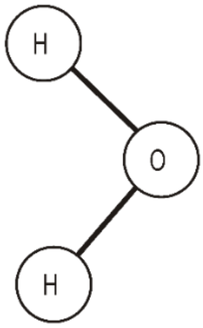
AQA AS Biology

3.1 Biological Molecules

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective, and use the revision notes to fill in any gaps

1. The figure below represents a water molecule.



Water molecules are polar. As a result, they attract each other.

Draw a second water molecule on the figure above.

Your drawing should show:

- The bond(s) between the two molecules
- The name of the bond
- The charges on each atom.

[Total 3 marks]

2. Ponds provide a very stable environment for aquatic organisms. Three properties of water that contribute to this stability are as follows:

- The density of water decreases as the temperature falls below 4°C, so ice floats on the top of the pond.
- It acts as a solvent for ions such as nitrates (NO3–).
- A large quantity of energy is required to raise the temperature of water by 1°C.

Explain how these three properties help organisms survive in the pond.

In your answer you should make clear the links between the behaviour of the water molecules and the survival of the organisms.

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[Total 8 marks]

3. Water is important in many biological reactions.

Complete the table below by writing an appropriate term next to each description.

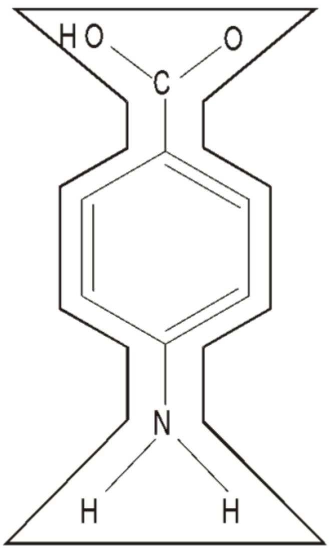
Description	Term
The type of reaction that occurs when water is added to break a bond in a molecule.	
The phosphate group of a phospholipid that readily attracts water molecules.	

[Total 2 marks]

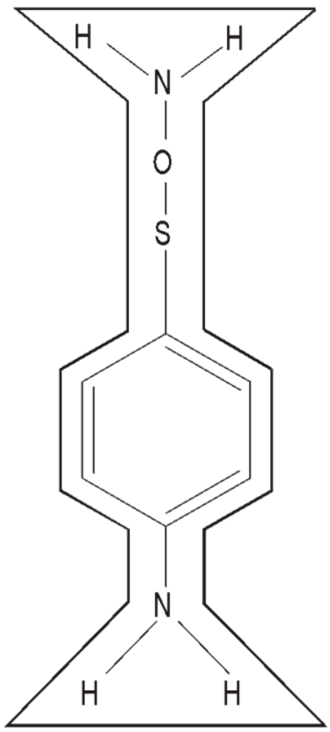
4. The enzyme DHPS is involved in the production of folic acid in bacteria.

- The substrate for DHPS is a molecule known as PABA.
- The enzyme DHPS is inhibited by the drug sulfonamide.

The figure below shows the structure of PABA and that of sulfonamide.

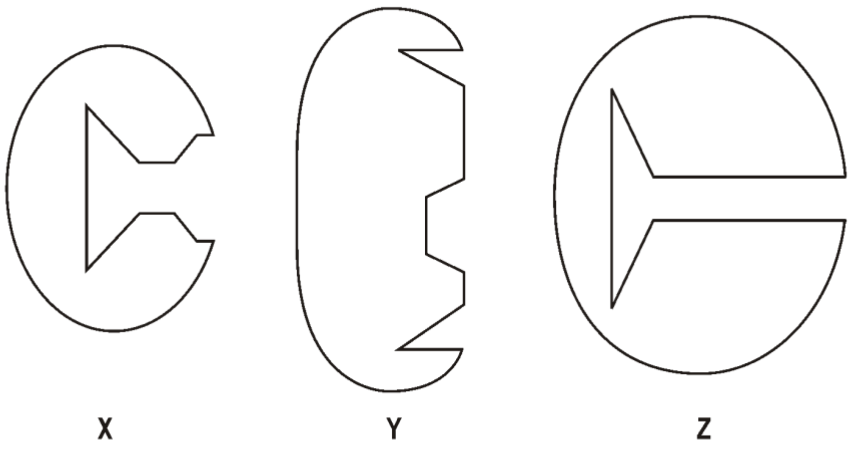


PABA



sulfonamide

(i) Diagrams X, Y and Z represent these enzyme molecules and their active sites.



State the letter, X, Y or Z, that most accurately represents the enzyme DHPS.

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[1]

(ii) Using the information in the figure above, explain why sulfonamide acts as a competitive inhibitor of DHPS.

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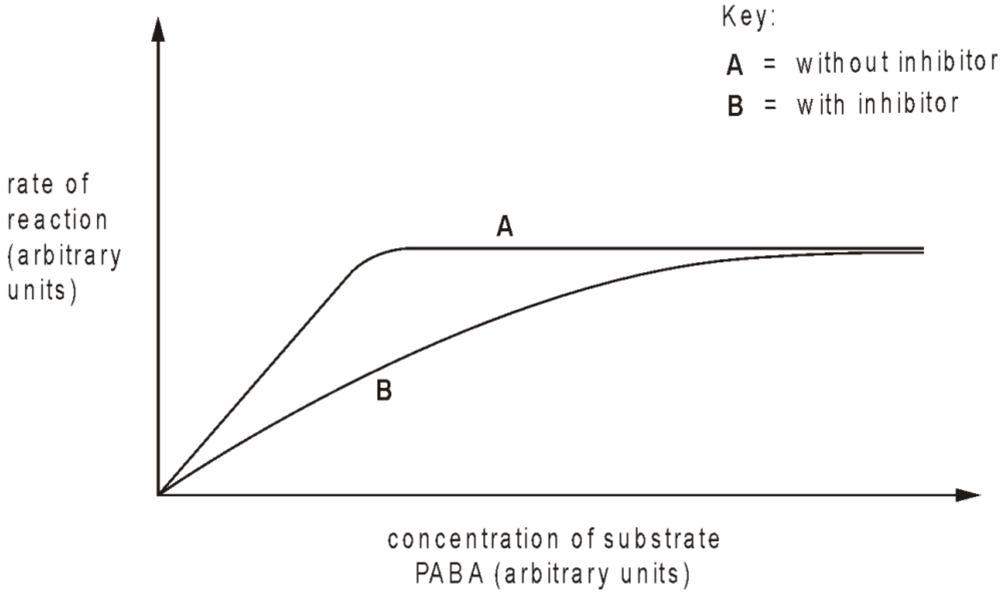
[3]

[Total 4 marks]

5. The figure below shows the effect of increasing the concentration of the substrate (PABA) on the rate of reaction.

- Curve A shows the rate of reaction without the presence of the competitive inhibitor sulfonamide.
- Curve B shows the rate of reaction in the presence of the competitive inhibitor sulfonamide.



Explain the effect of increasing the concentration of substrate on the rate of reaction;

(i) Without inhibitor,

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[3]

(ii) With inhibitor.

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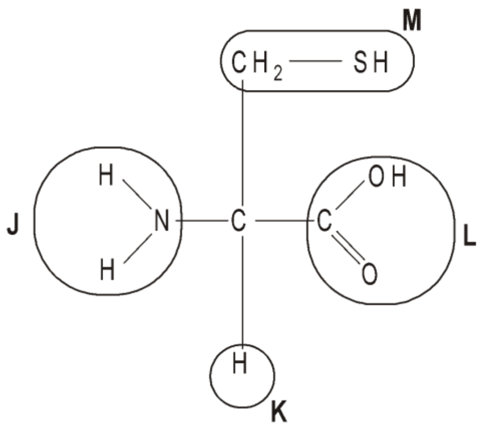
[2]

[Total 5 marks]

6. (a) Amino acids are the basic building blocks for proteins. The figure below shows the amino acid cysteine.



(i) Complete the table by selecting the letter, J, K, L or M, that represents the following groups in cysteine.

Group	**Letter**
Carboxyl	
R group	
Amine group	

[3]

(ii) The primary structure of a protein consists of a chain of amino acids.

Describe how a second amino acid would bond to cysteine in forming the primary structure of a protein.

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[3]

(b) Each amino acid has a different R group.

Describe how these R groups can interact to determine the tertiary structure of a protein.

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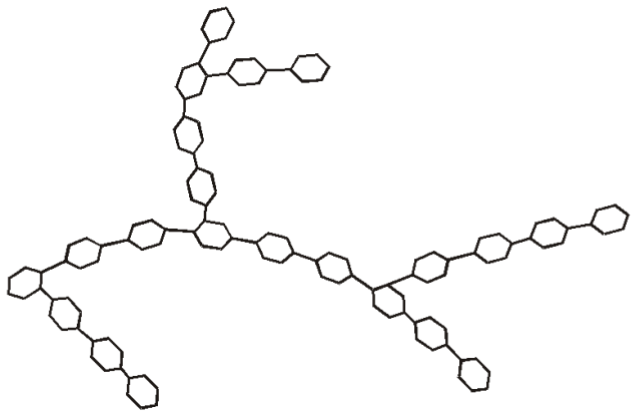
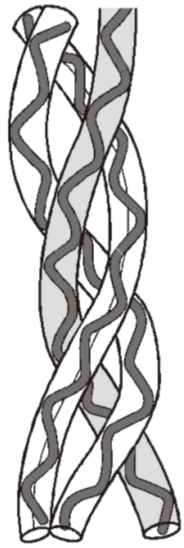
[4]

[Total 10 marks]

7. The figure below shows the structure of two polymers, glycogen and collagen, that are found in mammals.



glycogen



collagen

(i) Complete the table below to give three differences between the structure of glycogen and collagen.

Glycogen	Collagen

[3]

(iii) Collagen is found in the ligaments which hold bones together at joints. State two properties of collagen that make it suitable for this purpose.

1 ....

2 ....

[2]

[Total 5 marks]

8. DNA and RNA are nucleic acids.

(i) State the components of a DNA nucleotide.

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[3]

(ii) Describe how the structure of RNA differs from that of DNA.

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[2]

[Total 5 marks]

9. Before a cell divides, the DNA needs to be accurately replicated.

Describe how a DNA molecule is replicated.

In your answer you should make clear how the steps in the process are sequenced.

[Total 7 marks]

10. (i) State what a gene codes for.

....

....

....

[1]

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for.

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....

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[2]

[Total 3 marks]

11. Complete the following passage by using the most appropriate terms from the list to fill the gaps.

Each term should not be used more than once.

anti-parallel	β-pleated sheet	covalent
double helix	hydrogen	parallel
polypeptide	ribose	sugar-phosphate

DNA is found in the nucleus. The molecule is twisted into a ....

.... in which each of the strands are .... It

has two .... backbones attached to one another by

complementary bases. These bases pair in the centre of the molecule by means of

.... bonds.

[Total 4 marks]

12. The table below shows the relative proportions of different DNA bases in four different organisms.

Relative proportions of bases in DNA as a percentage				
Organism	**A**	**C**	**G**	**T**
Human	30.9	19.8	19.9	29.4
Grasshopper	29.3	20.7	20.5	29.3
Wheat	27.3	22.8	22.7	27.1
E. coli	24.7	25.7	26.0	23.6

(i) Describe the patterns shown by the data given in the table above.

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[3]

(ii) Suggest how the data given in the table above might have been helpful to scientists in working out the structure of DNA.

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[2]

[Total 5 marks]

13. DNA in the nucleus acts as a template for the production of RNA.

Complete the table below to show three ways in which the structure of DNA differs from that of RNA.

Feature	**DNA**	**RNA**
Number of strands		
Bases present		
Sugar present		

[Total 3 marks]

14. DNA codes for the structure of polypeptides.

State the role of messenger RNA (mRNA).

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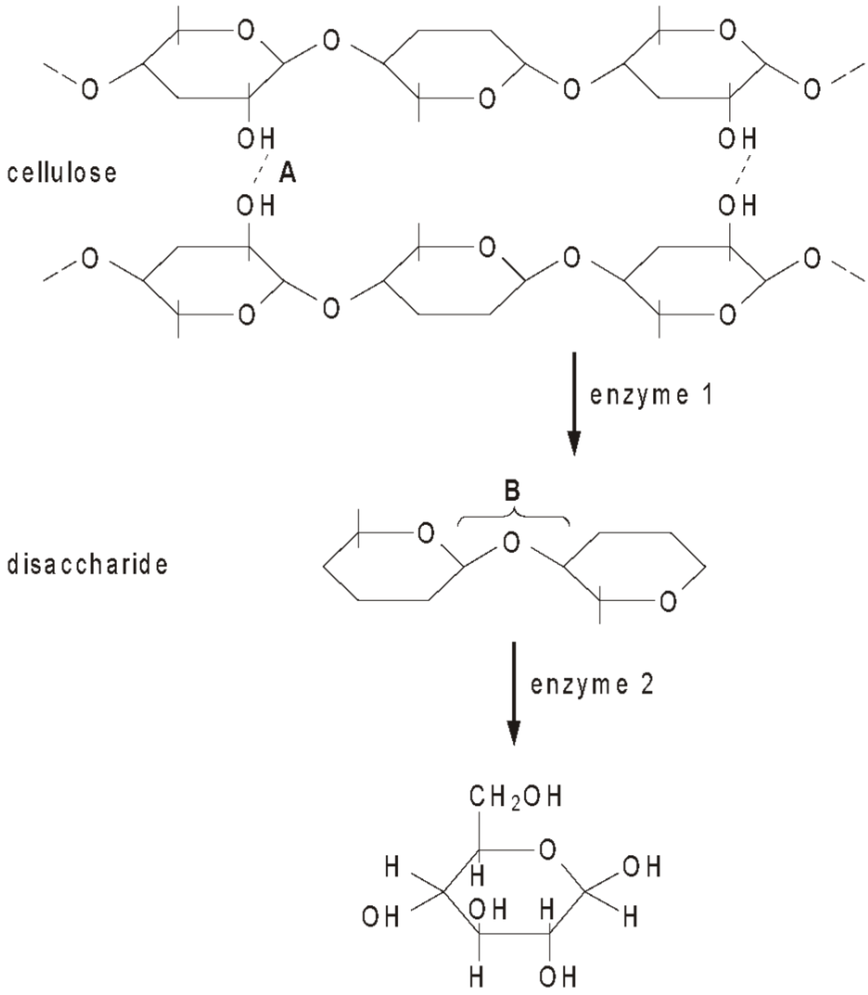
[Total 2 marks]

15. In the search for new biofuels, research has been done into the digestion of wood waste by fungi.

The cellulase enzymes produced by the fungi break cellulose into sugars. These sugars can then be converted into ethanol, a biofuel.

The figure below shows the stages in this digestion process.



(a) (i) Name bonds **A** and **B** shown in the figure.

A ....

B ....

[2]

(ii) State how bond **B** is broken in the digestion of the disaccharide.

....

....

[1]

(iii) Name the sugar that is the final product of this digestion process.

....

[1]

(b) Explain why different enzymes are involved in each stage of the digestion process.

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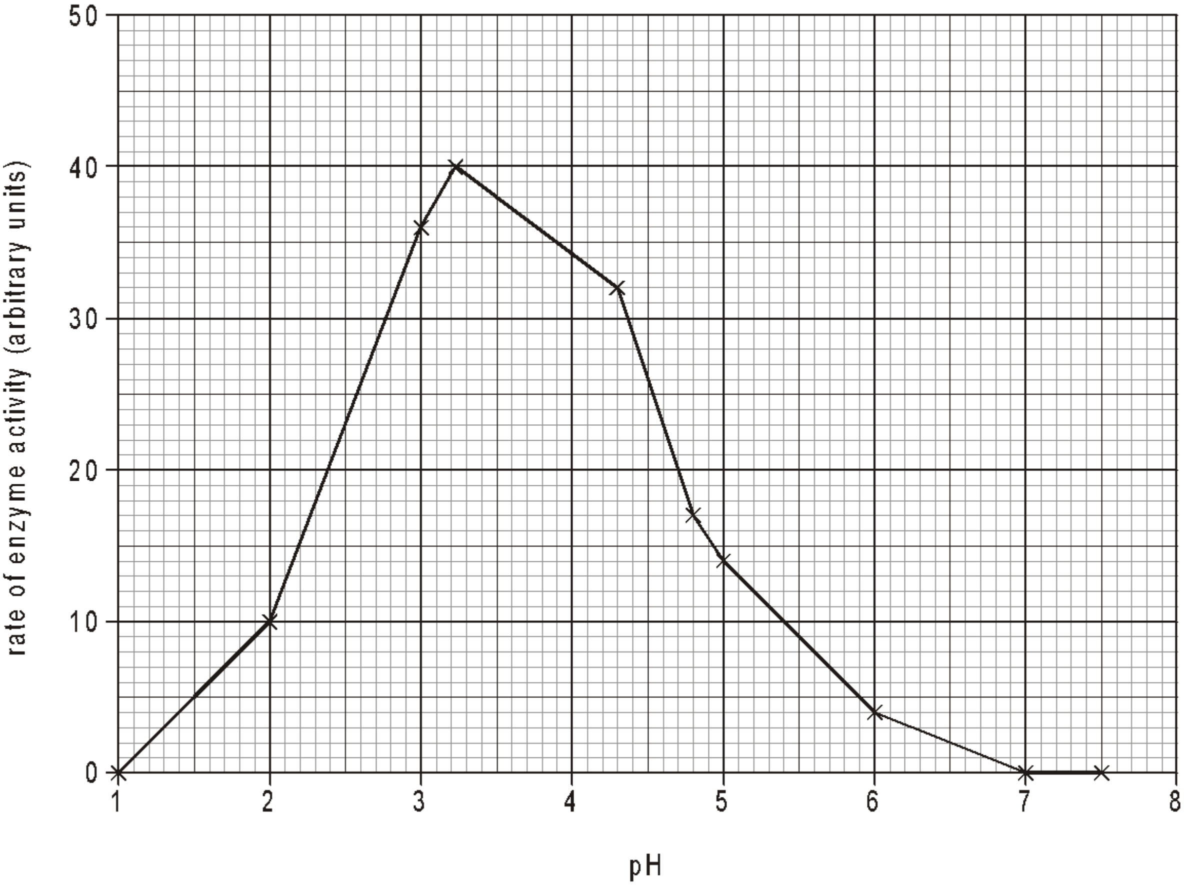
[3]

16. The figure below shows the effect of changing pH on the rate of activity of enzyme 2.



(i) Explain why the activity of enzyme 2 falls to zero at pH 7.

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[3]

(ii) State two factors that should have been controlled when investigating the effect of pH on the activity of enzyme 2.

1 ....

2 ....

[2]

[Total 12 marks]

17. The activity of an enzyme can be measured by testing for the concentration of its product at regular intervals.

Describe how the concentration of a reducing sugar can be measured using a colorimeter.

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[Total 6 marks]

18. Some species of Acacia tree produce gum arabic. Gum arabic is classed as a heteropolysaccharide. This means that it is made up of a number of different sugars.

Hydrolysis of gum arabic releases four different monosaccharides.

Describe what happens during the hydrolysis of a polysaccharide molecule.

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[Total 2 marks]

19. Complete the table below, comparing gum arabic with some other polysaccharides.

	Gum arabic	**Amylase**	**Cellulose**	**Glycogen**
Branched structure	yes		no	
Heteropolysaccharide	yes		no	
Found in animals/plants	plants		plants	
Function in organism	healing cuts			energy store

[Total 4 marks]

20. *Acacia senegal* is a species of tree which is common in the drier parts of Africa. Cattle are allowed to graze on both its leaves and the fallen seed pods. The seed pods have relatively high protein content.

(i) Describe how you would test an extract of the seed pods for protein.

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[2]

(ii) Describe how you could compare the reducing sugar content of the leaves with that of the seed pods.

In your answer you should make clear how the steps in the process are sequenced.

[8]

(iii) The seeds of Acacia species are sometimes eaten by people.

Suggest why it might be better for people living in areas where the tree grows to let their cattle feed on the trees and fallen seed pods and then obtain their nutrition from the cattle.

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[3]

[Total 13 marks]

21. DNA and RNA are nucleic acids.

(i) Describe the structure of a DNA nucleotide.

In your answer you should spell the names of the molecules correctly.

You may use the space below to draw a diagram if it will help your description.

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[3]

(ii) Describe how the two nucleotide chains in DNA are bonded together.

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[4]

[Total 7 marks]

22. State three ways in which the structure of DNA differs from that of RNA.

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3 ....

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[Total 3 marks]

23. The fungus, yeast, contains the enzyme catalase.

Catalase speeds up the decomposition of hydrogen peroxide, a toxic metabolic product, to oxygen and water.

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

A student decided to investigate the activity of catalase using the apparatus shown in Fig. 1.

The total volume of gas collected was recorded every 20 seconds.

The results are shown in Fig. 2.

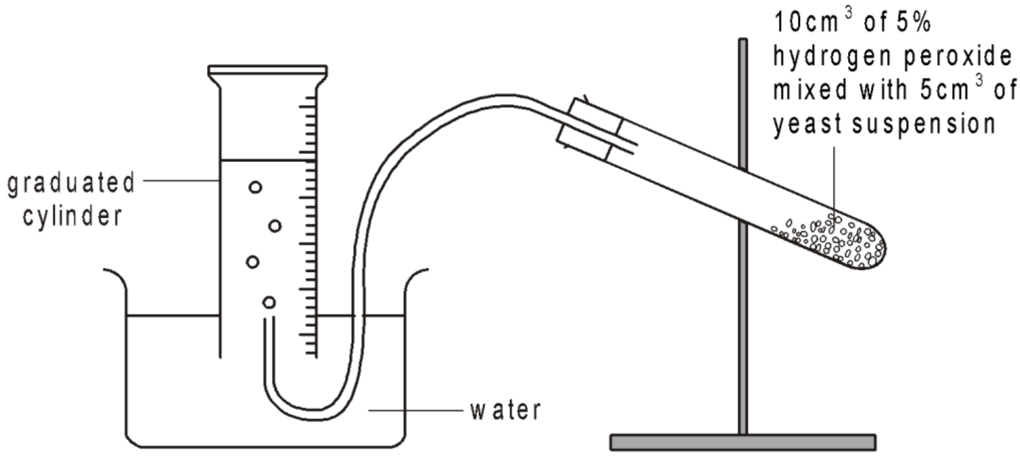

Fig. 1

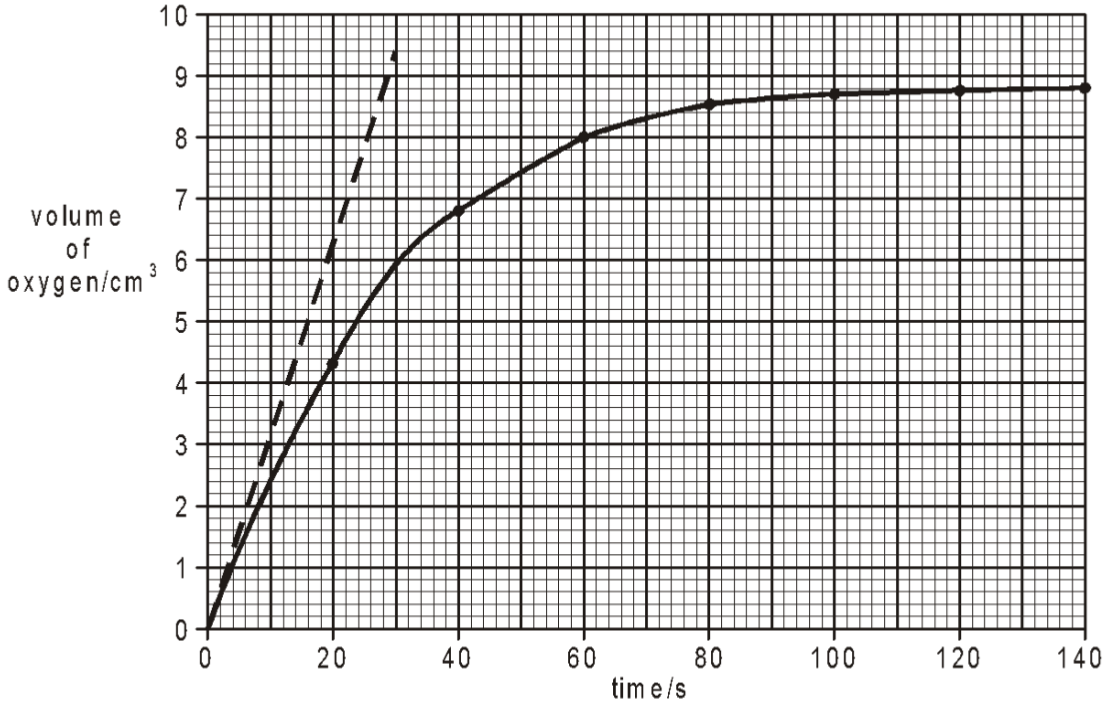

Fig. 2

The rate of decomposition can be calculated using the formula:

$$\text{rate of decomposition} = \frac{\text{volume of oxygen collected}}{\text{time taken for collection}}$$

(a) Calculate the rate of decomposition over the first 30 seconds.

Show your working and give your answer in cm3 min–1.

......................................cm3 min–1

[2]

(b) The initial rate of decomposition is the rate measured within the first few seconds. Using the dashed line in Fig. 2, the initial rate of decomposition is calculated to be 19 cm3 min–1.

Explain why the initial rate of reaction is greater than the rate you calculated in (a).

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[3]

[Total 5 marks]

24. Fungi such as *Fusarium venenatum* are grown in huge batch cultures to manufacture protein for food products.

Explain why these cultures are often maintained at the optimum temperature for protein production and not at a temperature above the optimum.

In your answer you should make clear how the structure and activity of enzymes relates to the effects described.

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[Total 8 marks]

25. ‘Health – Milk’ and ‘Energy – Boost’ are flavoured milk drinks.

The manufacturers make the following claims:

‘HEALTH – MILK’

Flavoured with real fruit extract.

No added sugar.

‘ENERGY – BOOST’

A delicious milk drink – packed full of energy.

Convenient, quick and easy.

The two different flavoured milk drinks and a sample of fresh milk were all tested for the presence of some biological molecules.

The methods used and the results obtained are shown in the table below.

Colour change observed for			
Method used	**Fresh milk**	**'Health – Milk'**	**'Energy – Boost'**
A few drops of iodine solution added	remains yellow	remains yellow	remains yellow
5 cm3 biuret solution added	blue to lilac	blue to lilac	blue to lilac
5 cm3 Benedict's reagent added and solution boiled	blue to green	blue to green to yellow	blue to green to yellow to orange
• Sample that has been tested with Benedict's reagent is filtered. • The filtrate (solution) is boiled with 5 cm3 dilute acid, cooled and neutralised. • Then 5 cm3 Benedict's reagent is added and the solution is boiled.	remains blue	blue to green to yellow to orange	blue to green to yellow to orange to red

(a) Using only the information in the table, state the biological molecules present in:

(i) Fresh milk;

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....

[2]

(ii) 'Health – Milk'.

....

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[3]

(b) What differences between 'Health – Milk' and 'Energy – Boost' are identified by the information in the table?

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[2]

(c) Explain why the claims made by the manufacturer for 'Health – Milk' could be misleading.

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[3]

(d) Suggest why it would not be appropriate to test milk for lipids using the emulsion test.

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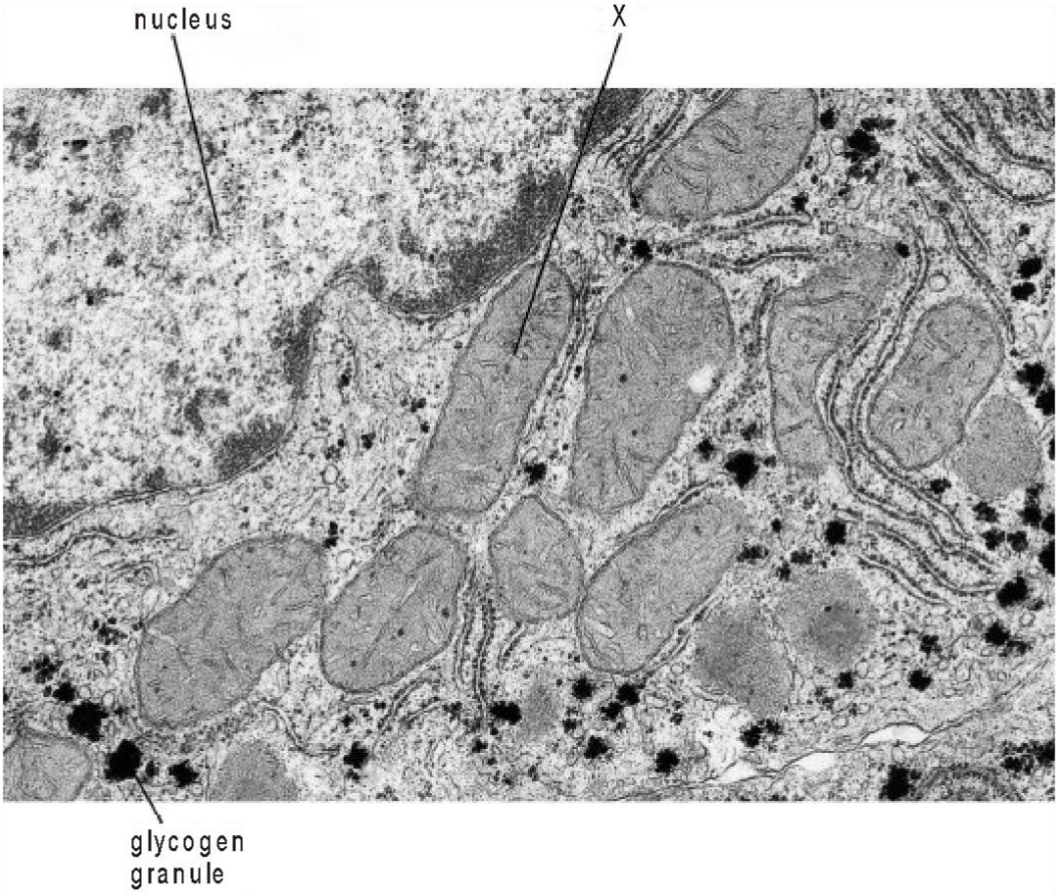
[1]

[Total 11 marks]

26. The diagram below is an electron micrograph of part of a cell from a human liver.

This cell is responsible for converting glucose in the body into glycogen for storage. The glycogen can be seen as granules in the cytoplasm.



(i) Describe the molecular structure of glycogen.

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[4]

(ii) Name the type of chemical reaction that takes place during the formation of glycogen.

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[1]

[Total 5 marks]

27. The formation of glycogen is one of many enzyme-controlled reactions carried out by liver cells in humans. The liver is a very active organ and generates a lot of heat. The temperature must not be allowed to increase too much as it will affect the rate at which glucose is converted into glycogen.

(i) Suggest the optimum temperature for these enzyme-controlled reactions.

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[1]

(ii) A significant increase in temperature above the optimum has an effect on the rate of an enzyme-controlled reaction.

Explain why this is so.

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[4]

[Total 5 marks]

28. The following statements, **A** to **H**, refer to events that may take place during:

- DNA replication only
- Transcription only
- Both DNA replication and transcription
- Neither DNA replication, nor transcription.

Complete the table by marking the appropriate boxes with a tick (✓) if the event takes place or a cross (✗) if it does not take place.

		DNA replication	Transcription
A	Nucleotides line up along an exposed DNA strand.		
B	The whole of the double helix 'unzips'.		
C	Uracil pairs with adenine.		
D	A tRNA triplet pairs with an exposed codon.		
E	Both DNA polynucleotide chains act as templates.		
F	Adjacent nucleotides bond, forming a sugar-phosphate backbone.		
G	The original DNA molecule is unchanged after the process.		
H	Adenine pairs with thymine.		

[Total 8 marks]

29. In order to reproduce asexually, Plasmodium needs to obtain amino acids from red blood cells of its host.

Suggest how Plasmodium obtains amino acids from haemoglobin within red blood cells.

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[Total 3 marks]

30. The table below shows six statements that apply to biochemical tests.

Complete the table to show which of these statements apply to the biochemical tests carried out on the substances listed.

Fill in each box using a tick (✓) to show that the statement applies or a cross (✗) if it does not. The first row has been completed for you.

	statement					
Substance	**Use heat**	**Use biuret reagent**	**Use Benedict's reagent**	**Boil with a dilute acid**	**A positive result is a blue-black colour**	**A positive result is an emulsion**
Lipid	✗	✗	✗	✗	✗	✓
Protein						
Starch						
Reducing sugar						
Non-reducing sugar						

[Total 4 marks]

31. A sucrose molecule is a carbohydrate molecule made by joining a glucose unit to a fructose unit.

(i) Name the bond that joins the units in a molecule of sucrose.

....

[1]

(ii) Name the type of reaction that breaks this bond.

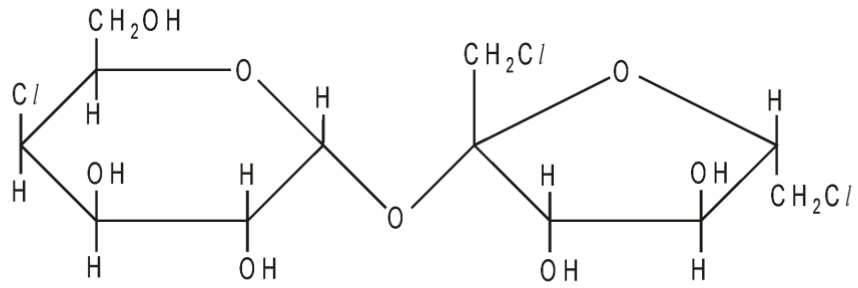
....

[1]

[Total 2 marks]

32. Sucralose is a chemical that is similar in structure to sucrose. It has been made from sucrose by replacing three of the OH (hydroxyl) groups with Cl (chlorine) atoms.

The diagram below shows a molecule of sucralose.



The following claim is made for sucralose:

Sucralose has the same sweet taste as sucrose. It cannot be digested by enzyme action in the human body and so it does not lead to weight increase.

Using the information in the diagram to help you, suggest why sucralose cannot be digested in the body.

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[Total 4 marks]

33. In this question, one mark is available for the quality of spelling, punctuation and grammar.

The immense biodiversity of the oceans includes:

- Corals that host symbiotic algae, which die if the sea temperature rises by 1°C;
- Animals, like polar bears, that use floating ice as a base for sea fishing expeditions;
- Sessile animals, like mussels, that feed by filtering food particles from the water and reproduce by releasing gametes into the water;
- Reef-building animals, like corals, that form hard calcium carbonate skeletons by extracting mineral ions such as Ca2+ from the water;
- Seaweeds of different colours, which occur in shallow water;
- Animals, like fish, that hunt prey using well-developed visual skills;
- Large animals such as the blue whale;
- Physically delicate organisms, like jellyfish, that lose their shape in air.

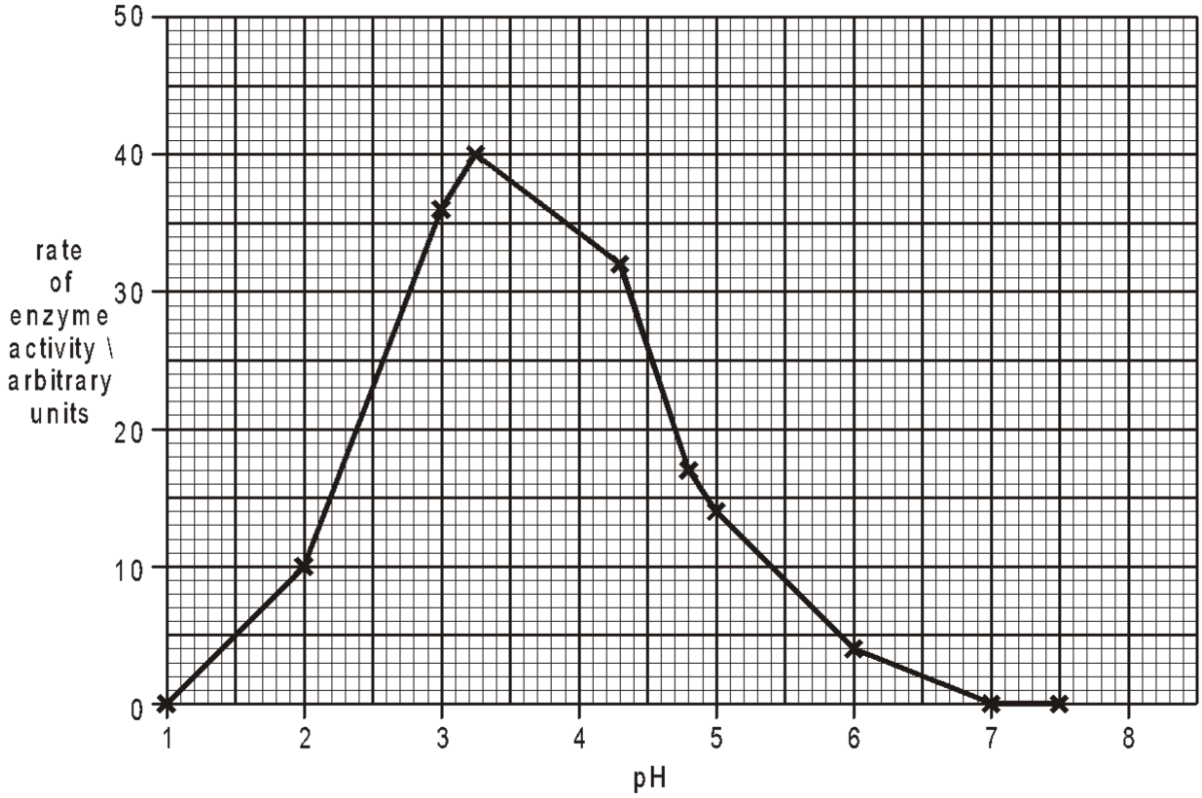
Using examples from the list above, describe and explain how the properties of water make it a suitable environment for these organisms.

[7]

Quality of Written Communication [1]

[Total 8 marks]

34. Two students carried out an investigation into the effect of pH on the activity of a lysosomal enzyme. Student A drew the graph shown in the diagram below.



(i) A teacher asked two students to state the optimum pH for this enzyme. Student A gave the answer 'pH 3.25' but student B gave the answer 'somewhere between pH 3.0 and pH 4.3'. The teacher said that student B had given the better answer.

Explain why student B's answer was better.

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[2]

(ii) Explain why this enzyme is not active at pH 7.

....

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[2]

[Total 4 marks]

35. In this question, one mark is available for the quality of spelling, punctuation and grammar.

Explain the effects of enzyme concentration, substrate concentration and competitive inhibitors on the rate of an enzyme-controlled reaction.

[9]

Quality of Written Communication [1]

[Total 10 marks]

36. Read the following passage and then answer the questions that follow.

Human Factor VIII is a glycoprotein found in blood plasma. It is involved in blood clotting.

This glycoprotein contains 2332 amino acids linked into a single chain. This chain is folded and coiled into a secondary structure and then further folded. The chain forms six individual regions, each with its own function.

An artificial source of Factor VIII, created using genetic engineering, is now used to treat patients with haemophilia, a medical condition in which the blood clots more slowly than normal. The Factor VIII gene is first removed from the genome of human cells. It is then inserted into the genome of hamster cells.

Cancer cells or cells taken from an ovary are usually used to produce Factor VIII as these grow very well in industrial tanks. The Factor VIII that is produced is then removed from the tanks and purified before use in treating patients.

(a) State what is meant by the term glycoprotein (line 1).

....

....

[1]

(b) The secondary structure of a protein is identified by its shape.

(i) Name a shape formed by coiling of the primary structure.

....

[1]

(ii) Name a shape formed by folding of the primary structure.

....

[1]

(c) State the name given to the level of structure formed by further folding of the secondary structure (line 4).

....

[1]

[Total 4 marks]

37. Complete the following passage by using the most suitable word(s) in each of the blank spaces.

Water is essential for life. It makes up a high proportion of the cytoplasm in a cell. Many different compounds can dissolve in it and it is therefore described as an excellent

....

Water remains in the .... state over a wide range of environmental temperatures. As it cools below 4°C it becomes less .... than warmer water. Ice floats on water, forming a layer that .... the water beneath with the result that large bodies of water rarely freeze entirely.

The .... bonds that form between water molecules are responsible for its high ...., which allows small insects such as pond skaters to move on its surface without sinking.

[Total 6 marks]

38. Cholesterol is a lipid which forms part of the structure of membranes of animal cells. It is absorbed from food and can also be synthesised by liver cells.

Cholesterol is transported by the blood with the help of specific transport proteins to which cholesterol molecules become reversibly attached. These complexes of lipid and protein are known as lipoproteins. There are three different types of lipoprotein transporting cholesterol in the blood. The concentration of cholesterol in blood can be measured, either as the total cholesterol, or as the amount carried by each of the different types of lipoprotein.

Explain why cholesterol must be carried in the blood by proteins while glucose does not need any transport protein.

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[Total 2 marks]

39. The table below shows information about tests that identify three different types of biological molecule.

Complete the table to show the names of the types of molecule that are tested, the reagents used and the results obtained.

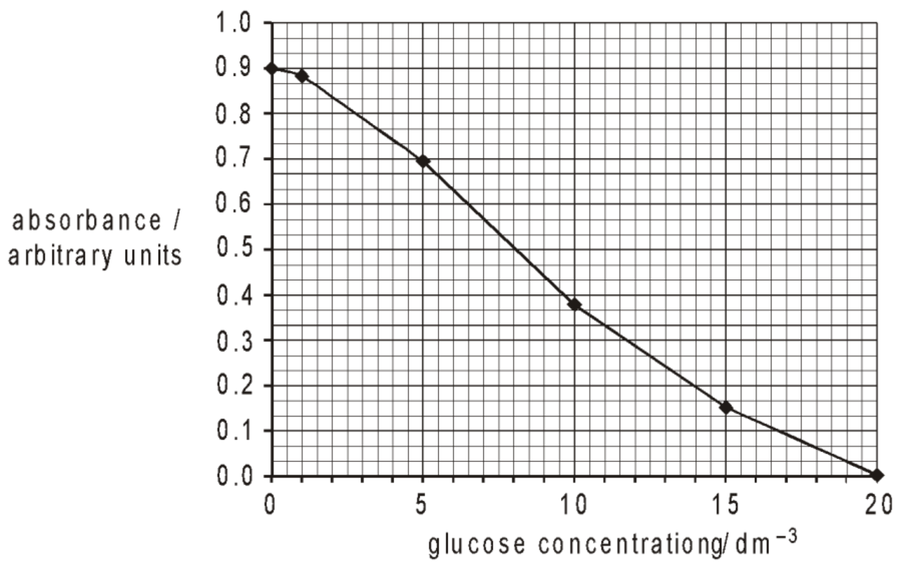
Type of molecule tested	**Reagents used**	**Positive result**	**Negative result**
Protein	....	....	blue solution
....	alcohol and water	white emulsion	clear liquid
Starch	....	....	yellow solution

[Total 5 marks]

40. A student followed a procedure to find the concentration of reducing sugars in a fruit juice. The first part of the method used was as follows:

- A range of glucose solutions of different concentrations was made up, starting with a 20 g dm–3 glucose solution.
- Each solution was boiled with excess Benedict's solution.
- When there was no further change in colour, the liquid was cooled and filtered.
- The absorbance of the liquid was measured with a colorimeter. (A colorimeter measures the amount of light that is absorbed by a coloured solution.)

The student's results are shown in the diagram below.



(i)   State two precautions that the student should have taken during the procedure to ensure that the results give a valid comparison between the different glucose solutions.

1 ....

....

2 ....

....

[2]

(ii)   In the second part of the method, the student tested the fruit juice. The absorbance reading obtained was 0.60 arbitrary units.

Use the diagram above to determine the reducing sugar concentration of the fruit juice.

.... g dm–3

[1]

(iii)   This procedure does not test for non-reducing sugars such as sucrose.

How should the procedure be altered to determine the concentration of non-reducing sugar in the fruit juice?

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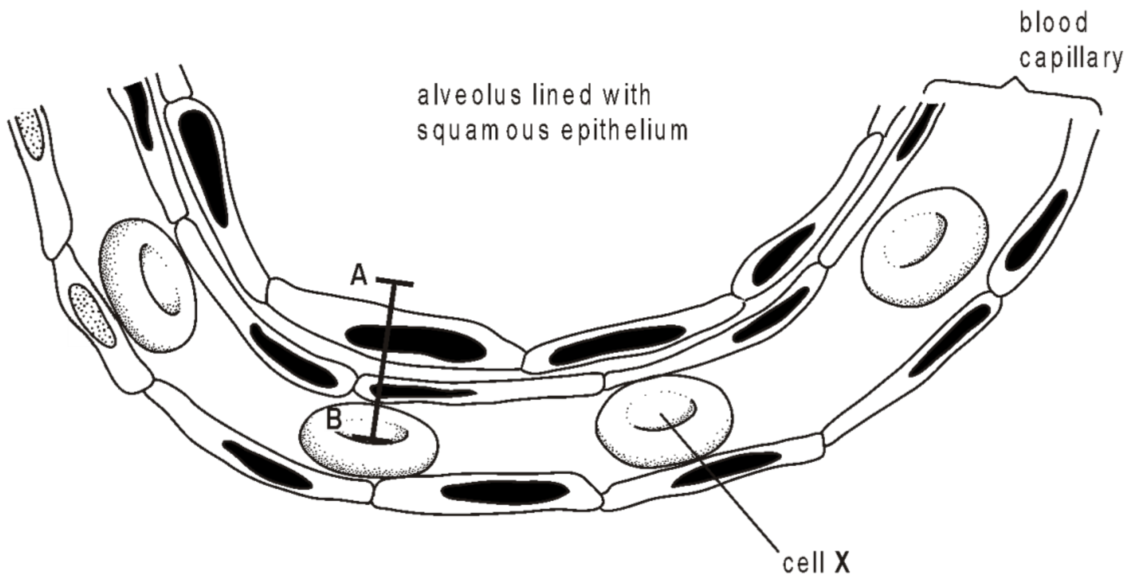
[2]

[Total 5 marks]

41. The diagram below is a drawing of an alveolus together with an associated blood capillary.



Oxygen diffuses from the alveolus into cell X. Cell X carries oxygen around the body in the blood stream.

(i) Name the compound inside cell X that combines with oxygen.

....

[1]

(ii) Name the metal ion required for the formation of the compound in (i).

....

[1]

[Total 2 marks]

42. An experiment was carried out in which the enzyme lipase was used to hydrolyse a triglyceride. The pH of the reaction mixture was recorded at regular intervals during the experiment. The results are shown in the table.

Time / min	**pH**
0	7.0
2	6.2
4	5.6
6	5.1
8	4.7
10	4.6
12	4.6
14	4.6

(i) State what is meant by the term hydrolysis.

....

....

[1]

(ii) Explain why the pH falls during the reaction.

....

....

....

[2]

(iii) After 14 minutes, the mixture was analysed and unreacted triglyceride was found to be present. No inhibitor was added to the reaction mixture.

Explain why the reaction had stopped after 10 minutes.

....

....

....

....

....

[2]

[Total 5 marks]

43. Explain how a non-competitive inhibitor affects the rate of an enzyme-catalysed reaction.

....

....

....

....

....

....

....

[Total 3 marks]

44. During research into the mechanism of DNA replication, bacteria were grown on a medium containing nitrogen isotopes. The nitrogen isotopes used were 'heavy' nitrogen, 15N, and 'light' nitrogen, 14N. After growth, the bacterial DNA was isolated from the cells and spun in a centrifuge. The DNA settled in the centrifuge tube at a position that corresponded to its density, indicating the proportion of the different types of DNA present in the sample.

Bacteria were grown for many generations in a medium containing only the 'heavy' isotope of nitrogen, 15N. This resulted in all the DNA molecules containing only 15N. The result after centrifugation is shown in Fig. 1.

These bacteria were then grown in a medium containing only 'light' nitrogen, 14N. After allowing time for the DNA to replicate once, the DNA was analysed as before. The result is shown in Fig. 2.

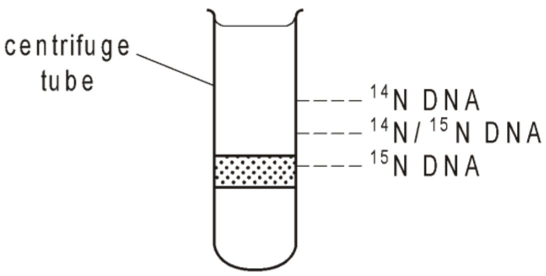


Fig. 1

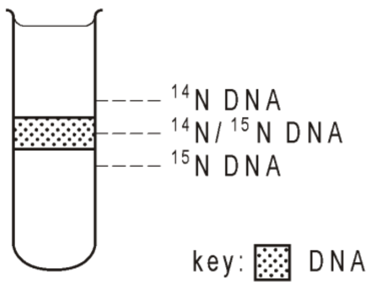


Fig. 2

(a) Explain how this information supports the semi-conservative hypothesis of DNA replication.

....

....

....

....

....

....

....

....

[4]

The bacteria were allowed to continue to grow in the 'light' nitrogen, 14N, until the DNA had replicated once more. The DNA was analysed as before and the result is shown in Fig. 3.

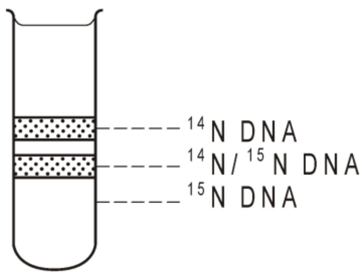


Fig. 3

Fig. 4 shows simple diagrams of DNA molecules, indicating the nitrogen content of each.

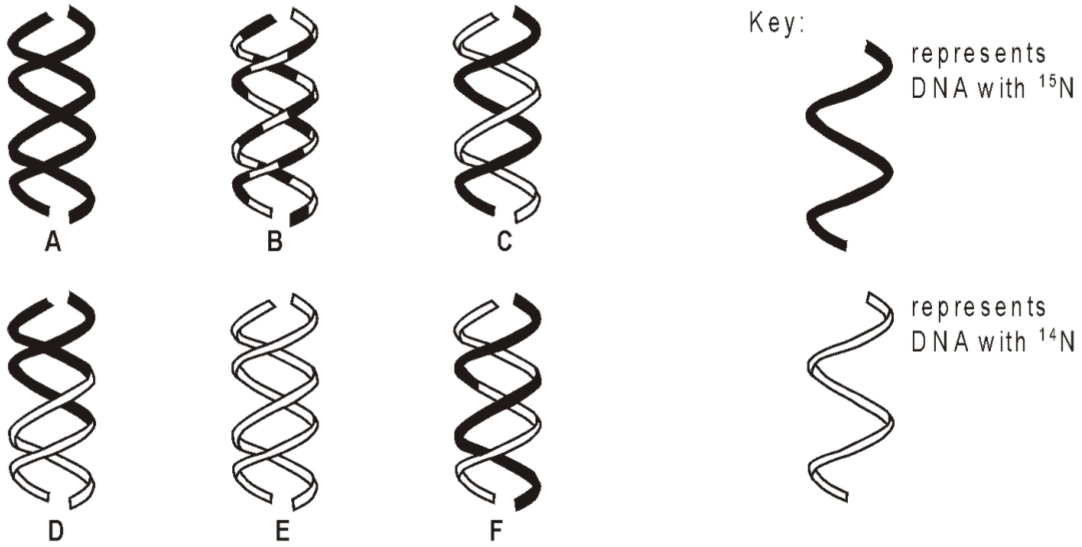


Fig. 4

(b) Select the letter or letters from Fig. 4 representing the bacterial DNA in Fig. 1, Fig. 2 and Fig. 3.

Fig. 1 ....

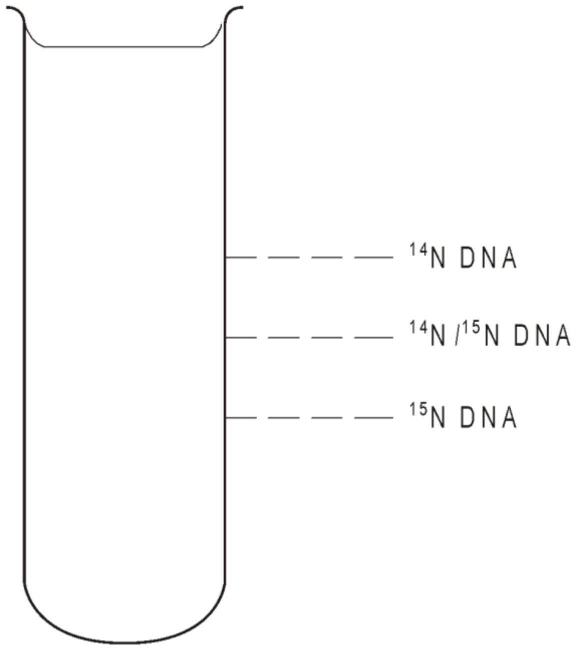
Fig. 2 ....

Fig. 3 ....

[3]

(c) The bacteria were allowed to continue to grow in the ‘light’ nitrogen, 14N, until the DNA had replicated once more. The DNA molecules were analysed as before.

Complete the diagram to indicate the expected results showing the composition of these DNA molecules.

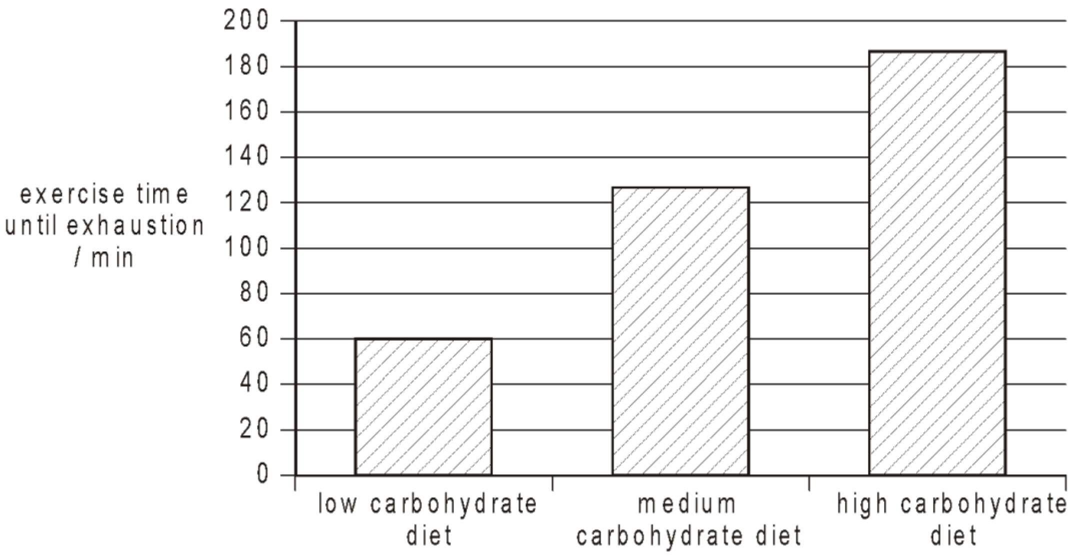


[2]

[Total 9 marks]

45. An investigation was carried out to determine the effects of increasing carbohydrate levels in the diet. Consuming extra carbohydrate is a technique called carbohydrate loading. It is often used by endurance athletes, such as long distance cyclists.

The diagram below shows the effect that different amounts of carbohydrate have on the length of time an athlete can continue exercising until exhausted.



Clyde Williams (1999) 'Does carbo-loading work?'
Biological Sciences Review vol. 12 No. 2

Using the evidence in the diagram, describe the effect of carbohydrate loading on an athlete's performance.

....

....

....

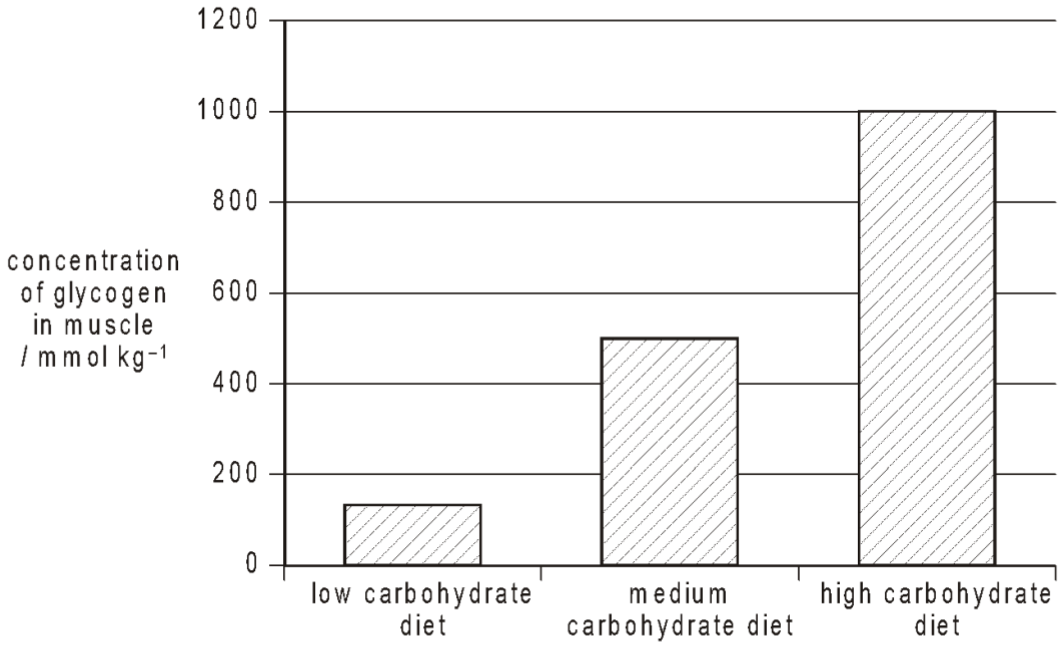
....

....

....

[Total 3 marks]

46. The diagram below shows the effect that different amounts of carbohydrate have on the concentration of glycogen stored in the muscles.



Clyde Williams (1999) 'Does carbo-loading work?'
Biological Sciences Review vol. 12 No. 2

Explain why a high concentration of glycogen in the muscles improves an athlete's performance in an endurance event.

....

....

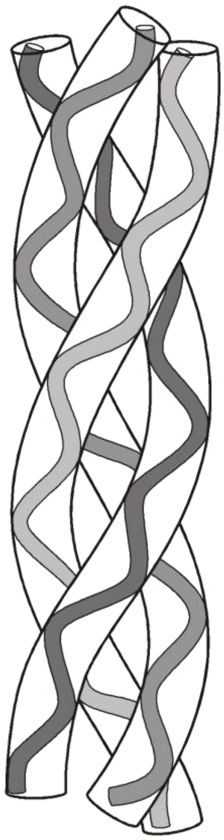
....

....

....

[Total 2 marks]

47. The diagram below represents part of a collagen molecule.



(i) Collagen is a protein made of three chains of amino acids, twisted together like a rope. State the name given to a chain of amino acids.

....

[1]

(ii) Name the amino acid that forms a high proportion of the collagen molecule.

....

[1]

(iii) Collagen has tremendous strength, having about one quarter of the tensile strength of mild steel. Using information given in the diagram to help you, explain how the structure of collagen contributes to its strength.

....

....

....

....

....

....

[2]

[Total 4 marks]

48. Complete the following passage by inserting the most appropriate terms in the spaces provided.

Cellulose and collagen are both fibrous molecules. Cellulose, a carbohydrate, is the

main component of the ……………… ……………… in plants.

Cellulose is made of chains of many …… glucose molecules which are joined by 1,4

……………………… bonds. Each glucose molecule is rotated ……………° relative

to its neighbour, resulting in a ……………………… chain. Adjacent chains are held

to one another by ……………………… bonds.

[Total 6 marks]

49. Deoxyribonucleic acid (DNA) is a polynucleotide.

(i) State how many different types of nucleotide are found in DNA.

....

[1]

(ii) Name the components of one of these nucleotides.

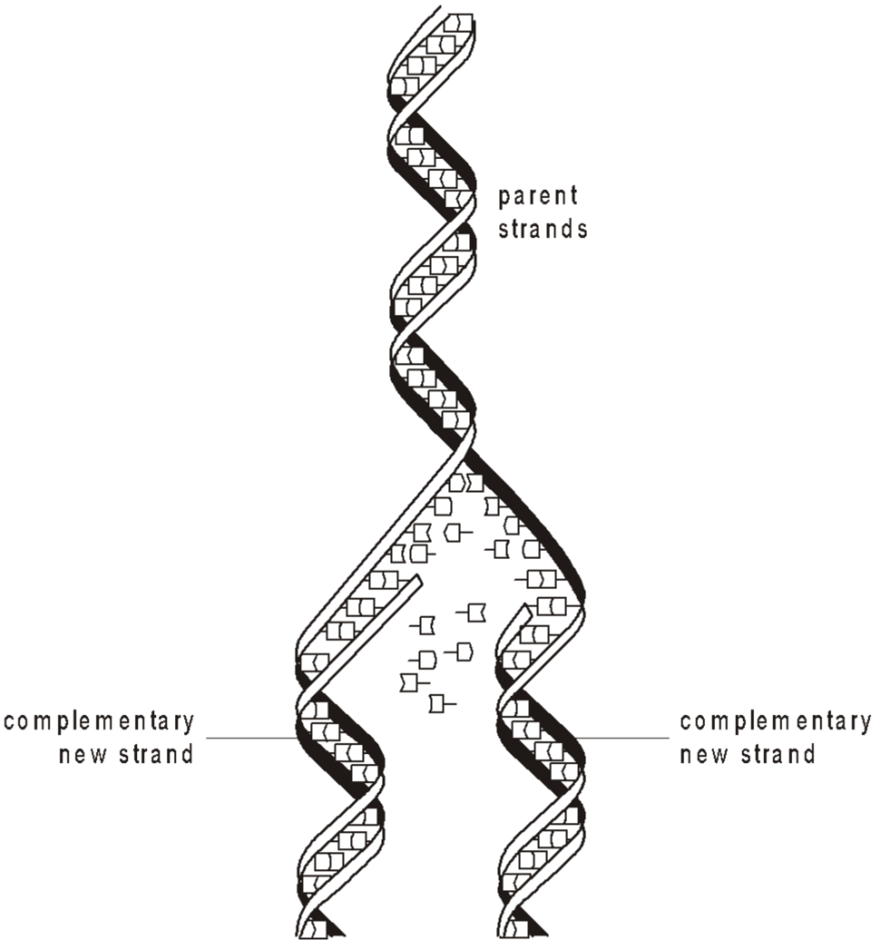
....

....

[3]

[Total 4 marks]

50. DNA replication is described as semi-conservative. Below is a diagram showing the replication of a DNA molecule.



Explain what is meant by the term semi-conservative replication.

………

………

………

………

[Total 3 marks]

51. Cyclo-oxidase (COX) is one of the enzymes needed in the formation of prostaglandins, compounds that are involved in causing fever, pain and inflammation. COX catalyses the conversion of arachidonate to prostaglandin H2, as shown in Fig. 1.

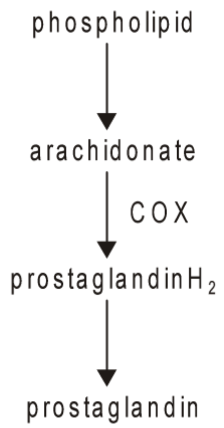


Fig. 1

The COX enzyme is found attached to the inner surface of the endoplasmic reticulum membrane. This is shown in Fig. 2.

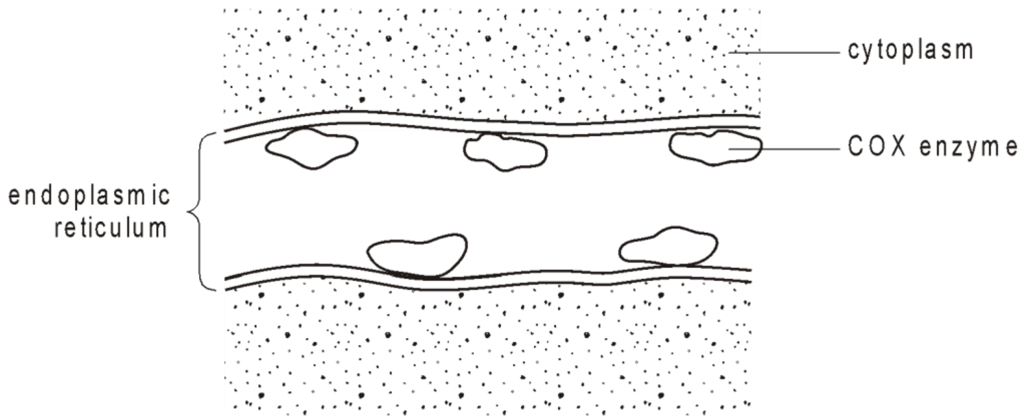


Fig. 2

(a) Using the information given above, suggest why the COX enzyme is found attached to the inner surface of the endoplasmic reticulum.

....

....

....

....

....

[2]

(b) Arachidonate reaches the active site of COX through a hydrophobic channel in the surface of the enzyme.
Ibuprofen and aspirin are drugs that inhibit the action of the COX enzyme.

• Ibuprofen enters and occupies the hydrophobic channel in the surface of the enzyme.

• Aspirin reacts with one of the R groups close to the active site of the enzyme.

Suggest how each drug inhibits the action of the COX enzyme.

Ibuprofen:

....

....

....

....

Aspirin:

....

....

....

....

[4]

(c) Describe the effect of low temperature, such as 5°C, on enzyme action.

....

....

....

....

....

....

....

....

....

[4]

[Total 10 marks]

52. Glucose:

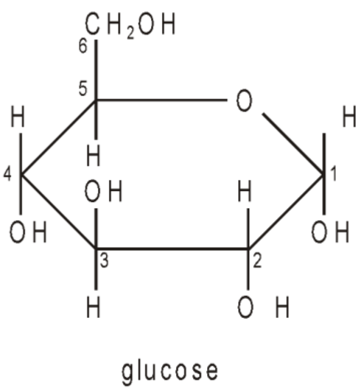
• Is a carbohydrate

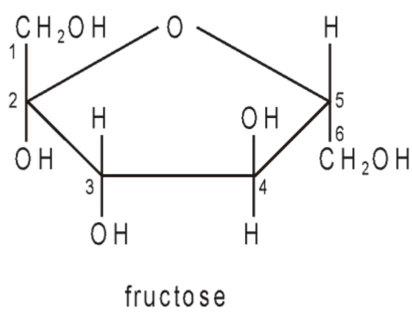
• Is a hexose (six-carbon sugar)

• Has the formula C6H12O6

• Has a six-membered ring structure.

The diagram below shows the molecular structures of two monosaccharide sugars, glucose and fructose.





State one way, visible in the diagram above, in which the structure of fructose is:

Similar to glucose;

....

....

Different from glucose.

....

....

[Total 2 marks]

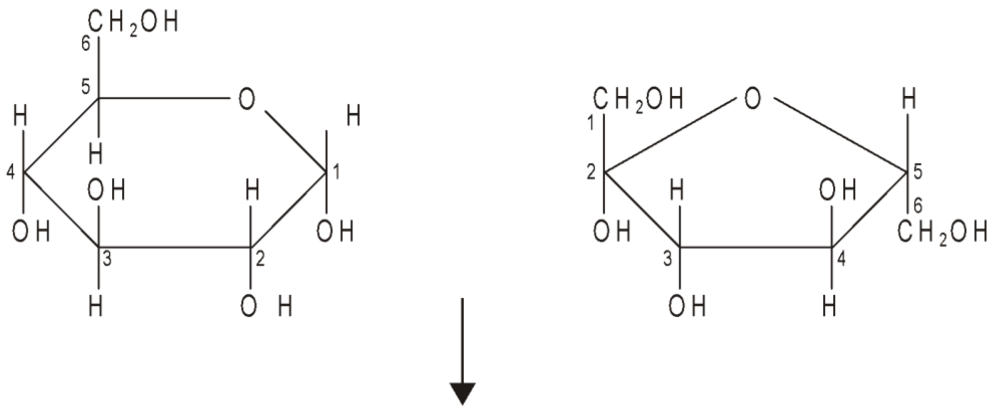
53. Maltose and sucrose are disaccharide sugars in which a bond joins two monosaccharide molecules. Sucrose is formed by the formation of a bond between carbon 1 of a glucose molecule and carbon 2 of a fructose molecule.

(i) Name the bond that joins the two molecules to form a disaccharide.

....

[1]

(ii) Complete the diagram below to show what happens when the glucose and fructose molecules join together.



[2]

[Total 3 marks]

54. (i) Describe the test that is used to indicate the presence of a reducing sugar, such as glucose, and state the observation that would be made if glucose was present.

Description of test:

....

....

....

....

Observation if glucose is present:

....

....

[3]

(ii) No change is observed if sucrose, a non-reducing sugar, is tested for in this way. The bond between the glucose and fructose units must first be broken. The test for a reducing sugar can then be carried out.

Describe how this bond can be broken chemically before carrying out the test for a reducing sugar.

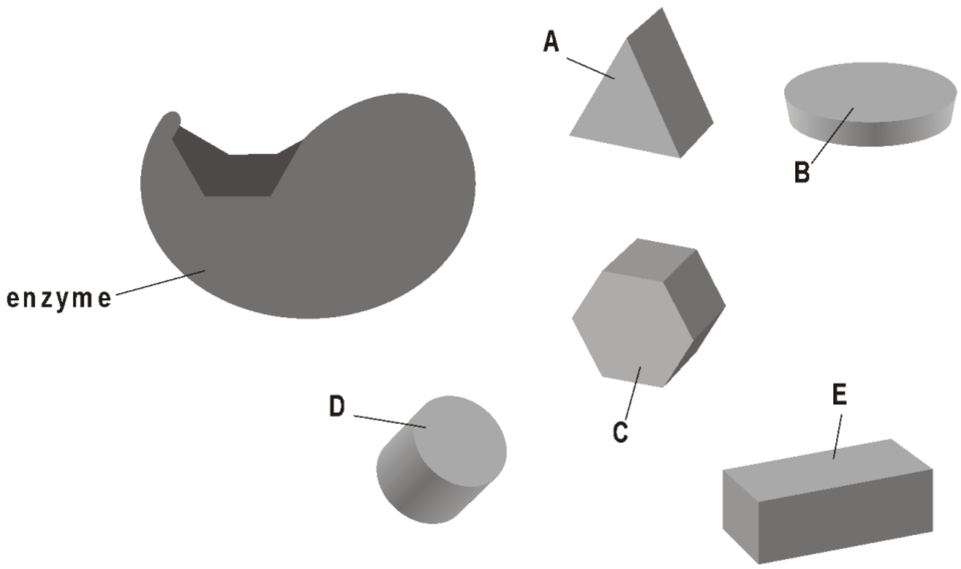
....

....

[1]

[Total 4 marks]

55. The diagram below represents an enzyme and a number of other molecules.



(a) Label on the diagram the active site of the enzyme.

[1]

(b) Write the letter of the molecule that is most likely to be the substrate for this enzyme.

....

[1]

(c) Use the information in the diagram to explain enzyme specificity.

....

....

....

....

....

....

[3]

(d) One hypothesis of the mechanism of enzyme action is the 'lock and key' hypothesis. Another hypothesis, the 'induced fit' hypothesis, involves the enzyme changing shape slightly to allow the substrate to fit perfectly. The substrate also changes shape slightly.

Suggest how the substrate changing shape slightly will assist enzyme action.

....

....

[1]

[Total 6 marks]

56. 'Scientists have discovered that certain microorganisms can survive in the Antarctic, completely surrounded by ice.'

Suggest how this discovery was useful in the development of certain biological washing powders.

....

....

....

....

[Total 2 marks]

57. In this question, one mark is available for the quality of written communication.

Some of the properties of water are listed below.

- Boils at 100°C.
- Freezes at 0°C.
- Water below 4°C is less dense than water above 4°C.
- Excellent solvent.
- Much energy is required to raise the temperature of water.
- Much energy is required to change water into water vapour.
- High surface tension and cohesion.

Describe and explain the roles of water in living organisms and as an environment for living organisms.

You will gain credit for using information about the properties of water.

[9]

Quality of Written Communication [1]

[Total 10 marks]

59. An enzyme, such as amylase, has a specific 3-dimensional shape.

Explain how DNA structure determines the specific shape of enzymes.

....

....

....

....

....

....

....

....

....

....

[Total 4 marks]

60. Read the following passage carefully, then answer the questions below.

Rhizobium is a bacterium that is closely associated with the roots of certain plants known as legumes. These plants produce chemicals to attract the bacteria and extra root hairs are produced. The bacteria attach to the surface of the root hairs. Chemical links are formed between a complex.

Polysaccharide on the bacterial surface and lectin, a protein, are formed by the plants. The bacteria penetrate the cell walls of the root hairs and enter the cells. The presence of the bacteria stimulates the cells of the root to divide, forming swellings known as nodules.

The bacteria produce an enzyme, nitrogenase, that is the catalyst for the conversion of nitrogen gas to ammonia. The bacteria use carbon compounds manufactured by the plant to respire, making energy available for this conversion. The ammonia is then used to form amino acids. Nitrogenase only functions in low oxygen concentrations. The root cells produce a pigment, leghaemoglobin, that is very similar to haemoglobin. Leghaemoglobin absorbs oxygen, leaving low concentrations in the nodules.

(i) Rhizobium is a prokaryotic organism.

State one characteristic that is typical of prokaryotes, but not of eukaryotes.

....

[1]

(ii) Lectin (line 5) and polysaccharides are compounds that are formed from small molecules joined together by chemical bonds.

Explain how the small molecules are joined together to form these compounds.

....

....

....

....

[3]

(iii) Leghaemoglobin contains the same metal element as haemoglobin.

Name this metal element.

....

[1]

(iv) State the names of two proteins, other than lectin, mentioned in the passage.

1 ....

2 ....

[2]

(v) Name the process that occurs in Rhizobium to convert nitrogen gas into ammonia.

....

[1]

(vi) It has been suggested that oxygen is an inhibitor of nitrogenase.

Explain one way in which oxygen could act as an inhibitor.

....

....

....

....

[2]

[Total 10 marks]

61. State the word or phrase that best describes a region on the surface of an enzyme molecule where a substrate can bind.

....

[Total 1 mark]

62. State the word or phrase that best describes the energy that must be provided for a chemical reaction to take place.

....

[Total 1 mark]

63. State the word or phrase that best describes a length of DNA that codes for a particular polypeptide.

....

[Total 1 mark]

64. A student was carrying out tests to determine which biological molecules were present in a food sample.

(a) (i) Describe a test that the student could carry out to discover whether this sample contained a lipid.

....

....

....

....

[2]

(ii) State what would be seen if a lipid was present.

....

[1]

(b) Describe how the structure of a phospholipid differs from that of a triglyceride.

You may use the space below for a diagram to help your answer.

....

....

....

....

....

[3]

(c) (i) Describe a test that the student could carry out to discover whether the food sample contained protein.

....

....

....

[1]

(ii) State what would be seen if protein was present.

....

[1]

[Total 8 marks]

65. Explain what is meant by the primary and secondary structure of a protein.

Primary structure:

....

....

Secondary structure:

....

....

....

....

....

[Total 5 marks]

66. An important enzyme that is used in respiration is succinate dehydrogenase. Its substrate is succinate, which is converted into fumarate. Malonate acts as a competitive inhibitor, but does not bind permanently to the enzyme.

(a) Describe how malonate inhibits the enzyme. You may use the space below for a diagram to help your answer.

....

....

....

[3]

(b) Explain what would happen to the reaction if the concentration of succinate was increased relative to the concentration of malonate.

....

....

....

....

....

....

[3]

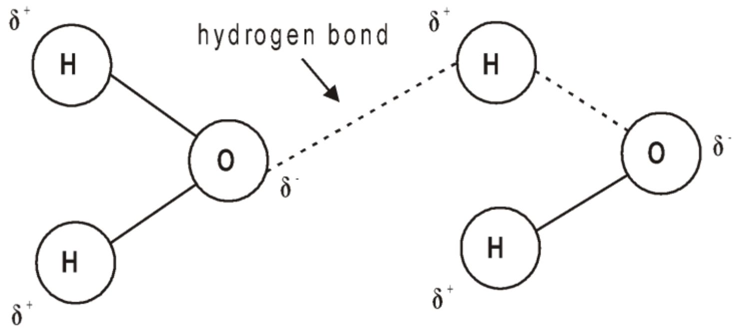
[Total 6 marks]

AQA AS Biology

3.1 Biological Molecules

Mark scheme

1.



1 hydrogen bond represented as,
horizontal / vertical, dashed line between **O** on one molecule and **H** on the adjacent molecule;

__DO NOT CREDIT__ if >1 H bond is drawn between the same two molecules

2 hydrogen / **H**, bond label (on any drawn bond between 2 molecules);

3 (delta positive) δ+ on **each** drawn **H**
__**and**__ (delta negative) (2) δ– on **each** drawn **O**;

*if both molecules drawn, δ+ and δ– on **all** atoms.*
***ACCEPT** d (lower case) for δ*

[3]

2. *ice floats*

P1 (ice is less dense because) molecules spread out;

P2 molecules form a crystal structure / lattice / AW;

P3 ice forms an insulating layer / clearly described;

e.g. acts as a barrier to the cold

P4 water (below ice), does not freeze / still liquid / remains water / kept at higher temperature;

S1 organisms do not freeze;

***DO NOT ACCEPT** die (because 'survival' stated in stem)*

S2 animals / organisms, can still, swim / move;

S3 allows, currents / nutrients, to circulate;

solubility

P5 ions / named ion, polar / charged;

P6 ions /named ion, attracted to / bind to / interact with, water;

S4 (named) organisms / plants / animals, uptake / AW, minerals / named mineral / nutrients;

> ***ACCEPT*** *obtain / enters / goes in / gets*

S5 correct use of named, mineral / nutrient, in organism;

> *needs to be more specific than 'for growth / metabolism'*
> *suitable examples include but are not limited to: nitrates for amino acids / protein / (named) nucleic acid / phosphate for ATP / phospholipids / plasma membrane / magnesium for chlorophyll etc*

temperature stability

P7 many / stable, (hydrogen) bonds between molecules;

> *Many hydrogen bonds between molecules = 2 marks (gets P7 and H)*

P8 at lot of energy to, force apart molecules / break bonds;

> ***ACCEPT*** *heat as an alternative to energy*

P9 high (specific) <u>heat capacity</u>;

> ***DO NOT CREDIT*** *latent heat capacity*

S6 temperature does not change much / small variation in temperature;

> *could refer to organisms* ***or*** *surrounding water*
> ***ACCEPT*** *stays cool in summer / stays warm in winter*
> ***DO NOT CREDIT*** *constant alone*

S7 effect of temperature on, enzymes / metabolic rate;

> ***ACCEPT*** *any reference to temperature affecting enzyme activity / metabolic rate*

S8 gases remain soluble;

Award once in any section

H hydrogen bonds;

DO NOT CREDIT *if in incorrect context*
(e.g. they are strong bonds)

7 max

QWC - Award if you see a P mark **and** an S mark within the **same** section;

Look for the ***S*** *mark first, then award QWC if there is a* ***P*** *mark*
in the same section *in the mark scheme*

1

[8]

3. hydrolysis / hydrolytic;
hydrophilic;

ACCEPT *phonetic spelling throughout*

IGNORE *head*

[2]

4. (i) X;

1

(ii) **1** substrate / PABA, **and**, inhibitor / sulfonamide, similar shape;

ACCEPT *similar structure* ***DO NOT CREDIT*** *same*

2 able to, bind / fit into / block, active site;

3 (shape) complementary to active site;

DO NOT CREDIT *refs to PABA and sulfonamide being complementary to each other or to the enzyme (alone)*

4 both have, hex / benzene / 6-C, (ring);

5 both have, NH_2 / amine;

6 correct ref to a difference between sulfonamide and PABA;

e.g. *only sulfonamide contains S*
sulfonamide has 1 more NH_2 *group*
sulfonamide has $SONH_2$ *but PABA has* N_2
only PABA has COOH group

3

[4]

5. (i) *without inhibitor*

1 more, PABA / substrate, molecules enter active site:

__ACCEPT__ more successful collisions between substrate and active site

2 more, enzyme substrate complexes / ESCs, formed;

3 at low concentration not all active sites occupied / at high concentration all active sites occupied;

__ACCEPT__ active sites filled / no free active sites
__DO NOT CREDIT__ active sites run out

4 achieves / reaches, max (turnover) rate / V_{max};

__ACCEPT__ 'cannot work any quicker'
__DO NOT CREDIT__ 'optimum rate' or 'rate levels off'

5 (at high substrate concentration) enzyme <u>concentration</u> limiting;

3 max

(ii) *with inhibitor*

1 inhibitor / sulfonamide, can, fit / block / bind to / compete for, <u>active site</u>;

2 (occupies it) for a short time / temporary / reversibly;

3 fewer active sites available (for substrate) / AW;

__ACCEPT__ substrate can't access active site

4 (idea of) more substrate reduces chance of inhibitor getting in;

__ACCEPT__ more ESC formed in context of overcoming inhibition / substrate can out-compete inhibitor

2 max

[5]

6. (a) (i) L;
M;
J;

If 2nd letter given, no mark

3

(ii) ***CREDIT*** *answers from clearly drawn diagrams with bonds labelled*

1 peptide bond;

ACCEPT *peptide link*

2 between, amine / **J** group (of one amino acid) and carboxyl / **L** group (of another);

3 H (from amine group) combines with OH (from carboxyl group);

4 condensation reaction
OR
water, lost / eliminated / produced / created / AW;

5 covalent;

3 max

(b) **1** some R groups, attract / repel;

2 disulfide, bridges / bond;

3 between, cysteine / SH / S (atoms);

4 hydrogen / H, bonds;

*DO NOT CREDIT in context of **secondary** structure*

5 ionic bonds between, oppositely charged / + and –, R groups;

6 hydrophilic R groups, on outside of molecule / in contact with water (molecules);

7 hydrophobic R groups, on inside of molecule / shielded from water (molecules);

4 max

[10]

7. (i) ***AWARD** 1 mark per correct row*
Comparative statements must be made in a row

	Glycogen	Collagen	
1	carbohydrate / polysaccharide	protein / polypeptide	;
2	(alpha) glucose (units)	amino acid (units)	;
3	identical units	different amino acid units	;
4	glycosidic, bonds / links	peptide, bonds / links	;
5	branched	unbranched / linear	;
6	non-helical	helical	;
7	one chain (per molecule)	three chains (per molecule)	;
8	no cross links	cross links (between chains)	;
9	contains C H O	contains C H O N	;

***2** **DO NOT CREDIT** beta*

***5** **ALLOW** straight*

7 ***DO NOT CREDIT** strands*

9 ***IGNORE S** (for collagen)*

3 max

(ii) (high tensile) strength / strong;

__IGNORE__ fibrous / tough

does not stretch / is not elastic;

insoluble;

flexible;

Mark the 1st answer on each numbered line

2 max

[5]

8. (i) <u>de</u>oxyrib<u>ose</u> (sugar);
phosphate (group);

***DO NOT CREDIT** dioxyribose*

***DO NOT CREDIT** phosphate head or phosphate backbone*

(nitrogenous / purine or pyrimidine) base / one correctly named base;

***DO NOT CREDIT** letter instead of named base*

***DO NOT CREDIT** uracil*

***DO NOT CREDIT** incorrect spelling of thymine with 'a'*

3

(ii) has ribose;

uracil / U, instead of, thymine / T;

***DO NOT CREDIT** incorrect spelling of thymine with 'a'*

single stranded;

3 forms / AW;

assume answer refers to RNA unless otherwise stated

2 max

[5]

9. **1** untwist / unwind;

__DO NOT CREDIT__ unravel

S **2** unzip / described;

__DO NOT CREDIT__ strands separating without qualification

S **3** H bond breaks;

4 both strands act as template;

N **5** (aligning of) free (DNA) <u>nucleotides</u>;

__DO NOT CREDIT__ bases

N **6** <u>complementary</u>, base / nucleotide, pairing;

N **7** C to G **<u>and</u>** T to A / purine to pyrimidine;

__6 & 7__ Do not consider for __QWC__ if mark awarded in the context of breaking apart or DNA structure only, rather than forming new double helix

R **8** hydrogen bonds reform;

R **9** sugar-phosphate backbone forms;

R **10** (using) covalent / phosphodiester, bond;

11 <u>semi-conservative</u> replication;

12 DNA polymerase;

__CREDIT__ at any stage in the process

13 AVP;

e.g. *ligase / helicase / gyrase used in correct context*
C – G 3 H bonds / T – A 2 H bonds
activation of free nucleotides (with 2 phosphates)
synthesis in the 5' to 3' direction
Okazaki fragments on lagging strand

6 max

QWC - correct sequence - 1 **S** mark, then 1 **N** mark, then 1 **R** mark;

It should be clear that candidate realises that the sequence is S, then N then R - even if not written in that order

DO NOT CREDIT *if any ref to transcription / translation*

1

[7]

10. (i) polypeptide / protein / primary structure / a sequence of amino acids;

DO NOT CREDIT *'codes for an amino acid'*
IGNORE *enzyme / named protein*

1

(ii) different, sequence of amino acids / primary structure / AW;
different protein / protein folds up differently / different tertiary structure;
(product) no longer functions / different function;

__DO NOT CREDIT__ 'product' or incorrect biochemical (e.g. carbohydrate)

__ACCEPT__ suitable example, e.g. active site of enzyme no longer complementary to substrate

2 max

[3]

11. double helix;
anti-parallel;
sugar-phosphate;
hydrogen;

[4]

12. (i) percentages / amount, C & G similar (in all organisms);
percentages / amount, A & T similar (in all organisms);

<u>different</u> / named, <u>organisms</u> have different proportions of, bases / named base / AW;
greatest similarity between human and grasshopper;
least similarity between *E coli* and the other three;
E. coli has similar proportions of all bases /
E.coli has <u>slightly</u> more CG than AT /
(named) eukaryote has more AT than CG;

mp 1 & 2 __DO NOT CREDIT__ ref to a single organism
mp 1 & 2 __IGNORE__ ref to complementary
__DO NOT CREDIT__ statements in context of organism size
e.g. statement that human has more A than E. coli /
human has the most AT / E. coli has the most CG

This mark is for a general statement

comparative figs with units to support any statement;

e.g. human C = 19.8<u>%</u> <u>and</u> G = 19.9<u>%</u>
human A = 30.9<u>%</u> <u>and</u> E. coli A = 24.7<u>%</u>

'human has more A (30.9%) than wheat (27.3%)' = ***2***
(mp 3 & 7)

3 max

(ii) (suggests) A, bonds / pairs / links / connects / joins, to T;
(suggests) C, bonds / pairs / links / connects / joins, to G;
(suggests) purine bonds to pyrimidine;
(evidence for) complementary base pairing /
which bases pair with each other / base pairing rules;
suggests bases point 'inwards' rather than 'outwards';

IGNORE *A – T or A = T unqualified*
IGNORE *C – G or C = G unqualified*
ACCEPT *'bond' instead of 'pair'*

2 max

[5]

13. ***Award 1 mark per correct row***

feature	*DNA*	*RNA*	
number of strands	two / double	one / single	;
bases present	thymine / T (+ adenine + cytosine + guanine)	uracil / U (+ adenine + cytosine + guanine)	;
sugar present	deoxyribose	ribose	;

If a choice of answers is given, do not credit unless both answers are valid (e.g. two and double strands for DNA / ribose and pentose sugar)

ACCEPT *letters instead of names of bases*
Names of bases must be unambiguous, so
DO NOT CREDIT *adenosine / thiamine / cysteine / etc.*
If more bases mentioned than T and U, then all bases must be included

DO NOT CREDIT *dioxyribose / oxyribose/ hexose / sugar*
IGNORE *pentose*

[3]

14. carries / transfers, the (complementary DNA),
code / <u>genetic</u> information / copy of gene;
out of the nucleus;
(transfers it) to the, ribosome / RER / site of translation;
for, protein / polypeptide, synthesis;

IGNORE *transcription*
DO NOT CREDIT *ref to the <u>whole</u> DNA code / molecule*

ACCEPT *'to make protein'*

[2]

15. (a) (i) **A** hydrogen;
B <u>glycosidic</u>;

DO NOT CREDIT *'H bond' as this is not a name*
Correct spelling only.
IGNORE *α or β or numbers*

2

(ii) hydrolysis / addition of water;

1

(iii) <u>β</u> / <u>beta</u>, glucose;

Must be qualified as β or beta or B or b

1

(b) enzymes are <u>specific</u>;
the, carbohydrate molecules / substrates,
are different <u>shapes</u>;

<u>active</u> <u>site</u> and substrate are complementary;
so that substrate will fit / formation of ESC;
lock and key / induced fit;

3 max

16. (i) pH <u>much</u>, higher / less acidic, than optimum (for enzyme 2);

Needs idea of <u>much</u> greater or too high
***DO NOT CREDIT** just 'higher than' or 'above'*
***DO NOT CREDIT** too / more, alkaline*

change in charge of active site;
hydrogen / ionic, bonds <u>break</u>;

tertiary structure / 3D shape / active site shape, altered;
enzyme / tertiary structure, <u>denatured</u>;

***DO NOT CREDIT** peptide / disulphide, bonds break*
***DO NOT CREDIT** in context of heat / vibration*

***IGNORE** ref to denaturing active site*

***IGNORE** ref to denaturing active site*
***DO NOT CREDIT** kill / die*

substrate no longer fits active site / ESC does not form;

'substrate doesn't bind to enzyme' is not quite enough

3 max

(ii) *Mark 1st response on each numbered line unless no answer on one line, then mark 1st 2 answers*
temperature;
substrate <u>concentration</u>;
enzyme <u>concentration</u>;

***IGNORE** ref to time*

2 max

[12]

17. Marking points 2 – 6 can be applied to the standard solutions or the sample

1 using, standard / known, concentrations (of reducing sugar);

2 <u>heat</u> with, Benedict's (solution) / $CuSO_4$ + NaOH;

3 (use of) same volumes of solutions (each time);

4 (use of) excess Benedicts;

5 changes to, green / yellow / orange / brown / (brick) red;

6 remove precipitate / obtain filtrate;

7 calibrate / zero, colorimeter;

8 using, a blank / water / unreacted Benedicts;

9 use (red) filter;

10 reading of, transmission / absorbance;

11 more transmission / less absorbance, of filtrate
= more sugar present; **ora**

12 (obtain) calibration curve;

13 plotting, transmission / absorbance,
against (reducing) sugar concentration;

14 use reading of unknown sugar solution and read off graph
to find conc.;

e.g. serial dilutions

ALLOW *boil / > 80^{o}C* ***DO NOT CREDIT*** *warm*
DO NOT CREDIT *amount / quantity*

CREDIT *description of method*
e.g. filtering / centrifuging & decanting

ACCEPT 'measure how much light, does / does not, pass through'

If precipitate is ***clearly indicated*** *as being present in sample,* ***ALLOW*** *'less transmission / more absorbance, = more sugar present'*

[6]

18. breaking (glycosidic) bond; **R** if incorrect named bond
glycosidic / correct bond drawn; treat 'covalent' = neutral
addition of water / H_2O;

max 2

[2]

19. *accept ✓ = yes ✗ = no*
each correct row = I mark

gum arabic		amylase	cellulose	glycogen
branched structure		no;		yes;
heteropolysaccharide		no;		no;
found in animals/plants		plants;		animals;
function in organism		storage / reserve; **R** 'energy' alone	structural / strength / stops bursting / cell wall / support / gives cell shape; **R** protects rigid = neutral	

[4]

20. (i) crush (small amount of) seed pod;
add (small volume of) biuret, A / NaOH, and biuret, B / $CuSO_4$;
positive = colour change from blue to, mauve/purple; max 2

(ii) *preparation - allow 2 marks max:*

1 crush, samples / leaves and seed pods, separately with water;

2 use same mass of each / AW and use same volume of water;

3 filter;

method - allow 4 marks max:

4 add benedict's reagent to filtrate; **A** $CuSO_4$ in alkaline solution

5 <u>excess</u> reagent used / stated volume;

6 same volume added;

7 heat in a water bath/ at near boiling;

8 for stated time (up to 5 min);

analysis - allow 2 marks max:
<u>either</u>

9 colour change from blue to green / yellow / orange / red;

10 shows increasing concentration of reducing sugar;

<u>or</u>

11 use of centrifuge to remove precipitate;

12 use of colorimeter to compare intensity of blue colour in liquid portion;

13 red filter used in colorimeter; 8

(iii) humans eat only the seeds so do not gain, nutrition / energy, from, leaves / pods;
seeds maybe deficient in (some) essential amino acids;
cattle better at digesting, plant matter / seeds / leaves / pods, than humans / AW;
meat (from cattle) provides more essential amino acids for humans (than plant material)/AW;
cattle also produce milk;

AVP; e.g. cattle naturally roam to find food / intensive labour needed for human collection of plant material;

max 3

[13]

21. (i) deoxyribose sugar;
a nitrogenous/ nitrogen containing, base / named base; ecf for thiamine
phosphate group;

AVP; e.g. deoxyribose is a pentose sugar/correct diagram of same

accept A, T, G and C in place of names.

max 3

(ii) hydrogen bonds between bases;
complementary base pairing;
purine to pyrimidine;
A to T and G to C;

AVP; further detail e.g. 2 H bonds between A and T / 3 H bonds between C and G
DNA polymerase

max 4

[7]

22. ribose (instead of deoxyribose);
uracil / U, replaces thymine;

single stranded (instead of double stranded);
smaller molecule / different 3-D structure to DNA;

[3]

23. (a) *award two marks if correct answer (12) is given*
6/30 / 6/0.5 × 60;
12; 2

(b) *assume candidates are referring to the initial rate unless otherwise stated.*

concentration of, substrate / H_2O_2, molecules, high / higher at start;
more chance of, substrate/ H_2O_2, molecules entering active site;
all / most, active sites occupied; 3

[5]

24. *at optimum temp - max 3 marks*
molecules in culture have kinetic energy;
(frequent) collisions between enzyme and substrate molecules;
more enzyme-substrate complexes formed;
max rate of reaction / protein production achieved;

at higher temp - max 5 marks
(at higher temperature) molecules have more kinetic energy /
collisions occur more frequently and with more energy;
molecules vibrate and, bonds/ hydrogen bonds, broken;
tertiary structure / 3D shape, of enzymes altered;
active site loses, precise / complementary, shape;
enzymes are denatured;
substrate molecule no longer fits active site;
(may be) irreversible so reaction/ protein production stops; **A** fungus destroyed

[8]

25. (a) (i) *Mark the first 2 types of biological molecule stated. Absence = neutral*
protein; **A** casein/polypeptide **R** *amino acid*
reducing sugar(s); **A** *correctly named reducing sugar(s)*
[but only lactose/galactose/glucose] 2

(ii) *Mark the first 3 types of biological molecule stated. Absence = neutral*

protein; **A** *casein/polypeptide* **R** *amino acid*
reducing sugar(s); **A** *correctly named reducing sugar(s)*
[but only lactose/galactose/glucose/fructose]
non-reducing sugar; **A** *sucrose* 3

(b) *Assume 'it' = 'Health-Milk'*

'Health – Milk' has

less reducing sugar(s); **A** *correctly named reducing sugar(s)*
[but only lactose/galactose/glucose/fructose]
less non-reducing sugar; **A** *sucrose*

"less sugar" = 1
credit converse statements relating to 'Energy – Boost'. 2

(c) states ‘no added sugar’/implies low sugar;
contains more sugar than (fresh) milk/high in sugar;
more reducing sugar (than milk); **R** *‘none in fresh milk’*
has non-reducing sugar (compared to none in milk);
fruit (extract) must contain (hidden) sugar;

3 max

(d) milk/drinks, already,
milky/cloudy/white/opaque/‘not see through’/emulsion;
A *‘positive result would not show up’* **R** *precipitate* 1

[11]

26. (i) **R**
statements linked to amylose/starch

max 3 if stated that glycogen <u>is</u> amylopectin

polymer/polysaccharide/described;
(made of) <u>α</u>-glucose;
joined by 1,4 links;
glycosidic;
(chain is) branched;
1,6 links where branches attach;
AVP; e.g. compact
detail of glycosidic bond

4 max

(ii) condensation; **A** *polymerisation* 1

[5]

27. (i) 37
<u>°C</u>; **A** *any figure in the range 35 – 40* 1

(ii) (enzyme) increases in <u>kinetic</u> energy; **A** *‘too much <u>kinetic</u> energy’*
enzyme vibrates too much;

breaks bonds;
named eg;
changes, tertiary/3-D, structure/shape, of enzyme;
active site changes, shape/AW;
substrate will not fit/no enzyme-substrate complex formed;
enzyme denatured;
will, decrease rate/stop reaction;

4 max

[5]

28. *1 mark per correct row*

Look for both ticks and crosses.

If a table consists of ticks ONLY or crosses ONLY, then assume that the blank spaces are the other symbol.

If a table consists of ticks, crosses and blanks then the blanks represent no attempt at the answer.

Nucleotides line up along an exposed DNA strand.	✓	✓;
The whole of the double helix 'unzips'.	✓	✗;
Uracil pairs with adenine.	✗	✓;
A tRNA triplet pairs with an exposed codon.	✗	✗;
Both DNA polynucleotide chains act as templates.	✓	✓;
Adjacent nucleotides bond, forming a sugar-phosphate backbone.	✓	✓;
The original DNA molecule is unchanged after the process.	✗	✓;
Adenine pairs with thymine.	✓	✓;

[8]

29. hydrolysis (of Hb);
by enzymes;
proteases;
breaks peptide bonds;
removal of haem group;
reference to, diffusion/active transport/pinocytosis/channel proteins;
AVP;

3 max

[3]

30. **one mark for each correct row**

if only ticks, assume that spaces are crosses; **if only crosses, assume that spaces are ticks**

R **hybrid ticks**

statement						
substance	***use heat***	*use biuret reagent*	*use Benedict's reagent*	*boil with a dilute acid*	*a positive result is a blue-black colour*	*a positive result is an emulsion*
lipid	✗	✗	✗	✗	✗	✓
protein	✗	✓	✗	✗	✗	✗;
starch	✗	✗	✗	✗	✓	✗;
reducing sugar	✓	✗	✓	✗	✗	✗;
non-reducing sugar	✓	✗	✓	✓	✗	✗;

4

[4]

31. (i) glycosidic; **A**
covalent / C-O-C / oxygen bridge
R oxygen bond / 'glucosidic' 1

(ii) hydrolysis / hydrolytic; *if qualified, needs to be correct* 1

[2]

32. **1** no (suitable) enzyme (in gut) to digest sucralose / sucrase will not act on sucralose / AW;

2 enzymes, are specific / only act on one substrate;

3 complementary shape;

4 idea that (*Cl* on sucralose instead of OH) gives different, shape / structure;

5 no ESC (enzyme substrate complex) / substrate will not fit into active site;

6 AVP; e.g. further detail of enzyme-substrate interaction

4 max

[4]

33. 1 hydrogen bonding;

2 detail; e.g. (electro)negative oxygen atom can hydrogen bond to (electro)positive H atom/ one water molecule hydrogen bonds with up to 4 others / H bonds individually weak / large collective effect of many hydrogen bonds

coral algae

3 (high) thermal stability / temperature remains fairly constant;

4 water has high specific heat capacity;

5 much energy needed to break hydrogen bonds;

polar bears

6 cooling allows maximum number of hydrogen bonds to form;

7 water molecules space out to allow this;

8 water expands as it freezes / ice is less dense than water;

mussels, filter-feeders and sessile animals

9 water is transport medium for, food particles / gametes;

10 (tentacles / appendages / cilia) create currents bringing food;

11 ref. tides / ocean currents;

12 medium for, male gametes to swim / external fertilisation;

13 no desiccation of gametes;

14 ref to low viscosity / AW;

corals

15 minerals / ions, are soluble in water;

16 water is polar / detail of electrostatic attraction; **A** AW

seaweeds, fish eyes

17 water is transparent to light;

18 photosynthesis possible (in shallow water);

19 wavelength of light varies with depth;

whales, jellyfish

20 cohesion / water molecules stick to each other;

21 water not easily compressed;

22 gives support to large bodies / detail of upthrust or relative density;

23 acts as hydrostatic skeleton;

24 AVP; e.g. zonation / pigments

25 AVP; e.g. solubility of named gas linked to use in named organism

7 max

QWC – legible text with accurate spelling, punctuation and grammar 1

[8]

34. (i) not enough points plotted / experiment not carried out at enough (different) pH values;
only 1 point between 3 + 4.3 / no points between 3.25 + 4.3;
don't know / uncertainty of, rate between those points / where peak should be / where optimum is;
3.25 reading might be anomalous;
cannot draw, curve / line of best fit;
rises to, 3 / 3.25, and falls after 4.3;

2 max

(ii) *note ~ enzyme is completely inactive at pH 7*

loss of tertiary structure / loss of 3D structure / (enzyme) denatured;
(change in pH/[H^+]) alters charge distribution on (enzyme) molecule;
hydrogen / ionic, bonds affected;
changes (shape of) active site;
enzyme substrate complex cannot be formed / substrate not attracted to active site / substrate cannot bind to active site / AW;

2 max

[4]

35. *mark each section (E, S and C) to max shown*

E ***enzyme concentration ~***

1 reaction (rate) increases with increased enzyme; **A** high / low

2 more active sites available;

3 in excess substrate / as long as enough substrate (molecules available to occupy active site);

4 (as reaction progresses) the rate will decrease as substrate, used up / becomes limiting; **R** plateau **E**

(3 max)

S ***substrate concentration ~***

1 reaction (rate) increases with increased substrate; **A** high / low

2 more, molecules available to enter active site / ESC formed;
A more successful collisions

3 reaches point where all active sites occupied;

4 no further increase in rate / reaches V_{max}; **A** plateau / levels off

5 enzyme conc. becomes limiting / unless add more enzyme; **S**

(3 max)

C *competitive inhibitor ~*

1 inhibitor has similar shape to substrate;

2 can, fit / occupy, active site;

3 for short time / temporary / reversible;

4 prevents / blocks, substrate from entering active site;

5 rate determined by relative concentrations;

6 little inhibition / rate little reduced, if substrate conc. > inhibitor conc.; *ora*

7 ref to chance of, substrate / inhibitor, entering active site;

8 effects can be reversed by increasing substrate conc.; **C**

(5 max)

general points ~

10 drawing a suitable graph to illustrate point made with labelled axes;

11 ref to optimum (rate); 9
max

QWC ~ legible text with accurate punctuation, spelling and grammar 1

[10]

36. (a) protein / polypeptide, with,
carbohydrate (chain) / polysaccharide / sugar / glucose;
(*R*) *glycogen* 1

(b) (i) (α)
helix; **R** double helix 1

(ii) (β) pleat(ed) (sheet); 1

(c) tertiary / 3°; 1

[4]

37. solvent;
liquid; **A** same
dense;
insulates; **A** keeps warm **R** protects / warms
hydrogen; **A** H / weak **R** H^+ / H_2
surface tension / cohesion; 6

[6]

38. cholesterol not soluble (in water) ;

lipids / cholesterol, hydrophobic / non-polar ;

glucose is (very) soluble (in water) ;

glucose is, hydrophilic / polar ;

2 max

[2]

39. **A** *correct formulae*
R *choice (if contradictory)*

type of molecule tested	*reagents used*	*positive result*	*negative result*
protein	biuret / copper sulphate and sodium (or potassium) hydroxide;	purple / mauve / lilac;	*blue solution*
fat / lipid / oil / triglyceride; **A** *phospholipid*	*alcohol and water*	*white emulsion*	*clear liquid*
starch	iodine (in potassium iodide solution);	blue-black / black;	*yellow solution*

[5]

40. (i) **R**
references to fruit juice

use same <u>volume</u> of glucose solution;
use same <u>volume</u> of Benedict's solution;
use same concentration of Benedict's solution; **A** *strength / same batch*
boil for the same length of time; **A** *heat*
calibrate colorimeter / AW; **A** *same, filter / colorimeter*

2 max

(ii) 6.5; 1

(iii) hydrolyse**,** filtrate / juice / bond / non-reducing sugar;
either
with acid, neutralise / add alkali
or
treat with**,** sucrase / invertase;

either, if started with filtrate …
boil with Benedict's + test filtrate / repeat original procedure; **A** *heat*

or, if started with juice …
boil with Benedict's + test filtrate / repeat original procedure**,** to measure difference in absorbance with original;

2 max

[5]

41. (i) haemoglobin / haem; **R** *Hb* 1

(ii) iron / Fe^{2+} / Fe^{3+}; **R** *ion / Fe / Fe+* 1

[2]

42. (i) breaking a bond with the addition of water; **A** *named bond* 1

(ii) fatty (acids produced);
[H+] increased / more acidic / products are acidic / acids produced;
'fatty acids produced' = 2 marks 2

(iii) *do not credit, substrate used up / lack of enzyme / end product inhibition*

pH**,** too low / not optimum; **A** *too acidic*
enzyme denatured;
equilibrium reached;
further detail;

2 max

[5]

43. reduces rate; **A** *stops* **R** *inhibits*
fits into**,** allosteric site / site other than active site;
A '*fits into active site <u>permanently</u>*'
alters**,** shape / charge**,** of active site;
so substrate cannot**,** fit to active site / bind to active site / form ESC;
will not reach V_{max};
increasing substrate concentration has no effect (on the rate); 3
max

[3]

44. (a) **R**
first reference to ^{15}N being radioactive

semi-conservative replication would give

1 one, template / original / old / parent**,** strand and one, new / daughter**,** strand;

2 complementary base pairing / joining of new nucleotides / other detail of forming the new strand;

data shows that

3 two isotopes in <u>molecule</u> / <u>molecule</u> contains both ^{14}N and ^{15}N;

4 one strand with**,** 'heavy' N / ^{15}N; **R** *molecule*

5 one strand with**,** 'light' N / ^{14}N; **R** *molecule*

6 no <u>molecules</u> with only**,** 1 isotope / ^{14}N / ^{15}N;

some points, particularly 4 and 5, could be awarded for a correctly labelled or keyed diagram

4 max

(b) *correct answer only - do not accept from a selection*

A;
C;
C <u>and</u> E; 3

(c) *1 band = 0*
3 bands = 0

band drawn for ^{14}N <u>and</u> $^{14}N/^{15}N$ only;
thick for ^{14}N <u>and</u> thin for $^{14}N/^{15}N$; 2

[9]

45. after a low carbohydrate diet athlete can exercise for, not long / (no more than) one hour; **AW *ora***
statement of trend observed; e.g. as carbohydrate in diet increases duration of exercise increases / carbohydrate loading improves performance; **AW *ora***
use of figures as a comparison; (look for 60, 125 – 130, and 185 – 190)
A two / three, times duration statements

3 max

[3]

46. *penalise sugar once in the answer*

glycogen is, source / store, of, energy / carbohydrate;
glycogen converted to glucose / glycogenolysis / glucogenesis;
glucose used in respiration;
to supply, energy / ATP, for muscle contraction;
more glycogen stored will last longer;
AVP; e.g. using muscle glycogen may be more efficient than transporting glucose from liver

2 max

[2]

47. (i) polypeptide; **A** oligopeptide 1

(ii) glycine; **A** proline / alanine 1

(iii) *in this answer assume that*
chain = polypeptide
molecule = groups of 3 polypeptide chains

A *ecf for named amino acid from (ii) but NOT a name of a base*
amino acids / glycine, small (to allow close packing);
the small one is, every 3rd amino acid / at every level in the molecule;
chains, form a tight coil / lie close to each other;
held together by hydrogen bonds; *ignore other bonds*

bonds form between R groups of lysines;
molecules form, fibres / bonds with adjacent molecules; **A** fibril
covalent bond between, adjacent molecules / CO-NH groups;
fibres composed of parallel molecules;
ends of parallel molecules staggered;
prevents line of weakness; 2
max

[4]

48. cell wall(s);
β / beta; **A** B
glycosidic; **NOT** glucosidic
180;
straight; **A** polysaccharide / unbranched / linear
hydrogen / H; **NOT** H_2 6

[6]

49. (i) 4; 1

(ii) <u>deoxyribose</u>; **NOT** ribose
<u>phosphate</u>;
nitrogen(ous) / organic / named, base; **A** purine / pyrimidine
NOT uracil
NOT letter
NOT thiamine / thyamine

take a correct base from a list unless that list includes uracil 3

[4]

50. **1** <u>2</u>, molecules / helices, (of DNA) produced;

2 identical (molecules of DNA produced);

3 (each made up of) 1, original / parent / old, strand;

4 1 new strand;

5 original / parent / old, strand<u>s</u>, act as template / described;

6 ref to (free DNA) nucleotides;

3 max

[3]

51. (a) idea that arachidonate is substrate;
phospholipid source in membrane;
prostaglandin / product, can be, transported / stored;
(S)ER for, lipid / steroid, synthesis / transport;
AVP;
AVP; e.g. separate from other reactions
cytoplasm environment not suitable for, reaction / enzyme ora
idea that prostaglandin isolated
COX does not, damage / use phospholipids from,
other membranes

2 max

(b) *ibuprofen*
competitive;
ibuprofen blocks / arachidonate cannot enter, channel; **A** substrate
cannot reach active site;

aspirin
non-competitive;
changes shape (of) / blocks;
active site;
AVP; e.g. <u>allosteric</u>

no ESC formed / AW; *allow once only*

4 max

(c) **A** *reverse argument as long as question is answered in terms of low temperature*

slows, reaction / rate / activity of enzyme / AW;
ref kinetic energy;
molecules moving, slowly / less;
few collisions / collisions less likely;
few ESC formed / ESC less likely to be formed;
reversible / enzyme not denatured / enzyme still works;
ref activation energy;
ref Q_{10} = 2;

4 max

[10]

52. *similar ~ allow valid similarities such as*

same number, carbon / oxygen / hydrogen (atoms) / OH (groups); **A** hexose
same formula; **R** similar / molecule
ring / ring with O (atom) in it;
correct ref CH_2OH;
contain C, H and O;

1 max

different ~ assume candidate is writing about fructose unless told otherwise
allow valid differences such as

(fructose has) 5-membered ring / glucose has 6-membered ring; **R** pentose
(*4 C in ring v. 5C in ring / furanose v. pyranose in glucose*)
(in fructose) 2 CH_2OH side chains / 1 CH_2OH side chain in glucose;
different angles between C atoms;
ref alignment of H and OH groups (on carbon 3 / carbon 4);
(in fructose) carbon 1 not in ring / carbon 1 in ring in glucose;

1 max

[2]

53. (i) glycosidic; **NOT** *glucosidic* 1

(ii) **1** carbon positions 1 and 2 on glucose and fructose;

2 formation of, water / H_2O, from 2 OH groups (plus separation);

3 oxygen bridge / – O –, shown;

2 max

[3]

54. (i) add / use, Benedict's (reagent);
heat; **NOT** use water bath alone
(blue to) green / yellow / orange / brown / red (precipitate); 3

(ii) hydrolysis;
boil / heat, with (dilute), acid / HCl; **A** (dil) NaOH
(add) hydrolytic enzyme / sucrase / invertase;

1 max

[4]

55. (a) active site correctly labelled; 1

(b) **C**; 1

(c) <u>shape</u> of active site;
<u>complementary</u>;
correct shape / correct molecule / correct substrate / **C**, will, fit / form ESC;
any other shape / any other molecule / any other substrate / **A** / **B** / **D** / **E**, will not;
award 2 marks if candidate writes '<u>only</u> correct …..')

3 max

(d) *look for points relating to the <u>substrate</u> changing shape*
ignore refs to enzyme changing shape

puts strain on the bonds in the substrate / bonds break more easily;
A weakens bonds

lowers activation energy;
AVP; e.g. referring to anabolic reaction

1 max

[6]

56. enzymes (of microorganisms) work in low temperatures;
enzymes used in stain removal / AW;
can be used for cool washes;
saves energy; 2
max

[2]

57. *marking points 1, 4, 8, 14, 19, 20 and 22 relate to the bullet points in the question*

1 liquid at normal temperatures;

2 hydrogen bonding between water molecules;

3 molecules more difficult to separate;

4 ice floats on water / water freezes from top down;

5 insulates water beneath;

6 large bodies of water don't freeze completely / animals can still swim etc.;

7 (change in density with temperature) causes currents to circulate nutrients;

8 solvent for, polar / ionic, substances;

9 solubility of gases in environment;

10 allows reactions to take place;

11 transport medium;

12 e.g. (of substance carried in what);

13 transport medium for, gametes / blood cells;

14 water slow to change temperature;

15 lakes / oceans / large volumes, provide thermally stable environment;

16 internal body temperature changes minimised;

17 used for cooling;

18 e.g. (sweating / panting / transpiration);

19 large amount of energy must be removed for water to freeze;

20 organisms can use surface of water (as habitat);

21 e.g.; (of organism)

22 can form (long / unbroken) columns of water;

23 ref. to vascular tissue / xylem;

24 reactant (photosynthesis);

25 role in, hydrolysis / condensation;

26 AVP; e.g. transparency

27 AVP; plants can photosynthesise under water
incompressible
hydrostatic skeleton / turgor
buoyancy
guard cell mechanism
support for large organisms on ice (penguins / polar bears)
further detail of any point

9 max

QWC – legible text with accurate spelling, **punctuation and grammar**; 1

[10]

59. DNA codes for, protein / polypeptide;
transcription <u>and</u> translation (or described);
enzyme is <u>globular</u> (protein);
3 bases ≡ 1 amino acid;
sequence of bases / triplets, determines, sequence of amino acids / primary structure;

coiling / α helix / β-pleated sheet / particular secondary structure;
determines projecting side groups;
folding / bonding, for tertiary structure;
3-D structure is tertiary structure;
AVP; e.g. ref. active site related to shape
2 or more genes produce quaternary structure

4 max

[4]

60. (i) *look for prokaryote feature*

no nucleus / no nuclear membrane / no nucleolus / DNA free (in cytoplasm); **R** DNA moving
naked DNA / DNA not associated with proteins / no chromosomes;
circular / loop, DNA;
no, membrane-bound organelles / e.g.;
smaller / 18nm / 70S, ribosomes;
no ER;
cell wall, not cellulose / polysaccharide and, amino acids / murein;
AVP; e.g. mesosomes / plasmids 1
max

(ii) glycosidic (link) <u>and</u> peptide (bonds) (in correct context);
condensation;
ref. OH groups;
ref. NH_2 and OH group;
water, removed / produced / by-product;
enzyme;
AVP; e.g. energy required 3
max

(iii) iron / Fe; *ignore pluses / minuses* 1

(iv) *treat enzyme as neutral*

nitrogenase;
leghaemoglobin;
haemoglobin; 2
max

(v) (nitrogen) fixation; **A** reduction 1

(vi) type of inhibition (competitive / non-competitive / reversible / irreversible);
basic mode of action (e.g. binds to active site);
detail;
consequence (e.g. prevents, substrate / nitrogen, from binding);

2 max

[10]

61. active site; 1

[1]

62. activation (energy); 1

[1]

63. gene / allele; **A** cistron **R** genes / alleles / operon / intron 1

[1]

64. (a) (i) add / mix with, alcohol / ethanol / propanone / (suitable) organic solvent;
then, add to / add / mix with, water;
water alone = 0
R heat 2

(ii) emulsion / milky colour / cloudy / AW; **R** precipitate 1

(b) *phospholipids have*

1 less fatty acid (residue) / 2 fatty acid (residues) not 3; **A** hydrocarbon
1 less ester bond / 2 ester bonds not 3;
phosphate;
choline / base / nitrogen;
hydrophilic / polar, end / head;

max 3

(c) (i) add, copper sulphate (solution) and sodium hydroxide (solution) / biuret (reagent);
R Biuret test unqualified
R heat — 1

(ii) purple / mauve / lilac; **R** blue — 1

[8]

65. *primary*
sequence / order, of amino acids (in a polypeptide); **A** R groups — 1

secondary
coiling / folding, of the,
polypeptide / chain of amino acids / peptide chain / primary structure;
(α-) helix;
(β-) pleated sheet;
hydrogen bonds;
between amino acids in (same) chain;
(between) –NH and –CO;
AVP; e.g. random coiling

max 4

[max 5]

66. (a) (malonate) same / similar, shape as, succinate / substrate;
A idea that inhibitor is complementary to active site

binds to / fits / blocks, active site;
for a limited time / reversible / may leave / AW;
R does not bind permanently

prevents, formation of ESC / substrate from binding; AW
no / less, product formed; **A** suitable ref. to conversion of succinate

max 3

(b) rate increased;
greater chance of substrate binding with, active site / enzyme; ora
more, product formed / substrate converted;

will reach V_{max} / rate unaffected, if great excess of succinate;

AVP; e.g. graph of rate against substrate concentration
effect of time (using up substrate)

max 3

[6]

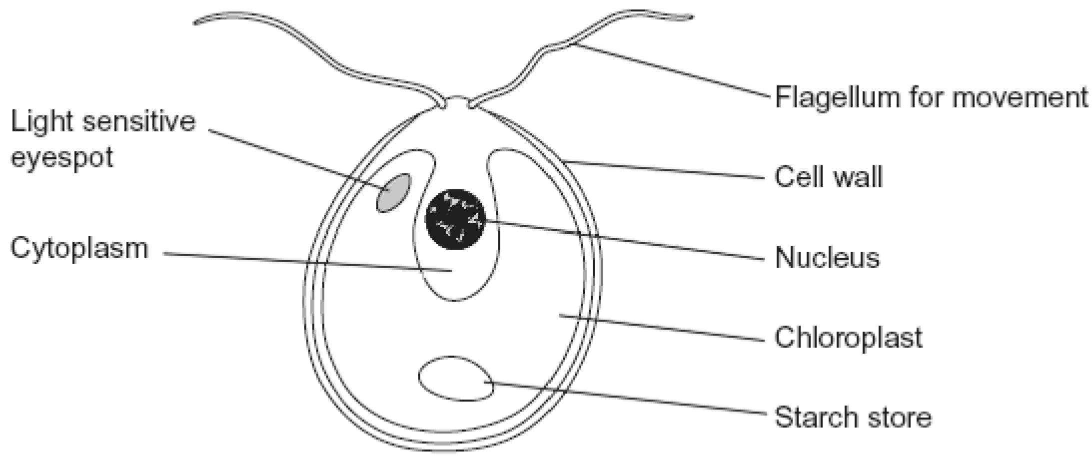
AQA AS Biology

3.2 Cells

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective, and use the revision notes to fill in any gaps.

Q1. The diagram shows an organism called *Chlamydomonas*.



(a) Name **two** structures shown in the diagram that are present in plant cells but are **not** present in animal cells.

1 ....

....

2 ....

....

(2)

(b) *Chlamydomonas* lives in freshwater ponds. Use your knowledge of osmosis to suggest an advantage of using starch as a carbohydrate store.

....

....

....

....

(2)

(c) *Chlamydomonas* has adaptations that help it to maintain a high rate of photosynthesis.

Use information in the diagram to explain what these adaptations are.

....

....

....

....

....

(Extra space)
....

....

....

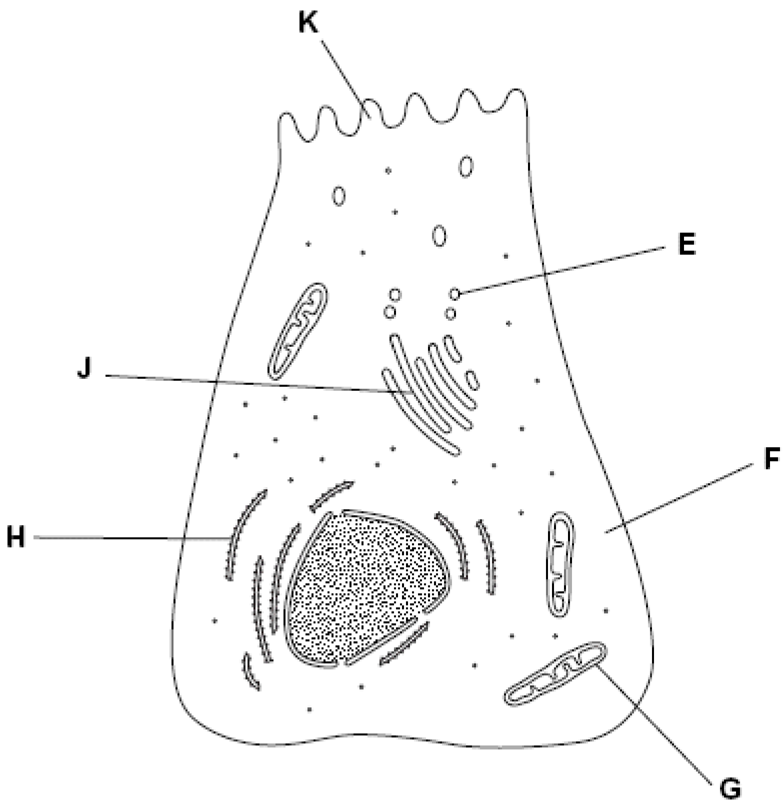
(3)
(Total 7 marks)

Q2. (a) Name the type of bond that joins amino acids together in a polypeptide.

....

(1)

The diagram shows a cell from the pancreas.



(b) The cytoplasm at **F** contains amino acids. These amino acids are used to make proteins, which are secreted from the cell.

Place the appropriate letters in the correct order to show the passage of an amino acid from the cytoplasm at **F** until it is secreted from the cell as a protein at **K**.

F				**K**

(2)

(c) There are lots of organelle **G** in this cell. Explain why.

....

....

....

(2)

(d) A group of scientists homogenised pancreatic tissue before carrying out cell fractionation to isolate organelle **G**.

Explain why the scientists:

(i) Homogenised the tissue.

....

....

(1)

(ii) Filtered the resulting suspension.

....

....

(1)

(iii) Kept the suspension ice cold during the process.

....

....

(1)

(iv) Used isotonic solution during the process.

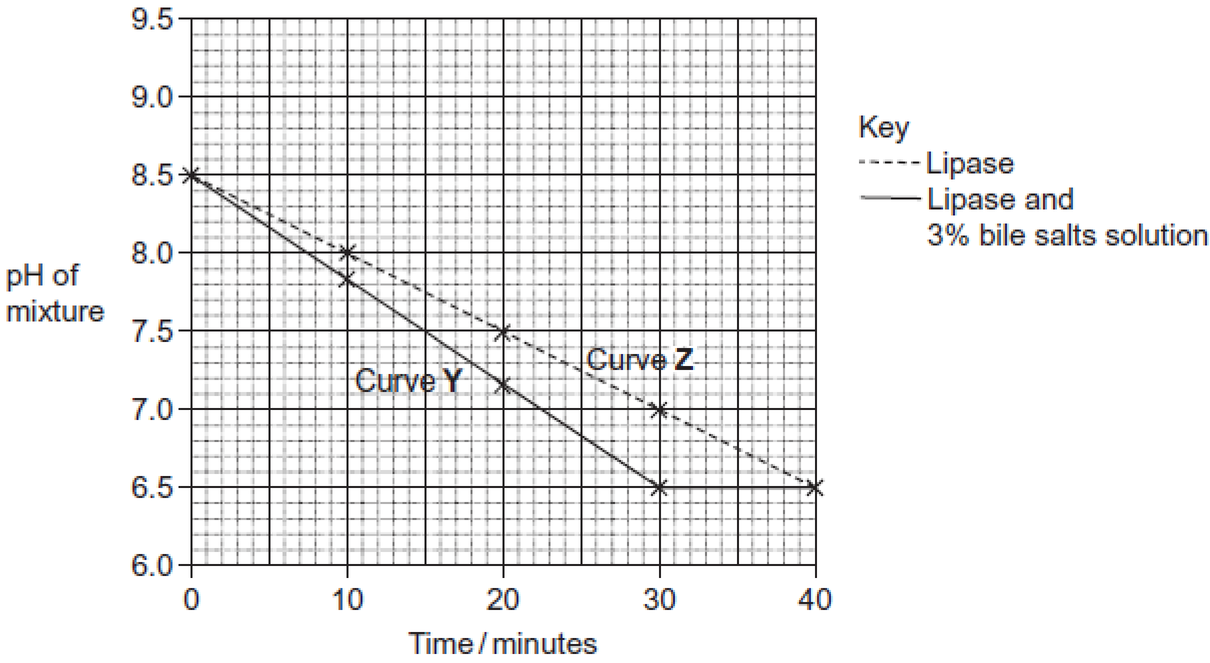
....

....

....

(2)
(Total 10 marks)

Q3. Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.



The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

	Concentration of bile salts /%	0	1	2	3	4	5
	Mean radius of triglyceride droplet / µm	6	5	4	3	2	1

(a) Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

....

....

....

....

(Extra space)
....

....

(3)

(b) (i) The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

Calculate the surface area of a droplet from the formula

$$A = 4\pi r^2$$

Where A = surface area
r = radius
π = 3.14

(2)

(ii) Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

....

....

....

....

(Extra space)
....

....

....

(3)
(Total 8 marks)

Q4. Scientists use optical microscopes and transmission electron microscopes (TEMs) to investigate cell structure. Explain the advantages and the limitations of using a TEM to investigate cell structure.

....

....

....

....

....

....

....

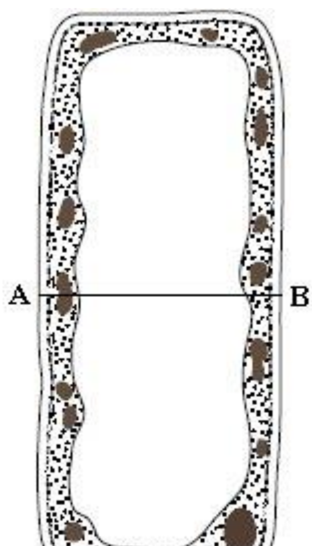
....

....

....

(Total 5 marks)

Q5. The figure shows a section through a palisade cell in a leaf as seen with a light microscope. The palisade has been magnified × 2000.



X2000

(a) Calculate the actual width of the cell, measured from **A** to **B**, in µm. Show your working.

Answer .... µm

(2)

(b) Palisade cells are the main site of photosynthesis. Explain **one** way in which a palisade cell is adapted for photosynthesis.

....

....

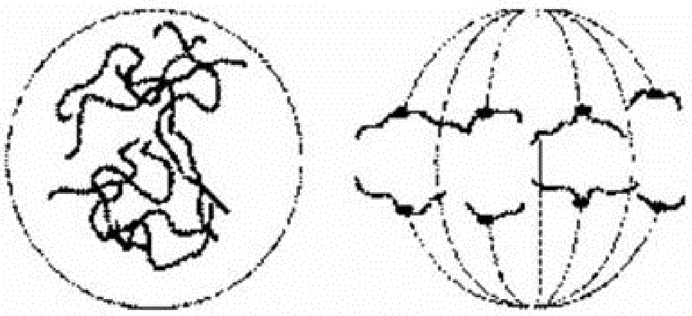
....

....

(2)

(Total 4 marks)

Q6. (a) The photographs show two stages in mitosis of a plant cell.



A **B**

Name stages **A** and **B**. In each case describe what is happening to the chromosomes.

(i) Stage **A** ....

....

....

....

(2)

(ii) Stage **B** ....

....

....

....

(2)

(b) Describe **two** events during interphase which prepare a cell for mitosis.

1 ....

....

2 ....

....

(2)
(Total 6 marks)

Q7. (a) Mitosis is important in the life of an organism. Give **two** reasons why.

....

....

....

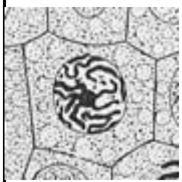
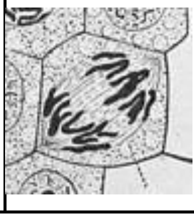
....

....

(2)

A biologist used a microscope to investigate plant tissue, where some of the cells were dividing by mitosis. She examined 200 cells and counted the number of cells in interphase and in each stage of mitosis.

The table shows some of the cells she saw, and the percentage of cells in interphase and in two stages of mitosis, **A** and **B**.

Stage of cell cycle		Percentage of cells
Interphase		90
Stage **A**		3
Stage **B**		1

Images by Edmund Beecher Wilson [Public domain], via Wikimedia Commons

(b) (i) Explain why the biologist chose to examine 200 cells.

....

....

....

(1)

(ii) Name Stage **A** and Stage **B**. Give the evidence from the photograph that you used to identify the stage.

Name of Stage **A** ....

Evidence ....

....

Name of Stage **B**

....

Evidence

....

....

(4)

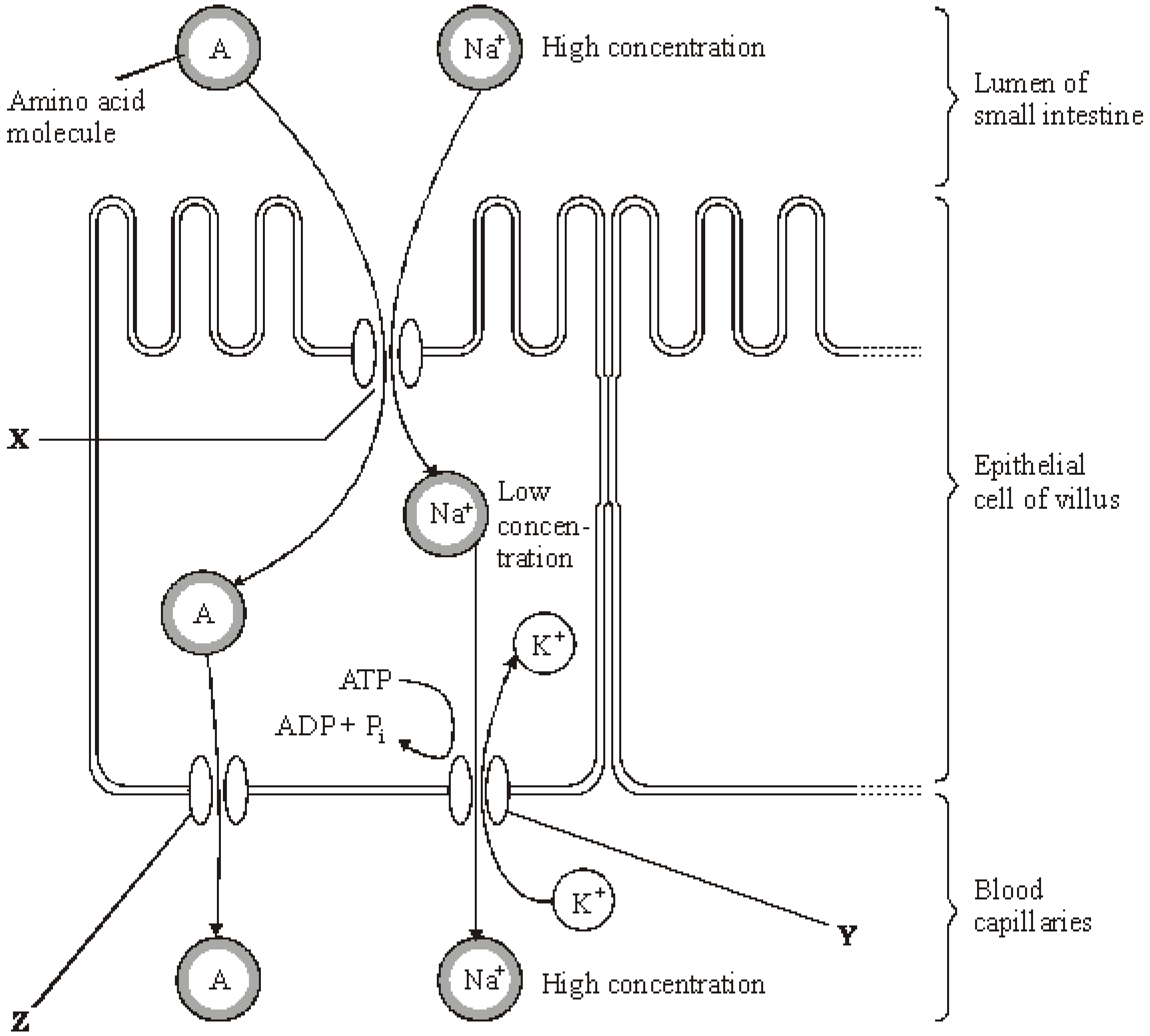
(c) In this tissue, one complete cell cycle took 20 hours.
Using information from the table, calculate the mean time for these cells to complete mitosis. Show your working.

Answer ....

(2)
(Total 9 marks)

Q8. The diagram shows one method by which amino acids are absorbed from the small intestine into the blood. They are co-transported into the epithelial cell with sodium ions (Na^+) at point **X** on the diagram. Normally, the concentration of sodium ions inside the epithelial cell is low.

Source: Adapted from M. ROWLAND,



Biology (University of Bath Science 16-19) (Nelson Thornes) 1992.

Dinitrophenol (DNP) prevents oxidative phosphorylation. When treated with DNP, the sodium-potassium pump at **Y** no longer works. As a result, the concentration of sodium ions in the cell rises and amino acid absorption stops.

(i) Explain why pump **Y** will **not** work in the presence of DNP.

....

....

....

....

(2)

(ii) Explain why sodium ions and amino acids are **not** absorbed from the lumen of the small intestine in the presence of DNP.

....

....

....

....

(2)

(iii) By what mechanism would amino acids leave the epithelial cell at point **Z**?

....

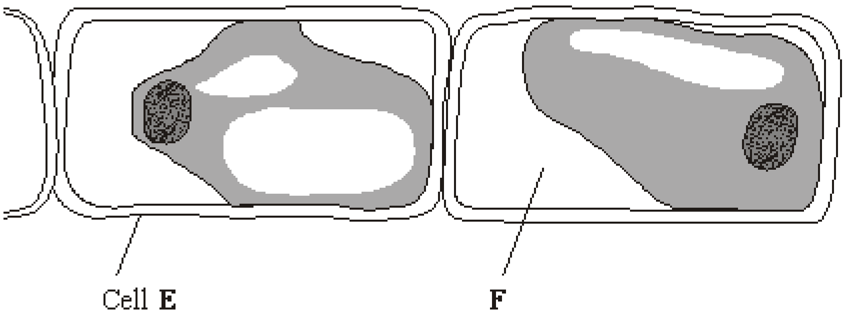
(1)
(Total 5 marks)

Q9. Tradescantia is a house plant. There are small hairs on its flowers. These hairs are made of cells. **Figure 1** shows the appearance of cells from one of these hairs after 20 minutes in distilled water. **Figure 2** shows cells from another hair after 20 minutes in a solution of potassium nitrate.

Figure 1 (in distilled wat

er)

Figure 2 (In potassium nitrate solution)



(a) What does **Figure 2** suggest about the permeability of the plasma membranes surrounding these cells?

....

....

(1)

(b) What is present in the space labelled **F**? Explain your answer.

....

....

....

....

(2)

(c) How would the water potential of the sap in the vacuole of cell **E** differ from the water potential of the sap in the vacuole of cell **D**? Explain your answer.

....

....

....

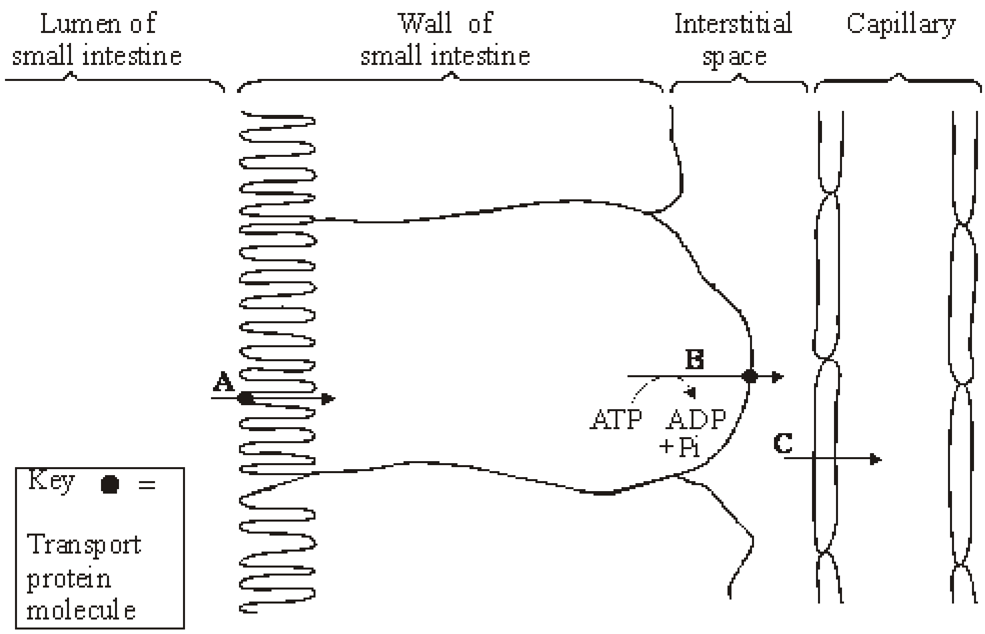
....

....

....

(3)
(Total 6 marks)

Q10. The figure below shows the processes involved in absorbing amino acids into a capillary from the small intestine.



(i) Name processes **A**, **B** and **C**. In each case, give the evidence for your answer.

A Process ....

Evidence ....

....

B Process ....

Evidence ....

....

C Process ....

Evidence ....

....

(3)

(ii) Explain how process **B** creates the conditions for process **A** to occur.

....

....

....

....

(2)

(Total 5 marks)

Q11. A student investigated the effect of putting cylinders cut from a potato into sodium chloride solutions of different concentration. He cut cylinders from a potato and weighed each cylinder. He then placed each cylinder in a test tube. Each test tube contained a different concentration of sodium chloride solution. The tubes were left overnight. He then removed the cylinders from the solutions and reweighed them.

(a) Before reweighing, the student blotted dry the outside of each cylinder. Explain why.

....

....

....

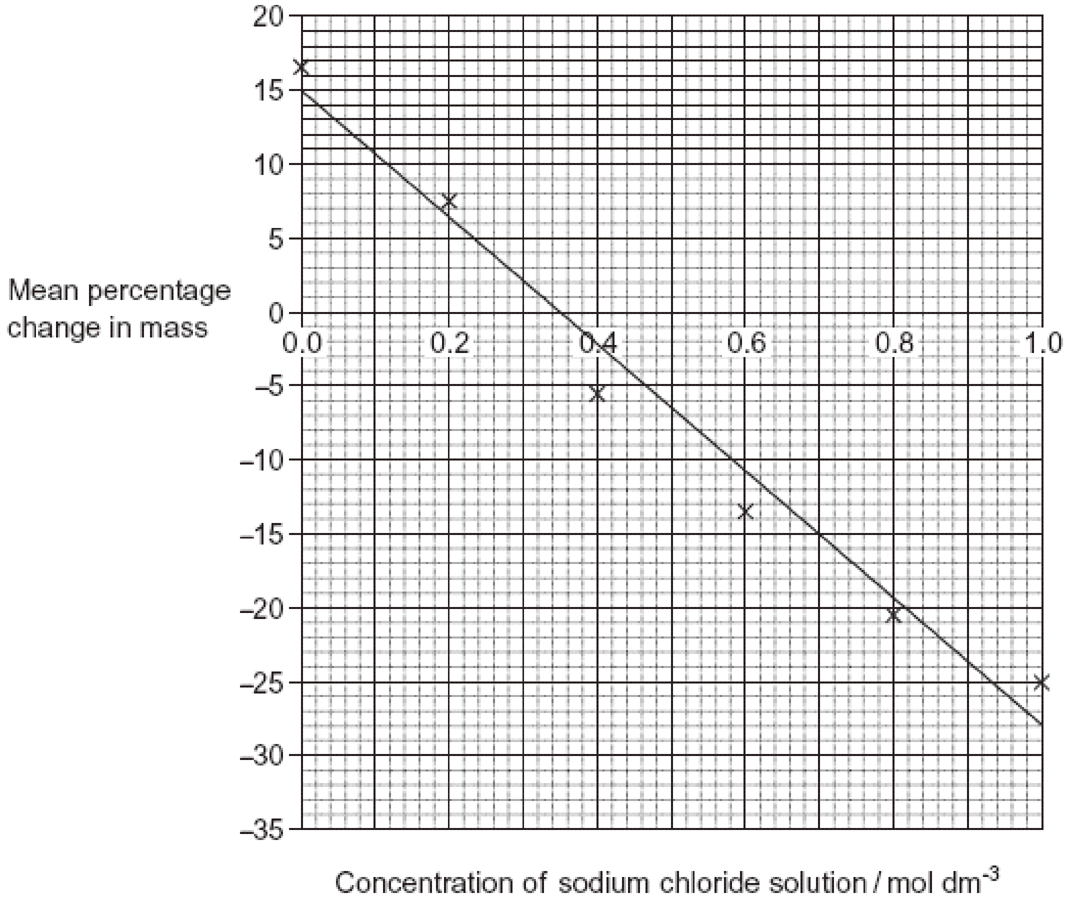
....

....

....

(2)

The student repeated the experiment several times at each concentration of sodium chloride solution. His results are shown in the following graph.



(b) The student made up all the sodium chloride solutions using a 1.0 mol dm^{-3} sodium chloride solution and distilled water.

Complete the table to show how he made 20 cm^3 of a 0.2 mol dm^{-3} sodium chloride solution.

	Volume of 1.0 mol dm^{-3} sodium chloride solution	**Volume of distilled water**

(1)

(c) The student calculated the *percentage* change in mass rather than the change in mass. Explain the advantage of this.

....

....

....

....

....

(2)

(d) The student carried out several repeats at each concentration of sodium chloride solution. Explain why the repeats were important.

....

....

....

....

....

(2)

(e) Use the graph to find the concentration of sodium chloride solution that has the same water potential as the potato cylinders.

.... mol dm^{-3}

(1)
(Total 8 marks)

Q12. (a) Contrast the processes of facilitated diffusion and active transport.

....

....

....

....

....

....

(Extra space) ....

....

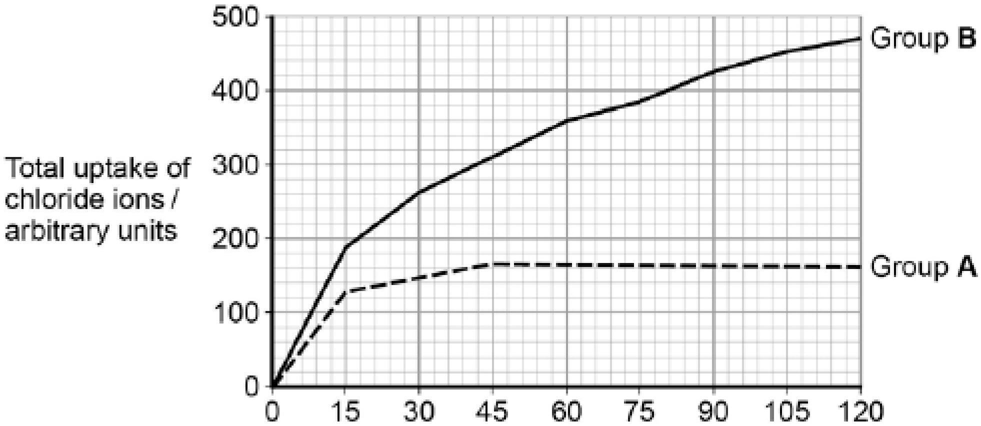
.... **(3)**

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.
- Group **B** plants did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in the figure below.

Time / minutes



(b) Calculate the ratio of the mean **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants.

Ratio = ... :1

(2)

(c) Explain the results shown in the figure above.

....

....

....

....

....

....

....

....

....

(Extra space) ....

....

....

....

(4)
(Total 9 marks)

Q13. The figure below shows a test that has been developed to find out if a person has antibodies to the human immunodeficiency virus (HIV) antigen.

	Step 1	HIV antigens are attached to a test well in a dish.

		↓
	Step 2	A sample of blood plasma is added to the well. If HIV antibodies are present, they bind to the HIV antigen.
		↓
	Step 3	The well is washed. A second antibody with an enzyme attached is then added. This binds specifically to the HIV antibody.
		↓
	Step 4	The well is washed again. A yellow solution is added, which changes to blue if the enzyme is present. A blue colour shows that the person has HIV antibodies.

(a) This test only detects the presence of HIV antibodies. Give **two** reasons why it cannot be used to find out if a person has AIDS.

1 ....

....

2 ....

.... **(2)**

(b) The solution will remain yellow if a person is **not** infected with HIV. Explain why.

....

....

....

....

(2)

(c) A mother who was infected with HIV gave birth to a baby. The baby tested positive using this test. This does not prove the baby is infected with HIV.
Explain why.

....

....

....

....

(2)

(d) A control well is set up every time this test is used. This is treated in exactly the same way as the test wells, except that blood plasma is replaced by a salt solution.

Use information from the figure above to suggest **two** purposes of the control well.

1 ....

....

2 ....

....

(2)
(Total 8 marks)

Q14.

	The human immunodeficiency virus (HIV) leads to the development of Acquired Immunodeficiency Syndrome (AIDS). Eventually, people with AIDS die because they are unable to produce an immune response to pathogens.	

	Scientists are trying to develop an effective vaccine to protect people against HIV. There are three main problems. HIV rapidly enters host cells. HIV causes the death of T cells that activate B cells. HIV shows a lot of antigenic variability.	
	Scientists have experimented with different types of vaccine for HIV. One type contains HIV in an inactivated form. A second type contains attenuated HIV which replicates in the body but does not kill host cells. A third type uses a different, non-pathogenic virus to carry genetic information from HIV into the person's cells. This makes the person's cells produce HIV proteins. So far, these types of vaccine have not been considered safe to use in a mass vaccination programme.	

Use the information in the passage and your own knowledge to answer the following questions.

(a) People with AIDS die because they are unable to produce an immune response to pathogens (lines 2-4).

Explain why this leads to death.

....

....

....

....

....

....

....

....

....

....

(3)

(b) Explain why each of the following means that a vaccine might **not** be effective against HIV.

(i) HIV rapidly enters host cells (lines 6-7).

....

....

....

....

....

....

(2)

(ii) HIV shows a lot of antigenic variability (lines 7-8).

....

....

....

....

....

(2)

(c) So far, these types of vaccine have not been considered safe to use in a mass vaccination programme (lines 14-15).

Suggest why they have **not** been considered safe.

....

....

....

....

....

....

(Extra space) ....

....

....

(3)
(Total 10 marks)

AQA AS Biology

3.2 Cells

Mark scheme

Q1. (a) Cell wall;

Starch (store);

Chloroplast;

Accept: phonetic spelling

2 max

(b) Insoluble;

Reduces / 'stops' water entry / osmosis / does not affect water potential / is osmotically inactive;

Accept: description for first point e.g. 'does not dissolve'.

2

(c) Light sensitive eyespot / eyespot detects light;

Flagellum enables movement towards light;

Chloroplast / chlorophyll absorbs light / for photosynthesis;

Do not penalise references to 'many chloroplasts'.

3

[7]

Q2. (a) Peptide;

***Q** Do not accept polypeptide*
Neutral: covalent

1

(b) (F) H J E (K);

All three boxes correct = 2 marks
Two boxes correct = 1 mark

2

(c) (Site of aerobic) respiration;

Release ATP / energy for active transport / transport against the concentration gradient / protein synthesis / exocytosis;

***Q** Reject: anaerobic respiration*

***Q** Reject: produces / makes energy*

Accept: produces ATP for energy

Reject: produces ATP for respiration

Neutral: protein secretion

2

(d) (i) Breaks open cells / disrupts cell membrane / releases cell contents / releases organelles / break up cells;

Reject: breaks down cell wall

Neutral: separates the cells

Reject: breaks up cells so they can be separated

Reject: breaks up / separates organelles

1

(ii) Removes (cell) debris / complete cells / tissue;

*Neutral: to isolate organelle **G** / mitochondria*

Neutral: removes unwanted substances / impurities

Reject: removes organelles / cell walls

1

(iii) Reduces / prevents <u>enzyme</u> activity;

Reject: ref. to denaturation

1

(iv) Prevents osmosis / no (net) movement of water / water does not enter organelle / water does not leave organelle;

So organelle / named organelle is not damaged / does not burst / does not shrivel;

Neutral: ref. to water potential

***Q** Ref. to cells rather than organelles negates the second mark only*

Reject: ref. to turgid / flaccid for second mark

Reject: organelle 'explodes' for second mark

2

[10]

Q3. (a) Measure with eyepiece graticule / scale;

Calibrate with stage micrometer / scale on slide / object of known size;
Repeats and calculate the mean;
OR
Use a ruler to estimate the field diameter under microscope;
How many droplets go across the field;
Repeats and calculate mean;

Accept references to radius

3

(b) (i) Two marks for correct answer of 4 : 1;;
One mark for incorrect answer but working shows that candidate has clearly attempted to compare values of r^2 / 6^2 and 3^2 / 36 and 9;

Idea of comparing ratios
A ratio of 1 : 4 should gain 1 mark

2

(ii) Small droplets have a larger surface area to volume ratio;

More surface for lipase (to act), leading to faster digestion of triglycerides;

Fatty acids are produced more quickly so pH will drop more quickly in curve **Y** / with bile salts / less fatty acids in curve **Z** / without bile salts so pH drop more slowly;

3

[8]

Q4. Advantages:

1 Small objects can be seen;

2 TEM has high resolution as wavelength of electrons shorter;

Accept better

Limitations:

3 Cannot look at living cells as cells must be in a vacuum / must cut section / thin specimen;

4 Preparation may create artefact

5 Does not produce colour image;

[5]

Q5. (a) 16 gains 2 marks;

(accept 15.5 . 16.5)

(principal of calculation i.e.
<u>measured distance (31-33mm / 3.1-3.3cm)</u> gains 1 mark)
Mag

2

(b) relevant adaptation;
and explanation for second mark; e.g.

idea of many chloroplasts / lots of chlorophyll;
to trap or absorb light (energy);

elongated cells;
idea of maximum light absorption / light penetration;

chloroplasts move;
to trap or absorb light (energy);

range of pigments;
can absorb a range of wavelengths / colours / for max light absorption;

large S.A. or cell wall feature e.g. thin / permeable;
for (rapid) CO_2 absorption;

2

[4]

Q6. (a) (i) prophase;
chromosomes thickening/becoming visible;

2

(ii) anaphase;
chromatids/chromosomes moving to opposite poles/
ends of spindles;

2

(b) DNA replication;
synthesis or proteins/build-up of energy stores/growth/
increase in cytoplasm;
replication of organelles/named example;

2 max

[6]

Q7. (a) 1. Growth / increase in cell number;

Ignore growth of cells

2. Replace cells / repair tissue / organs /body;

Ignore repair cells

Reject bacteria

3. Genetically identical cells;

3. 'Produces 2 genetically identical cells' does not reach MP1 as well as MP3

4. Asexual reproduction / cloning;

4. Allow example or description

2 max

(b) (i) (Ensures) representative (sample);

Accept find some cells in mitosis / not in interphase.
Accept 'more reliable' only if linked to percentage (of cells).'Improves reliability' on its own does not gain this mark

Neutral: Large sample

1

(ii) 1. A =Prophase;

2. Chromatin/chromosomes have condensed so that they can be seen

3. B = anaphase;

4. Chromatids / chromosomes separating / moving apart / moving to poles;

4. Reject homologous chromosomes

4

(c) 2 hours / 120 minutes;

Allow 1 mark if working shows candidate understood that mitosis would take 10%

2

[9]

Q8. (i) Lack of ATP;
Pump = <u>active</u> transport / requires <u>energy</u> / ATP provides <u>energy</u> / transport is up
concentration gradient;

2

(ii) Concentration of Na^+ inside cell no longer less than concentration in gut lumen / no longer a concentration gradient;
No (facilitated) diffusion of NA^+ ions possible / amino acid absorption requires diffusion of Na^+ ions into cell;

2

(iii) Diffusion / facilitated diffusion;

1

[5]

Q9. (a) partially / selectively permeable *accept semi-permeable*
allows water to pass through but not potassium nitrate / solute;

1

(b) potassium nitrate (solution);
cell wall permeable;

2

(c) water potential more negative / lower in cell E; water removed;
greater solute / sap concentration (in cell);

3

[6]

Q10. (i) In all cases reject 'energy' unless qualified

A – <u>facilitated</u> diffusion as transport protein needed but ATP not needed;
B – active transport 'energy' unless as (transport protein and) ATP needed; qualified
C – (simple) diffusion as neither ATP nor transport protein needed;

(Ignore all references to concentration gradients)

3

(ii) creates low concentration of amino acids / Na^+ in cell concentration gradient established between lumen and cell (of amino acids or Na^+)

2

[5]

Q11. (a) Water will affect the mass / only want to measure water taken up or lost;

Amount of water on cylinders varies / ensures same amount of water on outside;

Neutral: removes water

Accept: '(sodium chloride) solution' for water

Do not accept 'sodium chloride'

Neutral: refs. to fair testing

2

(b) 4 cm^3 (of 1.0 mol dm^{-3} sodium chloride solution) <u>and</u> 16 cm^3 (of distilled water);

Reject: factors and multiples of these figures e.g. 2 cm^3 and 8 cm^3, as final volume should be 20 cm^3

1

(c) Allows comparison / shows proportional change;

Idea that cylinders have different starting masses / weights;

Reject: if comparison is in context of the start and final mass of the same cylinder

Neutral: different masses

Neutral: different starting sizes

2

(d) (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised;

Makes the average / mean / line of best fit more reliable / allows concordant results;

Accept: 'outliers' instead of anomalies

Q *Reject: abnormalities*

Reject: idea of not recording anomalies / preventing anomalies from occurring

Accept: 'cancels out anomalies' as bottom line response

Q *Reject: makes the average / mean more accurate*

Neutral: makes the average / mean more valid

Neutral: makes 'it' / results / conclusion more reliable

2

(e) 0.35 (mol dm^{-3})

1

[8]

Q12. (a)
1. Facilitated diffusion involves channel or carrier proteins whereas active transport only involves carrier proteins;
2. Facilitated diffusion does not use ATP / is passive whereas active transport uses ATP;
3. Facilitated diffusion takes place down a concentration gradient whereas active transport can occur against a concentration gradient.

Since 'contrast', both sides of the differences needed

3

(b) 3.3:1.

Correct answer = 2 marks

If incorrect, allow 1 mark for 470–360 / 60 for rate in second hour

2

(c)
1. Group **A** – initial uptake slower because by diffusion (only);
2. Group **A** – levels off because same concentrations inside cells and outside cells / reached equilibrium;
3. Group **B** – uptake faster because by diffusion plus active transport;
4. Group **B** fails to level off because uptake against gradient / no equilibrium to be reached;
5. Group **B** – rate slows because few / fewer chloride ions in external solution / respiratory substrate used up.

4 max

[9]

Q13. (a) (To diagnose AIDS, need to look for / at)

1. (AIDS-related) symptoms;
2. Number of <u>helper</u> T cells;

Neutral: 'only detects HIV antibodies' as given in the question *stem*

2

(b) 1. HIV antibody is not present;

Accept HIV antibodies will not bind (to antigen)

2. (So) second antibody / enzyme will not bind / is not present;

2

(c) 1. Children receive (HIV) antibodies from their mothers / maternal antibodies;

2. (So) solution will always turn blue / will always test positive (before 18 months);

Allow 1 mark for the suggestion that the child does not produce antibodies yet <u>so</u> test may be negative

2

(d) (Shows that)

1. Only the enzyme / nothing else is causing a colour change;

2. Washing is effective / all unbound antibody is washed away;

2

[8]

Q14.(a) 1. Infected by / susceptible to (other) pathogen(s) / named disease caused by a pathogen (from environment);

Context is where immune system cannot prevent or stop these events

Allow attack / kill

2. Pathogen(s) reproduce / cause disease (in host);

MPs not given in context of HIV

3. Damage cells / tissues / organs;

4. Release toxins;

3 max

(b) (i) 1. (HIV enters cells) before antibodies can bind to / destroy it;

Ignore SAFETY comments

1. and 2. Relate to antibodies

2. Antibodies cannot enter cells (to destroy HIV) / stay in blood;

OR

3. (Enters cells) before (secondary) immune response caused / before memory cells have time to respond;

   3. and 4. Relate to virus

4. So no antibodies present (to attack HIV);

OR

5. Vaccine taken up too quickly to cause immune response;

   5. and 6. Relate to vaccine

6. So no antibodies / memory cells formed;

2 max

(ii) 1. Antigen (on HIV) changes;

   Accept mutates

2. (Specific) antibody / receptor no longer binds to (new) antigen;

   Ignore SAFETY comments

OR

3. Many different strains of HIV / many antigens present on HIV;

4. Not possible to make a vaccine for all antigens / vaccine may not stimulate an antibody for a particular antigen;

2 max

(c) 3 suitable suggestions:

QWC ignore reference to HIV cells

E.g.

1. Inactive virus may become active / viral transformation;

2. Attenuated virus might become harmful;

3. Non-pathogenic virus may mutate and harm cells;

4. Genetic information / protein (from HIV) may harm cells;

5. People (may) become / test HIV positive after vaccine used;

   Vaccinated people may develop disease from a different strain to that in the vaccine

6. This may affect their work / life;

May continue high risk activities and develop or pass on HIV

3 max

[10]

AQA AS Biology

3.3 Organisms exchange substances with their environment

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective, and use the revision notes to fill in any gaps.

1. (a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

....

....

....

....

....

....

....

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....

....

....

....

(6)

Mackerels live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(b) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

....

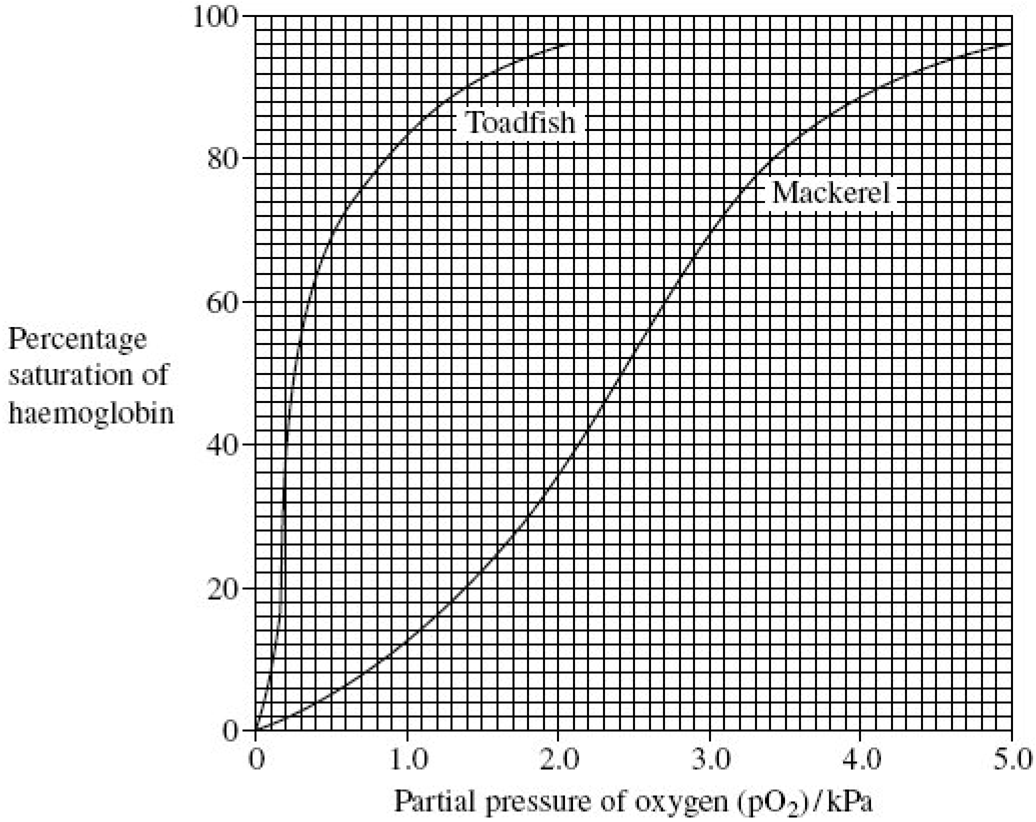
....

....

....

(2)

(c) The graph on the following page shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

....

....

....

....

(2)

(d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	**Position 87**	**Position 104**	**Position 125**
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

....

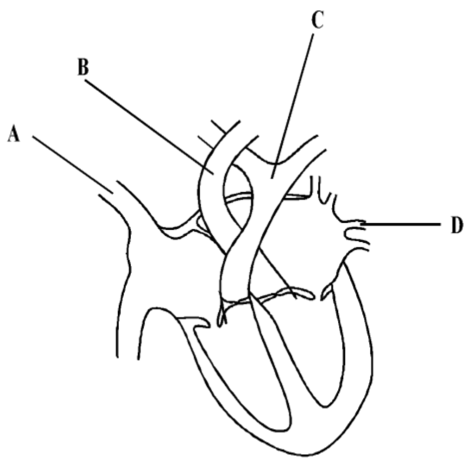
....

....

....

(2)
(Total 12 marks)

2. The diagram shows a section through a human heart.



(a) Which of the blood vessels labelled **A** to **D**

(i) Takes blood from the heart to the muscles of the arms and legs;

....

(1)

(ii) Is a vein which contains oxygenated blood?

....

(1)

(b) Is the right ventricle filling with blood or emptying? Give **two** pieces of evidence from the diagram to support your answer.

Filling or emptying? ....

Evidence

1 ....

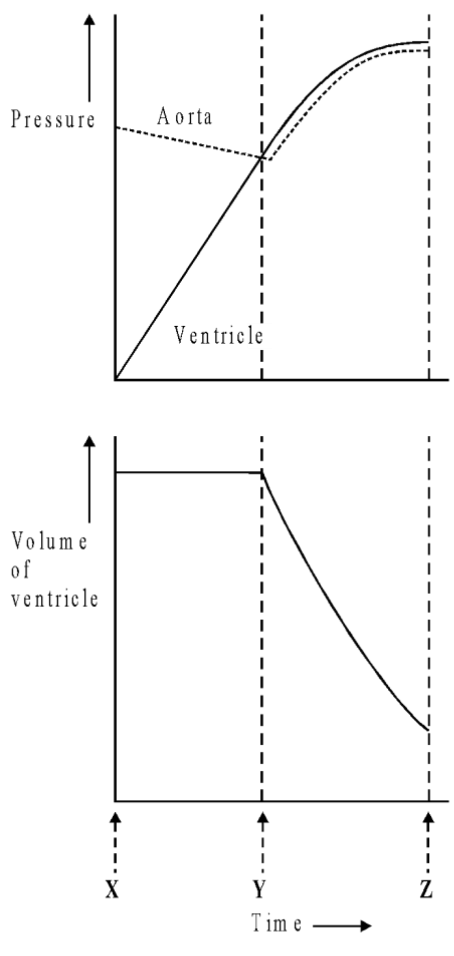
....

2 ....

....

(2)

The graphs show some changes in pressure and volume during part of a cardiac cycle.



(c) Describe what the graphs show about the pressure and volume in the ventricle between times **X** and **Y**.

....

.... **(1)**

(d) At point **Y,** the valve between the aorta and the ventricle opens. Use the information about pressure on the graph to explain why.

....

.... **(1)**

(e) Explain the changes in the volume of the ventricle between times **X** and **Z**.

....

....

....

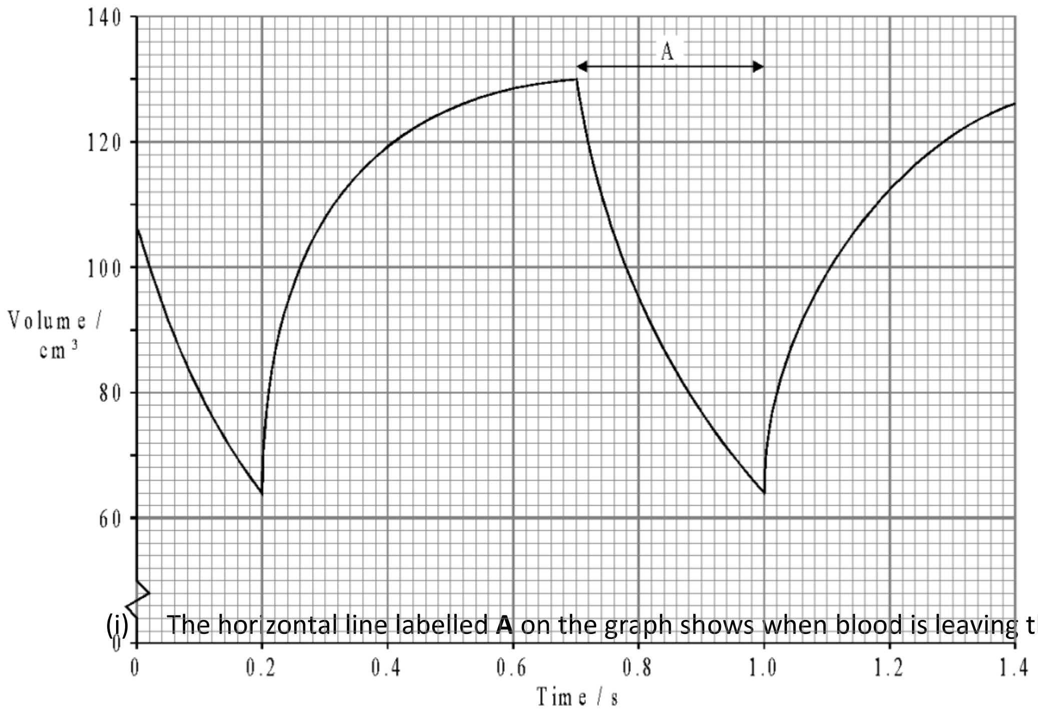
....

....

.... **(3)**

(Total 9 marks)

3. The graph shows changes in the volume of blood in the left ventricle as the heart beats.



(a) (i) The horizontal line labelled **A** on the graph shows when blood is leaving the ventricle. Explain, in

....

....

....

....

(2)

(ii) Draw a horizontal line on the graph, to show the period in one cardiac cycle when the muscle in the wall of the ventricle is relaxed. Label this line with the letter **B**.

(1)

(b) (i) Draw a horizontal line on the graph to show one complete cardiac cycle. Label this line with the letter **C**.

(1)

(ii) Use line **C** to calculate the number of times the heart beats in one minute. Show your working.

Answer ....

(2)

(c) The table shows the blood flow to different parts of the body at rest and during a period of vigorous exercise.

Part of the body	**Rate of blood flow/cm^3 $minute^{-1}$**	
	at rest	**during exercise**
Brain	750	750
Heart muscle	300	1 200
Gut and liver	3 000	1 400
Muscle	1 000	16 000
All other organs (except lungs)	1 550	1 550

(i) Use the figures in the table to calculate the cardiac output at rest.

Answer ....

(1)

(ii) Give **two** ways in which cardiac output is increased during a period of vigorous exercise.

1..

....

2...

....

(2)

4. **Table 1** shows the blood pressure in the left atrium, the left ventricle and the aorta at different stages in a cardiac cycle. These three parts of the circulatory system have been labelled **A**, **B** and **C**.

Time/s	**Blood pressure/kPa**		
	Part **A** (left atrium)	Part **B** (left ventricle)	Part **C** (aorta)
0	0.6	0.3	12.1
0.1	1.1	0.7	11.7
0.2	0.6	12.6	11.8
0.3	0.9	14.8	13.6
0.4	1.2	1.1	12.8
0.5	0.6	0.2	12.6
0.6	0.6	0.2	12.4

Table 1

(a) What is the evidence from the figures in **Table 1** that part **B** is the ventricle?

....

....

(1)

(b) (i) At 0.3s, the atrioventricular valves are closed. Give the evidence from **Table 1** which supports this statement.

....

....

(1)

(ii) For approximately how long is the valve between the left ventricle and the aorta open? Give the reason for your answer.

....

....

....

(2)

(c) The figures in the third column of **Table 1** show the changes in pressure in the left ventricle.

(i) Describe how the pressure in the left ventricle differs from that in the right ventricle.

....

(1)

(ii) Explain what causes this difference.

....

....

(1)

Table 2 compares some features of different blood vessels from a dog.

Property	Artery	Arteriole	Capillary
Diameter of lumen	0.4	30 µm	8 µm
Thickness of wall	1 mm	20 µm	1 µm
Tissues present in wall			
Endothelium	✓	✓	✓
Elastic tissue	✓	✓	✗
Muscle	✓	✓	✗

Table 2

Key ✓ Tissue present
✗ Tissue absent

(d) What is the thickness of one of the endothelial cells lining these blood vessels?

Answer: .... µm

(1)

(e) Explain why an arteriole may be described as an organ.

....

....

....

(2)

(f) Use the information in **Table 2** to explain how the structure of the walls of arteries, arterioles and capillaries is related to their function.

....

....

....

....

....

....

....

....

....

....

(6)

(Total 15 marks)

5. (a) During the cardiac cycle the heart fills with blood and then the ventricles contract. The table gives the filling time and the contraction time at different heart rates.

Heart rate/beats per minute	Filling time/seconds	Contraction time/seconds
39.7	0.37	1.14
49.6	0.38	0.83
71.4	0.38	0.46
81.1	0.38	0.36
87.0	0.39	0.30

(i) Give **two** conclusions that can be drawn from the figures in the table.

1 ....

....

2 ....

....

(2)

(ii) Explain how you would use the figures in the table to calculate the contraction time at a heart rate of 60 beats per minute.

....

....

....

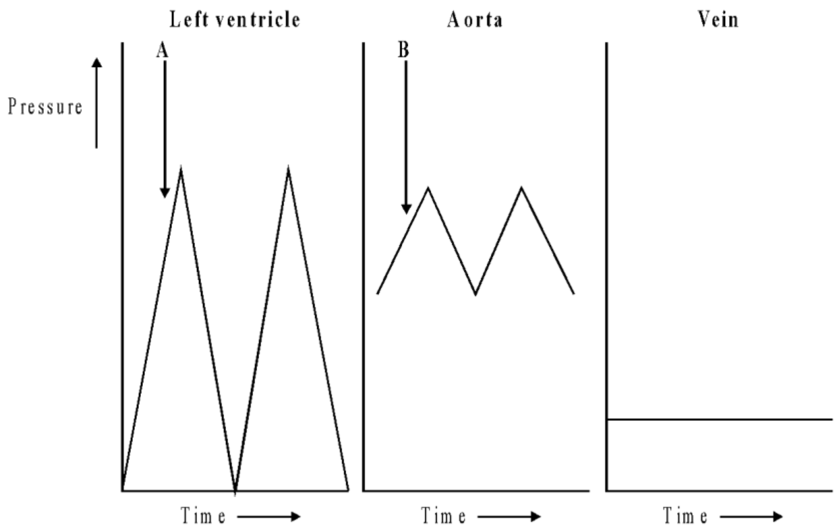
(2)

(iii) What additional information would you need in order to find the cardiac output at a particular heart rate?

....

(1)

(b) The diagram on the following page shows variations in blood pressure in different parts of the circulatory system.



(i) Complete the table with ticks to show whether each of the valves is open or closed at the point indicated with the letter **A** on the diagram.

Valve located between	Open	Closed
Left atrium and left ventricle		
Left ventricle and aorta		
Right atrium and right ventricle		

Right ventricle and pulmonary artery		

(2)

(ii) A pulse can be felt when the fingers are placed over an artery that is close to the surface. Explain why a pulse cannot be felt when the fingers are placed over a vein which is close to the surface.

....

....

(1)

(iii) What causes the blood pressure to increase at the point indicated with a letter **B** on the diagram?

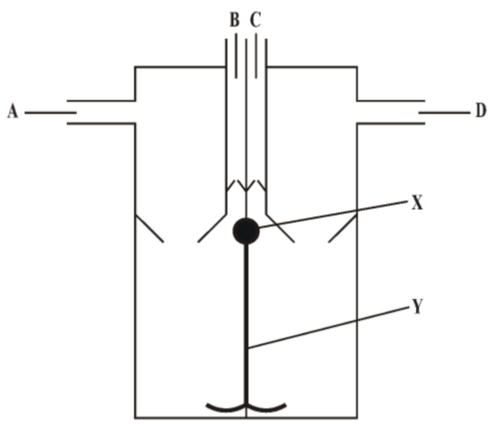
....

....

(1)

(Total 9 marks)

6. This diagram shows a human heart seen from the front.



(a) (i) Which **one or more** of vessels **A** to **D** contains oxygenated blood?

....

(1)

(ii) During a cardiac cycle, the pressure of the blood in vessel **C** is higher than the pressure of the blood in vessel **B**. Explain what causes this difference in pressure.

....

....

(1)

(b) What does the diagram suggest about the pressure in the atria compared to the pressure in the ventricles at the stage in the cardiac cycle represented in the diagram?

Explain your answer.

....

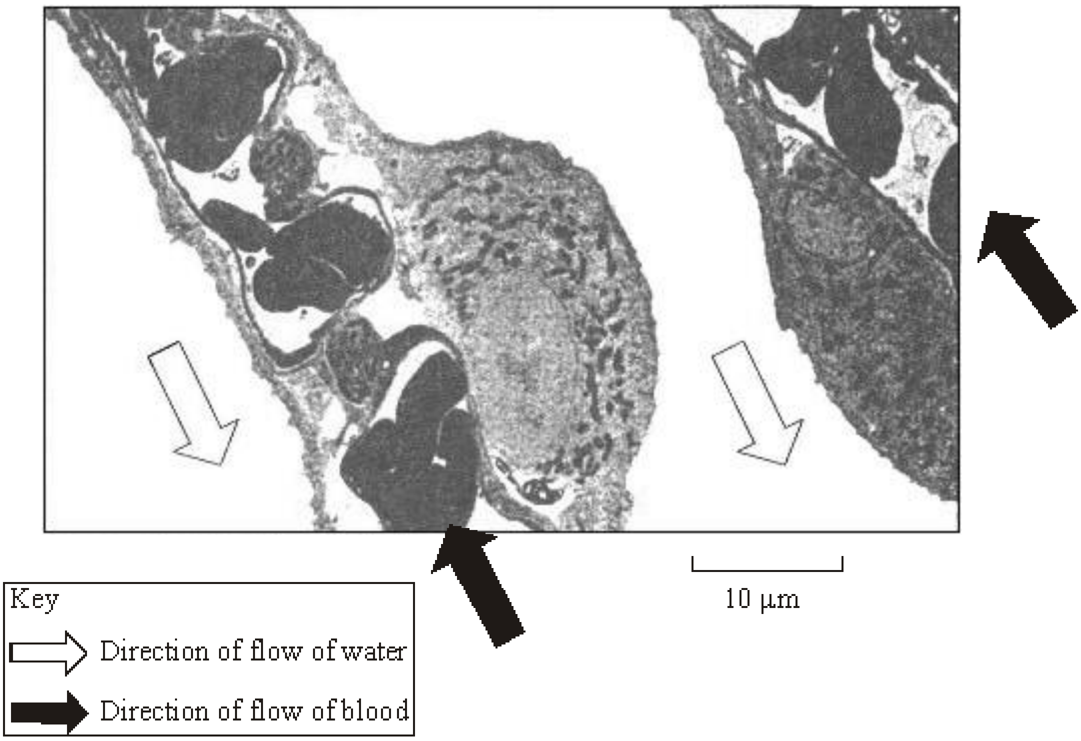
....

....

....

(2)

7. The electron micrograph on the following page shows a section through a fish gill. The directions of flow of water and of blood are indicated by arrows.



(a) Calculate the minimum distance that a molecule of oxygen would have to travel from the water to a red blood cell. Give your answer in micrometres and show your working.

Answer .... µm.

(2)

(b) Explain how the relationship between the direction of flow of water and of blood shown in the micrograph is useful to a fish.

....

....

....

....

(3)
(Total 5 marks)

8. (a) Describe the features of fish gills that give them a large surface area.

....

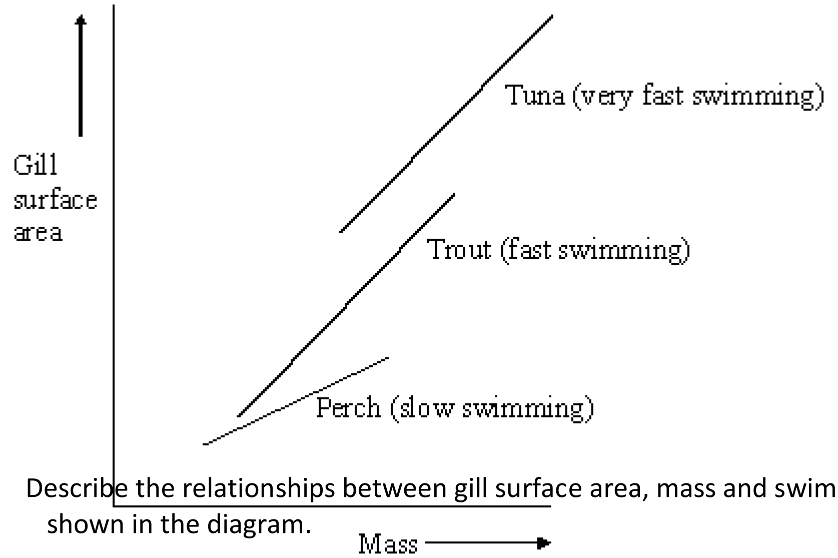
....

....

....

(2)

The graph shows the relationship between gill surface area and body mass for three species of fish.



(b) (i) Describe the relationships between gill surface area, mass and swimming speed shown in the diagram.

....

....

(1)

(ii) Explain the relationship between gill surface area and swimming speed.

....

....

....

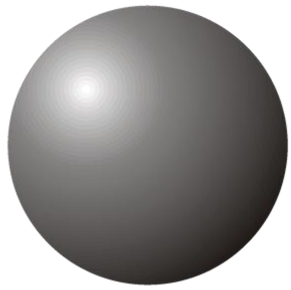
....

(2)

(Total 5 marks)

9. A student investigated how the surface area of a single-celled organism is related to its volume. The student used two spheres, **A** and **B**, as models of two organisms. The surface area and volume of each sphere was calculated.

The results are shown in the table below.

	Sphere **A**	Sphere **B**
		
Diameter / cm	1	3
Surface area / cm^2	3.14	28.27
Volume / cm^3	0.52	14.14

(i) The student calculated the surface area: volume ratio of sphere **B** as 2:1.

Calculate the surface area: volume ratio of sphere **A**. Show your working.

....

[2]

(ii) How does the surface area: volume ratio of sphere **B** differ from that of sphere **A**?

....

[1]

(iii) Single-celled organisms generally have a surface-area to volume ratio more like that of sphere **A** than sphere **B**.

Explain why.

....

....

....

....

....

[2]
[Total 5 marks]

10. The lungs in the mammalian body are well developed to allow effective exchange of gases.

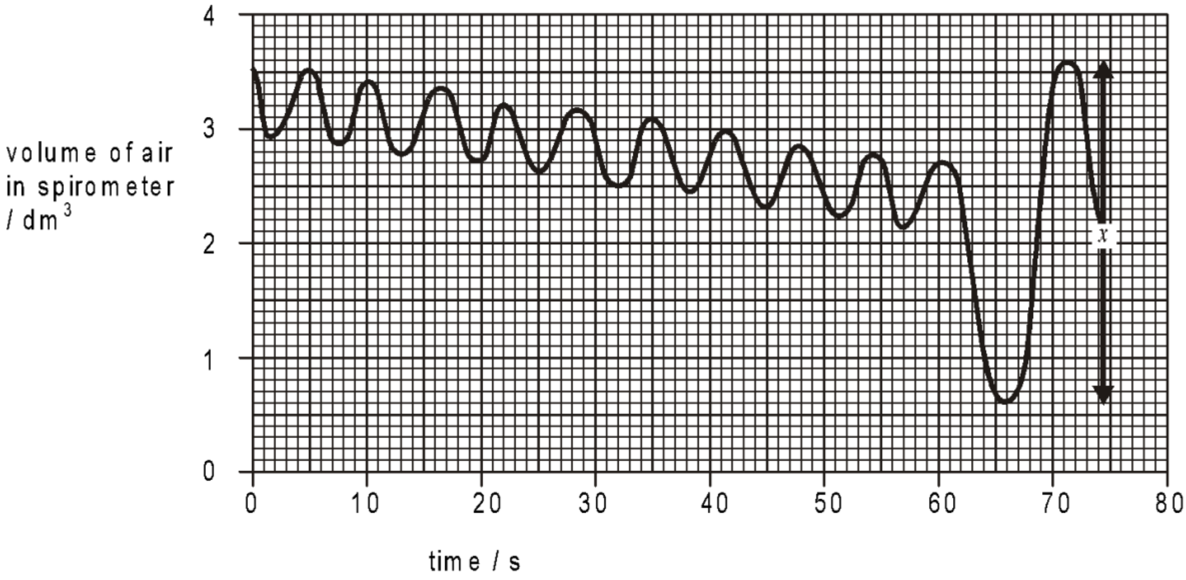
Describe the features of the lungs that make them effective organs for the exchange of gases.

✎ *In your answer, you should use appropriate technical terms, spelled correctly.*

(Allow one lined page).

[Total 5 marks]

11. The diagram below shows the trace from a spirometer. A spirometer is a device designed to measure the volume of air entering and leaving the lungs. A chamber in the spirometer contains soda lime to absorb the carbon dioxide released by respiration. The measurements shown were recorded from a healthy 17-year-old student at rest.



(i) Explain why the volume of air in the spirometer drops slowly over the first minute.

....

....

....

....

[2]

(ii) After one minute, the student was asked to breathe in as deeply as possible and then breathe out as much as possible.

The resulting change in the trace is shown in the figure above as **X**.

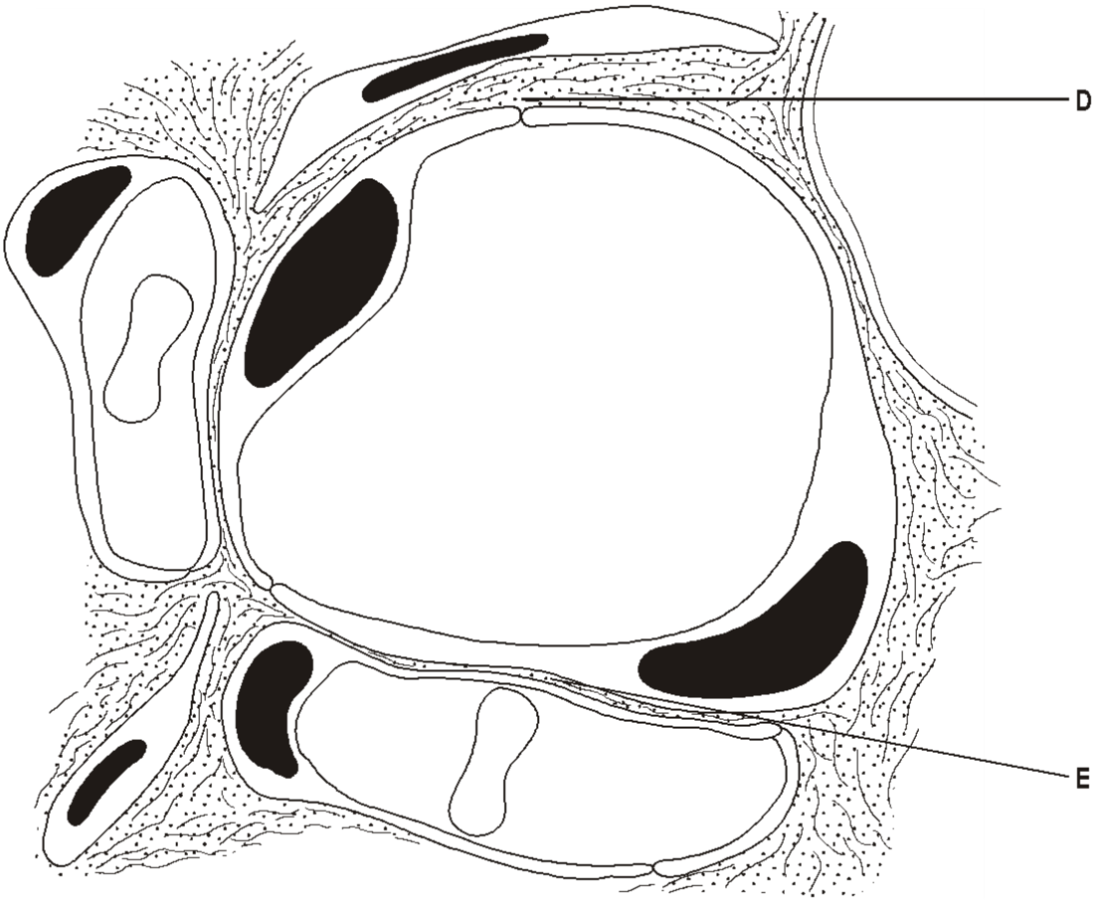
State the term given to measurement **X**.

....

[1]

[Total 3 marks]

12. The diagram below shows the detailed structure of a small part of the mammalian lung.



(i) State the name of the structure shown between lines **D** and **E**.

....

[1]

(ii) List **three** features of the structure which you have identified in (i) which make it suitable for gas exchange.

1 ....

....

2 ....

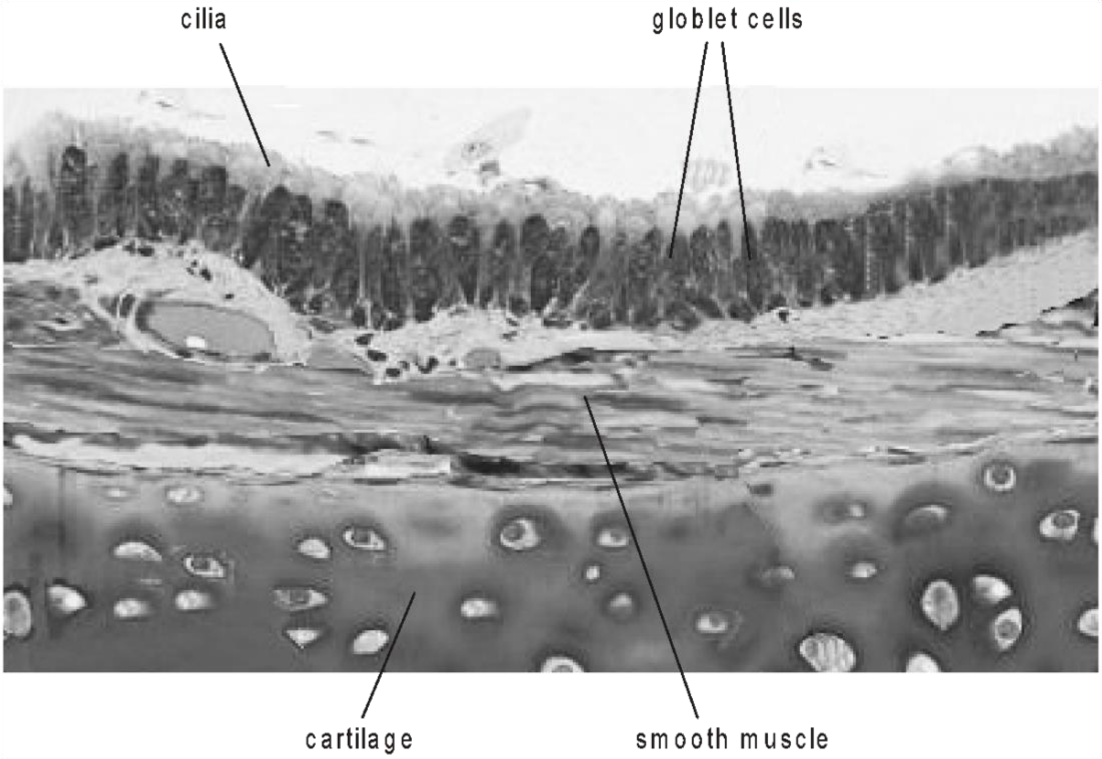
....

3 ....

....

[3]
[Total 4 marks]

13. The different parts of the gaseous exchange system, such as the bronchi, show structural adaptations to their functions. The diagram below shows a section through the wall of a bronchus as seen with a light microscope.



(a) (i) State **one** function for each of the following components of the bronchus wall.

Goblet cell ....

....

Cartilage ....

....

[2]

(ii) State **two** ways in which the **structure** of the wall of the bronchus would be different in a long-term smoker.

1 ....

....

2 ....

....

[2]

(b) Gaseous exchange occurs across the walls of the alveoli.

Explain why the walls of the alveoli contain elastic fibres.

....

....

....

....

[2]

(c) One feature of the disease emphysema is that the alveoli lose their elasticity.

Explain the effects of this loss of elasticity on the gaseous exchange system of a person with emphysema.

....

....

....

....

....

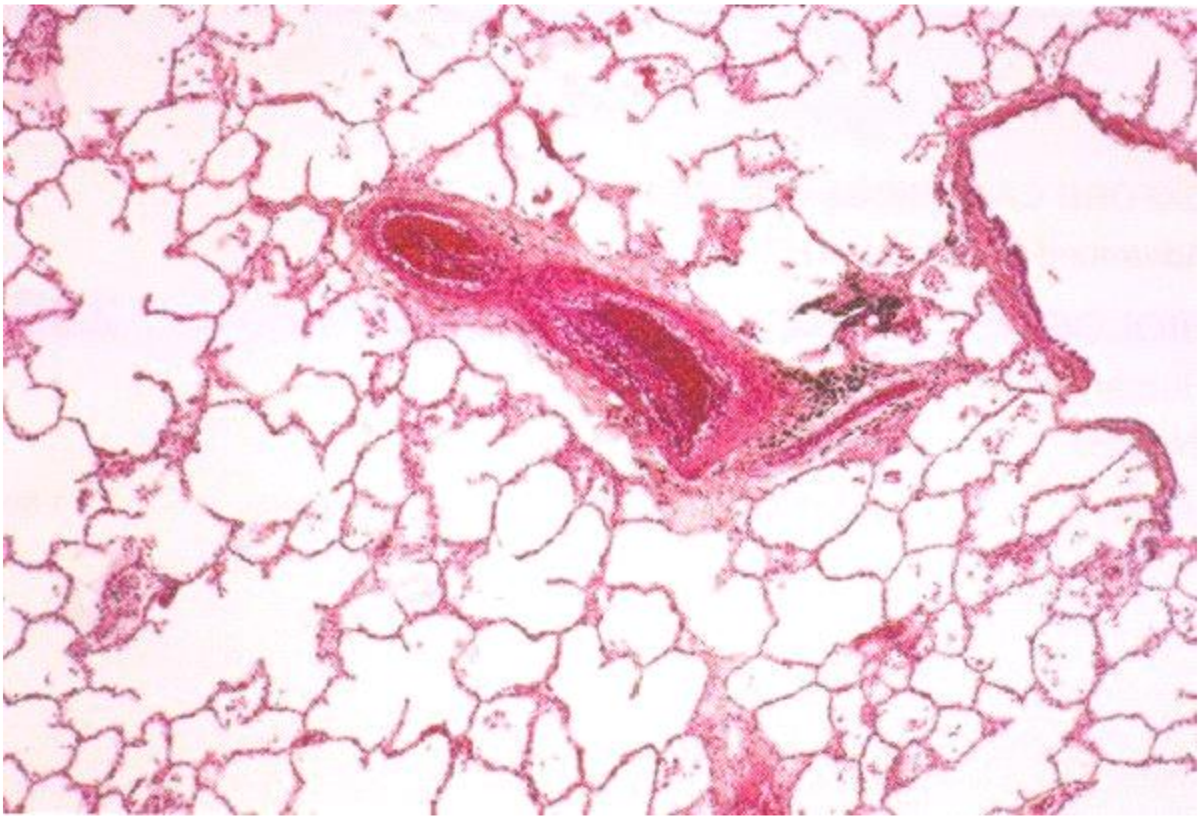
....

....

....

[4]
[Total 10 marks]

14. State **three** features of the lung, **visible in the photograph below**, that permit efficient exchange of gases.



1 ....

....

2 ....

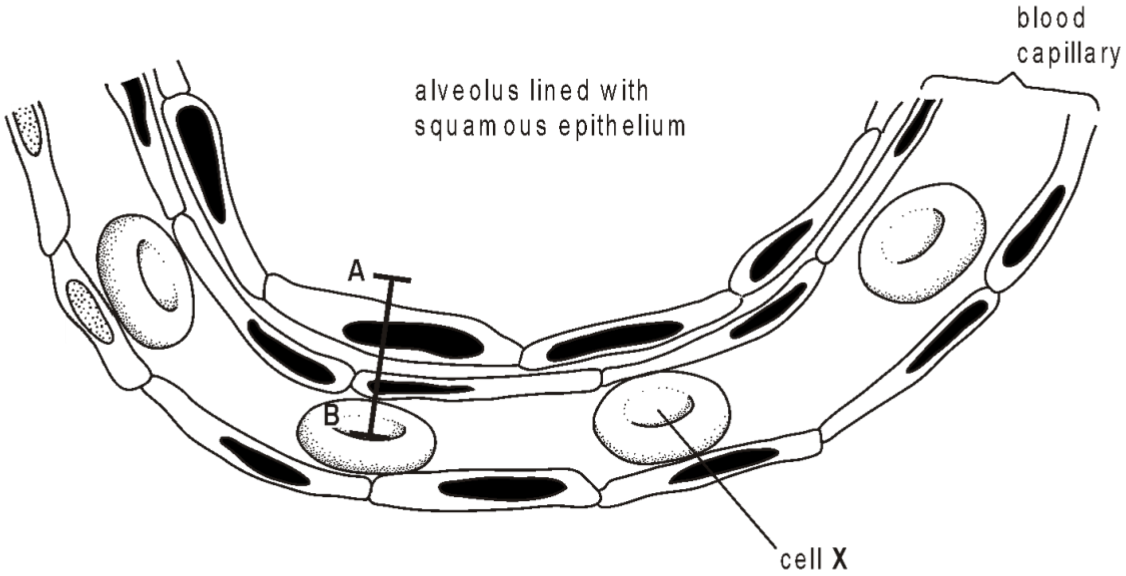
....

3 ....

....

[Total 3 marks]

15. The diagram below is a drawing of an alveolus together with an associated blood capillary.



(i) State a feature, **visible in the diagram**, which shows that squamous epithelial cells are eukaryotic.

....

[1]

(ii) State why squamous epithelium is described as a tissue.

....

....

[1]

(iii) State **two** features of a gas exchange surface, such as the lining of the alveolus.

1 ....

2 ....

[2]
[Total 4 marks]

16. A number of definitions are listed in the table below.

In the right hand column, write a term that **best** matches the definition in the left hand column. The first one has been done for you.

The type of B cell which secretes antibodies.	*Plasma cell*
The term which refers to any organism that causes infectious disease.	
Diseases which cause a progressive deterioration of part of the body.	
The type of exercise that uses the heart and lungs to provide oxygen for respiration in muscles.	
The volume of air breathed in or out during a single breath.	
A term used to describe a disease that spreads across continents.	

[Total 5 marks]

17. Lugworms are common animals that burrow in the sand of the seashore, just above the low tidemark. They are found where there is mild wave action and where the sand is rich in organic matter. The main external features of a lugworm are shown in Fig. 1.

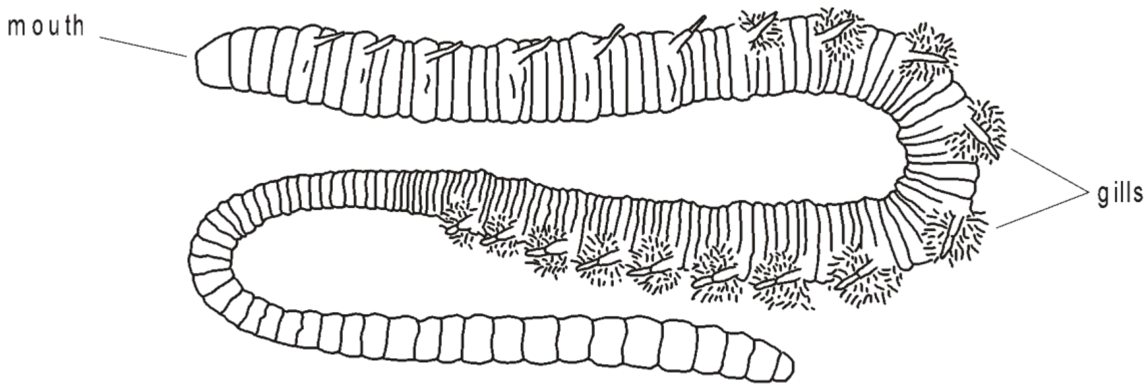


Fig. 1

Each lugworm makes a U-shaped burrow which reaches the surface in two places, as shown in Fig. 2.

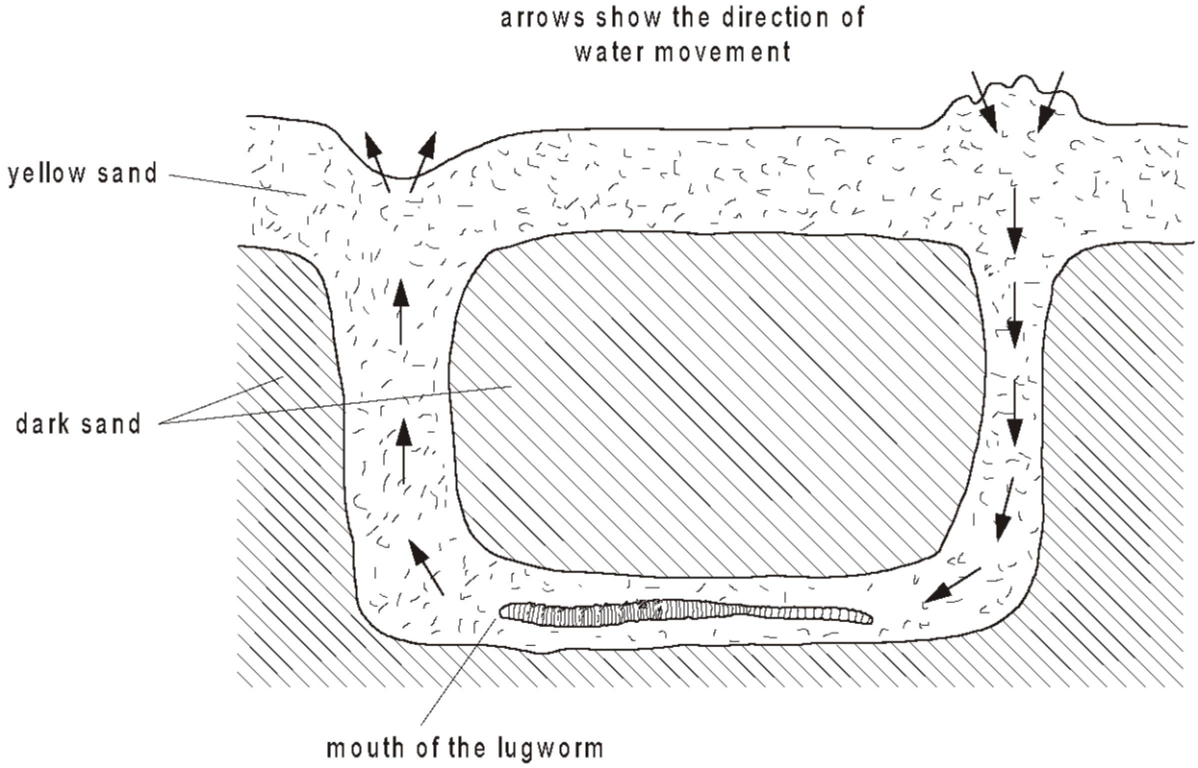


Fig. 2

While the beach is covered by the tide, the lugworm moves its body so that a current of seawater passes down the burrow, over the worm and up through the porous sand, in the direction shown. These ventilation movements allow water to flow slowly past the tufts of gills. The gills are feathery outgrowths of the body wall and appear dark red because they contain many small blood vessels.

A lugworm's blood plasma has a high concentration of haemoglobin dissolved in it. There are no red blood cells. Fig. 3 shows dissociation curves for lugworm haemoglobin and for human haemoglobin.

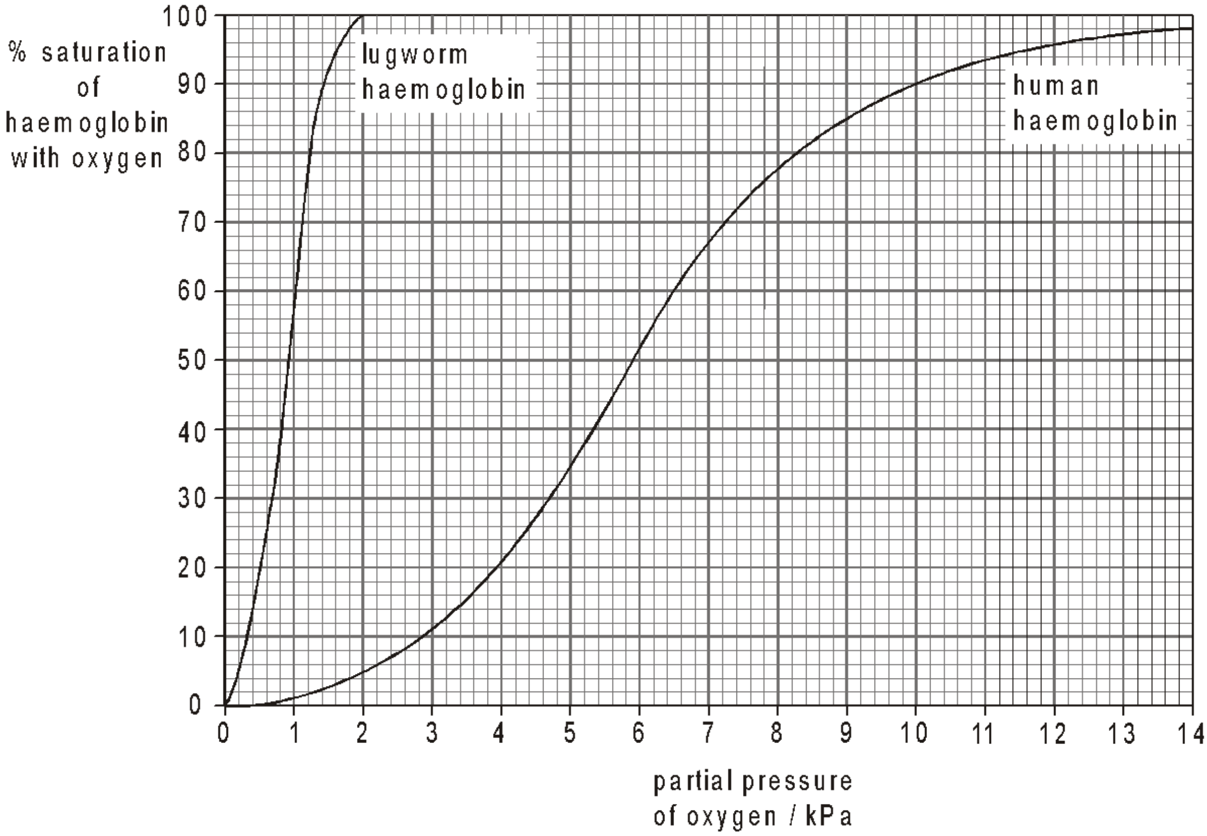


Fig. 3

(a) Describe and explain **one** way in which the dissociation curve for lugworm haemoglobin differs from that for human haemoglobin.

Difference ....

....

Explanation ....

....

[2]

(b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

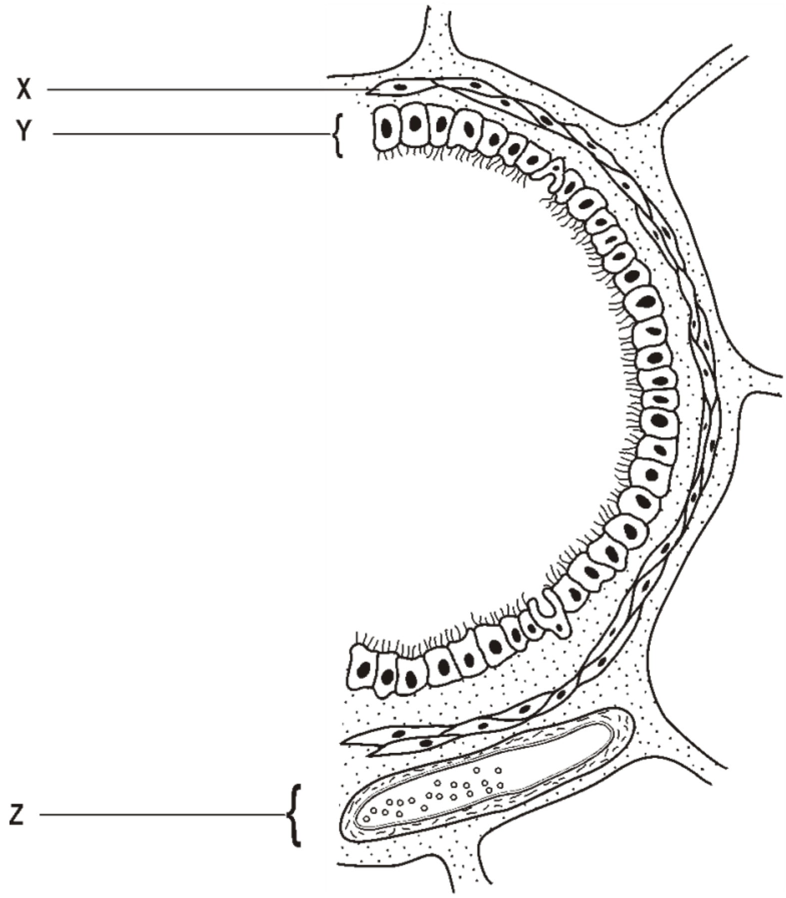
Describe the similarities and differences between the adaptations for gas exchange and transport of oxygen in mammals and lugworms.

You will gain credit for using information given in question 4.

(Allow one lined page)

[7]
Quality of Written Communication [1]
[Total 12 marks]

18. The diagram below is a drawing of a transverse section of part of a bronchiole from a healthy lung.



(i) Name tissues **X** and **Y**.

X ....

Y ....

[2]

(ii) Identify structure **Z**.

Z ....

[1]
[Total 3 marks]

19. In this question, one mark is available for the quality of spelling, punctuation and grammar.

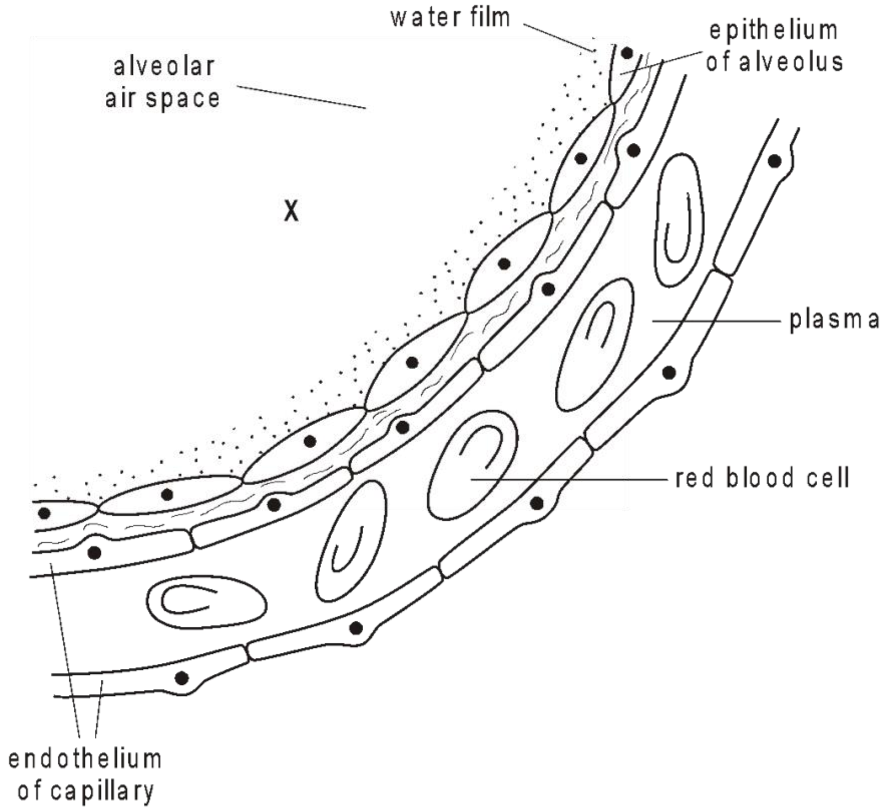
Describe how the tissues in the gaseous exchange system contribute to the functioning of the lungs.

(Allow one lined page).

[8]
Quality of Written Communication [1]
[Total 9 marks]

20. Mammals exchange respiratory gases via their lungs, whose surface area is greatly enlarged by the presence of many alveoli.

Below is a diagram showing part of the wall of an alveolus and an associated capillary.



Describe the mechanism by which oxygen gets from point **X** on the diagram to the red blood cells.

....

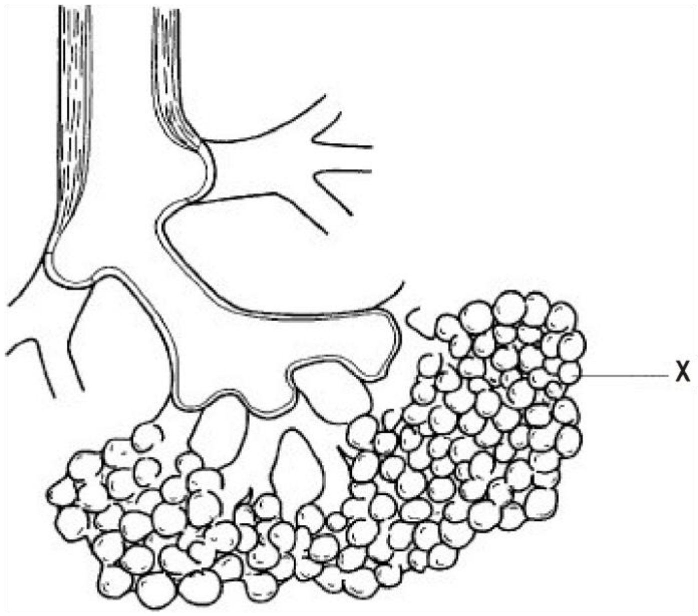
....

....

....

[Total 2 marks]

21. Many small animals rely on diffusion across outer surfaces of their bodies for gas exchange. Mammals have lungs for gas exchange. The diagram below shows the structure of part of a mammalian lung and associated airways.



Taken from 'Advanced Human Biology' by J. Simpkins and J.I. Williams
Fig 12.21, p233 (ISBN 0713527692)

(a) (i) Name structure X.

.... **[1]**

(ii) Describe the process by which gases are exchanged at **X**.

....

....

....

....

.... **[3]**

(b) Explain why mammals have large numbers of structure **X** in their lungs.

....

....

....

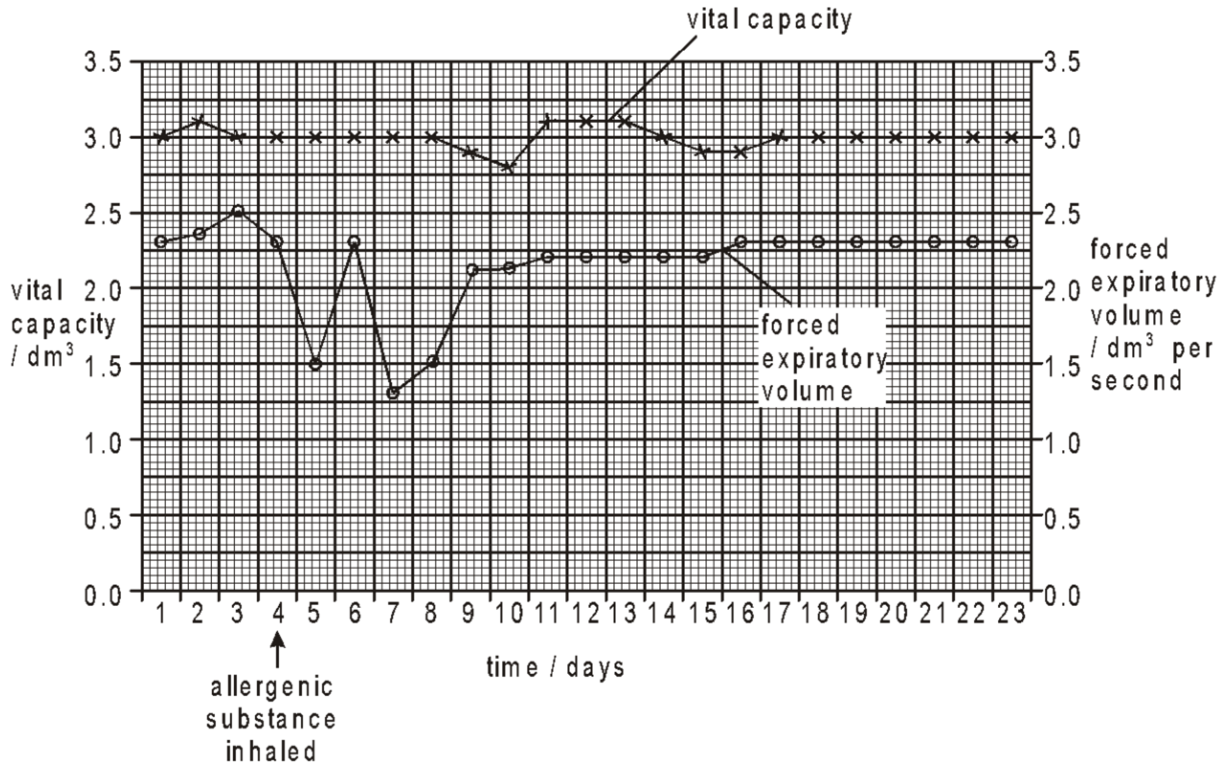
....

....

[2]
[Total 6 marks]

22. The vital capacity and the forced expiratory volume of a person with asthma were measured over a period of 23 days. The forced expiratory volume is the volume of air that can be breathed out in one second. On day 4 of the investigation, the person breathed in an allergenic substance.

The results are shown in the graph below.



Graph from ABC of Allergies, p28 top figure, edited by S.R.Durham.
The British Medical Journal, 1998 (ISBN 0727912364)

(i) Calculate for day 1 the percentage of the vital capacity that was breathed out in one second.

Show your working and give your answer to the nearest whole number.

Answer .... %

[2]

(ii) Using the data in the graph, describe the effect of the allergenic substance on the forced expiratory volume and the vital capacity.

Forced expiratory volume ....

....

....

....

Vital capacity ....

....

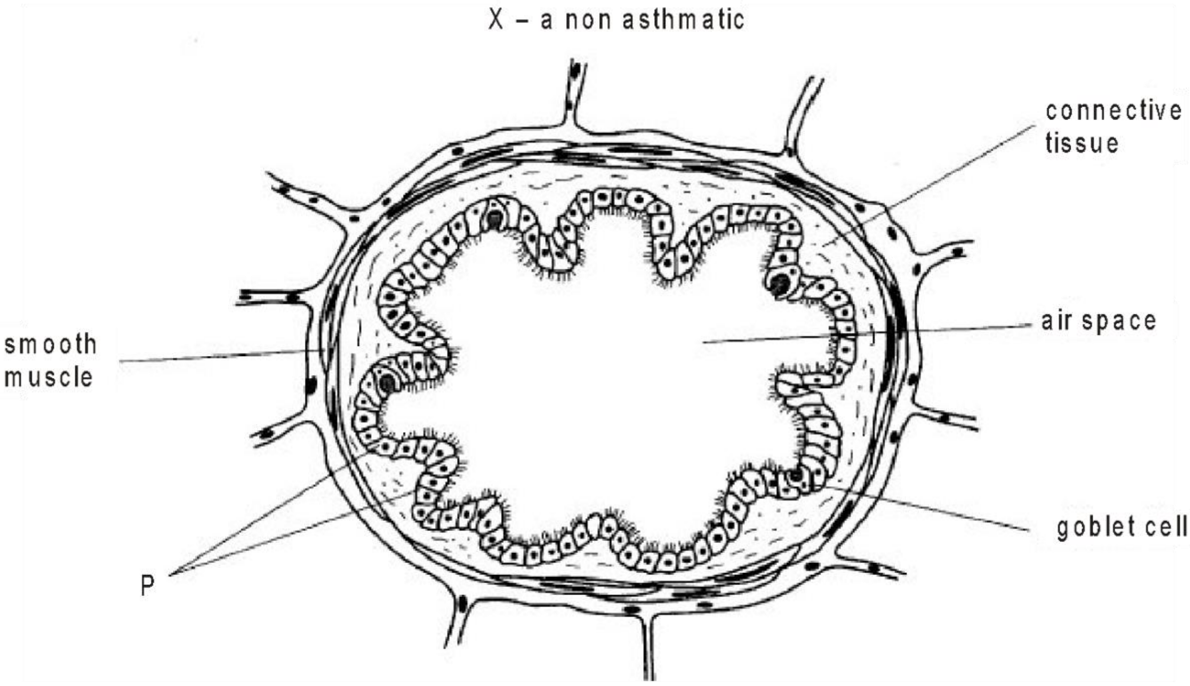
....

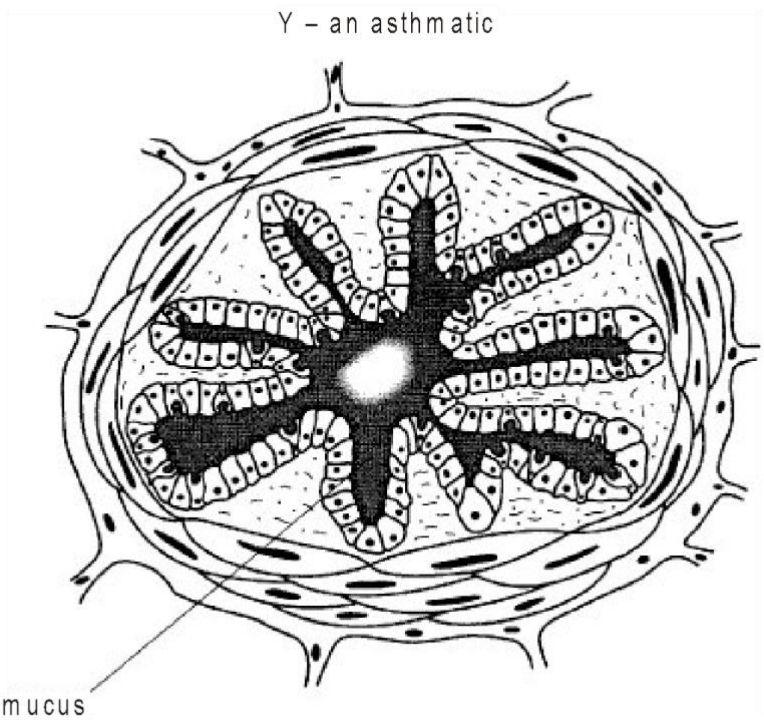
....

[3]
[Total 5 marks]

23. The diagram below shows drawings made from cross sections of the upper bronchioles of a non-asthmatic, **X**, and an asthmatic, **Y**. The sections were drawn from observations made with a light microscope.

Upper bronchioles normally have an epithelium with a few, scattered, goblet cells.





(a) Describe the function of the cells labelled **P** on the diagram in the gas exchange system.

....

....

....

....

....

[3]

(b) Use the information given in the diagram to explain the following observations made on the bronchioles of an asthmatic during an asthma attack.

(i) The bronchioles fill with mucus.

....

....

....

....

(ii) The cross sectional area of the air spaces in the bronchioles decreases.

....

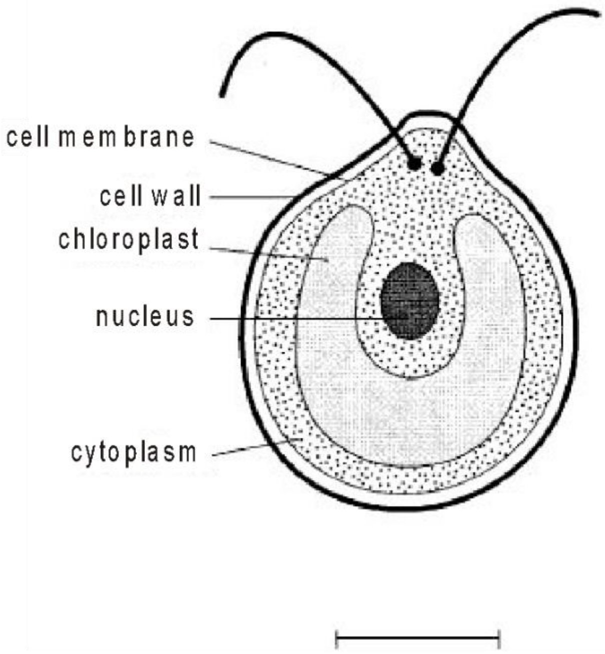
....

....

....

[3]
[Total 6 marks]

24. Fig. 1 shows the structure of a single-celled organism called *Chlamydomonas* which shares many features with plant cells. Fig. 2 shows a cedar tree. The cells of both organisms need water to carry out their metabolic functions.



5µm

Chlamydomonas

Fig. 1

5m

cedar tree

Fig. 2

(a) (i) *Chlamydomonas* lives in freshwater ponds.

Explain how single-celled organisms like *Chlamydomonas* obtain water from their external environment.

....

....

....

……………………………………………………………………………………………………

[2]

(ii) Seawater contains a much higher percentage of salts than the fresh water in which *Chlamydomonas* lives.

Suggest the changes that would take place in the *Chlamydomonas* cell if it were transferred to seawater.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

[2]

(b) *Chlamydomonas* has no water transport system whereas the tree shown in Fig. 2 has a well developed system for water transport.

Explain why a large multicellular organism like a tree needs a water transport system whilst *Chlamydomonas* does not.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

[3]
[Total 7 marks]

AQA AS Biology

3.3 Organisms exchange substances with their environment

Mark scheme

1. (a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;

Q *Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two.*

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;

4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;

5. Circulation replaces blood saturated with oxygen;

6. Ventilation replaces water (as oxygen removed);

6

(b) Mixing of air and water (at surface);

Air has higher concentration of oxygen than water;

Diffusion into water;

Plants / seaweeds near surface / in light;

Produce oxygen by photosynthesis;

2 max

(c) Not much oxygen near sea bed;

Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low <u>partial pressure</u> (of oxygen);

2

(d) The chimpanzee and the bonobo are more closely related (than to the gorilla);

They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12]

2. (a) (i) B/aorta; 1

(ii) D/pulmonary vein; 1

(b) Filling because valve between artery and ventricle closed;
Valve between atrium and ventricle/ cuspid valve open; 2
[Note: All answers must be in context of filling.
Answers specifically relating to left side are incorrect.]

(c) Pressure increases and volume stays constant; 1

(d) Pressure in ventricle (becomes) higher than pressure in aorta;
[Or converse] 1

(e) Ventricle contracts;
Produces increase in pressure;
Blood leaves ventricle/ goes into aorta (and volume falls);
Through open valve;
max 3

[9]

3. (a) (i) Blood Pressure in ventricle <u>higher</u> than in atrium;
(Causes) atrioventricular / mitral / (bi)cuspid / valve between atrium and ventricle to shut; 2

(ii) Line labelled **B** from 0.2 to 0.7s; 1
(*Ignore line from 1.0 to 1.4s.*)

(b) (i) Line labelled **C** from 0.2 to 1.0s, 1
(*Accept any other line between equivalent points in consecutive cycles.*)

(ii) $\frac{60}{0.8}$ = 75 beats per minute - method mark <u>60</u> length of cycle given by candidate;

- answer mark - calculation giving correct answer; 2

(c) (i) 6600; 1

(ii) Increased heart rate;
Increased stroke volume / proportion of blood pumped out of ventricle;
More blood retained in veins;
More adrenaline;
Increased stimulation by sympathetic (nerve);
SAN discharges faster; 2

4. (a) Pressure Reaches highest value / greatest range of pressure in ventricle /

description of sequence of changes; 1

(b) (i) Pressure in Ventricle / **B** is higher than pressure in atrium / **A**; 1

(ii) 0.2s;
Time when pressure in ventricle / **B** is higher than pressure in aorta / **C**; 2

(c) (i) Higher; 1

(ii) Thicker muscle in (wall of) left ventricle; 1

(d) 1 µm; 1

(e) 1 mark – made of different tissues
2 marks – made of specified tissues illustrated with at least two examples from the table 2

(f) 1 Thick elastic layer in artery;
2 Evening out flow / associated with recoil;
3 Link between pressure in artery and ventricular contraction / systole;
4 Arteriole with muscular layer;
5 Muscle contraction results in smaller diameter / vasoconstriction;
6 Alters blood supply to different organs;
7 Endothelium provides smooth surface / limits friction;
8 Capillary wall thin / only endothelium;
9 For exchange;
6 max

[15]

5. (a) (i) Filling time stays constant / increases very little / as heart rate increases;
Decrease in contraction time as heart rate increases;
Allow maximum of 1 mark if no reference to heart rate. 2

(ii) Work out time for one heartbeat / one heart beat takes 1 second;
Subtract filling time / 0.38s;
Credit these basic points however determined. If the calculation has been done, credit any point in method clearly explained.
OR
Plot contraction time against heart rate;
Read off value for 60 beats per minute; 2

(iii) Stroke volume / volume of blood pumped out at each beat; 1

(b) (i) 2

Valve located between	Open	Closed
Left atrium and left ventricle		✓
Left ventricle and aorta	✓;	
Right atrium and right ventricle		✓
Right ventricle and pulmonary artery	✓;	

(ii) Pressure constant / smooth in vein / only have pressure surges in artery; 1

(iii) Contraction of ventricle / systole / entry of blood into aorta; 1

[9]

6. (a) (i) **C** and **D**; 1

(ii) Left ventricle with thicker wall/more muscle / (muscle in) left ventricle contracts <u>more</u> forcefully/beats more strongly; 1

(b) Higher in atria/lower in ventricles;
atrioventricular valves/valves between atria and ventricles open; 2
(position of valves must be identified. Do not accept an unqualified reference to valves. Assume pronouns refer to atria.)

7. (a) $\frac{10}{20} \times \textit{measurment} \,/\, \frac{1}{2} \times \textit{measurement}$;

= 1.25 to 1.5;
allow 1 mark if correct working shown

max 2

(b) <u>Maintains</u> concentration gradient (over whole length of gill) / diffusion can occur over whole gill;
<u>More</u> oxygen enters blood (/ <u>more</u> CO_2 leaves);
<u>More</u> (aerobic) respiration / <u>more</u> energy release in muscle / for swimming; *'more' needed ONCE only*

3

[5]

8. (a) (gills have) lamellae on filaments;
lots of both;

2

(b) (i) All 3 go up;

Accept converse

1

(ii) More oxygen can be supplied;
for more respiration;

Accept answer relating to CO_2

2

[5]

9. (i) *award both marks for correct answer*

$\frac{3.14}{0.52}$ **;**

6:1**;** 2

(ii) Ratio for sphere **B** is three times smaller**;** ora

allow ecf if wrong calculation in (a)(i) 1

(iii) *any two from the following:*

living cells need to take in oxygen/ nutrients and remove (metabolic) waste**;**
ref. passive processes / diffusion**;**
rate of diffusion too slow if SA:V ratio too small**;** max 2

[5]

10. *Credit any five descriptions from the following:*
Many alveoli to produce large surface area**;**
Barrier, thin / only two cells thick**;**
Good blood supply / many capillaries**;**
To carry dissolved gases to and from the alveoli**;**
Ventilation / air movement to refresh the air in the alveoli**;**
(Contains) elastic tissue to stretch and recoil to help expel air**;**

[5]

11. (i) oxygen is used in respiration**;**
Carbon dioxide is released (in respiration)**;**
Carbon dioxide is absorbed (by soda lime)**;** 2

(ii) Vital capacity**;** 1

[3]

12. (i) Alveolus/alveolar air, sac/space; **A** *alveoli/air sac* **A** *squamous epithelium* 1

(ii) Large surface area to volume (ratio)/AW; **R** *large area unqualified*
thin/one cell thick, wall/short diffusion distance/AW;
A *appropriate figures for width*
squamous epithelium;

permeable;
blood supply, qualified;
elastic tissue/recoil (after expansion);
surfactant; 3 max

Error carried forward – mark (ii) independently. E.g. candidates who put 'capillary' in (i) – could still get points 1 to 4 in (ii)

[4]

13. (a) (i) produce / secrete / release, mucus**;**
prevent collapse of / hold open / support, airways**;**
A provide shape of bronchus
R gives wall, structure / strength 2

(ii) cilia, destroyed / damaged**; R** cilia not working
(epithelium replaced by) scar tissue / scarring**;**
(smooth) muscle becomes thicker**;**
mucous glands enlarge / larger goblet cells / more goblet cells**;**
R more mucus secreted
inflammation of connective tissue;

AVP; idea of tumour if it describes a structural change max 2

(b) stretch, as air is inhaled / allow alveoli to expand during inhalation**;**
to increase lung volume / surface area**;**
prevents alveoli bursting**;**
(elastic fibres) recoil, as exhale**; R** contract
more, complete / rapid, expulsion (from the alveoli)**; A** expel more air max 2

(c) tidal volume is reduced / less air inhaled and exhaled / residual volume is larger / air trapped in alveoli / vital capacity smaller;
more difficult to exhale**;**
(as) alveoli cannot, stretch / recoil**;**
rapid / shallow, breathing / breathlessness / wheezing**;**
alveoli may burst**;**
leaves gaps in tissue / larger air spaces / AW**;**
less surface area (for gaseous exchange)**;**
blood / haemoglobin, less well oxygenated / less carbon dioxide removed**;**

R *less able to do exercise / need to use oxygen* max 4

[10]

14. many, air spaces / alveoli**;**
large surface area**; R** ref to surface area to volume ratio
thin wall of, alveolus / capillary**; A** one cell thick **R '**thin wall' on its own
good blood supply / large capillary network**;**
air passage / bronchiole**;**
capillary close proximity to alveolus**;**

R refs. to cilia, mucus, elasticity 3 max

[3]

15. (i) nucleus / nuclear envelope / nuclear membrane**;** 1

(ii) (made up of) one type of / (squamous) epithelium**,** cell(s)**;**
A *same* **R** *similar alone*
(group of) cells performing the same function(s)**; A** *task / job* 1 max

(iii) large surface area**;**
permeable**;**
thin / short, diffusion path**;**
moist**;**
good blood supply / close to blood**;**
well ventilated / in contact with respiratory medium**;** 2 max

[4]

16.

	pathogen**;**
	degenerative**;**
	aerobic**;** **R** *aerobic respiration*
	tidal**;**
	pandemic**;**

[5]

17. (a) lugworm *curve* *human curve*

steeper;	shallow / gentle / sigmoid;
higher saturation at, low / same pp oxygen;	
has max (saturation) at 2 kPa ;	max at 13.5 - 14 kPa ;
reaches 100% (saturation);	(only) reaches 98%;

(max 1 of above differences)

lugworm haemoglobin has a high affinity for oxygen;
low oxygen in, lugworm habitat / water / ora ;
lugworm haemoglobin, stores oxygen / only releases oxygen when pp O_2 very low ;
two haemoglobins have different, structures / amino acid sequences; 2 max

(b) *differences (max 5)*

D1 ref to lugworm gills **and** mammal, alveoli / lungs;
D2 ref to internal **and** external, exchange surfaces;

D3 less oxygen in, water / sand; **A** ora
D4 lugworm haemoglobin adapted to, water / sand/ low O_2 environment ; **A** ora
D5 lugworm has no red blood cells / ora;
D6 detail of mammalian red blood cells;
D7 lung ventilation tidal / lugworm, throughflow / unidirectional / AW;
D8 AVP; e.g. ref. water loss from lungs

similarities (max 5)
S1 **both** (gas exchange surfaces have) large surface area;
S2 **both**, thin / have short diffusion distance;
S3 **both** well-vascularised ;
S4 **both** moist;
S5 ref to diffusion of, oxygen / carbon dioxide / gases;
S6 (blood carries) oxygen to tissues;
S7 haemoglobin transports oxygen;
S8 **both** move medium over gas exchange surface;
S9 AVP; 7 max

QWC – legible text with accurate spelling, punctuation and grammar ; 1

[10]

18. (i) X = (smooth) muscle**; A** involuntary muscle / non striated muscle
Y = (ciliated) epithelium**;**

(ii) Z = (branch of) blood vessel / artery / vein / arteriole / venule**; R** capillary 3

[3]

19. *cartilage*

1 in, trachea / bronchi**;**
2 holds airway open / prevents collapse**;**
3 prevents bursting (of trachea / bronchi as air pressure changes)**;**
4 low resistance to air movement**;**

ciliated epithelium / cilia

5 move mucus**;**
6 ref to how movement brought about**;**
e.g. metachronal rhythm / wave / sweep / waft

goblet cells

7 secrete mucus**;**
8 trap, bacteria / dust / pollen / particles**;**
9 remove particles from lungs**;**

blood vessels

10 supply, oxygen / nutrients (to tissues of lung)**;**
11 surround alveoli / good blood supply to alveoli**;**
12 deliver carbon dioxide / pick up oxygen**;**
13 ref to wall of capillary being thin**;**
14 ease of / rapid, gaseous exchange *or* short diffusion pathway**;**

smooth muscle

15 adjust size of airways (in, exercise / asthma)**;**

connective tissue / elastin / elastic tissue

16 stretch (inhalation)**;**
17 prevents alveoli bursting**;**
18 recoil**; R** contract
19 helps exhalation / forces air out (of lungs)**;**

squamous epithelium / described

20 alveolus wall thin**;**
21 ease of / rapid, gaseous exchange *or* short diffusion pathway**;**
22 AVP**;** e.g. ref to large surface area of numerous alveoli
23 AVP**;** ref to macrophages removing pathogens 8 max

QWC – legible text with accurate spelling, punctuation and grammar; 1
[9]

20. diffusion / down a (concentration) gradient**;**
dissolves in the water film / goes into solution / AW**;**
crosses , cell(s) / named cell / cytoplasm / plasma / membrane(s) / wall of alveolus *or* capillary**;**

2 max

[2]

21. (a) (i) alveolus / alveoli**; R** air sac 1

(ii) *no mark for diffusion alone*

down a gradient / from high to low (concentrations)**;**
oxygen at high(er) concentration in lung / ora**;**
dissolves in / crosses, water film**;**
(aqueous) path short / short diffusion path**;**
reverse gradient for carbon dioxide**;**
ref. to random molecular movement involved in diffusion**;**
ref. to maintenance of a steep gradient**;**

3 max

(b) (generally) larger / correct ref. to size**;**
surface area decreased relative to volume / ora**;**
lung / alveoli, gives increased area (for gas exchange)**;**
need for more oxygen**;**
due to, high (metabolic) activity / much respiration / more energy need**;**
cannot exchange across outer surface / no alternative surface**;**
high demand for carbon dioxide removal / AW**;**

2 max

[6]

22. (i) *award two marks if correct answer (77) is given – must be rounded up*
award one mark for calculation – 2.3 / 3.0 or 76.7 if answer incorrect

2.3 ÷ 3.0 / 76.7**;**
77**;** 2

(ii) forced expiratory volume decreases / AW**;**
returns to initial value / fluctuates / AW**;**
figs to show a change with correct units / e.g. 2.3 $dm^3\ s^{-1}$ to 1.5 $dm^3\ s^{-1}$**;**
A ecf from (i)

vital capacity remains constant**;**
at 3.0 dm^3**;**

max 3

[5]

23. (a) cilia, beat / waft**;** **R** 'hairs' **A** ciliated epithelium, sweeps / AW
move mucus**;**
particles / bacteria / dust / spores / pathogen / microbe, in mucus**;**
treat 'dirt' as neutral
(moves) away from alveoli / upwards / towards trachea / towards throat / towards mouth / out of lungs / out of bronchioles / AW**;**

max 3

(b) (i) *mark (i) and (ii) together to max 3 – look for annotations*

ref to (secretion / release of) histamine**;**
mucus is not moved / AW**;**
more goblet cells**;**
(goblet cells secrete / produce) more mucus / excess mucus**;**
fewer cilia (per cell)**;** **A** stunted, damaged, destroyed **R** dead

(ii) thicker / more, (smooth) muscle**;** **A** larger / expands **R** swollen, swells
(muscle) contracts**;** **R** constricts, spasm **A** 'muscle tenses'
connective tissue, swells / enlarges / fills with fluid**;**
lining of bronchiole thrown into deeper folds / AW**;**

max 3

[6]

24. (a) (i) osmosis**;**
down water potential gradient / from high to low water potential / implied**;**
ref to partially / differentially / selectively, permeable membrane**;** 2
max

(ii) lose water**;** **R** less uptake
metabolism affected / (may) die / AW**;** **R** in context of salt uptake
plasmolysis / flaccid / less turgid / description**;**
R shrivelled, dehydrated

AVP**;** e.g. adaptive responses qualified, such as encysting / mobilise solute / refs to altering water potential to reduce water loss

2 max

(b) *credit answers explaining why* Chlamydomonas *does not need a water transport system*

distance in tree is greater / AW**;**
e.g. roots far from aerial parts / AW**;**
not all tissues / cells in contact with water / AW**;**
diffusion too slow / AW**;**
AVP**;** e.g. outer layers waterproofed / ions carried in water / *Chlamydomonas* has large surface area:volume

R refs to greater quantities needed

3 max

[7]

AQA AS Biology

3.4 Genetic information, variation and relationships between organisms

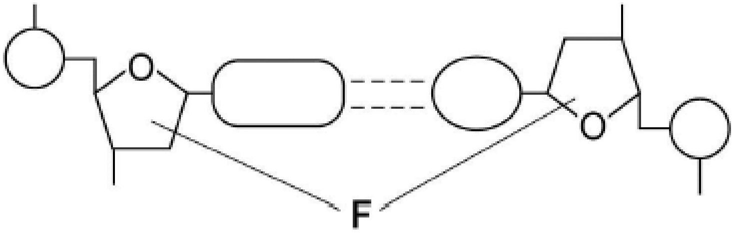
EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective, and use the revision notes to fill in any gaps.

.

1. **Figure 1** shows one base pair of a DNA molecule.

Figure 1



(a) Name part **F** of each nucleotide.

....

(1)

(b) Scientists determined that a sample of DNA contained 18% adenine.

What were the percentages of thymine and guanine in this sample of DNA?

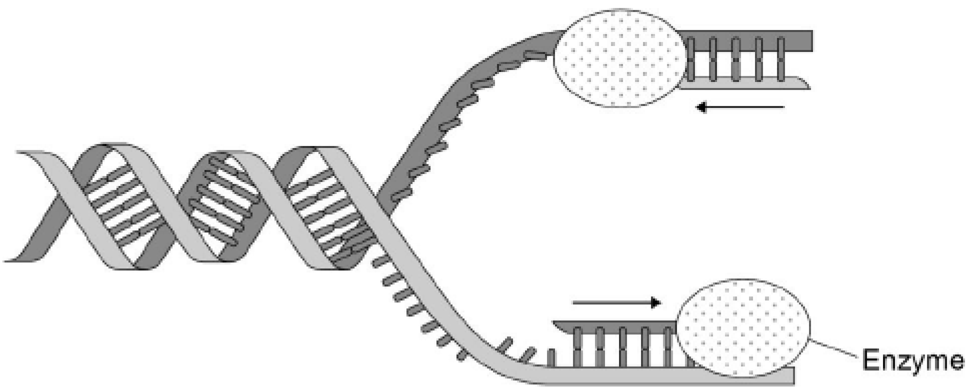
	Percentage of thymine	
	Percentage of guanine	

(2)

During replication, the two strands of a DNA molecule separate and each acts as a template for the production of a new strand.

Figure 2 represents DNA replication.

Figure 2



(c) Name the enzyme shown in **Figure 2**.

....

(1)

The arrows in **Figure 2** show the directions in which each new DNA strand is being produced.

(d) Use **Figure 1, Figure 2** and your knowledge of enzyme action to explain why the arrows point in opposite directions.

....

....

....

....

....

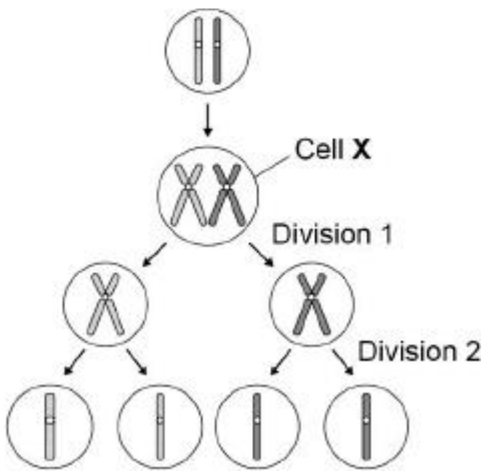
....

....

....

(4)
(Total 8 marks)

2. The figure below summarises the process of meiosis. The circles represent cells and the structures within each cell represent chromosomes.



(a) Describe and explain the appearance of **one** of the chromosomes in cell **X**.

....

....

....

....

....

....

....

(Extra space) ....

....

....

(3)

(b) Describe what has happened during division 1 in the figure above.

....

....

....

....

....

....

(2)

(c) Identify **one** event that occurred during division 2 but **not** during division 1.

....

(1)

(d) Name **two** ways in which meiosis produces genetic variation.

1 ....

2 ....

(2)
(Total 8 marks)

3. The Amish are a group of people who live in America. This group was founded by 30 Swiss people who moved to America many years ago. The Amish do not usually marry people from outside their own group.

One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld syndrome. People with this disorder have heart defects, are short and have extra fingers and toes. Ellis-van Creveld syndrome is caused by a faulty allele.

In America today, about 1 in 200 Amish people are born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish.

(a) Use the information provided and your knowledge of the founder effect to explain why Ellis-van Creveld syndrome occurs at a higher frequency in the Amish population than in people in America who are not Amish.

....

....

....

....

....

....

(Extra space) ....

....

....

(3)

(b) In America today, there are approximately 1 250 Amish people who have Ellis-van Creveld syndrome. Use the information provided to calculate the current Amish population of America.

Amish population ....

(1)

(c) The faulty allele that causes Ellis-van Creveld syndrome is the result of a mutation of a gene called *EVC.* This mutation leads to the production of a protein that has one amino acid missing.

(i) Suggest how a mutation can lead to the production of a protein that has one amino acid missing.

....

....

....

....

....

(2)

(ii) Suggest how the production of a protein with one amino acid missing may lead to a genetic disorder such as Ellis-van Creveld syndrome.

....

....

....

....

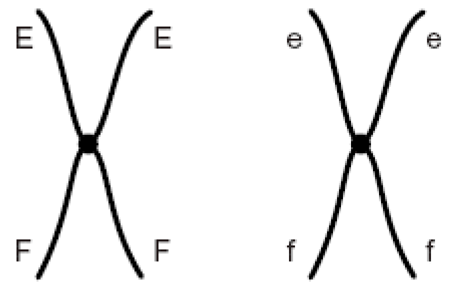
....

(2)

(Total 8 marks)

4. Figure 1 shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

Figure 1



(a) What is an allele?

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....

(1)

(b) Explain the appearance of one of the chromosomes in **Figure 1**.

....

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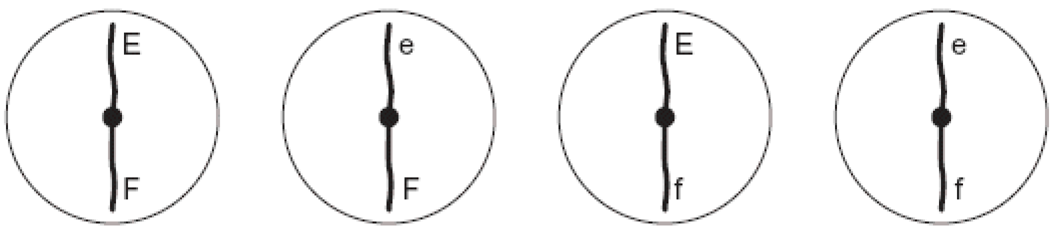
(2)

(c) The cell containing this pair of chromosomes divided by meiosis. **Figure 2** shows the distribution of chromosomes from this pair in four of the gametes produced.

Figure 2.



(i) Some of the gametes formed during meiosis have new combinations of alleles.

Explain how the gametes with the combinations of alleles Ef and eF have been produced.

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(2)

(ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

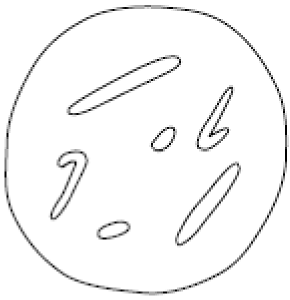
....

....

(1)

(d) **Figure 3** shows a cell with six chromosomes.

Figure 3



(i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2)

(ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes?

(1)
(Total 9 marks)

TURN OVER FOR QUESTION 5

5. Division of the nucleus by meiosis produces haploid cells from a diploid cell. Nuclei produced by mitosis have the same number of chromosomes as the parent nucleus.

(a) What is the biological importance of reducing the chromosome number when the cell divides by meiosis?

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(2)

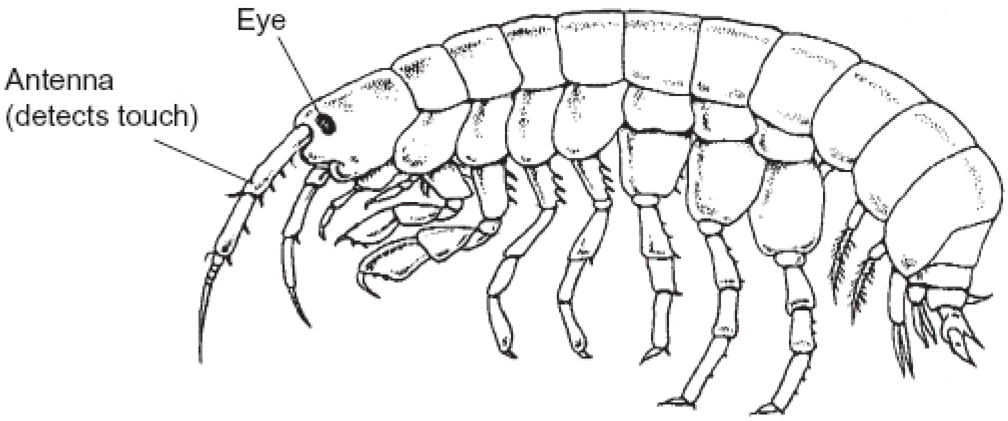
(b) The table gives one difference between meiosis and mitosis. Complete the table by giving **three** further differences.

		Meiosis	**Mitosis**
	1	Reduces the chromosome number.	Maintains the same chromosome number as in the parent nucleus.
	2		
	3		
	4		

(3)
(Total 5 marks)

6. **Figure 1** shows a freshwater shrimp.

Figure 1



Biologists collected shrimp from a stream inside a cave and from the same stream when it was in the open.

They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements, they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

		Shrimps from the stream	
		Inside the cave	In the open
	Mean diameter of eye /mm	0.09	0.24
	Mean length of antenna /mm	8.46	5.81

(a) The biologists measured the maximum diameter of each shrimp's eye.

Explain why they measured the **maximum** diameter.

....

....

....

(1)

(b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included:

- Smaller eyes.

- Greater use of sense organs such as those involved in detecting touch.

(i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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(2)

(ii) The data in **Figure 2** are mean values. Explain how standard deviations of these mean values would help you to interpret the data in **Figure 2**.

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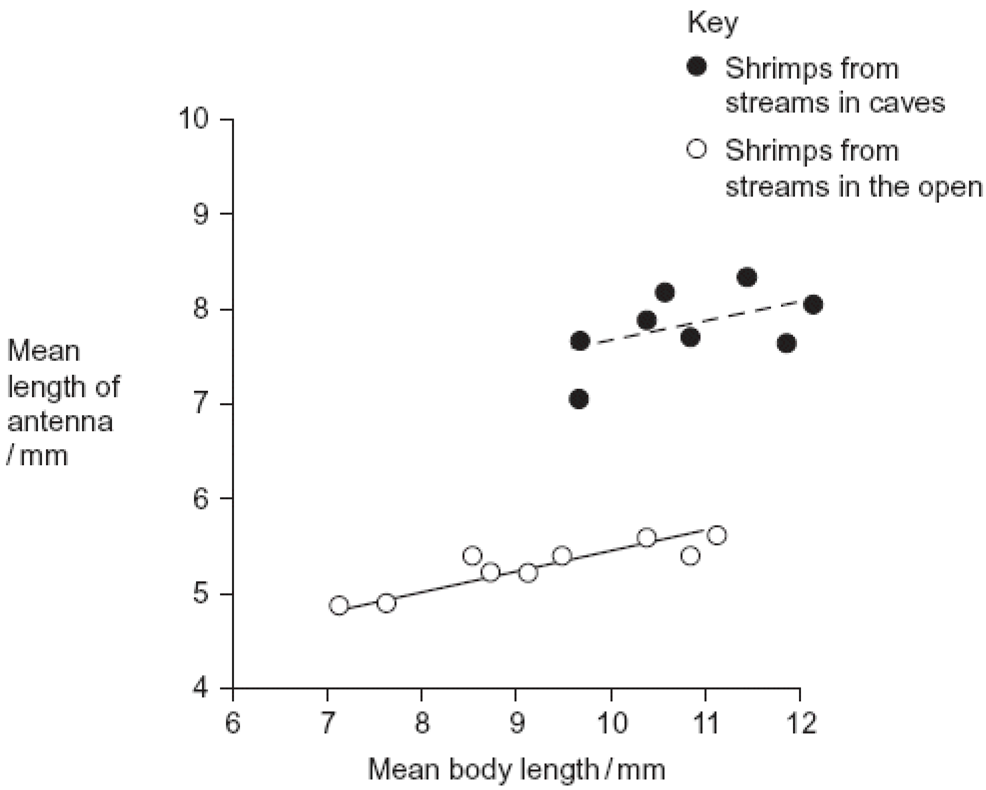
(2)

(c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

Figure 3



(i) What does the information in the graph suggest about the body length of shrimp living in caves and living in the open?

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(2)

(ii) Do the data in the graph support the conclusion that shrimp with longer bodies have longer antennae? Give the reason for your answer.

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....

(1)

Other biologists investigated the genetic diversity of these shrimp. **Figure 4** shows some of the data they collected.

Figure 4

	Gene	Allele	Percentage of shrimp with this allele in stream	
			Inside a cave	**In the open**
	PGI	**A**	0.9	2.5
		B	0.0	3.3
		C	98.2	66.4
		D	0.9	6.6
		E	0.0	21.3
	ACO2	**J**	0.0	5.6
		K	0.0	76.7
		L	100.0	17.8

(d) The biologists concluded that the shrimp in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** supports this conclusion.

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(1)

(e) The percentage of shrimp with allele **L** in the cave is different from the percentage of shrimp with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3)

(f) The biologists who studied these shrimp wanted to know if the shrimp living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

(i) Describe how the biologists should carry out these breeding experiments.

....

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....

(ii) The results of breeding experiments would help the biologists to conclude whether the shrimp were the same species. Explain how.

....

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(3)
(Total 15 marks)

7. (a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

(i) Explain the importance of taking a large number of samples at each site.

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....

....

(1)

(ii) Explain the importance of taking samples at random.

....

....

....

(1)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

	Species	**Number of plants per m^2**
	Sheep's fescue	11
	Creeping buttercup	6
	Clover	5
	Dandelion	2
	Sheep's sorrel	1
	Lady's bedstraw	7
	Stemless thistle	4

The index of diversity can be calculated from the formula

$$d = \frac{N(N-1)}{\sum n(N-1)}$$

Where

d = Index of diversity.
N = Total number of organisms of all species.
n = Total number of organisms of each species.

(b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer ....

(2)

(c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had:

- Some areas of very short grass, which was cut frequently.
- Some areas of longer grass, which was cut less frequently.
- Some areas of long grass and shrubs, which were never cut.

The index of diversity for insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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(Extra space) ....

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(3)
(Total 7 marks)

8. Scientists investigated the species of insects found in a wood and in a nearby wheat field. The scientists collected insects by placing traps at sites chosen at random, both in the wood and in the wheat field.

The table shows the data collected in the wood and in the wheat field.

Species of insect	Number of organisms of each species	
	Wood	**Wheat field**

Bird-cherry oat aphid	0	216
Beech aphid	563	0
Large white butterfly	20	0
Lacewing	12	3
Seven-spot ladybird	36	0
Two-spot ladybird	9	1
Total number of organisms of all species	**640**	**220**

(a) The scientists collected insects at sites chosen at random. Explain the importance of the sites being chosen at random.

....

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(1)

(b) (i) Use the formula

$$d = \frac{N(N-1)}{\sum n(N-1)}$$

to calculate the index of diversity for the insects caught in the wood, where

d = index of diversity *N* = total number of organisms of all species *n* = total number of organisms of each species.

Show your working.

Answer ....

(2)

(ii) Without carrying out any further calculations, estimate whether the index of diversity for the wheat field would be higher or lower than the index of diversity for the wood.

Explain how you arrived at your answer.

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(2)

(c) A journalist concluded that this investigation showed that farming reduces species diversity. Evaluate this conclusion.

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(2)

(d) Farmers were offered grants by the government to plant hedges around their fields. Explain the effect planting hedges could have on the index of diversity for animals.

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(2)
(Total 9 marks)

9. Species richness and an index of diversity can be used to measure biodiversity within a community.

(a) What is the difference between these two measures of biodiversity?

....

....

(1)

Scientists investigated the biodiversity of butterflies in a rainforest. Their investigation lasted several months.

The scientists set one canopy trap and one understorey trap at five sites.

- The canopy traps were set among the leaves of the trees 16–27m above ground level.
- The understorey traps were set under trees at 1.0–1.5m above ground level.

The scientists recorded the number of each species of butterfly caught in the traps. The table on the following page summarises their results.

	Species of butterfly	**Mean number of butterflies**		**P value**
		In canopy	**In understorey**	
	Prepona laertes	15	0	< 0.001
	Archaeoprepona demophon	14	37	< 0.001
	Zaretis itys	25	11	> 0.05
	Memphis arachne	89	23	< 0.001
	Memphis offa	21	3	< 0.001
	Memphis xenocles	32	8	< 0.001

(b) The traps in the canopy were set at 16–27m above ground level. Suggest why there was such great variation in the height of the traps.

....

....

(1)

(c) By how many times is the species diversity in the canopy greater than in the understory? Show your working.

Use the following formula to calculate species diversity,

$$d = \frac{N(N-1)}{\sum n\,(n-1)}$$

where N is the total number of organisms of all species and n is the total number of organisms of each species.

Answer = ...

(3)

(d) The scientists carried out a statistical test to see if the difference in the distribution of each species between the canopy and understorey was due to chance. The P values obtained are shown in the table.

Explain what the results of these statistical tests show.

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(Extra space) ....

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(3)
(Total 8 marks)

10. A student investigated the distribution of plants in a heathland.

The table below shows the number of plants he found in a sample area of $1m^2$.

	Species of plant	**Number counted in $1m^2$**
	Common heather	2
	Red fescue	14

	Vetch	2
	White clover	8

	(a)	What is the species richness of this sample?	

(1)

(b) Calculate the index of diversity of this sample. Show your working.

Use the following formula to calculate the index of diversity.

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

Where N is the total number of organisms of all species
and n is the total number of organisms of each species.

Index of diversity = ...

(2)

(c) Suggest how this student would obtain data to give a more precise value for the index of diversity of this habitat.

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(2)
(Total 5 marks)

11. **Table 1** shows how a bird called the bluethroat (*Luscinia svecica*) is classified by biologists.

Table 1

	Taxon	**Name of taxon**
	Domain	Eukaryota
		Animalia
		Chordata
		Aves
		Passeriformes
		Muscicapidae
	Genus	
	Species	

(a) Complete **Table 1** by filling the seven blank spaces with the correct terms.

(2)

A group of scientists investigated genetic diversity in different species of bird. For each species, the scientists:

- Collected feathers from a large number of birds.
- Extracted DNA from cells attached to each feather.
- Analysed the samples of DNA to find genetic diversity.

Table 2 summarises their results.

Table 2

	Species of bird	**Number of genes examined**	**Number of genes examined that showed genetic diversity**
	Willow flycatcher	708	197
	House finch	269	80
	Bluethroat	232	81

(b) In this investigation, what is meant by **genetic diversity?**

....

....

(1)

(c) The scientists concluded that the bluethroat showed greater genetic diversity than the willow flycatcher. Explain why they reached this conclusion. Use calculations to support your answer.

....

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(2)
(Total 5 marks)

12. Evolutionary relationships between different primates can be found by comparing their proteins and DNA.

(a) All primates produce a species-specific type of haemoglobin. An antibody against human haemoglobin could be used to compare the evolutionary relationships between different primates. Describe and explain how.

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....

(3)

(b) Scientists used DNA hybridisation to determine the evolutionary relationships between five species of primate.

The temperature at which a molecule of double-stranded DNA separates into two single strands is the separation temperature.

The scientists recorded the mean separation temperature of DNA in which both strands were from the same species.

The scientists then recorded the mean decrease in separation temperature of DNA in which one of the strands was from another species.

Their results are shown in the table.

	Primate	**Mean decrease in separation temperature / °C**				
		Human	Chimpanzee	Gorilla	Orangutan	Gibbon
	Human					
	Chimpanzee	1.7				
	Gorilla	2.3	2.3			
	Orangutan	3.6	3.6	3.5		
	Gibbon	4.8	4.8	4.7	4.9	

(i) These data suggest that gibbons are the most distantly related to humans. Explain how.

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(2)

(ii) There were differences in separation temperature of DNA formed from single-stranded DNA of the **same** species of primate. Suggest why.

....

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(1)

(iii) The scientists assumed that the decreases in separation temperatures are directly proportional to the time since the evolutionary lines of these primates separated. Gorillas are thought to have separated from orangutans 20 million years ago.

Use this information to calculate how long ago the evolutionary lines of humans and chimpanzees separated. Show your working.

.... million years

(2)
(Total 8 marks)

13. (a) What **two** measurements are needed to calculate an index of diversity?

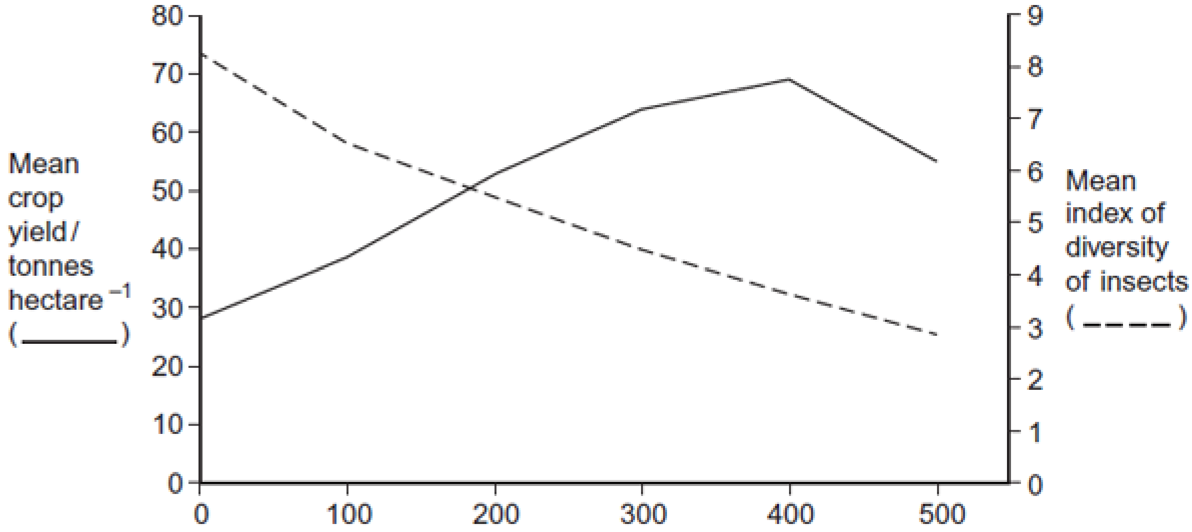
1 ....

2 ....

(2)

(b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

The figure below shows their results.



Concentration of herbicide sprayed on field / mg dm^{-3}

(i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

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....

....

(1)

(ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

....

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....

....

(2)

(iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

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(Extra space) ....

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(3)
(Total 8 marks)

14. The body markings of cheetahs vary, in particular the pattern of bands on their tails. Cheetahs are solitary animals but the young stay with their mother until they are between 14 and 18 months old.

Scientists investigated the banding pattern on the tails of cheetahs living in the wild.

- They drove a car alongside a walking cheetah and used binoculars to study the tail pattern.
- They gave each cheetah a banding pattern score based on the width of the dark and light bands on the end of the tail.
- They scored the width of the bands on the right and left side of the tail using a five-point scale of width.

A typical pattern on the right side of one cheetah's tail is shown in **Figure 1**.

Figure 1

	Band number	1	2 3	4	5	6	7

	Band width score	3	1 1	4	3	3	3

The scientists collected data from each cheetah on four separate occasions. **Figure 2** shows the data for one of the cheetahs.

Figure 2

	Side of tail	Mean band width score (± standard deviation)						
		Band 1	**Band 2**	**Band 3**	**Band 4**	**Band 5**	**Band 6**	**Band 7**
	Right	3.00 (± 0.82)	1.00 (± 0.00)	1.00 (± 0.00)	3.75 (± 0.50)	2.75 (± 0.50)	3.00 (± 0.00)	3.00 (± 0.00)
	Left	3.75 (± 0.50)	3.25 (± 0.50)	2.00 (± 0.50)	3.00 (± 0.00)	2.00 (± 0.00)	2.50 (± 0.50)	3.00 (± 0.50)

(a) The scientists only used data from cheetahs which were fully grown. Suggest why.

....

....

(1)

(b) The scientists estimated the width of the bands on the same cheetah on four separate occasions. They did not always get the same score.

(i) Give **two** pieces of evidence from **Figure 2** which show that the scientists sometimes obtained different scores for the same band.

1 ....

....

2 ....

....

(2)

(ii) The method the scientists used resulted in them getting different scores for the same band. Suggest why.

....

....

(1)

(c) What is the evidence from **Figure 2** that the dark and light bands do **not** form rings of equal width around the tail?

....

....

(1)

(d) The scientists found the difference in banding pattern between:

- Offspring in the same family.
- Cheetahs chosen randomly.

Explain how scientists could use this information to show that some variation in tail banding was genetic.

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(Extra space) ....

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(3)
(Total 8 marks)

15. There are wolves in many European countries. Scientists investigated the genetic diversity of these wolves. They collected samples of DNA from the mitochondria of wolves from different countries. For each sample, they identified which haplotypes were present in the DNA. A haplotype is a particular sequence of bases on DNA. Mutations can produce new haplotypes.

	Country	Number of wolves sampled	Number of different haplotypes in mitochondrial DNA
	Spain	84	3
	Portugal	19	2
	Italy	101	1
	France	7	1
	Bulgaria	29	6
	Sweden	93	1

The scientists wanted to find out whether one of the haplotypes in the Portuguese wolves was the same as one of those in the Spanish wolves. They used a restriction endonuclease, electrophoresis and a labelled DNA probe.

(a) For what purpose did they use:

(i) The restriction endonuclease?

....

....

(1)

(ii) Electrophoresis?

....

....

(1)

(b) Explain why the labelled DNA probe could be used to find out whether the haplotypes were the same.

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(2)

(c) The scientists analysed the DNA on the Y chromosome and the DNA in the mitochondria of the Swedish wolves. They concluded that the Swedish wolf population descended from one male wolf from Finland and one female wolf from Russia.

(i) Explain why DNA on the Y chromosome helped them to reach this conclusion.

....

....

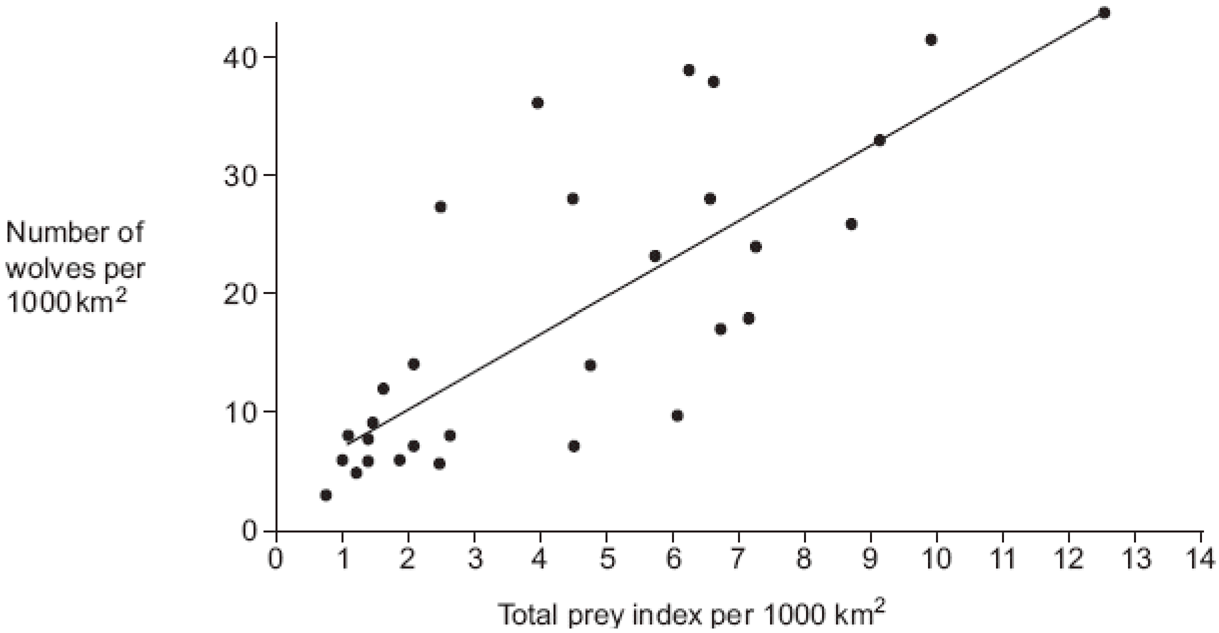
(1)

(ii) Suggest why DNA in the mitochondria helped them to reach this conclusion.

....

.... **(1)**

Wolves eat different mammals. An ecologist investigated factors that affect wolf numbers in North America. He collected data from different field studies carried out in different places. The graph shows his results.



(d) (i) The wolf numbers are given per unit area. Explain why.

....

....

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.... **(2)**

(ii) The ecologist calculated the total prey index for each of the places that had been studied. In order to do this, he gave each prey species a value based on how much food was available to wolves from the prey animal concerned. He called this value the prey index.

The ecologist considered that the prey index gave a better idea of the food available than the prey biomass in kg. Suggest why the prey index gives a better idea of food available.

....

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(2)

(e) The ecologist calculated the total prey index by combining the prey indices and the total number of animals of each species present in 1000 km^2. He plotted this information on the graph. What does the graph suggest about the factors that determine wolf numbers in North America? Explain your answer.

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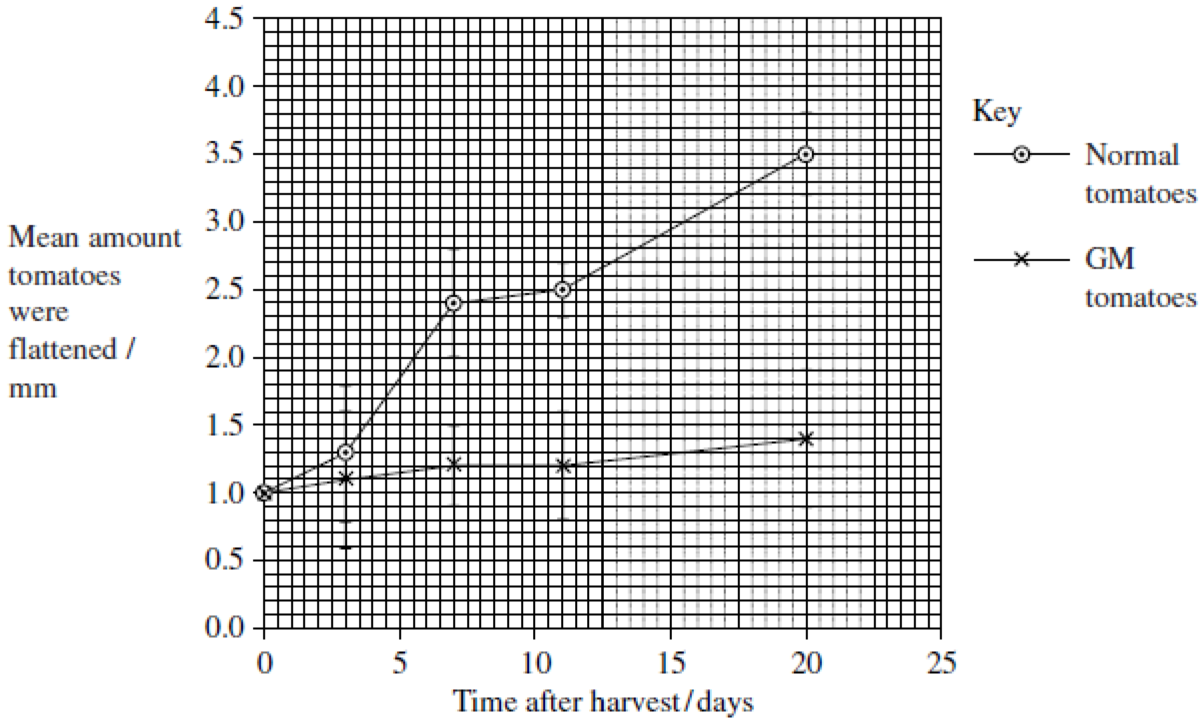
(2)
(Total 12 marks)

16. Tomatoes become softer as they ripen. This is due partly to the breakdown of pectin by the enzyme pectinase. Scientists have produced a genetically modified variety of tomato plant (GM tomato) that produces tomatoes that ripen more slowly. The DNA of the GM tomato plant has been altered so it does not produce pectinase.

Scientists tested the ripeness of normal and GM tomatoes. They placed a 500g mass on top of tomatoes at different times after they were harvested. The scientists measured the amount the tomatoes flattened. The following figure shows the results. The error bars represent standard deviation.



(a) The scientists used tomatoes of the same size in the technique described above to measure ripeness. Explain why.

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(2)

(b) What do the standard deviation bars suggest about the difference in ripeness of the two varieties of tomato at seven days? Explain your answer.

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(2)

(Total 4 marks)

AQA AS Biology

3.4 Genetic information, variation and relationships between organisms

Mark scheme

1. (a) Deoxyribose;

1

(b) 1. Thiamine 18 (%);

2. Guanine 32 (%);

2

(c) DNA polymerase;

1

(d) 1. (**Figure 1** shows) DNA has antiparallel strands / described;

2. (**Figure 1** shows) shape of the nucleotides is different / nucleotides aligned differently;

3. Enzymes have active sites with specific shape;

4. Only substrates with complementary shape/only the phosphate end (of the developing strand) can bind with active site of enzyme/active site of DNA polymerase;

4. Allow 3' end (of developing strand)

4

[8]

2. (a) 1. Chromosome is formed of two chromatids;

2. (Because) DNA replication (has occurred);

3. (Sister) chromatids held together by centromere;

3

(b) 1. Chromosomes in homologous pair;

2. One of each into daughter cells / haploid number;

2

(c) Separation of (sister) chromatids / division of centromere;

1

(d) 1. Independent segregation (of homologous chromosomes);

Accept random assortment

2. Crossing over / formation of chiasmata;

2

[8]

3.(a) 1. Population formed by a small number of founders / people / 30 people / less genetic diversity / small(er) gene pool / less variety of alleles;

Accept: converse arguments for the non-Amish population

1. ***Q*** *Neutral: fewer alleles*

2. Individuals breed within group / do not breed with outsiders;

2. Accept: inbreeding for 'individuals breed within group'

2. Accept: do not interbreed

2. ***Q*** *Reject: interbreeding for 'individuals breed within group'*

3. High(er) chance of inheriting <u>allele</u> (than in non-Amish population);

3. Do not award for 'allele passed on' only

3

(b) 250 000;

1

(c) (i) Loss of 3 bases / triplet = 2 marks;

'Stop codon / code formed' = 1 mark max unless related to the last amino acid

Loss of base(s) = 1 mark;

eg triplet for last amino acid is changed to a stop codon / code = 2 marks

3 bases / triplet forms an intron = 2 marks

Accept: descriptions for 'intron' eg non-coding DNA

'Loss of codon' = 2 marks

2

(ii) 1. Change in tertiary structure / active site;

Neutral: change in 3D shape / structure

2. (So) faulty / non-functional protein / enzyme;

Accept: reference to examples of loss of function e.g. fewer E-S complexes formed

2

[8]

4.(a) (Different) form / type / version of a gene / different base sequence of a gene;

1

(b) Two / sister <u>chromatids</u> joined by a <u>centromere</u>;

Due to <u>DNA</u> replication;

2

(c) (i) Crossing over;

1

Exchange (of alleles) between chromatids / chromosomes;

Negate first marking point for answers which refer to independent segregation.

Chiasma / chiasmata = first marking point

1

(ii) Is infrequent / rare;

References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.

1

(d) (i) Three chromosomes shown;

1

One from each homologous pair;

For first mark point allow drawings showing three chromosomes as single or double structures.

1

(ii) 8;

1

[9]

5. (a) Later fertilisation / cell fusion; (NOT just 'sexual reproduction')
Restoring diploid / original number / not doubling chromosome number;

ALLOW ref '½ + ½'

2

(b) Any three pairs from:

need comparison of meiosis and mitosis each time

Meiosis	Mitosis
(Homologous) chromosomes associate in pairs	(Homologues) independent / do not pair (IGNORE ref. separation
Crossing-over / chiasmata formation	No crossing-over

Two / (nuclear stages) divisions / → 4 offspring cells	One / (nuclear stage) division / → 2 offspring cells;
<u>Genetically</u> different (product)	Genetically identical (product)

IGNORE refs. To location

max 3

[5]

6. (a) (So results) can be compared / so measurement is the same each time / because eye is not perfectly round / uniform;

Accept eye opens to different amounts

1

(b) (i) 1. Eye (diameter) is smaller and antennae longer;

2. Antennae detecting touch;

3. Data only refers to shrimps / data may not apply to all animals / only in one area;

The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.

2 max

(ii) 1. Standard deviation gives a measure of spread / variation;

2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;

Do not accept range

Accept converse.

Although we are looking for the idea of significance, we cannot require this term.

2

(c) (i) Qualitative statement about

difference in size /

difference in variation /

overlap in size;

Quantitative statement about

difference in size /

difference in variation /

overlap in size;

Supported by relevant two sets of figures from graph;

Note simplistic answer involving a quantitative statement gains 1 mark.

More specific answer involving quantitative information gains 2 marks.

2

(ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

OR

(Yes) positive correlation in open / in cave;

Habitat not critical as a term.

Must refer to idea of same habitat

Accept description

1

(d) More alleles of each gene / shrimps in open have all the alleles;

Candidates are required to use the information from the table. Must therefore refer to alleles.

1

(e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

(f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses / large number of crosses / isolate beforehand;

Other valid equivalent suggestions should be accepted.

(ii) If same species the shrimps would breed, producing fertile young / courtship species specific;

Accept any form of evidence – mating / laying eggs / giving birth to young.

3

[15]

7.(a) (i) Produces a more reliable mean / average / makes sure sample was representative / reduce effect of extreme values / identify anomalies;

Ignore references to chance

1

(ii) Removes bias;

1

(b) Two marks for correct answer of 5.8;

One mark for incorrect answer that clearly shows denominator as 216;

2

(c) 1. Increase in variety of plants / shrubs / grass;

2. More habitats / niches;

3. Greater variety of food sources / more food sources;

Answers only referring to 'more food' should not be credited

3

[7]

8. (a) Removes bias;

1

(b) (i) 1. 1.28 / 1.29 / 1.285 / 1.3

1. Ignore more than 3dp

2. Answer incorrect but shows clear understanding of Σ

2. Σ = 318250. Allow mark if denominator written out. Incorrect *denominator but evidence of understanding gains mark*

2

(ii) Diversity index would be lower (NO MARK)

Assume wheat field if site unspecified

1. Fewer species / Beech aphid / Large white butterfly / 7-spot ladybird absent / only three species / species diversity lower / mostly one species / mostly bird-cherry aphid;

   1. Allow species richness in context of few species

2. Fewer plant species;

   2. Allow one type of food source if clearly plant

2

(c) For:

1. Data support the claim / evidence supports claim;

   1. Ignore reference to correlation / causation

Against:

2. Only wheat field / only comparing with wood / one type of habitat / only insects considered;

2 max

(d) 1. Greater variety of plants;

2. Another habitat / more habitats / places to live / niches / another food source / more food types;

   2. Answers referring to 'more food' should not be credited.
   Allow reference to either animal or plant as foods

2

[9]

9.(a) Species richness measures only number of (different) species / does not measure number of individuals;

1

(b) Trees vary in height;

1

(c) 1. Index for canopy is 3.73;

2. Index for understorey is 3.30;

3. Index in canopy is 1.13 times bigger;

If either or both indices incorrect, allow correct calculation from student's values

3

(d) 1. For *Zaretis itys*, difference in distribution is probably due to chance / probability of being due to chance is more than 5%;

2. For all species other than *Zaretis itys*, difference in distribution is (highly) unlikely to be due to chance;

3. Because P < 0.001 which is highly significant / is much lower than 5%;

3

[8]

10. (a) 4;

1

(b) 2.68(6);

If answer incorrect:
Σn(n-1) = 242 = 1 mark
N(N-1) = 650 = 1 mark

2

(c) 1. Take more samples and find mean;

2. Method for randomised samples described;

Allow larger area = 1 mark

2

[5]

11.(a) 1. Kingdom, Phylum, Class, Order, Family;

2. *Luscinia svecica;*

1 mark for each correct column
Allow Genus and Species if both placed in box for species but

not if both placed in genus box

2

(b) Number of different alleles of each gene;

Accept number of different base sequences (found) in each gene

1

(c) 1. Has greater proportion of genes / percentage of genes showing diversity;

2. Percentage is 35% compared with 28% / proportion is 0.35 compared with 0.28;

Allow correct figures that are not rounded up, i.e., 34.9% / 0.349 and 27.8% / 0.278

2

[5]

12.(a) 1. Antibody and haemoglobin / blood (of different primates) mixed / added / bind;

Neutral: methodology of how the human antibody would be obtained

Neutral: mix antibody and plasma / serum

*Neutral: reference to mixing antibody with **human** haemoglobin / blood*

Reject: idea of injecting (human) antibody into primates

2. Precipitate / complex / band formed;

3. Amount of precipitate / complex / thickness of band shows relationship / similarity (in protein / DNA);;

***Note:** MP3 is worth **2 marks outright** on its own as it subsumes MP2. If MP3 is awarded, do <u>**not**</u> also award MP2 for a total of 3 marks.*

Reject: incorrect relationship eg more precipitate = less closely related

3

(b) (i) (Largest decrease in separation temperature) – no mark

Accept: 'not many' for 'few'

Note: 'fewer hydrogen bonds between complementary bases / base pairs' = 2 marks

1. (So) few(er) <u>hydrogen / H</u> bonds;

2. (So) few(er) complementary bases / few(er) base pairs;

Neutral: fewer bases

Neutral: fewer similar base sequences

2

(ii) (Same species) have different alleles / different base sequences / (different) mutations / introns / non-coding DNA / multiple repeats;

***Q** Reject: different genes*

Neutral: different bases

Neutral: base sequences are not complementary

***Q** Neutral: 'junk DNA'*

Neutral: intraspecific variation / genetic differences

Reject: <u>inter</u>specific variation

1

(iii) Correct answer in range of **9.69** to **9.71(4286)** = 2 marks;

*Accept: **9 690 000** to **9 714 286** for 2 marks*

*If **10** is shown <u>**and**</u> an answer in the range of **9.69** to **9.71(4286)**, award **2 marks***

*If **10** is shown and an answer in the range of **9.69** to **9.71(4286)** is <u>**not shown**</u>, award **1 mark***

One mark for incorrect answers that show any of the following:

(1°C =) **5.7(14286)** (million years)

OR:

20 000 000 ÷ 3.5

OR:

20 ÷ 3.5

2

[8]

13. (a) 1. Number of (individuals of) each species;

Accept: 'population' for 'number'

2. Total number of individuals / number of species;

Accept: 'species richness'

MP2 allows for other types of diversity index

2

(b) (i) (Shows) results are due to the herbicide / are not due to another factor / (to) compare the effect of using and not using the herbicide / shows the effect of adding the herbicide;

Neutral: allows a comparison

Neutral: ensures results are due to the independent variable

Reject: 'insecticide'

Accept: 'pesticide'

1

(ii) 1. (More) weeds killed **so** more crops / plants survive / higher yield / less competition;

2. High concentrations (of herbicide) harm / damage / kill / are toxic to crops / plants;

Accept: 'pesticide'

Neutral: 'insecticide'

Accept: use of figures (eg 400+)

2

(iii) 1. Reduced plant diversity / fewer plant species / fewer varieties of plant;

Accept: 'weed' for 'plant'

Neutral: fewer plants

Accept: only one crop species remains

2. Fewer habitats / niches;

Q *Neutral: fewer homes / shelters*

3. Fewer food sources / varieties of food;

Neutral: less food

3

[8]

14. (a) Banding pattern changes as cheetah gets older / difficult to judge as tail is short / fluffy;

1

(b) (i) Mean not (always) a whole number;

Standard deviation not (always) zero;

2

(ii) Movement of tail / angle of sight / confused it with another band / subjective estimation;

*Accept reference to **Figure 1***

E.g. Bands 2 and 3 have same thickness but look different

1

(c) Band width not the same on both sides of tail;

1

(d) Offspring of the same family will be more similar genetically;
As have same mother (and father) / parent;
Expect to see more differences in randomly chosen cheetahs;

3

[8]

15. (a) (i) To cut the DNA;

Reject breakdown, cutting out

1

(ii) To separate the (pieces of) DNA;

1

(b) Complementary base sequence / complementary DNA; binds to both (haplotypes);

Label would show up in both;

Idea of complementarity required

2

(c) (i) Y chromosome inherited / comes from male parents / only found in males;

1

(ii) Mitochondria in egg / female gamete / no mitochondria come from sperm / male gamete;

1

(d) (i) Allows comparison;

Different (sized) areas covered;

2

(ii) Wolves do not eat all of prey animal / do not eat (large) bones / skin;

Inedible parts make up different proportions / wolf eats different proportions;

2

(e) Limited by food / prey; as prey increases so do wolf numbers / positive correlation;

Large range so other factors involved;

2

[12]

16. (a) To enable (valid) comparison;

Bigger / smaller tomatoes could compress more easily;

2

(b) SD bars do not overlap;

Difference (in ripeness) is real;

More variation in normal tomatoes (than in GM tomatoes);

2 max

[4]

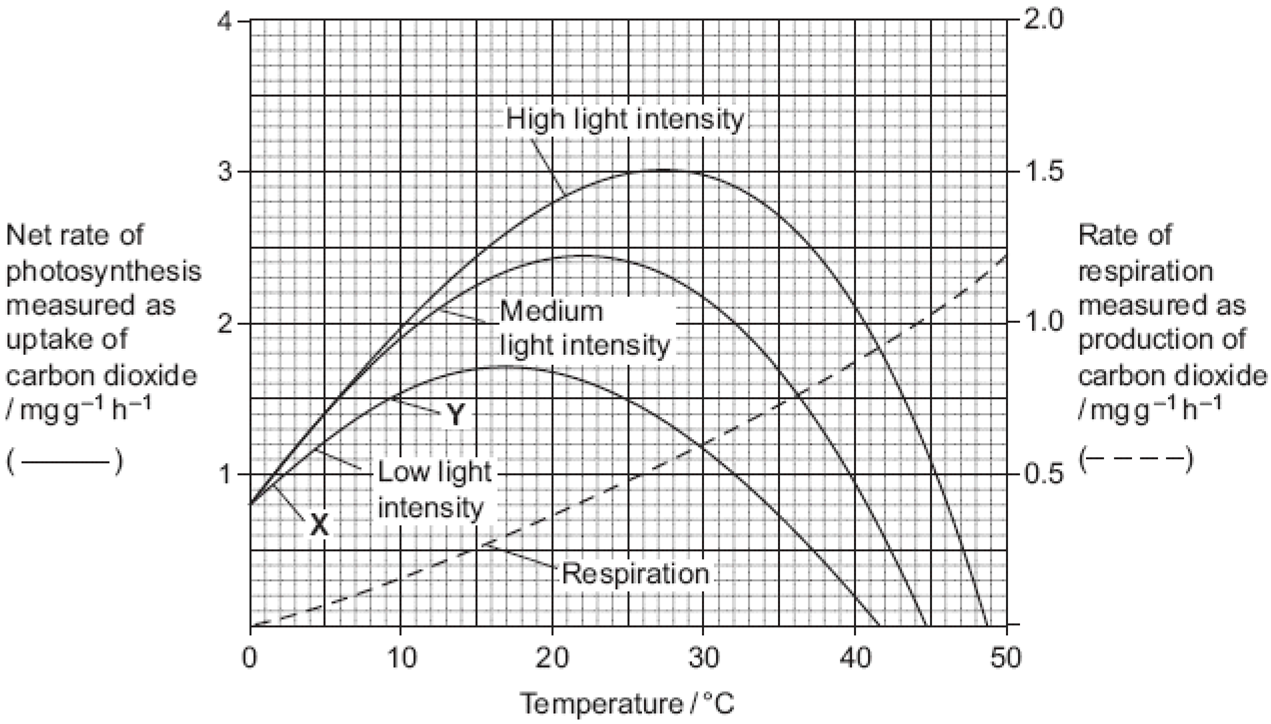
AQA A Level Biology

3.5 Energy transfers in and between organisms

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective and use the revision notes to fill in any gaps.

1. Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea. They investigated the effect of temperature on the net rate of photosynthesis at three different light intensities. They also investigated the effect of temperature on the rate of respiration. The graph shows the results.



(a) (i) Name the factors that limited the rate of photosynthesis between **X** and **Y**.

....

(1)

(ii) Use information from the graph to explain your answer.

....

....

....

....

....

(2)

(b) Use information from the graph to find the gross rate of photosynthesis at 20°C and medium light intensity.

Answer ....

(1)

(c) Creeping azalea is a plant which grows on mountains. Scientists predict that in the area where this plant grows the mean summer temperature is likely to rise from 20 °C to 23 °C. It is also likely to become much cloudier. Describe and explain how these changes are likely to affect the growth of creeping azalea.

....

....

....

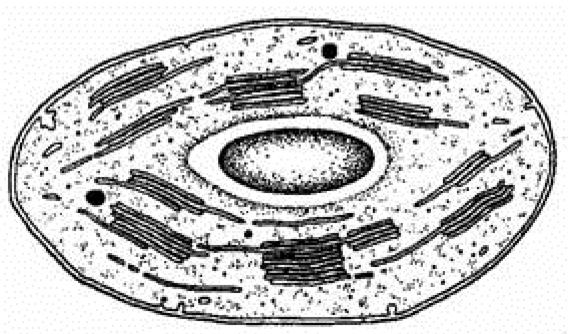
....

....

....

(3)
(Total 7 marks)

2. The diagram shows the structure of a chloroplast.



(a) Label the diagram with an **X** to show where the light-dependent reactions take place and with a **Y** to show where the light-independent reactions take place.

(1)

(b) The photolysis of water is an important part of the process of photosynthesis. Describe what happens in the photolysis of water.

....

....

....

....

(2)

(c) ATP and reduced NADP are two products of the light-dependent reactions. Describe **one** function of **each** of these substances in the light-independent reactions.

ATP ....

....

Reduced NADP ....

....

(2)
(Total 5 marks)

3. (a) Describe how NADP is reduced in the light-dependent reaction of photosynthesis.

....

....

....

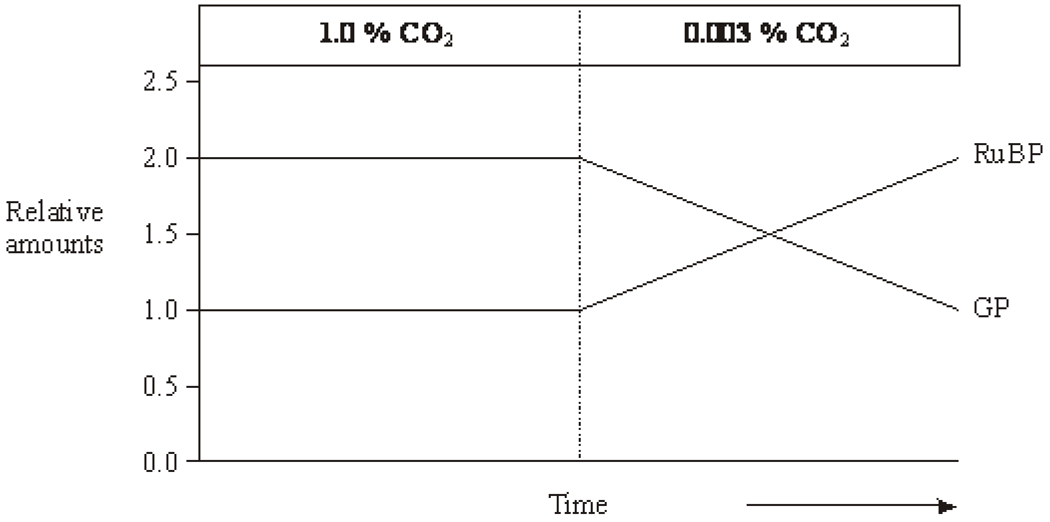
....

(2)

(b) In an investigation of the light-independent reaction, the amounts of glycerate 3-phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells were measured under different environmental conditions.

Figure 1 shows the effect of reducing the carbon dioxide concentration on the amounts of glycerate 3-phosphate and ribulose bisphosphate in photosynthesising cells.

Figure 1



(i) Explain why there is twice the amount of glycerate 3-phosphate as ribulose bisphosphate when the carbon dioxide concentration is high.

....

....

(1)

(ii) Explain the rise in the amount of ribulose bisphosphate after the carbon dioxide concentration is reduced.

....

....

(1)

(c) **Figure 2** shows the results of an experiment in which photosynthesising cells were kept in the light and then in darkness.

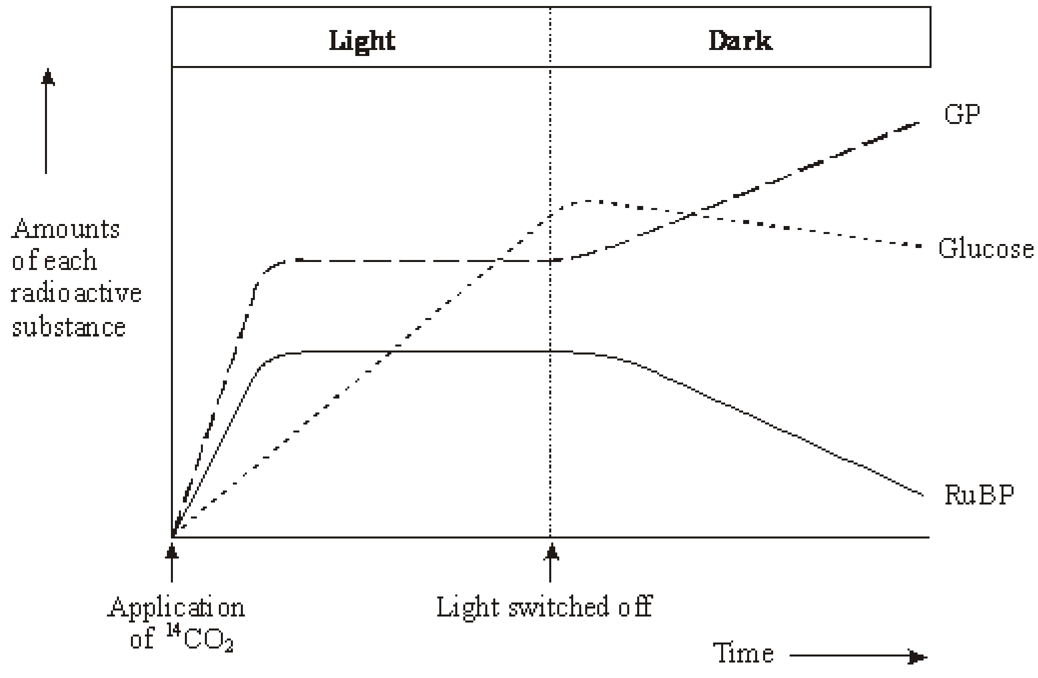


Figure 2

(i) In the experiment the cells were supplied with radioactively labelled $^{14}CO_2$. Explain why the carbon dioxide used was radioactively labelled.

....

....

(1)

(ii) Explain how lack of light caused the amount of radioactively labelled glycerate 3-phosphate to rise.

....

....

....

....

(2)

(iii) Explain what caused the amount of radioactively labelled glucose to decrease after the light was switched off.

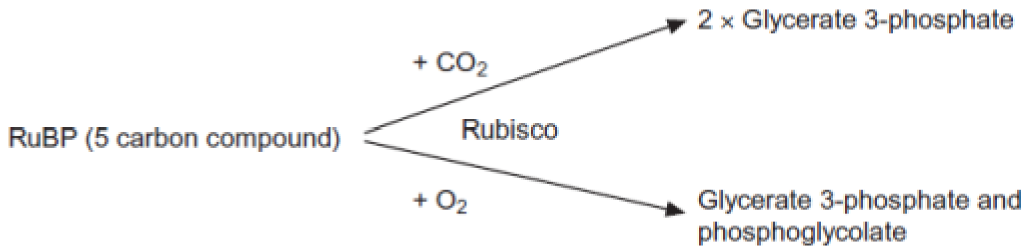
....

....

(1)
(Total 8 marks)

4. During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



(a) (i) Where exactly in a cell is the enzyme Rubisco found?

....

(1)

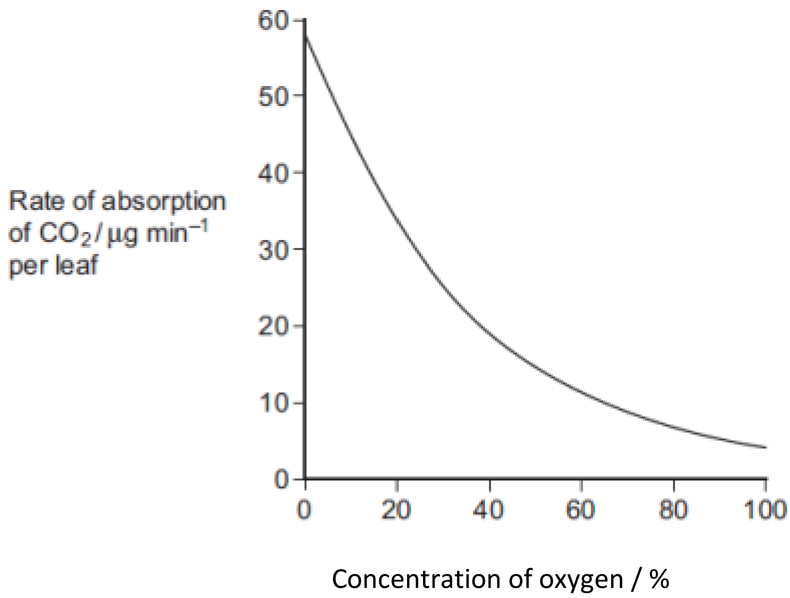
(ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

☐

(1)

(b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



Use **Figure 1** to explain the results obtained in **Figure 2**.

....

....

....

....

....

(2)

(c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

....

....

....

....

....

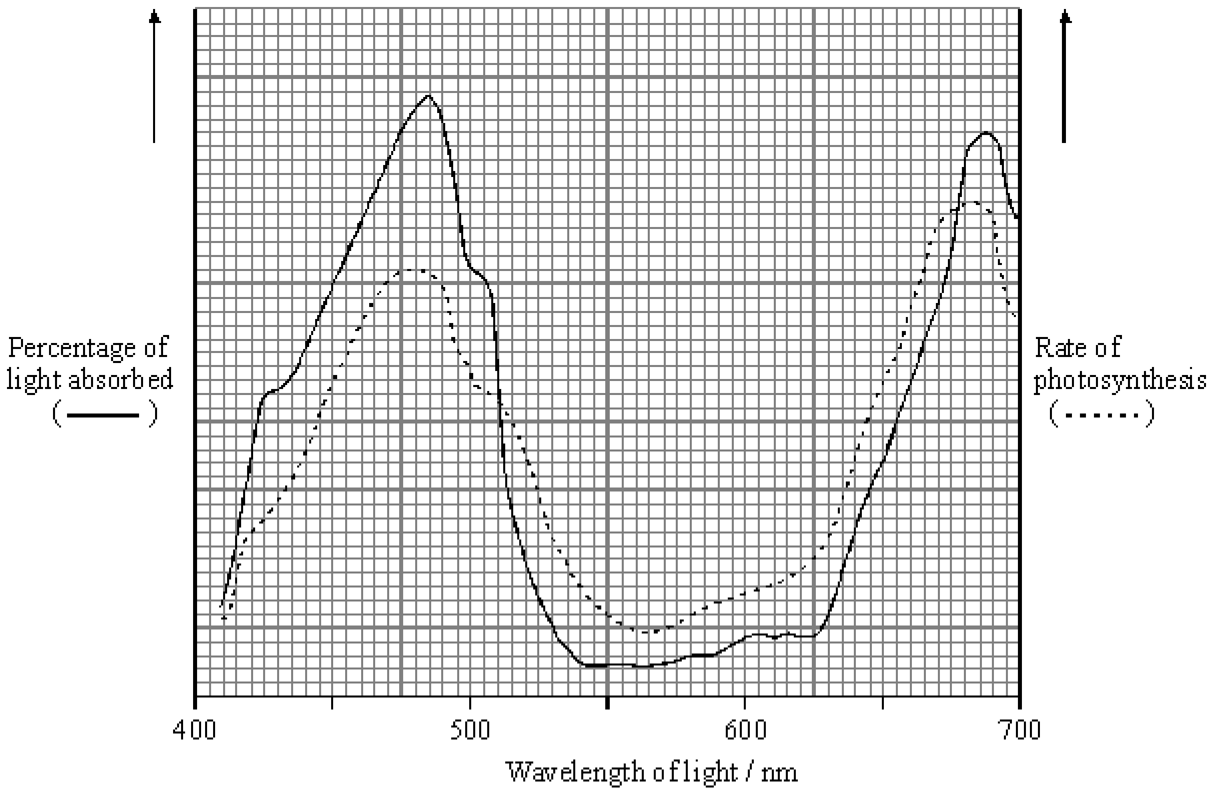
(Extra space) ....

....

....

(3)
(Total 7 marks)

5. The percentage of light absorbed by an aquatic plant was measured when it was exposed to different wavelengths. The rate of photosynthesis was also measured at each wavelength of light. The results are shown in the graph.



(a) Describe and explain the relationship between light absorption and the rate of photosynthesis for the wavelengths of light between 410 nm and 500 nm.

....

....

....

....

(2)

(b) Give **one** dependent variable you could measure in order to determine the rate of photosynthesis in an aquatic plant.

....

(1)

(c) Use the graph to identify the range of wavelengths of light that would be green in colour.

Give a reason for your answer.

Wavelengths .... to .... nm

Reason ....

....

(2)

(d) A suspension of chloroplasts was isolated from an aquatic plant and a reagent was added. The reagent is blue when oxidised and is colourless when reduced.

(i) The suspension of chloroplasts in blue reagent was exposed to sunlight. The blue colour disappeared. Use your knowledge of the light-dependent reactions of photosynthesis to explain why.

....

....

....

....

(2)

(ii) Another suspension of chloroplasts was set up as before. Small quantities of ADP and phosphate ions were added and then the tube was exposed to light. The blue colour disappeared more quickly. Explain why.

....

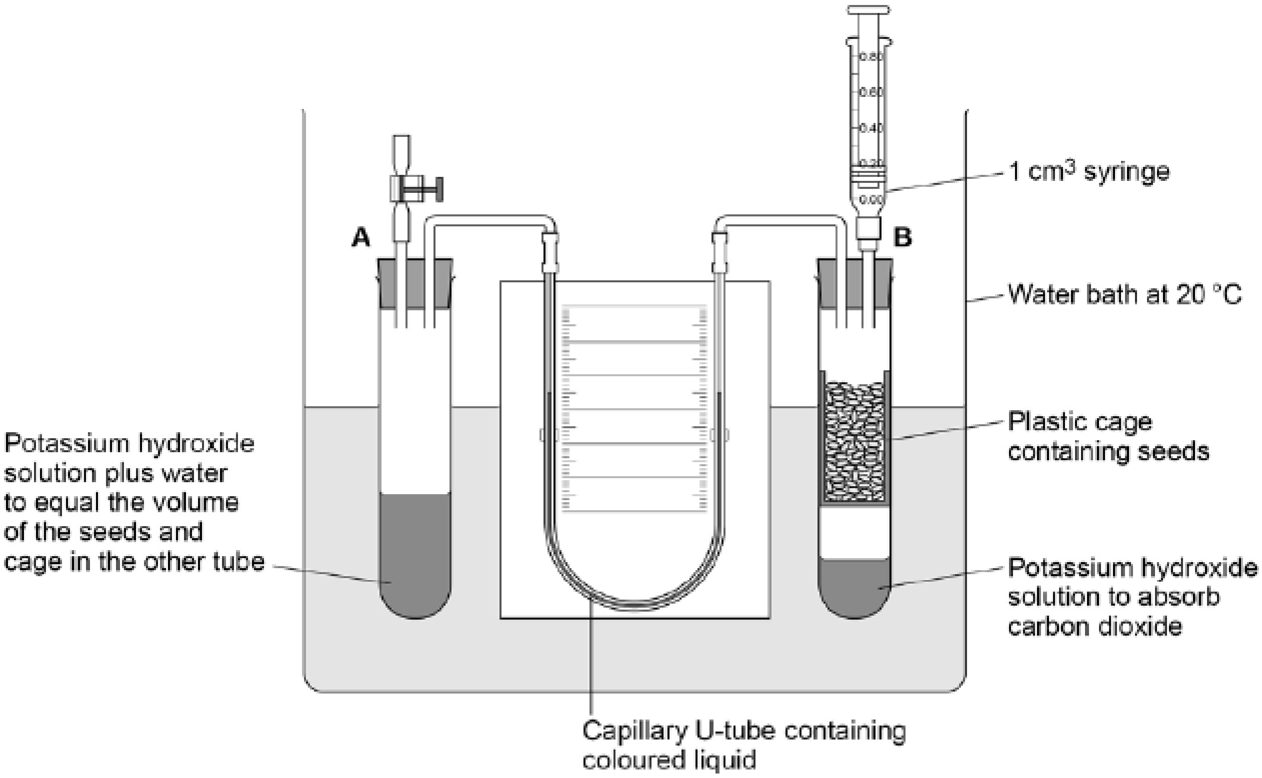
....

....

....

(2)
(Total 9 marks)

6. The figure below shows the apparatus used for measuring the rate of oxygen consumption in aerobic respiration by seeds.



(a) For the first 10 minutes, the tap attached to tube **A** was left open and the syringe from tube **B** was removed.

Suggest **three** reasons why the apparatus was left for 10 minutes.

1 ....

....

2 ....

....

3 ....

....

(3)

(b) Suggest and explain why the chosen temperature was 20 °C for this experiment.

....

....

....

After 10 minutes, the tap attached to tube **A** was closed and the syringe was attached to tube **B**. Every minute, the syringe plunger was moved until the levels in the U-tube were the same. The reading on the syringe volume scale was then recorded.

The results are shown in the table below.

	Time / minutes	Reading on syringe volume scale / cm^3
	0	0.84
	1	0.81
	2	0.79
	3	0.76
	4	0.73
	5	0.70
	6	0.68
	7	0.66
	8	0.63
	9	0.62
	10	0.58

(2)

(c) During the experiment, the coloured liquid in the tubing moved towards tube **B**.
Explain what caused this.

....

....

....

....

....

....

(Extra space) ....

....

....**(3)**

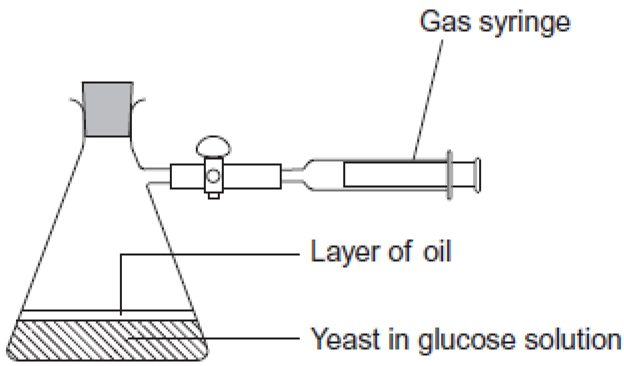
(d) The mass of the seeds was 1.6 g. Use the information in the table above to calculate the rate of oxygen consumption in $cm^3\ g^{-1}\ hour^{-1}$ by the seeds.

Show your working.

Rate = ... $cm^3\ g^{-1}\ hour^{-1}$

(2)
(Total 10 marks)

7. A student investigated the rate of anaerobic respiration in yeast. She put 5 g of yeast into a glucose solution and placed this mixture in the apparatus shown in the figure below. She then recorded the total volume of gas collected every 10 minutes for 1 hour.



(a) Explain why a layer of oil is required in this investigation.

....

....

(1)

(b) The student's results are shown in the following table.

	Time / minutes	Total volume of gas collected / cm^3
	10	0.3
	20	0.9
	30	1.9
	40	3.1
	50	5.0
	60	5.2

(i) Calculate the rate of gas production in $cm^3\ g^{-1}\ min^{-1}$ during the first 40 minutes of this investigation. Show your working.

Answer = ... $cm^3\ g^{-1}\ min^{-1}$

(2)

(ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

....

....

(1)

(iii) Yeast can also respire aerobically. The student repeated the investigation with a fresh sample of yeast in glucose solution, but without the oil. All other conditions remained the same.
Explain what would happen to the volume of gas in the syringe if the yeast were only respiring aerobically.

....

....

....

....**(2)**

(c) Respiration produces more ATP per molecule of glucose in the presence of oxygen than it does when oxygen is absent. Explain why.

....

....

....

....

(2)
(Total 8 marks)

8. (a) Describe the part played by the inner membrane of a mitochondrion in producing ATP.

....

....

....

....

....

....

(3)

(b) A scientist investigated ATP production in a preparation of isolated mitochondria. He suspended the mitochondria in an isotonic solution and added a suitable respiratory substrate together with ADP and phosphate. He bubbled oxygen through the preparation.

(i) Why was the solution in which the mitochondria were suspended isotonic?

....

....

(1)

(ii) Explain why the scientist did **not** use glucose as the respiratory substrate.

....

....

....

....

....

(2)

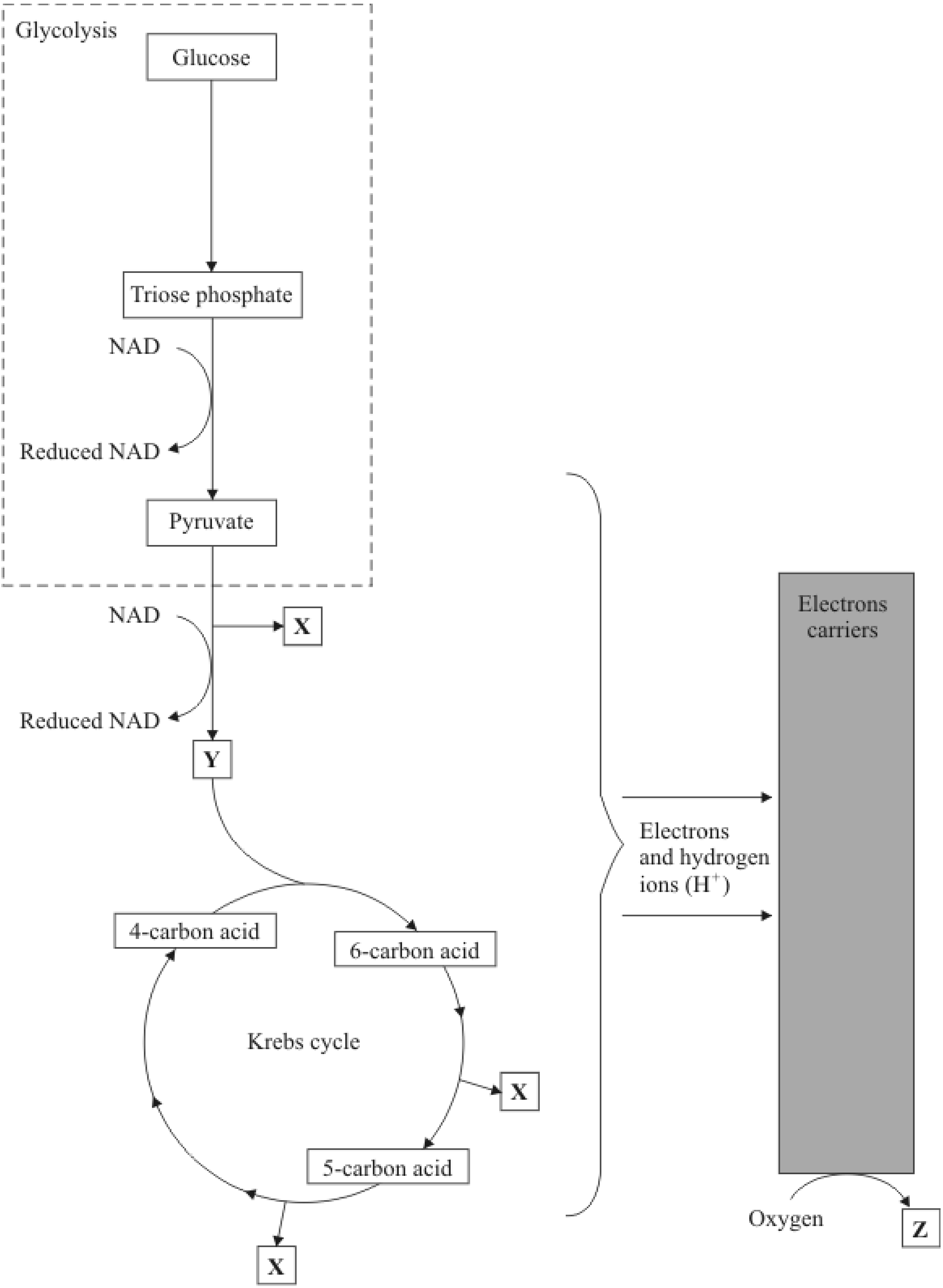
(iii) Explain why the oxygen concentration would change during this investigation.

....

....

(1)
(Total 7 marks)

9. The diagram gives an outline of the process of aerobic respiration.



(a) Name substances **X**, **Y** and **Z**.

X ....

Y ....

Z ....

(3)

(b) Give the location of each of the following in a liver cell.

(i) Glycolysis ....

(ii) The Krebs cycle ....

(2)

(c) (i) Write the letter **A** on the diagram to show **one** step where ATP is used.

(ii) Write the letter **B** on the diagram at **two** steps where ATP is produced.

(3)

(d) Apart from respiration, give **three** uses of ATP in a liver cell.

1 ....

2 ....

3 ....

(3)

(e) Human skeletal muscle can respire both aerobically and anaerobically. Describe what happens to pyruvate in anaerobic conditions and explain why anaerobic respiration is advantageous to human skeletal muscle.

....

....

....

....

....

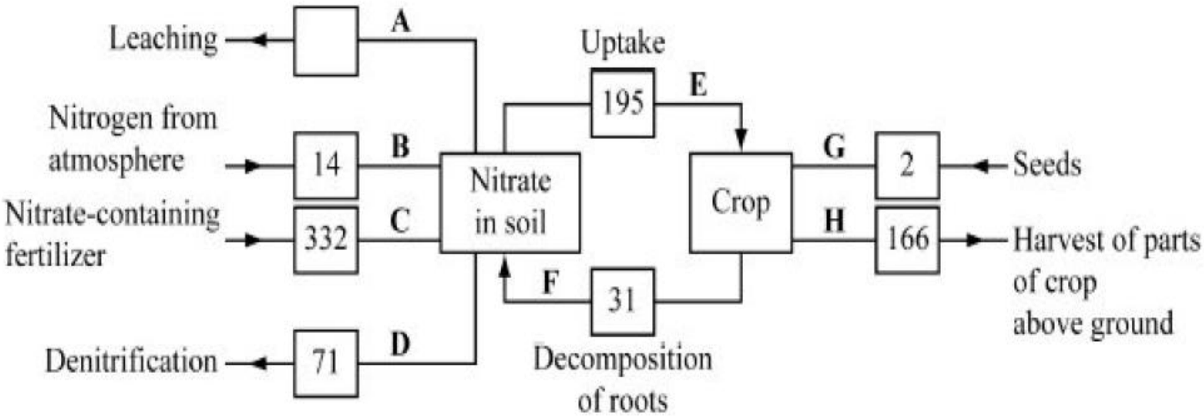
....

....

....

(4)
(Total 15 marks)

10. A wheat crop was grown in a field on a Dutch farm. When the wheat was harvested, all parts of the crop growing above ground were removed. The diagram shows the nitrogen cycle for this field. The figures are in kg of nitrogen per hectare per year.



(a) Give the letter of **one** pathway involving

(i) nitrifying bacteria

....

(1)

(ii) nitrogen-fixing bacteria.

....

(1)

(b) (i) Describe the part played by bacteria in pathway **D**.

....

....

....

(2)

(ii) This wheat crop was growing on clay soil. Clay is easily waterlogged. The figure for pathway **D** would be lower on a farm with sandy soil that does not become waterlogged. Explain why.

....

....

....

(2)

(c) (i) Calculate the maximum amount of nitrogen that could be leached from the soil where this crop was growing in a year.

Answer..............................kg ha–1

(1)

(ii) The information in the diagram could be useful to the farmer in reducing leaching. Explain **one** way in which it could be useful.

....
....
....
....

(1)
(Total 8 marks)

11. (a) Name the type of bacteria which convert

(i) nitrogen in the air into ammonium compounds;

....

(ii) nitrites into nitrates.

....

(2)

(b) (i) Other than spreading fertilisers, describe and explain how **one** farming practice results in addition of nitrogen-containing compounds to a field.

....
....
....

(2)

(iii) Describe and explain how **one** farming practice results in the removal of nitrogen containing compounds from a field.

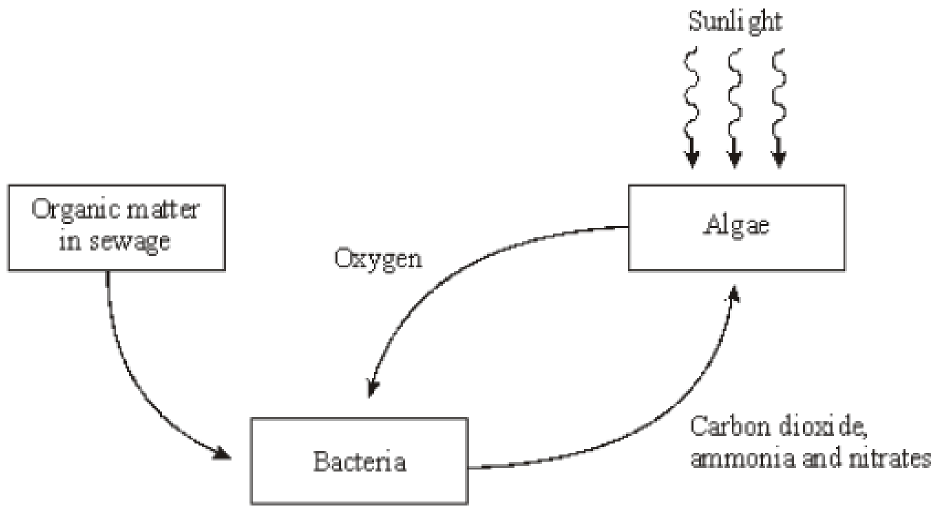
....

....

....

(2)
(Total 6 marks)

12. Purification ponds can be used in warm climates to break down sewage. The ponds are about 1m deep and contain bacteria and green algae. The diagram summarises the processes involved in the breakdown of sewage in a purification pond.



(a) Explain the advantage of having both algae and bacteria in a purification pond.

....

....

....

....

....

(4)

(b) Purification ponds only work efficiently when they are shallow and warm. Explain why.

....

....

....

....

....

....

(4)
(Total 8 marks)

13. Deforestation often involves clearing large areas of forest for use as agricultural land.

(a) Deforestation reduces the diversity index of an area cleared in this way. Explain why.

....

....

....

(2)

(b) Because the forest soil is often nutrient-poor, nitrogen-containing fertilisers may be applied to ensure good crop yields. Use your knowledge of the nitrogen cycle to explain the potential benefit of applying a fertiliser containing ammonium nitrate rather than one containing potassium nitrate.

....

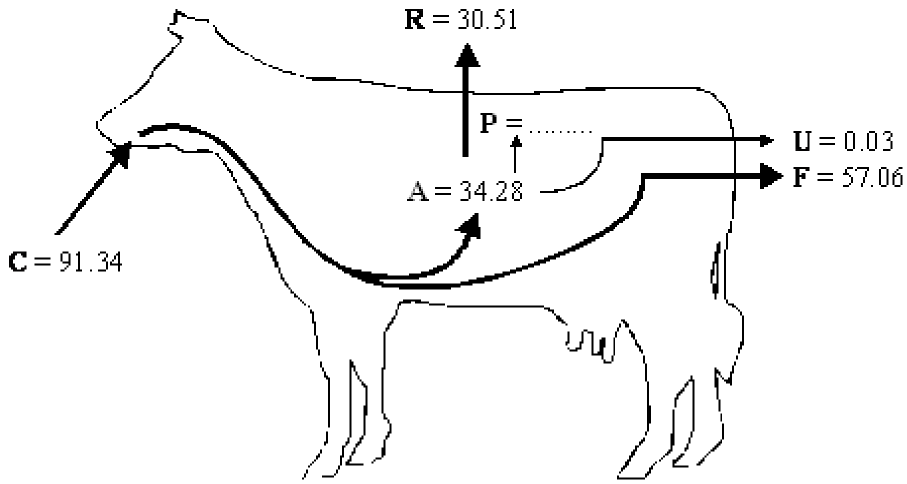
....

....

....

(3)
(Total 5 marks)

14. The diagram shows the transfer of energy through a cow. The figures are in kJ × 10^6 year^{-1}.



Key: **A** = energy absorbed from the gut
C = energy consumed in food
F = energy lost in faeces
P = energy used in production of new tissue
R = energy lost by respiration
U = energy lost in urine

(a) (i) Complete the following equation for the energy used in the production of new tissue. Use only the letters **C**, **F**, **R** and **U**.

P = ...

(1)

(ii) Calculate the value of **P**.

P = ... kJ × 10^6 year^{-1}

(1)

(b) It has been estimated that an area of 8100 m^2 of grassland is needed to keep one cow.

The productivity of grass is 21 135 kJ m^{-2} $year^{-1}$. What percentage of the energy in the grass is used in the production of new tissue in one cow? Show your working.

Answer .... %

(2)

(c) Keeping cattle indoors, in barns, leads to a higher efficiency of energy transfer.

Explain why.

....

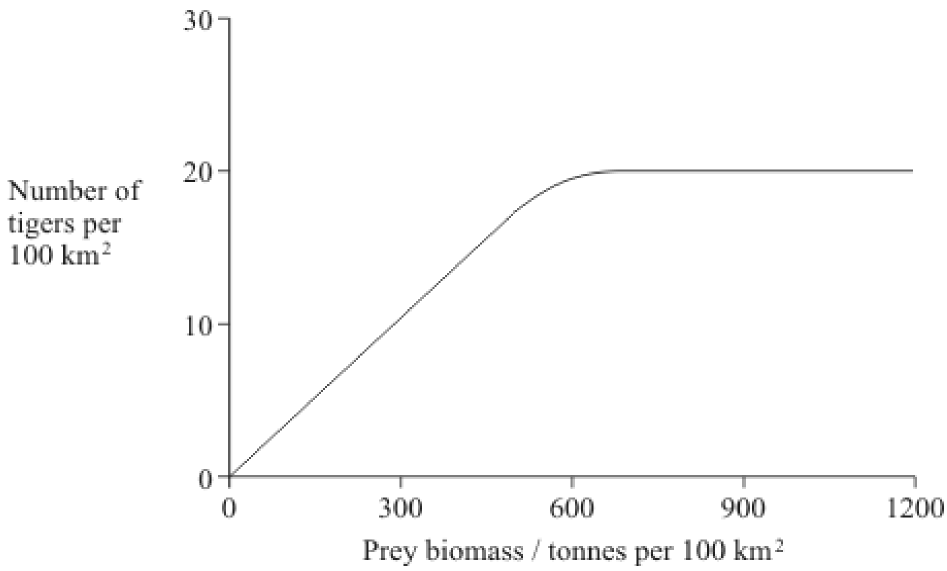
....

(1)

(Total 5 marks)

15. Tigers inhabit forests where they feed mainly on large prey animals. Over the past fifty years, there has been extensive deforestation in many areas where tigers are found.

The graph shows the relationship between the prey biomass of an area and the tiger population that the area can support.



(i) What is meant by the ecological term *population*?

....

....

(1)

(ii) Use the graph to explain how deforestation might cause a reduction in the number of tigers in an area.

....

....

....

....

....

....

(3)
(Total 4 marks)

AQA A Level Biology

3.5 Energy transfers in and between organisms

Mark scheme

1. (a) (i) Temperature and light;

1

(ii) Increase in temperature causes increase in rate of photosynthesis / uptake of carbon dioxide;

Increase in light / more / medium / high light (intensity) causes increase in rate of photosynthesis / uptake of carbon dioxide;

2

(b) 2.75 – 2.81 (mg g^{-1} hr^{-1})

Accept answers in range 2.75 – 2.81

1

(c) 1. Growth will decrease (at higher temperature);

2. Rate of respiration will increase at higher temperature;

3. Photosynthesis decreases as limited by light / as there is less light;

Ignore references to effect of temperature on rate of photosynthesis

3

[7]

2. (a) <u>On diagram, correctly labelled:</u>

Light-dependent: granum / thylakoid membranes – labelled 'X'
AND
Light-independent: stroma – labelled 'Y';

1

(b) <u>Any two from:</u>

(Water) forms H^+ / hydrogen ions <u>and</u> electrons / e^- ;

O_2 / oxygen formed; [*NOT* 'O', *NOT* 'O^-']

(Light) excites electrons / raises energy level of electrons / electrons to chlorophyll / to photosystem;

max 2

(c) (ATP) Provides <u>energy</u> for GP → TP / provides <u>P</u> for RuP / TP → RuBP;

(Reduced NADP) Provides <u>H / electrons</u> for GP → TP / <u>reduces</u> GP to TP;

2

[5]

3. (a) electrons;
from chlorophyll / photolysis;

2

(b) (i) RuBP combines with carbon dioxide to produce 2 x GP;

1

(ii) less used to combine with carbon dioxide /
less used to form glycerate 3-phosphate;

1

(c) (i) used in photosynthesis allows detection of products;

1

(ii) ATP and reduced NADP not formed;
GP is not being used to form RuBP / is being formed from RuBP;

2

(iii) used in respiration / formation of starch / cellulose;

1

[8]

4.(a) (i) Stroma (of chloroplasts);

Reject: stoma

1

(ii) 2;

1

(b) 1. As oxygen (concentration) increases less Rubisco / RuBP reacts / binds with carbon dioxide;

1. Accept - as oxygen (concentration) increases more Rubisco / RuBP reacts / binds with oxygen

1. Accept – less GP / more phosphoglycolate formed as oxygen (concentration) increases

2. Competitive inhibition / competition between oxygen and carbon dioxide for rubisco / enzyme / active site (therefore) less RuBP formed / regenerated

(to join with carbon dioxide);

2. Accept oxygen and carbon dioxide are complementary to active site

2

(c) 1. Less glycerate 3-phosphate / GP produced;

1. Accept one GP formed rather than two GP

2. (Less) triose phosphate to form sugars / protein / organic (product) / any named photosynthetic product;

3. Less RuBP formed / regenerated;

3. Accept RuBP takes longer to form

3

[7]

5. (a) the more light absorbed, the greater the rate of photosynthesis;
light provides the energy for light dependent reactions / photolysis / light independent reactions / production of reduced NADP / exciting electrons in chlorophyll;

(do not give credit if energy is used in photosynthesis)

2

(b) count the number of bubbles / measure the volume of gas / measure the change in pH / carbon dioxide / hydrogen carbonate ions;

(credit oxygen produced)

1

(c) 530 – 630 nm;

(any values within this range)

limited absorption of light / (green) plants reflect green light / limited photosynthesis at these wavelengths of light;

(allow references to no light absorbed or no photosynthesis)

2

(d) (i) chlorophyll excited / reduced NADP formed;
electrons from chlorophyll / reduced NADP changes the dye colour;

2

(ii) ADP and phosphate needed to produce ATP / ATP is a product of the light dependent reactions;
ADP levels are a limiting factor;

(must explain the idea of limiting factors – do not credit answers like more ADP causes more photosynthesis)

2

[9]

6. (a) 1. Equilibrium reached;

Accept equilibrate

2. Allow for expansion / pressure change in apparatus;

3. Allow respiration rate of seeds to stabilise;

Ignore seeds acclimatise

3

(b) 1. Optimum temperature / temperature for normal growth of seeds;

2. (Optimum temperature) for enzymes involved in respiration;

2

(c) 1. Oxygen taken up / used by seeds;

2. CO_2 given out is absorbed by KOH (solution);

3. Volume / pressure (in **B**) decreases;

3

(d) 0.975 / 0.98;

If incorrect,

0.26 × 6 / or incorrect numbers divided by 1.6 for 1 mark

2

[10]

7. (a) Prevents <u>oxygen</u> being taken up / entering / being absorbed;

Accept: any idea of no contact with oxygen.

Neutral: for anaerobic respiration / anaerobic conditions.

Neutral: prevents entry of air.

Reject: prevents entry of oxygen and another named gas.

1

(b) (i) 0.0155 / 0.016 = 2 marks;;

0.0775 / 0.077 / 0.078 / 0.08 = 1 mark

/ 0.62 = 1 mark

2

(ii) Glucose decreases / is a limiting factor / increase in ethanol / yeast / cells die / toxins build up;

Accept: glucose is used up.

1

(iii) 1. (Stays the) same / level / (relatively) constant;

2. Same volume / amount of oxygen uptake and carbon dioxide release;

Note: if m.p.1 is awarded m.p 2 can be obtained without referring to 'same volume / amount'.

2

(c) 1. Oxygen is final / terminal (electron) acceptor / oxygen combines with electrons and protons;

2. Oxidative phosphorylation / electron transport chain provides (most) ATP / only glycolysis occurs without oxygen / no Krebs / no link reaction;

2

[8]

8. (a) Electrons transferred down electron transport chain;

Provide energy to take protons / H^+ into space between membranes;

Protons / H^+ pass back, through membrane / into matrix / through ATPase;

Energy used to combine ADP and phosphate / to produce ATP;

Accept: alternatives for electron transport chain.

3 max

(b) (i) Prevent damage to mitochondria caused by water / osmosis / differences in water potential;

Accept: other terms that imply damage e.g. shrink / burst

1

(ii) Glucose is used / broken down during glycolysis in cytoplasm / not in mitochondria;

Accept: 'glucose is converted to pyruvate' for description of breakdown

Glucose cannot cross mitochondrial membrane / does not enter mitochondria;

Accept: only pyruvate can

2

(iii) Terminal / final acceptor (in electron transport chain) / used to make water;

Could be shown by symbols

1

[7]

9. (a) X = Carbon dioxide;
Y = Acetyl coenzyme A;

(ACCEPT Acetyl CoA)

Z = Water;

3

(b) (i) Cytoplasm;

1

(ii) Mitochondrion;

(IGNORE named part)

1

(c) <u>On the diagram:</u>

(i) '**A**' (ATP used) – <u>between</u> glucose and triose phosphate;

1

(ii) '**B**' <u>Any **two** from</u>:

(ATP produced) – between triose phosphate and pyruvate;
in Krebs cycle;
from electron carriers
(to right of bracket & not below grey box);

max 2

(d) <u>Any **three** from</u>:

Source of energy / of phosphate;
Active transport;
Phagocytosis / endo- / exocytosis / pinocytosis;
Bile production;
Cell division / mitosis;
Synthesis of: glycogen;
protein / enzymes;
DNA / RNA;

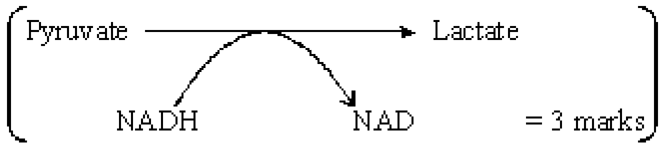
lipid / cholesterol;
urea;

max 3

(e) Any **four** from:
Forms lactate; [extras – C_2H_5OH / CO_2 – *CANCEL*]

Use of reduced NAD / NADH;

Regenerates NAD;



NAD can be re-used to oxidise more respiratory substrate / correct e.g. / allows glycolysis to continue;
Can still release energy / form ATP
when oxygen in short supply / when no oxygen;

max 4
[15]

10 (a) (i) **F**;

1

(ii) **B**;

1

(b) (i) Conversion of nitrate to nitrogen;
Use nitrate for respiration;

2

(ii) Denitrifying bacteria found in anaerobic conditions;
Sandy soils contain more oxygen;

Q *Accept converse argument for clay soils but answer must relate to denitrifying bacteria*

2

(c) (i) 253 (kg ha–1)

1

(ii) Suggests that less fertiliser might be applied/parts above ground not required could be ploughed in;

1
[8]

11. (a) (i) nitrogen-fixing;
(ii) nitrifying;

(names neutral, name only no mark)

2

(b) (i) growing legumes/ named legume;
ploughed in/allowed to decompose/nitrogen-fixing

(bacteria in nodules);

OR
allow cattle/named species/(farm) animals (to graze);
add dung/urine;

OR
spread/add manure/slurry;
decomposed to release nitrates/ammonia/nitrites;

2

(ii) bare soil/fallow in winter/hedge removal; leaching
(of nitrates)/soil erosion;

OR
uptake of nitrates/ammonium compounds by crop;
harvesting crop/named crop which would be harvested;

OR
(farm) animals eat plants
(in field); (then) animals removed;

2

[6]

12. (a) breakdown of organic matter/sewage by enzymes from bacteria;
nitrates/ammonia used by algae to make amino acids/proteins;
algae photosynthesise;
bacterial respiration uses O

2

/produces CO

2

for algae;
(respiration) allows for reproduction/growth of bacteria;

4

(b) sufficient light penetration for photosynthesis (of algae);
warm leads to faster enzyme activity;
faster bacterial respiration/decomposition;
faster photosynthesis;
increased growth/reproduction of bacteria/algae;

4
[8]

5]

13.

(a) deforestation removes many habitats/niches
fewer species/ fewer types of organisms;
(do not credit just fewer organisms);

2

(b) 1. ammonium nitrate contains more nitrogen per molecule than potassium nitrate;
2. nitrate ions in fertiliser available/ absorbed immediately;
3. ammonium converted to nitrate;
4. by nitrifying bacteria/Nitrosomonas and Nitrobacter;
5. fertiliser would provide only the initial release of nitrate/ potassium nitrate;

3 max
[5]

14. (a) (i) P = C – R – U– F / C – (R + U + F) / eq;

1

(ii) 3.74;

1

(b) Correct answer: 2.18
(Accept 2.19 or 2.2)

/ correct for candidate's (a)(ii) ;; = 2 marks

Correct use of data but wrong answer:

$$\frac{\text{(a)(i)} \times 10^6 \times 100}{21135 \times 8100}$$ = 1 mark

2

(c) Less energy lost as heat / in maintaining body temperature / in movement

1
[5]

15. (i) Population is the total number of organisms / individuals of a species / tigers in an area (at a given time);

1

(ii) (Deforestation involves) habitat destruction / destruction of niches;

Some prey animals move out or die / fewer suitable prey for tiger / less food for tiger; Reduces tiger population if prey biomass falls below 600 (tonnes per km^2);

3

[4]

AQA A Level Biology

3.6 Organisms respond to changes in their internal and external environments

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective and use the revision notes to fill in any gaps.

1. A biologist investigated the behaviour of a species of worm that lives in soil.

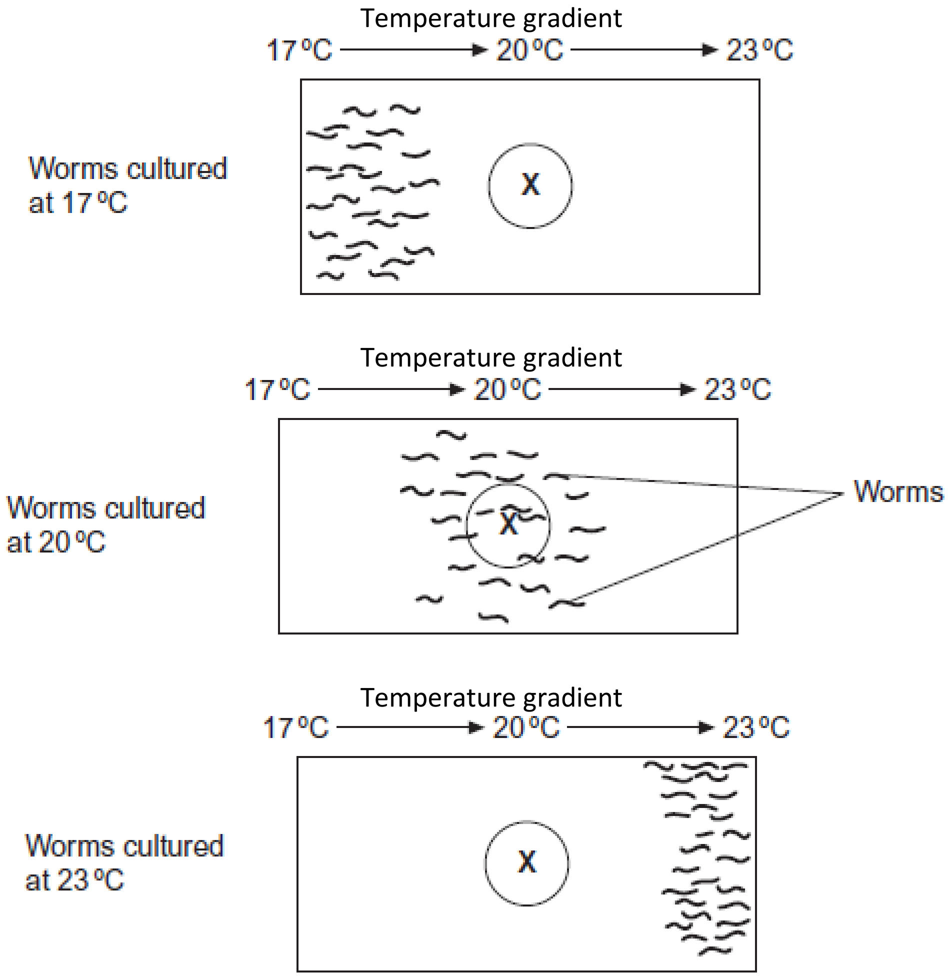
He cultured three samples of worms in three separate trays of soil for many days.
Each culture:

- contained a food supply
- was kept at a different temperature.

The temperatures of the cultures were 17 °C, 20 °C and 23 °C.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

The figure below shows his results. On each diagram, X marks where he released the worms onto the glass surface.



(a) The biologist concluded that the worms' behaviour demonstrated taxis.
How do these results support this conclusion?

....

....

....

....

(2)

(b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

....

....

....

....

....

....

(Extra space) ....

....

....

(3)

(c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was important that the light was dim and even.

1 ....

....

2 ....

....

(2)
(Total 7 marks)

2. Push-pull stimuli can be used together as part of a pest control system.

- A push stimulus drives the pest away from the crop plant.

- A pull stimulus attracts the pest towards a different species of plant or to a pesticide.

Scientists carried out an investigation to find out whether using **push-pull** stimuli could improve control of an insect pest.

In control experiments, insects had a choice between:

- food without pesticide and
- food with a pesticide added.

The scientists recorded how much of each food the insects ate.

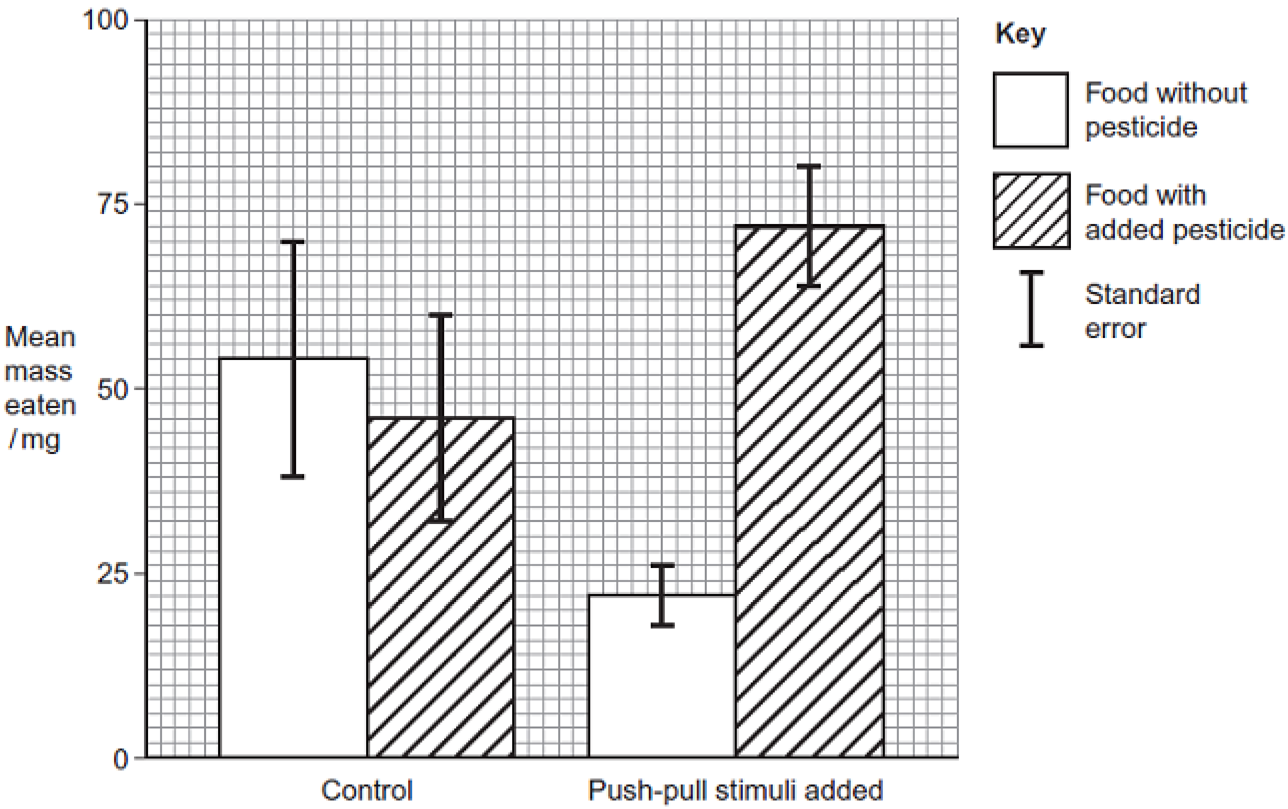
In the other experiments:

- a push stimulus was added to the food without pesticide and
- a pull stimulus was added to the food with pesticide.

Again, the scientists recorded how much of each food the insects ate.

The push stimulus was a chemical that repels the insect.
The pull stimulus was a hormone that attracts the insect.

The following figure shows the mean mass of each type of food eaten in the control experiments and when the **push-pull** stimuli were added.



(a) (i) It was essential to include a control experiment in this investigation.
Explain why.

....

....

....

(1)

(i) Describe the results of the control experiment.

....

....

....

....

....

(2)

(b) Name the type of behaviour the insects showed in response to the hormone.

....

(1)

(c) The scientists concluded that the **push-pull** stimuli would improve control of the insect pest.
How do these data support this conclusion?

....

....

....

....

....

....

(Extra space) ....

....

(3)

(d) The scientists' investigations were aimed at developing an integrated system of pest control. What is meant by an integrated system of pest control?

....

....

....

....

....

(2)
(Total 9 marks)

3. IAA is a specific growth factor.

(a) Name the process by which IAA moves from the growing regions of a plant shoot to other tissues.

....

(1)

(b) When a young shoot is illuminated from one side, IAA stimulates growth on the shaded side. Explain why growth on the shaded side helps to maintain the leaves in a favourable environment.

....

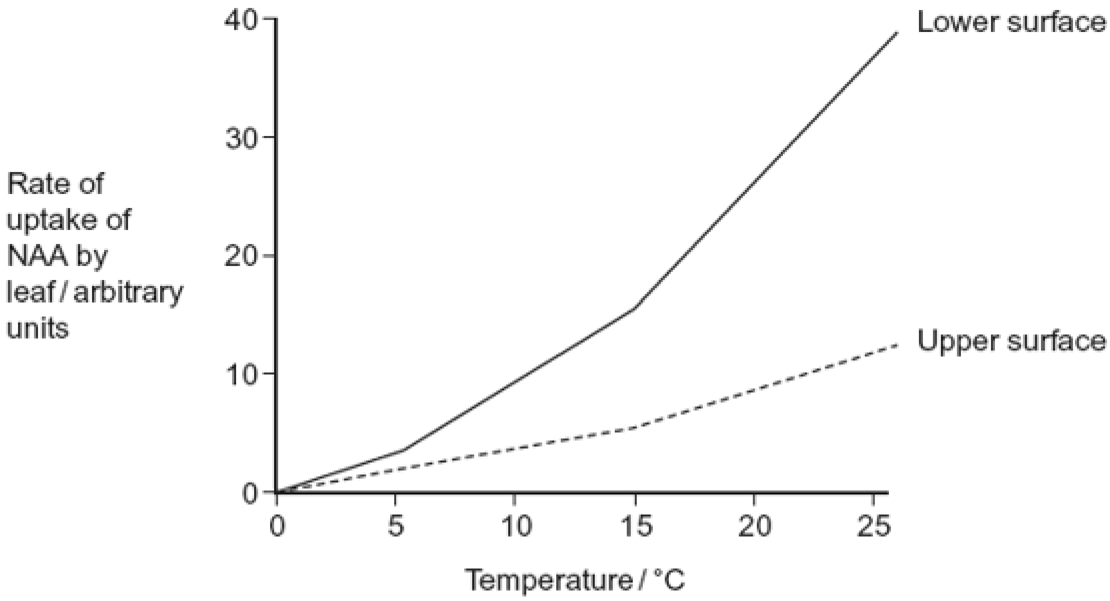
....

....

....

(2)

NAA is a similar substance to IAA. It is used to control the growth of cultivated plants. Plant physiologists investigated the effect of temperature on the uptake of NAA by leaves. They sprayed a solution containing NAA on the upper and lower surfaces of a leaf. The graph shows their results.



(c) Explain the effect of temperature on the rate at which NAA is taken up by the lower surface of the leaf.

....

....

....

....

....

(2)

(d) There are differences in the properties of the cuticle on the upper and lower surfaces of leaves.

(i) Suggest how these differences in the cuticle might explain the differences in rates of uptake of NAA by the two surfaces.

....

....

....

....

(2)

(ii) In this investigation, the physiologists investigated the leaves of pear trees.

Explain why the results might be different for other species.

....

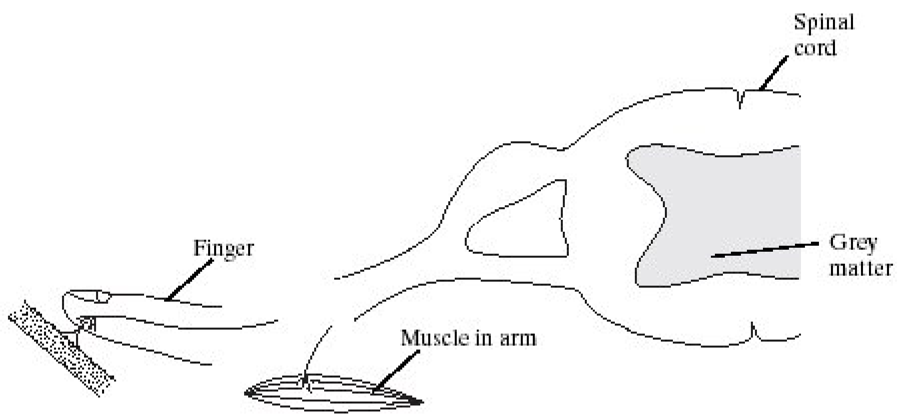
....

....

(1)
(Total 8 marks)

4. A gardener accidentally pricks a finger on a thorn. She quickly pulls the finger away. This reaction results from a simple reflex arc involving three neurones.

The diagram shows part of the pathway involved in this reaction.



(i) Complete the diagram to show the rest of the simple reflex arc.

(1)

On your diagram

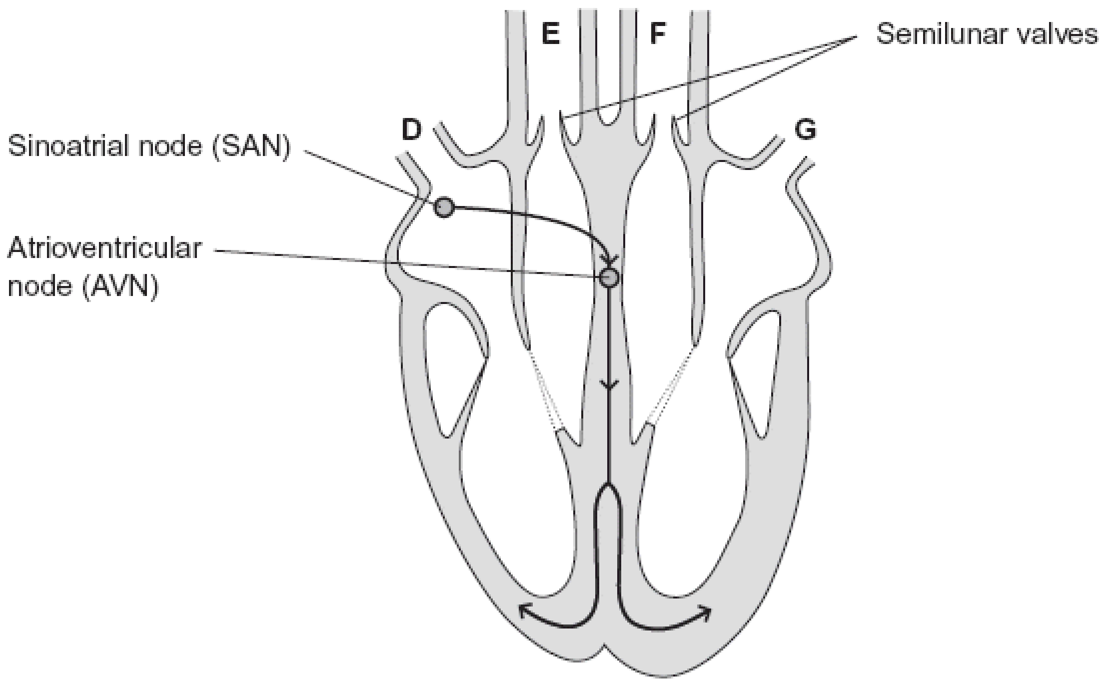
(ii) name and label the **three** neurones;

(iii) label the effector.

(2)

(Total 3 marks)

5. The diagram shows a human heart as seen from the front. The main blood vessels are labelled **D** to **G**. The arrows show the pathways taken by the electrical activity involved in coordinating the heartbeat in the cardiac cycle.



(a) Which of the blood vessels, **D** to **G**

(i) carries oxygenated blood to the heart

(1)

(ii) carries deoxygenated blood to the lungs?

(1)

(b) Explain, in terms of pressure, why the semilunar valves open.

....

....

....

(1)

(c) When a wave of electrical activity reaches the AVN, there is a short delay before a new wave leaves the AVN. Explain the importance of this short delay.

....

....

....

....

....

(2)

(d) The table shows the cardiac output and resting heart rate of an athlete before and after completing a training programme.

	Before training	**After training**
Cardiac out/cm^3	5000	5000
Resisting heart rate/beats per minute	70	55

(i) Calculate the athlete's stroke volume after training. Show your working.

.... cm^3

(2)

(ii) Use information from the table to explain how training has caused the resting heart rate of this athlete to be lower.

....

....

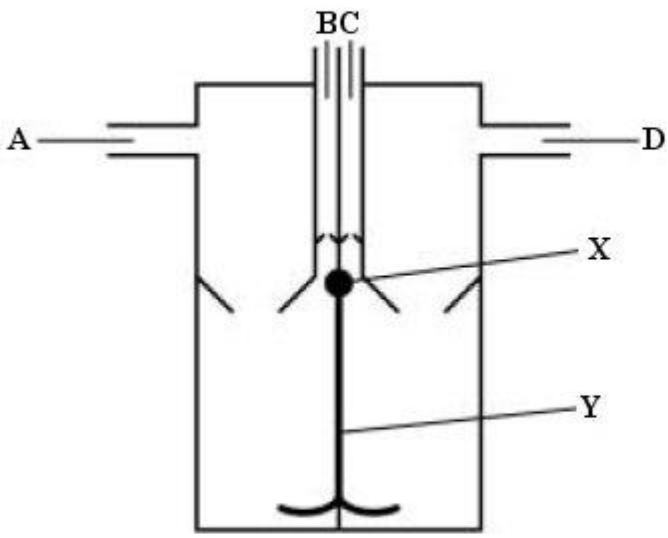
....

....

....

(2)
(Total 9 marks)

6. The diagram shows a human heart seen from the front.



(a) (i) Which **one or more** of vessels **A** to **D** contains oxygenated blood?

....

(1)

(ii) During a cardiac cycle, the pressure of blood in vessel **C** is higher than the pressure of blood in vessel **B**. Explain what causes this difference in pressure.

....

....

(1)

(b) What does the diagram suggest about the pressure in the atria compared to the pressure in the ventricles at the stage in the cardiac cycle shown?
Explain your answer.

....

....

....

....

(2)

(c) The wave of electrical activity which coordinates the heart beat is delayed slightly at part **X**. It then passes along part **Y** to the base of the ventricles.

Explain the importance of

(i) the slight delay at part **X**

....

....

....

....

(2)

(ii) the electrical activity being passed to the base of the ventricles.

....

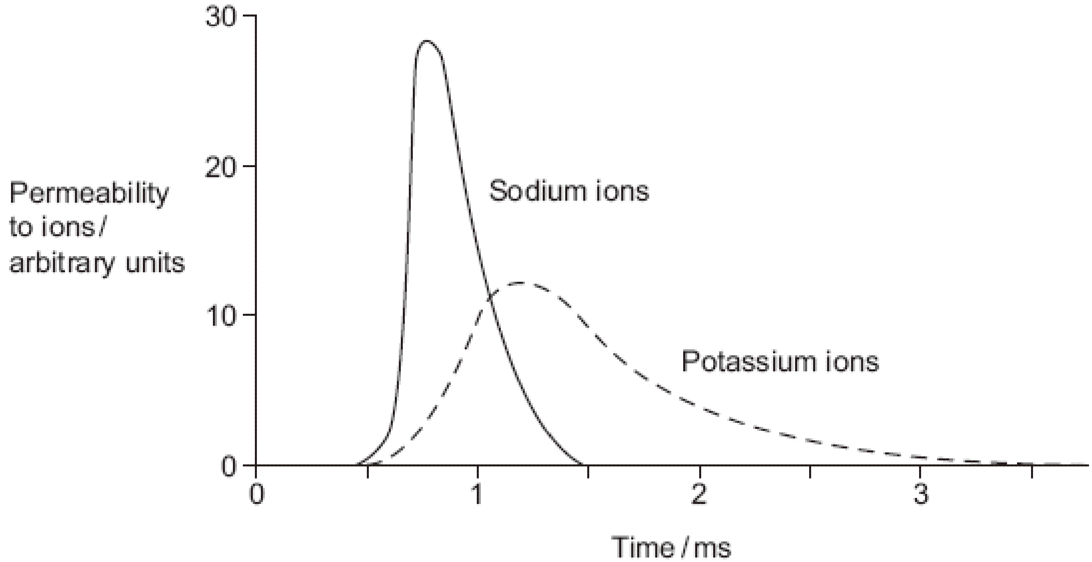
....

....

....

(2)
(Total 8 marks)

7. During an action potential, the permeability of the cell-surface membrane of an axon changes. The graph shows changes in permeability of the membrane to sodium ions (Na^+) and to potassium ions (K^+) during a single action potential.



(a) Explain the shape of the curve for sodium ions between 0.5 ms and 0.7ms.

....

....

....

....

(3)

(b) During an action potential, the membrane potential rises to +40 mV and then falls. Use information from the graph to explain the fall in membrane potential.

....

....

....

....

(3)

(c) After exercise, some ATP is used to re-establish the resting potential in axons. Explain how the resting potential is re-established.

....

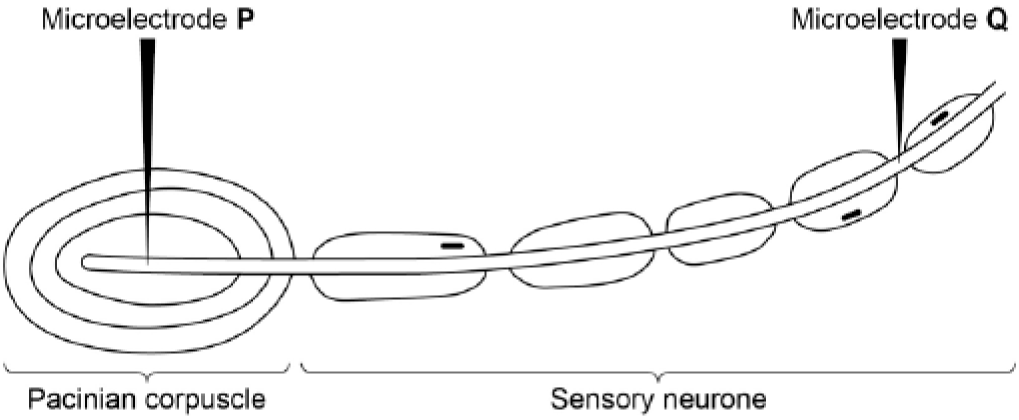
....

....

(2)
(Total 8 marks)

8. A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip. She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

The figure below shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.



The table below shows some of the biologist's results.

	Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
	None	–70	–70
	Light	–50	–70
	Medium	+30	+40
	Heavy	+40	+40

(a) Explain how the resting potential of –70 mV is maintained in the sensory neurone when no pressure is applied.

....

....

(2)

(b) Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **P**.

....

....

....

....

....

(3)

(c) The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the fingertip. Explain why.

....

....

....

(2)

(d) Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neurones are destroyed. Explain how this results in slower responses to stimuli.

....

....

(2)
(Total 9 marks)

9. Secretion of neurotransmitters into a synaptic cleft may produce an action potential in a postsynaptic neurone.

(i) Explain how the release of acetylcholine at an excitatory synapse reduces the membrane potential of the postsynaptic membrane.

....

....

....

(2)

(ii) Explain what causes transmission at a synapse to occur in only one direction.

....

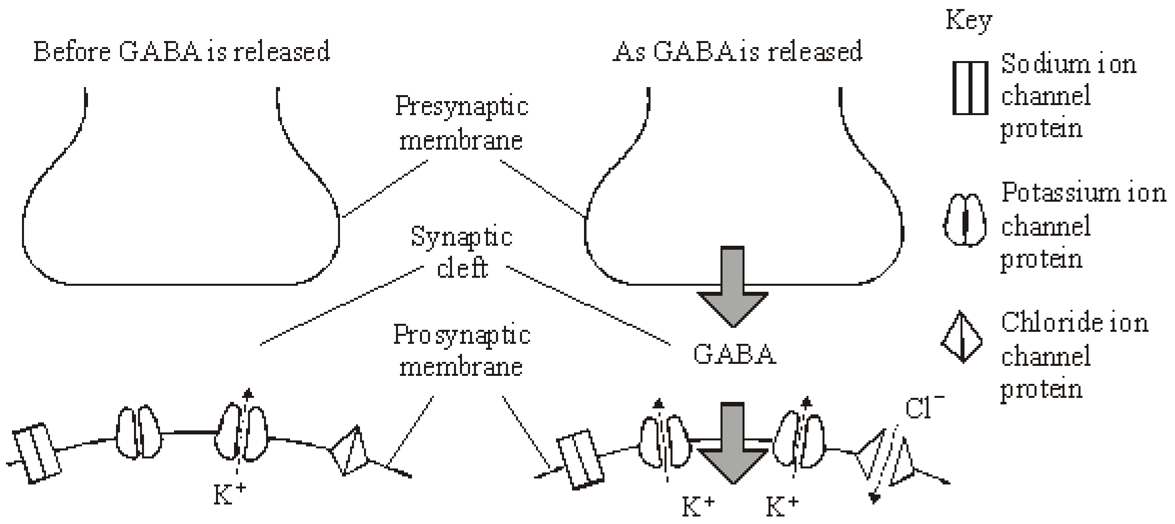
....

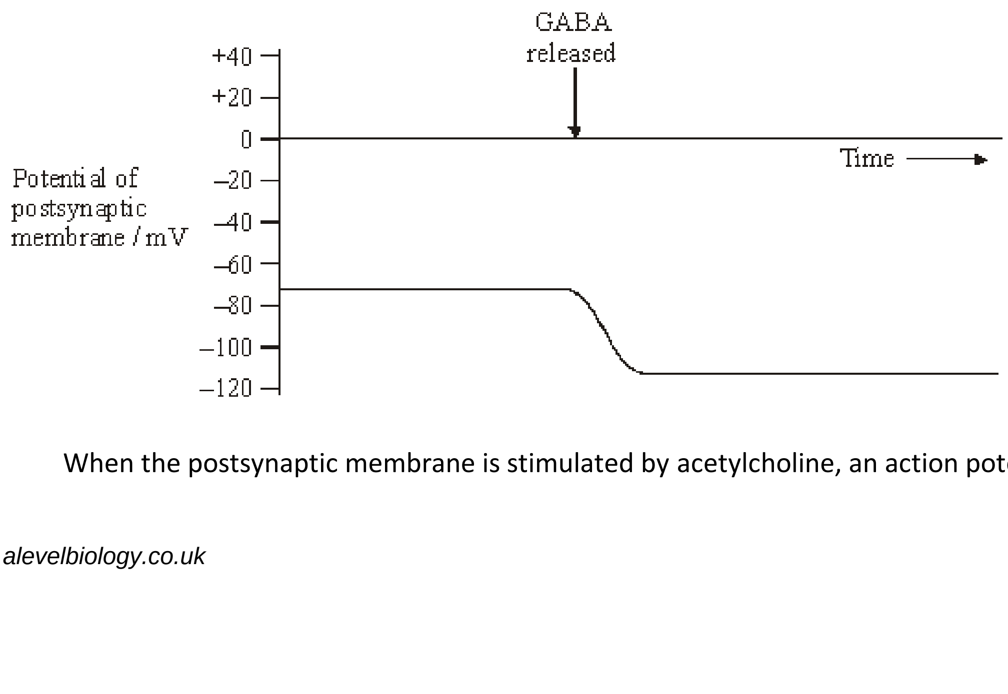
....

....

(2)

(iii) GABA is a neurotransmitter which inhibits the production of action potentials.
The diagram and the graph show how the release of GABA from a presynaptic membrane affects the membrane potential of a postsynaptic membrane.





When the postsynaptic membrane is stimulated by acetylcholine, an action potential is less likely if GABA is released at the same time. Explain why.

....

....

....

....

(4)
(Total 8 marks)

10. (a) Describe the part played by each of the following in myofibril contraction.

(i) Tropomyosin

....

....

....

(2)

(ii) Myosin

....

....

....

(2)

(b) The table shows features of fast and slow muscle fibres.

	Feature	**Fast muscle fibre**	**Slow muscle fibre**
	Type of respiration	Mainly anaerobic	Mainly aerobic
	Glycogen	High concentration	Low concentration
	Capillaries	Few	Many

Use information from the table to suggest and explain **one** advantage of:

(i) the high glycogen content of fast muscle fibres

....

....

....

(2)

(ii) the number of capillaries supplying slow muscle fibres.

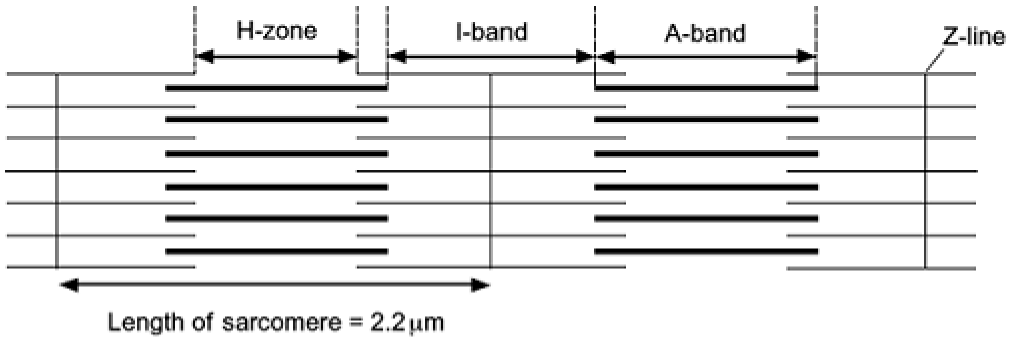
....

....

....

(2)
(Total 8 marks)

11. The diagram shows two relaxed sarcomeres from skeletal muscle.



(a) When the sarcomeres contract, what happens to the length of

(i) the I-band

....

(1)

(ii) the A-band?

....

(1)

(b) The length of each sarcomere in the diagram is 2.2 µm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification ....

(2)

(c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

....

....

....

....

....

(Extra space) ....

....

(3)
(Total 7 marks)

12. a) Describe how insulin reduces the concentration of glucose in the blood.

....

....

....

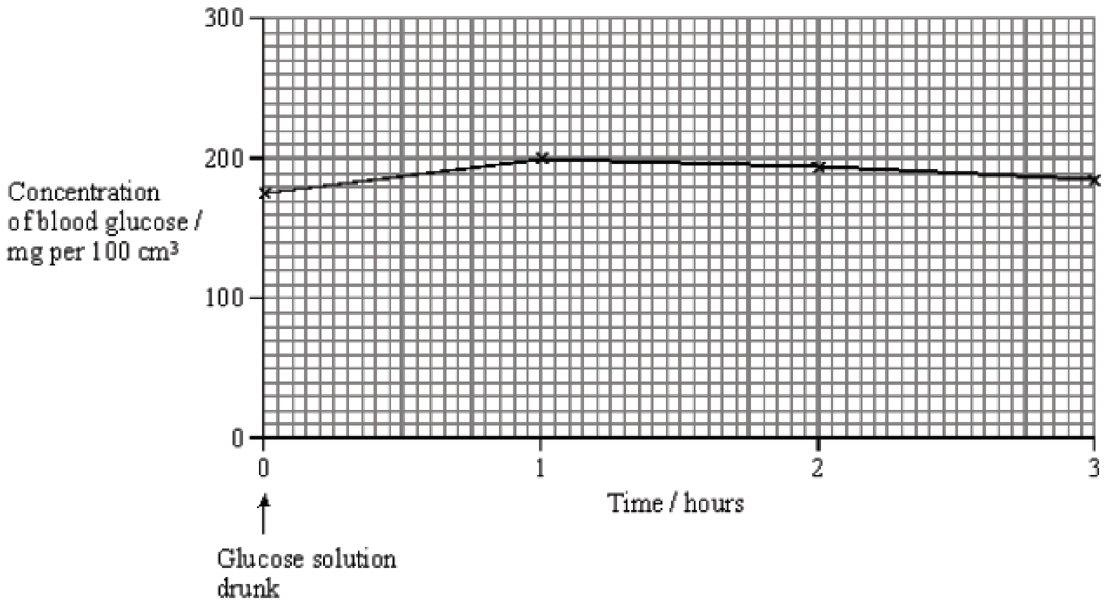
....

....

....

(3)

Some people produce no insulin. As a result, they have a condition called diabetes. In an investigation, a man with diabetes drank a glucose solution. The concentration of glucose in his blood was measured at regular intervals. The results are shown in the graph.



(b) Suggest **two** reasons why the concentration of glucose decreased after 1 hour even though this man's blood contained no insulin.

1...

....

2 ....

....

(2)

(c) The investigation was repeated on a man who did not have diabetes. The concentration of glucose in his blood before drinking the glucose solution was 80 mg per 100 cm3. Sketch a curve on the graph to show the results you would expect.

(1)

(d) The diabetic man adopted a daily routine to stabilise his blood glucose concentration within narrow limits. He ate three meals a day: breakfast, a midday meal and an evening meal.
He injected insulin once before breakfast and once before the evening meal.

The injection he used before breakfast was a mixture of two types of insulin. The mixture contained slow-acting insulin and fast-acting insulin.

(i) Explain the advantage of injecting both types of insulin before breakfast.

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....

(2)

(ii) One day, the man did not eat a midday meal. Suggest **one** reason why his blood glucose concentration did not fall dangerously low even though he had injected himself with the mixture of insulin before breakfast.

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....

....

(1)

(Total 9 marks)

13. Cows suffer from heat stress when the environmental temperature is too high. Heat stress occurs when their core body temperature rises above 39.4 °C. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm^3	Milk production / dm^3
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

(a) Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

Answer .... %

(b) Suggest how each of the following responses helps to maintain core body temperature.
(i) The change in water intake as environmental temperature increases.

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....

....

(1)

(ii) The change in food intake as environmental temperature decreases.

....

....

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....

....

(2)

(c) Explain the change in milk production as environmental temperature increases.

....

....

....

(1)

(d) The rectal temperatures of cows are recorded to monitor heat stress. This is a better measurement of core body temperature than measuring the temperature of the skin. Explain why.

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....

....

(2)

(e) Selective breeding can be used to produce cows with desirable features. This involves mating cows with bulls. Suggest how a bull is selected to increase the probability of producing cows with a high milk yield.

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(1)

Milk contains lactose. Human babies produce the enzyme lactase, which digests lactose.
Many human adults do not produce lactase and are lactose intolerant.
People who are lactose intolerant can become very ill if they drink milk or eat dairy products, such as butter and cheese.

(f) Scientists have recorded the percentage of adults who are lactose intolerant in different countries. Explain the advantage of using percentages in this type of study.

....

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(2)

(g) The scientists found that the percentage of people who can tolerate lactose is much higher in populations that drink a lot of milk and eat a lot of dairy products.
Use your knowledge of natural selection to explain this finding.

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(Extra space)

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(4)

(Total 15 marks)

14. MDMA is a compound that is often used as a recreational drug. It is commonly known as ecstasy. Unfortunately, a number of people have died soon after taking ecstasy.
A research team investigated the effects of MDMA. They chose to work with groups of mice. The mice in one group were injected with MDMA whilst a second group acted as a control.

(a) Suggest **two** reasons why the research team chose to use mice in this investigation.

1

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....

2

....

....

(2)

(b) How should the control group be treated?

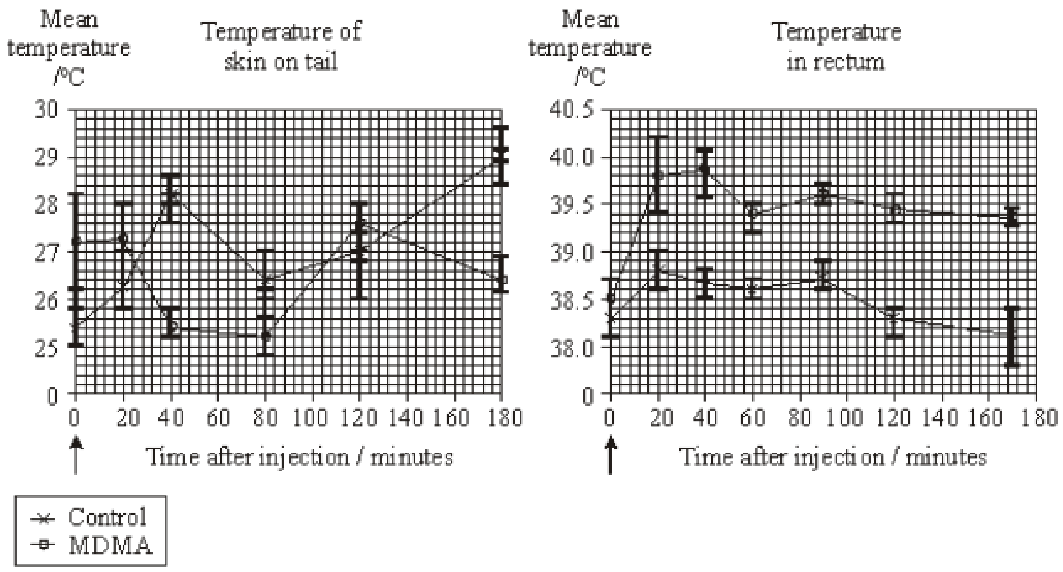
....

....

(1)

(c) For each mouse, the scientists monitored the temperature of the skin on its tail and the temperature in its rectum (lower part of the gut).

The graphs show the mean temperatures, and standard deviations of these means, after the injections were administered.



(i) Explain why the tail temperatures were always lower than the temperature in the rectum.

....

....

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(2)

(ii) The scientists concluded that MDMA causes death by stimulating heat generation. Use the data to evaluate their conclusion.

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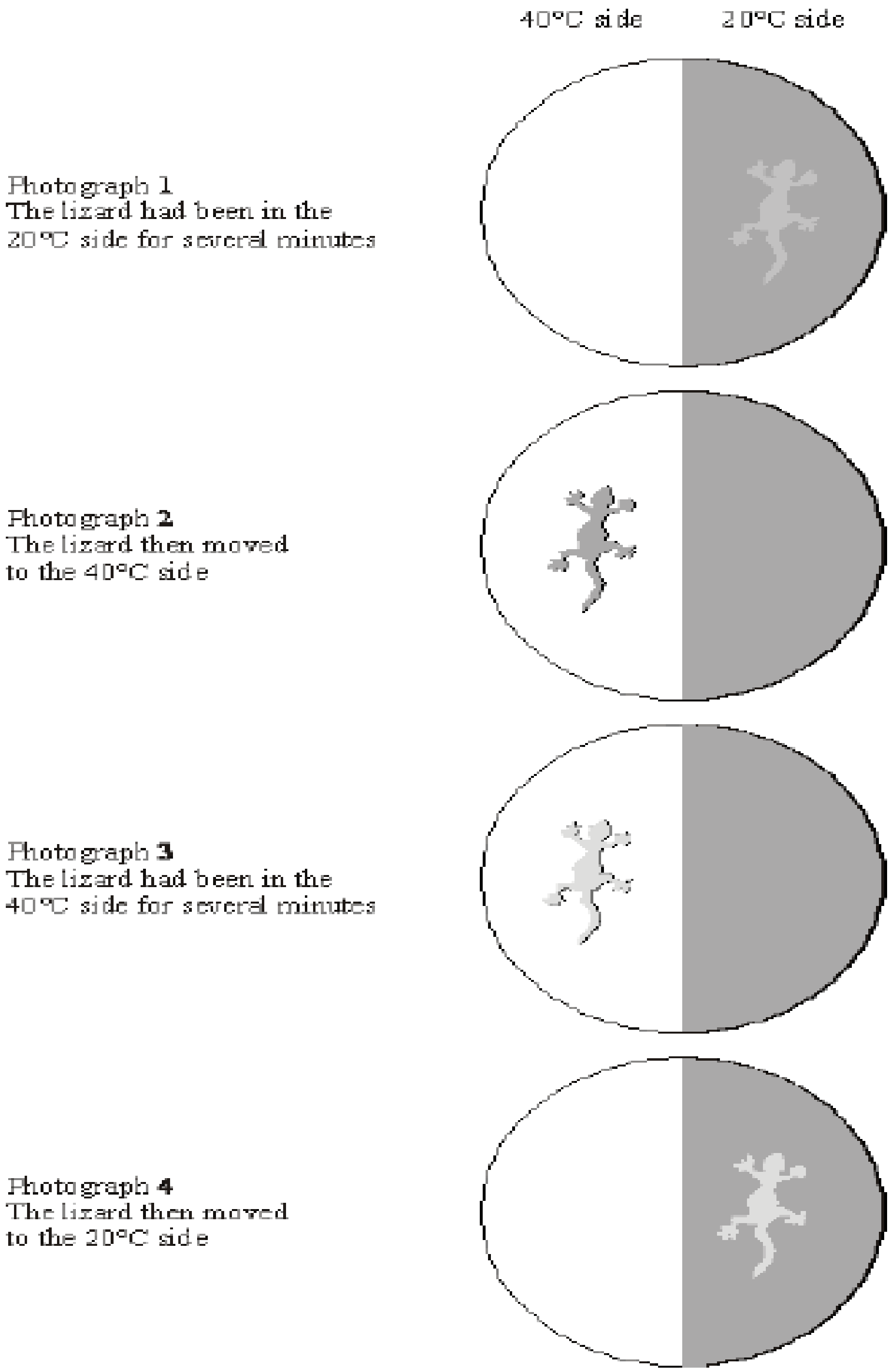
(3)
(Total 8 marks)

15. The body temperature of desert-living lizards is greatly affected by the temperature of their environment. A lizard was placed in a chamber where one half was maintained at 20 °C and the other at 40 °C. The lizard was free to move from one half to the other. The lizard's behaviour was observed using an infra-red camera, which records 20 °C surfaces as black and 40 °C surfaces as white. Temperatures between 20 °C and 40 °C appear as shades of grey. A series of photographs were taken.



(a) The position and appearance of the lizard, as recorded by the infra-red camera, changed during the experiment. Describe and explain these changes.

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....

(3)

(b) Suggest the advantage to the lizard of the behaviour shown.

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....

(2)

(c) The lizard responds to the stimulus of a change in its body temperature. Describe how the nervous system brings about this response.

....

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....

....

....

....

(3)
(Total 8 marks)

16. The mule deer is a large mammal that lives in hot deserts. It is most active for a few hours around dawn and dusk each day. During the day it keeps cool by lying in the shade. Its large ears also help it to keep cool.

(a) Explain how the ears of the mule deer help it to keep cool.

....

....

....

....

(2)

(b) Explain **one** way in which activity during the day would raise body temperature.

....

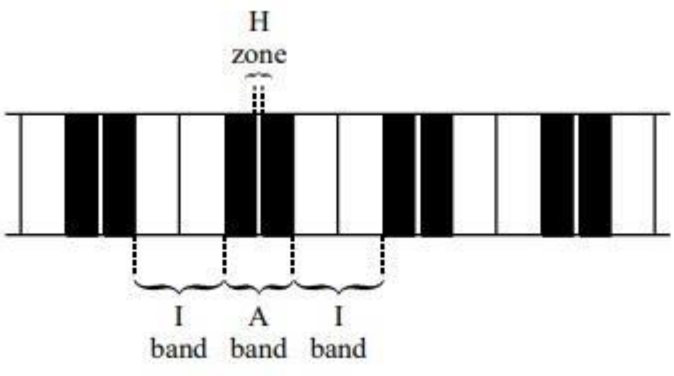
....

....

....

(2)
(Total 4 marks)

17. The diagram shows the appearance of part of a myofibril from a skeletal muscle fibre when viewed with a light microscope.



(a) The muscle fibre is relaxed. When the muscle contracts, what happens to the appearance of,

(i) the A band: ....

(ii) the I band: ....

(iii) the H zone: ....

(2)

(b) In which of the regions labelled in the diagram would the following be present?

(i) Myosin...

(ii) Actin...

(2)

(iii) Describe the events that occur within a myofibril which enable it to contract.

....

....

....

....

....

....

(3)

Max (7)

AQA A Level Biology

3.6 Organisms respond to changes in their internal and external environments

Mark scheme

1.(a) 1. (Taxis is) movement towards / away from a stimulus / a directional response / movement (to a stimulus);

2. (Move towards) temperature they were used to / cultured in;

Movement towards temperature they were used to = 2 marks

2 max

(b) 1. Hungry, so seeking food / in absence of food respond to temperature;

Ignore references to temperature and enzymes

Must be stated not inferred from other statements

2. Move towards temperature they were used to / cultured in;

3. Associate (this temperature) with food;

Accept they think food is here

Stated not inferred

4. (Then) stay in this temperature;

3 max

(c) 1. (Dim) worms live in soil / dark / affected by bright light / dim light is like normal environment / what they are used to;

2. (Even) because worms might move towards / away from bright light / to avoid creating light gradient / prevent worms showing phototaxis / all parts of surface exposed to same light;

Accept to avoid kinesis due to light

3. (Dim light) ensures heat from light not a variable / heat from lamp could kill / dry out worms;

Not just to control variables / factors

2 max

[7]

2.(a) (i) Any difference is due to the treatments / push-pull;

1

(ii) 1. More food eaten without pesticide (than food with pesticide);

2. (Standard error) bars overlap so no significant difference;

If bars are named then must be standard error bars i.e. do not credit 'standard deviation bars'.

Allow 'confidence limits overlap so no significant difference'.

(b) Taxis;

If more information is given then it must be correct for a positive chemotaxis.

1

(c) 1. More food with pesticide eaten when push-pull used;

2. No overlap of standard error bars so (suggests) significant difference;

3. (So) likely to result in death of more insects;

3

(d) 1. Keeping pest below economic injury level / controlling pest population rather than eradicating it;

2. Using a combination of pest control strategies with at least two examples eg biological, chemical, mechanical;

2

[9]

3. (a) Diffusion;

Ignore references to simple / facilitated

Accept active transport

1

(b) 1. Causes plant to bend / grow towards light / positive phototropism;

2. (Light) required for photosynthesis;

2

(c) 1. More kinetic energy / faster movement of molecules;

2. More diffusion;

Ignore references to opening stomata.

Answer should be in context of more but comparative statement only necessary once.

2

(d) (i) 1. Thick cuticle on upper surface / thin cuticle on lower surface / few stomata on upper surface / no stomata on upper surface;

2. More diffusion / shorter diffusion pathway (on lower surface);

1. Ignore cuticle only on upper surface. Ignore references to more or less waxy.

2. If candidate writes about stomata accept ref to greater area for diffusion.

2

(ii) Different species have different (qualified) properties;

Eg cuticle thickness

Leaf size

Number of stomata

1

[8]

4. (i) arc shows 3 neurones;

(3 distinct neurones, one of which is in the grey matter, with correct route through dorsal and ventral roots and indication of synapses. Ignore position of cell bodies.)

1

(ii) neurones labelled sensory, relay / intermediate, motor;

1

(iii) muscle labelled as effector;

1

[3]

5. (a) (i) **G**;

Neutral: name of blood vessel

1

(ii) **E**;

Neutral: name of blood vessel

1

(b) Pressure is greater below valve/in ventricle than (artery);

Must be comparative

Reject: pressure is greater in ventricle than atrium

Neutral: pressure in ventricle increases

Accept: ***E***/***F****/named artery*

Accept: converse argument

1

(c) Allow atria to empty/contract/ventricles to fill;

Before ventricles contract;

OR

Delays contraction of ventricles;

Until after atria have contracted/ventricles have filled;

Neutral: 'to pump blood'

2

(d) (i) Two marks for correct answer of 91/90.9;;

One mark for incorrect answers which clearly show understanding of the relationship between SV = CO/HR;

Correct answer = 2 marks outright

5000 divided by 70, 55 or 15 = 1 mark for principle

2

(ii) Increase in size or volume of heart/ventricles/increased heart muscle/increased strength of contraction/hypertrophy;

Cardiac output is the same (before and after training);

Increase in stroke volume/more blood leaves heart in each beat;

Accept: increased strength of heart muscle

Neutral: heart muscle contracts more

Q *Do not allow 'heart is stronger'*

Neutral: more blood leaves the heart

If the term 'stroke volume' is not used, it must be defined

2

[9]

6. (a) (i) **C** and **D**;

1

(ii) Left ventricle with thicker wall / more muscle / (muscle in) left ventricle contracts <u>more</u> forcefully; **1**

(b) Higher in atria / lower in ventricles;
Atrioventricular valves / valves between atria and ventricles open;

__Q__ Credit second mark only if valves are named or correctly located.

2

(c) (i) Allows blood to pass into ventricles / from atria / so that atria can empty;
Before ventricles contract;

2

(ii) Ventricle contracts from base / upwards;
Blood pushed through B and C / arteries / all blood rejected;

2

[8]

7. (a) (Ion) channel proteins open, sodium in;

Changes membrane potential / makes inside of axon less negative / positive / depolarisation / reaches threshold;

More channels open / positive feedback;

Accept other phrases for ion channel proteins providing that it is clear that it is something through which ions pass.
Reject carrier.

First marking point relates to opening.
Third point must relate to more (channels) opening.

3

(b) Potassium channels open;

Potassium out;

Sodium channels close;

Do not penalise candidate who refers to sodium or potassium.
Ions are mentioned in question.
Reject pump

3

(c) Pump / active transport / transport against concentration gradient;

Of sodium from axon / sodium out / of potassium in;

Do not penalise candidate who refers to sodium or potassium.
Ions are mentioned in question

2

[8]

8.(a) 1. Membrane more permeable to potassium ions and less permeable to sodium ions;

2. Sodium ions actively transported / pumped out and potassium ions in;

2

(b) 1. (Pressure causes) membrane / lamellae to become deformed / stretched;

2. Sodium ion channels in membrane open and sodium ions move in;

3. Greater pressure more channels open / sodium ions enter;

3

(c) 1. Threshold has been reached;

2. (Threshold or above) causes maximal response / all or nothing principle;

2

(d) 1. Less / no saltatory conduction / action potential / impulse unable to 'jump' from node to node;

2. More depolarisation over length / area of membranes;

2

[9]

9. (i) Binds to receptor / proteins; and opens Na^+ channels;
<u>Na^+ enter</u> and make membrane potential less negative / depolarised

2

(ii) (Vesicles containing) neurotransmitter only in presynaptic membrane / neurone;
receptor / proteins only in postsynaptic membrane / neurone;

2

(iii) GABA opens K^+ and Cl^- channels so K^+ passes out and Cl^- passes in;
Membrane potential more negative / hyperpolarised;
Requires increased stimulation / must open more Na^+ channels / allow

more Na^+ to enter;
To reach threshold;

4

[8]

10.(a) (i) 1. Moves out of the way when calcium ions bind;

1. Accept shape change with Ca^{2+}

1. Don?t accept just "calcium"

2. Allowing myosin to bind (to actin) / crossbridge formation;

1. Accept presence of calcium ions leads to movement instead of binds

Accept references to troponin

2

(ii) 1. Head (of myosin) binds to actin and moves / pulls / slides actin past;

2. (Myosin) detaches from actin and re-sets / moves further along (actin)

1. Accept myosin power stroke (to move actin)

1. Accept push

1. Accept crossbridges form instead of myosin head binds to actin

1. Must refer to myosin head or crossbridges

3. This uses ATP;

2 max

(b) (i) 1. (Glycogen broken down) gives (lots of) glucose for glycolysis / anaerobic respiration;

1. Give if context of anaerobic respiration clear

2. Glycolysis / anaerobic respiration not very efficient / only yields 2 ATP per glucose;

2. Accept anaerobic respiration is a quick source of ATP for exercise

2. Accept very little ATP

2

(ii) 1. (Many capillaries) give high concentration / lots of oxygen / shorter diffusion pathway for oxygen / large surface area for oxygen exchange / diffusion / good glucose supply with little glycogen present;

2. Allows high rate of / more aerobic respiration ***OR*** prevents build-up of lactic acid / (muscle) fatigue;

3. Accept idea of aerobic respiration during endurance events / long periods of exercise

2
[8]

11. (a) (i) Decreases;

Accept any word that means a decrease e.g. shorter / narrower / smaller etc

1

(ii) Nothing / stays the same length / does not change;

1

(b) 1. Two marks for correct answer of 29545-30455;

Correct answer = 2 marks outright. Range allows for a 1mm error in measuring

2. One mark for incorrect answers in which candidate clearly divides measured width by actual width;

Ignore rounding up

2

(c) (Idea ATP is needed for:)

1. Attachment / cross bridges between actin and myosin;

Accept the role of ADP in attachment

2. ‘Power stroke’ / movement of myosin heads / pulling of actin;

Not just ‘filaments slide’ as given in the question stem

3. Detachment of myosin heads;

4. Myosin heads move back / to original position / ‘recovery stroke’

3 max

[7]

12. (a) insulin binds to specific receptors (on membranes);
insulin activates carrier proteins / opens channels / causes more channels to form;
insulin increases the permeability of liver/muscle cells/tissues to glucose;

insulin action results in glucose conversion to glycogen / glycogenesis;

3 max

(b) glucose is used in cell respiration / as energy source / in metabolism;
(must qualify how glucose is used)
glucose enters cells / converted to glycogen in cells;
glucose is excreted / in urine;
(do not credit no reabsorption of glucose in kidneys)

2 max

(c) line from 80 mg, increasing but keeping below line for diabetic, dropping to 80 mg;
(line must stablise at, or fluctuate around 80 mg)

1

(d) (i) fast acting insulin reduces blood glucose from breakfast;
slow acting insulin reduces blood glucose from other meals before the evening meal / eliminates the need to inject at lunch;
(must be a reference to the meals)
(one mark if neither of the above but a clear reference is made to glucose conversion to glycogen);

2

(ii) glucagon is still active;
glycogen converted to glucose / glycogenolysis;
insulin injected at breakfast causes cells to take up glucose too slowly for levels to become dangerously low;
person is not active so little glucose used in respiration;
(do not credit statements about consuming large breakfasts)

1 max

[9]

13. (a) 1. 21 or 21.4;
Correct answer = 2 marks outright
2. One mark for the principle of difference / initial;
Ignore number of decimal places

2

(b) (i) Water intake linked to sweating / panting;
Neutral: ref. to urine
Neutral: dehydration

1

(ii) 1. Food intake linked to (increased) respiration;
1. Not 'increased metabolism'

Reject: decreases respiration

Neutral: references to environmental temperature increasing

2. Food intake linked to heat / energy release / maintaining body temperature;

2. This mark is independent of 1

2

(c) 1. Increased sweating so less water available (for milk production);

2. Less food so less energy / nutrients available (for milk production);

2. Not just 'less energy available (for milk production)'

3. Enzymes not working at optimum temperature;

3. Reject: references to enzyme denaturation

1 max

(d) (Skin temperature)

Accept: converse arguments for rectal temperature

1. Varies / fluctuates more / more heat lost / gained / (can be) further from core;

2. (As) more affected by environment / sweating / conduction / convection / radiation;

2. Accept: 'not affected by' in relation to rectal temperature

Accept: named environmental factors

Accept: idea that skin is more exposed to the environment

Accept refs. to vasoconstriction / vasodilation

2

(e) Select a bull whose mother / offspring produced a high milk yield;

1

(f) 1. Allows comparison;

2. (As) different countries have different population / sample sizes;

2

(g) 1. (Selective) advantage producing lactase / being lactose tolerant / able to digest milk / able to eat dairy foods;

Accept: converse arguments for people who are lactose intolerant

2. People (producing lactase) reproduce;

3. (And) pass on gene / allele;

If mark point 2 has ***not*** *already been given, then mark point 3 automatically gains 2 marks as reproduction must have occurred*

4. Allele frequency increases;

4. Neutral: gene frequency increases / allele frequency changes

Must be clearly stated and not implied

4

[15]

14. (a) Easy to manage / can be kept safely in small space;
Genome / strains well known;
Physiology similar to humans / can be used to predict human behaviour

2 max

(b) Same as control but inject with equal volume of solvent only;

1

(c) (i) Heat lost from tail;
By conduction / convection / radiation;

2

Q *Award credit to answers that refer to the evaporation of sweat from the tail.*
Q *Award credit to answers that are the converse of the above, relating to the rectal temperature*
(ii) Standard deviations show mean rectal temperatures are significantly different (in the two groups);
Rectal temperature indicates core temperature / heat generation;
Tail temperatures not significantly different (in the two groups);
Tail temperatures indicate no difference in heat loss;
None of the mice died (in this experiment);
Q *If candidates fail to gain credit above, they can be awarded one mark for a clear statement that MDMA increases heat production but does affect not heat loss.*

3 max

[8]

15. (a) moves to 40 °C side, then later to 20 °C;
gets lighter in hot side and darker in cool side;
lighter as it absorbs heat/darker as it loses heat;
by conduction/convection/radiation;

3 max

(b) lizard finds favourable environment;
(helps it to) maintain constant body temperature;
advantage of this, e.g. for enzyme activity;

2 max

(c) receptors in blood vessels/skin;
nerve impulses produced;
go to coordinator/brain/hypothalamus;
motor neurones send nerve impulses;

to effectors/muscles;

3 max

[8]

16. (a) large surface area;
so increases heat loss (to the air);
OR
increased blood flow into ears;
so increases heat loss;

2 max

(b) more movement needs greater energy use/ muscle contraction;
more heat generated through respiration;
OR
in sun, more heat absorbed;
harder to lose heat by sweating/vasodilation;

2 max

[4]

17. (a) (i) A-band: no change
(ii) I-band: shorter;
(iii) H-zone: shorter / disappears; 2

(b) (i) A/A + H; 2
(ii) A and I;
(iii) myosin heads bind to actin / cross bridge formation / actomyosin formed;
myosin heads / crossbridges swivel / ratchet mechanism;
causing actin to slide relative to myosin;
energy provided by hydrolysis of ATP;

3 max

[7]

AQA A Level Biology

3.7 Genetics, populations, evolution and ecosystems

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective and use the revision notes to fill in any gaps.

1. The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

(a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

1...

....

2...

....

(2)

(b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

(i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female		white-eyed male
Genotype of parents	....	×	....
Gametes	.............and................		.............and................
Phenotypes of offspring	red-eyed females	a n d	red-eyed males
Genotype of offspring	....		....

(3)

(ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

....

....

.... **(1)**

(c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

....

....

....

....

....

(2)
(Total 8 marks)

2. In birds, **males are XX** and **females are XY**.

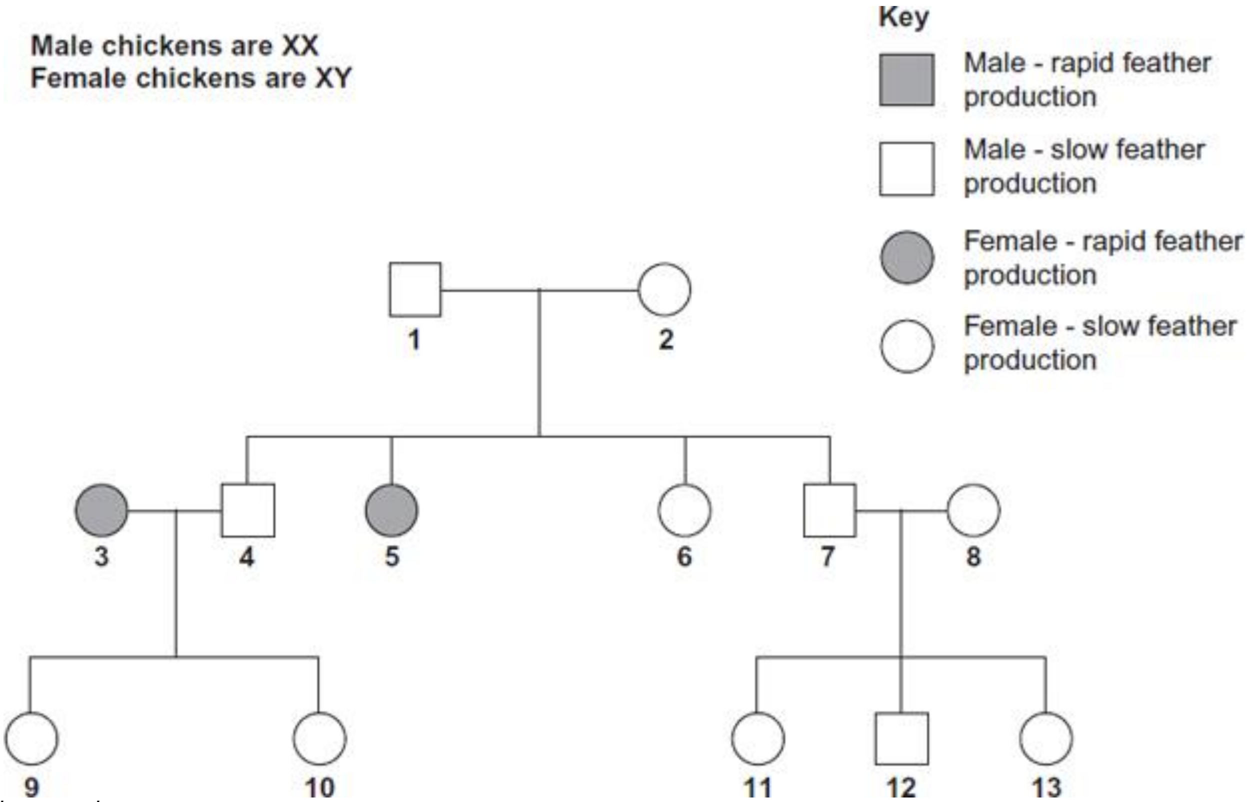
(a) Use this information to explain why recessive, sex-linked characteristics are more common in female birds than in male birds.

....

....

(1)

(b) In chickens, a gene on the X chromosome controls the rate of feather production. The allele for slow feather production, **F**, is dominant to the allele for rapid feather production, **f**. The following figure shows the results produced from crosses carried out by a farmer.



) Explain **one** piece of evidence from the figure which shows that the allele for rapid feather production is recessive.

....

....

....

....

(2)

(ii) Give all the possible genotypes of the following chickens from the figure.

Chicken 5 ....

Chicken 7 ....

(2)

(iii) A cross between two chickens produced four offspring. Two of these were males with rapid feather production and two were females with slow feather production. Give the genotypes of the parents.

....

(1)

(c) Feather colour in one species of chicken is controlled by a pair of codominant alleles which are **not** sex-linked. The allele $\mathbf{C}^B$ codes for black feathers and the allele $\mathbf{C}^W$ codes for white feathers. Heterozygous chickens are blue-feathered.

On a farm, 4% of the chickens were black-feathered. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be blue-feathered. Show your working.

Answer .... %

(3)

(Total 9 marks)

3. Researchers investigated some characteristics of people from different parts of England. In the north of England they selected 200 people and recorded their phenotypes for three different characteristics.

Their results are shown in the figure below.

Phenotype produced by dominant allele	**Number of people**	**Phenotype produced by recessive allele**	**Number of people**
Tongue roller	131	Non-tongue roller	58
Right-handed	182	Left-handed	14
Straight thumb	142	Hitch-hiker thumb	50

(a) Calculate the ratio of straight thumb to hitch-hiker thumb in this study.

Ratio = ...

(1)

(b) The numbers for the tongue rolling and thumb characteristics do not add up to 200. For each characteristic suggest **one** reason why the numbers do **not** add up to 200.

Tongue rolling

....

....

Thumb

....

....

(2)

(c) One student looked at the researchers' results and concluded that 91% of people in the UK are right-handed.
Do you agree with this conclusion? Give reasons for your answer.

....

....

....

....

....

(2)
(Total 5 marks)

4. **Figure 1** and **Figure 2** show the chromosomes from a single cell at different stages of meiosis.

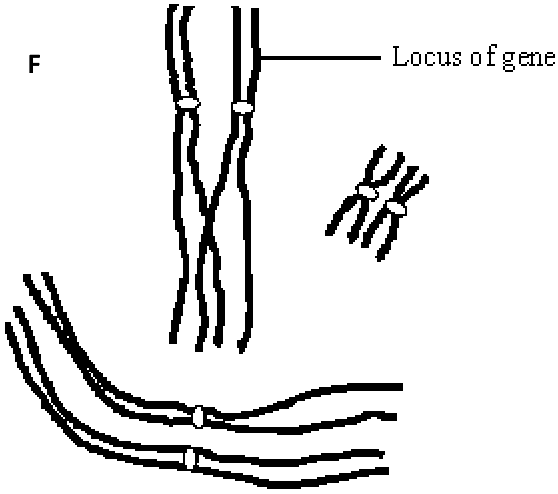


Figure 1

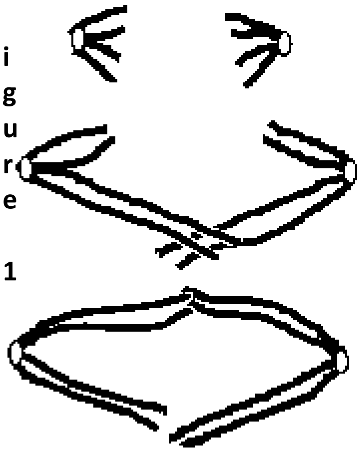


Figure 2

(a) What is the diploid number of chromosomes in the organism from which this cell was taken?

....
(1)

(b) Describe what is happening to the chromosomes at the stage shown in

(i) **Figure 1**;

....

....

....

....

(2)

(ii) **Figure 2**.

....

....

....

....

(2)

(c) (i) The genotype of this organism is **Bb**. The locus of this pair of alleles is shown in **Figure 1**.

Label **two** chromosomes on **Figure 2** to show the location of the **B** allele and the location of the **b** allele.

(1)

(ii) How many genetically different gametes can be produced by meiosis from a cell with the genotype, **Bb Cc Dd**? Assume these genes are located on different pairs of homologous chromosomes. Show your working.

....

(2)
(Total 8 marks)

5. (a) (i) Explain what is meant by a **recessive** allele.

....

....

....
(1)

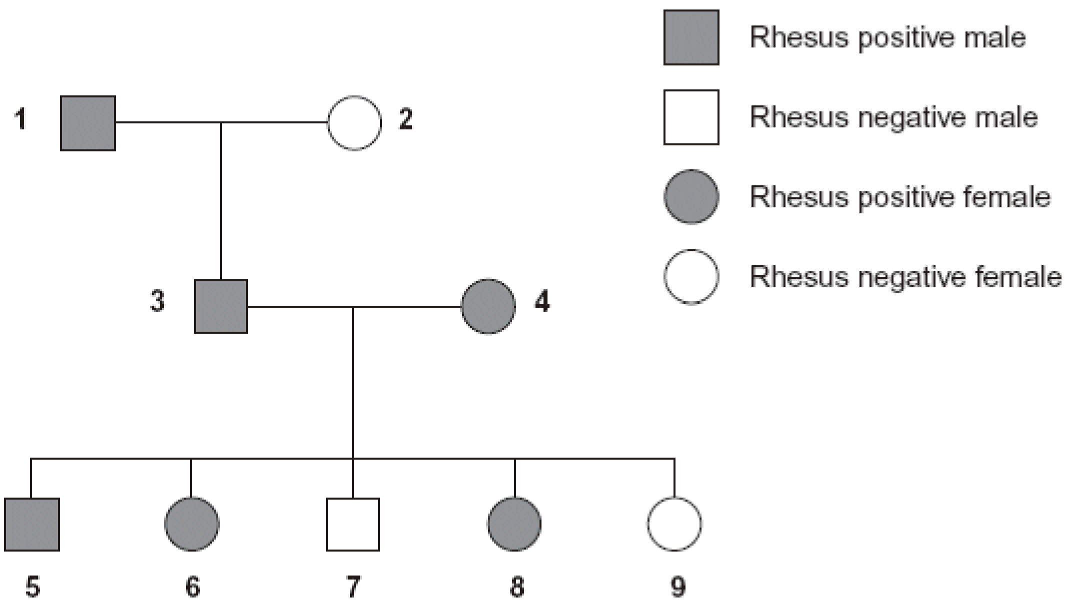
(ii) Explain what is meant by **codominant** alleles.

....

....

....
(1)

(b) The Rhesus blood group is genetically controlled. The gene for the Rhesus blood group has two alleles. The allele for Rhesus positive, **R**, is dominant to that for Rhesus negative, **r**. The diagram shows the inheritance of the Rhesus blood group in one family.



(i) Explain **one** piece of evidence from the diagram which shows that the allele for Rhesus positive is dominant.

....

....

....

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(2)

(ii) Explain **one** piece of evidence from the diagram which shows that the gene is **not** on the X chromosome.

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(2)

(c) Sixteen percent of the population of Europe is Rhesus negative. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for the Rhesus gene.

Show your working.

Answer ....

(3)

(Total 9 marks)

6. (a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2)

(b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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(2)

(c) The proteins of different species can be compared using immunological techniques. The protein albumin obtained from a human was injected into a rabbit. The rabbit produced antibodies against the human albumin. These antibodies were extracted from the rabbit and then added to samples of albumin obtained from four different animal species. The amount of precipitate produced in each sample was then measured. The results are shown in the table.

Species from which albumin was obtained	**Amount of precipitate / arbitrary units**
Rat	23
Chimpanzee	96
Marmoset	65
Trout	11

What do the results suggest about the evolutionary relationship between humans and the other species?

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(2)
(Total 6 marks)

7. (a) Succession occurs in natural ecosystems. Describe and explain how succession occurs.

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(5)

(b) Changes in ecosystems can lead to speciation. In Southern California 10 000 years ago a number of interconnecting lakes contained a single species of pupfish.

Increasing temperatures caused evaporation and the formation of separate, smaller lakes and streams. This led to the formation of a number of different species of pupfish. Explain how these different species evolved.

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(5)

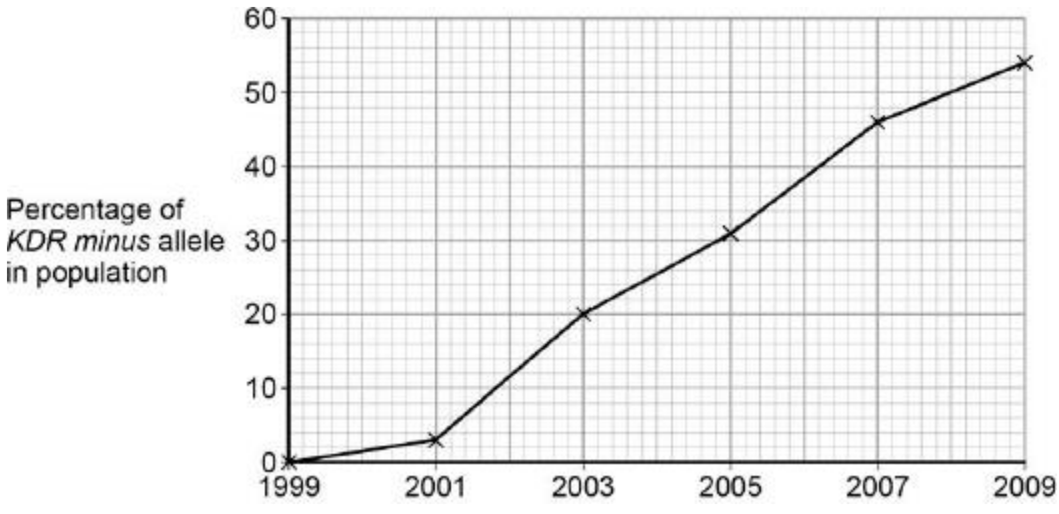
(Total 10 marks)

8. Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR* plus, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



(a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygous for the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003 ....

(2)

(b) Suggest an explanation for the results in the figure above.

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(Extra space) ....

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(4)

The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time. Use this information to suggest how DDT kills insects.

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(2)

(d) Suggest how the *KDR minus* allele gives resistance to DDT.

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(2)
(Total 10 marks)

9. The Amazonian forest today contains a very high diversity of bird species.

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
- Different plant communities developed in each of these smaller forests.
- Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.

(a) Use the information provided to explain how a very high diversity of bird species has developed in the Amazonian forest.

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(Extra space) ....

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(5)

(b) Speciation is far less frequent in the reformed Amazonian forest. Suggest one reason for this.

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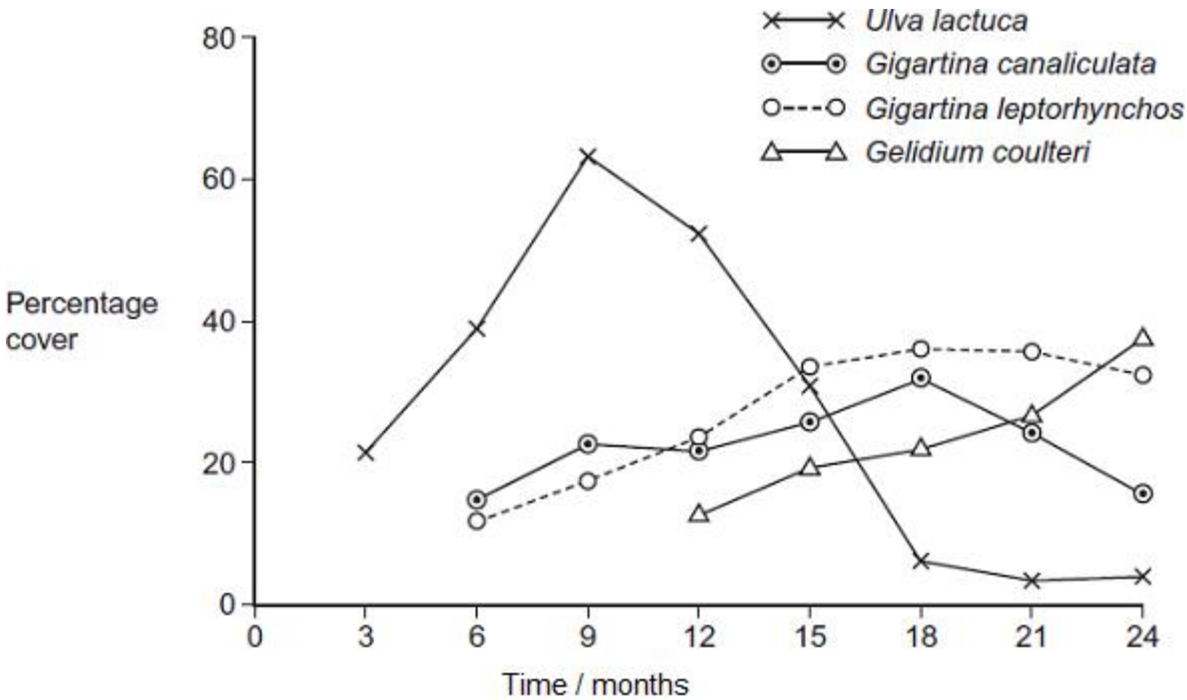
(1)
(Total 6 marks)

10. Algae are photosynthesising organisms. Some algae grow on rocky shores. A scientist investigated succession involving different species of algae. He placed concrete blocks on a rocky shore. At regular intervals over 2 years, he recorded the percentage cover of algal species on the blocks. His results are shown in the graph.



(a) Name the pioneer species.

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(1)

(b) (i) The scientist used percentage cover rather than frequency to record the abundance of algae present. Suggest why.

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(1)

(ii) Some scientists reviewing this investigation were concerned about the validity of the results because of the use of concrete blocks.
Suggest **one** reason why these scientists were concerned about using concrete blocks for the growth of algae.

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(1)

(c) Use the results of this investigation to describe and explain the process of succession.

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(Extra space) ....

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(4)
(Total 7 marks)

11. Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

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(1)

(b) Explain the increase in the diversity of birds as the woodland developed.

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(Extra space) ....

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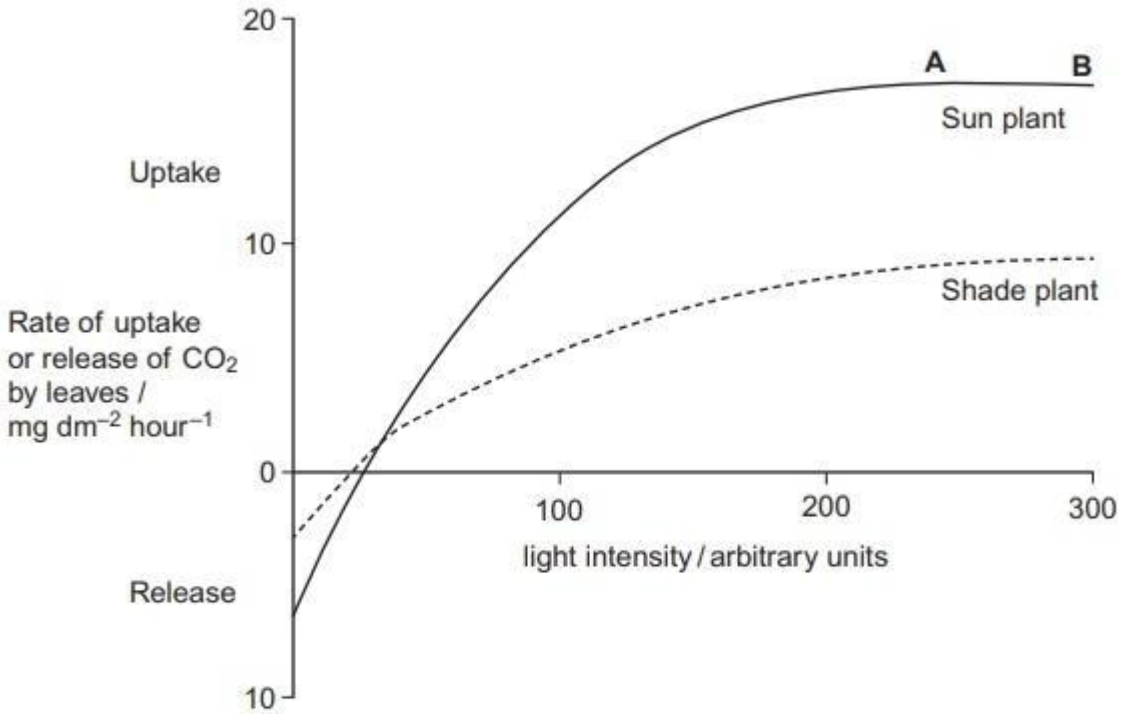
(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

1...

2...

(1)

(ii) Explain why CO_2 uptake is a measure of net productivity.

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(Extra space) ....

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(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

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(Extra space) ....

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(2)
(Total 8 marks)

12. A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

(a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

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(Extra space) ....

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(3)

(b) The diversity of animal species is higher at **E** than **A**. Explain why.

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(2)

(c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

(i) Give **two** conditions for results from mark-release-recapture investigations to be valid.

1...

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2...

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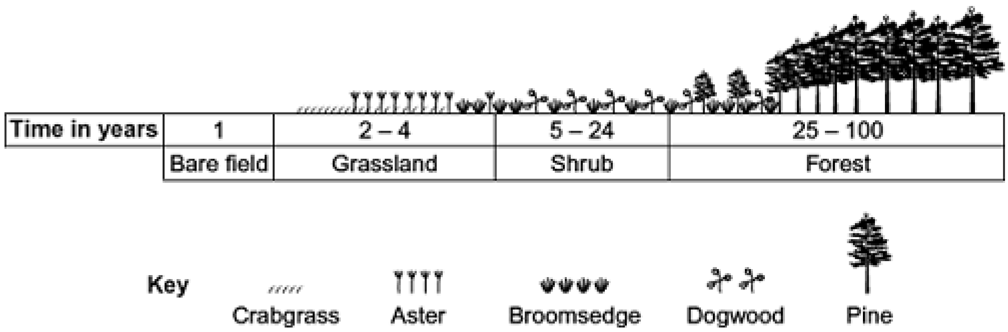
(2)

(ii) Calculate the number of sand lizards on this area of moorland. Show your working.

Answer = ...

(2)
(Total 9 marks)

13. The diagram shows the dominant plants in communities formed during a succession from bare soil to pine forest.



(a) Name the pioneer species shown in the diagram.

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(1)

(b) The species that are present change during succession. Explain why.

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(2)

(c) The pine trees in the forest have leaves all year. Explain how this results in a low species diversity of plants in the forest.

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(1)
(Total 4 marks)

14. (a) Succession occurs in natural ecosystems. Describe and explain how succession occurs.

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(5)

(b) Managed ecosystems such as wheat fields are prone to pest infestations. Describe the advantages and disadvantages of using biological agents to control pests.

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(5)

(c) Changes in ecosystems can lead to speciation. In Southern California 10 000 years ago a number of interconnecting lakes contained a single species of pupfish.

Increasing temperatures caused evaporation and the formation of separate, smaller lakes and streams. This led to the formation of a number of different species of pupfish.

Explain how these different species evolved.

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(5)
(Total 15 marks)

AQA A Level Biology

3.7 Genetics, populations, evolution and ecosystems

Mark scheme

1. (a) 1. Large number of eggs / offspring / flies (therefore) improves reliability / can use statistical tests / are representative / large sample (size) / reduces sampling error;

Each mark point requires a feature linked in mark scheme (by therefore) to an explanation

Do not accept a large number of eggs produces a large number of flies unless the term sample is used

Ignore references to accuracy or precision

2. Small size / (breed) in small flasks / simple nutrient medium (therefore) reduces costs / easily kept / stored;

Accept small size so can be kept in small flasks

3. Size / markings / phenotypes (therefore) males / females easy to identify;

Answers must relate to size, markings or use the term phenotype

4. Short generation time / 7 - 14 days / develop quickly / reproduce quickly (therefore) results obtained quickly / saves times / many generations;

2 max

(b) (i) 1. X^RX^R and X^rY;

All marking points are completely independent. Allow crosses from the following parents for a possible three marks:

X^RX^R and X^r-

X^RX^R and X^rY;

RR and rY / rY⁻

RR and r– or RR and r

2. X^R and X^R plus X^r and Y;

3. X^RX^r and X^RY;

OR

1. X^RX^r and X^rY;

OR

X^RX^r and X^r–

X^RX^r and X^rY;

2. X^R and X^r plus X^r and Y;

Rr and rY / rY^-

Rr and r^- or Rr and r

Accept different symbols e.g. W and w

2. Accept gametes in a punnet square

3. X^RX^r and X^RY;

3

(ii) Fertilisation is random / fusion of gametes is random / small / not large population / sample /

selection advantage / disadvantage / lethal alleles;

Mutation = neutral

Random mating = neutral

Accept fertilisation / fusion of gametes is due to chance

1

(c) 1. Males have one <u>allele</u>;

Answers should be in context of alleles rather than chromosomes

2. Females need two recessive alleles / must be homozygous recessive / could have dominant and recessive alleles / could be heterozygous / carriers;

2

[8]

2. (a) (Recessive) allele is always expressed in females / females have one (recessive) allele / males need two recessive alleles / males need to be homozygous recessive / males could have dominant and recessive alleles / be heterozygous / carriers;

Accept: Y chromosome does not carry a dominant allele. Other answers must be in context of allele not chromosome or gene.

1

(b) (i) 1. 1, (2) and 5;

Accept: for 1 mark that 1 and 2 have slow (feather production) but produce one offspring with rapid (feather production).

Neutral: any reference to 3 being offspring of 1.

2. 1 must possess / pass on the recessive <u>allele</u> / 1 must be a carrier / heterozygous / if slow (feather production) is recessive all offspring of (1 and 2) would be slow (feather production) / if rapid (feather production) was dominant 1 would have rapid (feather production);

Reject: both parents must be carriers / possess the recessive allele.

Reject: one of the parents (i.e. not specified) must be a carrier / heterozygous.

2

(ii) 5 = X^fY / X^fY^- / f / f- / fY ;

7 = X^FX^f **and** X^FX^F (either way round) /

or X^fX^F **and** X^FX^F (either way round) /

or X^FX^f, X^fX^F **and** X^FX^F(in any order);

Note: allow 5 = X^fY, X^fY.

Accept: for both 5 and 7 a different letter than F. However, lower case and capital letter must correspond to that shown in the answer. For example accept 7 = X^RX^r and X^RX^R.

2

(iii) X^FX^f **and** X^fY **or** X^fX^F **and** X^fY

or X^FX^f **and** X^fY^- or X^fX^F **and** X^fY^- /

or Ff **and** fY /

or Ff **and** fY^- /

or Ff **and** f- /

or Ff **and** f;

Accept: a different letter than F. However, lower case and capital letter must correspond to that shown in the answer.

Accept: each alternative either way round.

1

(c) Correct answer of 32 (%) = 3 marks;

Accept: 0.32 = 2 marks

If incorrect answer, allow following points

1. p^2 / q^2 = 4% / 0.04 / or p / q = 0.2;

2. Shows understanding that 2pq = heterozygotes / carriers;

Accept: answer provided attempts to calculate 2pq. This can be shown mathematically i.e. 2 x two different numbers.

3

[9]

3. (a) <u>2.84</u>:1;

Accept '2.84 to 1' or (just) 2.84

Do not accept 1:2.84 or 142:50

1

(b) 1. Some embarrassed / some not willing to show tongue / cannot tell;

2. Could not decide whether thumb was straight or not / thumb bending is judgemental / subjective;

2

(c) 1. (No) - should be 92.9% / should be calculated from 182 out of 196 / should not be calculated from 182 out of 200;

Allow either no or yes approach but no mark awarded for no or yes on its own

2. (Yes) – assumes 4 out of 200 use either hand;

Accept ambidextrous

3. (But) sample may not be representative;

This could be expressed in other ways e.g. only based on one part of the country / might not be the same in different parts of the UK / might not be representative of UK

4. Small sample size / only sampled 200;

2 max

[5]

4. (a) 6;

1

(b) (i) chromosomes are arranged in (homologous) pairs / bivalents;
crossing over / chiasma present / exchange of genetic information;
bivalents arranged independently;

2 max

(ii) separation / spliting / pulling apart of <u>homologous</u> chromosomes / <u>pairs</u> of chromosomes;

(must give indication that one chromosome moves to each side)
(must be in the context of meiosis – not chromatid movements and not chromosomes separate)

pulled at centromere / by spindle / fibres;

2

(c) (i) the short arm of both chromosomes labelled on the middle homologous pair;

*(**B** and **b** must be labelled on separate chromosomes)*

1

(ii) 8 = 2 marks;
working showing genotypes with 1 allele from each pair
(for example, **B C D**) = 1 mark

2

[8]

5. (a) (i) Only expressed / shown (in the phenotype) when homozygous / two (alleles) are present / when no dominant allele / is not expressed when heterozygous;

1

(ii) Both alleles are expressed / shown (in the phenotype);

Allow both alleles contribute (to the phenotype).

1

(b) (i) Evidence (not a mark)

3 and 4 / two Rhesus positives produce Rhesus negative child / children / 7 / 9;

Explanation (not a mark)

Both Rhesus positives / 3 and 4 carry recessive (allele) / are heterozygous / if Rhesus positive was recessive, all children (of 3 and 4) would be Rhesus positive / recessive;

Do not negate mark if candidate refers to gene rather than allele.

Answers including correct and incorrect evidence = zero marks evidence and explanation.

2

(ii) Evidence (not a mark)

3 would not be / is Rhesus positive / would be Rhesus negative;

Explanation (not a mark)

3 would receive Rhesus negative (allele) on X (chromosome) from mother / 3 could not receive Rhesus positive (allele) from mother / 3 would not receive Rhesus positive (allele) / X (chromosome) from father / 1 / 3 will receive Y (chromosome) from father / 1;

OR

Evidence (not a mark)

9 would be Rhesus positive / would not be / is Rhesus negative /
8 and 9 / all daughters of 3 and 4 would be Rhesus positive;

Explanation (not a mark)

As 9 would receive X chromosome / dominant allele from father / 3;

Do not negate mark if candidate refers to gene rather than allele.

One mark for evidence and one mark for explanation linked to this evidence.

Any reference to allele being on Y chromosome negates mark for explanation.

2

(c) Correct answer of 48(%) = 3 marks;

q^2 / p^2= 16% / 0.16 / p / q = 0.4;

Shows that 2pq = heterozygotes / carriers;

Final answer of 0.48 = 2 marks

Allow mark for identifying heterozygotes if candidate multiplies incorrect p and q values by 2.

3

[9]

6. (a) 1. Closer the (amino acid) sequence the closer the relationship;

2. (Protein structure) related to (DNA) base / triplet sequence;

Amino acid sequence is related to (DNA) base / triplet sequence = two marks;

2

(b) 1. Reference to base triplets / triplet code / more bases than amino acids / longer base sequence than amino acid sequence;

Different (base) triplets code for same amino acids = 2 marks;

Degeneracy of triplet code = 2 marks

2. Introns / non-coding DNA / degeneracy of code / more than one code for each amino acid;

Ignore reference to codon.

2

(c) 1. Most closely related to chimpanzee;

2. Least closely related to trout;

2

[6]

7. (a) 1. (Colonisation by) pioneer (species);

2. Change in environment / example of change caused by organisms present;

3. Enables other species to colonise / survive;

4. Change in diversity / biodiversity;

5. Stability increases / less hostile environment;

6. Climax community;

Example of change e.g. formation of soil / humus / organic matter / increase in nutrients;

Do not accept genetic diversity for mark point 4.

5 max

(b) 1. Geographical isolation;

2. Variation due to mutation;

3. Different environmental / abiotic / biotic conditions / selection pressures;

4. Selection for different / advantageous, features / characteristics / mutation / / allele / differential reproductive success / (selected) organisms survive and reproduce;

5. Leads to change in <u>allele</u> frequency;

In this question must refer to allele where appropriate, not gene.

5

[10]

8. (a) 0.32;

Correct answer = 2 marks

Accept 32% for 1 mark max

Incorrect answer but identifying 2pq as heterozygous = 1 mark

2

(b) 1. Mutation produced *KDR minus* / resistance allele;

2. DDT use provides selection pressure;

3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce;

4. Leading to increase in *KDR minus* allele in population;

4

(c) 1. Neurones remain depolarised;

2. So no action potentials / no impulse transmission;

2

(d) 1. (Mutation) changes shape of sodium ion channel (protein) / of receptor (protein);

2. DDT no longer complementary / no longer able to bind;

2

[10]

9. (a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;

Accept: all marks if answer written in context of producing increased diversity of plants

1 Do not award this mark in context of new species being formed and then not interbreeding

1 Accept reproductive isolation as an alternative to no interbreeding

2. Mutation;

2 Accept: genetic variation

3. Different selection pressures / different foods / niches / habitats;

3 Accept: different environment / biotic / abiotic conditions or named condition

3 Neutral: different climates

4. Adapted organisms survive and breed / differential reproductive success;

5. Change / increase in allele frequency / frequencies;

5

(b) Similar / same environmental / abiotic / biotic factors / similar / same selection pressures / no isolation / gene flow can occur (within a species);

Accept: same environment

1

[6]

10. (a) *Ulva lactuca*;

Reject: Ulva on its own

Accept: lactuca on its own

Accept: Incorrect spelling

1

(b) (i) Difficult / too many / too many to count / individual organisms not identifiable / too small to identify / grows in clumps;

Neutral: easier / quicker / representative / more accurate, unless qualified

1

(ii) Any described feature of concrete eg texture / flat / composition chemicals / nutrients etc;

Neutral: not natural / man made / are different, without further qualification

1

(c) 1. Pioneer species / *Ulva* increases then decreases;

1 and 4. Growth / reproduces = increases. Dies = decrease

2. Principle of a species changing the conditions / a species makes the conditions less hostile;

2. Accept description of change in conditions eg soil / humus forms, nutrients increased

3. New / named species better competitor / previous / named / pioneer species outcompeted;

Pioneer species grows, dies and forms humus = 2 marks

G. coulteri / Gelidium outcompetes other / named species = 2 marks

4. *G. coulteri / Gelidium* increases and other / named species decreases;

4

[7]

11. (a) Succession;

Ignore any word in front of succession e.g. secondary / ecological succession.

Neutral 'forestation'.

1

(b) 1. Greater variety / diversity of plants / insects / more plant / insect species;

Neutral: more plants.

2. More food sources / more varieties of food;

Neutral: more food / more / greater food source (singular).

3. Greater variety / more habitats / niches;

Accept: more nesting sites.

Q *Neutral: more homes / shelters.*

3

(c) (i) Temperature and carbon dioxide;

Neutral: water, chlorophyll.

1

(ii) Shows (gross) photosynthesis / productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;

Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.

1

(iii) 1. (Shade plant) has lower (rate of) respiration / respiratory losses;

Accept use of figures.

Accept: lower compensation point.

2. (Shade plant) less CO2 released at 0 light intensity / in dark;

3. Greater (net) productivity / less sugars / glucose used / more sugars / glucose available;

Neutral: any references to rate of photosynthesis.

2

[8]

12. (a) 1. Decrease in (percentage cover) of bare ground / water linked to more plants / species / increase in plant coverage;

*Allow **one maximum mark** for answers which describe all three changes **without** a suitable explanation for any change*

1. Must be idea of more / increase not just change in species / plants

2. Change in diversity / number of plant / species / named (species) as abiotic conditions altered / due to <u>competition</u> / more soil / less hostile;

2. Accept pioneer species replaced due to competition

2. Accept description of change in species

2. Accept 'more suitable' = less hostile

3. Increase in depth of soil as plants die / humus formed;

3

(b) 1. Greater variety of food / more food <u>sources</u>;

1.'More food' = neutral

2. More / variety of habitats / niches;

2. Ignore 'more homes' or reference to 'shelters'

2

(c) (i) 1. Marking is not removed / marking does not affect survival / predation;

2. Limited / no immigration / emigration;

2. Accept 'migration' and descriptions of immigration / emigration

2. and 4.

Increase / decrease in population is not sufficient – there must be a reason

3. Sufficient time for (marked) individuals to mix (within the population);

   3. Accept – 'For mixing to occur between samples'

4. No / little births / deaths / breeding;

5. Sampling method is the same;

   5. Ignore 'random sampling'

2 max

(ii) Correct answer of ...34 = 2 marks;

*1. **Allow one mark** for an answer of 51 as candidate has misinterpreted the second sample as being = 30*

Incorrect answer but shows correct formula in words or numbers

e.g. 17 × 20 ÷ 10;

2. Reject correct formula multiplied by 100

2

[9]

13. (a) Crabgrass;

Reject: grass or grassland

Reject: crabgrass if another organism is also included

1

(b) 1. Species / plants / animals change the environment / conditions / add humus / nutrients etc.;

Accept 'they' for species/plants in mark points 1 and 3

2. Less hostile (habitat);

Allow 'more hospitable' or equivalent for mark point 2

3. Species/plants better competitors;

2 max

(c) (Only) plants which can photosynthesise with less light (remain);

Accept converse but do not award mark for idea that plants *cannot photosynthesise and die because there is no light*

Answers must be in context of being or not being able to photosynthesise with less light

1

[4]

14. (a) 1. (Colonisation by) <u>pioneer</u> (species);

2. Change in environment/example of change caused by organisms present;

3. Enables other <u>species</u> to colonise/survive;

4. Change in <u>diversity/biodiversity</u>;

5. Stability increases/less hostile environment;

6. Climax community;

Example of change e.g. formation of soil/humus/organic matter/increase in nutrients;

Do not accept genetic diversity for mark point 4.

5 max

(b) <u>Advantages</u>

1. Specific (to one pest);

2. Only needs one application/reproduces;

3. Keeps/maintains low population;

4. Pests do not develop resistance;

5. Does not leave chemical in environment/on crop/no bioaccumulation;

6. Can be used in organic farming;

<u>Disadvantages</u>

7. Does not get rid of pest completely;

8. May become a pest itself;

9. Slow acting/lag phase/takes time to reduce pest population;

Max 3 for advantages or disadvantages.

Ignore references to leaching, eutrophication.

Ignore references to cost.

5 max

(c) 1. Geographical isolation;

2. Separate gene pools/no interbreeding (between populations);

3. Variation due to mutation;

4. Different environmental/abiotic/biotic conditions/selection pressures;

5. Selection for different/advantageous, features/characteristics /mutation//allele;

6. Differential reproductive success/(selected) organisms survive and reproduce;

7. Leads to change in <u>allele</u> frequency;

8. Occurs over a long period of time;

In this question must refer to allele where appropriate, not gene.

5 max

[15]

AQA A Level Biology

3.8 Control of gene expression

EXAM QUESTIONS BOOKLET

Use this booklet to revise for exams and improve exam technique. Ensure you identify areas of strength and weakness near exam time to make your revision effective and use the revision notes to fill in any gaps

1. (a) Explain how the structure of DNA is related to its functions.

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(Extra space) ....

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(6)

Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division.

They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk. The following table shows the scientists' results.

Gene C	**Gene D**	**Gene E**	**Risk of developing lung cancer**
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present M = two copies
of the mutant allele are present

(b) What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

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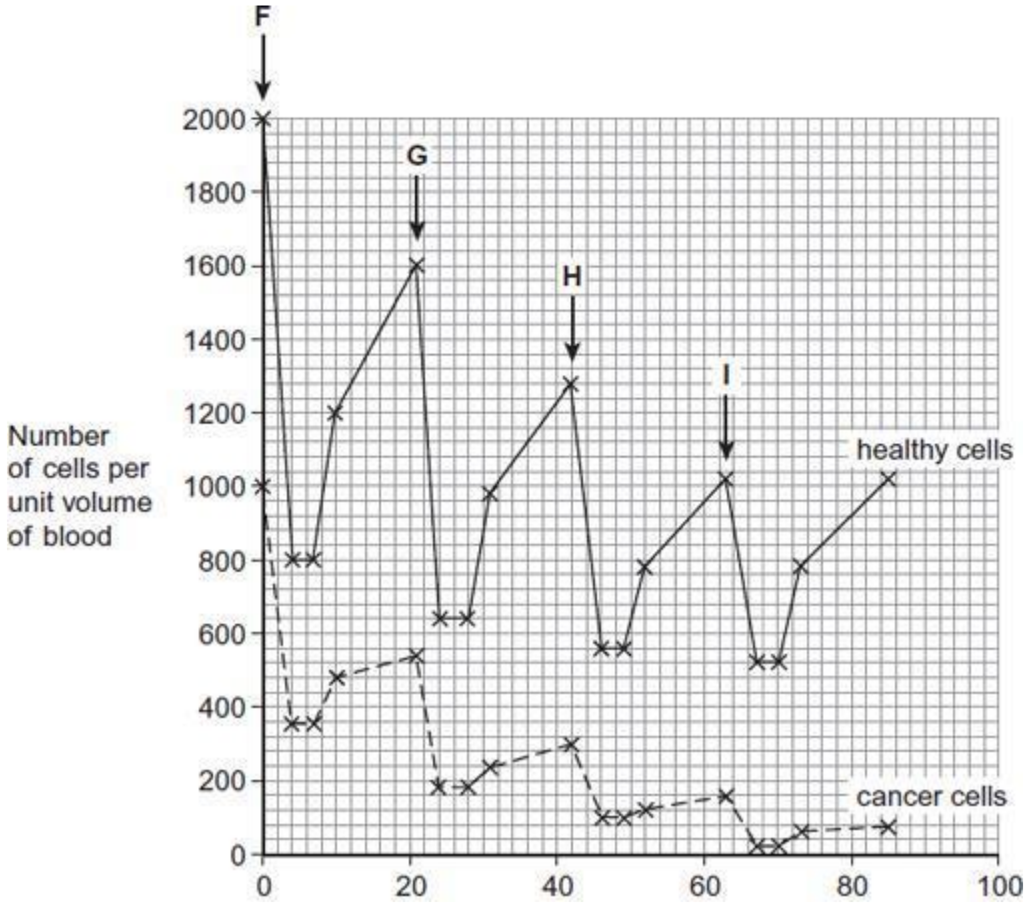
(3)

Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells.

The figure below shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.



Time / days

(c) Calculate the rate at which healthy cells were killed between days 42 and 46.

.... cells killed per unit volume of blood per day

(1)

(d) Describe similarities and differences in the response of healthy cells and cancer cells to the drug between times **F** and **G**.

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(3)

(e) More cancer cells could be destroyed if the drug was given more

frequently. Suggest why the drug was **not** given more frequently.

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(2)
(Total 15 marks)

2. The Amish are a group of people who live in America. This group was founded by 30 Swiss people, who moved to America many years ago. The Amish do not usually marry people from outside their own group.

One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld syndrome. People with this disorder have heart defects, are short and have extra fingers and toes. Ellis-van Creveld syndrome is caused by a faulty allele.

In America today, about 1 in 200 Amish people are born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish.

(a) In America today, there are approximately 1250 Amish people who have Ellis-van Creveld syndrome. Use the information provided to calculate the current Amish population of America.

Amish population ....

(1)

(b) The faulty allele that causes Ellis-van Creveld syndrome is the result of a mutation of a gene called *EVC.* This mutation leads to the production of a protein that has one amino acid missing.

(i) Suggest how a mutation can lead to the production of a protein that has one amino acid missing.

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(2)

(ii) Suggest how the production of a protein with one amino acid missing may lead to a genetic disorder such as Ellis-van Creveld syndrome.

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(2)
(Total 5 marks)

3. (a) What name is used for the non-coding sections of a gene?

....

(1)

Figure 1 shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. **Figure 2** shows DNA triplets that code for different amino acids.

Figure 1

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation **1** DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation **2** DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Figure 2

DNA triplets	**Amino acid**
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser

CTC, CTT, CTA, CTG	Leu

(b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence.

(1)

(c) Some gene mutations affect the amino acid sequence. Some mutations do not.
Use the information from **Figure 1** and **Figure 2** to explain

(i) whether mutation **1** affects the amino acid sequence

....

....

....

(2)

(ii) how mutation **2** could lead to the formation of a non-functional enzyme.

....

....

....

....

....

(3)

(d) Gene mutations occur spontaneously.

(i) During which part of the cell cycle are gene mutations most likely to occur?

....

(1)

(ii) Suggest an explanation for your answer.

....

....

(1)

(Total 9 marks)

4. Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

(a) (i) What is the maximum number of amino acids for which this base sequence could code?

☐

(1)

(ii) Explain how this mutation leads to the formation of non-functioning PAH.

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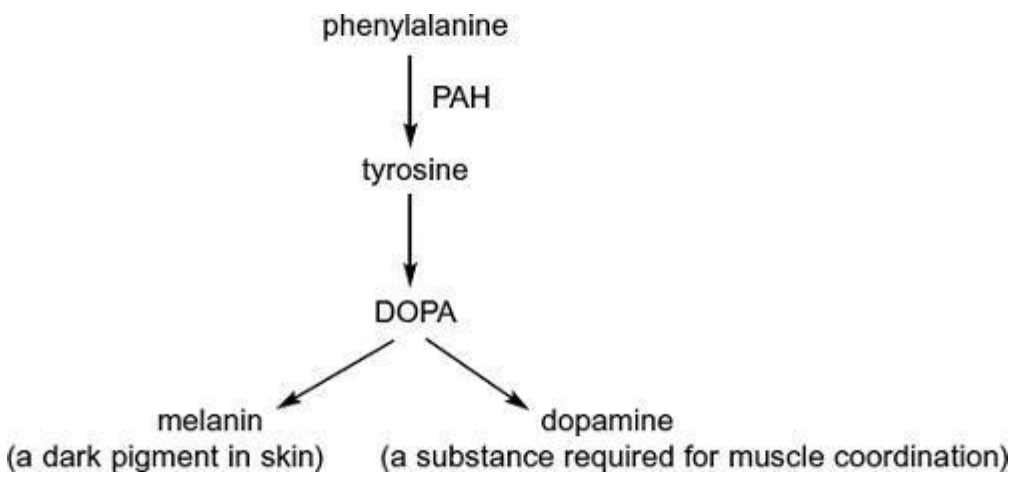
(3)

PAH catalyses a reaction at the start of two enzyme-controlled pathways.
The diagram shows these pathways.



(b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 ....

2 ....

(2)

(c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

....

....

....

(
1)

5. Lysozyme is an enzyme consisting of a single polypeptide chain of 129 amino acids.

(a) What is the minimum number of nucleotide bases needed to code for this enzyme?

....

(1)

(b) The diagram shows the sequence of bases in a section of the mRNA strand used to synthesise this enzyme.

G G U C U U U C U U A U G G U A G A U A U

(i) Give the DNA sequence which would be complementary to the first four bases in this section of mRNA.

....

(1)

(ii) How many different types of tRNA molecule would attach to the section of mRNA shown in the diagram?

....

(1)

(c) Give **two** factors which might increase the frequency at which a mutation in DNA occurs.

1 ....

2 ....

(2)

(d) Two single base mutations occurred in the DNA coding for this section of mRNA. These mutations caused an alteration in the sequence of amino acids in the enzyme. The tables below show the original and altered sequence of amino acids.

Original amino acid sequence	Gly	Leu	Ser	Tyr	Gly	Arg	Tyr
Original mRNA base sequence	GGU	CUU	UCU	UAU	GGU	AGA	UAU

Altered amino acid sequence	Gly	Leu	Tyr	Leu	Trp	Arg	Tyr
Altered mRNA base sequence	GGU	CUU				AGA	UAU

(i) Use the mRNA codons provided in the table to complete the altered mRNA base sequence.

Amino acid	**mRNA codons which can be used**
Arg	AGA
Gly	GGU
Leu	CUU or UUA
Ser	UCU
Trp	UGG
Tyr	UAU or UAC

(ii) Use the information provided to determine to precise nature of the two single base mutations in the DNA.

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(3)

(Total 9 marks)

6. (a) (i) What is the role of RNA polymerase in transcription?

....

....

(

1)

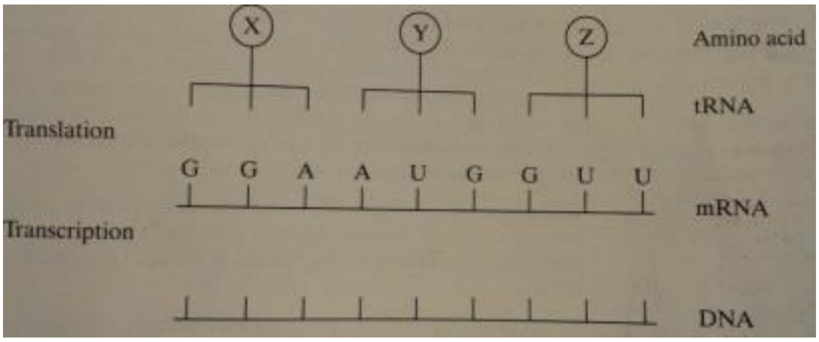
(ii) Name the organelle involved in translation.

....

(

1)

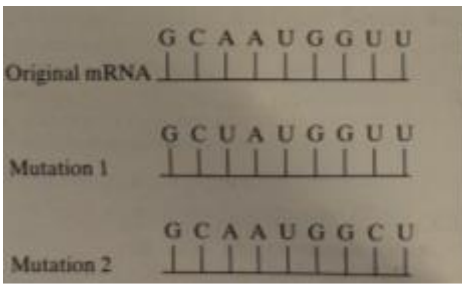
(b) below shows some molecules involved in protein synthesis.

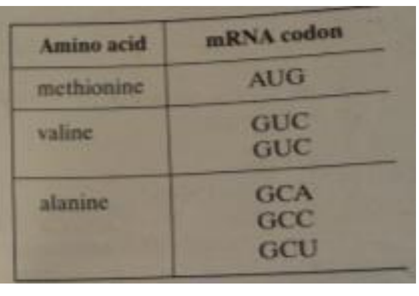


Complete the diagram to show:

(i) The bases on the DNA strand from which the mRNA was transcribed
(ii) The bases forming the anticodons of the tRNA molecules.

(c) Below shows the effects of 2 different mutations of the DNA on the base sequence of the mRNA codons for 3 amino acids.





Amino acid	mRNA codon
methionine	AUG
valine	GUC GUC
alanine	GCA GCC GCU

Name the type of mutation represented by mutation 1.

……………………………………………………………………………………..

(d) Use the information in the table to;

(i) Identify amino acid X in figure 1.

…………………………………………………………………………………….

(ii) Explain how each mutation may affect the polypeptide for which this section of DNA is part of the code.

Mutation 1:

……

……

(2)

Mutation 2:

……

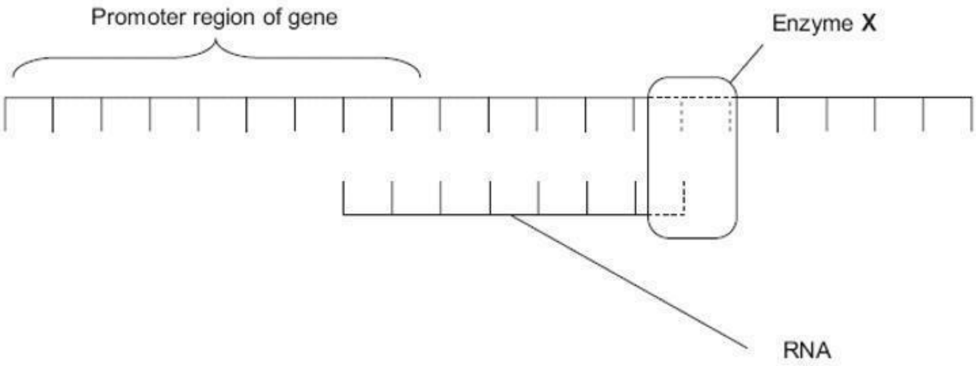
……

(2)

(Total 10 marks)

7. Figure 1 shows part of a gene that is being transcribed.

Figure 1



(a) Name Enzyme X.

……
…………

(1)

(b) (i) Oestrogen is a hormone that affects transcription. It forms a complex with a receptor in the cytoplasm of target cells. Explain how an activated oestrogen receptor affects the target cell.

....

....

....

....

(2)

(ii) Oestrogen only affects target cells. Explain why oestrogen does not affect other cells in the body.

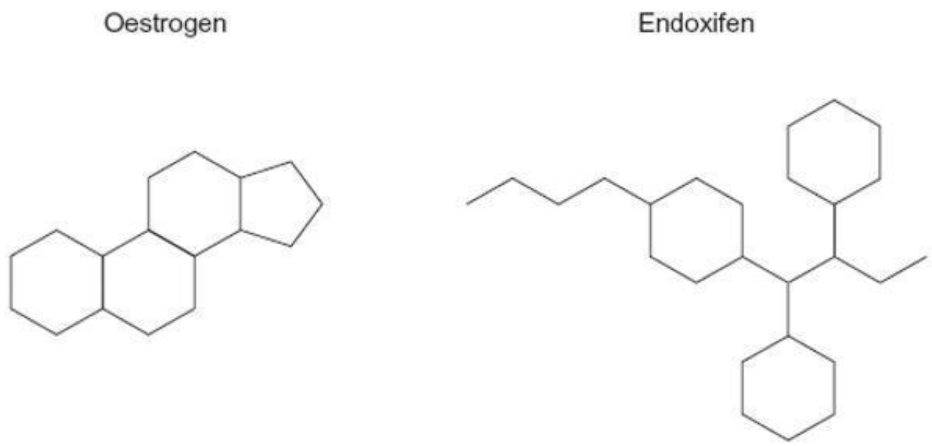
....

....

(1)

(c) Some breast tumours are stimulated to grow by oestrogen. Tamoxifen is used to treat these breast tumours. In the liver, tamoxifen is converted into an active substance called endoxifen. Figure 2 shows a molecule of oestrogen and a molecule of endoxifen.

Figure 2



Use Figure 2 to suggest how endoxifen reduces the growth rate of these breast tumours.

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(2)

(Total 6 marks)

8. (a) Name one mutagenic agent.

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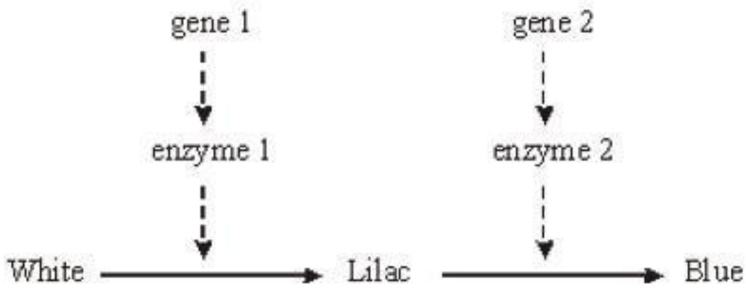
(1)

(b) In flax plants the flowers are white, lilac or blue. The diagram shows the pathway by which the flower cells produce coloured pigments.



(i) A deletion mutation occurs in gene 1. Describe how a deletion mutation alters the structure of a gene.

....

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(2)

(ii) Describe and explain how the altered gene could result in flax plants with white coloured flowers.

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(4)

(Total 7 marks)

9.

(a) The table shows the mRNA codons for some amino acids.

Codon	Amino acid
CUA	Leucine
GUC	Valine
ACG	Threonine
UGC	Cysteine
GCU	Alanine
AGU	Serine

(i) Give the DNA sequence coding for cysteine.

....

(1)

(ii) Name the amino acid coded by the tRNA anticodon UCA.

....

(1)

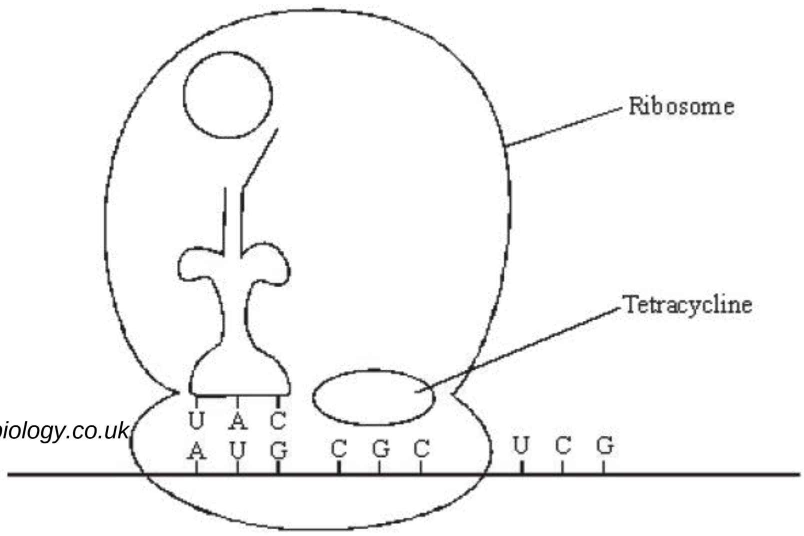
(b) A particular gene is 562 base-pairs long. However, the resulting mRNA is only 441 nucleotides long. Explain this difference.

....

....

(1)

(c) Tetracycline binds to bacterial ribosomes. This is shown in the diagram.



Protein synthesis in bacteria is similar to that in eukaryotic cells. Explain how tetracycline stops protein synthesis.

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(2)

(Total 5 marks)

10. (a) Explain how the methylation of tumour suppressor genes can lead to cancer.

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(Extra space) ....

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(3)

Scientists investigated a possible relationship between the percentage of fat in the diet and the death rate from breast cancer in women from 10 countries.

Their data is shown in the table below.

Percentage of fat in diet of population	**Death rate of women from breast cancer per 100 000 women**
9.5	1.5
15.0	7.0
20.0	12.0
25.0	9.0
32.0	15.0
35.0	8.0
35.0	20.0
40.5	18.0
43.0	24.0
45.0	26.0

(b) Describe how you would plot a suitable graph of these data. Explain your choice of type of graph.

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(Extra space) ....

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....

(3)

(c) What can you conclude from these data?

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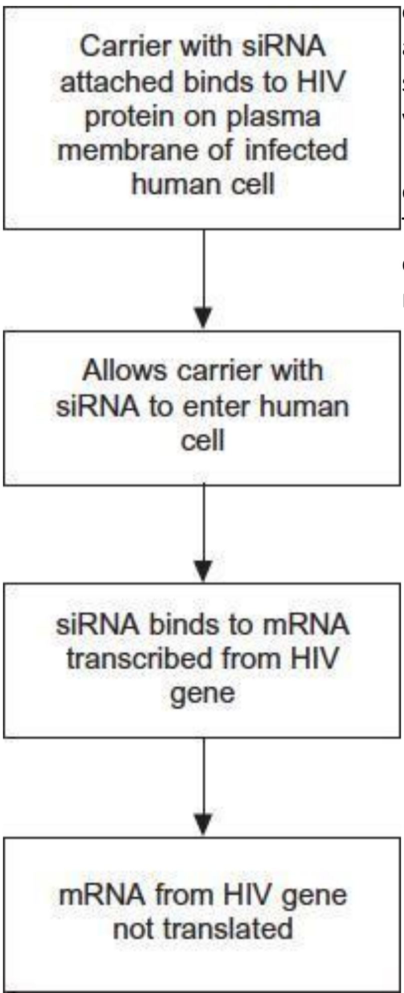
(2)

(Total 8 marks)

11. Human immunodeficiency virus (HIV) particles have a specific protein on their surface. This protein binds to a receptor on the plasma membrane of a human cell and allows HIV to enter. This HIV protein is found on the surface of human cells after they have become infected with HIV.

Scientists made siRNA to inhibit expression of a specific HIV gene inside a human cell. They attached this siRNA to a carrier molecule. The flow chart shows what happens when this carrier molecule reaches a human cell infected with HIV.



(a) When siRNA binds to mRNA, name the complementary base pairs holding the siRNA and mRNA together. One of the bases is named for you.

....with...

....................**Adenine**.........................with...

(1)

(b) This siRNA would **only** affect gene expression in cells infected with

HIV. Suggest **two** reasons why.

1...

....

....

....

2...

....

....

....

(4)

(c) The carrier molecule on its own may be able to prevent the infection of cells by

HIV. Explain how.

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....

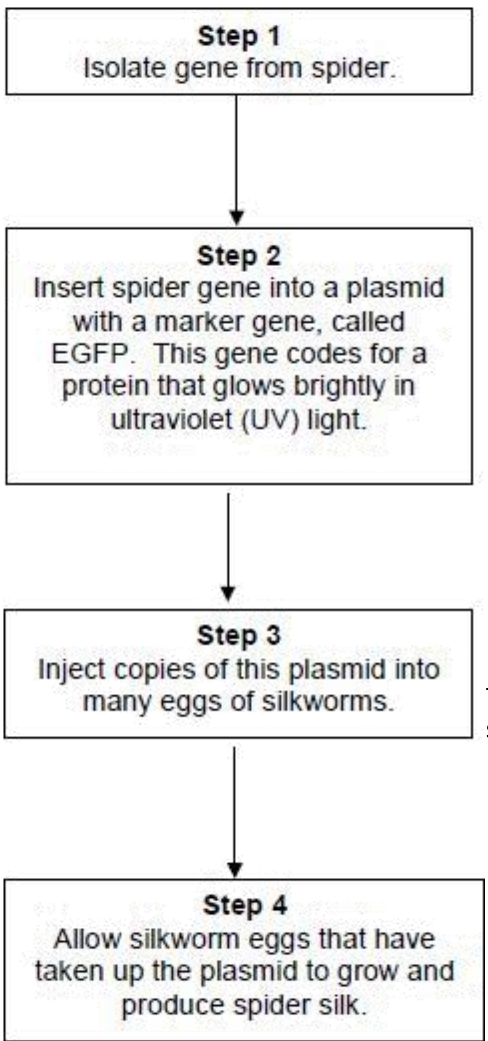
(2)
(Total 7 marks)

12. Silkworms secrete silk fibres, which are harvested and used to manufacture silk fabric.

Scientists have produced genetically modified (GM) silkworms that contain a gene from a spider.

The GM silkworms secrete fibres made of spider web protein (spider silk), which is stronger than normal silk fibre protein.

The method the scientists used is shown in the figure below



(a) Suggest why the plasmids were injected into the eggs of silkworms, rather than into the silkworms.

....

....

....
(2)

(b) Suggest why the scientists used a marker gene and why they used the EGFP gene.

....

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....

(2)

(c) The scientists ensured the spider gene was expressed only in cells within the silk glands. What would the scientists have inserted into the plasmid along with the spider gene to ensure that the spider gene was only expressed in the silk glands of the silkworms?

....

(1)

(d) Suggest **two** reasons why it was important that the spider gene was expressed only in the silk glands of the silkworms.

1

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2

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(2)

(Total 7 marks)

13. Scientists are working to produce a genetically modified bacterium to treat patients suffering from a disease of the digestive system. They plan to collect mRNA from human cells. This will be used to produce the DNA of the gene for the protein interleukin. They will then transfer this human gene into the bacterium *Lactococcus*. The scientists intend patients to swallow the genetically modified bacteria. These bacteria will release interleukin inside the digestive system to treat the disease.

(a) (i)Name the type of enzyme which will be used to produce the DNA from the mRNA.

....

(1)

(ii) It is easier to obtain the interleukin gene from mRNA rather than directly from the DNA removed from human cells. Explain why.

....

....

(1)

(b) The scientists propose to put the gene directly into the DNA of *Lactococcus*. Describe the role of the enzyme ligase in this process.

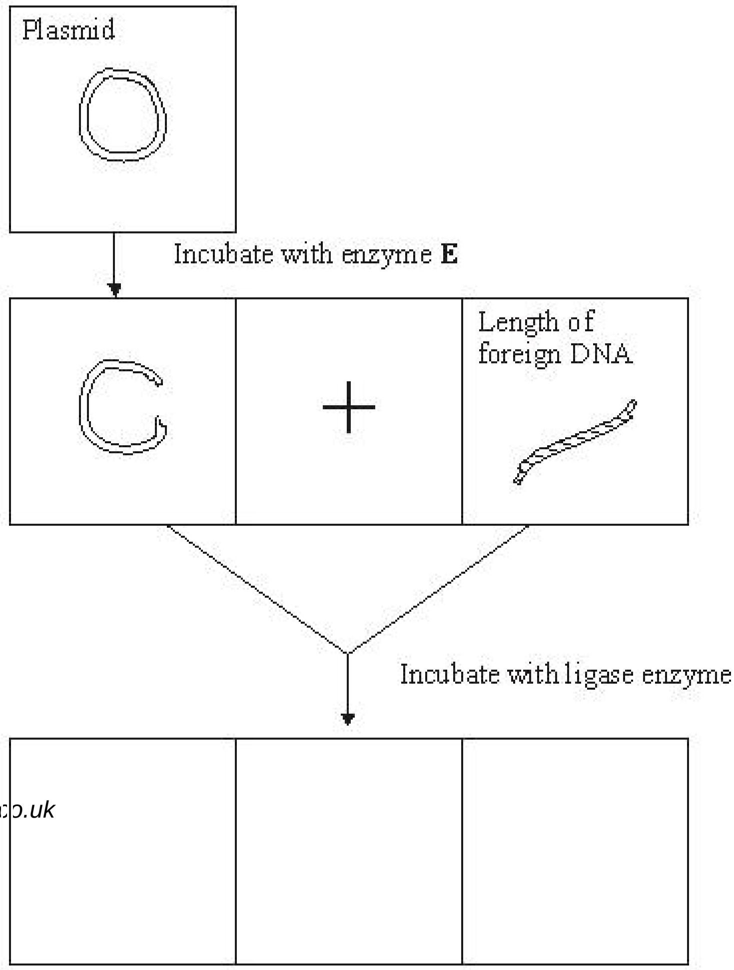
....

....

(1)

(Total 3 marks)

14. Plasmids can be used as vectors to insert lengths of foreign DNA into bacteria. The diagram shows how this is achieved.



(a) Name enzyme **E**.

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....

(1)

(b) Cut plasmids and lengths of foreign DNA can join. What features of their ends allows them to join?

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....

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....

(2)

(c) Draw **three** different structures that could be formed by incubating cut plasmids and lengths of foreign DNA with ligase. Use the spaces provided on the diagram.

(3)
(Total 6 marks)

15. (a) (i) Some human DNA was cut into separate pieces using a restriction enzyme which produced a staggered cut. A scientist wanted to insert these pieces of DNA into plasmids and used the same restriction enzyme to cut the plasmids. Explain why the pieces of human DNA would be able to join to the cut DNA of the plasmids.

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(2)

(ii) Which other enzyme must the scientist have added to the mixture to form recombinant plasmids?

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(1)

(b) A plasmid may be used as a vector. Explain what is meant by a *vector*.

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(2)

(c) Molecular biologists often use plasmids which contain antibiotic resistance genes. Explain the reason for this.

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(2)

(Total 7 marks

AQA A Level Biology

3.8 Control of gene expression

Mark Scheme

1. (a) 1. Sugar-phosphate (backbone) / double stranded / helix **so** provides strength / stability / protects bases / protects hydrogen bonds;

Must be a direct link / obvious to get the mark

Neutral: reference to histones

2. Long / large molecule **so** can store lots of information;

3. Helix / coiled **so** compact;

Accept: can store in a small amount of space for 'compact'

4. Base sequence allows information to be stored / base sequence codes for amino acids / protein;

Accept: base sequence allows transcription

5. Double stranded **so** replication can occur semi-conservatively / strands can act as templates / complementary base pairing / A-T and G-C so accurate replication / identical copies can be made;

6. (Weak) hydrogen bonds **for** replication / unzipping / strand separation / many hydrogen bonds **so** stable / strong;

Accept: 'H-bonds' for 'hydrogen bonds'

6

(b) 1. (Mutation) in **E** produces highest risk / 1.78;

2. (Mutation) in **D** produces next highest risk / 1.45;

3. (Mutation) in **C** produces least risk / 1.30;

Must be stated directly and not implied

E *>* ***D*** *>* ***C*** *= 3 marks*

Accept: values of 0.78, 0.45 and 0.30 for MP1, MP2 and MP3 respectively

If no mark is awarded, a principle mark can be given for the idea that all mutant alleles increase the risk

3

(c) **180**;

1

(d) **(Similarities):**

1. Same / similar pattern / both decrease, stay the same then increase;

2. Number of cells stays the same for same length of time;

Ignore: wrong days stated

(Differences):

(Per unit volume of blood)

3. Greater / faster decrease in number of healthy cells / more healthy cells killed / healthy cells killed faster;

   Accept: converse for cancer cells

   Accept: greater <u>percentage</u> decrease in number of cancer cells / greater <u>proportion</u> of cancer cells killed

4. Greater / faster increase in number of healthy cells / more healthy cells replaced / divide / healthy cells replaced / divide faster;

   Accept: converse for cancer cells

   *For **differences**, statements made must be comparative*

3 max

(e) 1. More / too many healthy cells killed;

2. (So) will take time to replace / increase in number;

   Neutral: will take time to 'repair'

3. Person may die / have side effects;

2 max

[15]

2. (a) 250 000;

1

(b) (i) Loss of 3 bases / triplet = 2 marks;;

'Stop codon / code formed' = 1 mark max unless related to the last amino acid

Loss of base(s) = 1 mark;

eg triplet for last amino acid is changed to a stop codon / code = 2 marks

3 bases / triplet forms an intron = 2 marks

Accept: descriptions for 'intron' eg non-coding DNA

'Loss of codon' = 2 marks

2

(ii) 1. Change in tertiary structure / active site;

Neutral: change in 3D shape / structure

2. (So) faulty / non-functional protein / enzyme;

Accept: reference to examples of loss of function eg fewer E-S complexes formed

2

[5]

3. (a) Introns;

1

(b) Ile Gly Val Ser;

1

(c) (i) Has no effect / same amino acid (sequence) / same primary structure;

Q *Reject same amino acid formed or produced.*

1

Glycine named as same amino acid;

1

It still codes for glycine = two marks.

(ii) Leu replaces Val / change in amino acid (sequence) / primary structure;

Change in hydrogen / ionic bonds which alters tertiary structure / active site;

Q *Different amino acid formed or produced negates first marking point.*

Substrate cannot bind / no longer complementary / no enzyme-substrate complexes form;

Active site changed must be clear for third marking point but does not need reference to shape.

3

(d) (i) Interphase / S / synthesis (phase);

1

(ii) DNA / gene replication / synthesis occurs / longest stage;

Allow 'genetic information' = DNA.

Allow 'copied' or 'formed' = replication / synthesis

1

[9]

4.(a) (i) 4;

1

(ii) 1. Change in amino acid / (sequence of) amino acids / primary structure;

1. Reject = different amino acids are 'formed'

2. Change in hydrogen / ionic / disulphide bonds alters tertiary structure / active site (of enzyme);

2. Alters 3D structure on its own is not enough for this marking point.

3. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme- substrate complexes form;

3

(b) 1. Lack of skin pigment / pale / light skin / albino;

2. Lack of coordination / muscles action affected;

2 max

(c) Founder effect / colonies split off / migration / interbreeding;

Allow description of interbreeding e.g. reproduction between individuals from different populations

1

[7]

5. (a) 387;

1

(b) (i) CCAG;

1

(ii) 5;

(c) high energy radiation / X rays / ultraviolet light / gamma rays;
high energy particles / alpha particles / beta particles;
named chemical mutagens e.g. benzene / caffeine / pesticide / mustard gas / tobacco tar / free radicals;

(two named examples of any of the above = 2 marks)

length of time of exposure (to a mutagen);

dosage (of mutagen);

2 max

(d) (i) UAC UUA UGG;

1

(ii) addition and deletion (of bases/nucleotides);
thymine added;
adenine deleted;

(addition of thymine and deletion of adenine = 3 marks)

(allow addition of adenine (RNA) and deletion of uracil (RNA) = 2 marks)

3

[9]

6. (a) (i) join/attach nucleotides, to form a strand/along backbone/ phosphodiester bonds;

(reject reference to H bonds, complementary base pairing)

1

(ii) ribosome/RER;

1

(b) (i) CGTTACCAA;

1

(ii) CGU UAC CAA;

1

(c) substitution;

1

(d) (i) alanine;

1

(ii) (mutation 1)
no change(to sequence of amino acids);
codon for alanine/degenerate codon/same amino acid coded for;

2

(mutation 2)
(change in sequence) valine replaced by alanine/codon for alanine;
folding/shape/tertiary structure/position of bonds may change;
(reject peptide bonds)

2
[10]

7. (a) RNA polymerase;

DNA polymerase is incorrect
Ignore references to RNA dependent or DNA dependent
Allow phonetic spelling

1

(b) (i) (Receptor/transcription factor) binds to promoter;

Stimulates RNA polymerase/enzyme X;

Transcribes gene/increase transcription;

2 max

(ii) Other cells do not have the/oestrogen/ERα receptors;

But do not accept receptors in general.

1

(c) Similar shape to oestrogen;

Binds receptor/prevents oestrogen binding;

Receptor not activated/will not attach to promoter/no transcription;

Accept alternative
Complementary to oestrogen;
Binds to oestrogen;
Will not fit receptor;

2 max

[6]

8. (a) high energy radiation /ionising particles;
named particles/α, β, γ;
colchicine;
x rays/cosmic rays;
uv (light);
carcinogen / named carcinogen;
mustard gas / phenols / tar (qualified);

1 max

(b) (i) removal of one or more bases/nucleotide;
frameshift/(from point of mutation) base sequence change;

2

(ii) sequence of bases in mRNA would change;
(sequence of) amino acids different / different primary structure;
(active site / enzyme 1) changed tertiary shape / changed active sites;
white pigment does not bind;
lilac pigment not produced / white pigment remains unchanged/ enzyme 1 does not function;

4 max

[7]

9. (a) (i) ACG;

1

(ii) serine;

1

(b) idea that DNA contains introns/ mRNA is only exons/ mRNA is "edited';
(allow junk/ non-sense DNA)

1

(c) translation cannot occur; binds to/blocks codon/ triplet on mRNA;
anticodon/tRNA will not fit in/base-pair; amino acids not
delivered/ joined;

2 max
[5]

10. (a) 1. Methylation prevents transcription of gene;
2. Protein not produced that prevents cell division / causes cell death / apoptosis;
3. No control of mitosis.

3

(b) 1. Scatter graph;
2. Fat on *x* axis and death rate on *y* axis;
3. (Because) looking at relationship between two discrete / independent variables.

3

(c) 1. (Trend) shows positive correlation / shows the more fat in diet, the higher death rate from breast cancer;
2. But number of points off line / anomalies.

2
[8]

11. (a) Cytosine with Guanine <u>and</u> (Adenine) with Uracil;
Ignore G, C and U

1

(b) Two reasons, with suitable amplification;
Q

Only infected cells have HIV protein on surface;

So carrier only attaches to / specific to these cells / siRNA can only enter these cells;

OR

siRNA (base sequence) complementary / specific to one mRNA;
Accept idea of specificity

Only infected cells contain mRNA of HIV / this gene / stops translation of this gene / only binds to this mRNA / destroys this mRNA;
Accept could not inhibit other / non-HIV mRNA

4 max

(c) 1. Carrier binds to (protein on) HIV;

1. Accept references to HIV membrane

2. Prevents HIV / it binding to (receptor on human) cell;

2. Reject references to binding to HIV protein on human cell

2

[7]

12. (a) 1. (If injected into egg), gene gets into all / most of cells of silkworm;

2. So gets into cells that make silk;

2

(b) 1. Not all eggs will successfully take up the plasmid;

2. Silkworms that have taken up gene will glow;

2

(c) Promoter (region / gene);

1

(d) 1. So that protein can be harvested;

2. Fibres in other cells might cause harm;

2

[7]

13. (a) (i) Reverse transcriptase;

1

(ii) Idea that mRNA is present in large amounts in cell making the protein / mRNA has been edited / does not contain introns / mRNA codes for single protein;

1

(b) (Ligase) splices / joins two pieces of DNA / “sticky ends”;

1

[3]

14. (a) restriction (enzyme) / endonuclease / named example;

1

(b) unpaired bases / sticky ends / staggered;
complementary / explained;

2

(c) *1 mark for each correct outcome*
plasmid with foreign DNA joined in ring;
ring with plasmid only; ring of foreign DNA only;
ignore linear structures

3

[6]

15. (a) (i) Sticky ends / description;
Reference to complementary base-pairing

2

(ii) Ligase;

1

(b) Carrier of DNA / gene; *(context of foreign DNA)*
Into cell / other organism / host;

2

(c) Act as marker gene;
Allows detection of cells containing plasmid / DNA;

2

[7]