

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

Starch is a polysaccharide.

Other polysaccharides synthesised by organisms include

- A. lactose.
- B. sucrose.
- C. glucose.
- D. glycogen.

Question 2

Anabolic reactions, also called endergonic reactions, include

- A. glycolysis.
- B. Kreb's cycle.
- C. photosynthesis.
- D. protein digestion.

Question 3

The protein chymotrypsin is derived from a parent molecule, chymotrypsinogen.

Cell organelles that are essential for the production of chymotrypsinogen include

- A. ribosomes.
- B. microtubules.
- C. cell membrane.
- D. Golgi apparatus.

Question 4

Molecules found in an animal cell membrane include

- A. chitin.
- B. cellulose.
- C. cholesterol.
- D. nucleotides.

Question 5

The formula that represents a protein is compound

- A. $C_{18}H_{32}O_2$
- B. $C_{58}H_{114}PNO_8$
- C. $C_{600}H_{1000}O_{500}$
- D. $C_{708}H_{1130}N_{180}O_{224}S_4$

Question 6

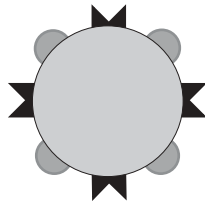
The chloroplast is the organelle responsible for photosynthesis in eukaryotic cells.

In chloroplasts





- A. the light independent reactions require water as the initial reactant.
- B. the light independent reactions occur in the inner membrane area.
- C. the final product of the light reaction is glucose.
- D. the light reactions occur in the grana.

Question 7

A disease-causing bacterium has the following structure.



The kind of antibodies most effective against this type of bacterium would be

<p>A.</p> 	<p>B.</p> 
<p>C.</p> 	<p>D.</p> 

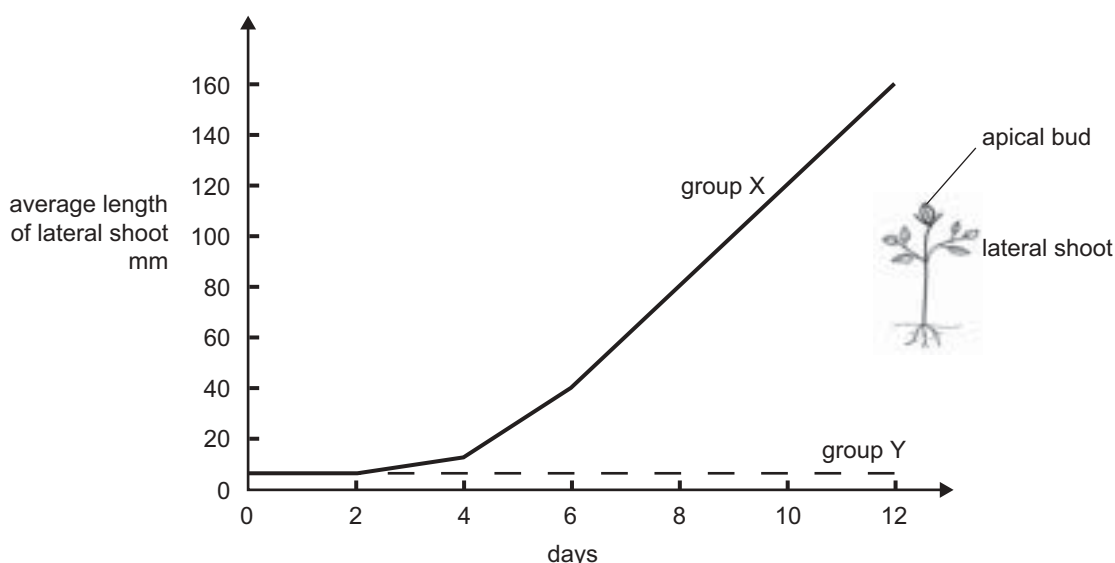
Question 8

Long-term immunity results from

- A. administration of chicken pox vaccine.
- B. the inflammatory response to a bee sting.
- C. an injection of immunoglobulin if exposed to mumps.
- D. the passage of maternal antibodies to the developing fetus.

Question 9

A student investigated the growth of lateral shoots in bean plants. Two groups of 20 plants, all identical, were used. One group (group X) had their apical buds removed, the other group (group Y) were unchanged. At various time intervals, the total lengths of the lateral shoots were measured and the average lateral shoot length calculated for each group. The result for each group is shown in the following graph.



From this data, you could reasonably conclude that

- A. group X is the control group.
- B. roots produce a substance that promotes lateral shoot growth.
- C. apical buds produce a substance that inhibits lateral shoot growth.
- D. lateral shoots produce a hormone that stimulates apical growth.

Question 10

Consider two cells (X and Y) in a reflex arc in the nervous system. Cell X is transmitting a signal to cell Y. Signal transduction commences

- A. in the cytosol of cell X.
- B. along the axon of cell X.
- C. in the myelin sheath of cell X.
- D. at the synapse between cells X and Y.

Question 11

There are 4 polypeptide chains in a human haemoglobin molecule. The monomers in a small section of each of the 4 chains is shown.

chain 1 ... leu-ser-pro-ala-asp-lys-thr-asn-val-lys ...
 chain 2 ... leu-thr-pro-glu-glu-lys-ser-ala-val-thr ...
 chain 3 ... leu-ser-pro-ala-asp-lys-thr-asn-val-lys ...
 chain 4 ... leu-thr-pro-glu-glu-lys-ser-ala-val-thr ...

Consider the sections of the chains shown.

The information given suggests that

- A. each of the chains is the result of the same DNA sequence.
- B. each total chain contains the same number of monomers.
- C. adjacent monomers are linked by a peptide bond.
- D. each monomer is specified by a nucleotide.

Question 12

In Addison's disease, the immune system attacks cells of the adrenal organs. These cells are progressively destroyed.

This form of disease could be due to

- A. T cells recognising adrenal cells as antibodies.
- B. the failure of blood complement proteins to be activated.
- C. the failure of the immune system to recognise adrenal hormones as self.
- D. the immune system failing to recognise cells of the adrenal organs as self.

Question 13

The following data represents a small section of a sequence of bases of a nucleic acid taken from an animal cell.

... G C U C G U U ...

From this data it is reasonable to assume that the seven bases

- A. would lead to the production of a chain of seven amino acids.
- B. would be complementary to the sequence C G T G C T T.
- C. must contain the sugar ribose.
- D. would be from DNA.

Question 14

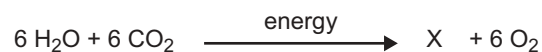
After contact with the polio virus a child developed polio and recovered. Twelve months later the child came in contact with the polio virus again but did not show any symptoms of the disease.

This happened because, shortly after the first infection, the child

- A. had an injection of polio antibodies.
- B. grew B memory cells specific to polio.
- C. grew B memory cells that could respond to any virus.
- D. developed T cells that consumed the new polio particles.

Question 15

Consider the following diagram that is a summary of an important biochemical process.

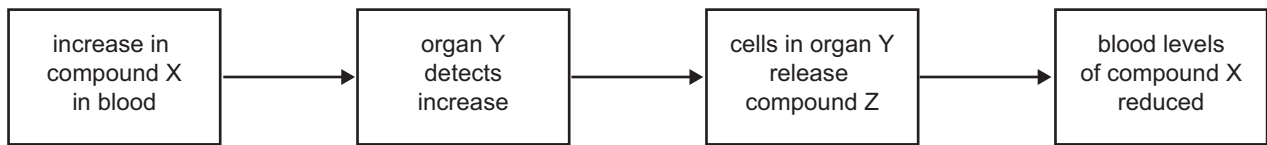


The product, X, in this biochemical process is

- A. ADP.
- B. a polymer.
- C. an amino acid.
- D. a monosaccharide.

Question 16

The following diagram is a summary of a homeostatic mechanism for compound X.



In organ Y

- A. the cells must act as exocrine glands.
- B. there must be sensors for compound X levels.
- C. compound Z must act to increase blood levels of compound X.
- D. compound X sensors and compound X effectors are part of the nervous system.

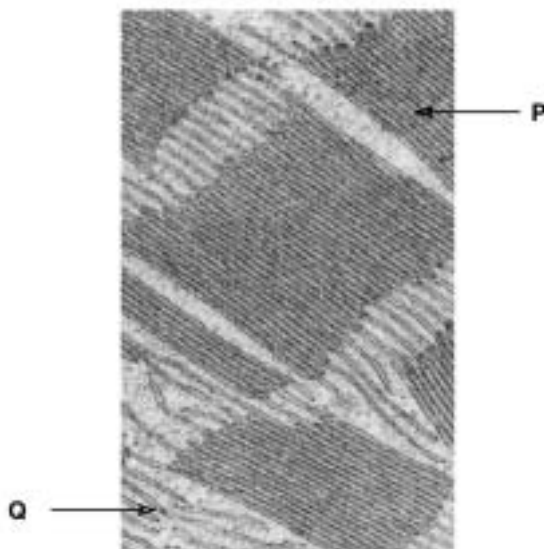
Question 17

The packaging and transport of biomolecules within a cell involves their

- A. distribution through a series of microfilaments.
- B. transport by Golgi apparatus to the endoplasmic reticulum.
- C. movement from the ribosomes into the endoplasmic reticulum.
- D. transport from the plasma membrane into the cytosol by secretory vesicles.

Question 18

The following image shows a portion of an electron photomicrograph of a chloroplast.



Light-dependent reactions occur in region P and the Calvin cycle reactions occur in region Q.

Considering events that occur in a chloroplast during photosynthesis it is reasonable to claim that

- A. oxygen is an input to reactions at P.
- B. carbon dioxide is an input to reactions at Q.
- C. chlorophyll is essential for reactions that occur at Q.
- D. ADP produced during the events at P is used by events at Q.

Question 19

Bacteria such as *Thermus aquaticus* live in hot springs where temperatures are around 90°C. The most likely reason that the bacteria are able to carry out their metabolic functions in this environment is that the bacteria

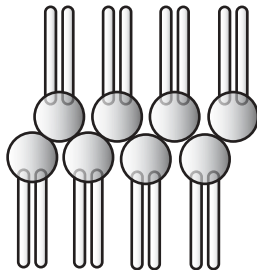
- A. have enzymes with a high optimal temperature.
- B. can lower the temperature of the cellular environment.
- C. use compounds other than enzymes to catalyse reactions.
- D. have enzymes other than proteins that do not respond to changes in temperature.

Question 20

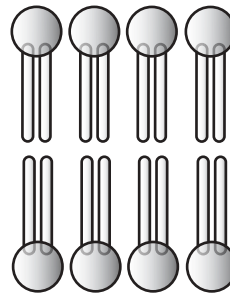
Phospholipids are built from lipids and phosphate. They are found in plasma membranes.

The diagram that most closely resembles the arrangement of phospholipids in a plasma membrane is

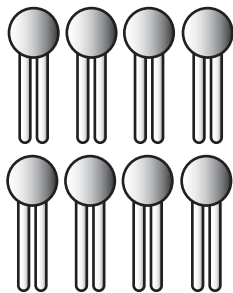
A.



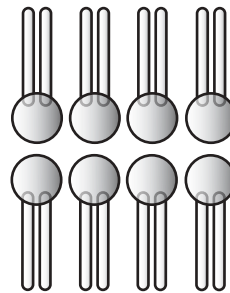
B.



C.



D.

**Question 21**

Pheromones are

- A. hormones found only in plants.
- B. used to repel pest insects from crops.
- C. effective only over very short distances.
- D. chemicals that often act as sex attractants.

Question 22

Each individual contains millions of different kinds of B cells that produce different kinds of antibodies.

This diversity of B cells is due to the

- A. rearrangement of gene segments.
- B. splicing of protein molecules.
- C. action of cytotoxic T cells.
- D. interferon proteins.

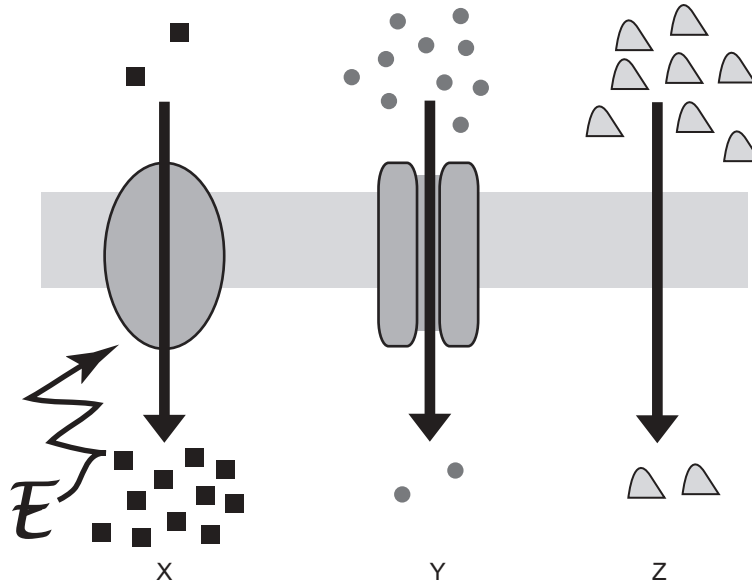
Question 23

The lymphatic system

- A. has no valves.
- B. contains red blood cells.
- C. contains white blood cells.
- D. contains fluid that flows in both directions.

Question 24

Three types of movement across a plasma membrane are shown at X, Y and Z.



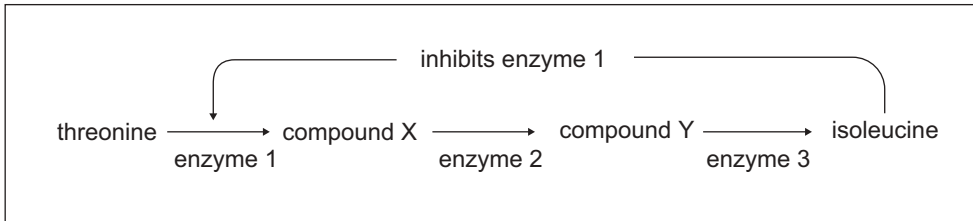
The three types of movement are correctly described as

	X	Y	Z
A.	active transport	diffusion	facilitated diffusion
B.	active transport	facilitated diffusion	diffusion
C.	facilitated diffusion	active transport	diffusion
D.	diffusion	active transport	facilitated diffusion

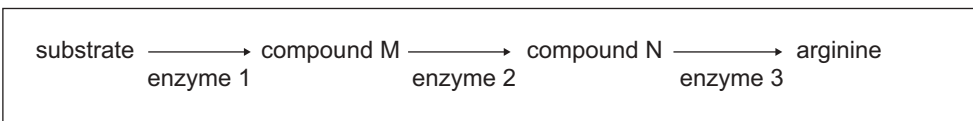
Question 25

In the production of isoleucine from threonine in bacteria (Biochemical Pathway 1 [**BP 1**]), the end product acts as an inhibitor of the first enzyme in the pathway. In the production of arginine (Biochemical Pathway 2 [**BP 2**]), the end product has no influence on other enzymes in the pathway.

Biochemical Pathway 1 (BP 1)



Biochemical Pathway 2 (BP 2)



It is reasonable to conclude that in

- A. BP 1, if the production of enzyme 3 stops there would be continuous production of isoleucine.
- B. BP 2, if the production of enzyme 3 stops there would be continuous production of arginine.
- C. BP 1, providing all enzymes are present, the production of isoleucine would be continuous if there was a continuous supply of threonine.
- D. BP 2, providing all enzymes are present, the production of arginine would be continuous if there was a continuous supply of substrate.

SECTION B – Short-answer questions**Instructions for Section B**

Answer this section in **pen**.

Answer all questions in the spaces provided.

Question 1

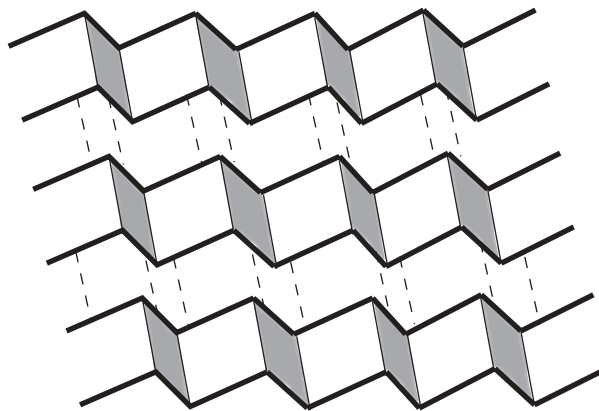
Scientists are now turning to the study of the proteome (all of the proteins) of an organism rather than the study of single proteins.

- a. Briefly outline **one** reason why the emphasis is now on the study of all the proteins of an organism rather than on one protein at a time.

1 mark

Protein molecules come in many shapes and forms that can be classified into primary, secondary, tertiary and quaternary. The secondary, tertiary and quaternary shapes arise as a result of different kinds of folding of a primary structure.

One kind of secondary structure is a pleated sheet where the primary molecule extends along the folded sheet. The primary structures in the layers are held together by hydrogen bonding.



- b. Explain why such a structure may be important in the function of a particular protein.

1 mark

Proteins can also be classified on the basis of their general function. Three of these functions are shown in the table below.

- c. Complete the table by giving an example of a protein for each of the functions listed.

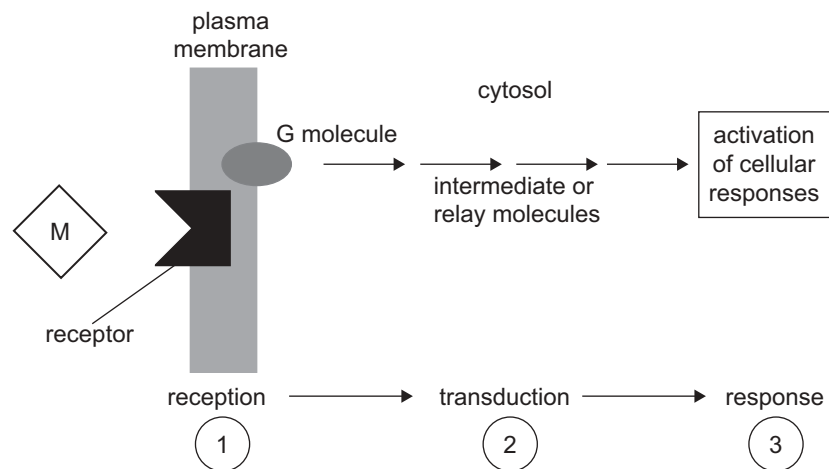
Function of protein	Example
structural	
transport	
regulatory	

3 marks

Total 5 marks

Question 2

A general signal transduction pathway is shown in the following figure. Some of the parts of the pathway are labelled.



- a. **M** represents a compound which could initiate signal transduction. Give an example of compound **M**.

1 mark

- b. The initiation of signal transduction in a cell is controlled and specific. Explain what feature ensures this specificity.

1 mark

- c. What type of molecules generally act as intermediate or relay molecules?

1 mark

- d. Name a response in the cell which may occur after signal transduction initiated by the compound **M** you have named in **part a**.

1 mark

Total 4 marks

SECTION B – continued
TURN OVER

Question 4

2,4-dinitrophenol is a chemical that is toxic to mitochondria. When added to mitochondria this chemical allows electron transport to occur but prevents the phosphorylation of ADP to ATP. The chemical achieves this by breaking the essential link between electron transport and ATP synthesis. This toxin causes mitochondria to produce heat instead of ATP. The greater the amount of toxin added, the quicker is its action.

- a. If mitochondria are poisoned with 2,4-dinitrophenol by what process could a plant cell produce more ATP?

1 mark

- b. Where in the mitochondria does electron transport and ATP production occur?

1 mark

A researcher wanted to study cellular respiration in insect cells. She cultured some muscle cells from the common field cricket, *Teleogryllus oceanicus*, then studied the effects of adding 2,4-dinitrophenol to these cells. An agricultural company may want to fund this research.

- c. Give one reason why an agricultural company might want to fund research on the effects of this toxin on field crickets.

1 mark

The experiment is summarised in the table below. Temperature observations in each trial were made at equal time intervals.

Observations made at equal time intervals	Temperature °C		
	control (no 2,4-dinitrophenol)	trial 1 (2,4-dinitrophenol added)	trial 2
1 (start)	28	28	28
2	27	28	29
3	28	29	
4	29	31	
5	28	36	
6	28	23	
7	27	21	

- d. In terms of energy production, why did the temperature go up in trial 1 and not in the control?

1 mark

- e. Explain why the temperature went down after the fifth observation in trial 1.

1 mark

- f. Trial 2 had twice the concentration of 2,4-dinitrophenol added. Complete the table by writing in temperatures in the spaces provided to predict the trend.

2 marks

Another researcher suggested adding pyruvate to the cells to cancel out the effects of this toxin.

- g. Explain what effect adding pyruvate would have on cancelling out the effect of this toxin.

1 mark

Total 8 marks

Question 5

Examine the following table.

Summary carbon dioxide and oxygen levels in air and water

Chemical	Solubility in water	Concentration in air
Oxygen	poor	~20.0%
Carbon dioxide	high	0.03%

The respiratory gases, oxygen and carbon dioxide, are under homeostatic control. The gas in shorter supply is normally regulated because it is the limiting factor. For instance, aquatic organisms, like fish, regulate levels of oxygen. Terrestrial organisms, like mammals, regulate levels of carbon dioxide.

A build-up of carbon dioxide in the blood can cause the pH of the blood to become acidic. Mammals are more susceptible to this build-up of carbon dioxide than fish. Receptors in the brain and arteries detect such changes in carbon dioxide and pH and stimulate ongoing breathing.

- a. Why are mammals more susceptible to a build-up of carbon dioxide than fish?

1 mark

- b. Consider a mammal that experiences an increase in its blood pH. Name one effector and suggest what its response would be?

2 marks

Hyperventilation is the practice of breathing deeply and rapidly to remove carbon dioxide from the lungs. This results in a significant lowering of the amount of carbon dioxide in the blood. It is extremely dangerous and can cause a person to become unconscious.

- c. Explain why underwater pearl divers, who use no special diving apparatus, would hyperventilate.

1 mark

- d. Why does hyperventilating cause a person to become unconscious?

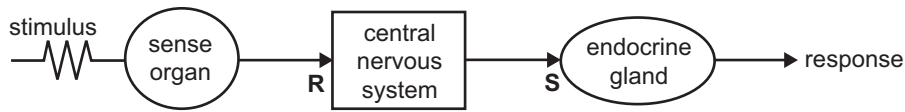
1 mark

Total 5 marks

Question 6

A number of different kinds of signals are responsible for the coordination and regulation of systems in humans.

Consider the following model of one of these systems.



Two different kinds of signalling molecules operate at points R and S in this system.

- a. For each point, name the kind of signalling molecule that would act and the kind of cell that produced the signalling molecule. Write your answer in the following table.

point R	Signalling molecule	
	Type of cell producing the molecule	
point S	Signalling molecule	
	Type of cell producing the molecule	

4 marks

In many nervous control systems, a large network of cells is involved. Some of the signals delivered by these cells may inhibit further action while some promote an action.

- b. Explain why such an arrangement is beneficial to a control system.

2 marks

Total 6 marks

Question 7

Plants and animals are both susceptible to infection.

- a. i. Name one feature of plants that inhibits the entry of infective organisms.

- ii. Name one feature of humans that inhibits the entry of infective organisms.

1 + 1 = 2 marks

Assume that infection has occurred in a plant.

- b. Outline one way in which a plant responds to minimise damage to its tissues.

1 mark

Assume that infection has occurred in a human.

- c. Outline two general features of inflammation that minimise the impact of the infection.

Feature 1 _____

Feature 2 _____

2 marks

- d. Explain how cells of the immune system determine self from non-self molecules.

1 mark

- e. What substance does the body normally produce in response to an antigen?

1 mark

Many people have an adverse reaction to a particular kind of food or other material. The material causing the reaction is called an allergen and the reaction is called an allergic response.

- f. Explain the relationship between an allergen, mast cells and histamines.

2 marks

Total 9 marks

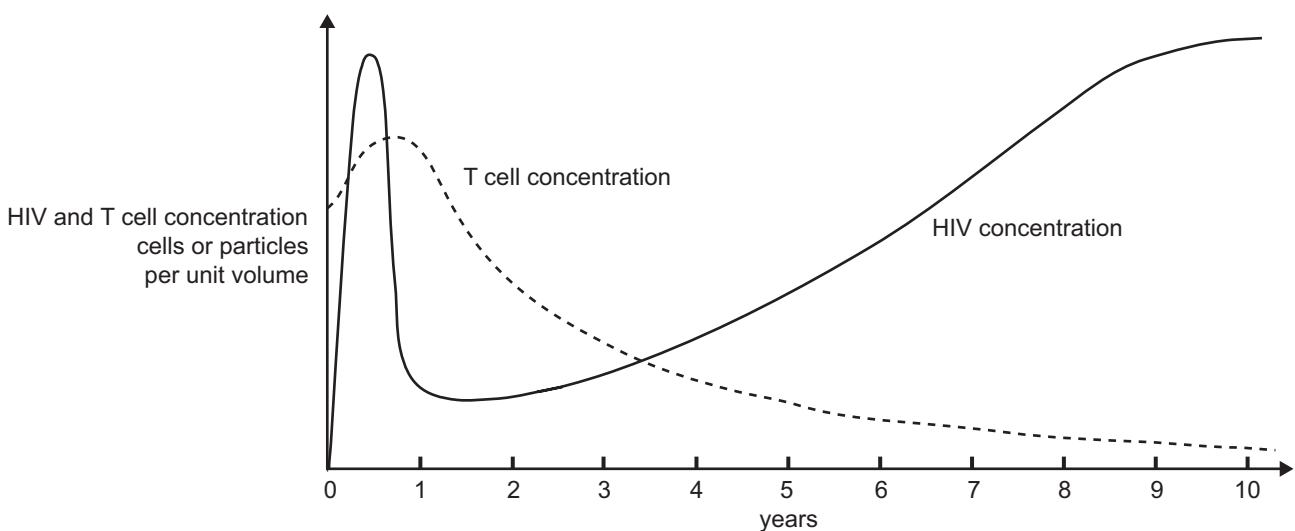
Question 8

The disease AIDS is the result of infection by the human immunodeficiency virus (HIV), a retrovirus which has RNA as its genetic material.

- a. RNA is a nucleic acid, which is described as a polymer composed of a series of monomers. Draw a labelled diagram of a monomer of RNA.

2 marks

A person infected with the HIV virus was monitored for several years for the level of T cells and HIV particles. The results are summarised in the following graph.



- b. Explain what is happening in the first year after infection with the HIV virus.

1 mark

- c. In the second to fifth years (inclusive) after infection the patient has swollen lymph nodes. Explain.

1 mark

- d.** Nine years after infection, describe what has happened to the immune system of the patient.

1 mark

- e.** During its cycle in a cell the virus undergoes many changes in its genetic material. This has made treatment very difficult. Currently a mixture of drugs which target different stages of the viral cycle are used. Why has this treatment been more successful than treatment with only one drug?

1 mark

Total 6 marks