OCR
Oxford Cambridge and RSA

Wednesday 5 June 2024 – Afternoon

A Level Biology A

H420/01 Biological processes

Time allowed: 2 hours 15 minutes

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

H420/01

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.

1 Which statement about lipids is correct?

A Lipids are polar molecules.

B Lipids that contain fatty acids with carbon–carbon double bonds are liquid at room temperature.

C Saturated fatty acids, which are present in some lipids, contain carbon–carbon double bonds.

D The presence of carbon–carbon double bonds in fatty acids allows lipids to pack more closely together.

Your answer ☐ **[1]**

2 Lipids, polysaccharides, nucleic acids and proteins are all macromolecules.

Which statement about macromolecules is correct?

A All macromolecules are formed in hydrolysis reactions.

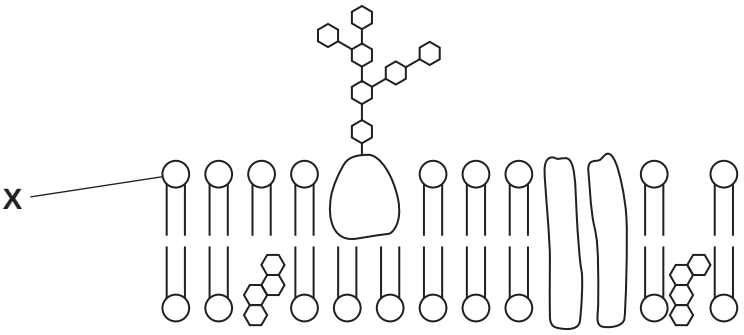
B Lipids are not polymers, but polysaccharides, nucleic acids and proteins are polymers.

C Lipids are polymers of fatty acids and glycerol.

D Macromolecules all consist of repeating units of monomers.

Your answer ☐ **[1]**

3 The diagram shows part of a plasma membrane.



How can molecule **X** be described?

A It has a hydrophilic head and a hydrophobic tail.

B It is formed when the glycerol in a triglyceride is replaced by a phosphate.

C It is non-polar.

D The tails are joined to the head by peptide bonds.

Your answer ☐ **[1]**

4 Which statement describes a feature of plasma membranes?

A Channel proteins are a type of intrinsic protein.

B Glycolipids are intrinsic proteins that have lipid molecules attached.

C Phospholipids form a rigid bilayer that membrane proteins are attached to.

D The plasma membrane forms an impermeable barrier.

Your answer ☐ **[1]**

5 The adrenaline receptor is one of a class of receptors known as GPCRs. The glucagon receptor on liver cells is another type of GPCR.

Glucagon stimulates conversion of glycogen to glucose in liver cells.

What is the action of glucagon?

A Cyclic AMP catalyses the conversion of glycogen to glucose.

B Glucagon is a second messenger.

C The glucagon receptor is located in the cytoplasm of liver cells.

D When glucagon binds to its receptor it stimulates the conversion of ATP to cyclic AMP.

Your answer ☐ **[1]**

6 Lymph and tissue fluid are both formed from the blood.

Which statement describes the composition of these fluids?

A Lymph contains more protein than tissue fluid because of antibody production.

B Lymph is similar in composition to tissue fluid but has more oxygen and nutrients.

C Tissue fluid does not contain hormones such as insulin and glucagon.

D Tissue fluid contains red blood cells and platelets.

Your answer ☐ **[1]**

7 Which statement describes features of the mammalian heart?

A Branches of the pulmonary artery supply blood to the heart muscle.

B Semi-lunar valves prevent backflow of blood from the ventricles to the atria.

C The left ventricle pumps deoxygenated blood to the lungs.

D The wall of the left ventricle is thicker because it needs to pump blood around the whole body.

Your answer ☐ **[1]**

8 Bumblebees are large insects that have a high demand for oxygen during flight.

What adaptation enables bumblebees to obtain sufficient oxygen during flight?

A Accumulation of lactate in muscles during flight increases the amount of tracheal fluid which increases the surface area for gas exchange.

B Muscle contraction before or during flight increases ventilation of the tracheal system.

C Spiracles take air directly to the respiring tissues.

D Tracheoles can open and close to allow gas exchange and minimise water loss.

Your answer ☐ **[1]**

9 Which option is **not** an adaptation that helps fish increase the efficiency of gas exchange?

A Blood capillaries lie close to the surface of the lamellae to minimise the diffusion distance.

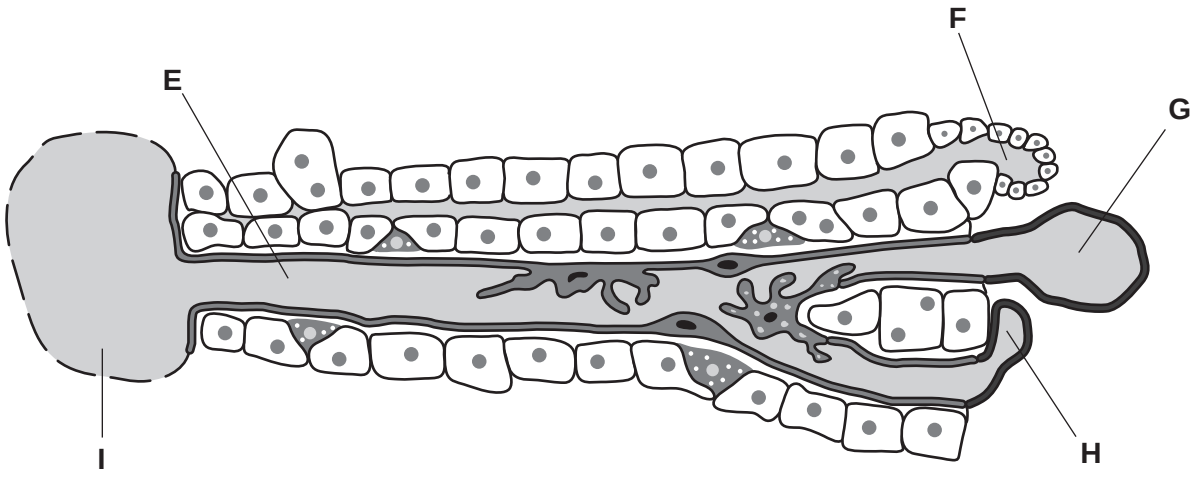
B Blood flows in the capillaries in the same direction as the flow of water over the lamellae to maximise gas exchange.

C Gill filaments have many lamellae that increase the surface area for gas exchange.

D Raising and lowering of the floor of the buccal cavity helps maintain a flow of water over the gills.

Your answer ☐ **[1]**

10 The diagram shows part of a liver lobule.



Which statement about liver function is correct?

A Blood flows from **I** towards **G**.

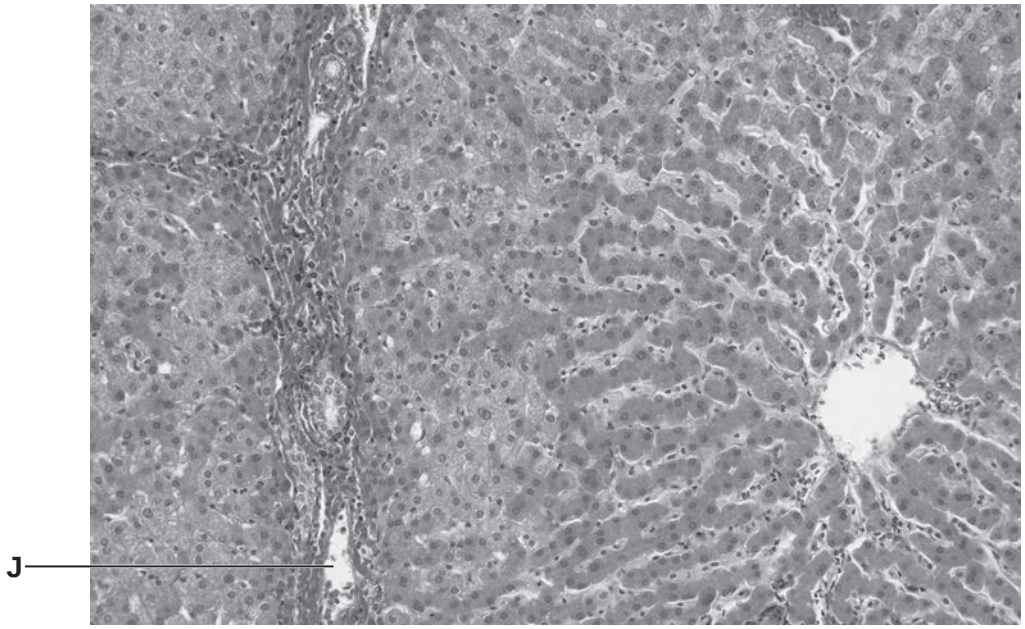
B **H** carries blood arriving from the digestive system.

C Hepatocytes produce urea that flows into **F**.

D Toxic substances enter liver cells from the blood at **E**.

Your answer ☐ **[1]**

11 The photomicrograph shows a stained section of liver tissue.



What is the structure labelled **J**?

A Hepatic artery

B Hepatic portal vein

C Hepatic vein

D Sinusoid

Your answer ☐ **[1]**

12 Which statement describes urea production in the liver?

A Amino acids enter the ornithine cycle.

B Ammonia and carbon dioxide combine to make urea in the Krebs cycle.

C Ammonia is produced by the deamination of amino acids.

D The ornithine cycle makes urea less harmful.

Your answer ☐ **[1]**

13 Which of the statements about the effect of light intensity on the concentrations of GP, RuBP and TP is/are correct?

1 At low light intensity, less GP is converted into TP because there is less product of the light dependent stage available.
2 At high light intensity, RuBP concentration is high because it is regenerated from TP.
3 At high light intensity, RuBP accumulates because it cannot be converted to GP.

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 Which of the statements about factors affecting the rate of photosynthesis is/are correct?

1 Lack of water is not usually a limiting factor, although it does cause closure of stomata which reduces carbon dioxide levels.
2 Carbon dioxide concentrations can be low inside greenhouses; therefore, growers will often enrich the atmosphere with carbon dioxide.
3 Between zero and 25 °C the rate of photosynthesis doubles for every 10 °C rise in temperature.

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]**

15 Which option about the relative energy values of different foods is **not** correct?

A Carbohydrates have lower energy values because they have a higher oxygen content.

B Food that has a mixture of carbohydrate, lipid and protein, e.g. chocolate, has a higher energy value than the same mass of sugar.

C Lipids have energy values lower than proteins because they have a low ratio of hydrogen and carbon atoms to oxygen atoms.

D Proteins and carbohydrates have similar energy values.

Your answer ☐ **[1]**

Section B

16

(a) The table lists some biological molecules.

Complete the table by putting a tick (✓) in the appropriate box or boxes on each line to show whether the corresponding feature is present.

The first line has been completed for you.

Biological molecule	Is a monomer	Is a polymer	Contains glycosidic bond(s)
Amino acid	✓		
Amylopectin			
Glucose			
Sucrose			

[3]

(b) Describe the bond between the two glucose monomers in maltose.

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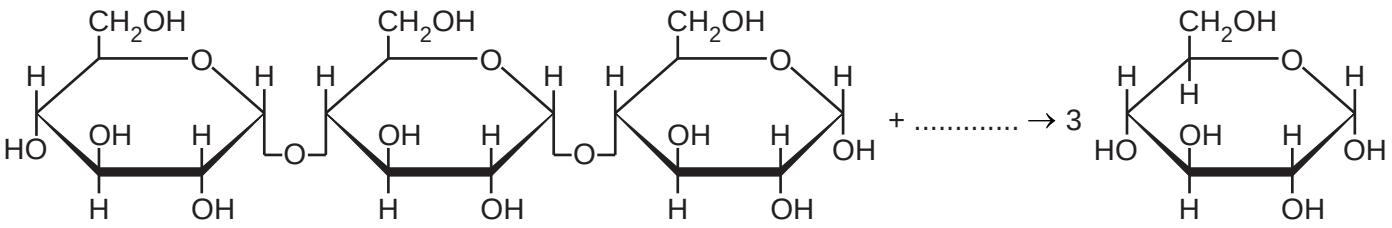
..... **[2]**

(c) Maltotriose is a trisaccharide formed during the breakdown of starch by amylase. It can be broken down further to produce glucose.

(i) Complete the equation for the conversion of maltotriose to glucose.



[2]

(ii) The enzyme maltase converts maltose to glucose during the final stages of starch digestion in the small intestine.

Suggest why maltotriose can also be converted to glucose by maltase.

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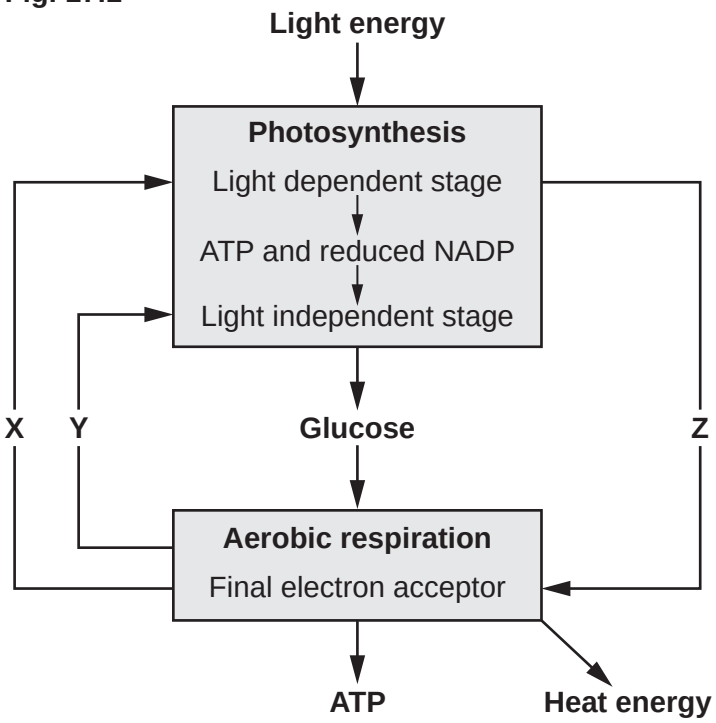
17

(a) **Fig. 17.1** shows the relationship between photosynthesis and aerobic respiration.

Fig. 17.1



(i) Identify the molecules labelled **X**, **Y** and **Z** in **Fig. 17.1**.

X .....

Y .....

Z .....

[2]

(ii) Use the information in **Fig. 17.1** to explain how plants are able to survive in a sealed glass container, such as a terrarium or bottle garden, for many months or even years.

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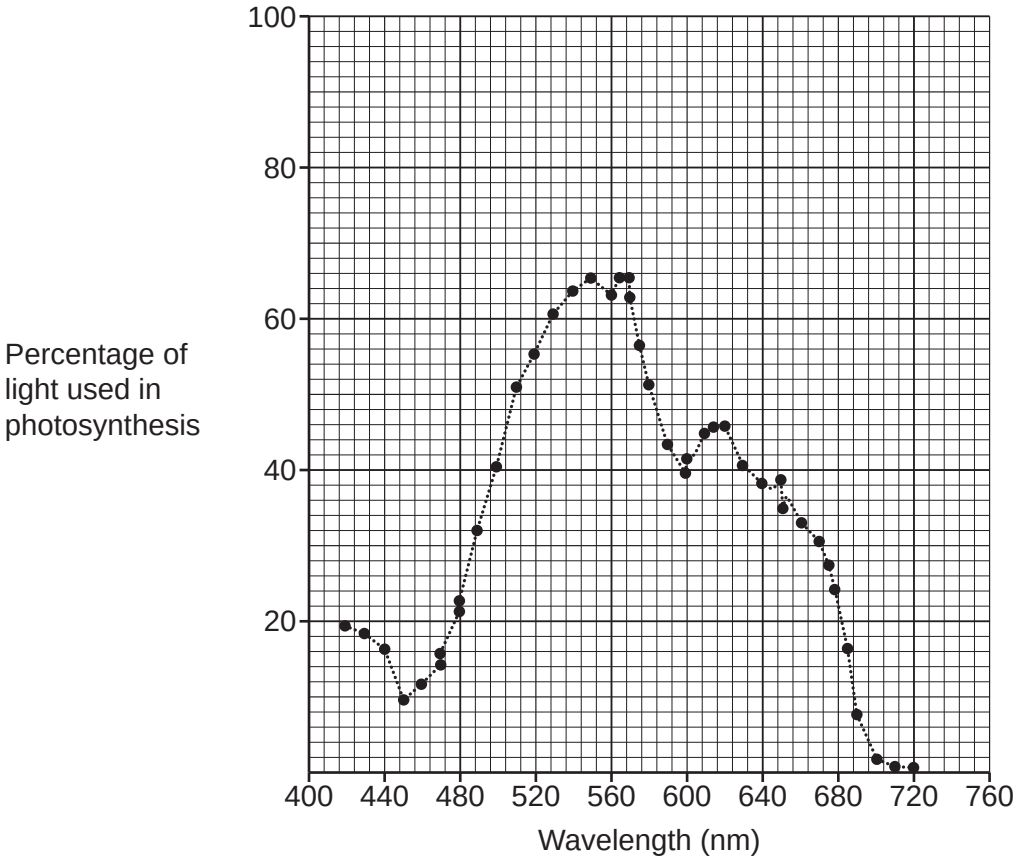
(b) Algae, such as seaweed, can occur in a range of colours. Algae carry out photosynthesis in the same way as plants, using chlorophyll a as the primary photosynthetic pigment.

Fig. 17.2 shows the percentage of light at each wavelength that is used in photosynthesis by the red alga *Porphyra naiadum*.

Fig. 17.2



(i) Chlorophyll a has an absorption peak at 680 nm.

Use **Fig. 17.2** to estimate the percentage of light absorbed by chlorophyll a that is used in photosynthesis by *Porphyra naiadum*.

Percentage absorbed = ... **[1]**

(ii) Explain why the percentage of light used in photosynthesis is higher than your answer to part **(i)** at wavelengths other than 680 nm.

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(iii) *Porphyra naiadum* grows in deep water.

Use the data in **Fig. 17.2** to suggest how it is able to survive in conditions where other types of algae or plant cannot.

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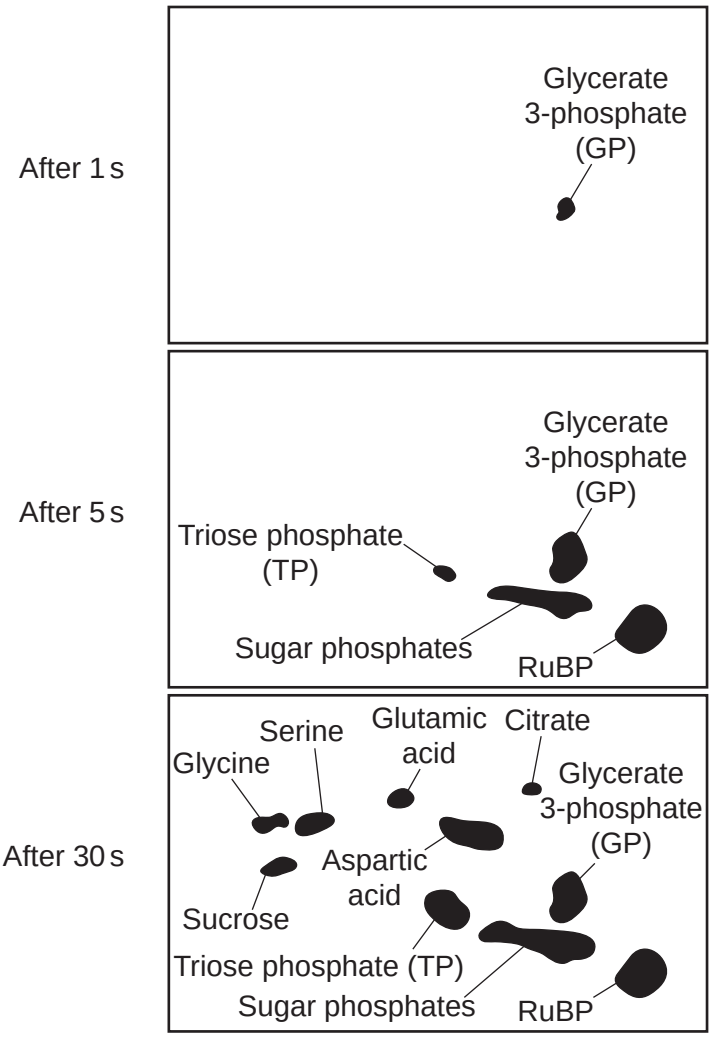
..... **[2]**

(c) Melvin Calvin and co-workers worked out the reactions of the light independent stage of photosynthesis.

They illuminated a suspension of green algae in the presence of radioactive carbon dioxide. They removed samples of the suspension at different times after addition of the radioactive carbon dioxide and used paper chromatography to identify the compounds in what is now known as the Calvin cycle.

Fig. 17.3 shows their results.

Fig. 17.3



(i) Calvin concluded that GP was the first product of carbon fixation, and that GP was converted into TP.

Use the data in **Fig. 17.3** to explain how Calvin reached this conclusion.

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(ii) State what you can conclude from **Fig. 17.3** about what happens to TP.

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18

(a) Furosemide is a type of drug known as a diuretic that acts on the nephron to decrease reabsorption of water in the collecting ducts. Diuretics are often prescribed to treat high blood pressure.

Furosemide is on the list of banned substances published by the International Olympic Committee.

(i) State **one** other type of drug on the list of banned substances that can be detected in urine samples.

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

(ii) Furosemide can also be misused by jockeys or boxers who need to be below a certain weight.

Explain how a diuretic could help to reduce weight.

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(iii) Furosemide is a banned substance because it can be used as a masking agent, to hide the use of performance enhancing drugs.

Suggest how furosemide could act as a masking agent.

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

(b) Urine analysis can also be used in medical diagnosis.

(i) Bladder cancer can be diagnosed by surgical removal of a small piece of bladder tissue (a biopsy sample).

State **one** advantage of urine analysis over a biopsy sample.

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

(ii) Give **one** other application of urine analysis in diagnosis.

State the substance measured and the corresponding medical condition.

Substance .....

Medical condition .....

[1]

(c) The formation of tissue fluid has many similarities with the process of ultrafiltration in the kidneys.

The table shows the factors involved in formation of tissue fluid and its return to the blood.

Location	Hydrostatic pressure (kPa)		Oncotic pressure (kPa)	
	Blood	Tissue Fluid	Blood	Tissue Fluid
Arteriole end	4.5	1.1	–3.3	–1.2
Venule end	1.7	1.1	–3.3	–1.2

(i) The net pressure at the arteriole end is +1.3 kPa.

Calculate the net pressure at the venule end.

Net pressure at venule end = ... kPa **[2]**

(ii) Use the information in the table to explain the formation of tissue fluid and its return to the blood.

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

(d)* Describe the homeostatic mechanisms that regulate the water content of the blood by changing how much water is reabsorbed from the collecting duct.

You do **not** need to describe how the loop of Henle sets up a water potential gradient in your answer.

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Extra answer space if required.

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19

(a) Plants respond to their environments in different ways.

(i) Describe the meaning of the term **tropism**.

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

(ii) State **one** named example of a tropism.

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

(iii) Give **one** example of an abiotic stress and the corresponding plant response.

Example .....

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Plant response .....

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[2]

(b) Mycorrhizae are associations between some types of fungi and the roots of plants, including trees. The fungal hyphae grow into the roots and help the trees take up water and minerals.

Trees respond to insect attack by producing chemicals that defend against insects.

Trees also release pheromones into the air that stimulate nearby trees to produce defensive chemicals in preparation for possible insect attack.

It is now known that communication between trees of the same or different species can also be carried out via the mycorrhizae.

Some scientists investigate this phenomenon using young fir and pine plants.

This is the method that they use:

- grow a 'donor' fir plant together with a 'recipient' pine plant in the same large pot
- repeat to create 40 pairs of plants
- divide the plants into four groups, with ten pairs of plants in each group
- enclose the roots of the 'recipient' plants of each pair in a mesh bag
- simulate insect herbivory by removing the leaves of 'donor' plants in half of the groups.

The treatment groups are summarised in the table.

Group	Leaves of 'donor' removed	Mesh bag around 'recipient' roots
1	No	0.5 μm mesh bag that allowed passage of solutes but blocked passage of roots and hyphae.
2	Yes	
3	No	35 μm mesh bag that allowed passage of solutes and hyphae but blocked passage of roots.
4	Yes	

The scientists measure the concentration of the enzyme polyphenol oxidase (PPO) in the recipient seedlings at the start of the experiment and after 72 hours. PPO is involved in the production of defence chemicals.

(i) Suggest how the scientists could ensure that airborne pheromones did **not** contribute to communication between plants in this investigation.

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

(ii)* The results are shown in the table.

Group	Mean PPO Activity ± Standard Deviation (Arbitrary Units)	
	At start	After 72 h
1	18 ± 2	20 ± 2
2	16 ± 2	50 ± 4
3	12 ± 2	22 ± 4
4	18 ± 2	116 ± 14

The scientists conclude:

- Removing the leaves of the donor plants leads to a chemical defence response in the recipients.
- This is due to signals carried by the mycorrhizal hyphae.

Evaluate the support given by the results to the scientists' conclusions.

You should comment on the quality of the scientists' data in your answer.

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Extra answer space if required.

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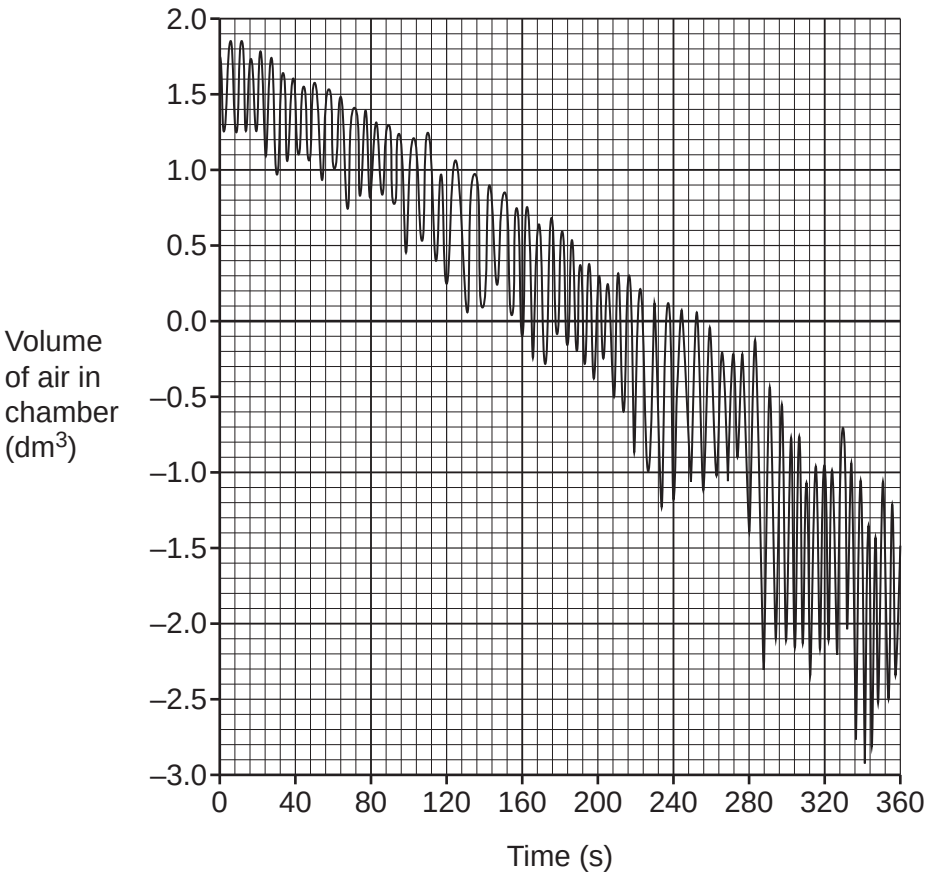
20 A student investigated ventilation and heart rate in a resting subject.

The subject breathed in and out through a spirometer.

The spirometer chamber was filled with room air. Soda lime was present to absorb carbon dioxide.

The results are shown in **Fig. 20.1**.

Fig. 20.1



(a)

(i) The downward slope of the spirometer trace in **Fig. 20.1** is due to oxygen consumption.

The subject exhales the same volume of air as they inhale.

State why the trace slopes downwards.

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

(ii) The subject had a mass of 75 kg.

Calculate the subject's oxygen consumption in $cm^3\,kg^{-1}$ during the first 2 minutes of the experiment.

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

Oxygen consumption = ... $cm^3\,kg^{-1}$ **[2]**

(iii) Using **Fig. 20.1**, compare the breathing pattern between 0–120 s and 120–240 s.

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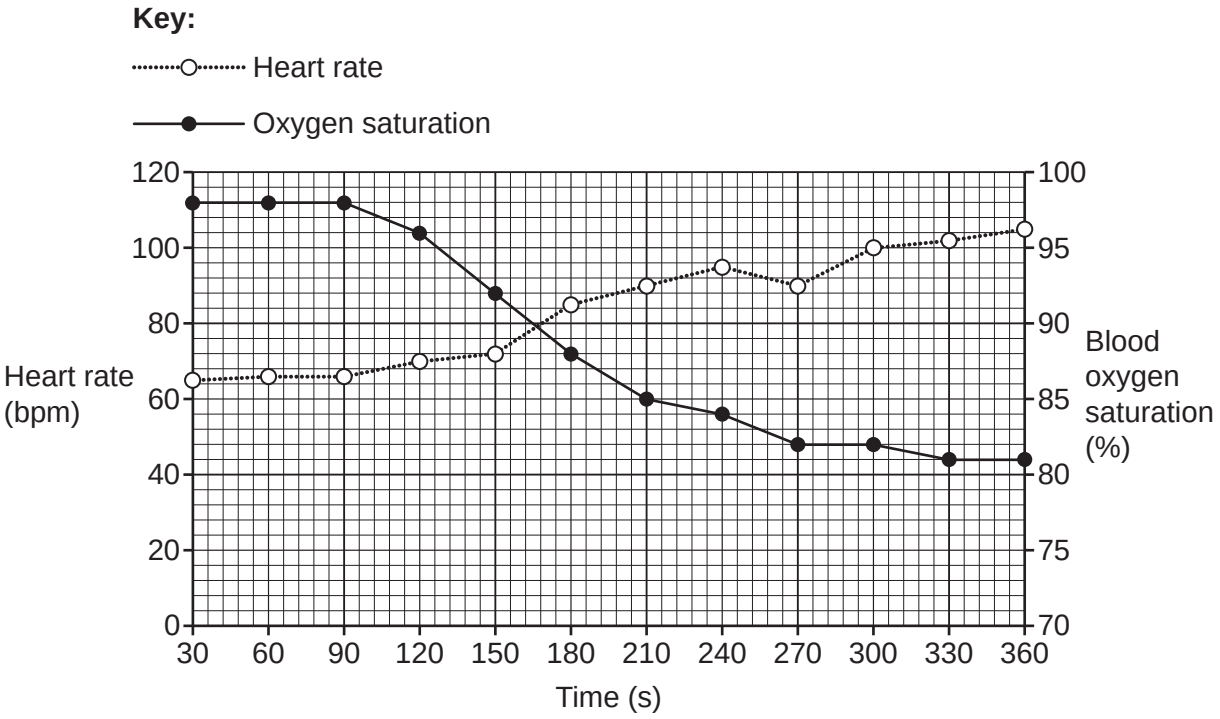
The student measured the subject's heart rate and blood oxygen saturation every 30 seconds.

The results are shown in **Fig. 20.2**.

Fig. 20.2



(iv) Use the data in **Fig. 20.1** and **Fig. 20.2** and your own knowledge of homeostatic control to explain the changes in breathing rate and heart rate during the experiment.

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(b) Blood oxygen saturation of less than 90% can be dangerous.

Explain **one** modification that you could make to the experiment to safely study the effect of extended periods of exercise.

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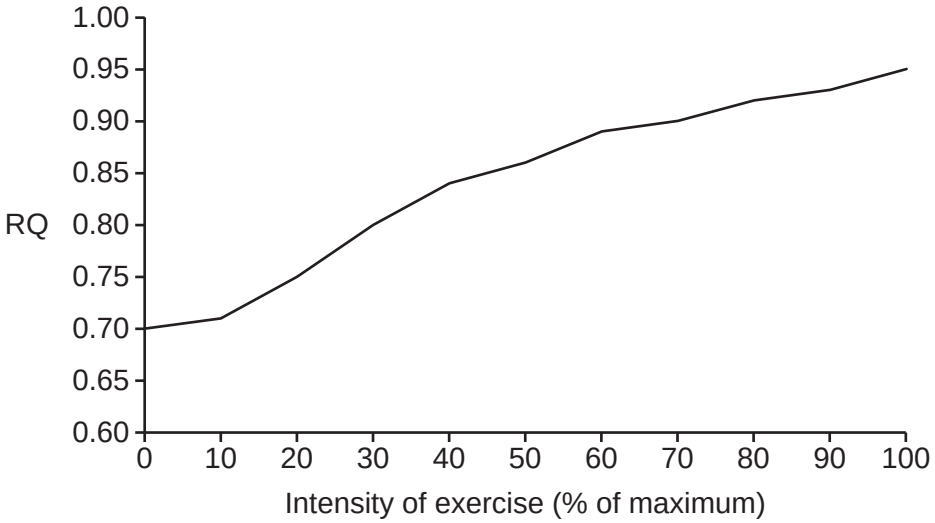
(c) **Fig. 20.3** shows how the respiratory quotient (RQ) of an athlete changed during exercise, from rest (0%) up to 100% maximum effort.

Fig. 20.3



(i) State the **two** measurements that you would need to make during the experiment to calculate RQ.

1 .....

2 .....

[1]

(ii) Explain what **Fig. 20.3** shows about the respiratory substrate(s) used at different intensities of exercise.

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

21

(a) Most digestive enzymes are extracellular.

Complete the sentences about the synthesis and secretion of a typical digestive enzyme using the most appropriate terms.

The polypeptide chain is assembled at ribosomes on the ..... .

After this, the protein is transported to the ..... where

further processing occurs. The final protein is packaged into .....

for transport to the plasma membrane where the protein is released by exocytosis.

[3]

(b) Hydrogen peroxide is a highly reactive chemical.

Catalase is an intracellular enzyme that catalyses the breakdown of hydrogen peroxide.

(i) Explain why it is important that catalase is able to break down hydrogen peroxide very quickly.

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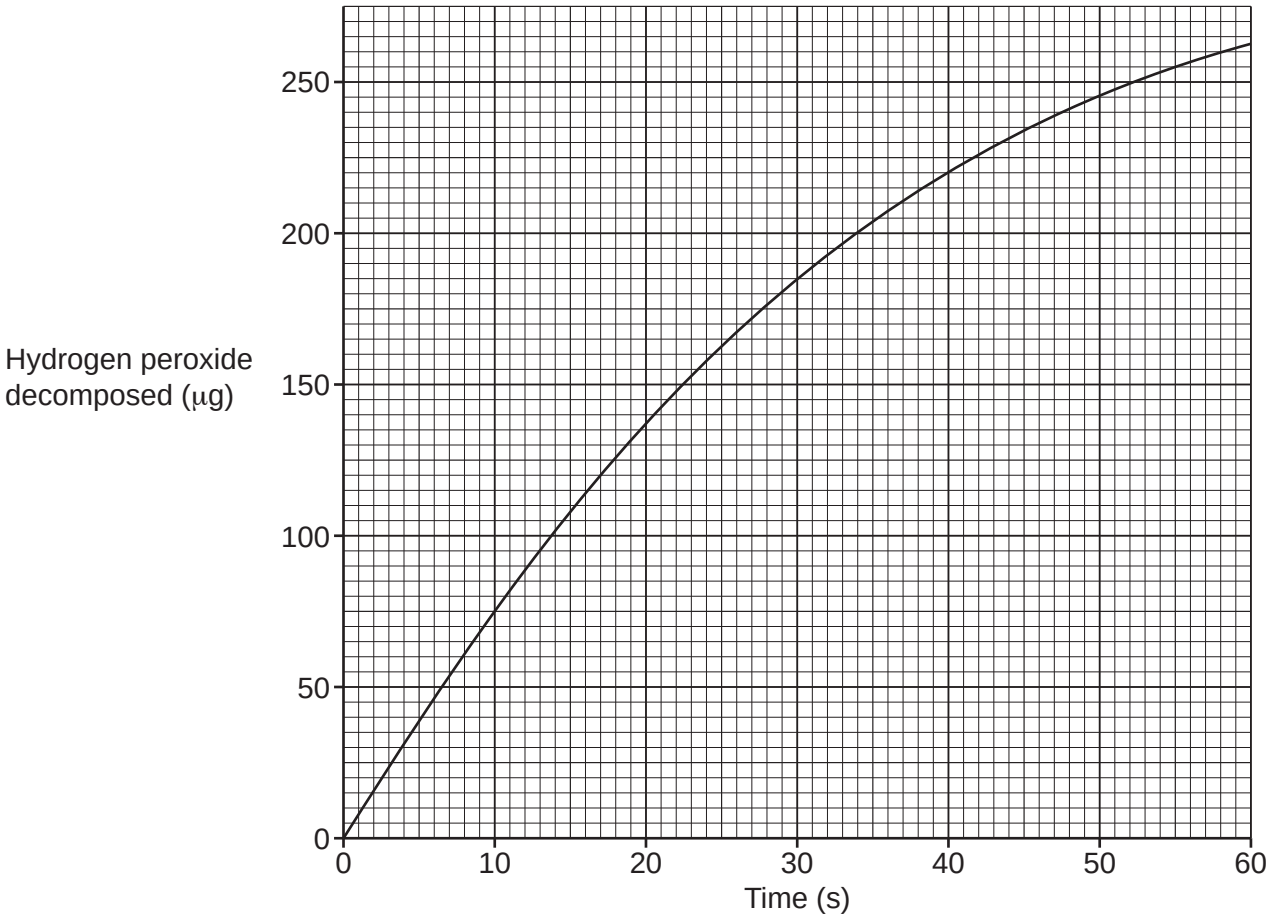
(ii) **Fig. 21.1** is a graph of decomposition of hydrogen peroxide against time for catalase.

Fig. 21.1



Calculate the rate of the enzyme catalysed reaction **at 30 s**.

Rate = ... Units = ... **[3]**

(c) Male infertility is associated with low motility (ability to move) of sperm cells.

(i) Superoxide dismutase (SOD) is an enzyme that is often located together with catalase in cells.

Superoxide ions are produced in mitochondria and are highly reactive. Superoxide ions cause damage to many biological molecules, including DNA and lipids.

SOD converts superoxide ions into hydrogen peroxide and oxygen.

Explain why sperm cells might have high concentrations of hydrogen peroxide.

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

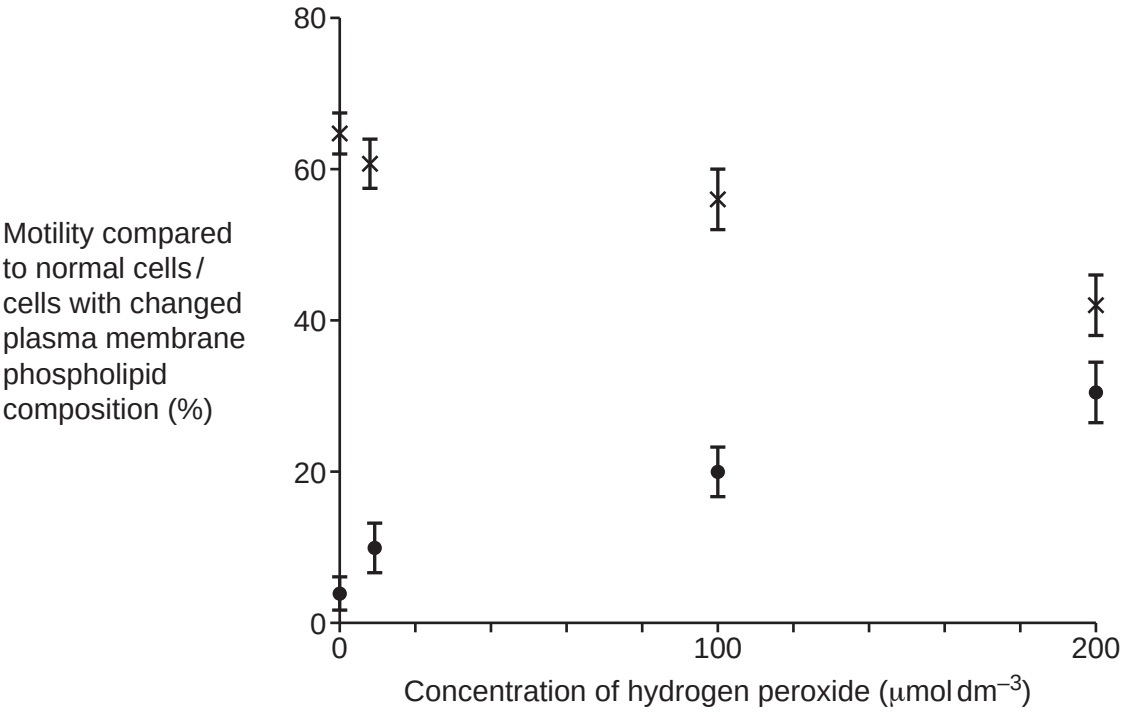
(ii) Scientists investigate the effect of hydrogen peroxide on sperm cells. This is the method that they use:

- incubate sperm cells with different concentrations of hydrogen peroxide for two hours
- measure the motility of the cells compared with normal sperm cells
- measure the percentage of cells that have changes in the composition of phospholipids in the plasma membrane.

They use sperm samples from 10 different men attending a fertility clinic and calculate mean values.

Their results are shown in **Fig. 21.2**.

Fig. 21.2



Key:

× = motility

● = cells with changed plasma membrane

The scientists conclude that hydrogen peroxide causes changes in the plasma membrane of sperm cells that reduces their motility.

Evaluate this conclusion.

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(iii) Suggest how hydrogen peroxide could affect the plasma membrane.

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

22 A student investigates the effect of ethanol on the membranes of beetroot cells at 25 °C.

They place equal masses of beetroot in tubes containing different concentrations of ethanol.

They then use a colorimeter to measure the concentration of purple pigment that leaked out of the cells.

The student replicates the experiment five times at each ethanol concentration and plots a graph of absorption in arbitrary units (A.U.) against concentration of ethanol.

(a) The student controls the mass of beetroot in this investigation.

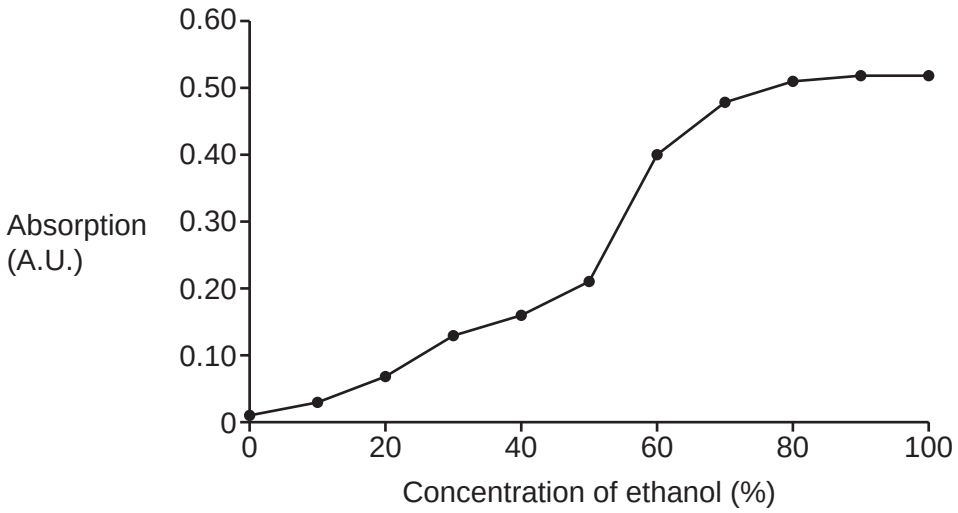
Identify **two** other variables that the student should control in this investigation.

1 .....

2 .....

[2]

(b) The student's graph is shown below.



(i) Explain the shape of the graph.

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

(ii) The student repeats the experiment at a temperature of 30 °C.

Sketch the graph you expect the student to obtain.

Answer on the graph. **[2]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.