18 (a) Light intensity, carbon dioxide concentration and temperature are all limiting factors in photosynthesis.

Explain what is meant by a **limiting factor**.

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..... **[2]**

Question 18(b) begins on page 20

(b) An investigation was carried out into the effect of adding different volumes of water on the survival of seedlings.

There were 60 seedlings in each group.

The results are shown in Table 18.

Volume of water added to soil (cm^3)	Day	Number of seedlings surviving
10	3	60
	6	59
	9	59
	12	58
	15	57
	18	57
20	3	60
	6	57
	9	54
	12	54
	15	54
	18	53
30	3	60
	6	58
	9	56
	12	50
	15	50
	18	48
40	3	60
	6	48
	9	40
	12	34
	15	26
	18	20
60	3	60
	6	41
	9	21
	12	6
	15	2
	18	2

Table 18

(i) Summarise the conclusions that can be drawn from these data.

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..... **[3]**

(ii)* Water can fill air spaces in the soil surrounding the roots.

This prevents oxygen from reaching root hair cells.

Using your knowledge of aerobic and anaerobic respiration, explain why overwatering can kill plants.

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..... **[6]**

(c) (i) Soluble mineral ions are present in soil.

Explain why water molecules can form hydrogen bonds with nitrate (NO_3^-) ions.

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..... **[2]**

(ii) Fig. 18 shows a process that occurs in the cell surface membrane of the endodermis in the root.

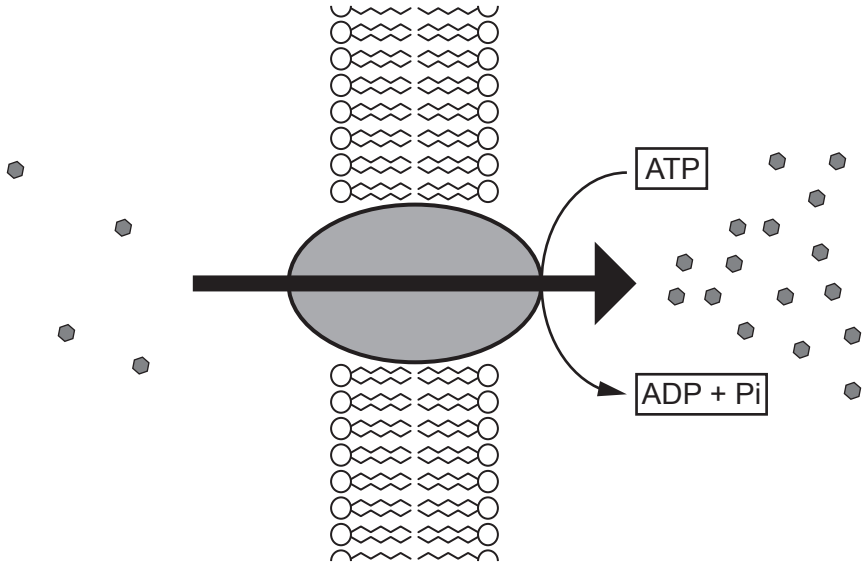

Fig. 18

Explain how the events shown in Fig. 18 cause water to enter the endodermis.

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..... **[2]**

(d) Explain why a plant leaf is described as an organ.

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..... **[4]**

21 The Titicaca water frog, *Telmatobius culeus*, is an aquatic amphibian found in Lake Titicaca in sub-tropical South America. The water frog has an unusual appearance with large folds of skin as shown in Fig. 21.1.

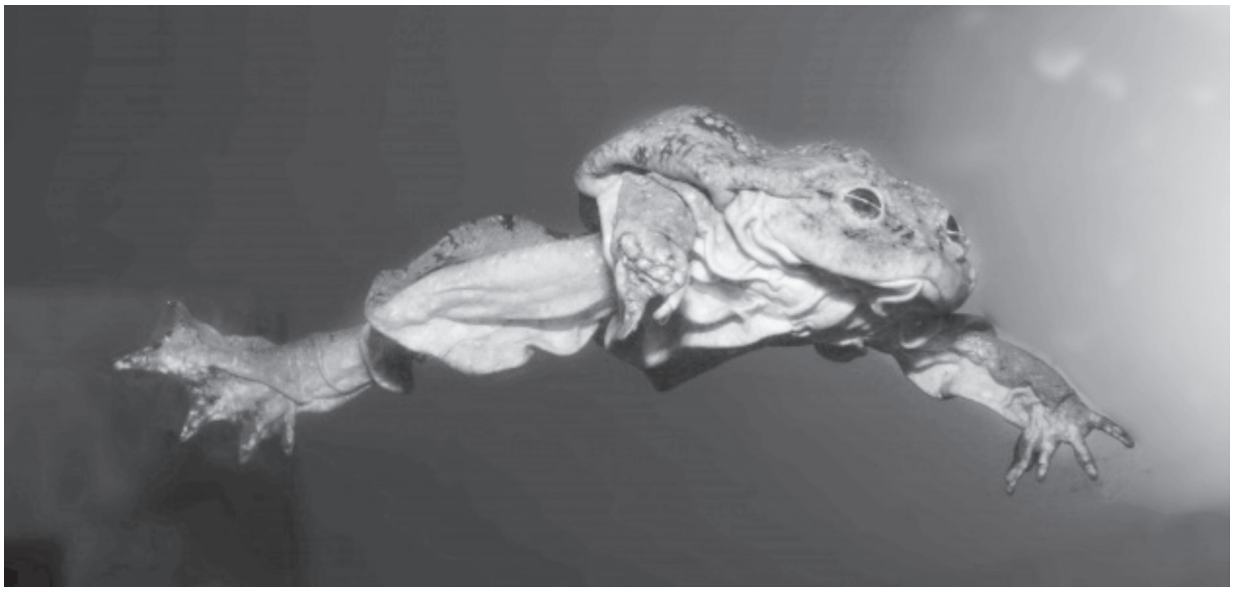

Fig. 21.1

(a) Name the genus of the Titicaca water frog.

..... **[1]**

(b) Outline the properties of water which make it an ideal habitat for an amphibian.

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..... **[2]**

(c) Like all amphibians, frogs are able to absorb oxygen through the skin as well as their lungs.

(i) Suggest why the Titicaca water frog has evolved the unusually large folds of skin seen in Fig. 21.1.

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..... **[2]**

(ii) When out of the water, the Titicaca water frog is able to use its lungs to absorb oxygen.

Lungs contain specialised gaseous exchange surfaces.

Describe and explain how **one** feature of the lungs provides an efficient gas exchange surface.

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..... **[2]**

(d) A student was investigating the effect of cell size on the rate of diffusion into model cells. They had two cubes of agar containing phenolphthalein indicator as shown in Fig. 21.2.

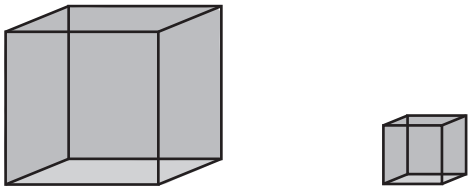

Fig. 21.2

The student placed the cubes in beakers of dilute hydrochloric acid, which caused the indicator to become colourless. They then measured how much of each cube became colourless over time.

(i) State **two** ways the student could have ensured they had confidence in their results.

1 .....

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2 .....

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[2]

(ii) In Fig. 21.2, Cube A is 10 mm along each side and Cube B is 4 mm along each side. Calculate the surface area to volume ratio (SA:V) for both cubes A and B.

Show your working. Give your answers to **one** decimal place.

Cube A .....

Cube B .....

[2]

(iii) Explain why the surface area to volume ratio of an organism determines whether it needs a circulatory system.

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..... **[3]**

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows the general structure of an amino acid.

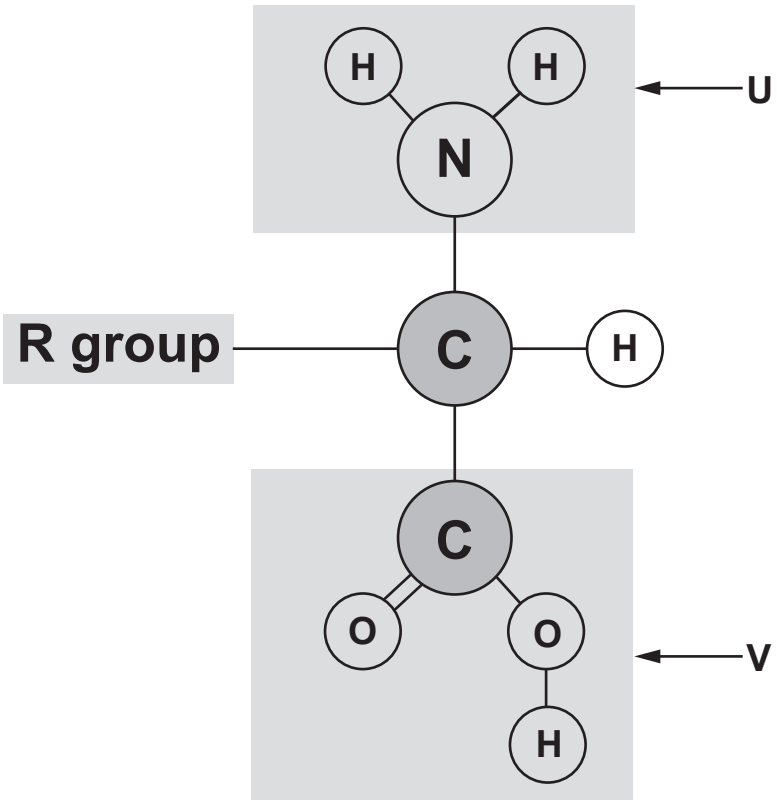

Fig. 1.1

(i) State the names of the groups labelled **U** and **V**.

U .....

V .....

[1]

(ii) Fig. 1.2 shows a representation of a short polypeptide chain made from three amino acids.

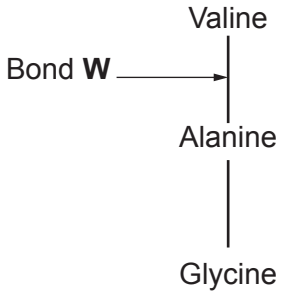

Fig. 1.2

Name bond **W and** state what type of reaction takes place to form this bond.

Name of bond **W** .....

Type of reaction .....

[1]

(b) Pepsin is a protease enzyme with a polypeptide chain containing 327 amino acids.

Titin is the largest known protein. It has a polypeptide chain containing at least 92 times more amino acids than pepsin.

(i) DNA sequences in genes code for polypeptide molecules such as pepsin and titin.

Explain why a process known as transcription is necessary for polypeptide synthesis.

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..... **[2]**

(ii) Calculate the minimum length of the DNA base sequence required to code for titin.

Show your working.

Answer ..... **[2]**

(iii)* Titin is a fibrous protein. Pepsin is a globular protein.

Compare the properties and functions of fibrous proteins and globular proteins in the human body.

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..... **[6]**

(iv) Another protease enzyme is HIV1 protease, which is essential for the life cycle of the human immunodeficiency virus (HIV). Inhibition of this protease prevents HIV from maturing.

In 1995, saquinavir was the first HIV1 protease inhibitor drug to be approved by the US Food and Drug Administration (FDA).

The data in Fig. 1.3 show the number of acquired immune deficiency syndrome (AIDS) diagnoses and deaths between 1981 and 2007 in the US.

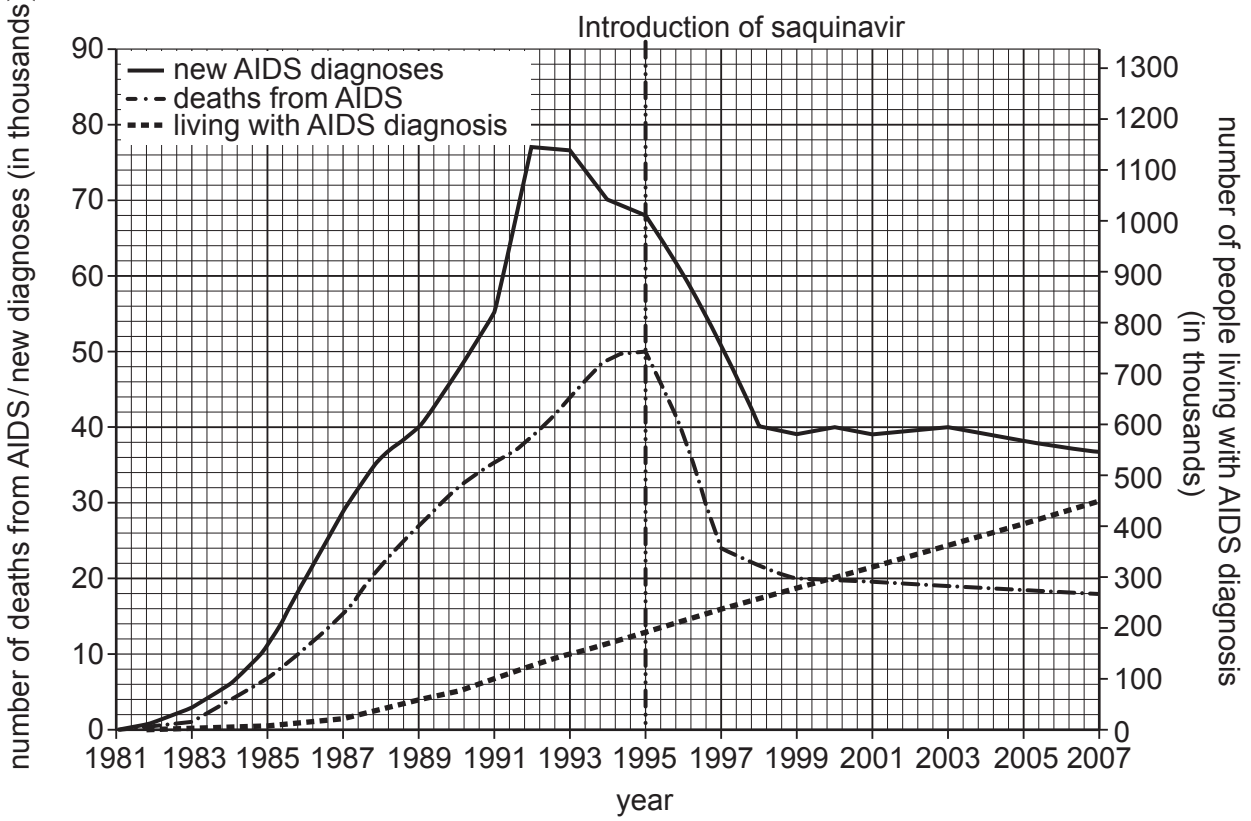

Fig. 1.3

Calculate the rate of decrease in deaths from AIDS between 1995 and 1998.

Give your answer to **two significant figures**.

Show your working.

Answer ..... Units ..... **[2]**

(v) A student looking at the data in Fig. 1.3 made the following conclusion:

> "The decrease in deaths from AIDS after 1995 is because of the use of saquinavir by HIV patients."

Suggest why this conclusion may be invalid based on the data in Fig. 1.3.

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..... **[2]**

(c) A group of students wanted to use thin layer chromatography to identify four amino acids.

To produce the chromatogram, the students:

- drew a pencil line 1 cm from the bottom of the chromatography plate and put solvent into the beaker to a height of approximately 0.9 cm
- held the chromatography plate firmly in the middle with their hands and lowered it into the beaker
- left the apparatus to stand as shown in Fig. 1.4.

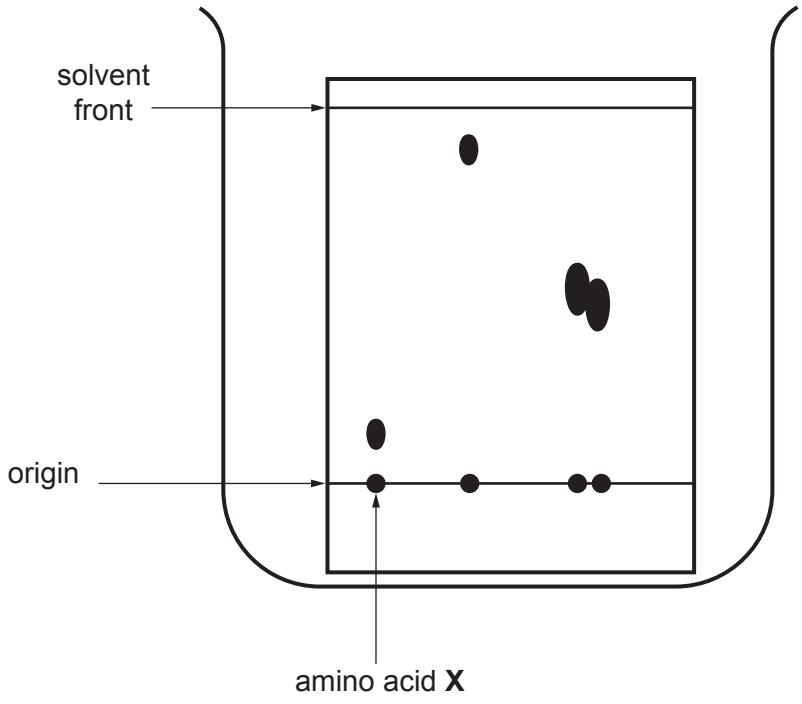

Fig. 1.4

(i) Describe **four** ways you would refine the method used by the students. For each change you suggest, give a reason why this would improve the results of the experiment.

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..... **[4]**

(ii) Table 1 shows the R_f values of some amino acids.

Name of amino acid	R_f value
Alanine	0.31
Cysteine	0.40
Glutamine	0.13
Phenylalanine	0.59

Table 1

Using the information in Table 1 and Fig. 1.4, identify amino acid **X** by calculating its R_f value.

Show your working.

R_f value of amino acid **X** .....

Name of amino acid **X** .....

[2]

3 **(a)** Polymers are important molecules that have structural and functional roles in organisms.

Chitin is a polymer that is found in insects, where it forms a major part of the structure of the exoskeleton.

- Chitin is a macromolecule that is similar to a polysaccharide.
- Chitin is composed of molecules of N-acetylglucosamine, the structure of which is shown in Fig. 3.1 below.
- The monomers of N-acetylglucosamine join by 1–4 glycosidic bonds to form the chitin molecule.

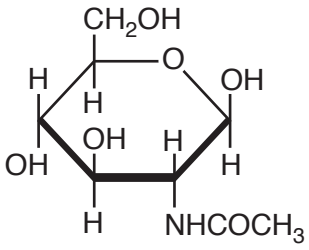

Fig. 3.1

(i) How does the composition of N-acetylglucosamine differ from the composition of a monosaccharide sugar?

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..... **[1]**

(ii) Which monosaccharide sugar does N-acetylglucosamine most closely resemble?

..... **[2]**

(iii) Using your knowledge of the formation of structural polysaccharides, describe the formation of the chitin molecule from its monomer and predict its structure.

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..... **[4]**

(b) Fig. 3.2 is a photomicrograph of the trachea of a honeybee, *Apis mellifera*.

The trachea of this honeybee is infected with honeybee tracheal mites, *Acarapis woodi*. Some of these mites are labelled **M** on Fig. 3.2.

The trachea and tracheoles of insects have circular bands of chitin. One of these bands is labelled **C** on Fig. 3.2.

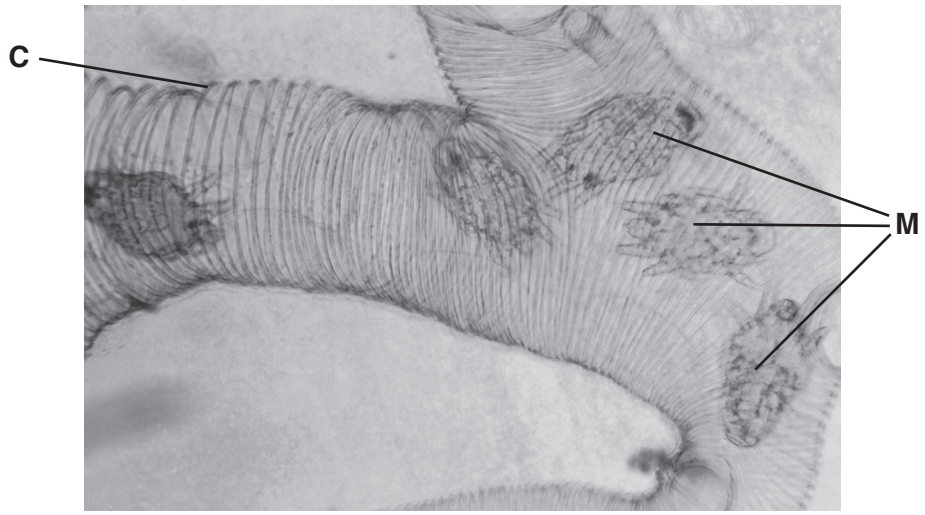

Fig. 3.2

(i) What is the function of the circular bands of chitin labelled **C**?

.....

.....

..... **[1]**

(ii) The mites use their mouthparts to bite through the walls of the trachea. They then feed off the haemolymph, the blood-like liquid that bathes the cells and organs of the honeybee.

Suggest **one** other way in which the presence of the mites might affect the honeybee.

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..... **[1]**

22 Many multicellular organisms need to be able to convert monosaccharides into polysaccharides and back again.

Mammals convert the monosaccharide glucose into a highly branched polysaccharide called glycogen, which gets stored in liver cells.

(a) Explain why mammals store glycogen instead of glucose.

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..... **[3]**

(b) Humans use the enzyme α-amylase to break down polysaccharides in food for absorption into the blood.

The gene for human α-amylase is found on chromosome 1.

The gene is transcribed in the nucleus and translation occurs on the rough endoplasmic reticulum in cells of the salivary gland.

Describe how the molecule is prepared and secreted by cells of the salivary gland after translation has taken place.

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..... **[3]**

22 Fig. 22 shows a triglyceride molecule found in sunflower oil.

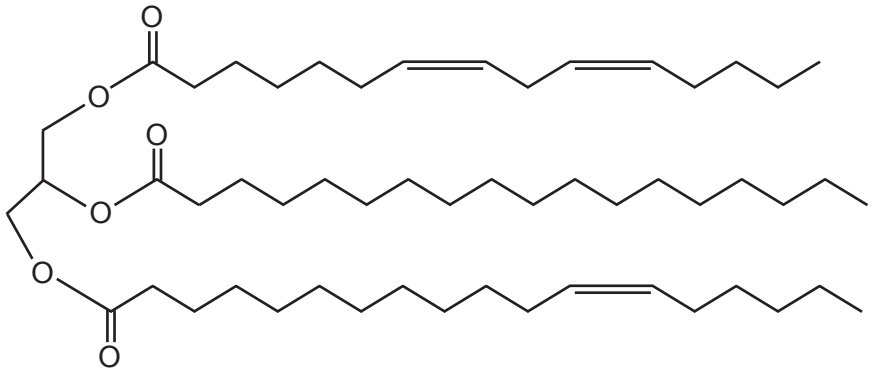

Fig. 22

(a) On Fig. 22 circle an ester bond.

[Answer on Fig. 22] **[1]**

(b) Sunflower oil is used to make biodiesel, which contains methyl esters. The fatty acids in the triglyceride molecule are reacted with methanol in a process called transesterification.

After the reaction, two liquid products form which naturally separate from each other. The methyl esters float on top of a more dense liquid.

Name the part of the molecule seen in Fig. 22 that forms this more dense liquid.

..... **[1]**

(c) Living organisms have many uses for triglycerides, one of which is the production of phospholipids.

(i) Name three **other** functions of triglycerides in living organisms.

1 .....

2 .....

3 .....

[3]

(ii) Table 22 shows the melting points of some of the methyl esters made from the transesterification of sunflower oil fatty acids.

Methyl ester	Formula	Melting point (°C)
Methyl sterate	$C_{19}H_{38}O_2$	39.1
Methyl oleate	$C_{19}H_{36}O_2$	–19.9
Methyl linoleate	$C_{19}H_{34}O_2$	–35.0

Table 22

Describe and explain the pattern of the melting points of these three methyl esters.

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..... **[2]**

(d) Phospholipid molecules also contain fatty acids.

Explain how the fatty acids in phospholipids allow the formation of membranes.

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..... **[2]**

4 Haemoglobin is a protein that carries oxygen in the blood of all mammals. The structure of haemoglobin can vary slightly between species.

Fig. 4.1 shows a llama, a relative of the camel.

Fig. 4.1

- Llamas live at high altitudes and camels live at low altitudes.
- At high altitudes the partial pressure of oxygen is low.
- Llama and camel haemoglobin consists of 2 α subunits and 2 β subunits.
- Each subunit contains a haem group and is able to bind to one molecule of oxygen.
- In the β subunits, one amino acid present in camel haemoglobin has been replaced by a different amino acid in llama haemoglobin.

Fig. 4.2 shows dissociation curves for llama haemoglobin and camel haemoglobin.

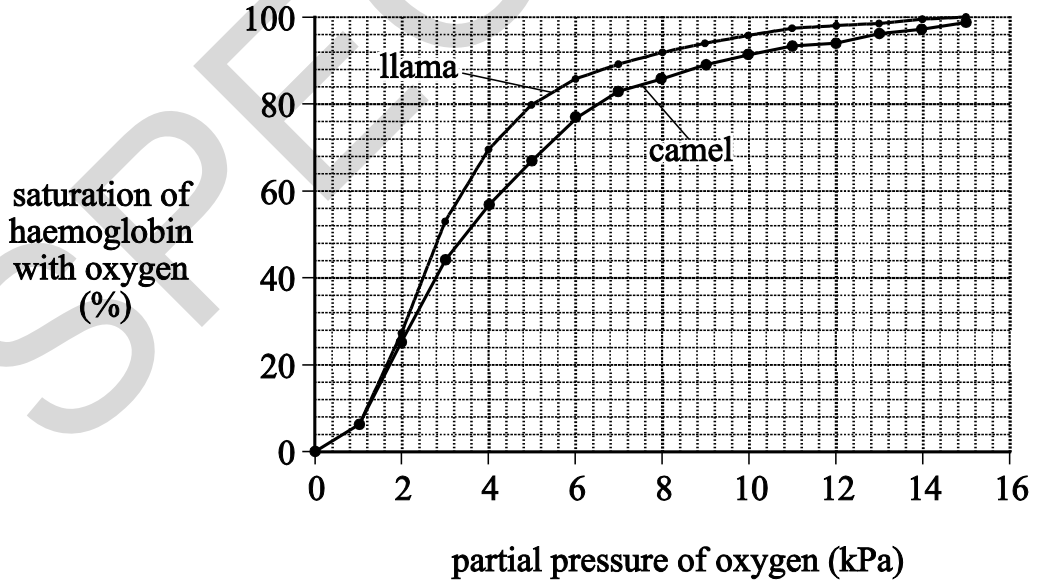

Fig. 4.2

(a) (i) State the partial pressure of oxygen that results in a saturation of 50% in llama haemoglobin.

Answer…… **[1]**

(ii) Explain why it is important for the survival of the llama that the llama haemoglobin dissociation curve is to the left of the camel haemoglobin dissociation curve.

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…… **[2]**

(**b)*** Describe how the structure of llama hamoglobin is likely to be different from that of camel haemoglobin with reference to the four levels of protein structure.

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…….… **[6]**

(c) Collagen is a fibrous protein.
State three **properties** of a fibrous protein that are different from those of a globular protein.

1……

2……

3……
[3]

(d) A vet is concerned that a llama is unwell. The vet suspects there may be haemoglobin in the urine of the llama.

Explain how the vet could confirm this suspicion?

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…… **[2]**

4 (a) (i) Ions have a number of important roles in living organisms.

Complete the table below by identifying the ion that plays each of the roles. Choose from the following list.

NH_4^+ Cl^- H^+ OH^- PO_4^{3-} Ca^{2+}

Important role	Ion
Production of nitrate ions by bacteria	NH_4^+
Loading of phloem	
DNA structure	
Cofactor for amylase	

[2]

(ii) Dissolved ions diffuse between blood plasma and tissue fluid.

Pressure differences at the arterial and venous ends of capillaries are responsible for the formation of tissue fluid. The following measurements were made in one capillary:

- Net hydrostatic pressure at the arterial end was 4.6 KPa
- Net oncotic pressure was −3.0 KPa
- Net hydrostatic pressure at the venous end was 2.3 KPa.

Use this information to explain the movement of fluid in and out of a capillary.

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..... **[2]**

(b) Copper (II) ions act as irreversible non-competitive inhibitors of the enzyme catalase.

(i) Describe how a non-competitive inhibitor works to inhibit the activity of an enzyme.

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..... **[2]**

(ii) Catalase is found in all living things that are exposed to oxygen. It protects cells from oxidative damage by breaking down hydrogen peroxide to water and oxygen.

Catalase is a useful biomarker of oxidative stress in fish exposed to water contaminated with copper ions.

A group of students carried out an experiment to explore the effects of copper sulfate on the action of catalase. They measured the activity of catalase exposed to different concentrations of copper sulfate.

The results of their experiment are shown in Table 4.

Concentration of copper sulfate (moles dm^{-3})	Volume of oxygen gas produced (cm^3)
0.00	14.50
0.05	10.50
0.10	7.55
0.15	5.80
0.20	4.20

Table 4

In the space provided below, **sketch** a graph of the results in Table 4.

[2]

(iii) What can the students conclude from their results?

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..... **[2]**

(iv) Three rivers in the Himalayan foothills were polluted with copper, which affected the aquatic wildlife. Scientists were provided with one dead Indian Barb fish, *Esomus danricus*, from each of the rivers.

Scientists were unable to take a direct measurement of the copper ion concentration in the fish.

Using the information provided in 4(b)(ii), suggest how the scientists could use the fish tissue to compare the copper ion pollution in the three rivers.

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..... **[3]**

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer for each question in the box provided.

1 Microscopes vary in their magnification and resolution.

Which of the rows, **A** to **D**, in the table below is correct?

	Light microscope		Transmission electron microscope		Scanning electron microscope	
	Magnification	**Resolution (nm)**	**Magnification**	**Resolution (nm)**	**Magnification**	**Resolution (nm)**
A	× 1500	200	× 10 000	0.2	× 50 000	0.2
B	× 400	100	× 500 000	10.0	× 100 000	0.2
C	× 1500	200	× 500 000	0.2	× 100 000	0.2
D	× 1500	100	× 500 000	10.0	× 100 000	10.0

Your answer ☐ **[1]**

2 Carbohydrates, such as starch, are made from monosaccharides joined together.

Which of the bonds, **A** to **D**, joins monosaccharides together?

A ester

B glycosidic

C peptide

D phosphodiester

Your answer ☐ **[1]**

3 Some inorganic ions have roles in enzyme-controlled reactions.

Which of the rows, **A** to **D**, in the table below is correct?

	Role of ion	
	Cofactor for amylase	**Prosthetic group for carbonic anhydrase**
A	Zn^{2+}	Cl^{-}
B	Zn^{+}	Cl^{-}
C	Cl^{2-}	Zn^{+}
D	Cl^{-}	Zn^{2+}

Your answer ☐ **[1]**

4 Which of the following statements, **A** to **D**, about the nature of the genetic code is **incorrect**?

A It is a degenerate code.

B It is a triplet code.

C It is overlapping.

D It is universal.

Your answer ☐ **[1]**

5 Ventilation involves various parts of the mammalian respiratory system.

Which of the following statements, **A** to **D**, describes **inhalation**?

A ribcage moves upwards and outwards; external intercostal muscles relax; diaphragm relaxes

B ribcage moves downwards and inwards; external intercostal muscles relax; diaphragm relaxes

C ribcage moves upwards and outwards; external intercostal muscles contract; diaphragm contracts

D ribcage moves downwards and inwards; external intercostal muscles contract; diaphragm contracts

Your answer ☐ **[1]**

6 Which of the following structures, **A** to **D**, are found in prokaryotes **and** in eukaryotes?

A a cell wall made of peptidoglycan

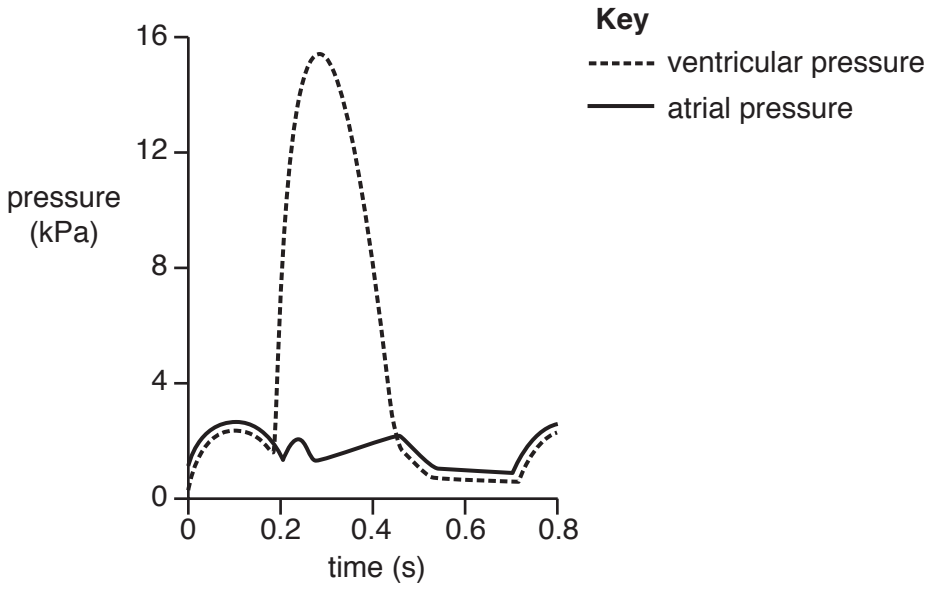
B circular genomic DNA

C a nucleus surrounded by a nuclear membrane

D ribosomes

Your answer ☐ **[1]**

7 The pressure changes in one mammalian cardiac cycle are shown in the graph below.



Which of the following time periods, **A** to **D**, shows ventricular systole?

A 0.0 to 0.1 s

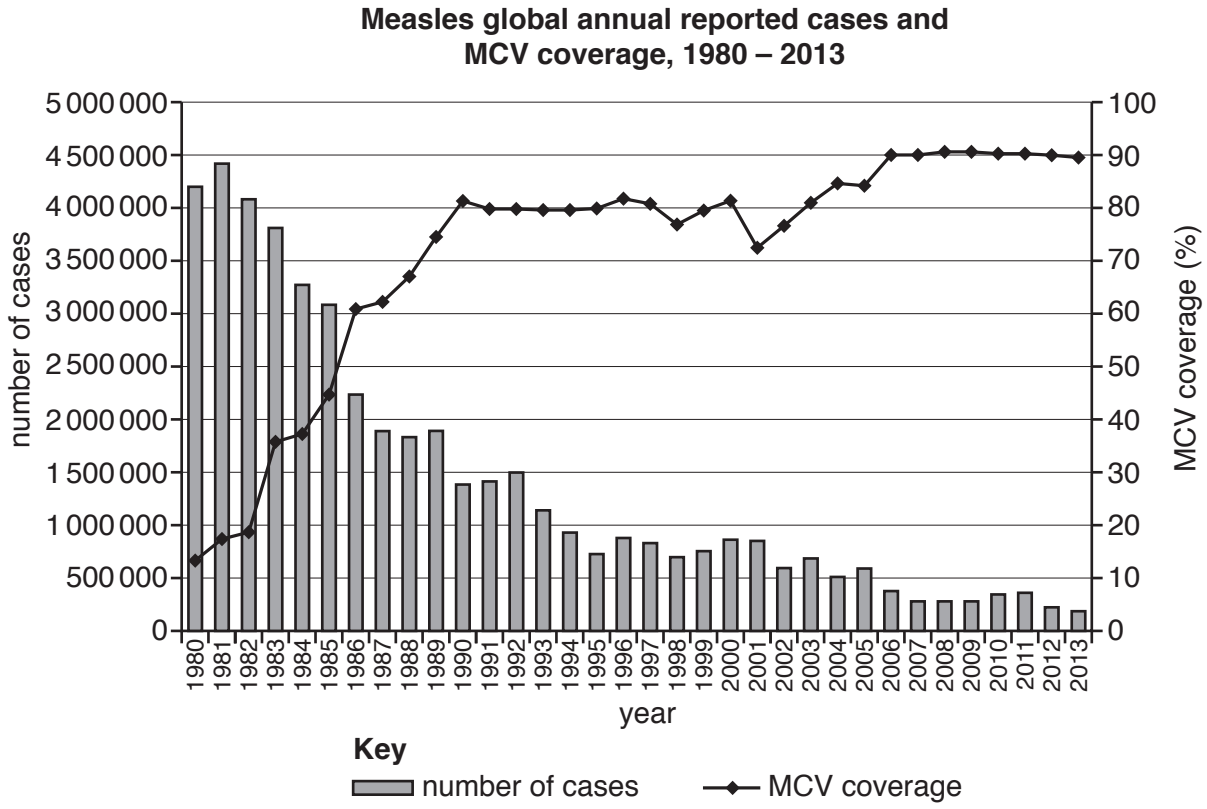
B 0.2 to 0.3 s

C 0.4 to 0.5 s

D 0.6 to 0.8 s

Your answer ☐ **[1]**

8 Measles is a serious disease that can be prevented by vaccination. The chart below shows the Measles-containing Vaccine (MCV) coverage and annual reported cases of measles between 1980 and 2013.



Which of the following statements, **A** to **D**, is a correct interpretation of the chart?

A An increase in herd immunity resulted in fewer deaths from measles.

B The highest number of measles cases occurred when MCV coverage was at its lowest.

C A 90% MCV coverage resulted in fewer than half a million cases of measles each year.

D There is a positive correlation between the number of measles cases and the MCV coverage.

Your answer ☐ **[1]**

9 Two different fields, field **G** and **H**, were sampled for three common species of wildflower. The results are shown below.

	Number of individuals	
Species	**Field G**	**Field H**
Daisy	300	20
Dandelion	335	49
Buttercup	365	931
Total	1000	1000

Which of the options, **A** to **D**, is correct?

A Field **G** will have a greater Simpson's diversity index.

B Field **H** has greater species evenness.

C Field **H** will have a greater Simpson's diversity index.

D Field **G** has greater species richness.

Your answer ☐ **[1]**

10 Which of the following options, **A** to **D**, lists the three domains of life?

A Archaea, Bacteria and Eukaryota

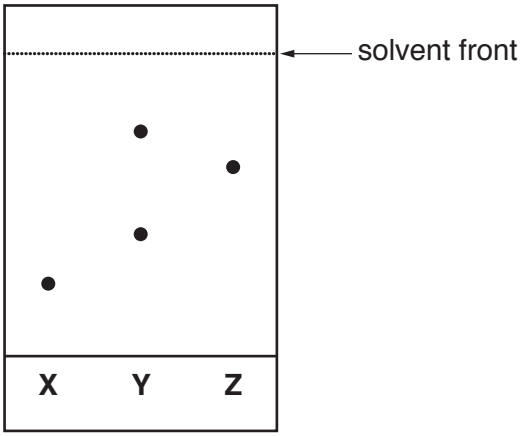
B Bacteria, Prokaryota and Eukaryota

C Prokaryotae, Protoctista and Eukaryota

D Protoctista, Plantaea and Animalia

Your answer ☐ **[1]**

11 A student investigates some solutions, **X**, **Y** and **Z**, using paper chromatography. The results are shown below.



Which of the following options, **A** to **D**, is the Rf value of **Z**?

A 0.63

B 1.6

C 0.85

D 0.25

Your answer ☐ **[1]**

12 Pressure varies in different parts of the mammalian circulatory system.

	Blood in aorta	Tissue fluid	Lymph	Blood in vena cava
Pressure				

Which of the following options, **A** to **D**, correctly completes the table above?

A high high low low

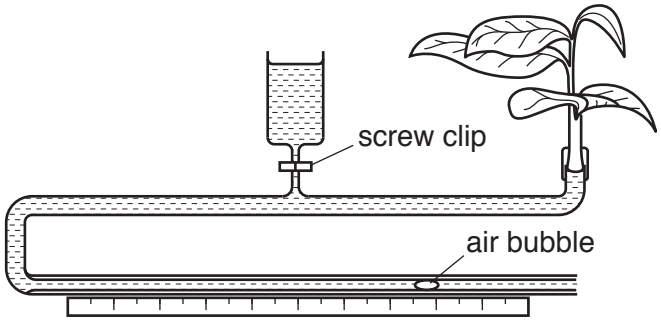
B high low high low

C high low low low

D high low low high

Your answer ☐ **[1]**

13 A diagram of a potometer is shown below.



Which of the following options, **A** to **D**, is a precaution that is **not** needed when setting up a potometer?

A Remove excess water from the surface of the leaves before readings are taken.

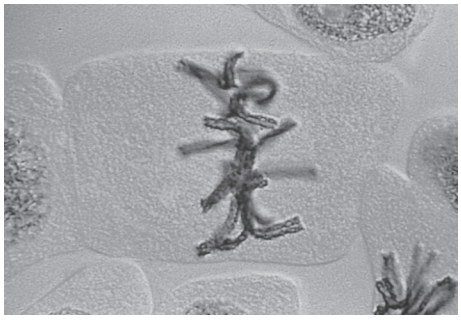
B The screw clip must be opened while taking the readings.

C The shoot should be cut whilst under water.

D There should be no extra air bubbles.

Your answer ☐ **[1]**

14 The image shows a stage in mitosis.



Which of the following options, **A** to **D**, is the stage of mitosis shown above?

A anaphase

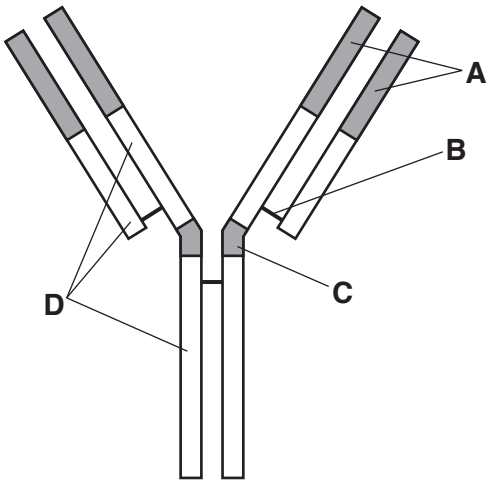
B metaphase

C prophase

D telophase

Your answer ☐ **[1]**

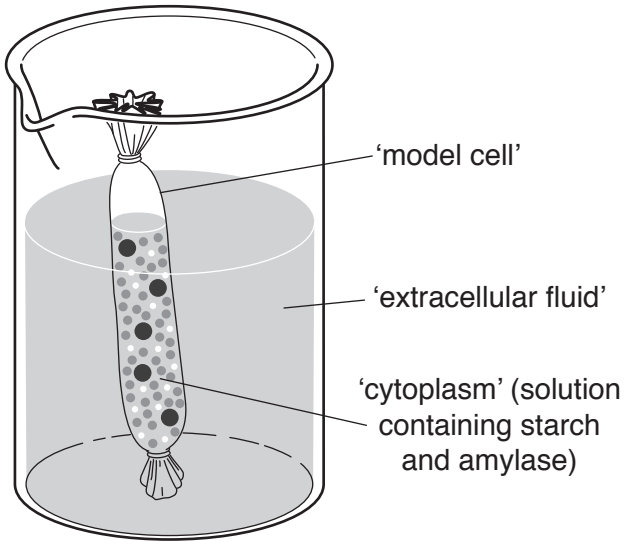
15 The diagram below shows the simplified structure of an antibody.



Which of the letters, **A** to **D** identifies the region of the antibody that allows the distance between the antibody binding sites to vary.

Your answer ☐ **[1]**

16 A group of students were investigating the diffusion of molecules across membranes using a 'model cell', as shown below.



Biochemical tests were used to identify the types of molecules present. The results are shown in the table below.

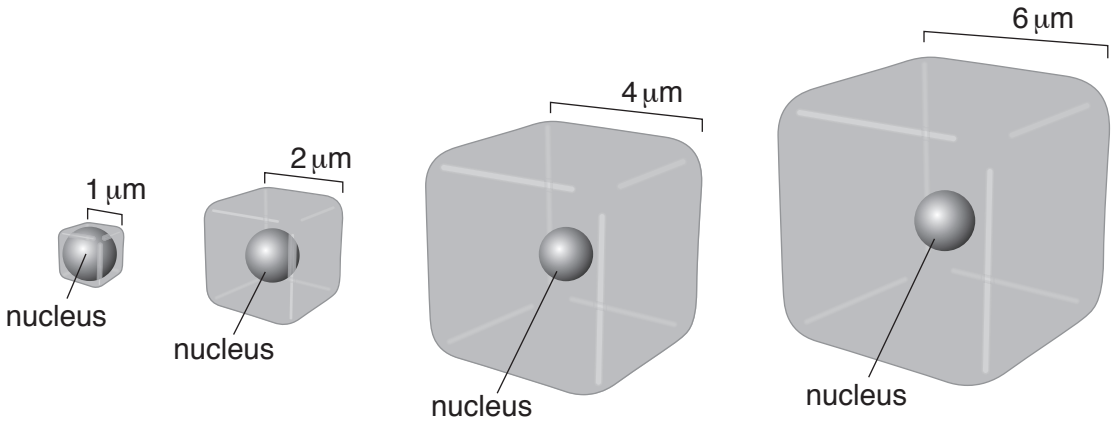
A tick (✓) represents a positive result.

Which of the rows, **A** to **D**, shows the correct results for the 'cytoplasm' at the beginning of the experiment **and** the 'extracellular fluid' at the end of the experiment?

	Benedict's test		**Biuret test**		**Iodine test**	
	'cytoplasm'	'extracellular fluid'	'cytoplasm'	'extracellular fluid'	'cytoplasm'	'extracellular fluid'
A		✓	✓		✓	
B		✓	✓	✓	✓	
C	✓	✓			✓	✓
D	✓		✓		✓	

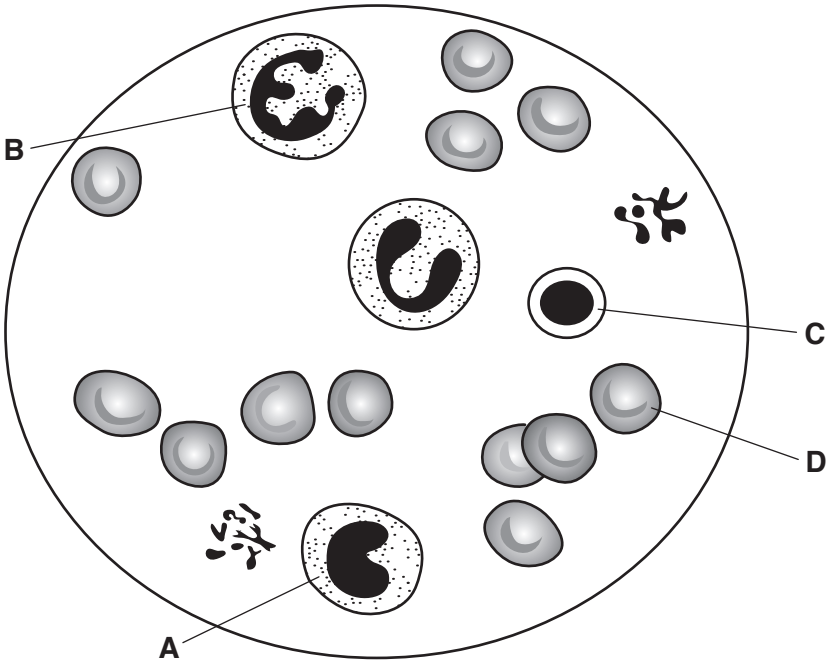
Your answer [ ] **[1]**

17 Which of the cells below, represented by cubes **A** to **D**, has a surface area to volume ratio of 3 : 1 ?



Your answer ☐ **[1]**

18 A diagram of a stained blood smear observed under a light microscope is shown below.



Which of the structures labelled **A** to **D** in the diagram is a neutrophil?

Your answer ☐ **[1]**

19 Which of the following options, **A** to **D**, is a primary defence mechanism against pathogens?

A neutralisation

B agglutination

C phagocytosis

D blood clotting

Your answer ☐ **[1]**

20 Pathogens cause disease and are transmitted from individual to individual in a variety of ways.

Which of the rows, **A** to **D**, in the table below is correct?

	Disease	**Type of pathogen**	**Means of transmission**
A	Athlete's foot	Fungus	Direct and indirect contact
B	HIV/AIDs	Virus	Indirect contact
C	Malaria	Bacterium	Vector
D	Tuberculosis	Protoctist	Direct contact

Your answer ☐ **[1]**

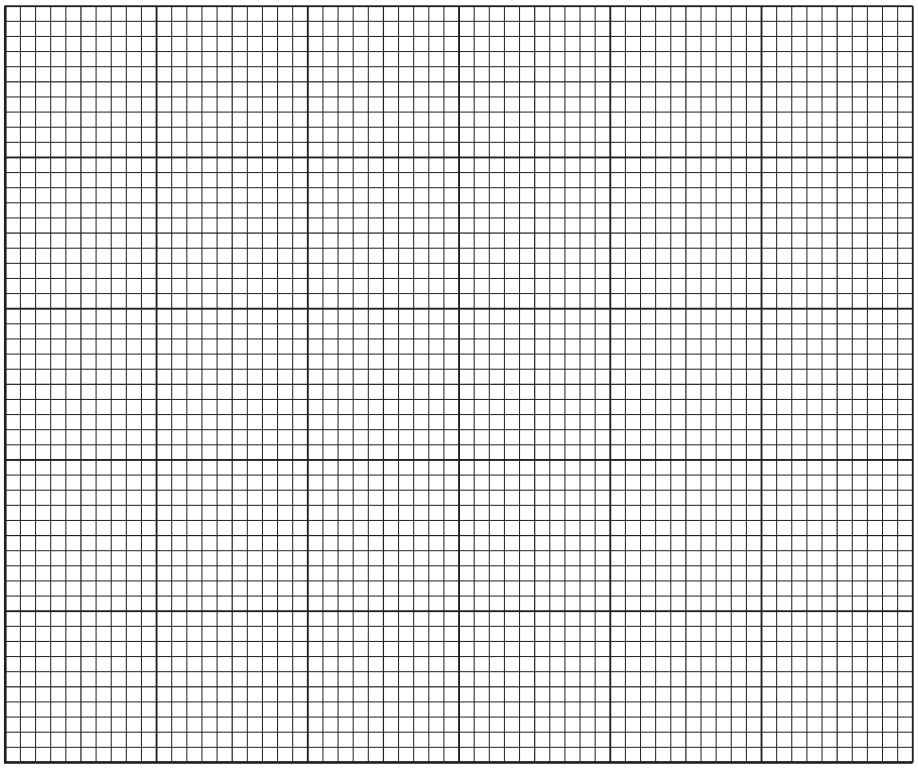
6 A group of students decided to investigate the glucose content of three types of fruit juice. They carried out the Benedict's test on known concentrations of glucose solutions and used these to calibrate a colorimeter.

The results of their calibration are shown in Table 6.

glucose concentration (mmol dm^{-3})	% absorbance			
	Trial 1	Trial 2	Trial 3	Mean
1.0	67	68	65	67
2.0	54	52	55	54
3.0	47	46	48	47
4.0	41	41	40	41
5.0	27	25	25	26
6.0	16	16	17	16

Table 6

(a) (i) Plot a graph of the mean % absorbance at each glucose concentration.



[3]

(ii) The students were provided with three different fruit juices labelled A, B and C. The Benedict's test was carried out on each fruit juice and samples were prepared for the colorimeter.

Explain how the students would use the calibration curve to estimate the glucose concentration of the fruit juices.

.....

.....

.....

..... **[2]**

(b) The students wrote the following hypothesis:

'The higher the concentration of glucose in the fruit juice, the sweeter it will be.'

(i) Describe how you would carry out a controlled experiment to test this hypothesis **without** using a colorimeter.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(ii) Suggest one reason why the results for this experiment might **not** support the students' hypothesis.

.....

.....

..... **[1]**

(c) Glucose and cholesterol are both molecules transported in the bloodstream that may need monitoring in people with different medical conditions.

Fig. 6 represents the structure of a cholesterol molecule.

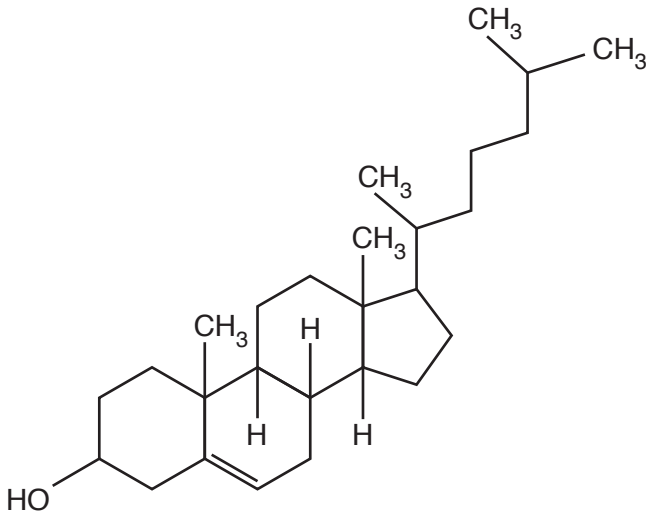


Fig. 6

(i) State **two** ways in which the molecular structure of cholesterol is similar to the molecular structure of glucose.

.....

.....

.....

..... **[2]**

(ii) Glucose is an important biological molecule required by cells for cellular respiration.

State the physical property of glucose that allows it to be easily transported in the bloodstream.

.....

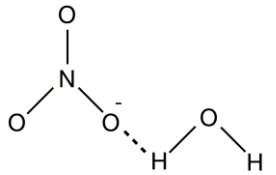
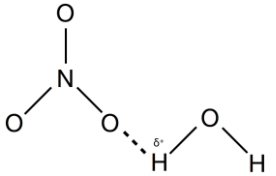
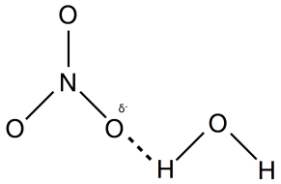
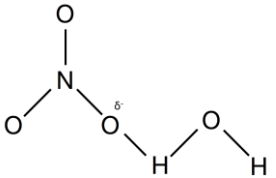
..... **[1]**

END OF QUESTION PAPER

Question			Answer	Marks	Guidance
18	(a)		the factor that will , determine / limit / AW , the rate ✓ when at , low(er) / sub-optimal / AW , level ✓	2	**Both marks can be gained from a correctly described example** e.g. when CO_2 (concentration) is in short supply, it prevents the rate of photosynthesis increasing **DO NOT ALLOW** inhibits / reduces **ALLOW** prevents rate from increasing / slows down rate of increase / stops rate from increasing / causes rate to plateau **ALLOW** when in short (est) supply
18	(b)	(i)	increased volume of water added (to seedlings) , leads to lower survival (of seedlings) ✓ larger decrease in survival for added water , above / from , 30 (cm^3) ✓ volume of water has no effect on number (of seedlings) surviving up to the first 3 days / AW ✓ quote data points / calculation(s) used , to support any point ✓	3 max	**ALLOW** the more water the faster they die **ALLOW** ora e.g. less / little , decrease in survival for 30(cm^3) and below **DO NOT ALLOW** at 30cm^3 minimum one pair of readings quoted for two water volumes (no units needed)

18	(b)	(ii) *	Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • **The science content determines the level.** • **The communication statement determines the mark within a level.** **Level 3 (5–6 marks)** A detailed scientific statement about aerobic respiration **AND a** detailed scientific statement about anaerobic respiration **AND** more than one scientific consequence for the plant of overwatering	6	**Indicative scientific points may include…** **Aerobic respiration (A)** *Statement* **(S)** *The scientific statement can be implied by giving good scientific detail* • (No oxygen so) no aerobic respiration occurs *Further detail* **(D)** • No , link reaction / Kreb's cycle / ETC / oxidative phosphorylation • No oxygen to act as the final , electron / hydrogen acceptor **Anaerobic respiration (An)**

			There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Level 2 (3–4 marks)** A detailed scientific statement about either aerobic or anaerobic respiration **AND** a scientific consequence for the plant of overwatering *There is a line of reasoning presented with some structure. The information presented in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** A statement about either aerobic or anaerobic respiration **AND** a scientific consequence for the plant of overwatering *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant and correct.* **0 marks** No response or no response worthy of credit.		*Statement* **(S)** *The scientific statement can be implied by giving good scientific detail* • (Plant has to) switch to anaerobic respiration / only anaerobic respiration can occur *Further detail* **(D)** • Only glycolysis occurs • Alcoholic fermentation occurs • NAD regenerated (for glycolysis) • Pyruvate to ethanal to ethanol • Named enzyme e.g. pyruvate decarboxylase • (Only) 2 ATP **Scientific consequences for the plant (C)** • ethanol is toxic • (alcoholic fermentation) is irreversible • Less ATP produced / only 2 ATP from glycolysis • Less / no , active transport • (root hair cells) cannot take up mineral ions (by active transport) • so (plant) cannot make , proteins / amino acids / DNA / chlorophyll etc • cannot generate water potential gradient (into roots) / water potential (in root hair cells) is too high • water cannot be absorbed (so cells cannot remain turgid) • less / no , photosynthesis

Question			Answer	Marks	Guidance
18	(c)	(i)	water is (a) polar (molecule) ✓ nitrate (ion) / NO_3^- , is , charged / negative ✓ (hydrogen bonds form) between H on water and O on nitrate ✓	2 max	*Read answer first; if two marks from written response, **IGNORE** diagram. If two marks not awarded refer to diagram to find additional mark(s).* **DO NOT ALLOW** water is charged **ALLOW** water has slightly positive / δ^+ , H **IGNORE** 'δ^- O' if describing water **IGNORE** 'δ^- O' if describing nitrate or on diagram **DO NOT ALLOW** nitrate is polar **IGNORE** solid line for H bond on diagram **NOTE** 'delta plus of water is attracted to negative charge of nitrate' = 2 marks (MP1 and 2) **NOTE** the following examples  = 2 marks (MP 2 & 3)  = 2 marks (MP 1 & 3)  = 1 mark (MP3)  = 0 mark

Question			Answer	Marks	Guidance
18	(c)	(ii)	solutes / ions / named ion , enter , against concentration gradient / by active transport ✓ reduces water potential of (endodermal) cell(s) ✓ water , moves / diffuses , by osmosis / down water potential gradient ✓	2 max	**ALLOW** Ψ for water potential throughout **DO NOT ALLOW** ref to concentration of water in mps 2 or 3 **ALLOW** 'pumped' as AW for active transport **ALLOW** water potential of cell(s) becomes more negative **ALLOW** from high to low water potential
18	(d)		*organ is* collection / AW , of tissues ✓ perform / carry out / adapted to , function / role ✓ *leaves have* **two** from: epidermis / spongy mesophyll / palisade mesophyll / vascular / phloem / xylem , (tissues) ✓ (to carry out) photosynthesis / gaseous exchange ✓	4	**IGNORE** cells throughout **ALLOW** working together **IGNORE** mesophyll (unqualified) **IGNORE** stomata
			Total	19	

Question			Answer	Mark	Guidance
21	(a)		Telmatobius ✓	1	must be written with a capital T note: the spelling must be correct **DO NOT ALLOW** if species name included
	(b)		(good) solvent ✓ high specific heat (capacity) / temperature stability OR described ✓ (high) density (so frog floats / buoyant) ✓ ice is less dense than water ✓	2 max	**ALLOW** it has <u>oxygen</u> dissolved in it **IGNORE** 'high heat capacity', 'no temperature change', **IGNORE** 'specific latent heat'
	(c)	(i)	large / increase the, surface area / SA:Vol ratio ✓ *idea of*: increase (the rate of) oxygen absorption / described ✓ oxygen levels in the lake are low ✓	2 max	**ALLOW** 'for oxygen absorption' if mp1 given e.g. of description: 'for (more) oxygen to diffuse in (through skin)'

Question			Answer	Mark	Guidance
		(ii)		2 max	Mark first **D** response or **E** response only For two marks the **E** mark must be linked to the **D** mark
			D large surface area ✓		**IGNORE** increase surface area, ref to SA:Vol ratio
			E for (maximum) diffusion ✓		**ALLOW** idea of more or faster diffusion
			D squamous, epithelium / cells OR alveolar wall, only 1 cell thick / thin ✓ **E** (providing) a short diffusion distance ✓		
			D good, blood supply / ventilation ✓ **E** maintaining / creating a (steep) concentration gradient ✓		
	(d)	(i)	repeat (readings) ✓	2 max	
			calculate mean ✓		this could be mean distance/size of colourless area, or mean time if cube allowed to go completely colourless
			identifying anomalies ✓		
			use statistical test to identify difference ✓		**ALLOW** calculate standard deviation

Question			Answer	Mark	Guidance
		(ii)	cube A = 0.6 (: 1) ✓ cube B = 1.5 (: 1) ✓	2	**ALLOW** 1 mark for 600 : 1000 **and** 96 : 64 6 : 10 **and** 3 : 2 3 : 5 **and** 3 : 2 (as correct ratios but not expressed correctly) Allow these ratios if written anywhere in the answer space. **DO NOT ALLOW** if units given

		(iii)	large(r) organism has small(er) SA : Vol ratio ✓
			
			(rate of) diffusion (too) slow /
			diffusion distance (too) long ✓
			
			for (sufficient), delivery / uptake of, oxygen / nutrients
			OR
			for (sufficient) removal of (named) waste products ✓
			
			for, (aerobic) respiration / metabolic demands ✓
				3 max	**ALLOW ORA** for first three mark points

Question	Answer	Mark	Guidance
1(a)(i)	**Both must be correct for mark** **U** = amino / amine (group) **and** **V** = carboxyl / carboxylic acid (group) ✓	1	**Additional incorrect answer on either line = 0 marks** **DO NOT ALLOW** imino / amide for **U** **ALLOW** carboxil / spelling that looks and sounds same **DO NOT ALLOW** carbonic / carbonyl for **V**
1(a)(ii)	**Both must be correct for mark** peptide / amide (bond) **and** condensation (reaction) ✓	1	**Additional incorrect answer on either line = 0 marks** **IGNORE** covalent **DO NOT ALLOW** dipeptide **DO NOT ALLOW** hydrolysis
1(b)(i)	**1** gene / DNA**,** copied / transcribed**,** to (m)RNA ✓ **2** (*idea that* RNA goes to / translation is at) ribosome(s) / RER ✓ **3** DNA**,** is too large to / cannot / is not able to**,** leave nucleus / cross nuclear envelope / fit through nuclear pores ✓	2 max	**Read all and mark as prose** **ALLOW** used as a template to create / AW, for 'copied to' **ALLOW** RNA, copies / takes a copy of, gene / DNA **DO NOT ALLOW** replicated for 'copied' **ALLOW ORA** 'RNA, is small enough to / can / is able to' or just 'RNA leaves nucleus' **ALLOW** nuclear membrane for 'nuclear envelope' **DO NOT ALLOW** leave the cell for 'leave nucleus'
1(b)(ii)	90 252 **or** 90 255 **or** 90 258 ✓✓	2	**Correct final answer gets 2 marks**, even if no working is shown. Wrong final answer (which may include a 90 252 stage in the working) = **ALLOW 1 mark for seeing any of these:** 327 x 92 x 3 **OR** 30 084 **OR** 981

Question	Answer	Mark	Guidance
1b(iii)	For answers marked by levels of response: Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, **best** describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • **The science content determines the level.** • **The communication statement determines the mark within a level.**	6 max	*Communication may be via bullet points, a table of comparisons, labelled diagrams or prose.* Indicative scientific points may include the following: FIBROUS PROTEINS Properties: • insoluble • elongated / long / rods / filaments / ropes / strands • strong / tough • flexible IGNORE size refs / compact / coiled / bond types / hard Functions: Look for the general category or for a named protein or glycoprotein example with supporting detail. Related categories and examples are paired or grouped together: • for structure • collagen in, bone / cartilage / connective tissue / tendons / ligaments / skin / blood vessels • fibrin + role described • for protection • keratin in, skin / hair / nails • to give, elasticity / elastic properties • elastin in, (named) blood vessels / alveoli / cartilage • for, contraction / mechanical movement • actin / myosin, in muscle • microtubules in, cilia / flagella / spindle / cytoskeleton

Question	Answer	Mark	Guidance
	Level 3 (5–6 marks) A detailed comparison of the properties **and** functions of fibrous **and** globular proteins. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated*. **Level 2 (3–4 marks)** A comparison of the properties **and/or** functions of fibrous **and** globular proteins. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** A limited comparison of the properties **or** functions of fibrous **and** globular proteins. *A basic structure and some relevant information is provided, although a clear line of reasoning may not be present. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.		GLOBULAR PROTEINS Properties: • soluble • spherical / ball-shaped • have, 3D / tertiary / 3o, shape / structure • specific / complementary (to another molecule) • ref. conjugated / contain prosthetic group • temperature / pH, sensitive • hydrophilic on outside IGNORE size refs, compact, round, bond types Functions: Look for the general functional category name or description, or a named protein or glycoprotein example with some supporting detail. • enzymes / metabolic role / to catalyse reaction(s) / to lower activation energy • named enzyme + its specific role described • hormones / receptors / for cell signalling • named hormone / insulin + role described • antibody / for immunity / defence against infection • opsonin / antitoxin / agglutinin + role described • fibrinogen in blood clotting • to transport substances across cell membranes • carrier / channel / pump + role described • to transport substances in blood • haemoglobin + role described e.g. carry oxygen • to, package / organise DNA

Question	Answer	Mark	Guidance
1(b)(iv)	**EITHER** **1** 9300 / 9700 ✓ **2** deaths year $^{-1}$ or deaths per year or deaths / year ✓ **OR** **3** 9.3 / 9.7 ✓ **4** thousand deaths year $^{-1}$ or thousand deaths per year or thousand deaths / year ✓	2	Correct answer to 2 s.f. **with** correct matching units = **2 marks** **ALLOW** mark for unit even if no or wrong figure given **ALLOW** minus sign with number or 'fewer' with unit **ALLOW** from AIDS / of AIDS in unit **ALLOW** mp 3 so long as the **word thousand** appears afterwards or in the units (even if the unit is wrong in another respect) **DO NOT ALLOW** '*9.3 1000 deaths per year*' for mp3 (but gets mp 4)
1(b)(v)	*(answers must relate to **data** on graph)* **1** decrease in new diagnoses, from 1992 / already / began before 1995 ✓ **2** peak / plateau, in deaths, from 1994 / already / began before 1995 ✓ **3** no change in / same, (rate of) increase in people living with AIDS, before / after, 1995 ✓	2 max	**ALLOW** when, saquinavir / drug / medicine, was introduced for '1995' in mps **1**, **2** and **3** **ALLOW** new diagnoses decrease at same time as deaths **ALLOW** from / since / after, 1993 (instead of 1992)

Question	Answer	Mark	Guidance
1(c)(i)	*(suggestion(**S**) PLUS reason (**R**) needed)* **1 S** put pencil line / origin / amino acids, higher (than the solvent / 1cm) **+** **1 R** to stop, spots / samples / amino acids, dissolving into / mixing with / touching, <u>solvent</u> ✓ **2 S** put, amino acids / spots / them, further apart / on separate plates **+** **2 R** to stop them, merging / touching / clashing / AW ✓ **3 S** touch plate edges / wear gloves / use forceps / don't touch middle, **+** **3 R** to prevent, contamination / transfer of substances from hands ✓ **4 S** place, lid / cover, over beaker **+** **4 R** to prevent evaporation (of solvent) ✓ **5 S** support the plate / attach plate to beaker **+** **5 R** to keep plate, vertical / still / at constant height ✓ **6 S** use ninhydrin **+** **6 R** to, see / visualise, amino acids ✓ **7 S** repeat and find, mean / average (Rf value) **+** **7 R** to improve, accuracy / check for repeatability / exclude anomalies ✓ **8 S** label, amino acids / spots / samples (in pencil / on beaker) **+** **8 R** to know which is which / avoid confusion ✓	4 max	**Read all and mark as prose**. **ALLOW** paper / chromatogram / gel, for 'plate' **IGNORE** measure in mm instead of cm **ALLOW** 'or otherwise x would happen' in place of the reason 'to stop x' throughout **ALLOW 1S** ORA less solvent / make solvent lower **OR** make plate / paper, higher **DO NOT ALLOW 1S** pen / permanent marker, line **ALLOW 1R** so only bottom of plate touches solvent **ALLOW 2S** put same distance apart / spread them apart **ALLOW 2R** ORA so they are, distinguishable / clear **ALLOW 3R** amino acids / oils for 'substances' **ALLOW 3R** *idea of* not damaging, stationary phase / silica gel / alumina / AW **ALLOW 4S** close beaker / line beaker with filter paper soaked in solvent **ALLOW 5S** description e.g. use clips / pencil / clamp / rod **ALLOW 5R** ORA to stop plate, tilting / trembling / moving **IGNORE 6S** UV / iodine / permanganate **ALLOW** '*no need, to stain / for ninhydrin, as spots shown up already*' (on Fig. 1.4) **= 1 mark**

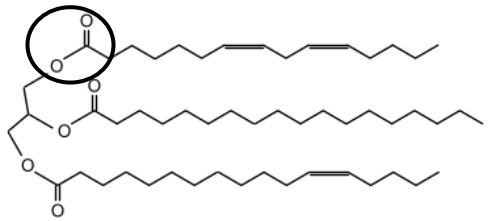
Question	Answer	Mark	Guidance
1(c)(ii)	**1** *answer must lie within this range:* 0.1(0) to 0.15 **AND** *supporting calculation must be shown, e.g:* $\frac{0.65}{4.95}$ (= 0.13) ✓ **2** glutamine ✓		**No mark** for figure in correct range unless it also shows the working out of this calculation: $\frac{\text{distance from origin to spot}}{\text{distance from origin to solvent front.}}$ **ALLOW** figures given in **mm** **ALLOW** figures with no unit shown **ALLOW** variation in measurements taken **so long as** the final answer falls within the allowed range. **ALLOW** mp2 even if no attempt is made at working stage

Question			Answer	Marks	Guidance
3	(a)	(i)	it contains , N / nitrogen **or** monosaccharide does not contain nitrogen ✓	1	**CREDIT** any correct ref to the nitrogen-containing group in Fig. 3.1 $NHCOCH_3$ **ACCEPT** 'OH is replaced with $NHCOCH_3$' **or** '$NHCOCH_3$ is replaced with OH' **ACCEPT** ref to H not being twice C / 15 H instead of 12 / 8 C instead of 6 **ACCEPT** has no OH on carbon 2 **ACCEPT** 'monosaccharide **only** contains C, H & O' **DO NOT CREDIT** 'it has a nitrogen molecule'
3	(a)	(ii)	beta / β ✓ glucose ✓	2	**IGNORE** alpha / α **DO NOT CREDIT** B / b / beta pleated sheet
3	(a)	(iii)	*four from* 1 (in chitin glycosidic bond(s) formed by) condensation ✓ 2 (molecule of) H_2O / water , produced / released ✓ 3 alternate monomers are , upside-down / flipped / rotated through 180° ✓ 4 because of the position of the , OH / H , on carbon 1 ✓ 5 forms a , straight / linear / unbranched , chain / molecule / polymer ✓ 6 similar to cellulose ✓	4	**IGNORE** ref to 1-4 linkage & glycosidic (as given in Q) **ACCEPT** shown on a diagram 3 **ACCEPT** sugars / units / residues / molecules **DO NOT CREDIT** glucose 4 Must be a clear statement **ACCEPT** the 2 OH groups cannot , line up / bond 5 **IGNORE** ref to branching **IGNORE** ref to polysaccharide 6 **ACCEPT** ref to H bonds crosslinking between , molecules / chains

Question			Answer	Marks	Guidance
3	(b)	(i)	support **or** prevents the trachea(e) from collapsing / keeps the airways open ✓	1	**IGNORE** protection / structure / shape / squashed / strength / stability
3	(b)	(ii)	*idea that* (their presence) restricts the airflow in the trachea / blocks the airways **or** (leakage of haemolymph) deprives the **,** tissues / cells **,** of **,** oxygen / O_2 / nutrients **or** use of **,** oxygen / O_2 / nutrients **,** by mites **or** disease transmission **or** (mites) release toxins ✓	1	**IGNORE** statements that simply refer to the mites feeding on the haemolymph (as given in Q) **ACCEPT** causes the trachea to collapse **IGNORE** 'affects airflow' unqualified **IGNORE** ref to 'difficult to breathe' **ACCEPT** ref to inflammatory / immune **,** response
			Total	9	

Question			Answer	Marks	Guidance
22	(a)		*glycogen is* **1** insoluble **,** so has no effect on **,** water potential / Ψ (of cell) ✓ **2** <u>metabol</u>ically inactive ✓ **3** compact / lots can be stored in a small space ✓ **4** able to store **,** large amounts / lots **,** of <u>energy</u> ✓ **5** (highly branched so) has lots of ends for **,** adding / removing **,** <u>glucose</u> (when needed) **or** can be broken down **,** fast / quickly / rapidly **,** to release <u>glucose</u> ✓	**3**	**ACCEPT** ORA for glucose for **mps 1, 2 3 & 4 only** **1 ACCEPT** insoluble so has no osmotic effect (on cell) **5 IGNORE** ref to surface area **Note:** 'compact so can store large amounts of energy' = 2 marks (mps 3 & 4)

Question			Answer	Marks	Guidance
22	(b)			3 max	***NOTE*** *answers must be the in context of* ***protein*** *transport.* *Penalise once if a different material (e.g. gene) is transported* to max 2
			1 <u>transport</u> vesicle from RER ✓		
			2 modification / processing / folding ✓		**2** **ACCEPT** example of modification e.g. converted into a glycoprotein **ACCEPT** in context of RER or Golgi
			3 in / at , Golgi (body / apparatus) ✓		**3** **IGNORE** SER / smooth endoplasmic reticulum
			4 (packaged into) <u>secretory</u> vesicle ✓		
			5 vesicles move along the cytoskeleton ✓		**5** **ACCEPT** use of motor proteins / chaperones / microtubules
			6 (vesicle) fuses with , cell <u>surface</u> / plasma , membrane ✓		**6** **ACCEPT** merges with **DO NOT ACCEPT** binds / attaches / dissolves
			7 (secretion occurs by) <u>exocytosis</u> ✓		**7** **DO NOT ACCEPT** exocytosis in context of excretion (rather than secretion) **DO NOT ACCEPT** vesicle being released by exocytosis

Question			Answer	Mark	Guidance
22	(a)		any appropriate bond circled ✓	1	 Accept more than one correct circle Circle should include both O atoms and the C between them
	(b)		glycerol ✓	1	
	(c)	(i)	energy source for respiration / respiratory substrate ✓ energy storage ✓ thermal insulation ✓ electrical insulation ✓ buoyancy ✓ *idea of:* (physical) protection ✓	3 max	**DO NOT ALLOW** energy for respiration **IGNORE** for warmth unless linked to insulation e.g protection around kidneys
		(ii)	fewer hydrogens / more double bonds / less saturated, gives lower melting point ✓ (fewer hydrogens / less saturated) more kinked, chain / molecule ✓ (molecules) less uniformly packed together (so lower temperature needed for melting) ✓	2 max	**One mark** for description (1st mark point) **One mark** for explanation. Note mp1 only awarded for clear statement of trend not for full description of data **DO NOT ALLOW** hydrogen, ions / bonds / molecules
		(d)	they / fatty acids, hydrophobic / described ✓ phospholipid bilayer (formed) ✓ fatty acids / tails, on the inside / pointing inwards ✓	2 max	**ALLOW** marks in suitably annotated diagram

Question			Answer	Marks	Guidance
4	(a)	(i)	2.8 (kPa)	1	**ALLOW** answer in the range of 2.8–3.0 kPa
		(ii)	(llama) haemoglobin needs higher affinity for oxygen (so) can pick up oxygen at lower partial pressure (of oxygen)	2	
	(b)*		**Level 3 (5–6 marks)** Describes differences and similarities of llama and camel haemoglobin at all four levels of protein structure with correct reference to bonding. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes differences and similarities of llama and camel haemoglobin in some levels of protein structure with some reference to bonding. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes a difference or similarity of llama and camel haemoglobin at a level of protein structure. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.*	6	**Indicative scientific points include:** • difference in primary structure • different amino acid / polypeptide sequence • one amino acid changed. • amino acid change could cause change to secondary structure • initial coiling or folding of polypeptide chain • α-helix • β-pleated sheet • hydrogen bonding. • amino acid change could cause change to tertiary structure • further coiling of secondary structure • ionic bonding • disulphide bonds • hydrophilic/hydrophobic bonds • 3D shape.

Question			Answer	Marks	Guidance
			0 marks No response or no response worthy of credit.		• amino acid change has not changed quaternary structure • alpha and beta subunits still able to form haemoglobin in both camel and llama.
	(c)		insoluble strong / AW unreactive / AW	**3**	**IGNORE** flexible.
	(d)		*two from* add biuret / NaOH and $CuSO_4$, solution / reagent to urine observe colour change (from blue to purple) compare with, control / blank (urine containing no protein)	**2**	**IGNORE** biuret test unqualified.
			Total	**14**	

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th>Important role</th><th>Ion</th></tr>
<tr><td>Production of nitrate ions by bacteria</td><td>NH_4^+</td></tr>
<tr><td>Loading of phloem</td><td>H^+</td></tr>
<tr><td>DNA structure</td><td>PO_4^{3-}</td></tr>
<tr><td>Cofactor for amylase</td><td>Cl^-</td></tr>
</table>
✓✓</td><td>2</td><td>Additional incorrect answer in a cell = 0 marks

Symbols must be fully correct

all three correct = 2 marks

one or two correct = 1 mark

none correct = 0 marks</td></tr>
<tr><td>4(a)(ii)</td><td>at arterial end
AND
hydrostatic / 4.6, is greater than, oncotic / –3
AND
(fluid / plasma) moves, out / from, (capillary) ✓

at venous end
AND
hydrostatic / 2.3, is lower than, oncotic / –3
AND
(tissue fluid) moves into (capillary) ✓</td><td>2</td><td>Statements must:
• name the end of the capillary
• make a comparative statement about the two pressures in the capillary (using name or number)
• state the direction of movement of fluid.

ALLOW bigger / higher / more, for ‘greater’
ALLOW ORA oncotic / –3, less than hydrostatic / 4.6

ALLOW ORA fluid moves into tissues
IGNORE osmosis

ALLOW smaller / less, for ‘lower’
ALLOW ORA oncotic / –3, more than hydrostatic / 2.3

ALLOW ORA fluid moves, out of / from, tissues
IGNORE osmosis</td></tr>
</table>

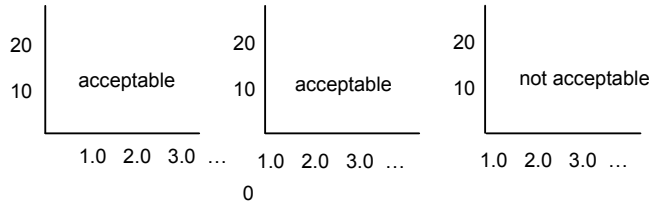
Question	Answer	Mark	Guidance
4(b)(i)	**1** inhibitor binds to, allosteric site / enzyme away from active site ✓ **2** changes, tertiary / 3D, structure of, enzyme / active site / protein **OR** active site no longer complementary to substrate **OR** substrate and, enzyme / active site, cannot, bind / fit (together) **OR** E-S compex cannot form ✓	2	**ALLOW** catalase for 'enzyme' throughout **ALLOW** hydrogen peroxide / H_20_2, for 'substrate' throughout **ALLOW** joins / fits into, for 'binds' **ALLOW** shown on diagram **ALLOW** conformation / shape for 'structure' **IGNORE** denatures
4(b)(ii)	**1** downward-sweeping curve showing negative correlation drawn ✓ ***2*** x axis label = conc(entration) of copper sulfate in moles dm^{-3} **AND** y axis label = vol(ume) of oxygen (gas produced) in cm^3 ✓	2	**DO NOT ALLOW** straight line or plotted points that are not joined. Curve may level off at end. Allow 'dot-to-dot' curve. **ALLOW** $CuSO_4$ / copper sulphate, for 'copper sulfate' **ALLOW** slash before unit / slash or 'per' in the unit / brackets round unit **ALLOW** variant symbols: M **OR** moles L^{-1} **OR** moles / L **OR** mol dm^{-3} **ALLOW** O_2 for 'oxygen'

Question	Answer	Mark	Guidance
4(b)(iii)	*(trend described)* **1** as (concentration of) copper, sulphate / ions, **increases**, (volume of) oxygen / H_2O_2 breakdown, **decreases** ✓	2 max	**ALLOW** AW for 'decrease' e.g.reduce / decline / drop / fall **ALLOW** AW for 'increase' e.g. go up / rise / climb **ALLOW** AW so long as inverse trend is still made clear by use of comparative terms such as: increases / decreases, higher / lower, more / less E.g. *'when there is more $CuSO_4$, less oxygen is produced'* **ALLOW** ORA, e.g. '*the lower the concentration of Cu^{2+} the higher the volume of oxygen produced'*
	(conclusion / inference, about activity of enzyme) **2** copper, sulphate / ions, inhibit(s) / decrease(s), <u>catalase</u> activity ✓		**IGNORE** '*disturbs the action of catalase*'
	(detail) **3** at high concentrations / 0.15 / 0.20 **EITHER** most enzymes, (irreversibly / already) damaged / inhibited **OR** adding more copper (sulphate / ions) has little effect ✓		

Question	Answer	Mark	Guidance
4(b)(iv)	**1** compare / measure / test, catalase activity / oxygen produced ✓ **2** experimental detail ✓ **3** further experimental detail ✓ **4** less, oxygen / catalase (activity), means more, copper / pollution ✓ **5** use, Table 4 / graph, to estimate copper (ion) concentration ✓	3 max	**IGNORE** how much oxygen is in each fish **IGNORE** how much catalase is in each fish *experimental detail points:* **ALLOW** AW throughout **IGNORE** amount throughout **i** prepare a , catalase / fish / tissue, extract / sample (e.g. ref. pestle and mortar / chopping / liquidiser) **ii** equal / known / controlled, volume / sized samples (of fish / tissue / extract) **iii** equal / known / controlled, concentration / volume, of hydrogen peroxide **iv** measure, volume of, oxygen / gas, in a given time **v** use gas syringe / collect gas under water **ALLOW** correct statement of relationship between copper or pollution **and** oxygen **or** amount of catalase present **or** catalase activity **even if wrong experiment is done** (e.g. adding catalase or copper sulphate to fish) or measuring 'how much oxygen is in fish'

SECTION A

Question	Answer	Marks	Guidance
	Mark the letter that is in the box. Credit a letter that is clearly the intended answer if the letter in the box is crossed out. Do not credit ambiguous letters, unless the correction is clearly thicker than the original. If there is no letter in the box, credit a very clear indication of the correct answer.		
1	C	**1**	
2	B	**1**	
3	D	**1**	
4	C	**1**	
5	C	**1**	
6	D	**1**	
7	B	**1**	
8	C	**1**	
9	A	**1**	
10	A	**1**	
11	A	**1**	
12	C	**1**	
13	B	**1**	
14	B	**1**	
15	C	**1**	
16	A	**1**	
17	B	**1**	
18	B	**1**	
19	D	**1**	
20	A	**1**	
	Total	**20**	

Question			Answer	Mark	Guidance
6	(a)	(i)	**1** appropriate scale chosen **and** x axis labelled glucose concentration (mmol dm^{-3}) **and** y axis labelled mean % absorbance ✓ **2** points plotted correctly ✓ **3** straight line of best fit drawn on graph (not extending beyond the plot points) ✓	3	**1 IGNORE** presence or absence of 0 at origin(s) unless either axis is deemed to have started above 0  **2** x axis glucose concentration (mmol dm^{-3}): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 y axis mean % absorbance: 67, 54, 47, 41, 26, 16 Centre of cross or dot within + or – half a small square one error in the plotted points **ALLOW** Points for glucose concs 1, 3, 5 & 6 mmol dm^{-3} should be in a straight line. Points for glucose concs 2, 3 & 4 mmol dm^{-3} should be in a straight line with a shallower gradient **Note:** A bar chart will only be able to access mp 2

Question			Answer	Mark	Guidance
6	(a)	(ii)	find the absorbance (of the juice using the colorimeter) ✓ (from the graph) find the concentration that corresponds to this absorbance ✓ follow the , absorbance value / value on y axis , across to , line of best fit / (calibration) curve , and then down to the , concentration / x axis ✓	2 max	**ACCEPT** vertical and horizontal for x and y

Question			Answer	Mark	Guidance
6	(b)	(i)	**1** taste the fruit juices to see how sweet they are ✓ **2** place a sample of each fruit juice in a biosensor **and** take the reading **or** test each fruit juice with **,** Benedict's / diastix / clinistix / (diagnostic) test strip **and** observe colour(s) ✓ **3** obtain rank order for **,** sweetness / fruit juice glucose concentration ✓ **4** compare rank orders (of fruit juices) for sweetness and glucose concentration ✓ **5** how a variable was controlled during **,** taste / glucose concentration **,** test ✓	**4 max**	**1** could be in the context of different juices **or** a series of dilutions of the same juice (to give different glucose concentrations) **or** a series of glucose concentrations **2 ACCEPT** semi-quantitative test for reducing sugar Benedict's tests on each fruit juice **and** weigh mass of precipitate formed for each juice perform **ACCEPT** plausible way of determining glucose concentration e.g. relative density / specific gravity / mass change as a result of osmosis Benedict's – blue to red with increasing concentration diastix – green/blue to red clinistix – green/blue to red **or** pink to (dark) purple **4 ACCEPT** the use of a statistical test if rank orders for both are numerical **5** e.g. use same **,** number of drops / volumes **,** of fruit juice cleanse palate between juices blind taste test / stated way to avoid bias tasted by a number of subjects (and results pooled) keep test strip in sample for same length of time add excess Benedict's heat for same length of time / at the same temperature (Benedict's only) filter precipitate in same way (semi-quantitative Benedict's only)

Question			Answer	Mark	Guidance
6	(b)	(ii)	tasting is , subjective / (only) qualitative / not quantitative **or** hard to quantify sweetness **or** people may have different , judgement / opinion / taste buds ✓ colour judgement (in Benedict's) is subjective ✓ (juice) may contain , sucrose / fructose / other (named) sugar / (artificial) sweetener ✓	1 max	**IGNORE** accuracy / reliability **ACCEPT** ref to biased opinion **ACCEPT** sensible ref to acidity in juice masking sweetness **IGNORE** ref to 'other ingredients' unqualified
6	(c)	(i)	*both* contain , C / carbon (atoms) **and** H / hydrogen (atoms) ✓ contain , O / oxygen (atoms) ✓ have , OH / hydroxyl / hydroxide (groups) ✓	2	**Mark the first 2 answers** **IGNORE** properties e.g. solubility **IGNORE** ref to hexagons / rings **IGNORE** hydrocarbon **DO NOT ACCEPT** hexose **DO NOT ACCEPT** ions **DO NOT ACCEPT** molecules / groups **DO NOT ACCEPT** molecules / groups **ACCEPT** alcohol group **DO NOT ACCEPT** molecules
6	(c)	(ii)	(glucose is) soluble (in water) ✓	1	**ACCEPT** polar / dissolves (in water)
			Total	70	