but rates have plateaued.

Built environment

The built environment has a significant influence on perceived safety. As mentioned above, safety is vital in encouraging active transportation. In addition to separate cycling and walking paths, other examples of built environment that can enable active transportation include:

- lockers and showers, to allow people to store belongings and shower before and during work
- bike racks, to allow people to safely store bikes
- aesthetically pleasing walkways and stairwells, that are well-lit and clean, can encourage people to use these as opposed to the lifts.

Geographic location

'Back in my day, we used to ride for kilometres to get to school and work . . .' Many people would have heard this from their parents or grandparents. Research does show that the distance kids are willing or allowed to travel on their own has dramatically declined compared to past generations. Many children now attend a school of choice rather than the closest school. Many smaller schools have amalgamated to become bigger schools increasing the distances required for travel. Urban sprawl has also led to increased distances between the home and important amenities and facilities, including schools. This increased distance can result in active transport being less appealing and practical.

studyon

Unit 2
AOS 2
Topic 15
Concept 2

Factors influencing active transportation
Concept summary and practice questions

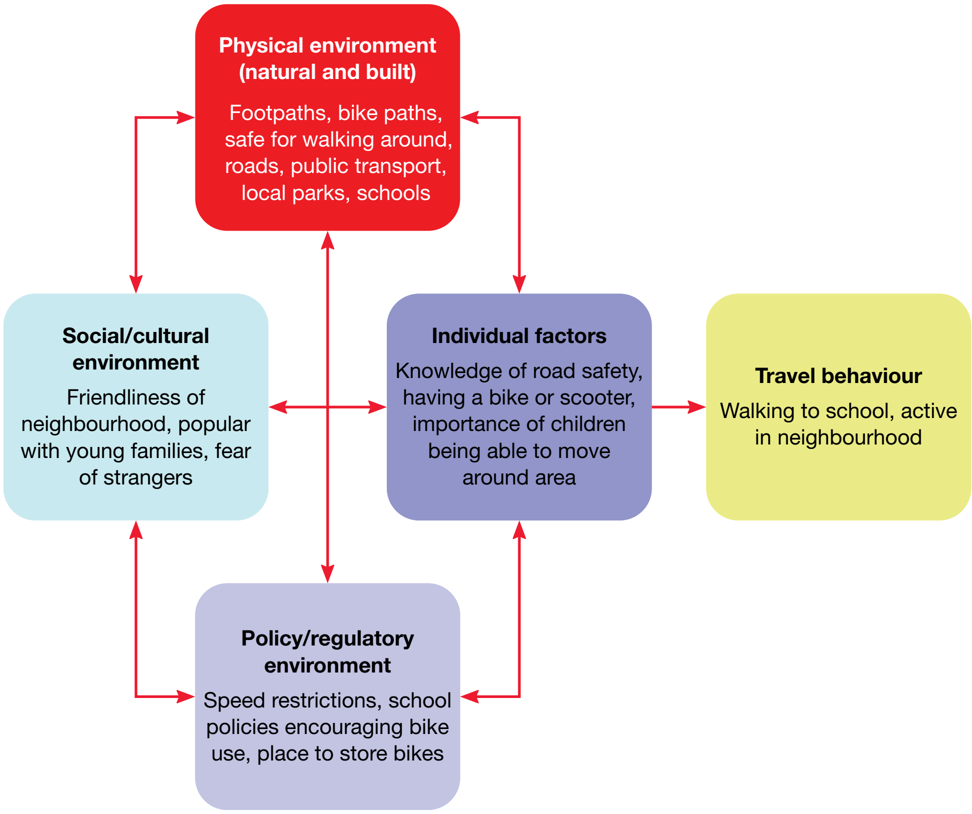


FIGURE 15.5 Environmental influences on children walking to school

Source: Garrard, J. 2009, *Active transport: children and young people. An overview of recent evidence*, Victorian Health Promotion Foundation (VicHealth), Melbourne.

The factors shown in figure 15.5 can act as enablers or barriers to active transport. For example:

- access to attractive, public open space is associated with higher levels of walking
- creating supportive environments, particularly footpaths and walking paths in attractive neighbourhoods, has the potential to increase walking and vigorous physical activity
- where there is a lack of safe and well-lit paths, cycling and/or walking can be perceived as dangerous, limiting opportunities for active transport.

Canberra primary school makes bike riding part of the curriculum

BY HANNAH WALMSLEY

Learning to ride a bike will be part of the curriculum for year five and six students at Curtin Primary School, with the introduction of a new program to give kids confidence on a bike.

The initiative, Ride or Walk to School, is designed to get kids moving for at least 60 minutes each day.

More than 50 Canberra schools are already part of the three-year program run by the ACT Government-funded Physical Activity Foundation.

Students learn road and pedestrian safety, and bike maintenance skills.

Coordinator for the program at Curtin Primary School, Hugh Peoples, said the students would learn the skills to confidently ride to and from school.

'Bikes are going to be a very important part of our PE program for the rest of the year for the whole of year five and six,' he said.

'Anyone can ride a bike fast, but it's really tricky to learn how to control a bike and learn how to multi-task and be aware of the surroundings when riding.'

Curtin Primary School and schools registered with the program were given 15 new bikes and bike helmets to ensure all students had the opportunity to learn to ride a bike.

As well as encouraging students who live near the school to walk or ride, teachers at Curtin Primary School plan to establish a riding club where parents can be involved in group rides.

'We'll also be trying to engage those kids who aren't [easily engaged] in the classroom, to use their hands to help maintain and fix the bikes,' Mr Peoples said.

Year six student at Curtin Primary School, Elenor Parkinson, said riding to school was a relaxing way to start the day.

'It calms you before you go to school and refreshes you,' she said.

FIGURE 15.6 Year 5 and 6 students at Curtin Primary School will learn bike skills to allow them to safely ride to and from school.

'When you ride, it's sort of like being in your own little bubble, distant from the rest of the world.

'It's a really good thing to do before coming to school where you have children rushing around everywhere and going into class.'

Curtin Primary School had already successfully encouraged students and families to use the commute to school as an exercise opportunity.

'Originally we had about 15 to 25 per cent riding to school last year and it's up to around 40 per cent if not more riding to school on a daily basis,' Mr Peoples said.

Source: abc.net.au, 8 April 2015.

TEST your understanding

1 Describe the new program to be introduced at Curtin Primary School. Outline the purpose of this new program.
2 Explain how this program will impact on the physical activity levels of the students at this school.
3 List all the factors that may influence a student riding to school and categorise them as either enablers or barriers.

APPLY your understanding

4 Using your knowledge of the social-ecological model, explain how this policy would impact on the other levels of influence.

15.3 Implications of the decline in active transportation

KEY CONCEPT In order to improve active transport, it is important that we understand how participation in active transport has changed over time and more importantly why.

Historical

Research suggests that in the last 40 years, the number of children using active transport to travel to school has declined by 42 per cent. Active transportation to work has also decreased significantly as cities become more congested with traffic and are affected by urban sprawl. Many people now live further from work, making distance an increasing barrier to walking or cycling.

Current

Typically, only half of Australia's children and young people use active transport at least once per week to travel to and/or from school. On census day in 2006, 80 per cent of employed people in Victoria travelled to work by car, with only 4 per cent walking and 1 per cent cycling.

In 2011 a minority of Australians used active transport as their primary mode of travel.

FIGURE 15.7 Urban sprawl is contributing to a decline in people engaging in active transport.

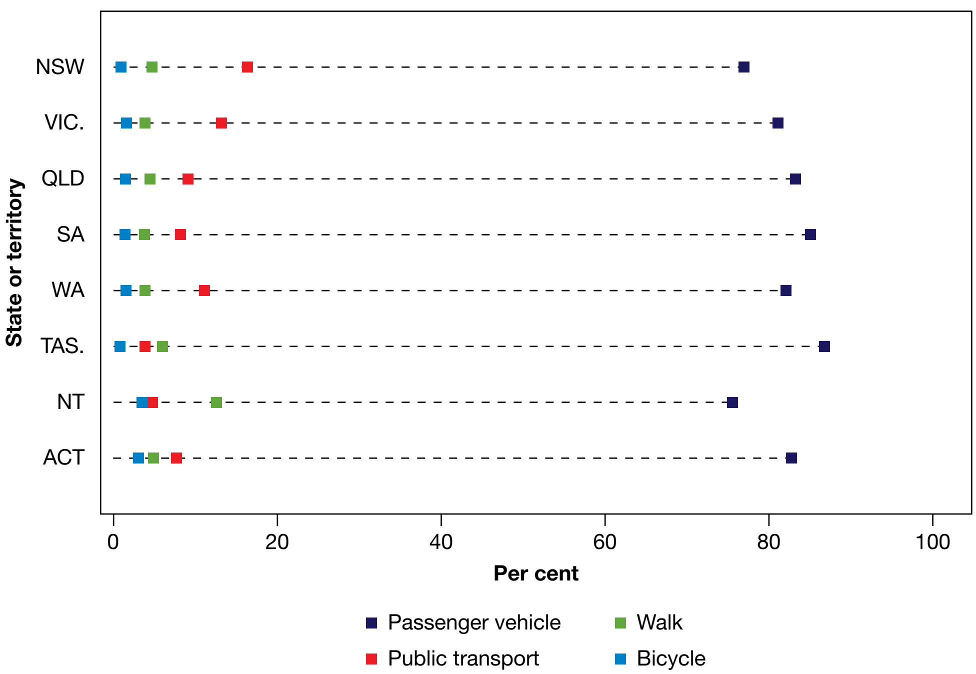


FIGURE 15.8 Methods of travel to work across Australia, 2011

Source: abs.gov.au, July 2013.

There are many initiatives aimed at encouraging active transport.

Vic Health's Walk to School month is aimed at encouraging Victorian primary students to walk, ride or scoot to and from school. Primary schools and students can sign up to track their achievements throughout October. Participation is also encouraged by being eligible to win prizes.

The Bicycle Network has a national *Ride2Work* day held each year also in October. The aim of the annual event is to normalise the idea of riding to work. In doing so, it is hoped that more Australians will ride to work on a regular basis. It targets those who have never ridden to work before and encourages them to try it. It also allows frequent riders to stay motivated and encourage their workmates to get involved.

There are similar walk/ride to work days/weeks around the world, all aiming to increase the number of people using active transport.

studyon

Unit 2 | AOS 2 | Topic 15 | Concept 3

Implications of the decline
Concept summary and practice questions

TEST your understanding

1. Using figure 15.8, identify which state/territory had the greatest amount of active transport and suggest a reason for this.
2. Discuss how using public transport can lead to increased active transport.
3. In figure 15.8, all states/territories had a higher percentage of people walking than cycling to work. Suggest why this is may be the case.

APPLY your understanding

4. Discuss how a cycle share program could have an impact on the data in figure 15.8.
5. Compare the factors influencing walking and riding to work. Use these to justify Victoria's data.

15.4 Different perspectives on active transport

KEY CONCEPT There are many ways to encourage active transport and, in order for rates to increase, there must be work done at the local and national levels.

Local perspectives

As the Victorian population grows, so does the number of people using active transportation. Walking is the most popular form of physical activity in Victoria, but cycling is growing in popularity (9.5 per cent increase between 2013 and 2014). In 2014, Melbourne had more bicycle commuters than any other city in Australia (25 594), and 41 per cent of all women who rode to work in Australia lived in Melbourne.

Factors that have influenced this include:

- increased safe bicycle lanes and paths
- bike-share program
- increased cost of car travel (tolls).

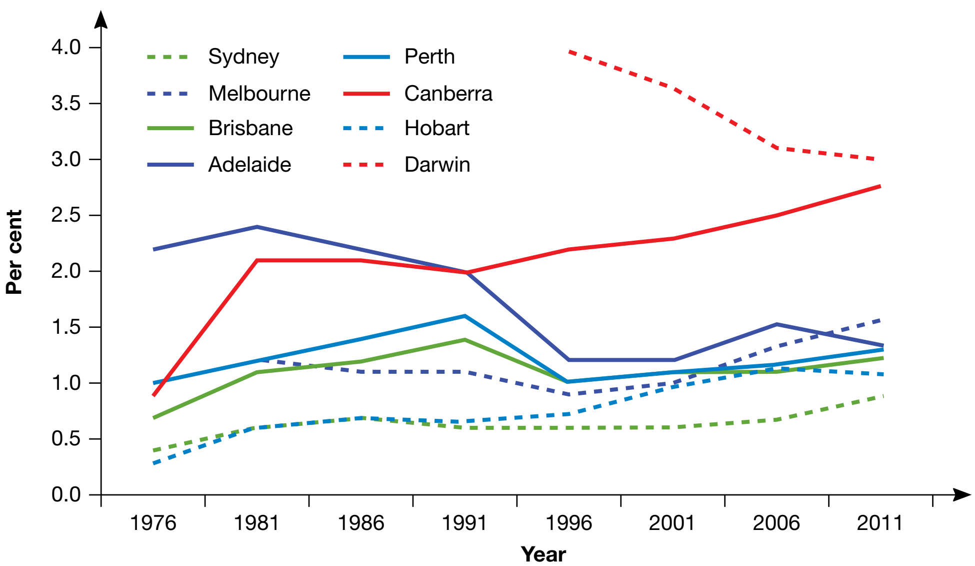


FIGURE 15.9 Journeys to work by cycling (only), by home location

Source: Chris Loader, Charting Transport.

National perspectives

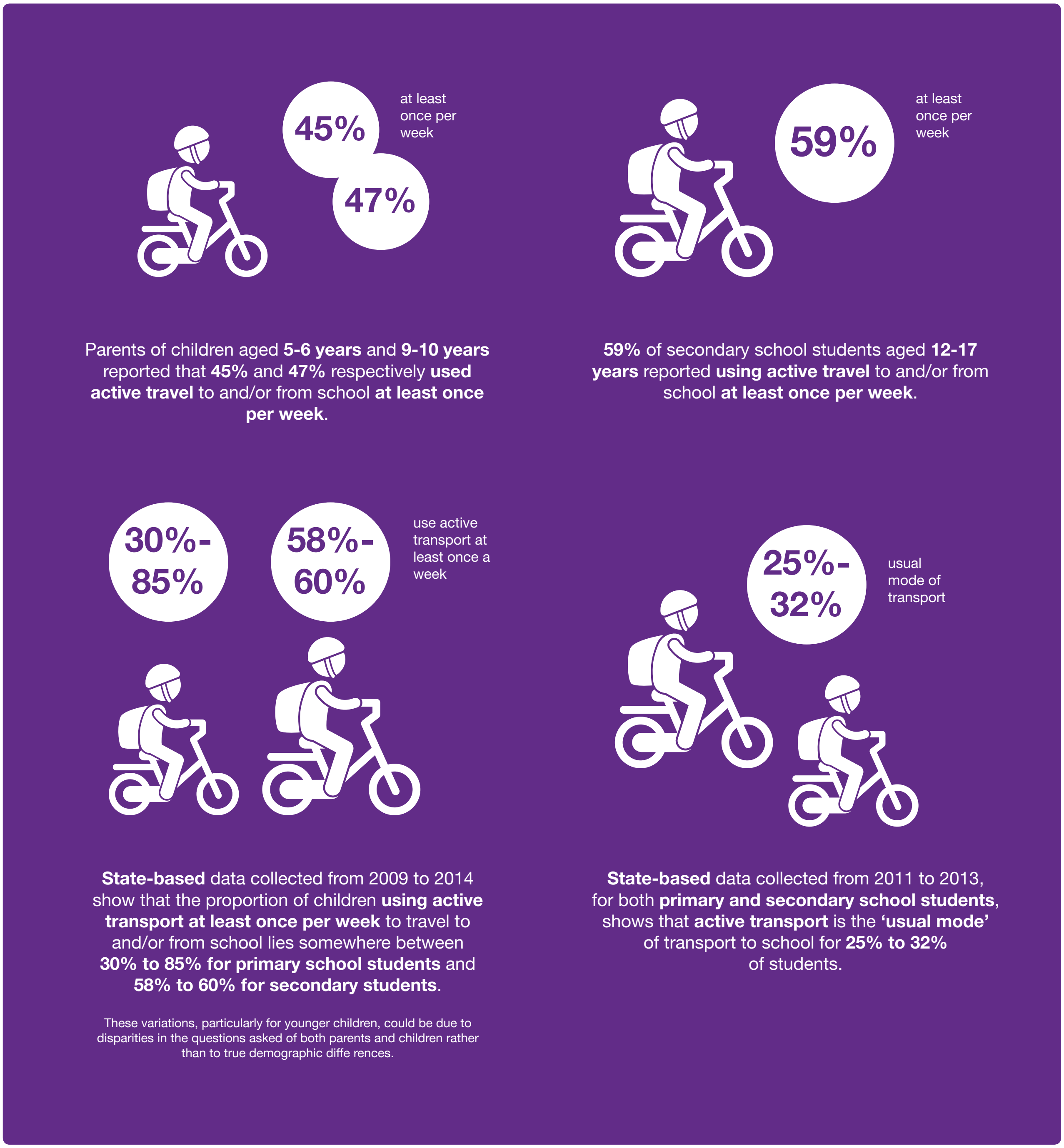
Despite being a 'sporting nation', Australia has often been behind in terms of participation in active transport. Historically it was argued that geographic location was a barrier to this but now as our cities become more densely populated and we are experiencing urban sprawl, geographic location continues to be a barrier in a slightly different way. We are well behind other developed countries. Many argue our strict bicycle helmet laws act as a barrier but we are also well behind on walking to work and school.

Recent research shows that 90 per cent of Australian households have at least one child's bike in working order but only 11 per cent of children currently ride a bike to/from school on a regular basis. So what is it that is stopping kids from riding to school?

For 42 to 51 per cent of parents, the main reasons they did not allow their child to ride to or from school was that they were concerned about 'stranger danger' and the dangers posed by traffic and other road users.

The key findings in an active travel report card in 2015 suggested that, while almost 50 per cent of children aged 5 to 6 and 9 to 10 and just over 50 per cent of children aged 12 to 17 reported using active travel to and/or from school at least once a week, only 25 to 32 per cent claim active travel as being their usual mode of transport to and/or from school.

FIGURE 15.10 Key findings on active transport



Using walking and cycling as a means of active transport is more cost effective than structured exercise programs in achieving population health outcomes. In addition, using public transport is also a cost-effective way to achieve environmental and economic benefits.

Global perspectives

Australia's decline in active transportation over time is reflected in global trends.

A significant influence on this global decline is our increased use of technology. So much of our time is now spent on social media, gaming and other technology, yet

FIGURE 15.10 *(continued)*

Source: *Active Healthy Kids Australia,* 2015, University of South Australia.

many argue they 'do not have time' to engage in active transport, as active transport often takes longer than passive transport.

However, countries which have higher rates of active transportation (such as the Netherlands, Denmark, Germany, Sweden, Finland and Norway), also have lower rates of obesity and type 2 diabetes than Australia, so targeting this may be vital to tackling our obesity epidemic.

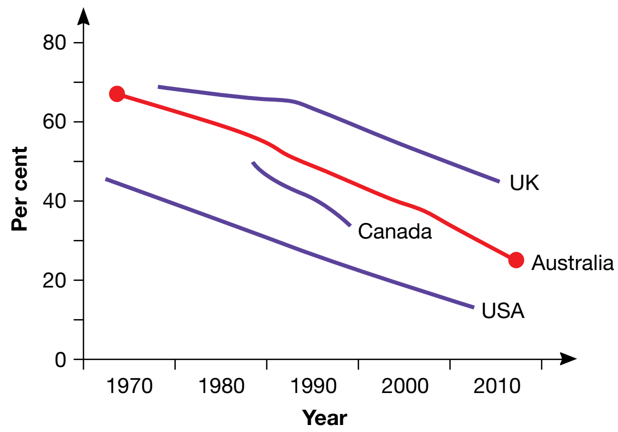


FIGURE 15.11 The percentage of children who use active transport to and/or from school from 1970

Source: *Active Healthy Kids Australia*, 2014.

FIGURE 15.12 The Netherlands has the highest rate of active transport. This is because there is excellent cycling infrastructure there, including a continuous network of cycling paths and tracks, protected intersections and bike-parking facilities, as well as bike-friendly policies.

Australian parents more reluctant than English to allow kids to walk to school, study shows

Australian parents of 10 to 12 year olds are more reluctant to allow their children to walk home from school alone than their English counterparts, according to a study.

Just over half of Australian primary school children (51 per cent) are ferried to school by car, compared with less than a third (32 per cent) of primary school children in England, despite generally walkable distances in Australia, the study by Deakin University and VicHealth found.

The research compared the journeys of 784 primary school children and 455 secondary school children in rural and metropolitan areas of England and Victoria.

The Australian schools were all public and located in Fitzroy, Collingwood, Clifton Hill, Month Albert North, Surrey Hills, Knoxfield, Ferntree Gully, Gisborne, Korumburra and Kyneton.

Four in five (78 per cent) 11-year-old English children were allowed to walk home from school alone, compared with less than half of Australian children of the same age (43 per cent).

And most English children of that age were allowed to cross the road alone, compared with only two-thirds of Australian kids.

The researchers looked at parents granting 'licenses' — or permission — for several activities, including crossing roads alone, travelling to places other to school alone, going home from school, going out after dark alone, travelling on buses, and cycling solo.

While greater access to a second vehicle played a role in the Australian parents' decision-making, lead researcher Dr Alison Carver says, it was far outweighed by factors such as fear of their child being abducted by a stranger and traffic issues.

These concerns existed despite statistics showing a low risk of abduction and increased traffic due to more parents driving their children to school.

'[Australian] parents are concerned about stranger danger and traffic issues, although ultimately more cars contributes to traffic,' she said.

'Abduction rates is a funny issue: most children are abducted by someone they know. Random attacks, strangely, are very rare.'

Freedom of choice means Australian children live further from school

Dr Carver said more freedom of choice in public schooling also contributed to Australian kids on average travelling further to school.

'Over half of kids are attending a school further from them than the closest [public] school,' she said.

She compared the Australian experience with that of Switzerland, where public school zoning was far stricter.

'In Switzerland, most kids live within a kilometre of their school,' she said adding that '95 per cent of them walk to school'.

Dr Carver said children's independence often increases when they reach secondary school, however: 'Most Australian 11 and 12 year olds are still at primary school and face greater parental restrictions than those in England, who start school at an earlier age and are already attending secondary school.'

'Park and Walk facilities located 500 to 800 metres from schools may encourage children to walk at least part of the way and help ease congestion around school gates.'

Findings come as childhood obesity rates soar

VicHealth CEO Jerril Rechter says the research confirms the number of children walking to school is declining, at a time when childhood obesity has reached record levels.

'There seems to be a symbolic granting of freedom when a child transitions to high school, regardless of the child's age,' she said.

'So while many kids are capable of independence when they are 10 to 12 years old, they're generally not given permission to travel alone until they're in secondary school.'

Despite parents' concerns about time constraints, traffic, road safety and stranger danger, she said, 'Once parents make the decision to let their kids walk, they tend to realise that these fears are unwarranted and walking can be a wonderful activity for children's confidence and their health.'

The paper will be published in the hard copy edition of Children's Geographies this month, coinciding with VicHealth's Walk to School campaign.

Source: abc.net.au, 7 November 2013

studyon

Unit 2 | AOS 2 | Topic 15 | Concept 4

Different perspectives (active transportation) Concept summary and practice questions

TEST your understanding

1 Use figure 15.9 to answer the following questions.
   (a) Suggest a reason for the trend in most parts of Australia from 1991–96.
   (b) Discuss two social environmental and two physical environmental influences that may explain the difference in the data for Canberra and Melbourne.
   (c) Explain how the Melbourne bike-share program may increase the number of people using active transport.
2 Using figure 15.11, describe the global trend from 1970–2010 in walking and cycling to school.
3 Data shows that more Australians walk than cycle as a form of active transport. Suggest two reasons why this may be the case.
4 Explain why Australia has lower rates of active transport compared to many other countries.
5 Outline three social environmental and three physical environmental factors that may act as barriers to active transport in Australia.
6 Suggest two reasons why other countries have higher rates of active transport.

APPLY your understanding

7 Devise a program that will encourage more active transport in your local area.

15.5 Future implications

KEY CONCEPT Active transport is an important life-long physical activity habit. It is vital, for the good health of individuals but also of the community, that we stop the decline of active transport.

One of the implications of our ever-increasing population is that the safety of people using active transportation may be sacrificed; for example, more cars on the roads make it harder for us to cycle safely.

The Australian Local Government Association has made nine recommendations to support greater use of active transport and public transport in the report *An Australian vision for active transport in 2010*.

1. Develop an integrated national active transport strategy and establish a national active transport authority.
2. Develop clear and realistic targets for active transport and physical activity outcomes.
3. Provide local government authorities with targeted funding for active transport.
4. Support the development of 'Healthy Spaces and Places' planning principles.
5. Encourage regional and local projects such as cycle routes and hiking tracks.
6. Promote safer environments for people who choose to walk and cycle, or use public transport.
7. Fund social marketing programs to promote the benefits of walking and cycling for people of all ages.
8. Support cycling training and pedestrian education in schools.
9. Provide incentives for persons to walk, cycle or take public transport to work.

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Weblink
Active Visions for Active Transport

The *2015 Active Healthy Kids report card* has suggested the following for local communities and governments.

- Ensure high street connectivity and optimal density levels to reduce the distance needed to travel by students.
- Advocate for changes being made to the physical environment that make it easier for children to negotiate traffic.
- Ensure appealing landscapes within close proximities to homes that children can easily access and that encourage physical activity (e.g. playgrounds, sporting fields and courts, natural environments, skate parks etc.).

Developing healthy active transportation habits in kids is essential in changing the habits of Australia's future.

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Weblink
Active Healthy Kids report card

The *2015 Active Healthy Kids report card* has also suggested the following for schools.

- Consider the size of their 'zones'. The closer children live to their school, the more likely they are to use active transport.
- Have active transport policies to promote and encourage the use of active travel to/from school including:
  - facilities within the school grounds to encourage walking and cycling (e.g. secure bike shelters and access to change rooms so can travel in all weather)
  - engaging with the wider school community to initiate walking/riding school groups (that could be adult supervised)
  - traffic-calming initiatives (e.g. crossing guards)
  - practices adopted by teachers and school leaders to encourage active transport use to and from school.

FIGURE 15.13 In order to encourage more children to walk to school it is paramount that there are safety measures in place in congested areas.

studyon

Unit 2	**Future implications (active transportation)** Concept summary and practice questions
AOS 2	
Topic 15	
Concept 5	

TEST your understanding

1 List four common types of active transport for children.
2 Outline how active transport can lead to healthy habits for life.
3 List common barriers to active transport for children and briefly discuss how these have changed over time.

APPLY your understanding

4 **Practical activity: the amazing race**
 (a) Using key locations in the school/local community, create clues for students to walk/run around the campus. This may even be a map with numbers to follow.
 (b) Track steps using a pedometer. Teams are rewarded for the time it takes them to complete the race (the fastest team receives the highest amount of points) and for the number of steps.
  i Outline when walking can be used as the primary mode of transport.
  ii Identify three barriers and enablers to youth walking more.
  iii Reflect on your own transport, and outline two situations in which you could use walking as your mode of transport.
5 **Practical activity: bike safety**
 Complete a safe bicycle-riding practical or cycle class. Before you do your practical, research key bicycle safety.
6 **Practical activity:** Complete a spin class. Record the kilometres ridden.
 (a) Convert the kilometres ridden to destinations you could have travelled to.
 (b) Based on your data in the practical, how long would it take you to ride to school? (Tip: work out average time per km, then work out how far you live from school.)
 (c) Calculate how much physical activity time you could accumulate in a week if you rode to school.
7 Using the **Be active** weblink in your eBookPLUS and your own research, answer the following questions.
 (a) Describe a strategy aimed at increasing active transportation:
  – in the community
  – in the workplace
  – in schools.
 (b) Outline four ways in which governments can help encourage active transportation.
 (c) Consider two of the walking case studies. Discuss how they are different and why.

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Be active

15.6 Active transportation and the Youth Physical Activity Promotion Model

KEY CONCEPT The YPAP Model can be used to create programs to increase physical activity in children and young people with the goal of long-term behaviour change.

FIGURE 15.14 With physical activity levels in decline in Australia, we need to look at other ways to get people moving. Active transportation has been proven to increase physical activity levels.

The Youth Physical Activity Promotion Model (see chapter 12) can be used to help create, evaluate and modify programs. If each aspect is addressed in detail specific to the target population, it is more likely to be successful and therefore result in long-term behaviour change. The model is organised around three broad factors that together influence how active children and adolescents are: predisposing, enabling and reinforcing factors.

Predisposing factors

When considering participation in active transport, the predisposing factors could be:

- improve perceptions of competence (*Am I able?*)
  - do the participants have the skills (walking, bike riding, scooting) to safely participate in the activity? Does the program provide guidance and/or teaching of basic skills to enable participants to be successful?
- improve attraction to physical activity (*Is it worth it?*)
  - is the program fun and exciting, and do the participants see the purpose and benefits of participating in the program? Does the program educate participants about the benefits of the program?

Programs should aim for all participants to answer yes to the above questions.

Enabling factors

Enablers provide the opportunity to be active. Possible enablers that active transportation programs may address include:

Biological enablers	Environmental enablers
Skill level	Walking tracks
Physical fitness	Presence of safe footpaths/bike paths
	Access to equipment (bikes, helmets)
	Safe storage of equipment (lockers, bike racks)
	Good weather (alternative options in poor weather)

Reinforcing factors

In addition to strengthening enabling factors, a program is more likely to be successful if it also strengthens reinforcing factors. Reinforcing factors include the support and encouragement of family, peers, teachers and role models to be active. In active transport, an example may be a parent volunteering to lead a 'walking bus' to school, or servicing a bike so it is ready for 'Ride to School' day. Other examples are parents engaging in active transportation with their children or creating groups where peers can engage in active transportation together. Reinforcing factors can be exhibited through either indirect or direct influence. For example, direct influence is the facilitation of participation such as a parent volunteering and taking their child along. Indirect influence includes a parent's encouragement of the child to participate.

Personal demographics

Personal demographics such as age, gender, ethnic/cultural background and socioeconomic status lay the foundation for how the various influences combine to impact on physical activity behaviour. An active transportation program may cater for the personal demographics within a population by:

- having activities specific to the interests of the age group; for example, primary school children are more likely to scoot to and from school than secondary school students
- ensuring that all can access equipment, regardless of socioeconomic status; for example, a school having a bike loan program
- having role models of both genders; for example, using male and female leaders in walking groups.

Evaluating a program using the Youth Physical Activity Promotion Model

The HandsUp! Program

Aim: Supports thousands of schools across Australia to create and maintain an active travel culture. Suggestions to help make encouraging walking and riding to school quick and easy.

What they do:

- Monthly HandsUp! count system, so you can keep track of how you are going as a school.

HandsUp! counts provide each school with the opportunity to measure their progress in supporting more students to become physically active and is a great way to reward their success. HandsUp! counts are simple. Schools simply count how students arrived at schools on any given day during the school week and enter the data they collect through their Ride2School account.

- Star Rewards and Barrier Buster Initiative — offering awards such as bike parking, bike education, a class set of bikes
- National Ride2School Day
- Local and state government support to create active travel environments (e.g. school crossings, reduced speed limits, paths etc.)

How to be involved:

- Schools can sign up for free using the online system.
- Schools must submit data once a week.

An evaluation of a program breaks down each of the factors and determines if they have been accounted for and, if so, how, using specific examples from the stem of the question. For factors that have not been addressed, an evaluation requires you to make appropriate suggestions to increase the likelihood of a program being successful. The table below provides an example of this.

What aspects of the framework are addressed/not addressed?

Predisposing factors	Am I able?	Options given to suit skill set; for example, if someone can't ride a bike they can walk.
	Is it worth it?	While one of the prizes is bike education lessons, the program could be improved if these lessons were part of signing up to the program to help educate students about the benefits of active transport.
Strengthen enabling factors	Biological	The program caters for a variety of skills (walking or riding)
	Environmental	Tools to help local and state government to create positive active transport environment (e.g. school crossings, reduced speed limits, paths etc.) Prizes include bike parking and a class set of bikes. This helps provide equipment.
Strengthens reinforcement factors		Participating as a school community can be a very strong reinforcement factor as students can actively travel to school with peers and teachers.
Personal demographics		The program is free, quick and easy.

Evaluation

In order for a program to be effective, it needs to recognise that there are many factors that influence behaviour. There is no single factor that determines physical activity participation. The HandsUp! Program is free. It allows everyone, no matter their personal demographics or socioeconomic status, to be involved. By allowing students to contribute if they walk or ride, it allows a greater number of students to answer yes to the predisposing question of 'am I able?'. These choices may also strengthen the biological enabler of skill.

The HandsUp! Program also aims to strengthen the environmental enablers by providing support tools to help local and state government to create positive active transport environment (e.g. school crossings, reduced speed limits, paths etc.) and prizes which include bike parking and a class set of bikes. This may help provide equipment. To strengthen reinforcement factors, the HandsUp! Program encourages participating as a school community. This can be a very strong reinforcement factor as students can actively travel to school with peers and teachers.

While it addresses most aspects of the Youth Physical Activity Promotion Model, the predisposing factor of 'is it worth it?' could be addressed better in order to ensure long-term effectiveness. While one of the prizes is bike education lessons, the program could be improved if these lessons were included in signing up to the program to help educate students about the benefits of active transport.

studyon
Unit 2
AOS 2
Topic 15
Concept 6
Applying the YPAP Model
Concept summary and practice questions

CHAPTER 15 REVISION

- yellow identify the action word
- pink key terminology
- blue key concepts
- light grey marks/marking scheme

KEY SKILLS

- Identify contemporary issues associated with participation in physical activity and sport
- Participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue
- Collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, print and electronic material
- Analyse the historical, current and future implications on the issue identified
- Apply the social-ecological model or Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue
- Draw informed conclusions and report in a suitable format on the socio-cultural and environmental influences that impact on participation in physical activity and/or sport, based on research findings

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Walking School Bus

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- apply the Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue.

PRACTICE QUESTION

1 **List** each component of the Youth Physical Activity Promotion Model and **outline** if it has been considered in the Walking School Bus Program. *(5 marks)*

Sample response

Outline whether this program will be effective in increasing physical activity based on whether or not it addresses all aspects of the Youth Physical Activity Promotion Model.

Participation in active transportation is influenced by a number of different factors. The Walking School Bus Program addresses these **by addressing** the predisposing factors. Most students are able to participate as it involves walking. They can 'walk' the bus with friends which can help give it worth. Some education about the benefits of using the walking school bus **would increases its effectiveness**. The program seeks to strengthen enabling factors by allowing all students to join, no matter the age, gender or skill level, and they ensure safe routes to increase the safety. By using parents as conductors and encouraging groups of students to be involved, it strengthens reinforcement factors. The program is also free which can help overcome personal demographics barriers. **While it addresses most aspects of the Youth Physical Activity Promotion Model, it could provide** more incentives, like education on the life-long benefits of active transportation, to help better address predisposing factors.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action words:**
  List — enter in a list with others
  Outline — general description but not in detail
- **Key terminology:** Youth Physical Activity Promotion Model — predisposing factors, strengthen enabling factors, strengthens reinforcement factors, personal demographics
- **Key concept:** Walking School Bus Program — use examples from the stimulus
- **Marking scheme:** *5 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question

HOW THE MARKS ARE AWARDED

- **1 mark** — mention that physical activity behaviour and the factors influencing it are complex. There is no single factor that determines physical activity participation.
- **4 marks** — list each component of the Youth Physical Activity Promotion Model and outline if it has been considered in in the Walking School Bus Program.

PRACTISE THE KEY SKILLS

1 Outline two social environmental and two physical environmental barriers to active transport for youth and two sociocultural and two environmental barriers to active transport for adults.
2 Identify three strategies that could be used by a local government to increase the percentage of people using active transport.
3 Consider a local workplace and outline five specific barriers that would need to be overcome for the employees to engage in active transport. Identify these barriers as being social, cultural or physical environmental.

CHAPTER REVIEW

CHAPTER SUMMARY

- Use of active transport can increase physical activity levels and decrease sedentary behaviour.
- Active transportation can result in health, environmental and economic benefits for individuals and communities.
- Active transportation levels, across all age groups, are decreasing.
- There are many factors that influence active transport, many of which can act as enablers or barriers.

- Australia’s levels of active transport are declining and are well below the levels of many other developed countries around the world.
- In the last decade, Australia has begun to implement strategies that are aimed at increasing the participation in active transportation.
- Programs that are most effective in encouraging active transportation are those that are tailored to the specific needs of a target group.
- In order to critique programs that are aimed at increasing active transportation using the Youth Physical Activity Promotion Model, it is important to understand how active transportation is influenced by predisposing factors to be active, enabling factors to be active and reinforcing factors to be active.

INQUIRY QUESTION

Everyone needs to move, no matter what their cultural background, ethnicity or nationality. How do we develop a culture of inclusiveness that encourages physical activity for all Australians?

CHAPTER

16 Cultural diversity and inclusion in physical activity

The Australian Sports Commission describes inclusion as 'providing a range of options to cater for people of all ages, abilities and backgrounds, in the most appropriate manner possible'. Inclusion is about strategies to make people feel welcome at sporting events or within organisations. An inclusive sporting club or event is one that encourages participation both in the activity and the administration. Inclusion is different to diversity. Diversity is a term used to explain variation in nationality, ability, education and ethnicity. Inclusion is about how this diversity is catered for by the sporting organisation/event.

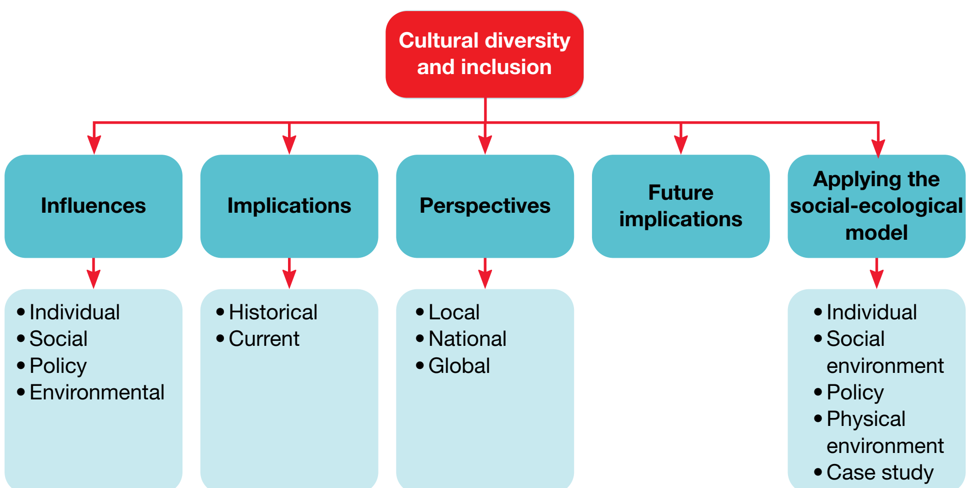
KEY KNOWLEDGE

- The role of the social-ecological model and/or the Youth Physical Activity Promotion Model in evaluating physical activity promotion and sedentary behaviour reduction initiatives and strategies
- The key concepts associated with the selected contemporary issue associated with participation in physical activity and/or sport in society
- Individual, social, policy and environmental influences on participation in physical activity and/or sport in reference to the selected issue
- Local, national and/or global perspectives of the selected issue
- Historical, current and future implications of the selected issue
- Government, community and/or personal strategies or programs designed to promote participation in physical activity and/or sport

KEY SKILLS

- Identify contemporary issues associated with participation in physical activity and sport
- Participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue
- Collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, print and electronic material
- Analyse the historical, current and future implications on the issue identified
- Apply the social-ecological model or Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue
- Draw informed conclusions and report in a suitable format on the sociocultural and environmental influences that impact on participation in physical activity and/or sport based on research findings

CHAPTER PREVIEW



16.1 Cultural diversity and inclusion

KEY CONCEPT Today, one in four Australians were born in another country. The increased number of culturally and linguistically diverse (CaLD) individuals provides many benefits and some challenges to Australia. The benefits related to sport, exercise and physical activity are numerous. The increased cultural diversity in Australia continues to impact the popularity of activities, the level of community engagement and the strategies that are used to engage the population in an active lifestyle.

studyon
Unit 2 | AOS 2 | Topic 16 | Concept 1
Cultural diversity and inclusion
Concept summary and practice questions

Cultural diversity and inclusion

The Australian population is becoming more diverse. With the increase in patterns of migration globally, Australia will continue to be a diverse and multicultural nation into the future. Over the last decade, the proportion of immigrants born in north-west Europe has decreased and migration from the Asian and Middle-Eastern regions has increased. In 10 years from 2004 to 2014, the number of Australian residents born in India nearly tripled, from 132 800 to 397 200. In the same period, the number of residents born in China more than doubled, increasing from 205 200 to 447 400.

Traditionally CaLD communities have been underrepresented in physical activity programs. Studies conducted at Deakin University in 2005 and by the Northern Sydney Health Promotion agency in 2002 have presented data that support this view. Data collected by the ABS (Australian Bureau of Statistics) in 2013–14 showed that 67 per cent of Australians who were born in Australia participated in sport and recreation, compared to 59 per cent of those who were born in other countries. The difference was even greater for children. 69 per cent of children between 5 and 14 years whose parents were born in Australia participated in physical activity, compared to only 41.5 per cent of children of this age whose parents were born in another country.

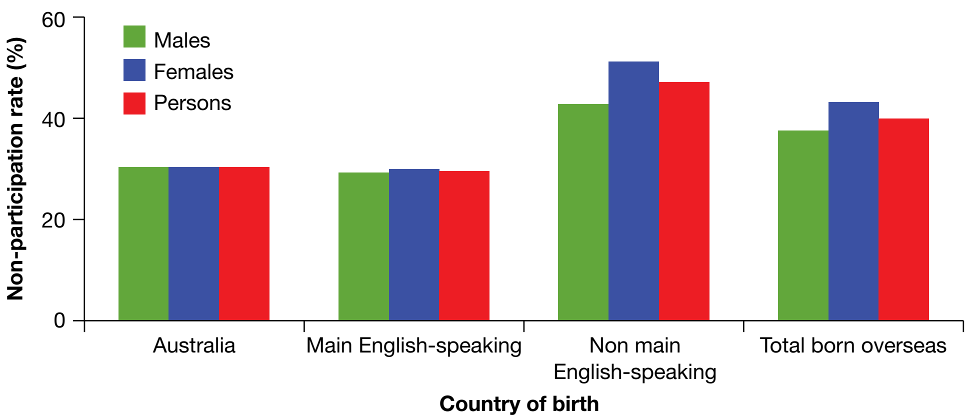


FIGURE 16.1 Adult non-participants in sport and physical recreation by country of birth, 2009–10
Source: abs.gov.au

The benefits related to sport, exercise and physical activity are numerous and include the introduction of new sports, healthier communities and population, more personnel for local sporting teams and a greater talent pool for elite sports.

One of the major challenges of the increase in cultural diversity is the change in values and beliefs related to activity that now exist in Australia. The Moonee Valley Melbourne Primary Care Partnership Physical Activity Network is an alliance of health and government agencies in the Moonee Valley area in Melbourne. In 2006, this organisation released a discussion paper which, among other things, presented findings related to the attitudes towards physical activity within CaLD communities.

This group found that the beliefs associated with physical activity varied within and between CaLD communities. For example, they found that parents from one CaLD community preferred their children to participate in study rather than sport, while parents from another CaLD community thought physical activity was beneficial for children because it avoided rebellion, mixing in wrong crowds and bad behaviour.

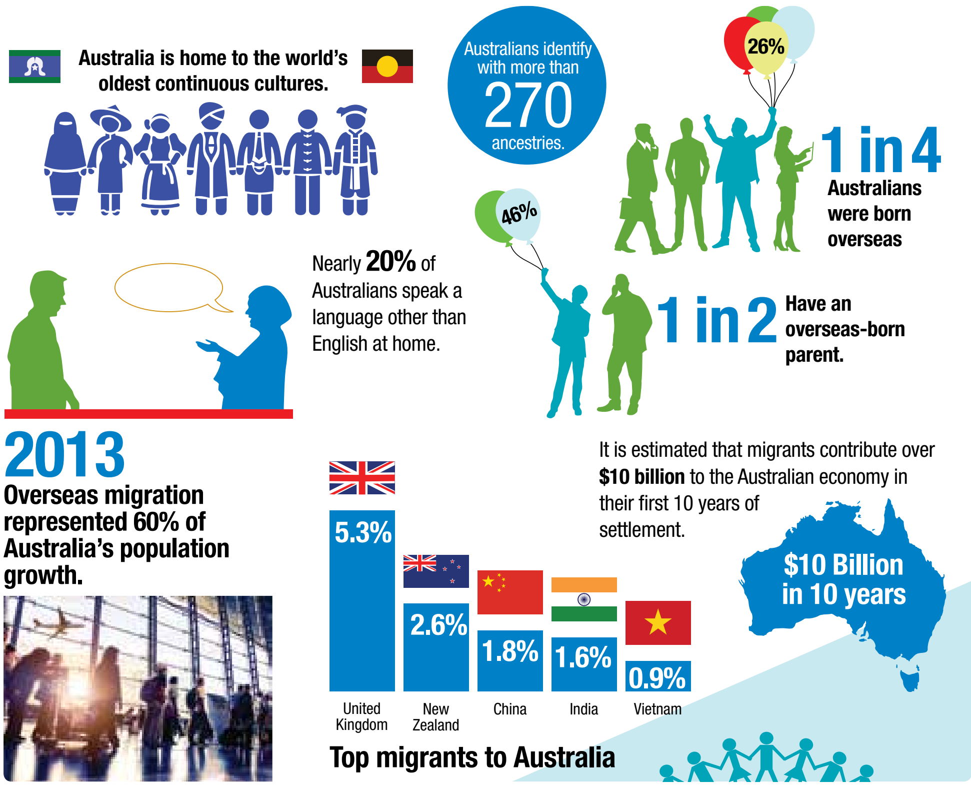


FIGURE 16.2 Statistics related to immigration in Australia

Many immigrants to Australia are enthusiastic about sport but, due to language and cultural barriers, they are sometimes reluctant to participate. Also, their experience of sport may be very different to the way sport is practised in Australia and this is a further barrier to their engagement. It is important that we work hard to remove the barriers to immigrants' participation in sport, as the benefits to all people in terms of physical and mental health are well documented. In addition to these benefits, there are social benefits too, with increased sport participation linked to a reduction in crime and other anti-social behaviour. Sport builds social cohesion and is one of the best ways to break down barriers between people.

Language barriers and cultural traditions are also a challenge when it comes to engaging a broad spectrum of the community in physical activity. For example, Somali women in Adelaide reported that language proficiency affected women's opportunities to find out about, access and participate in sport and recreation activities, and poor English skills could leave women socially isolated and uninformed. A woman from Pakistan who participated in a University of New South Wales project said 'Muslim women would swim privately: because we are Muslim, we do not like the women to swim [in public]. But I think most women swim in their homes. Some women have a swimming pool at their home so they can swim, but not in public or as an organised game.'

Cultural traditions such as these may clash with the norms and requirements of sporting organisations. Ideally, sporting organisations are to reflect the community. For this to be achieved, there is a need for sporting organisations to adapt to these challenges. Programs, policies and relationships need to be considerate of this new reality. The traditional approach to promotion and participation may need to be reviewed in an effort to overcome some of the barriers that prevent some ethnic groups from engaging in physical activity. These changes affect many individuals and organisations. Participants in local sport face the challenge of building relationships with team mates of different nationalities and languages, organisations such as schools and workplaces face the challenge of engaging culturally diverse groups in physical activity, and the government has the challenge of introducing policies that cater for cultural diversity. It's easier for the dominant culture to adapt to these changes and much harder for the immigrant population to feel like they belong. For this reason an increase in physical activity among the CaLD community is dependent on the removal of the barriers to their participation in physical activity, exercise and sport.

FIGURE 16.3 An example of the cultural diversity in Australian sport

FIGURE 16.4 Cultural factors can sometimes inhibit a person's participation in physical activity.

Sociocultural factors
Language
Education
Cultural norms
Role models
Cost
Knowledge
Funding
Gender segregation

+

Environmental factors
Transport
Privacy
Safety
Built environment

→

Physical activity levels within CaLD communities

FIGURE 16.5 Sociocultural and environmental barriers and enablers of physical activity for CaLD communities

TEST your understanding

1 Identify two changes related to the nationalities and people that are immigrating to Australia.
2 Explain three challenges related to physical activity, sport and exercise, and the growing cultural diversity in Australia.

APPLY your understanding

3 Develop a survey that can be used to a) identify the various nationalities in your class or year level and b) identify cultural beliefs and practices that may affect movement or participation in physical activity, sport and exercise.
4 Use the internet to access statistics related to cultural diversity and physical activity. If you are unsure where to look, you can search for Australian Bureau of Statistics (ABS) and the key words nationality, physical activity, recreation, sport, exercise, participation and/or recreation.

16.2 Factors influencing cultural diversity and inclusion

KEY CONCEPT Cultural differences, attitudes (interpersonal, institutional and internalised) and a lack of awareness, knowledge and accessibility are all barriers/enablers that have contributed to the underrepresentation of people from CaLD backgrounds in physical activity, sport and exercise.

Individual factors

Language

The Australian population is approximately 24 million people. There are people from 200 countries, and 300 languages are spoken by Australian residents. Language is a barrier to communication in a number of ways. It reduces the social benefits of physical activity due to the inability to communicate with team mates. Information about programs and promotional literature could be published in languages other than English so that an inability to read English is not a barrier to participation.

Education

Most Australians have been educated about the importance of a healthy diet and adequate exercise. Some CaLD people have not. Education programs about the benefits of exercise and exercise opportunities customised for their local community would be an enabler to physical activity participation.

Cost

Some CaLD people may have periods of low income when they arrive in Australia. This would limit their ability to purchase exercise equipment, and to travel and pay membership fees to use facilities and join clubs.

Knowledge

The sports and activities that a migrant knows about may not be easily accessible in Australia. For example, Chinese migrants may know about badminton but find there are no badminton clubs in their area. The sports that are available, such as netball and cricket, they may not understand as they are not sports commonly played in their country of origin.

Social factors

Role models

In Australia we have many healthy and active role models. Not all ethnicities have such an abundance of role models, and multiculturalism may not be promoted by many exercise facilities or in popular culture. This means many CaLD people don't have any role models from their culture to look up to. For example, Sudanese youth who participate in sport and physical activities at school may benefit from the presence of pictures of some Sudanese sporting personalities.

Cultural norms

Cultural and religious norms (for example those related to dress) may hinder CaLD people in balancing the requirements of their culture against the practicality and requirements of participation in some forms of physical activity. For example, teenage Muslim girls who wear hijab may be unable to participate in certain sports due to their style of clothing.

Policy factors

Funding

To engage some ethnic groups, funding is required for individuals in the form of subsidies for memberships, for councils to alter facilities to make them culturally appropriate, and to produce promotional and educational material in different languages.

Lack of gender segregation

Many CaLD women prefer to exercise in a women-only environment. A 2009 University of New South Wales study reported that the women from some CaLD communities prefer access to female-only facilities over exercising in modest attire in mixed gender contexts, as adapted dress was seen as uncomfortable and potentially stigmatising.

Environmental factors

Transport

Transport to facilities may not be possible due to cost or lack of public transport.

Privacy

Privacy in change rooms and privacy while exercising can be a barrier to some.

Safety

Safety while commuting to facilities and during activities such as walking, and the threat for some of racial hostility is a barrier.

Built environment

Migrants who come from lifestyles that require a high level of activity for the completion of daily chores may become sedentary due to the lack of incidental exercise, especially in a built-up city environment. The presence of green space, outdoor courts and walking tracks would be an enabler to physical activity.

FIGURE 16.6 A well-designed skate park in an accessible location acts as a community hub and can bring together people from different cultural backgrounds who have a shared interest.

Cultural diversity makes for good sports in Bendigo

BY ERIN HANDLEY

La Trobe researchers study how local sporting groups can be more welcoming to different cultures

FIGURE 16.7 Queen Elizabeth Oval, Bendigo

For local footballer Danny Dahl, one of the places he feels most at home is on the field.

He moved to Australia from South Sudan with his family and he knows his team has his back.

But it wasn't always that way — at first, he had a mixed reception at the club, which has since undergone a cultural change for the better.

'Some people were accepting, but some others could be racist,' he said.

'It changed. There are more multicultural people coming to play football now; that makes it easier for me.'

'I get along with some of them and they have my back.'

He said now everyone makes him feel welcome — his team mates check in with him after the game to see if he copped any slurs from the other side during a match.

'I am part of them now, because I have been there for so long — it's my sixth year playing footy,' he said.

Sport is often touted as a way to unite athletes of every culture, but three La Trobe occupational therapy students found there wasn't much research on how to measure how culturally safe sporting teams were for players of diverse backgrounds — especially in regional Australia.

Grace Gillett, Jessica Robertson and Maddie Hammet teamed up with the Bendigo Football Netball League (BFNL) to uncover how successfully local sports clubs embrace cultural diversity.

'Our main aim of the project is to allow for clubs to be able to reflect on what they're currently doing and look at areas for improvement,' Ms Gillett said.

'Clubs are already pretty open to accepting all types of people . . . but they might need more support or guidance to help with it,' Ms Robertson said.

'It's about accessibility, making sure everyone is able to access the facilities, including the social events as well as the sporting events,' Ms Hammet said.

They said the tools they had developed to help clubs assess how culturally sensitive and aware they were — on matters of ethnicity, sexuality and diversity — were designed not to judge clubs, but to improve them.

AFL Central Victoria General Manager Paul Hamilton said local clubs need to have a welcoming atmosphere and the student project came at a fitting time.

'Bendigo's in the middle of a major population boom. As more people settle in our region, we want to introduce new resources and build culturally appropriate facilities,' Mr Hamilton said.

They had three key points for clubs: avoid a 'one size fits all' approach, focus on the sport building community links, and there should be organisational planning for cultural difference.

Source: *Bendigo Advertiser*, 16 September 2015

Pool debate gains depth

BY MEGAN DOHERTY

FIGURE 16.8 Cultural or religious traditions may make women more comfortable swimming in a single-sex environment.

The Greens' call for women-only swimming in the ACT unleashed a torrent of comment this week — most of it against the proposal. 79 per cent of people were against the idea of pools allowing women-only swimming sessions because 'we shouldn't be limiting access on the basis of gender'. The idea was supported by 21 per cent of respondents because 'it would encourage greater participation in physical activity among women'.

One person wrote: 'I am a quite stocky male, with a large amount of body hair. I do not feel comfortable to swim in public pools around women, as I get shy and feel uncomfortable about my body. Can we have male-only swimming as well?'.

Another suggested: 'As a woman I find this extremely offensive. I want to be included, I want to show that I can swim just as well, if not better than a lot of men and if I have wobbly bits that offend people then look away'.

But some were in favour of the idea: 'At long last my tax dollars will fund an opportunity for my wife to go swimming, my kids to go swimming, and possibly myself in the future. We do not know how to swim because of the mix issue in public pools'.

Greens leader Meredith Hunter says . . . 'There are many women across the community who would like this option made available to them. Women for cultural reasons. Women with disabilities. Women with body image issues. It is not just about one group.'

Despite the heated debate, women's-only swimming has worked successfully in other cities and also been run on an ad-hoc basis in Canberra without much fanfare.

With support from the Canterbury City Council, NSW Sport and Recreation has run women's-only swimming and learn-to-swim classes at a public pool in Roselands in south-western Sydney for five years, development officer Rose Powell says. The program runs for a couple of hours one day a week, with the pool booked out for the women. 'It's extremely popular and we've got waiting lists all the time,' she says. 'We've been able to see the progression of women from not being able to swim to becoming regular leisure swimmers.'

Source: *The Canberra Times*, 10 February 2012.

The full version of the 'Pool debate gains depth' article can be viewed using the **Women-only swimming** weblink in your eBookPLUS.

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Weblink
Women-only swimming

TEST your understanding

1 Read the article 'Diversity makes for good sports in Bendigo' and answer the following questions.
   (a) What was the aim of the project?
   (b) In the article Ms Robertson says: 'Clubs are already pretty open to accepting all types of people. . . but they might need more support or guidance to help with it'.
      i Identify an example of an organisation in Bendigo; for example, the Bendigo Softball Club.
      ii Choose three factors from the list presented in section 16.2.
      iii For each factor, suggest strategies that Ms Robertson may recommend to local sporting clubs to make their environment more inviting for people from CaLD communities.
   (c) List the three recommendations that the researchers had for local organisations.

2 Use the article 'Pool debate gains depth' to answer the following questions.
   (a) Outline some of the factors that the University of New South Wales identified as barriers to participation in swimming for women.
   (b) Use examples from the article to discuss some of the challenges that policy-makers face when introducing policies that are aimed at engaging CaLD communities in physical activity.
   (c) Use the article to identify three swimming programs that already exist.

3 Define the term 'sociocultural influences' in relation to cultural diversity and physical activity.

4 List five sociocultural enablers of movement for culturally diverse groups.

APPLY your understanding

5 Use the knowledge that you have gained from section 16.2 to develop a poster that promotes an exercise class aimed at engaging a culturally diverse group. You can use an existing program or you can make up a hypothetical program.

study on

Unit 2	**Factors influencing cultural diversity and inclusion**
AOS 2	
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16.3 Historical perspective

KEY CONCEPT Not so long ago there were no programs or initiatives to cater for different cultures in Australian sports. Times have changed and now there is a greater awareness of the benefits of inclusion and diversity in sport.

Throughout the last century, cultural diversity and inclusion were not a priority for physical activity in Australia. The 1990 *Year Book Australia* outlines several initiatives including those aimed at increasing the activity of older adults and the promotion of workplace health and fitness programs; however, there is no mention of cultural diversity as a priority. The ABS 2006 'Migrants and participation in sport and physical activity' report showed that 47 per cent of immigrants who arrived in Australia had attended or participated in physical activity. This number increased to 58 per cent for those who arrived between 1991 and 1997 and 55 per cent for those who arrived between 1998 and 2002.

A VicHealth report that was prepared in 2001 made the following statement about the current state of cultural diversity in sport.

> 'Culturally specific teams or tournaments should be valued and supported as important avenues for CaLD young people to acquire the skills and confidence to play a specific sport. Instead, sporting bodies often view ethno-specific teams as separatist, exclusive and only perpetuating problems. Culturally specific teams are, however, no different to a group of friends with varying skills but with the same background or interests getting together to play, for example, basketball. Ethno-specific teams may not be the problem. The problem is how they are perceived and accepted in sporting competitions.'

FIGURE 16.9 Are the AFL's efforts to embrace multiculturalism genuine, or part of a slick marketing campaign?

Sport has traditionally been mono-cultural. As the number of CaLD people within the population has increased, so too have the various cultural representations within physical activity, sport and exercise. In the past, health, fitness and sporting organisations have commented on the need to become more multicultural. However, in previous decades, policies and strategies have not been put in place to engage participants from a range of nationalities. During the past decade, the Australian

Government and many organisations have allocated funding and initiated programs to facilitate an increase in physical activity participation among the CaLD community.

The following article provides an informative look at one town's journey towards cultural diversity and inclusion in sport.

A world away from the MCG, every round is multicultural round

BY SEAN GORMAN AND RAMON SPAAIJ

Standing in the social rooms of Robinvale Football Netball Club on presentation night is perhaps like standing in any sports club in regional Australia when their vote count is on. There are the usual signs of the club's history: trophy cabinets of past glories and photographs of past players lining the wall. The names of sponsors from around town, the special corner near the bar with a plaque commemorating a long-time club identity or past champion who has passed away. The canteen does a roaring trade in burgers as the smoke from the barbecue outside indicates that no one inside will go home hungry.

But what sets Robinvale apart is its diversity. Looking around the social rooms of the club, it's obvious that cultural diversity is not just some concept or buzzword used by policy makers in Melbourne or Canberra.

Diversity is standing next to you at the bar. Diversity is serving you a burger. Diversity is coaching your son or daughter. Diversity is winning your best and fairest award on vote count night.

Everyday multiculturalism is alive and well in Robinvale and has been for some time.

Residents come from everywhere

It does not take much for the cultural diversity of Robinvale to hit you. Driving down the tiny main drag, Perrin Street, one is struck by the variety of people from culturally diverse backgrounds. Robinvale for many is seen as the multicultural epicentre of the Sunraysia district, stretching across the border of north-western Victoria and into south-western New South Wales. But how does that compare to the rest of Australia?

Within its local population of nearly 4000, just under 50 different nationalities are represented. This includes Vietnamese, Malaysian, Greek, Italian, Chinese, Thai, New Zealander, not to mention the massive and highly diverse Pacific Island community, including Tongan, Samoan, Fijian and so on.

Nearly 40 per cent of Robinvale's population was born overseas. This might not seem to be such a notable statistic until it is compared with the region's biggest city, Mildura. With a population of 30 000, Mildura has only half that number not born in Australia.

It is the type of work that is undertaken around the Robinvale hinterland that has drawn people here. Grapes, olives, fruit: these intensive horticultural industries need specialised human husbandry to succeed. As public debate about the value of immigrants to Australian society continues, Robinvale has prospered on the labour of new Australians.

But sport and sporting clubs are the genuine barometer of how a town is faring. It is those towns without sports teams that struggle and can quickly become ghost towns once the team ceases to be. For Robinvale it would seem that its football and netball club is successful. It is a genuine multicultural melting pot in the bush, one from which metropolitan debates and initiatives could learn a few things.

Club secretary and unofficial elder-in-residence Marion Leslie has seen many things come and go in Robinvale. The one constant has been her love of the Robinvale football club and what it represents to the town. But Leslie laments that the AFL has not engaged with the staunch football community for some time whereas rugby is establishing a beachhead and spending a great deal of money to offer the town's Pacific Island communities a viable alternative sport, which already runs in their blood.

A sporting force for harmony

Everyday multiculturalism in Robinvale has its challenges, too. Cultural diversity has at times led to divisions within the community, never more so than when local resident Suli Ikafunga was assaulted five years ago.

The football club played a lead role in bringing disparate community groups together to ensure such violence would never happen again. The club staged a Harmony Match featuring Pacific Islander and Indigenous players in a bid to promote respect for difference. The Harmony Match is now a recognised feature on the annual sporting calendar.

The club is also a pioneer in the inclusion and celebration of Indigenous players and their families. That's no surprise, perhaps, as Robinvale has the highest proportion of Indigenous people in Victoria, at nearly 18 per cent of the local population.

(continued)

In 2009, the club introduced an Indigenous round, played against local rivals Wentworth, a primer in the Sunraysia league and a first outside the AFL.

A special Indigenous jumper, designed by local Koori artist Barbara Egan, is worn by all players during the annual round, instilling immense pride among both Indigenous and non-Indigenous community members. Robinvale football president Tony Calarco says of the initiative:

'I got a fair buzz out of it and I don't normally get excited about those things. I felt good about it because I was not doing it just for the hell of it. It had merit and was not a token gesture.'

All of these efforts have been initiated 'from below', by individuals and community groups who voluntarily dedicate their precious time to make a difference. This is the way local residents have always done things, with little direction and support from outside sporting or government agencies.

Their current efforts are also focused on engaging Robinvale's diverse Asian communities. While some migrants from Asia have briefly played football or netball in Robinvale, locals recognise that this is an ongoing challenge due to the transient and mobile nature of this group, whose movements are dictated by the seasonal labour patterns of the fruit industry.

For concrete examples of a diverse community coming together through sport, one need not look any further. While the spotlight of multicultural sport has been focused on the culturally diverse suburbs of Melbourne and Sydney, this regional club's achievements in forging community relations deserve greater attention and recognition from the metropolis. Everyday multiculturalism is being lived right here, in Robinvale, on the oval.

Source: www.theconversation.com

Key points from the article include:

- Rural Robinvale, near Mildura, is an example of everyday multiculturalism with nearly 40 per cent of its 4000 population born overseas.
- Sporting clubs can be an indicator of a town's success.
- Robinvale's football and netball club is a 'genuine melting pot in the bush'.
- Cultural diversity has at times led to violence and divisions in the community.
- The football club has played a lead role in bringing community groups together to try and avoid violent clashes.
- Efforts include a Harmony Match featuring Pacific Islander and Indigenous players in a bid to promote respect for difference.
- The football club has also focused on the inclusion and celebration of Indigenous players and their families.
- All of these efforts have been initiated 'from below', by individuals and community groups who voluntarily work to make a difference.
- This represents a deliberate effort by the club to change the culture of the club and proactively include its multicultural community, and is evidence of what a grassroots effort can achieve.

studyon

Unit 2 | AOS 2 | Topic 16 | Concept 3

Historical perspectives (cultural diversity and inclusion) Concept summary and practice questions

TEST your understanding

1 Provide an outline of Australia's journey towards cultural diversity in sport and physical activity since the 1980s.

2 Identify and provide examples of sociocultural enablers.

APPLY your understanding

3 Write a report that celebrates the increase in enablers for movement or participation in physical activity, sport and exercise for culturally diverse groups within Australia.

4 Read the article on pages 369–70 and answer the following.

(a) What is the 'everyday multiculturalism' described in the article?

(b) Discuss in small groups how and when grassroots efforts to bring together cultural diverse communities through sport are more effective than national or state level attempts.

16.4 Current perspective

KEY CONCEPT Multiculturalism in Australia has brought many benefits to our communities such as great food, multicultural celebrations and festivals, and better understanding of different cultures and traditions. In sport we now have programs to encourage people of different nationalities to participate and become part of and help shape our sporting culture.

There are many programs and initiatives within Australia that are aimed at increasing cultural diversity in physical activity. The AFL has a whole round of football devoted to cultural diversity, called the Multicultural Round. The players wear modified uniforms, there are additional festivities and promotions throughout the week which promote cultural diversity in sport, and the games are broadcast in different languages.

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Weblink
AFL Multicultural Round

FIGURE 16.10 The Australian Football League is a keen promoter of diversity in sport.

Other sports such as cricket employ diversity managers to ensure that the needs of CaLD people are being met from beginners to the elite players.

Several community programs and government initiatives also exist, such as:

- **Multicultural Youth Action Group (MYAG)**, City of Casey, Victoria

This is a coalition of agencies which focuses on engaging CaLD youth with the broader community. While initially involved in direct delivery of programs and services, the City of Casey team has since found that providing support to existing agencies and programs is a more effective approach. They aim to establish links and 25 partnerships with service providers, schools, churches, sport clubs and other groups which work with the CaLD and refugee communities, to remove some of the barriers to the CaLD community's participation in sport and other activities. Examples of the City of Casey's initiatives include holding multilingual information nights on sport programs, providing minibuses for transport to sport venues, using school principals as a link between service providers and CaLD families; and using schools as a venue for the delivery of sport programs.

eBook*plus*
Weblink
Dae's AFL story

- **Healthy Eating and Physical Activity Program for Multicultural Communities**, South Western Sydney

This program teaches community members how to achieve a healthy diet and include the right levels of physical activity. The program incorporates behaviour change through weekly goal-setting and the referral into ongoing support from the Get

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Weblink
Multicultural Youth Action Group (MYAG), City of Casey

Healthy Coaching Service. The program is promoted and delivered in 13 different languages.

FIGURE 16.11 Youth ambassadors promoting cultural diversity in physical activity

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WimSWIM

WimSWIM, NSW and SA

Learn-to-swim program for females only. Typically conducted outside of pool opening hours, WimSWIM is a combination of a learn-to-swim and leisure swimming program, in a women-only environment. WimSWIM is open to all females aged 4½ and over, and does not target either refugees or the CaLD community. However, WimSWIM has appealed to women who, for cultural and/or religious reasons, cannot swim in front of men. Women from Arabic communities (including Lebanese, Egyptian, Iraqi, Afghani and Iranian women), as well as women from Chinese and Korean backgrounds, have been involved in the program. The NSW Department of Sport and Recreation supports the program, but does not provide funding for it — participants must pay to take part in the program.

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Weblink
Sports Without Borders

Sports Without Borders

Sports Without Borders is a not-for-profit organisation which provides support for young people from new and emerging communities to overcome the barriers of participation in community sport.

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Unit 2	**Current perspective (cultural diversity and inclusion)**
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FIGURE 16.12 SEACC girls' soccer tournament

16.5 Different perspectives

KEY CONCEPT Strategies that are used in your school to promote movement or physical activity are different from those used by local, state and federal government organisations. However, they are often dependent on each other for the development of effective programs.

Local perspectives

This chapter has provided you with information about local and national initiatives related to cultural diversity in physical activity, exercise and sport. It has also presented information related to some of the barriers faced by CaLD groups and considerations for sporting organisations. What is the real situation though in your school and community?

To get a different perspective, you could use the information presented in this chapter to discuss initiatives at your school that are aimed at addressing the issue of cultural diversity and physical activity participation. Refer to the Apply your understanding question below for ideas and resources.

National perspectives

The Australian government is committed to its multicultural policy. Encouraging cultural diversity in physical activity is one area that is covered by this policy. For example, the government has committed funding to programs that create sustainable opportunities for youth from CaLD backgrounds to participate in sport and physical activity. This funding initiative is called the *Multicultural Youth Sports Partnership* (MYSP). An outline of the policy is provided below.

- The MYSP program was established to create connections and involve youth from new and emerging communities, and culturally and linguistically diverse backgrounds, in physical activity.
- The Australian Sports Commission coordinated the application and administered the funds.
- $900 000 was available to 12 organisations over three years, starting in 2011.
- The successful applicants were able to develop safe, fun and inclusive physical activity opportunities for CaLD youth.

You can use the **Multicultural Youth Sports Partnership** weblink in your eBookPLUS to access further information about the program.

The **Sports Without Borders — Funding** weblink can be used to read about how this funding is being used in parts of metropolitan Melbourne.

eBook*plus*
Weblink
Multicultural Youth Sports Partnership

FIGURE 16.13 The Multicultural Youth Sports Partnership aims to get young people from diverse backgrounds involved in physical activity.

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Weblink
Sports Without Borders — Funding

study on

Unit 2	**Different perspectives (cultural diversity and inclusion)** Concept summary and practice questions
AOS 2	
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TEST your understanding

1 To enhance your knowledge of the various ways in which government funding is spent, use the **Sports Without Borders — Funding** weblink in your eBookPLUS to:
   (a) find some of the organisations that have been successful and
   (b) write a summary of what some of them are doing with the funds that they received from the grant.

2 List two organisations that have received Multicultural Youth Sports Partnership (MYSP) funding.

3 Using an example, describe how local organisations and government may work together to increase enablers of movement for CaLD people.

APPLY your understanding

4 Use the information in this chapter to discuss initiatives at your school that are aimed at addressing the issue of cultural diversity and physical activity participation.

5 Use the internet to search for a program in another country that focuses on the inclusion of cultural diversity in physical activity, sport and/or exercise. Write a paragraph that identifies the country, the program, the aim of the program and the steps that they are taking to address the issue of cultural diversity in physical activity, sport and/or exercise.

16.6 Future implications

KEY CONCEPT Programs that are more specific to the needs of CaLD communities and enable greater inclusion can increase the amount of physical activity that CaLD communities are participating in. This can enhance the benefits that are available from the increase in cultural diversity in physical activity, exercise and sport.

The growth of CaLD communities in Australia and the greater awareness of the need to be more inclusive will lead us to more specific programs and a different approach to research. In the years to come, physical activity programs will be less homogenous and more tailored to the needs of particular CaLD communities. Greater consideration will be given to notions of health and wellbeing, sport and physical activity within particular communities. Program planners will become more knowledgeable about how to overcome sociocultural and environmental barriers. They will be more skilled in delivering programs that are tailored to the specific expectations of CaLD communities.

The increased proportion of CaLD communities will influence the type of activities, participation rates and even the broadcasting of sporting events. New sports may be introduced, some sports and activities will have an increase in participation and others may reduce in popularity. Most of the research into cultural diversity and the theoretical models for participation has been developed in western cultures. The increasing CaLD population may generate the development of new models and research from within these communities.

In relation to planning and research, there may also be a need for greater separation between physical activity and sport. Although some of the barriers are shared, there appear to be some barriers that are unique to certain cultures and therefore a clear focus on one or the other may be necessary for successful cultural diversity within physical activity, exercise and sport.

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Weblink
Cultural diversity and sport

studyon

Unit 2	Future implications (cultural diversity and inclusion)
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Practical tips for planning inclusive programs

La Trobe University has developed a resource that can be used for sporting clubs to guide their planning. Their framework suggests:

- consulting with experts in the area of cultural diversity
- making the venue welcoming to people of various cultures
- reviewing rules and modifying as required to accommodate cultural traditions
- educating players and officials about cultural diversity.

TEST your understanding

1. Identify two simple practical strategies that would help organisations be more inclusive of people from different cultures.
2. From the information presented in this chapter, discuss the relative importance of government funding for a) training up culturally diverse champions and b) increasing programs for CaLD people in local communities.
3. Find a location — anywhere in Australia — where CaLD communities may typically settle. Identify physical activity opportunities in their local community. You may wish to highlight these on the map. If public transport is needed, find out how much it would cost for participants to get to their destination.

APPLY your understanding

4. Based on your understanding of the content of this chapter and how your school approaches physical activity, write a report on the cultural diversity in your school, the strengths of the school in relation to inclusion in physical activity and some things that could be improved.
5. **Practical activity:** Play some multicultural games with your class. You can use the **Multicultural games** weblink in your eBookPLUS to get some ideas.

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Weblinks
The future of Australian sport
Multicultural games

16.7 Applying the social-ecological model to cultural diversity and inclusion

KEY CONCEPT There is no single factor that determines physical activity behaviour. The social-ecological model provides a framework to develop strategies for increasing participation and analysing existing programs.

Applying the social-ecological framework to cultural diversity and inclusion in physical activity

There are many strategies that can be implemented to overcome individual, social environment, physical environment and policy barriers to participation among CaLD communities. Some of these are identified below.

FIGURE 16.14 Teaching children skills such as swimming helps them to take part in more physical activity.

Individual

- Education about the benefits of physical activity and the provision of information about facilities and programs, presented in a way that is relevant to particular communities.
- Programs that target increasing skills in children would provide them with greater confidence to be active. For example, a focus on swimming skills would be an enabler for participation in aquatic activities.
- More programs delivered in languages other than English or tailored to the cultural needs of some nationalities.
- Providing low-cost or free sports and activities.

FIGURE 16.15 Activities such as hiking can provide an opportunity for people to interact with others in the community.

Social environment

- Providing opportunities for CaLD groups to increase the number of people they know in the wider community. For example, the WimSWIM program allowed women from a range of nationalities to meet.
- Organising group exercise and sporting activities for particular CaLD communities.
- Buddy system, in which new Australians are assigned to an existing immigrant from the same cultural group. This person makes regular contact and helps with education and integration. For example, new immigrants who are interested in participating in local physical activity programs may be assigned a person from their cultural group who already lives in Australia and can help them with transport to the venue, accompany them for the classes and make follow-up calls to check on their wellbeing.
- Promotion of sporting success and role models among CaLD communities.

Policy

- Uniform guidelines could be modified to include the dress requirements of different cultures.
- Government-funded physical activity programs that are aimed at meeting the needs of CaLD groups. For example, MYAG in section 16.4 used government funding to support their program.
- Modification of codes of conduct to discourage exclusive attitudes and encourage inclusive behaviour.
- Funding for research that can be conducted by CaLD groups themselves so that they can develop a non-westernised framework for participation.

FIGURE 16.16 Modifying uniform requirements for participation in sport can encourage more cultural diversity in participants.

Physical environment

- Greater access to paths and trails.
- Building sports facilities in locations where there are high numbers of CaLD people.
- Increasing lighting and safety of paths.
- Courts and other recreational facilities for activities that CaLD groups like to participate in. For example, soccer and basketball are popular sports in Sudan so the presence of basketball rings and soccer goals in areas where Sudanese people settle may encourage physical activity.
- Providing facilities for activities/sports that culturally diverse groups like to participate in, not just traditional cricket pitches and netball courts.
- Facility sharing. Allocation of times when particular CaLD communities can use a facility.

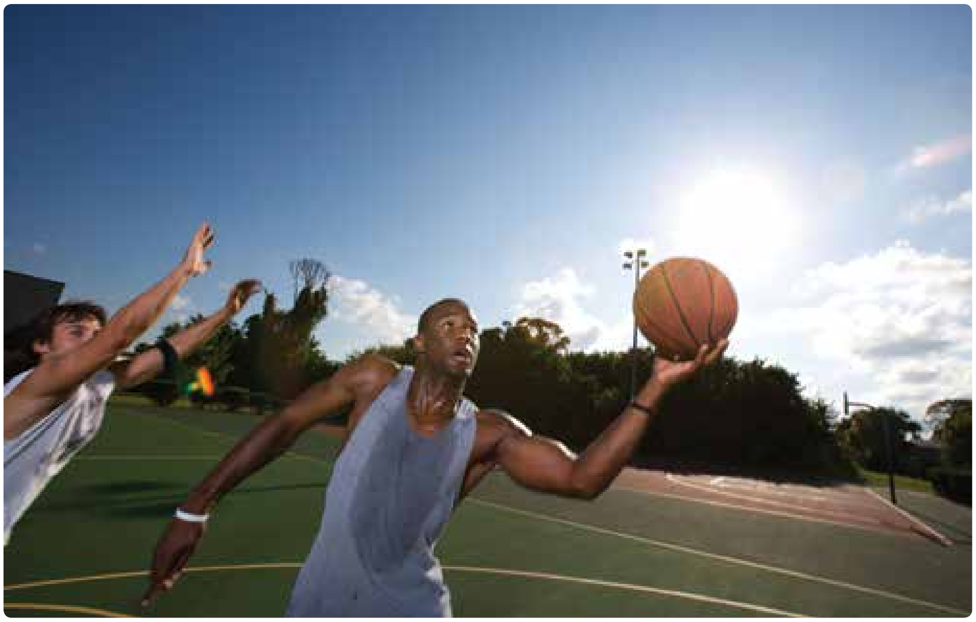

FIGURE 16.17 Provision of public sporting facilities, such as basketball rings in parks, especially in areas in which people from CaLD communities live, makes physical activity more accessible for these communities.

Redskins Basketball Club

The Redskins Basketball Club is located in Braybrook, Melbourne. When the basketball club was first established in 1996, 50 per cent of the local population were living below the poverty line. Braybrook was chosen as the venue because it is central to other suburbs such as St Albans and Sunshine where many new immigrants settle. The club continues to engage culturally diverse youth and now has over 450 children and youth who are involved as players, leaders or support staff.

It runs basketball training and competitions for local youth. Basketball is the vehicle used to encourage physical activity and to educate children and youth about the 'bigger game of life'. Every Wednesday night, over 350 children and youth from a range of cultural backgrounds spread themselves over four indoor basketball courts. They have girls-only teams, basic skill development squads and an elite program. The training and uniforms are free of charge and there is a small fee for registration. Some families who participate in the program have 6 to 10 children. The club helps these and others with transport to training and games. The organisers of the basketball club acknowledge the importance of family within many cultures so they encourage whole families and siblings to attend.

A year-long structured youth leadership program within the club provides youth with the opportunity to develop leadership skills and give back to the club and the community. This program provides a context for further personal development. The culture of the Redskins Basketball Club is based on the acronym EMBRACE.

Educate
Motivate
Belief in self
Resilience
Acceptance of self, friends, religions and others
Confidence
Engage

The last term, engage, relates to the youth giving something back to the community: giving something back to school, church, the basketball club or other aspects of community life

FIGURE 16.18 The Redskins Basketball Club is using basketball to help teach CaLD youth about the bigger game of life.

Redskins Basketball Club and the social-ecological model

When you are evaluating a program, you should consider all four components of the model. Here is a table that contains some examples of what to look for.

Component	Examples of factors to look for in a program
Individual	Helps to educate, is considerate of a person's values and beliefs, time constraints or cost
Social environment	Uses family or friends to influence, provides opportunities for social contact, uses the influence of role models
Physical environment	Changes made to the physical environment such as paths, hand rails, installation of change rooms, or if the environment is made more appealing
Policy	Rules, regulations and/or funding

The Redskins Basketball Club program is likely to be effective because it addresses all four components of the social-ecological model. Here's how the program addresses each component.

Individual

- The low cost reduces income as a barrier.
- Basketball skill development develops the skills of the children so that they can continue to play.
- Leadership development builds the confidence of some participants.
- The availability of beginners through to intermediate programs enables children and youth of all abilities to play.
- Provision of transport assists members of CaLD communities to access the program.

Physical environment

- The program occurs in a location that is central to many CaLD communities.
- They use a large stadium that can accommodate hundreds of youth.

Social environment

- Families are encouraged to attend.
- Children/youth play with their age group.
- The presence of players from many CaLD communities may reduce feelings of isolation.
- The use of youth as leaders provides role models.

Policy

- The cost of the uniforms is subsidised.
- There are no limits on who can join the club.

TEST your understanding

1. Identify two factors that relate to each of the components of the social-ecological model.
2. List three individual factors that could be an enabler of movement.
3. Identify two sociocultural factors and two environmental factors that have been included by the organisers of the Redskins Basketball Club.

APPLY your understanding

4. Use the table on page 378 and your knowledge of the social-ecological model to justify why the Redskins Basketball Club has been so successful in engaging children and youth from CaLD communities.

studyon

Unit 2
AOS 2
Topic 16
Concept 7

Applying the social-ecological model
Concept summary and practice questions

CHAPTER 16 REVISION

- **yellow** identify the action word
- **pink** key terminology
- **blue** key concepts
- **light grey** marks/marking scheme

KEY SKILLS

- Identify contemporary issues associated with participation in physical activity and sport.
- Participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue.
- Collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, print and electronic material.
- Analyse the historical, current and future implications on the issue identified.
- Apply the social-ecological model or Youth Physical Activity Promotion Model to analyse and evaluate strategies and programs associated with the selected issue.
- Draw informed conclusions and report in a suitable format on the socio-cultural and environmental influences that impact on participation in physical activity and/or sport based on research findings.

UNDERSTANDING THE KEY SKILLS

To address these key skills, it is important to remember the following:

- explain barriers to people of CaLD backgrounds in participating in physical activity
- use the social-ecological or YPAP model to analyse and evaluate strategies to increase participation in sport in CaLD communities
- report on the socio-cultural and environmental influences on CALD communities in relation to participation rates in physical activity and sport.

STRATEGIES TO DECODE THE QUESTION

- **Identify the action words: Apply** — use theory to help in a practical example; show or make links, relationships or connections. Normally part of a larger question — requires you to **link** your theoretical knowledge to the case study
  Explain — to make the meaning of something clear and understandable
- **Key terminology:** social-ecological model
- **Key concept:** social-ecological model — an understanding of how the social-ecological model works
- **Marking scheme:** *6 marks* — always check marking scheme for depth of response required, linking to key information highlighted in the question.

PRACTICE QUESTION

Read the following advertisement:

Women-only gym group

A women-only gym group open to women of all ages and all backgrounds; however, priority is given to refugee women. Blinds cover all windows to ensure privacy. Come along and improve strength, balance, cardiovascular fitness and general health and wellbeing in a fun and positive environment. Assessment by our physiotherapist prior to starting is essential.

Venue: Community Gym, Collingwood Housing Estate

Time: Wednesdays, 1:00–2:00 pm

Cost: Free

Using the information provided, **apply** the socio-ecological model to critique this program. **Explain** the likelihood of success of this program. *(6 marks)*

Sample response

The purpose of the women-only gym group is to increase physical activity. Physical activity behaviour is complex. No single factor is responsible for determining physical activity participation *(1)*.

The installation of the blinds is an aspect of the physical environment *(1)* that has been modified to suit the privacy requirements of the refugee women. Women-only program addresses the individual component by meeting the cultural needs of some refugee women *(1)*. The program addresses the social environment by providing women with opportunities to meet other refugee women *(1)*. It would be further enhanced by employing buddies for the women, from their own culture, to integrate them into the program. There is an absence of any policy mentioned in the program, however, the funding for the physiotherapist and the costs of the program must be covered by the local council or some other organisation *(1)*.

The program is likely to be effective because it addresses all four components of the social-ecological model *(1)*.

HOW THE MARKS ARE AWARDED

1 mark: demonstrated an understanding of the social-ecological model and the interrelationship between factors that determine physical activity behaviour

1 mark: identifying an example of physical environment, individual component, social environment, policy

1 mark: critique — stating that the program is effective because it addresses all four components.

PRACTISE THE KEY SKILLS

Use the social-ecological model to critique the Multicultural Youth Action Group (MYAG) initiative in the City of Casey. *6 marks*

KEY SKILLS EXAM PRACTICE

1. List two sociocultural and two environmental barriers to physical activity participation for CaLD communities.
2. Identify three strategies that could be used by a local sporting organisation that is making an effort to be inclusive of players from different cultures.

3 Choose a CaLD community and identify five specific barriers that would need to be overcome for them to engage in physical activity. Identify these barriers as being social, cultural or environmental.
4 Review the list of organisations that have received the Multicultural Youth Sports Partnership (MYSP) funding. Choose one of these organisations and outline how they used the funding to promote cultural diversity in physical activity. The weblink for MYSP can be found in section 16.5.

CHAPTER REVIEW

CHAPTER SUMMARY

- One in four Australians living here today were born in another country.
- In the last decade, Australia has begun to implement strategies that are aimed at increasing the participation of CaLD communities in physical activity.
- Physical activity provides many benefits to CaLD communities and the increase in CaLD people within the population can benefit sport and physical activity in Australia.
- Programs that are most effective in engaging CaLD communities are those that are tailored to the specific needs of that community.
- The increase in cultural diversity within the Australian sporting landscape may result in a change in the type of sports that are played and the type of sports that are broadcast.
- In order to critique programs that are aimed at increasing activity within CaLD communities, it is important that students are able to use the components of the social-ecological model. Therefore, it is helpful if they understand some of the individual, social environment, physical environment and policy needs of CaLD communities.
- Students could use the information presented in this chapter to consider the sociocultural and environmental enablers and barriers to physical activity for CaLD communities.

GLOSSARY

acute injury an injury that occurs quickly and for which pain and loss of function is immediate
acute responses the body's immediate, short-term responses that last only for the duration of the activity and for a short time afterwards (recovery)
agonist the muscle that causes the major action (prime mover)
'all or nothing' principle states that if the nerve impulse meets a certain threshold, maximal action occurs in the muscle fibre. If the stimulation is less than threshold, no muscle action occurs in the muscle fibre.
altitude training training at levels greater than 1500 m above sea-level to induce physiological changes that enhance the oxygen-carrying capacity of the blood
anatomical position standing erect, facing forward with arms by the side and palms facing forward
antagonist the muscle that relaxes and lengthens to allow movement to occur
anti-doping codes codes established to eradicate the use of drugs and other illegal performance-enhancing methods in sport
arteries large, thick-walled blood vessels that carry blood away from the heart
arteriovenous oxygen difference (a-VO_2 diff.) the difference between the concentration of oxygen in the arterial blood and the concentration of oxygen in the blood in the veins. This is measured in mL/100 mL of blood.
arthritis a condition characterised by inflammation of a joint, causing pain and stiffness
atherosclerosis narrowing and hardening of the arteries due to deposits on the walls of the arteries that slow down blood flow
atria the two upper chambers of the heart. They receive blood from the veins and pump it into the lower chambers (ventricles).
barrier something that prevents progress or makes it difficult for someone to achieve something. It has a negative effect on one's physical activity behaviour or outcome of movement.
beta blockers drugs that block adrenalin hormones from binding to receptors on nerves, reducing the effect they have on the heart and blood vessels
bicarbonate a source of sodium that neutralises acids; it is ingested orally as a capsule or effervescent powder
blood the fluid circulated by the heart around the body. It consists of plasma, red and white blood cells, and platelets.
blood doping the process of infusing extra human blood (red blood cells) into an athlete's body prior to performance
blood pooling a collection of blood in the leg veins when high-intensity activity stops too suddenly
blood pressure the pressure exerted by the arterial blood against vessel walls as it is forced through the cardiovascular system by the beating or relaxing of the system
blood vessels a transport network of arteries, capillaries and veins that carry nutrients and waste around the body
caffeine stimulant that acts on the central nervous system (CNS) to stimulate the release of adrenalin and alters perception of effort and fatigue
calcium a mineral found mainly in the hard part of bones and is essential for healthy bones. It is also important for muscle contraction, nerve transmission, enzyme activity and blood clotting.
capillaries tiny blood vessels in the cardiovascular system between the ends of the arterioles and the venules. They are the site for the exchange of gases between the cells and the cardiovascular system.
carbohydrate loading involves the manipulation of training and nutrition prior to endurance events to maximise muscle glycogen (carbohydrate) stores
cardiac cycle the movement of blood through the heart in one heartbeat. It consists of alternate systole and diastole of the atria and the ventricles.
cardiac output ($\dot{Q}$) the amount of blood ejected from the left ventricle of the heart per minute. It is the product of stroke volume (SV) multiplied by heart rate (HR), so $\dot{Q} = SV \times HR$, and is measured in litres per minute (L/min).
cardiovascular disease conditions that affect the functioning of the heart and blood vessels
cardiovascular system the heart and blood vessels circulating blood throughout the body, delivering water, oxygen and nutrients to cells, and removing waste products such as carbon dioxide
cartilage a tough, fibrous connective tissue located at the end of bones and between joints. It protects bones by absorbing the impact experienced in movements such as jumping.
chronic adaptation the long-term responses of body systems, developed over a period of time in response to a training program
chronic injury an injury that recurs due to weakness or insufficient rehabilitation

chronic obstructive pulmonary disease (COPD) a condition that limits airflow into the lungs
concentric contraction shortening of muscle length as force is being produced
continuous training continuous, submaximal (70–85% HR max) activity lasting longer than 20 minutes
cool-down low-intensity activity completed at the end of a training session or competition that allows the body to recover by breaking down lactic acid and preventing venous pooling, gradually returning the body to its resting physiological state
coronary arteries supply oxygen and nutrients to the cardiac muscle (heart)
coronary heart disease (CHD) build-up of plaque in the coronary arteries causing insufficient blood supply to the heart
creatine a naturally occurring compound found in skeletal muscles that assists in the regeneration of ATP in the muscle cells
demographics the physical characteristics of the population such as age, gender, ethnicity, family size, job status and education
deoxygenated refers to oxygen-poor (carbon dioxide-rich) blood
diastole a relaxation of the heart muscle
diastolic blood pressure the blood pressure recorded during the relaxation phase of the heart cycle. It is the lower of the two blood-pressure values.
diffusion the movement from a higher concentration to a lower concentration
direct injury caused by external force
doping the use by, or distribution to, an athlete of certain substances or methods that could have the effect of artificially improving the athlete's physical and/or mental condition and enhancing their performance
eccentric contraction lengthening of muscle length as force is being produced
emotional health the capacity to appropriately display and control one's emotions
enabler something or someone who makes it possible for a particular thing to be done. It has a positive effect on one's physical activity behaviour or outcome of movement.
environmental influences characteristics of the environment in which people live and spend their time that either enable exercise or create a barrier which can prevent people from exercising
epiphyseal plates (or growth plates) the growth centre of developing bones
erythropoietin (EPO) a naturally occurring hormone secreted by the kidneys that stimulates the production of red blood cells. Can also be produced synthetically.
exercise physical activity that is planned or structured, involving repetitive body movement done to improve or maintain one or more components of fitness
expiration the movement of air out of the lungs to the external environment (breathing out)
fartlek training continuous training involving changes of intensity to work both the aerobic and anaerobic energy systems
gender the state of being male or female (typically used with reference to social and cultural differences rather than biological ones)
glycaemic index a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood-glucose levels after eating
growth hormone a synthetically produced drug that mimics the effect of the hormone human growth hormone (hGH)
haemoglobin a substance found in red blood cells that transports oxygen around the body
heartbeat one contraction and relaxation of the heart muscle
heart rate (HR) the number of times the heart contracts or beats per minute (bpm)
high cholesterol greater amounts of cholesterol in the blood than required, which can increase the risk of cardiovascular disease
high-intensity interval training (HIIT) involves repeated bouts of high intensity efforts followed by varying periods of complete rest or recovery at a lower intensity
homeostasis a constant internal environment for optimal functioning of the body and its systems
hypertension high blood pressure
hyperthermia a rise in the body's core temperature above 37.5–38.3 degrees Celsius
hypothermia a reduced core body temperature below 35 degrees Celsius
hypoxic a low level of oxygen is available
indirect injury caused by internal force
insertion usually attached to the bone that moves most when the muscle contracts. It is further (or distal) to the body's midline.
inspiration the movement of air from the external environment into the lungs (breathing in)
interval training consists of intervals of work followed by intervals of rest or recovery
intrinsic motivation an individual's inner drive to perform a certain action or behave in a specific way. Examples include doing something for pleasure or believing a specific action is the correct thing to do.

involuntary control no conscious control of the muscle

isoinertial contraction a type of dynamic muscle work where the muscle length can shorten, lengthen or remain the same as the resistance remains constant

isokinetic contraction when force created by the muscle is maximal for all angles of the joint movement via use of a machine

isometric contraction when force is developed but there is no change in the length of the muscle

ligament a strong fibrous band of connective tissue that holds together two or more moveable bones or cartilage or supports an organ

liquid-meal supplements supplements typically containing a carbohydrate-rich, protein-moderate, low-fat powder formula that can be mixed with water or milk

long-interval training consists of intervals of work followed by equal intervals of rest or recovery to develop the aerobic energy system

maximum oxygen uptake (VO_2 max) the maximum amount of oxygen per minute that can be taken in, transported to, and used by the working muscles to produce ATP

mental health the capacity of the brain to function well

METs (metabolic equivalents) commonly used to express the intensity of physical activities. A MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. Your MET level would be 1 if you were generally sedentary (e.g. lying down, reading or sitting and talking). Participation in an activity of moderate intensity would result in a MET level of 3-6.

minerals inorganic substances in the body required for adequate functioning of the body; they are important components of bone, muscle, skin and blood

motor unit one motor neuron and the muscle fibre it stimulates. (Each neuron may stimulate a number of muscle fibres.)

musculoskeletal injury any damage that occurs to the structures of the muscular or skeletal systems of the body

nutritional supplements food or preparations ingested in excess of those consumed in a normal diet to supplement or increase the amount of nutrients available

objective assessment information obtained via measurable or observable means

origin the fixed point of attachment that is closer (or proximal) to the body's midline

osteoporosis a condition in which the bones become weak and thin and therefore brittle

overtraining a physical condition characterised in its most severe form by decreased athletic performance, increased fatigue, persistent muscle soreness, mood disturbances, and a feeling of being 'burnt-out' or 'stale'

overuse injury an injury caused by excessive and repeated use of the same muscle, bone or joint

oxygenated refers to oxygen-rich blood

performance enhancement includes methods, devices or substances that enhance athletic performance

physical activity any movement of the body produced by skeletal muscles, resulting in energy expenditure

physical health the efficient functioning of the body, free from disease and illness

physical inactivity refers to lack of involvement in physical activity during an individual's leisure time

plyometric training aims to increase muscular power by first stretching a muscle then contracting it in the shortest time possible

precapillary sphincters one-way valves that control blood flow within capillaries

proprioception the ability of the muscles, tendons and joints to receive and process stimuli about their position

protein supplements nutritional supplements used by many athletes to aid in the growth and repair of muscle tissue and cells

pulmonary circulation the arteries and veins that feed blood from the heart to and from the lungs where blood is oxygenated

pulmonary diffusion the process to describe the exchange of gases in the lungs

reactivity the change in the behaviour of an individual who is aware they are being assessed

reciprocal inhibition the process of one muscle contracting (agonist) while the other muscle relaxes (antagonist) to create movement

resistance training aims to build muscle strength, muscle power or local muscular endurance by exercising muscles or a group of muscles against a resistance

respiratory rate (RR) the amount of breaths per minute

respiratory system consists of the lungs and associated structures responsible for gas exchange in the body, bringing air into the body and removing waste products

sarcomere the smallest unit of muscle contraction

sedentary behaviour behaviour associated with sitting or lying down, including activities such as watching television, working or playing on the computer, driving or sitting in a car, bus or train. It also includes homework, studying or reading. MET of 1-2.
self-efficacy an individual's belief that they can execute behaviours that can achieve a certain attainment of success
settings-based approach involves strategies aimed to encourage healthy behaviour in specific environments known as settings, such as school, work and community settings
size (Henneman) principle states that the recruitment of motor units in skeletal muscles starts with small motor units to large motor units
skeletal system a rigid structure made of bones that provides support, protection and sites to which muscles attach to create movement
social desirability bias the tendency of individuals to respond to questions in a survey in a way that they think will be viewed favourably by others, which often results in overreporting 'good behaviour' and underreporting 'bad behaviour'
social-ecological model a framework used to develop, implement and critique health-promotion strategies aimed at improving the health of people by promoting physical activity and limiting sedentary behaviour
social health the capacity to get on well with others
sociocultural influences the combination of social and cultural influences on an individual. Social influences include the interactions an individual has with family, peers and teachers. The cultural component relates to shared ways of thinking and acting (ideas, values, beliefs and behaviours).
sport a range of activities that are highly organised and involve rules, complex skills and tactics, physical exertion and competition between participants
sports gels and bars fortified foods containing a blend of carbohydrates and protein to provide a large boost of fuel in one serving
sports injury prevention strategies any processes completed by a coach, athlete or sports administrator to minimise the risk of injury
stabiliser the group of muscles that ensure that the joint remains stable during movement
stakeholders individuals or groups of people who have a vested interest in a particular issue
steady state the state in which oxygen supply equals oxygen demand and energy is being supplied aerobically
steroids synthetically produced drugs that mimic the effect of the hormone testosterone
stroke a condition caused by lack of blood flow to the brain
stroke volume (SV) the amount of blood ejected from the left ventricle with each heartbeat (contraction) of the heart. It is measured in millilitres per beat (mL/beat).
subjective assessment information obtained from a person's perception, understanding and interpretation of an event
synergist the muscle that assists the agonist to produce the required movement
synovial joint a specialised joint that allows more or less movement and has a joint capsule
systemic circulation the arteries and veins that feed blood from the heart to the whole body and back to the heart again for reoxygenation
systems thinking a way of viewing things where the entities within a system influence one another
systole a contraction of the heart muscle, specifically the ventricles
systolic blood pressure the blood pressure recorded as blood is ejected during the contraction phase of the heart cycle. It is the higher of the two blood-pressure values.
taping the use of strapping tape to limit the range of movement in a joint as part of an athlete's prevention or rehabilitation strategy
tendon a fibrous connective tissue that attaches muscles to bones
thermoregulation the maintenance of core body temperature with a narrow range
training principles rules that must be adhered to in order to benefit from any form of fitness training program
tidal volume (TV) the amount of air breathed in and out in one breath
vasoconstriction a process whereby blood vessels narrow or constrict causing a decrease in blood flow
vasodilation a process whereby blood vessels increase their diameter causing an increase in blood flow
veins blood vessels that carry deoxygenated blood and waste products from the body's cells back to the heart
ventilation (V) the amount of air that is inspired and expired during 1 minute
ventricles the two lower chambers of the heart. They receive blood from the atria and pump it to the lungs (right ventricle) and to the body (left ventricle).
vertebrae the 33 moveable and immoveable bones that make up the vertebral column

vertebral column (or spine) the column of irregular bones comprised of three distinct curves that provides the body's central structure for the maintenance of good posture

vital capacity the maximum amount of air that can be expired after a maximal inspiration

vitamins essential components of a balanced diet; they allow normal body growth and maintenance by assisting chemical reactions in the body

voluntary control conscious control of the muscle

warm-up activities and exercise undertaken at the beginning of a training session with the aim of preparing the body both physiologically and psychologically for the training session that follows

weight management the ability to maintain a balance between energy intake and energy expenditure, resulting in a relatively stable weight

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