Chapter 4
How do organisms respond to pathogens?

Keywords and terms

Responding to antigens

allergen
antigen
bacterium
complement protein
eosinophil
fever
humoral immunity
infection
lymph
major histocompatibility complex (MHC)
neutrophil
pathogen
specific immune response
helper T cell

antibody
antigen-presenting cell
cell mediated immunity
dendritic cell
interferon
histamine
immune response
inflammation
lymph node
mast cell

non-self-antigen
phagocyte
T lymphocyte
virus

adaptive immune response
B lymphocyte
clonal expansion
disease
microbiotic
host
immunoglobulin
innate immune response
macrophage
memory cell

non-specific immune response
self- antigen
T cytotoxic cell

Acquiring immunity

active immunity
artificial immunity
cancer
immunotherapy
passive immunity
pandemic
virulence

AIDS
agglutination
epidemic
monoclonal antibody
HIV
vaccination
zoonose

allergy
autoimmune disease
herd immunity
natural immunity
quarantine

Content review questions

Responding to antigens

1 How do organisms determine which cells are theirs and which cells are foreign?

2 Distinguish between the following terms: pathogen, antigen, antibody and allergen.

3 What is disease? Are all diseases infectious?

4 Explain the relationship between infectious diseases and pathogens.

5 In terms of pathogens, what is meant by the term 'host'?

6 Pathogens can be non-cellular or cellular. Give three examples of each.

7 What physical and chemical barriers do plants have against infection?

8 The human body has a number of levels of defence against disease. What is the first line of defence?

9 Complete the following table.

Component of the innate immune response	Role in the innate immune response
Macrophage	
Neutrophil	
Dendritic cells	
Eosinophil	
Natural killer cell	
Mast cell	
Complement protein	
Interferon	

10 What are the functions of inflammation?

11 Describe the stages of inflammation.

12 Explain whether the features described above provide specific defence.

13 Give two roles of fever in the immune response.

Acquiring immunity

14 Complete the following table.

	Examples
Primary lymphoid organs	
Secondary lymphoid organs	

15 What are the two main functions of lymph vessels?

16 What is the function of lymph nodes?

17 What is the role of the adaptive immune response?

18 Distinguish between T lymphocytes and B lymphocytes. Where is each sort of cell formed and matured?

19 What is the difference between antibodies and antigens? How do they relate to each other?

20 What are antibodies made of and by what cells are they made?

21 Why is the shape/structure of antibodies so important?

22 List the major steps involved in humoral immunity.

23 List the major steps involved in cell-mediated immunity.

24 Describe the different ways that T cells are involved in specific defence.

25 How does natural immunity differ from artificial immunity?

26 What is the principle behind active immunity?

27 How does active immunity differ from passive immunity? Which is best?

28 Explain why most people get mumps or measles once only. (Assume they were not vaccinated!)

29 What are the differences between infectious and non-infectious diseases?

30 Explain the relationship between infectious diseases and pathogens.

31 Give two explanations as to why new diseases emerge.

32 Why is scarlet fever considered to be a re-emerging disease?

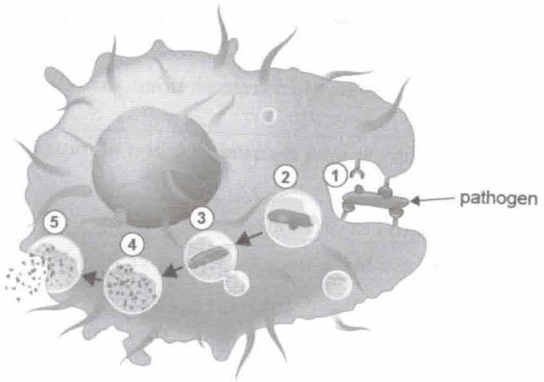
Multiple-choice questions

56 [VCAA 2015 SA Q17]
Which one of the following is an example of a plant defence against a pathogen?
A production of antibodies
B an active immune system
C extensive cell death throughout the plant
D waxy leaf surfaces acting as physical barriers

57 [VCAA 2014 SA Q15]
The first line of defence against pathogens includes the
A activation of helper T cells.
B presence of acid in the stomach.
C release of histamine from mast cells.
D production of interferon from virus-infected cells.

58 [VCAA 2013 SA Q14]
As part of the first line of defence in the human immune system, naturally occurring barriers to invading pathogens include
A lysozymes in tears.
B the production of antibodies.
C the engulfing of pathogens by phagocytes.
D inflammation at the site of infection.

59 [VCAA 2019 SA Q20]
The diagram that follows shows the process of phagocytosis. This process is vital for immunity against extracellular infections.



What is happening at position 3?
A Enzymes that break down the microorganism are released into the vesicle.
B Antibodies are added to the vesicle to kill the microorganism.
C The cell is sampling the vesicle for antigen presentation.
D Intracellular microbes are attacking the microorganism.

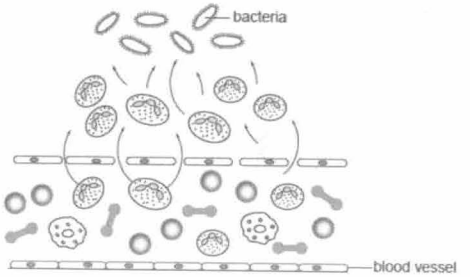
60 [VCAA 2016 SA Q20]
The inflammatory response is a defence mechanism that evolved in higher organisms to protect them from infection and injury.
This response
A includes phagocyte migration to the site of the injury.
B is part of the adaptive immune system.
C is specific to the type of foreign body.
D involves the production of lymphocytes.

61 [VCAA 2015 SA Q18]
A girl is carrying a piece of wood. A small piece breaks off and becomes embedded in her finger. The next day, she notices an inflammatory response occurring in her finger.
In the region around the small piece of wood embedded in her finger
A mast cells would release antibodies.
B the skin tissue would become pale and cold.
C the capillaries would become more permeable.
D red blood cells would leave the blood vessels and engulf foreign material.

62 [VCAA 2014 SA Q16]
An example of a non-specific response by the immune system is
A phagocytes engulfing non-self-material.
B cytotoxic T cells releasing chemicals into infected cells.
C production of memory T cells.
D cloning of B cells to produce plasma cells.

63 [VCAA 2013 SA Q15]
Defence mechanisms against bacterial pathogens include
A the production of interferon.
B neutralisation by histamines.
C destruction by complement proteins.
D agglutination by cytotoxic T cells.

64 [VCAA 2012 E1 SA Q10]
Consider the following diagram showing a bacterial infection within a human.



Cells moving from the blood vessel towards the bacteria
A are natural killer cells.
B would act as phagocytes.
C cause vasodilation of the blood vessel.
D release histamine in response to tissue damage.

65 [VCAA 2012 E1 SA Q23]
Interferon is a chemical that
A kills bacteria by producing holes in the bacterial wall.
B protects uninfected cells from viral attack.
C suppresses the immune response.
D is produced by T cells.

66 [VCAA 2011 E1 SA Q6]
It is reasonable to infer that an infection has occurred if
A histamine is released by cells.
B a scab has formed on a cut in the skin.
C bacteria are found in the large intestine.
D pathogens are found in leg muscle tissue.

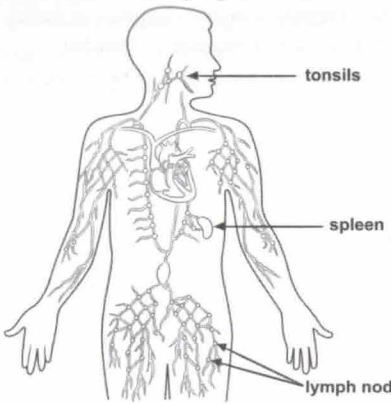
67 [VCAA 2011 E1 SA Q8]
Nonspecific defences of the immune system that act against bacteria include
A antibodies.
B phagocytes.
C interferons.
D plasma cells.

68 [VCAA 2015 SA Q15]
Which one of the following is true of prions?
A They have an outer wall made of cellulose.
B They cause some brain diseases.
C They contain nucleic acids.
D They are unicellular.

69 [VCAA 2014 SA Q14]
An example of 'self' material in an adult human female is
A pollen inhaled from flowers in her garden.
B sperm cells present in her reproductive tract.
C cells lining her nose and trachea.
D malarial parasites inside her red blood cells.

70 [VCAA 2012 E1 SA Q9]
Major Histocompatibility Complex (MHC) class 1 molecules
A release complement proteins.
B are found only on B and T cells.
C present foreign antigens to B and T cells.
D produce antibodies that are specific to each antigen.

71 [VCAA 2017 SA Q23]
The human lymphatic system



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The lymphatic system includes the lymph nodes, spleen and tonsils.
In these particular organs
A clotting factors are inactivated to help seal a wound.
B clonal selection and proliferation of B cells occurs.
C non-self-antigens are identified by red blood cells.
D the initial response to an allergen is triggered.

72 [VCAA 2013 SA Q18]
Di George syndrome is a rare, congenital disease that can disrupt the normal development of the thymus gland. This disease would result in the
A swelling of lymph nodes.
B overproduction of B cells.
C reduced production of T cells.
D release of histamines from mast cells.

73 [VCAA 2013 SA Q20]
In the lymphatic system
A clonal selection occurs.
B mast cells are produced.
C vessels have thick, muscular walls.
D lymph is pumped by the heart.

74 [VCAA 2011 E1 SA Q7]
The lymphatic system contains
A B cells only.
B T cells only.
C B cells and T cells.
D neither B cells nor T cells.

75 [VCA 2018 SA Q17]

Antigen-presenting cells deliver antigens to lymphocytes found within lymphoid tissue. These lymphocytes recognise these antigens as being non-self, causing the lymphocytes to become activated and increase in number.

Which of the following lymphocytes are activated by antigen-presenting cells?

A T helper cells
B dendritic cells
C plasma cells
D neutrophils

76 [VCAA 2019 SA Q19]

In adaptive immunity, which cells, directly destroy virally infected cells?

A B cells.
B plasma cells.
C T helper cells.
D T cytotoxic cells.

77 [VCAA 2013 SA Q19]

Cytotoxic T cells are

A antibodies.
B able to kill virus-infected cells.
C part of the humoral response.
D part of the second line of the immune defence.

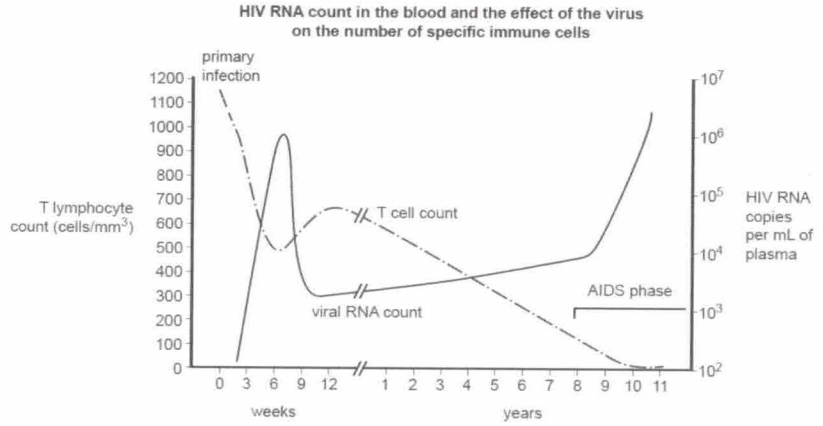
78 [VCAA 2017 SA Q22]

Which of the following matches a cell correctly with its role in an immune response?

	Cell	Role
A	macrophage	stimulates inflammation by secreting interferon
B	dendritic cell	presents fragments of antigens to T helper cells
C	mast cell	engulfs bacteria and debris
D	neutrophil	secretes antibodies

79 [VCAA 2019 SA Q23]

The graph on the following page shows the HIV RNA count in the blood and the effect of the virus on the number of specific immune cells in an untreated patient.

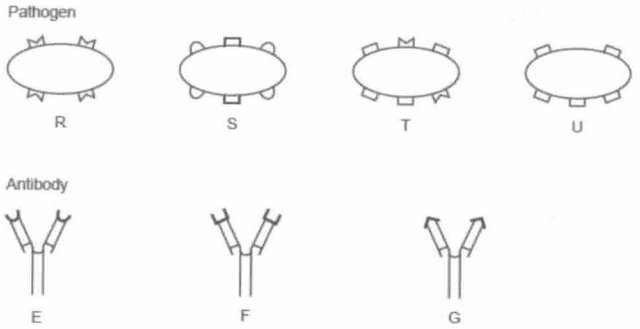


Based on your knowledge and the information in the graph on the previous page, what is the effect of the change in the number of T cells over time?

A a decrease in the viral RNA count during the AIDS phase.
B loss of effective function of the adaptive immune system.
C failure of macrophages to engulf HIV.
D failure of complement proteins.

80 [VCAA 2015 SA Q16]

Consider the following diagram of four pathogens and three antibodies.



Which one of the following statements is correct?

A Antibody E would be effective against both pathogen S and pathogen R.
B Antibody F is effective against three of the pathogens.
C There are no antibodies effective against pathogen U.
D Antibody G is only effective against pathogen R.

81 [VCAA 2012 E1 SA Q16]

The ABO blood group system has four main groups. Consider the following table.

	Blood group samples			
	O	**A**	**B**	**AB**
Antigens on red blood cells	Neither A nor B	A	B	Both A and B

Agglutination of blood cells would occur if

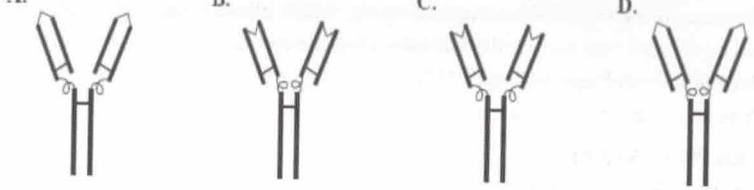
A antibodies of type A were added to a sample of group O blood.
B antibodies of type A were added to a sample of group B blood.
C antibodies of type B were added to a sample of group A blood.
D antibodies of type B were added to a sample of group AB blood.

82 [VCAA 2011 E1 SA Q13]

This diagram shows a group of antigens.

An appropriate antibody to use against these antigens would be type

A. B. C. D.



83 [VCAA 2020 SA Q19]

The role of T helper cells is to

A destroy cells that are infected with bacteria.
B control the adaptive immune response.
C generate antibodies.
D engulf parasites.

84 [VCAA 2020 SA Q20]

Which one of the following describes a feature common to both T cells and B cells?

A having immunological memory
B rapidly responding to pathogens on first exposure
C providing a physical barrier to the entry of pathogens
D being able to attach to both microorganisms and viruses

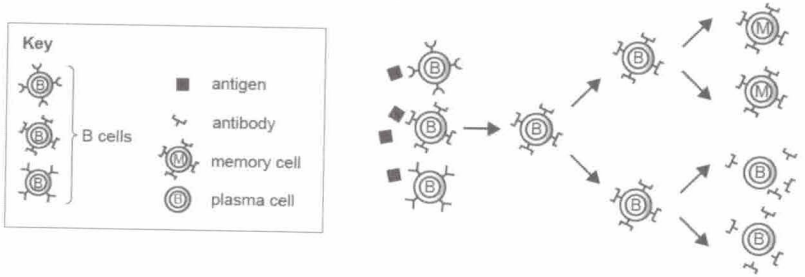
85 [VCAA 2020 SA Q21]

The property of the immune system that enables it to fight infections and destroy cancer cells is the

A ability to kill all invading organisms.
B ability to adapt to donor tissue, facilitating transplants.
C ability to distinguish self from non-self-biological molecules.
D generation of complement proteins and other chemical barriers.

86 [VCAA 2019 SA Q21]

Consider the diagram below of clonal selection in B cells.

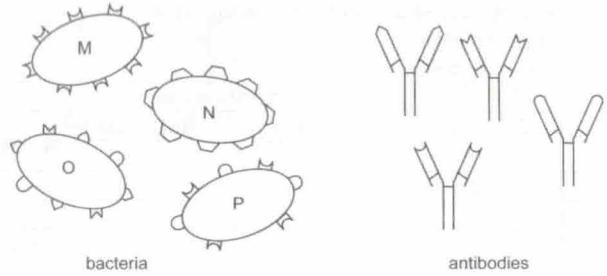


In adaptive immunity, which part of this process allows long-term (sometimes lifetime) protection against pathogens?

A recognition of one antigen by one B cell clone.
B production of specific antibodies.
C generation of memory cells.
D production of plasma cells.

87 [VCAA 2009 E1 SA Q20]

A young woman stood on a dirty, rusty nail. The following diagrams show bacteria isolated from the wound and a range of antibodies that were already present in her body.



The microorganism most likely to cause a severe infection is

A M.
B N.
C O.
D P.

88 [VCAA 2018 SA Q23]

Rabies is a viral disease spread to people by infected animals. A person bitten by an infected animal should be given an injection of specific antibodies.

Following the injection, this person should have

A natural active immunity.
B artificial active immunity.
C natural passive immunity.
D artificial passive immunity.

89 [VCAA 2016 SA Q23]

A park ranger was injected with an antivenom serum to treat a snakebite. The treating doctor explained that the injection would not protect him against future snakebites.

This is because antivenom serum is used to achieve

A active and natural immunity.
B passive and natural immunity.
C active and induced (artificial) immunity.
D passive and induced (artificial) immunity.

90 [VCAA 2011 E1 SA Q9]

Antibodies passed from a mother to her baby during breast-feeding would be best described as

A naturally acquired, passive immunity.
B naturally acquired, active immunity.
C artificially acquired, passive immunity.
D artificially acquired, active immunity.

*The following information relates to Questions **91** and **92**.*

People that have been infected with one or more different respiratory viruses develop antibodies in response to each kind of virus in their blood. The blood of four patients was tested to diagnose which viruses each patient had previously been infected with. The results are shown in the following table.

Key: ++ agglutination
0 no agglutination

	Antibody to			
Blood from	Rhinovirus	Influenza A	Influenza B	RSV
Becky	++	++	0	0
Emily	0	++	++	++
Mary	++	++	0	0
Stella	0	0	++	0

91 [VCAA 2011 E1 SA Q24]
From the information in the table it is reasonable to infer that

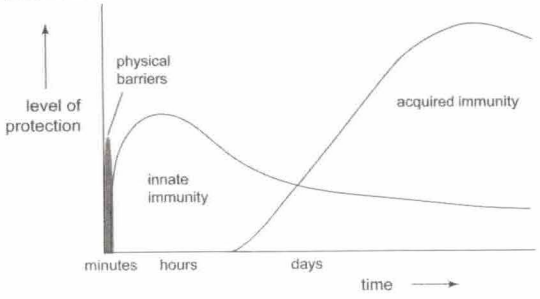
A Stella has been infected with RSV.
B Mary has been infected with three kinds of virus.
C Emily has been infected with the greatest number of different viruses.
D Becky and Stella have each been infected with the same set of viruses.

Once the antibody distribution was known, doctors vaccinated the four patients against viruses for which each patient had no immunity.

92 [VCAA 2011 E1 SA Q25]
From the information given in the table it is reasonable to infer that Becky would be given

A vaccines for Rhinovirus and influenza A.
B vaccines for influenza B and RSV.
C the same vaccines as Emily.
D vaccines for influenza A.

93 [VCAA 2009 E1 SA Q21]
After an individual is exposed to a microbial infection, the immune system increases its activities.
The graph that follows summarises the timeline of the level of those activities.

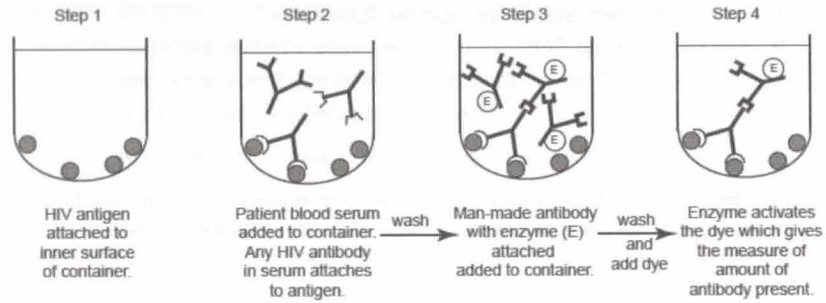


It is reasonable to conclude that

A Physical barriers involve macrophages.
B innate immunity lacks involvement of living cells.
C lymph nodes are involved in the acquired immunity phase.
D the protection developed against the disease ceases at the end of the infection.

*Use the following information to answer Questions **94** and **95**.*

A diagnostic test for HIV infection includes the following steps.



94 [VCAA 2012 E1 SA Q24]
This test for HIV is reliable because the

A dye reacts with the patient's blood serum.
B enzyme has an active site for the HIV antigen.
C man-made antibody has the same shape as the HIV antigen.
D HIV antigen has a complementary shape specific to the HIV antibody.

95 [VCAA 2012 E1 SA Q25]
The results of the tests of three patients are given in the following table.

Positive control	Negative control	Patient R	Patient S	Patient T
1.689	0.153	0.155	0.675	1.999

Numbers are expressed as optical density at 450 nm. The more intense the dye is, the higher the optical density. The cut-off value indicating a positive result is 0.500.

Values below 0.300 are considered to be negative.

The results of these tests suggest that

A patient T has not been exposed to HIV.
B patient R has been exposed to the HIV antigen.
C patient S has responded to exposure to HIV by developing antibodies.
D the positive control contained fewer HIV antibodies than the negative control.

*Use the following information to answer Questions **96** and **97**.*

Ross River fever is caused by a virus that lives in kangaroos and wallabies. When a female mosquito bites an infected animal, it picks up viral particles. When the mosquito bites a human, the virus enters the bloodstream. The virus then reproduces in blood cells, resulting in fever, rashes and joint pain.

96 [VCAA 2013 SA Q16]
Using the information given, it can be concluded that

A the viral vector is a mosquito.
B the virus is a cellular pathogen.
C Ross River water transmits the virus.
D many kangaroos and wallabies would be killed.

97 [VCAA 2013 SA Q17]

The most effective way to reduce the incidence of Ross River fever in Australia would be to

A prevent humans from living near the Ross River.

B use an attenuated form of the virus to create a human vaccine.

C increase spending on anti-inflammatory drugs to treat the symptoms.

D isolate kangaroos and wallabies in nature reserves near the Ross River.

*Use the following information to answer Questions **98** and **99**.*

In early 2016, there was an outbreak of food poisoning in Victoria linked to the consumption of pre-packaged lettuce. In investigations carried out by the Department of Health and Human Services, several products tested positive for the prokaryote *Salmonella anatum*.

98 [VCAA 2016 SA Q21]

It is reasonable to say that *S. anatum* is

A a virus.

B a prion.

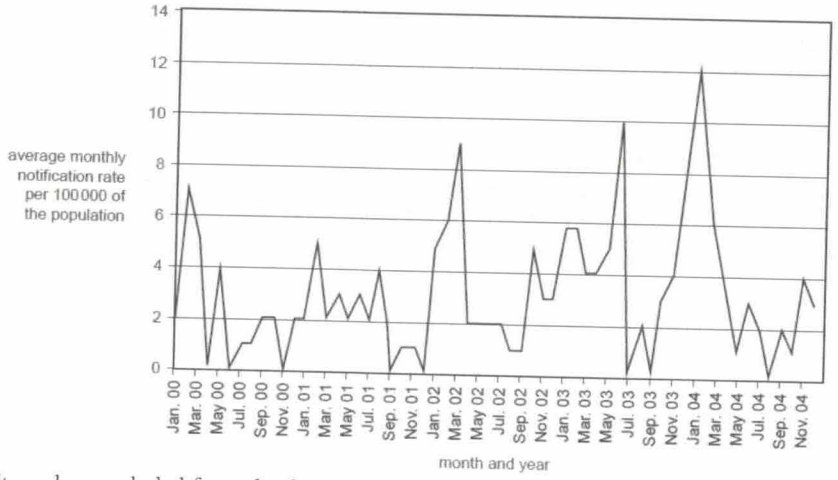
C an insect.

D a bacterium.

99 [VCAA 2016 SA Q22]

S. anatum is not a common cause of food poisoning. Data has been collected and analysed for the occurrence of illness caused by this organism in Queensland over a five-year period.

The graph below displays the average monthly notification rate per 100 000 of the population for the illness caused by *S. anatum*.



It can be concluded from the data that

A there are four periods in which the notification rate is greater than six per 100 000.

B the notification rate is always lowest during September of each year.

C the notification rate is fairly steady over the five-year period.

D the notification rate in 2001 was highest in May.

100

Why are quarantine measures needed when there is an outbreak of an infectious disease in Australian farm animals?

A To prevent the spread of the disease to food imported into Australia.

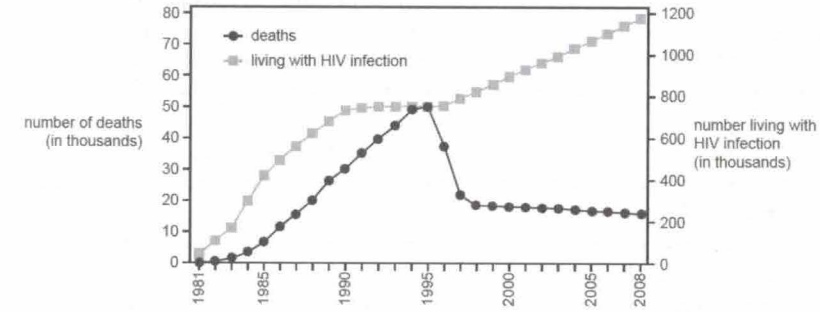
B To prevent Australian animals from becoming immune to the disease.

C To prevent introduced plants threatening the survival of Australian farm animals.

D To prevent the disease from spreading to farm animals in different regions of Australia.

101 [VCAA 2018 SA Q29]

The graph below shows the death rates from acquired immune deficiency syndrome (AIDS) and also the number of people infected with the human immunodeficiency virus (HIV). Before 1995 many people infected with the virus went on to develop AIDS, which led to their deaths.



Based on the information in the graph, what is the most likely reason for the change in death rates, even though infection rates continued to climb after 1995?

A People had access to new antiviral drugs.

B People were educated about what caused HIV infection.

C People infected with HIV were isolated from the rest of the public.

D A widespread vaccination program for HIV was introduced within a targeted population.

*Use the following information to answer Questions **102** and **103**.*

The table below compares how eight diseases spread and the number of people likely to be infected by one other infected person.

Disease	measles	whooping cough	rubella	polio	smallpox	mumps	severe acute respiratory syndrome (SARS)	Ebola
How it spreads	airborne droplets	airborne droplets	airborne droplets	fecal–oral route	airborne droplets	airborne droplets	airborne droplets	bodily fluids
No. of people infected from one other person	12 to 18	12 to 17	6 to 7	5 to 7	5 to 7	4 to 7	2 to 4	1 to 4

102 [VCAA 2018 SA Q32]

What would be the most effective method of preventing the spread of measles during an outbreak?

A Wash hands thoroughly after going to the toilet.
B Establish a 'clean needle' exchange program.
C Vaccinate all infected people.
D Isolate all infected people.

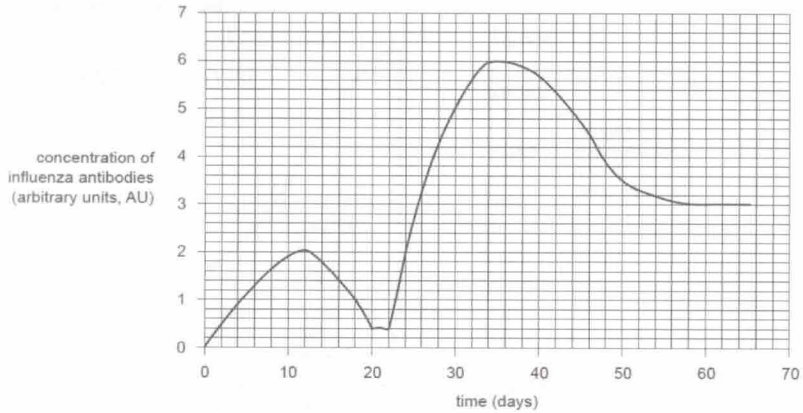
103 [VCAA 2018 SA Q33]
Based on the information in the table, which one of the following statements is correct?
A Ebola is the most contagious disease.
B Polio and smallpox have a similar infection rate.
C More people would die from measles than any other disease shown.
D The fecal–oral route is the most effective means of spreading pathogens.

104 [VCAA 2017 SA Q37]
Yellow fever is a viral disease that is transmitted primarily by mosquitoes.
An outbreak of yellow fever was reported to have occurred in an area of Brazil in January 2017. This outbreak was reported to be spreading to other areas within Brazil. Which one of the following is a correct statement about this outbreak of yellow fever?
A This outbreak of yellow fever is considered to be a pandemic.
B Infected individuals who travel to other areas of Brazil will not increase the spread of the disease.
C This outbreak of yellow fever is occurring in populations with high vaccination rates for yellow fever.
D Elimination of mosquito breeding sites in areas with yellow fever will reduce the number of individuals affected.

105 [VCAA 2020 SA Q34]
Bovine spongiform encephalopathy (BSE) is a prion disease of cattle. It is sometimes called mad cow disease. It is caused by feeding cattle food that contains prions from other infected animals. The time between infection and symptoms appearing can be up to five years. There are concerns that variant Creutzfeldt-Jakob disease (vCJD) in humans could be caused by eating infected cattle meat.
Yellow fever is a viral disease that affects humans. The yellow fever virus can cause symptoms three to six days after infection. The virus is carried by a mosquito vector.
Which combination of approaches would be most effective at controlling the risk of outbreaks of both vCJD and yellow fever?

	vCJD	Yellow Fever
A	Prevent all cattle that show symptoms of mad cow disease from reproducing.	Remove breeding grounds for mosquitoes.
B	Test all cattle for the presence of the prions.	Ensure that all healthcare professionals wear gloves when working with infected patients.
C	Destroy all cattle that have been fed infected food containing the prions.	Ensure that people take measures to reduce their chances of being bitten by mosquitoes.
D	Stop selling cattle meat.	Instruct people who are infected with yellow fever to wear masks in public places.

106 [VCAA 2017 SA Q26]
A daily blood sample was obtained from an individual who received a single vaccination against a particular strain of the influenza virus. The individual had no prior exposure to this strain of influenza. The graph on the following page shows the concentration of antibodies present in the individual's blood for this strain of influenza over a period of 65 days.

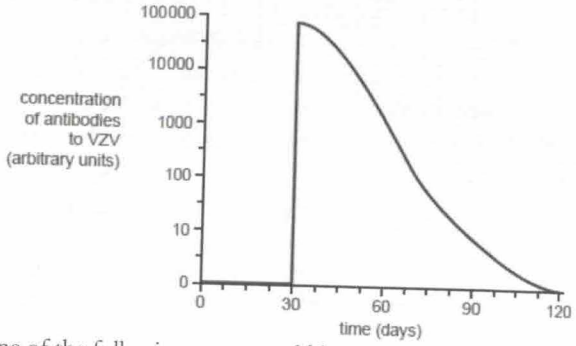


Which one of the following conclusions can be made using this data?
A Memory B cells were activated by exposure to the same strain of the influenza virus on day 22.
B B plasma cells specific to this strain of influenza were most numerous on day 12.
C Herd immunity to this particular strain of influenza was achieved by day 55.
D The vaccination containing weakened influenza antigens occurred on day 10.

107 [VCAA 2016 SA Q24]
In the search for a malaria vaccine, scientists have focused on a protein called circumsporozoite protein (CSP).
CSP is secreted by the malaria parasite and is present on its surface.
For the vaccination to work, the scientists want CSP to act as
A an antigen.
B an allergen.
C an antibody.
D a complement protein.

108 [VCAA 2015 SA Q14]

Chickenpox (varicella) is a highly contagious viral disease caused by the varicella-zoster virus (VZV). A technician measured the concentration of antibodies to VZV in a person's blood over a 120-day period. An event occurred on day 30 that significantly altered the concentration of antibodies. The concentration of antibodies over the 120 days is displayed in the graph below.



Which one of the following events could have occurred on day 30?

A an exposure of the person to VZV.
B a booster vaccination against VZV for the person.
C an injection of antibodies to VZV into the person.
D an oral dose of antibiotics was given to the person.

109 [VCAA 2012 E1 SA Q18]

Rubella is a virus that causes a highly contagious infection. When infected with rubella, humans initially produce IgM antibodies and then IgG antibodies. IgM antibodies do not cross the placenta.

Tests for the presence of IgM and IgG antibodies are carried out on a newborn baby if its mother has been diagnosed with a rubella infection during pregnancy. The results from tests carried out on four newborn babies before they had been fed are shown in the following table.

	Antibodies for the rubella virus found in the baby's blood
Baby 1	none
Baby 2	IgG
Baby 3	IgM
Baby 4	IgM

Using your knowledge and the information given, it would be correct to conclude that

A the mother of baby 1 has immunity to the rubella virus.
B baby 2 will have about two years of passive immunity to the rubella virus.
C baby 3 received IgM antibodies to the rubella virus from its mother.
D baby 4 was exposed to the rubella virus during fetal development.

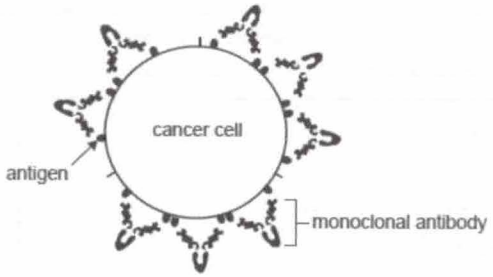
110 [VCAA 2012 E1 SA Q19]

At about 12 months of age a baby is immunised against measles, mumps and rubella. The immunity the baby acquires as a result of this vaccination is called

A active and natural.
B active and induced (artificial).
C passive and natural.
D passive and induced (artificial).

111 [VCAA 2020 SA Q35]

Monoclonal antibodies attaching to antigens on a cancer cell are shown in the diagram below.



Source: adapted from N Halim, 'Monoclonal antibodies: A 25-year roller coaster ride', *The Scientist*, 20 February 2000, <www.the-scientist.com>

Monoclonal antibodies

A are used to suppress B cells acting on cancer cells.
B make it easier for cells of the immune system to detect cancer cells.
C can bind to dendritic cells to stimulate them to destroy cancer cells.
D can attach to many structurally different proteins found on the surface of cancer cells.

112 [VCAA 2020 SA Q25]

DOCK8 syndrome is a disorder in which both B cells and T cells are defective. Patients with DOCK8 syndrome face a range of health issues, including repeated bacterial and viral infections, as well as an increased risk of cancer.

DOCK8 syndrome could be classified as

A acquired immunity.
B an allergic reaction.
C an autoimmune disease.
D an immune deficiency disease.

113 [VCAA 2019 SA Q22]

In multiple sclerosis, which specific part of the nervous system do immune cells attack?

A the receptors of post-synaptic nerve cells
B the myelin sheath around nerve cells
C the nuclei of nerve cells
D the neurotransmitters

114 [VCAA 2018 SA Q16]

Lupus is a condition that results in the increased secretion of antibodies that attach themselves to healthy cells in a patient's body. The accumulation of these antibodies causes inflammation, joint pain, rash, fatigue and fever.

Lupus is an example of

A an allergic reaction.

B an autoimmune disease.

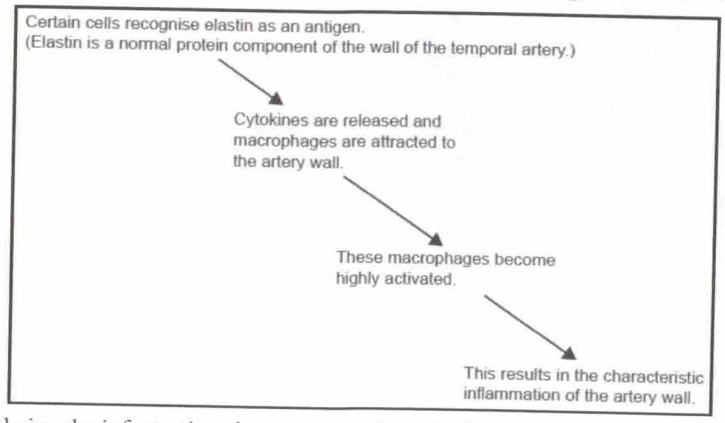
C an immune deficiency disease.

D a complement protein response.

115 [VCAA 2016 SA Q25]

Temporal arteritis is a human disease in which the temporal arteries become inflamed. This causes headaches and may result in blindness or stroke.

The sequence of responses in this disease is as shown in the diagram that follows.



Considering the information above, temporal arteritis is

A an immunodeficiency disease.

B a pathogenic disease.

C an allergic response.

D an autoimmune disease.

116 [VCAA 2015 SA Q19]

Autoimmune diseases are different from diseases caused by pathogens because in all autoimmune diseases

A certain self-tissues are not recognised as 'self' and this causes an immune response to the tissues.

B histamine is released from mast cells to cause an inflammatory response.

C complement protein causes the breakdown of healthy cells.

D interferon is released to kill infected tissue.

117 [VCAA 2017 SA Q24]

Researchers investigating MS have analysed various tissue samples from patients.

In these samples they would expect to find

A an abundance of allergens in nerve cells.

B cancer cells in MS plaques in brain tissue.

C increased numbers of T helper cells in spinal fluid.

D an absence of T cytotoxic cells in the spinal cord and brain.

118 [VCAA 2017 SA Q25]

Scientists are investigating factors that increase the likelihood of developing MS. Recently, the 'hygiene theory' has been considered a possible factor. This theory proposes that, if a child's environment is overly hygienic and does not allow sufficient exposure to a wide range of non-self antigens, an overactive immune system will result later in life.

A recent study tested for the presence of antibodies to the bacteria that cause stomach ulcers, *Helicobacter pylori*, in the blood of 550 MS patients and 299 healthy people. Both groups of people had the same proportion of each gender and were of similar age. Exposure to *H. pylori* usually occurs by the age of two years. The results of the antibody testing showed that the rate of *H. pylori* infection was 30% lower in the women with MS than in the healthy women or healthy men.

A monoclonal antibodies could be used to treat MS.

B males are affected by MS 30% more often than females.

C suffering from a stomach ulcer is a common symptom of MS.

D in females childhood exposure to *H. pylori* helps to protect against MS.

119 [VCAA 2014 SA Q10]

In the disease multiple sclerosis, the myelin sheath surrounding the axons of neurons is broken down. One of the symptoms of multiple sclerosis is weakening of the muscles.

A possible cause for this weakening could be

A the transmission of electrical impulses along the axons of neurons is slowed.

B the size of the electrical impulses travelling along the axons is smaller.

C neurotransmitter receptors on the muscle cells have become less sensitive.

D neurotransmitters are inhibited from travelling along the neurons.

120 [VCAA 2018 SA Q24]

Monoclonal antibodies can be produced and used to treat different types of cancers. Which one of the following is a correct statement about monoclonal antibodies?

A Monoclonal antibodies are carbohydrate molecules.

B Monoclonal antibodies produced from the same clone of a cell are specific to the same antigen.

C Monoclonal antibodies pass through the plasma membrane of a cancer cell and attach to an antigen within the cell.

D Monoclonal antibodies produced to treat stomach cancer will be identical to monoclonal antibodies produced to treat breast cancer.

121 [VCAA 2018 SA Q35]

The emergence of antibiotic-resistant diseases in humans means that

A antibiotics are causing resistance mutations in bacteria.

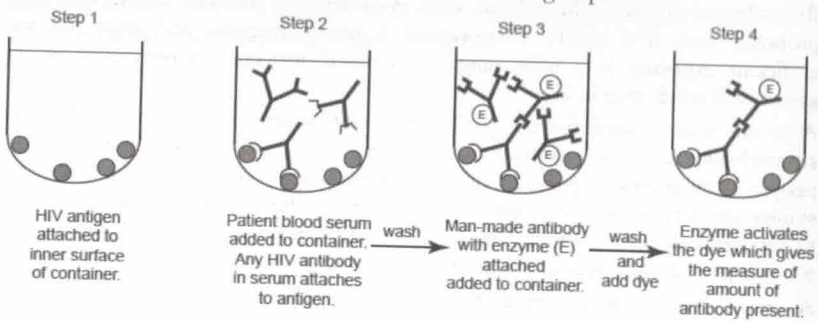
B some bacteria are less sensitive to antibiotics.

C viruses are becoming resistant to antibiotics.

D humans are less sensitive to antibiotics.

*Use the following information to answer Questions **122** and **123**.*

A diagnostic test for HIV infection includes the following steps.



122 [VCAA 2012 E1 SA Q24]

This test for HIV is reliable because the

A dye reacts with the patient's blood serum.

B enzyme has an active site for the HIV antigen.

C man-made antibody has the same shape as the HIV antigen.

D HIV antigen has a complementary shape specific to the HIV antibody.

123 [VCAA 2012 E1 SA Q25]

The results of the tests of three patients are given in the following table.

Positive control	Negative control	Patient R	Patient S	Patient T
1.689	0.153	0.155	0.675	1.999

Numbers are expressed as optical density at 450 nm. The more intense the dye is, the higher the optical density. The cut-off value indicating a positive result is 0.500. Values below 0.300 are considered to be negative.

The results of these tests suggest that

A patient T has not been exposed to HIV.

B patient R has been exposed to the HIV antigen.

C patient S has responded to exposure to HIV by developing antibodies.

D the positive control contained fewer HIV antibodies than the negative control.

Short-answer questions

124 [VCAA 2019 SB Q3]

The human immune system consists of a series of defensive barriers that protect the body from infection. When bacteria come into contact with the body, they immediately encounter these defences and must bypass each barrier if they are to survive and infect the body.

a When bacteria come into contact with the body, they must gain access to the living tissues to become pathogens.

List **two** possible routes the bacteria could use to access the living tissues of the body. [2 marks]

b Once bacteria are within or have access to the living tissues of the body, but before cells are aware of their presence, the bacteria will encounter chemical barriers.

List **one** of these chemical barriers and explain its function. [2 marks]

c When an inflammatory response starts, the first cellular responders will be cells from the innate immune system. One of these cells releases histamine.

How does histamine contribute to the inflammatory response? [1 mark]

d If bacteria are not destroyed by innate immune responses, adaptive immune responses become involved.

Describe how an adaptive immune response is initiated during a bacterial infection. [2 marks]

[Total 7 marks]

125 [VCAA 2018 SB Q3]

Plants are a rich source of nutrients for many organisms, including bacteria, fungi and viruses. Although plants lack an immune system that is comparable to animals, plants have evolved chemical barriers to stop invading pathogens from causing significant damage.

a Describe **two** chemical barriers that could be present in a plant that is protecting itself from an invading pathogen. [2 marks]

b Humans have a sophisticated immune response to invading pathogens.

State **two** ways that pathogens are prevented from entering the internal environment of the human body. [2 marks]

c Outline how complement proteins and natural killer cells protect the human body once a pathogen has gained entry to the internal environment. [2 marks]

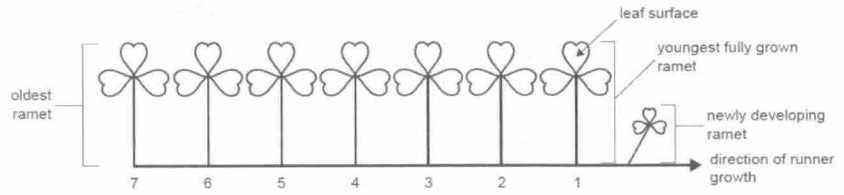
[Total 6 marks]

126 [Adapted VCAA 2017 SB Q2]

Although plants have no immune systems, they do have many chemical and physical methods of defence against pathogens and attacks by insects.

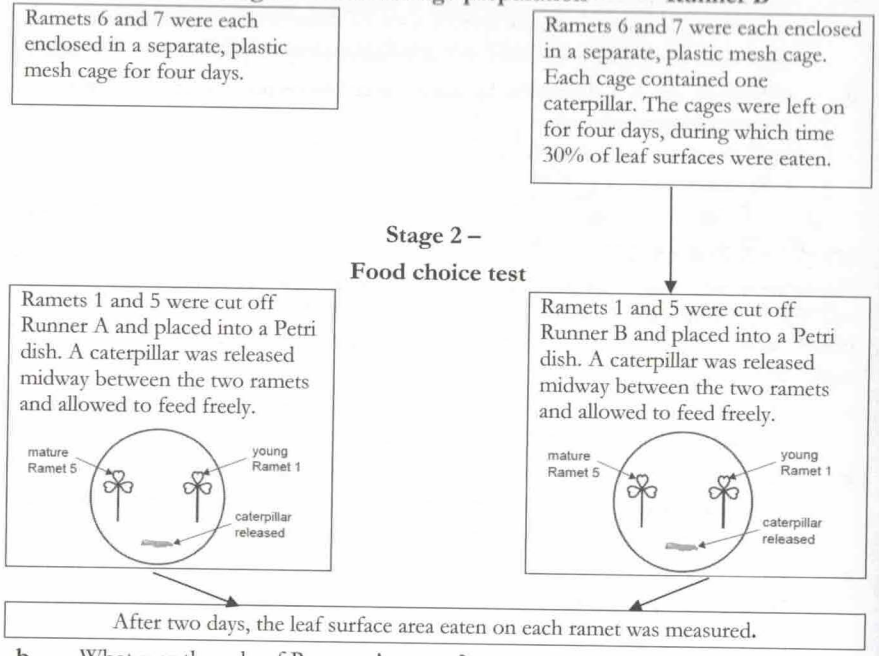
a Describe **one** example of a physical method of defence in a plant. [2 marks]

White clover (*Trifolium repens*) reproduces asexually from a runner that grows along the soil surface. The connected new plants are called ramets. The white clover plant in the diagram on the next page is producing ramets in the direction left to right. The fully grown ramets are numbered 1 to 7, from the youngest ramet to the oldest ramet.



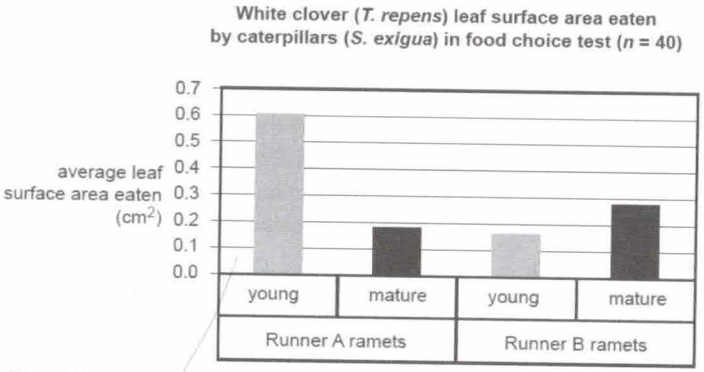
Source: adapted from S Gómez, Y Onoda, V Ossipov and JF Stuefer, 'Systemic induced resistance: A risk-spreading strategy in clonal plant networks?', *The New Phytologist*, vol. 179 no. 4 (September 2008), p. 1144

Scientists hypothesised that when *T. repens* ramets are damaged by caterpillars of *Spodoptera exigua*, the damaged ramets stimulate other ramets to defend themselves against attack by the caterpillars. The scientists conducted an experiment to test their hypothesis. The experiment used two genetically identical runners, A and B. The method is outlined in the flow chart on the next page.



b What was the role of Runner A ramets? [1 mark]

The experiment was repeated 40 times. The average results obtained after Stage 2 are shown in the graph on the next page.



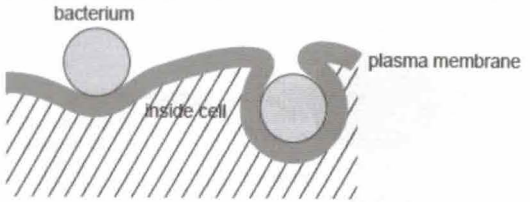
Data: S Gómez, Y Onoda, V Ossipov and JF Stuefer, 'Systemic induced resistance: A risk-spreading strategy in clonal plant networks?', *The New Phytologist*, vol. 179 no. 4 (September 2008)

c Referring to the data, compare the average leaf surface area of young ramets eaten by the caterpillars in Runner A and Runner B. [1 mark]

[Total 4 marks]

127 [Adapted VCAA 2011 E1 SB Q5]

Neisseria meningitidis is a bacterium that causes meningitis. This disease causes inflammation of tissue surrounding the brain and spinal cord in humans. Bacteria enter through plasma membranes as shown in the figure below.



a Name the process shown in the figure. [1 mark]

In an attempt to prevent the spread of the bacteria, the immune system releases antibodies and macrophages to an area of infection.

b Describe how antibodies and macrophages inhibit the spread of *N. meningitidis*. [2 marks]

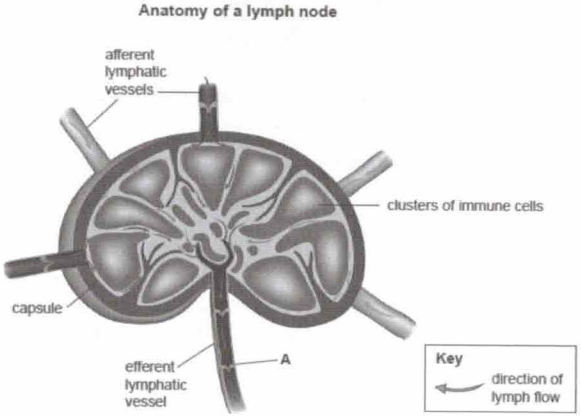
N. meningitidis can protect itself from the immune system by releasing a protease that breaks the subunits of the antibody.

c Why is this enzyme named a protease? [1 mark]

[Total 4 marks]

128 [VCAA 2015 SB Q5]

Consider the following diagram of a lymph node.



a Describe the role of the structure labelled A, found within the efferent lymphatic vessel. [1 mark]

Immune cells are clustered within the lymph node (see diagram). There is more than one type of immune cell within each of these clusters.

b Name and describe the role of one type of immune cell found within these clusters that plays a role in the innate immune response. [2 marks]

c Another of the immune cell types found within these clusters has a large nucleus and extensive rough endoplasmic reticulum, and plays an important role in an adaptive immune response.

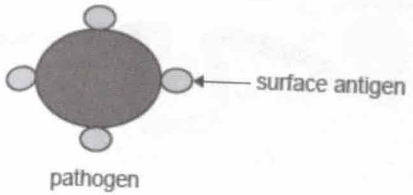
Name this cell type and explain how the extensive rough endoplasmic reticulum assists this cell to perform its function. [2 marks]

[Total 5 marks]

129 [VCAA 2014 SB Q4]

a Define the term 'pathogen'. [1 mark]

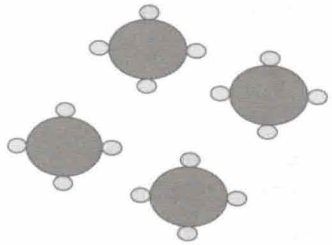
The diagram below shows a generalised pathogen with antigens on its surface. The immune system responds to antigens by making antibodies.



b Draw an antibody that would be effective against this pathogen. Label the different parts of the antibody. [2 marks]

One way that antibodies work is by forming antigen–antibody complexes.

The diagram below shows four pathogens.



c i Illustrate on the diagram above how the antigen–antibody complex forms, using at least four antibodies in your drawing. [2 marks]

ii Explain how an antigen–antibody complex provides protection against these pathogens. [2 marks]

[Total 7 marks]

130 [VCAA 2016 SB Q5]

Yellow fever is a potentially fatal, mosquito-borne, viral disease that occurs in many countries in Africa, the Caribbean, and Central and South America. An effective and safe vaccine has been available since 1938.

a What is a vaccine? [1 mark]

b For the vaccine to be effective, it is recommended that travellers to these regions have the vaccination approximately two to four weeks before travelling.

Why is this time frame recommended? [2 marks]

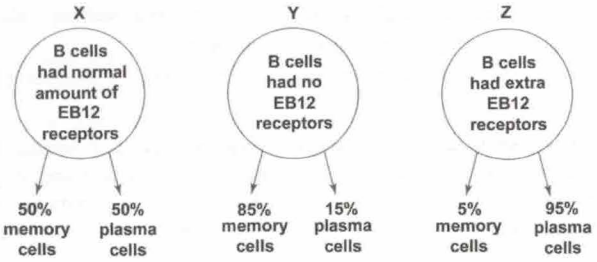
c Recent research shows that the vaccine gives lifelong immunity.

Name **two** different cell types that would be important in providing lifelong immunity and explain the **role** of each in providing lifelong immunity. [4 marks]

[Total 7 marks]

131 [VCAA 2010 E1 SB Q4]

EB12 is a receptor on the B cells of mice that helps determine if a cell becomes a plasma or a memory cell. Scientists used three different strains of mice to investigate B cell immunity. None of the strains had been exposed to the influenza virus. The strains were as follows.



The three mice strains were infected with the influenza virus.

a Explain which strain, X, Y or Z, would be best at destroying the fast-acting influenza virus. [2 marks]

b Explain how blocking the action of EB12 receptors could result in the production of a more efficient vaccine. [2 marks]

[Total 4 marks]

132 [VCAA 2020 SB Q5]

a The human immune system uses several different types of cells to eliminate virally infected cells.

Name **one** of these cells and outline how it eliminates virally infected cells. [2 marks]

b i State the role played by the lymphatic system in an immune response. [1 mark]

ii Describe the sequence of events that occurs in the secondary lymphoid tissue that results in the production of antibodies. [4 marks]

[Total 7 marks]

133 [VCAA 2017 SB Q4]

Australian marsupials, such as wallabies, kangaroos, wombats and koalas, give birth to very undeveloped young called joeys. When a joey enters the mother's pouch, it is at a stage equivalent to a seven-week-old human fetus. It spends many weeks in the pouch feeding on milk produced by mammary glands. Although the pouch provides protection from predators, it is neither sealed nor sterile.

a i What is meant by the term 'sterile' in the context given? [1 mark]

ii Consider a hospital environment. Give two examples of how sterile conditions can be achieved in a hospital. [2 marks]

The joey's primary immune tissue (in the bone marrow and thymus) does not mature until 30 days after birth and its humoral immunity does not function effectively until 90 days after birth. Biologists have analysed milk samples from several marsupial species and found that they contain various antibodies. Some of the antibodies in the mother's milk remain in the joey's gut, while others cross the gut wall and enter the joey's bloodstream.

b Describe at a molecular level how antibodies perform their function. [2 marks]

c Name the type of immunity that the joey obtains from the antibodies in the milk and explain how this form of immunity is beneficial to the joey. [3 marks]

Scientists have found that the milk of the tammar wallaby (*Macropus eugenii*) contains high levels of peptides with antibiotic properties, as well as lysozyme, complement proteins, cytokines and venom inhibitors.

d i Name the part of the immune system to which these peptides and the other listed chemicals belong. [1 mark]

ii Circle one of the chemicals below, found in tammar wallaby milk, and describe its role in protecting the joey against pathogens.

lysozyme complement proteins cytokines venom inhibitors

[1 mark]

e Scientists tested the tammar wallaby milk peptides and found them to be 10 times more effective than antibiotics such as tetracycline and ampicillin, which are commonly used to fight human diseases. The scientists are keen to find a pharmaceutical company that will support further testing and development of these peptides with antibiotic properties.

Suggest what the scientists would hope to achieve as a result of further testing of these peptides with antibiotic properties. [1 mark]

[Total 11 marks]

134

Captain Arthur Phillip accompanied by about 1500 convicts, soldiers and civilians arrived in Sydney Cove in 1788. Within 10 years the indigenous population was reduced by 90%. Name and explain two reasons for this decrease.

Reason	Explanation

135 [VCAA 2020 SB Q10]

Measles in Samoa

Measles is one of the most contagious viruses affecting humans. Measles spreads when an infected person coughs or sneezes and the virus is breathed in by another person, or by direct contact with bodily fluids. In a susceptible population – people who have neither been vaccinated nor had measles previously – one person with measles could infect 12 to 18 other people.

The Pacific Island nation of Samoa had a significant measles outbreak in 2019. This started when a person who had measles arrived in Samoa by plane in August 2019. In the following months, over 5000 measles cases were recorded and more than 70 people died.

A measles outbreak was declared by the Samoan Government in October 2019. On 15 November the Samoan Government declared a 30-day state of emergency as the number of measles cases continued to rise and more people died. Ninety per cent of the deaths were among children less than five years old.

More than one in five Samoan babies aged six to 11 months contracted measles during this outbreak and more than one in 150 babies in this age group died. Fewer deaths occurred in babies who were less than six months old.

Prior to the measles outbreak in Samoa, the vaccination rate for measles for five-year-old children in the country had fallen to 31% in 2018. One of the responses of the government to the outbreak was a mandatory vaccination program for all people. By early December 2019 over 90% of the population had been vaccinated.

In Australia a measles-containing vaccine (MMR vaccine) is recommended for children aged 12 months of age or older. A single dose of the measles vaccine provides protection for between 95% and 98% of recipients, while two doses protect 99% of vaccinated people. In 2018 in Australia, 95% of five-year-old Australian children were fully vaccinated.

Reference: K Gibney, 'Measles in Samoa: How a small island nation found itself in the grips of an outbreak disaster', The Conversation, 12 December 2019, www.theconversation.com/au

a Is the measles outbreak discussed in the article above best described as an epidemic or a pandemic? Give your reasoning. [2 marks]

b Consider the Samoan children who were less than five years old during the measles outbreak. Of this group, what age were the children who were least likely to die from measles? Explain why children of this age would be less likely to die. [2 marks]

People who are vaccinated are unlikely to be affected by the measles virus.

c i What is the percentage difference between vaccinated five-year-old children in Samoa and Australia in 2018? [1 mark]

ii The MMR vaccine contains antigens for measles, mumps and rubella. What form of immunity is given when a person is vaccinated with the MMR vaccine? [1 mark]

iii Some children, for example those undergoing chemotherapy, cannot be vaccinated. Explain how high vaccination rates can also protect unvaccinated individuals. [2 marks]

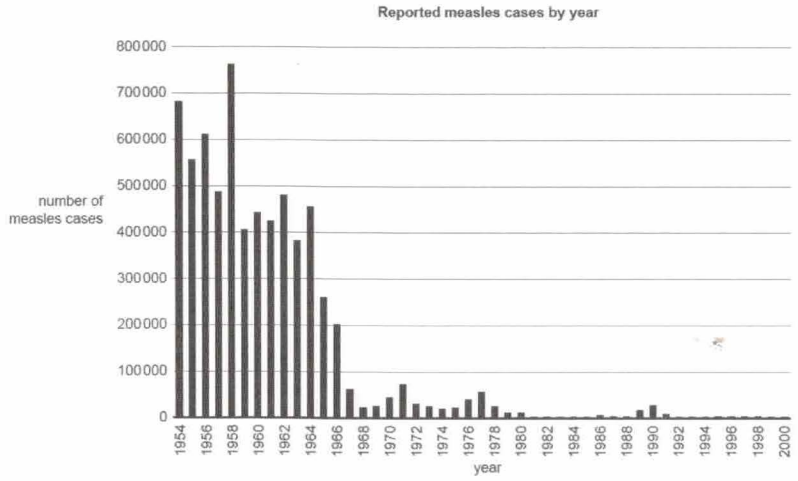
d Describe two strategies, other than vaccination, that could reduce the transmission of measles. [2 marks]

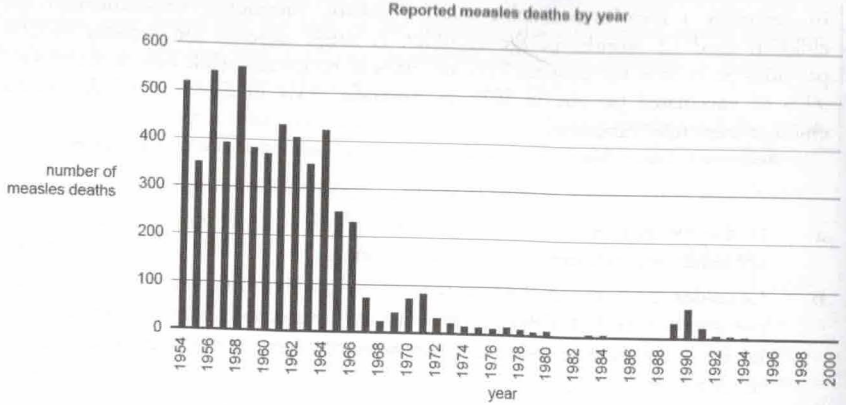
[Total 10 marks]

136 [VCAA 2018 SB Q5]

Measles is a highly infectious and dangerous disease. Young children and individuals with impaired immunity are especially susceptible to measles.

Analyse the graphs on the next page that show the number of people in the United States of America (USA) who were infected with measles during the period 1954–2000 and the number of people who died as a result of having measles during the same period.





Data: ProCon.org

a i Which year had the greatest number of reported measles cases? [1 mark]

ii What trends can be observed when the two graphs are compared? [2 marks]

b Controlling the number of measles cases in a population relies on herd immunity.

What is herd immunity and how does it help control the number of cases of this disease? [2 marks]

[Total 5 marks]

137 [VCAA 2015 SB Q4]

In 2014, an outbreak of Ebola virus disease (EVD) occurred in West Africa. Humans may contract the virus from infected animals or from an infected person.

In 2014, there was no safe and effective vaccine available to prevent EVD.

a Explain how an effective vaccine could provide long-term immunity to EVD. [4 marks]

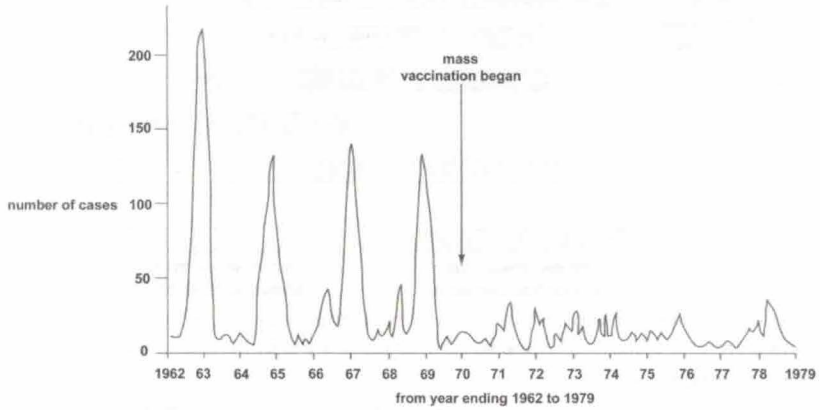
b Scientists developing new vaccines for EVD are conducting trials in animal subjects. To evaluate the effectiveness of a new vaccine, both humoral and cell-mediated responses are measured in the animal subjects.

Explain how these two immune responses are different. Give two differences in your answer. [2 marks]

[Total 6 marks]

138 [VCAA 2010 E1 SB Q8]

Measles is a highly contagious, serious disease caused by an RNA virus. There were regular epidemics of the disease until the introduction of mass vaccination. The following graph indicates the incidence of measles in Victoria from 1962 to 1979.



a What was the time period between successive epidemics? [1 mark]

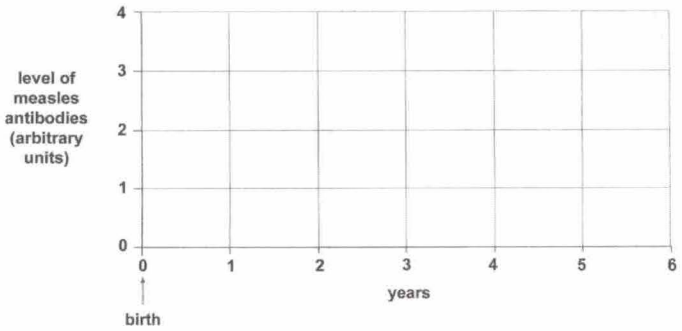
An unaffected person without immunity has a 90 per cent chance of catching the disease if they live in the same house as a person with the disease. If a child is suspected of having measles, a serum sample is taken and tested for measles-specific IgM and IgG antibodies.

b What conclusion could be made if high levels of these antibodies were found and what action would be taken? [2 marks]

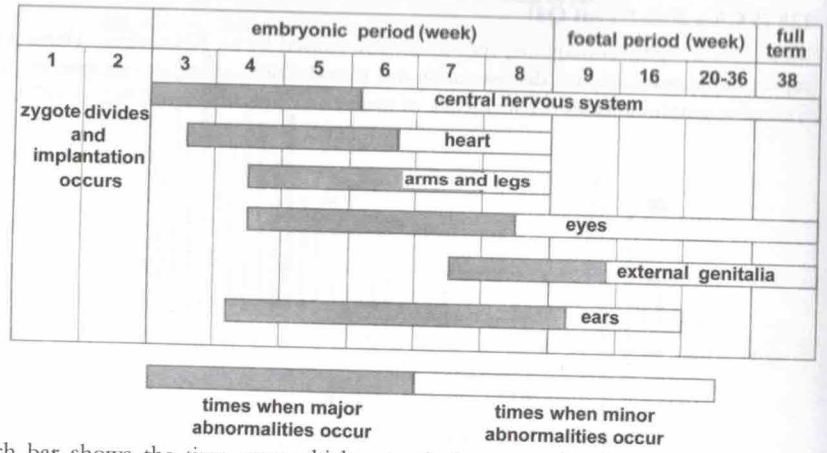
In Australia, vaccination against measles is a two-dose schedule. The first dose is generally given at age 12 months and the second dose at 4 years.

c On the grid on the next page, graph the level of measles antibodies you would expect in a vaccinated child. The child's mother is known to have had measles as a child.

[2 marks]



Rubella is a contagious viral disease. An individual may have the disease for two or more weeks before it is diagnosed. If a pregnant woman is infected with Rubella, the developing baby may develop serious defects. The diagram on the following page outlines the development of various organs of a baby in utero.



Each bar shows the time over which a particular organ develops. Two pregnant women are diagnosed with Rubella. Mrs Smith is 6 weeks pregnant, and Mrs Jones is 28 weeks pregnant.

d Which embryo or foetus is at greater risk of developing a major defect? Refer to at least two areas of development to support your answer. [2 marks]

[Total 7 marks]

139 [VCAA 2013 SB Q4]

In 1995, the Australian Bureau of Statistics released a report showing that only 53 per cent of children aged between three months and six years had completed the immunisation schedule.

a Is childhood immunisation an active or passive form of protection against a disease? Justify your answer. [2 marks]

After a major advertising campaign by the government, the immunisation rate increased to 92 per cent.

b Complete the following flow chart to show the immune response in a person receiving their first vaccination. The following words must appear in your flow chart. [3 marks]

plasma cells memory cells B cells antibodies cytokines

The first step has been completed.

Step 1

antigens detected by T-helper cells

Step 2

Step 3

Step 4

Many immunisation schedules include regular booster injections.

c Explain how these work, and why they are necessary. [2 marks]

[Total 7 marks]

140 [VCAA 2012 E1 SB Q4]

Australia is currently experiencing an epidemic of pertussis. Pertussis is a highly contagious respiratory infection caused by the bacteria *Bordetella pertussis* (whooping cough). Pertussis vaccine is offered as part of an immunisation program for children at two months, four months, six months, four years and in Year 10 of secondary school.

a i Name the cells that are responsible for the production of antibodies. [1 mark]

Two children have been immunised according to the schedule. One is two months old and the other is four months old.

ii What difference would there be in the children's levels of antibodies against *Bordetella pertussis*? [1 mark]

Consider a Year 10 student. Memory cells will have been produced during the periods of immunisation when the student was younger.

b What are two advantages of having these memory cells when the student receives their immunisation in Year 10? [2 marks]

In Victoria in the past two years, the number of cases of pertussis has increased dramatically. In 2010 there were over 6500 reported cases of pertussis; 66 per cent of these cases were adults and most of these adults had been immunised in childhood.

c i Outline a likely reason for the high percentage of adults with pertussis in 2010. [1 mark]

ii Describe one process that could be introduced by the Department of Health, Victoria, to reduce the number of adults being infected with pertussis. [1 mark]

The human immune response to antigens of *Bordetella pertussis* can be measured by the level of antibodies in the blood.

d Is this test a measure of cell-mediated immunity? Explain your answer. [1 mark]

[Total 7 marks]

141 [VCAA 2013 SB Q5]

Sufferers of autoimmune diseases produce autoantibodies.

a What role do these autoantibodies play in causing the symptoms of an autoimmune disease? [1 mark]

A teenager with a family history of an autoimmune disease underwent a genetic screen for the disease. After receiving a positive result for the genetic screen, she had an additional autoantibody test. The result of this autoantibody test was negative.

b Explain why the autoantibody test could be negative even though the genetic screen was positive. [2 marks]

[Total 3 marks]