OCR
Oxford Cambridge and RSA

Monday 11 October 2021 – Morning

A Level Biology A

H420/01 Biological processes

Time allowed: 2 hours 15 minutes

You must have:
- the Insert (inside this document)

You can use:
- a ruler (cm/mm)
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **36** pages.

ADVICE
- Read each question carefully before you start your answer.

SECTION A

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

Answer **all** the questions.

1 Which of the options is **not** a function of the liver?

A production of urea in the ornithine cycle

B removal of amino groups from amino acids

C storage of excess amino acids as protein

D storage of glucose as glycogen

Your answer ☐ **[1]**

2 Which of the statements about the control of blood glucose is correct?

A Pancreas cells increase their release of glucagon when blood glucose concentration rises above a set level.

B Glucagon stimulates the conversion of glycogen to glucose by liver cells.

C Insulin increases blood glucose concentration by stimulating glycogenesis and gluconeogenesis.

D The interaction of insulin and glucagon keeps the blood glucose concentration constant.

Your answer ☐ **[1]**

3 Which of the options describes the path taken by proteins, such as digestive enzymes, that are exported from a cell?

A Golgi apparatus ⟶ rough endoplasmic reticulum ⟶ secretory vesicle

B ribosome ⟶ smooth endoplasmic reticulum ⟶ Golgi apparatus

C rough endoplasmic reticulum ⟶ Golgi apparatus ⟶ secretory vesicle

D smooth endoplasmic reticulum ⟶ ribosome ⟶ Golgi apparatus

Your answer ☐ **[1]**

4 Which of the statements about enzyme catalysed reactions is true?

A Binding of a substrate to the active site can weaken bonds in the substrate.

B Enzymes allow reactions to happen at a rate faster than the V_{max}.

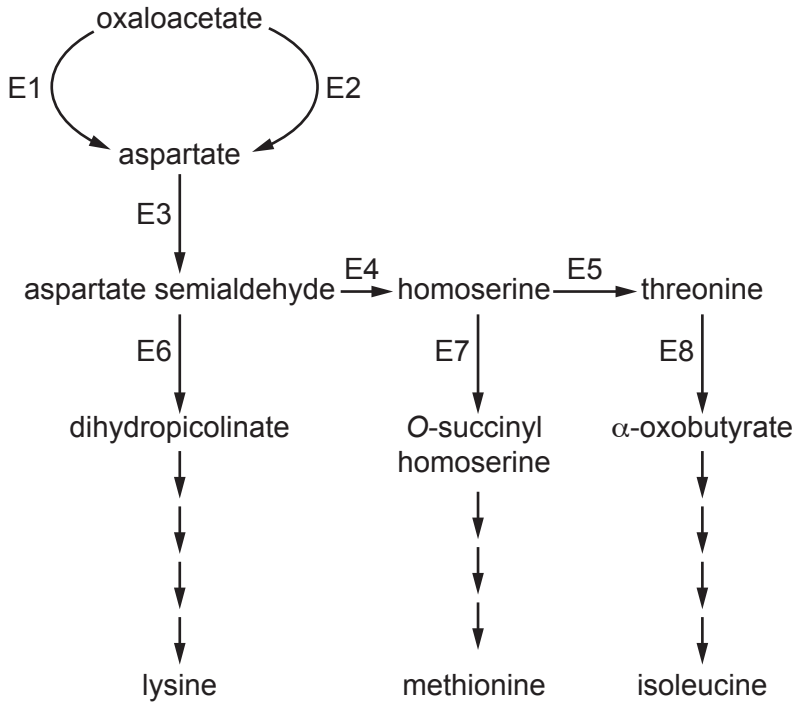
C Enzymes increase the rate of reactions by increasing the activation energy.

D Every 10 °C increase in temperature will approximately double the rate of all enzyme controlled reactions.

Your answer ☐ **[1]**

5 The figure shows the metabolic pathways leading to synthesis of five amino acids: aspartate, lysine, methionine, threonine and isoleucine.

E1 to E8 represent different enzymes involved in these pathways.



Which of the options is an example of end-product inhibition?

A aspartate inhibits E3 and E4

B isoleucine inhibits E7

C lysine inhibits E1 and E6

D methionine inhibits E8

Your answer ☐ **[1]**

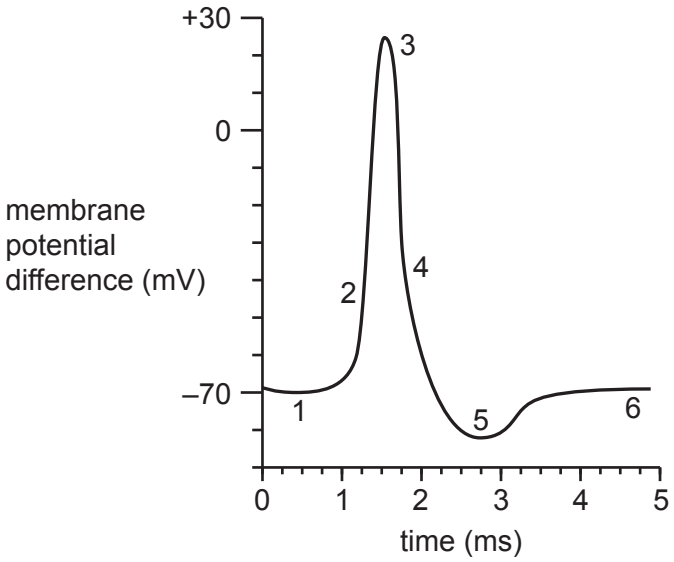
6 The table describes adaptations of three types of specialised cell.

	Erythrocytes	Neutrophils	Palisade cells
A	biconcave shape with flattened nucleus to allow them to squeeze through narrow capillaries	a large, spherical nucleus and cytoplasm that contains many lysosomes	thick cell walls to maintain turgor
B	biconcave shape with no nucleus and flexible to allow them to squeeze through narrow capillaries	a multi-lobed nucleus that makes it easier to squeeze through small gaps	thin cell walls allowing rapid diffusion of carbon dioxide
C	biconcave shape with no nucleus and flexible to allow them to squeeze through narrow capillaries	a large, spherical nucleus and cytoplasm that contains many lysosomes	thick cell walls maintain turgor
D	biconcave shape with flattened nucleus to allow them to squeeze through narrow capillaries	a multi-lobed nucleus that makes it easier to squeeze through small gaps	thin cell walls allowing rapid diffusion of carbon dioxide

Which of the rows, **A** to **D**, is a correct description of the three cells?

Your answer ☐ **[1]**

The graph represents the potential difference across the membrane of an axon during an action potential.



Use the graph to answer questions **7** and **8**.

7 Which row in the table correctly describes the events occurring during the action potential?

	Position on graph	Na^+/K^+-pump is operating	Voltage-gated Na^+ channels are open	Voltage-gated K^+ channels are open
A	1	yes	no	yes
B	2	yes	yes	no
C	3	no	no	yes
D	4	no	yes	no

Your answer ☐ **[1]**

8 Which of the statements about the graph is correct?

A Depolarisation is occurring at 4 and hyperpolarisation is occurring at 6.

B Depolarisation is occurring at 2 and hyperpolarisation is occurring at 5.

C Hyperpolarisation is occurring at 5 and repolarisation is occurring at 6.

D Repolarisation is occurring at 4 and hyperpolarisation is occurring at 6.

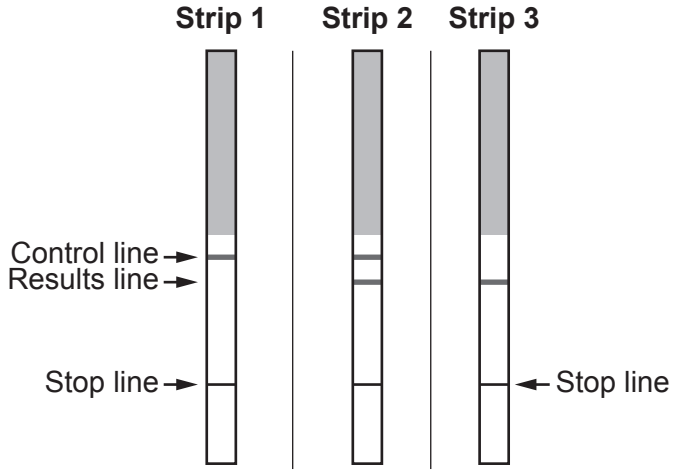
Your answer ☐ **[1]**

9 The figure shows the results of three pregnancy tests using test strips with mobile and fixed (immobilised) monoclonal antibodies that bind to human chorionic gonadotrophin (hCG).

The mobile monoclonal antibodies are labelled with coloured beads.

The Results line and the Control line contain the fixed monoclonal antibodies.

Each strip is dipped in a sample of urine up to the stop line. They are then laid flat for 10 minutes and read.



Which of the statements about these pregnancy tests is true?

A In Strip 1 hCG has bound to mobile antibodies that have been captured by fixed antibodies on the Control line. The pregnancy test is positive.

B In Strip 2 hCG has bound to the mobile antibodies and these have been captured by fixed antibodies on the Results line. The pregnancy test is positive.

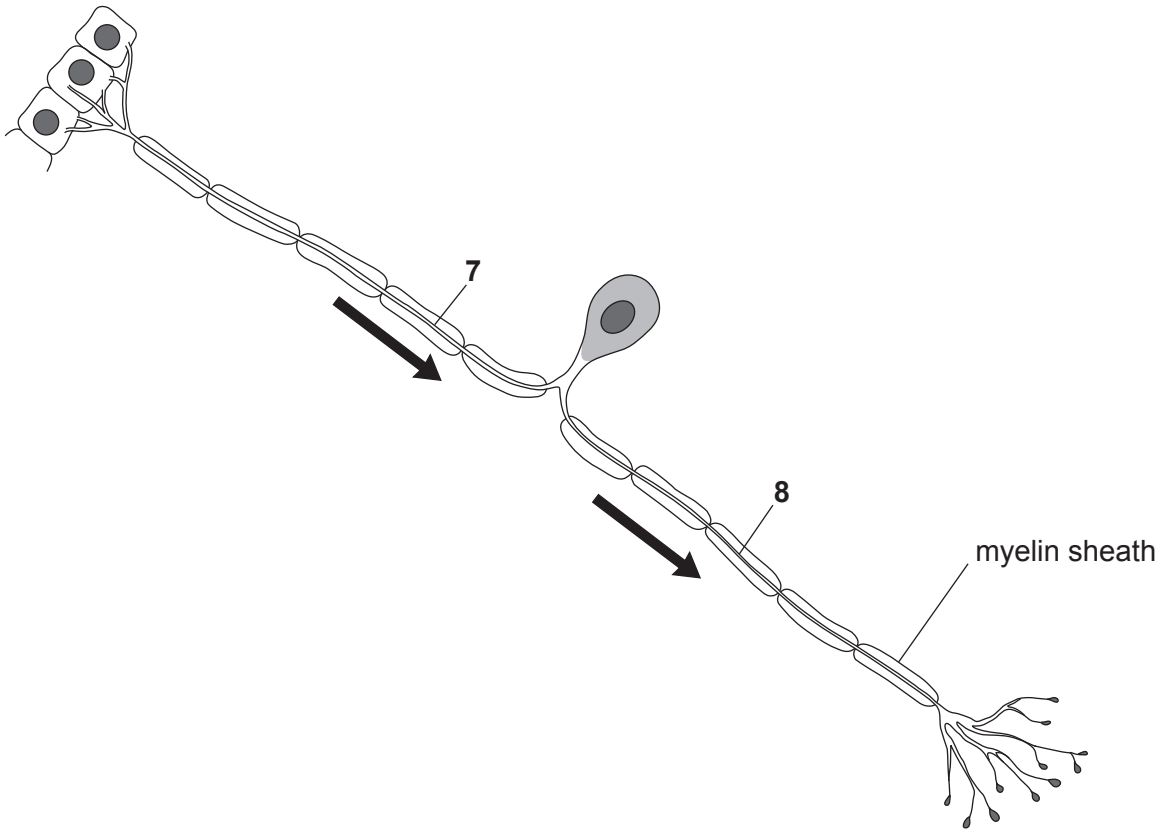
C In Strip 3 hCG has bound to the mobile antibodies and these have been captured by fixed antibodies on the Results line. The pregnancy test is negative.

D In Strip 3 hCG has bound to the mobile antibodies and these have been captured by fixed antibodies on the Results line. The pregnancy test is positive.

Your answer ☐ **[1]**

10 Below is a diagram of a neurone.

The arrows show the direction of the nerve impulse.



Which row in the table correctly identifies structures **7** and **8** and the type of neurone shown in the diagram?

	Structure 7	**Structure 8**	**Type of neurone**
A	axon	dendron	sensory
B	axon	dendron	motor
C	dendron	axon	sensory
D	dendron	axon	motor

Your answer ☐ **[1]**

11 Which of the following statements about nervous transmission is **not** correct?

A Breakdown of the myelin sheath can lead to uncoordinated movement.

B Saltatory conduction increases the rate of propagation of a nerve impulse.

C The myelin sheath is formed from Schwann cells.

D The nodes of Ranvier act as electrical insulators.

Your answer ☐ **[1]**

12 Which of the following statements is/are correct?

1 The autonomic nervous system contains sensory and motor neurones.
2 Somatic and parasympathetic motor neurones use different neurotransmitters.
3 Somatic motor neurones stimulate skeletal muscles whereas autonomic motor neurons stimulate only glands.

A 1, 2 and 3 are correct

B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐ **[1]**

13 NAD, FAD and Coenzyme A (CoA) are molecules that are involved in cellular respiration.

Which of the following statements about these molecules is/are correct?

1 NAD and FAD are examples of coenzymes.
2 NAD is reduced by accepting hydrogen atoms.
3 CoA delivers the three carbon atoms of pyruvate to the Krebs cycle in the form of an acetyl group.

A 1, 2 and 3 are correct

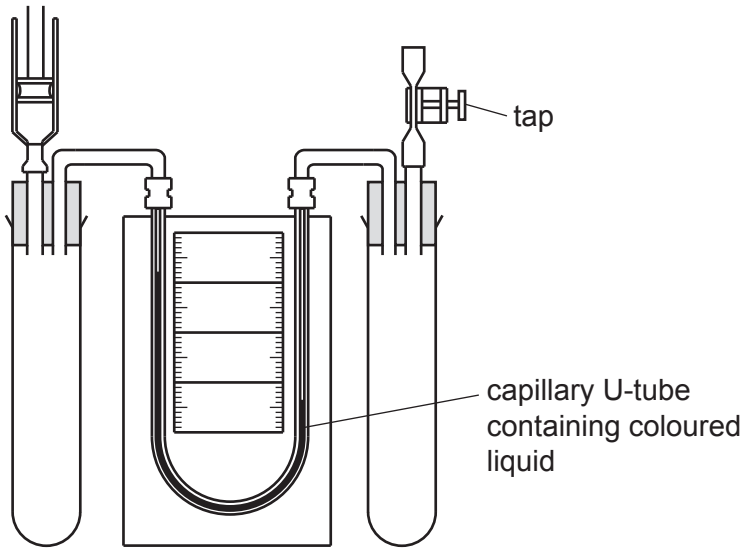
B only 1 and 2 are correct

C only 2 and 3 are correct

D only 1 is correct

Your answer ☐ **[1]**

14 A respirometer, shown below, can be used to investigate respiration.



A student placed 5 cm^3 of potassium hydroxide solution in the left-hand tube of the respirometer. The student suspended a basket above the liquid and placed 10 g of respiring seeds in the basket.

Which of the following statements about this investigation is **not** correct?

A The level of the liquid in the left-hand arm of the capillary tube would decrease (move downwards) with time.

B The potassium hydroxide solution absorbs carbon dioxide.

C The rate of movement of the liquid in the capillary tube is a measure of the rate of respiration.

D The tap can be opened to equalise the pressure in each tube.

Your answer ☐ **[1]**

15 Water is transported across the root of a plant by more than one pathway.

Which of the following statements about water molecules moving via the symplast pathway is **not** correct?

A Water molecules can move from cell to cell without crossing a membrane.

B Water molecules can pass through the Casparian strip.

C Water molecules must pass through the endodermis.

D Water molecules travel between cells down a water potential gradient.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 **Fig. 16.1** shows a drawing of a dissected human heart.

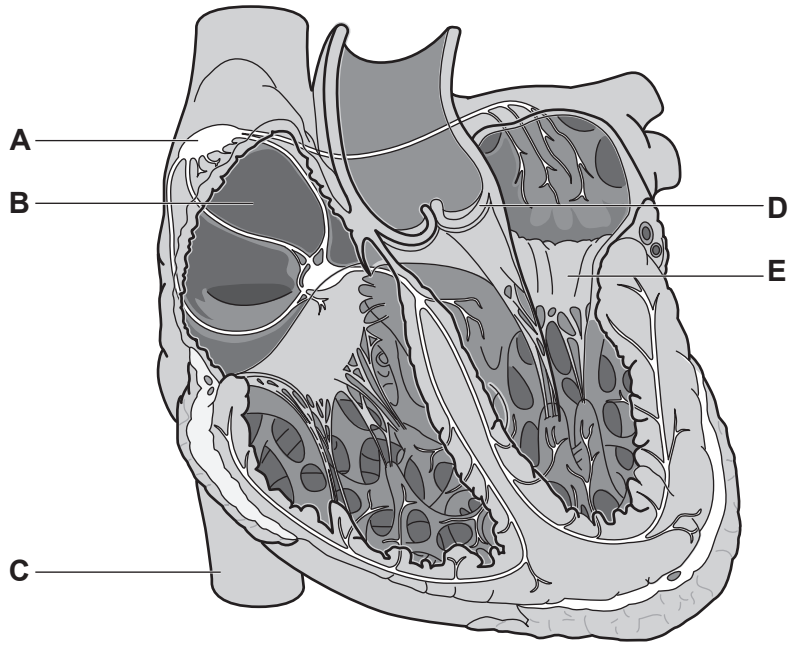

Fig. 16.1

(a) **(i)** Identify the structures labelled **A** to **E** on **Fig. 16.1**.

A .....

B .....

C .....

D .....

E .....

[5]

(ii) State which subdivision of the peripheral nervous system supplies structure **A** on **Fig. 16.1**.

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

(b) **Fig. 16.2** is a diagram of a section through the human brain.

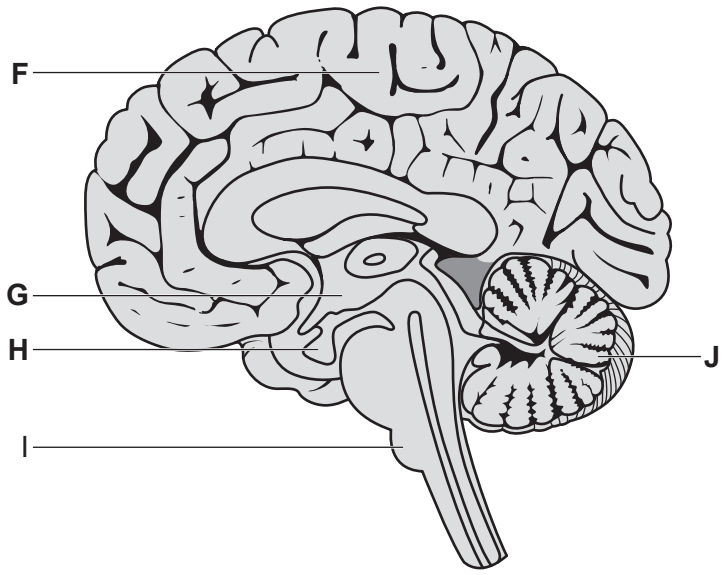

Fig. 16.2

(i) Identify the letter and name of the structure in **Fig. 16.2** that is connected by nerves to structure **A** in **Fig. 16.1**.

Letter .....

Name .....

[2]

(ii) Normal human resting heart rate is approximately 70 beats per minute (bpm). Cutting the parasympathetic nerve to the heart increases this to approximately 100 bpm.

Suggest **two** conclusions that could be made from this observation about the control of resting heart rate in normal humans.

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2 .....

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[2]

(iii) Injury to the parts of the brain labelled **G** and **H** in **Fig. 16.2** can lead to a range of symptoms including:

- fatigue
- weight gain
- menstrual irregularities
- low blood pressure or dizziness
- increased sensitivity to cold.

Outline how injury to **G** and **H** is able to cause such a wide range of symptoms.

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

(iv) Suggest why it can be difficult for a doctor to conclude that the symptoms described in part **(iii)** are definitely caused by damage to parts of the brain.

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

(c) Complete the following passage using the most appropriate terms.

The knee-jerk reflex is an example of a spinal reflex as it only goes through the ..... whereas the blinking reflex is a cranial reflex as the pathway goes through the brain.

Reflexes are very fast as they only involve one or two ..... , which are the slowest parts of nerve transmission. This is one reason why reflexes give a survival advantage.

[2]

17 The pancreas produces digestive enzymes and is also involved in the regulation of blood glucose concentration.

(a) **Fig. 17**, **in the insert**, shows a light micrograph of a section of mouse pancreas.

Identify the structures labelled **K** and **L** in **Fig. 17**.

K .....

L .....

[2]

(b) Scientists investigated the effect of the drug nifedipine on the secretion of insulin from pancreas cells in culture.

Pancreas cells were first incubated with glucose at a concentration of $3\,mmol\,dm^{-3}$. The concentration of glucose was then increased to $20\,mmol\,dm^{-3}$ in the presence or absence of nifedipine.

The scientists then measured the amount of insulin secreted by the cells. They recorded their results as a percentage of the total insulin content of the cells. Each experiment was repeated seven times.

The results are shown in the table.

Condition	Mean insulin secreted (%)
Without nifedipine	7.8 ± 0.78
With nifedipine	0.8 ± 0.15

(i) Name the cells that secrete insulin.

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

(ii) Explain why it was necessary to increase the concentration of glucose surrounding the cells before they measured insulin secretion.

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

(iii) Suggest and explain which statistical test the researchers would have used to analyse their data.

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

(iv) The statistical test gave a value of $p < 0.001$. Use the words 'chance' and 'probability' to draw a conclusion from the result of the statistical test.

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

(v) Nifedipine blocks Ca^{2+}-channels.

Explain how blocking calcium channels could inhibit insulin secretion.

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

(c)* Type 1 diabetes has been treatable for many years, but treatments are always improving.

Evaluate the treatments for type 1 diabetes that have been used in the past as well as current and potential future treatments.

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

Additional answer space if required.

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18 The liver is an organ with a wide variety of functions.

(a) **Fig. 18.1**, **in the insert**, shows a light micrograph of a section of normal human liver.

(i) Identify the structures labelled **N** and **O** in **Fig. 18.1**.

N .....

O .....

[2]

(ii) The walls of the structure labelled **M** in **Fig. 18.1** are lined with cells.

Suggest and explain how these cells are adapted to carry out their function.

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

(b) Liver is a rich source of the enzyme catalase.

The table below describes examples of three terms from the list below.

coenzyme **competitive inhibition** **enzyme-product complex**

induced-fit **lock and key** **non-competitive inhibition**

prosthetic group **secondary structure** **tertiary structure**

Complete the table by choosing a term from the list that matches each example.

Example	Term
The haem molecule bound to each polypeptide chain of catalase.	
Binding of the hydrogen peroxide substrate to catalase causes a change in the shape of the active site of catalase.	
Cyanide ions decrease the action of catalase even at high concentrations of hydrogen peroxide.	

[3]

(c) **Fig. 18.2** shows the effect of concentration of hydrogen peroxide on the rate of reaction of catalase.

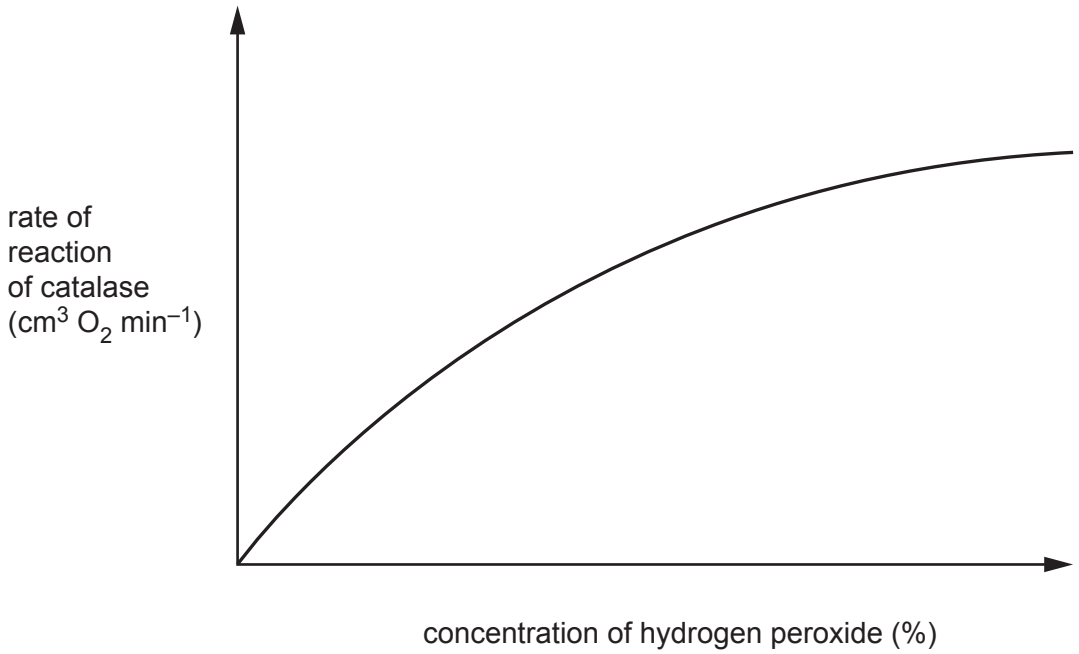

Fig. 18.2

Cyanide ions inhibit catalase, even at high concentrations of hydrogen peroxide.

Sketch a line on **Fig. 18.2** to show the effect of repeating the experiment in the presence of cyanide ions.

[Answer on Fig. 18.2] **[1]**

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19 (a) The Hill reaction is a model system used to study the light-dependent stage of photosynthesis. It uses a blue dye, DCPIP, which is colourless when reduced.

A student was provided with the following method:

- Cut three small spinach leaves into small pieces and place in a mortar containing 20 cm^3 of 0.5 mol dm^{-3} sucrose solution.
- Homogenise by grinding vigorously.
- Filter the mixture and pour the filtrate into a centrifuge tube.
- Centrifuge at high speed for 5 minutes.
- Gently pour the supernatant (liquid part) into a clean tube labelled A.
- Resuspend the pellet (sediment) in 20 cm^3 of pH 7.0 buffer.
- Add 5 cm^3 of resuspended pellet to each of tubes labelled B – D.
- Boil tube B for 5 minutes and then cool.
- Add 10 cm^3 DCPIP solution to each of tubes A – E.
- Transfer tube C to a dark cupboard.
- Observe colour of the tubes after 5 minutes.

The table shows the results of the experiment.

	Tube A	**Tube B**	**Tube C**	**Tube D**	**Tube E**
Contents	supernatant	resuspended pellet	resuspended pellet	resuspended pellet	distilled water
Boiled for 5 minutes	no	yes	no	no	no
DCPIP	yes	yes	yes	yes	yes
Illumination	light	light	dark	light	light
Colour after 5 minutes	blue	blue	blue	colourless	blue

(i) State the name of the final electron acceptor in the light-dependent stage of photosynthesis.

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

(ii) DCPIP is reduced in the Hill reaction.

Suggest and explain the function of DCPIP in the Hill reaction.

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

(iii) Using the results shown in the table, explain what can be concluded from each tube, or pair of tubes, about the light-dependent stage of photosynthesis.

Tube A .....

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Tube B .....

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Tubes C & D .....

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Tube E .....

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

(iv) The student knew that it was important to use sucrose solution when homogenising the leaves.

Explain why it was important that the pellet was suspended in buffer solution **and** why it did not contain sucrose.

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

(v) Suggest and explain **two** improvements that would increase the validity of the method.

Improvement 1 .....

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Explanation .....

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Improvement 2 .....

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Explanation .....

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[4]

(b) Terrariums are popular for growing houseplants.

A terrarium is a glass container containing soil and small plants.

Once established, a terrarium can be sealed and the plants will be able to grow for months or even years despite not being in contact with the outside atmosphere.

The terrarium maintains moist conditions for the plants.

(i) Suggest **one** other reason why the plants in a sealed terrarium continue to grow.

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

(ii) Cacti are popular house plants.

Suggest why cacti do **not** grow well in a terrarium.

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

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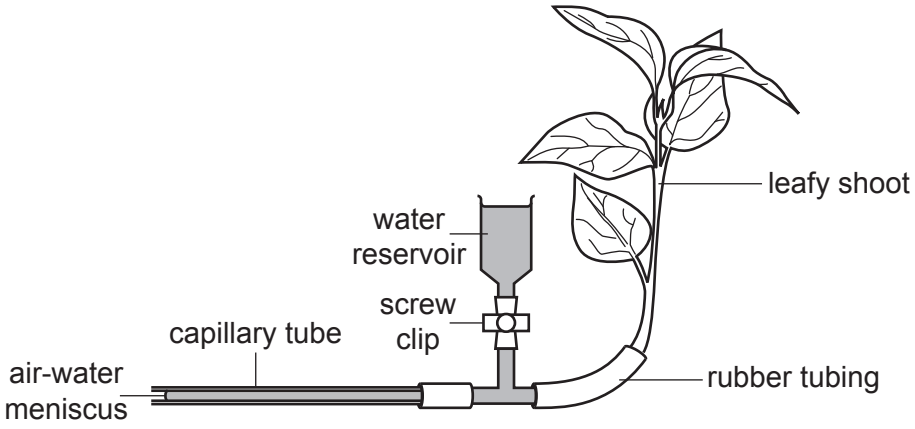
20 The figure shows a potometer used to measure the rate of transpiration in a leafy shoot.



(a) Besides safety precautions, explain **one** practical precaution that should be taken when using a potometer.

Precaution .....

Explanation .....

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[2]

(b) A student carried out an investigation to measure the effect of air movement on the rate of transpiration.

The student used the apparatus shown in the figure, adding an electric fan to create air movement. They measured the distance travelled by the air-water meniscus in 5 minutes.

This was replicated five times with the fan switched off and then five times with the fan switched on.

The results are shown in the table.

Replicate number	**Distance travelled by meniscus in 5 minutes (mm)**	
	fan switched off	**fan switched on**
1	87	128
2	89	124
3	91	125
4	98	123
5	99	128
Mean	92.8	125.6
Standard deviation	5.40	

(i) Calculate the standard deviation for the distance travelled when the fan was switched on.

Use the formula: $s = \sqrt{\dfrac{\Sigma(x - \overline{x})^2}{n - 1}}$

Give your answer to **2** significant figures.

Standard deviation = ... **[2]**

(ii) What can you conclude from comparing the standard deviations of the two means?

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

(c) The student carried out another investigation.

(i) The student wanted to estimate the total leaf surface area of the shoot.

At the end of the investigation they removed all the leaves from the shoot.

They placed the leaves on graph paper and then counted squares to obtain an estimate of leaf area.

State **two** things the student would have to do to ensure that the estimate of leaf area was accurate.

1 .....

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2 .....

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[2]

(ii) In this investigation, the student calculated the rate of transpiration to be $30\,mm^3\,min^{-1}$.

They estimated the total leaf surface area of the shoot to be $37\,cm^2$.

Calculate the rate of transpiration in $cm^3\,hr^{-1}\,cm^{-2}$.

Give your answer in standard form to **2** significant figures.

Rate = ... $cm^3\,hr^{-1}\,cm^{-2}$ **[2]**

(d) Plant growth requires the production of new xylem cells.

Describe how new xylem cells are produced.

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

(e)* Explain how glucose produced in photosynthesis is translocated to parts of the plant where glucose is metabolised or stored.

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Additional answer space if required.

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21 The formation of tissue fluid is an example of ultrafiltration. Osmosis plays an important part in ultrafiltration.

(a) The water potential of the blood depends on the concentration of solutes such as glucose, amino acids and mineral ions as well as large plasma proteins.

(i) State the effect on the water potential of the blood if the concentration of glucose increases.

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

(ii) Explain why the oncotic pressure of the blood depends **only** on the concentration of large plasma proteins.

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

(b) The table below compares a capillary with the surrounding tissue fluid.

Property	Capillary	Tissue fluid
Oncotic pressure	4.2 kPa	0.03 kPa
Hydrostatic pressure	4.5 kPa	0.15 kPa
Concentration of the protein albumin	0.04 g cm^{-3}	0.02 g cm^{-3}

Net movement of fluid between the capillary and tissue fluid depends on the net driving force (J_v):

$J_v = (P_c - P_i) - \sigma (\pi_c - \pi_i)$

Where:

P_c = capillary hydrostatic pressure

P_i = tissue fluid hydrostatic pressure

π_c = capillary oncotic pressure

π_i = tissue fluid oncotic pressure

σ = reflectance factor

The reflectance factor is a measure of how permeable the capillary is to albumin. It varies between 0 (totally permeable) and 1 (totally impermeable).

Inflammation can reduce the value of the reflectance factor.

(i) In one type of capillary the reflectance factor was found to be 0.75.

Use this information and the data in the table to calculate a value for the net driving force and predict the direction of movement.

Net driving force, J_v = ... kPa

Direction of movement .....

[2]

(ii) Nephrotic syndrome is a kidney disease where protein is excreted in the urine.

One group of patients with nephrotic syndrome had a plasma albumin concentration of $0.015\,g\,dm^{-3}$.

Explain what effect this would have on the net driving force. (There is no need to perform a further calculation.)

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

(iii) A medical student concluded that a patient with kidney disease and a plasma albumin concentration of $0.015\,g\,dm^{-3}$ would show signs of swelling, such as swollen ankles.

Evaluate the student's conclusion.

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

(c) The table below contains statements about the composition of lymph and tissue fluid.

Place ticks (✓) in the boxes in the table to indicate whether the statements are true or false.

Statement	True	False
Lymph is similar in composition to tissue fluid but has more oxygen.		
Tissue fluid does not contain lymphocytes because they are too large to pass through the capillary wall.		
Lymph contains more protein than tissue fluid because of antibody production by plasma cells.		

[2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).