Oxford Cambridge and RSA

Thursday 9 June 2022 – Afternoon

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 **32** pages.

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

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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 statement describes the properties or functions of cholesterol?

A It increases the fluidity of the phospholipid bilayer at high temperatures.

B It is an unsaturated fatty acid because it contains carbon–carbon double bonds.

C It is used to produce some hormones.

D It is very hydrophilic so is attracted to the fatty acid tails in the membrane.

Your answer ☐ **[1]**

2 Which statement describes triglycerides?

A They are broken down by condensation reactions.

B They are polymers of glycerol and fatty acids.

C They contain ester bonds.

D They contain glycosidic bonds.

Your answer ☐ **[1]**

3 Kendal Mint Cake is made from sugar, flavoured with peppermint, and was famously taken on the 1953 ascent of Mount Everest.

Which statement describes why climbers now prefer to take chocolate?

A Chocolate contains fat. Fat stores and releases less energy per gram than sugar.

B Chocolate contains fat. Fat stores and releases more energy per gram than sugar.

C Fat contains more oxygen than glucose.

D Glucose can be digested more rapidly than fat.

Your answer ☐ **[1]**

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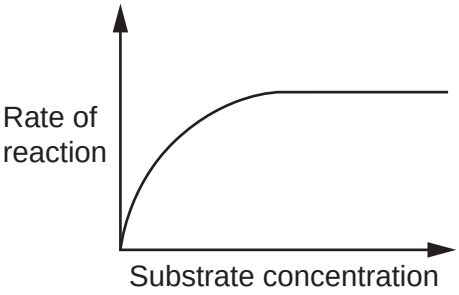
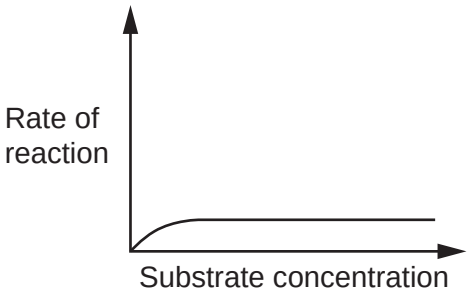
4 The graph below shows the effect of changing substrate concentration on the rate of an enzyme-controlled reaction.



Which graph shows how increasing the concentration of enzyme would affect the rate of this reaction?

A



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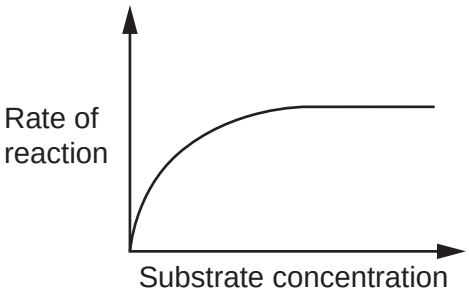

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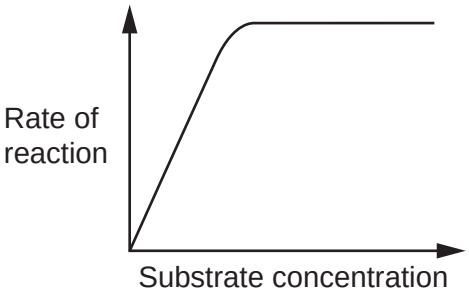
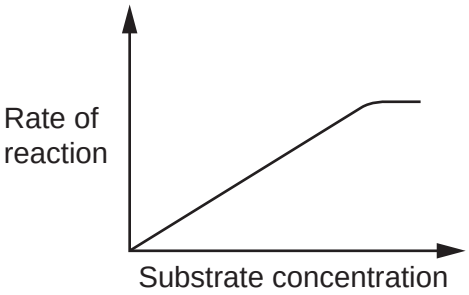


D



Your answer ☐ **[1]**

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5 Which statement about the effect of temperature on enzyme-controlled reactions is **not** correct?

A At temperatures above 40 °C the rate of all enzyme-controlled reactions decreases.

B Increasing the temperature above the optimum changes the tertiary structure of the active site.

C Increasing the temperature increases the kinetic energy of the enzyme and substrate.

D Increasing the temperature increases the probability of enzyme-substrate collisions.

Your answer ☐ **[1]**

6 Ventilation of the lungs involves muscles working together.

Which option describes expiration?

A In expiration at rest, the external intercostal muscles and the diaphragm relax and the rib cage moves down and in.

B In expiration at rest, the internal intercostal muscles and the diaphragm contract pulling the rib cage down and in.

C In forced expiration, the diaphragm relaxes and the external intercostal muscles contract pulling the rib cage down and in.

D In forced expiration, the internal intercostal muscles and the diaphragm contract pulling the rib cage down and in.

Your answer ☐ **[1]**

7 Which option is **not** a component of a chloroplast?

A Cristae

B DNA

C Ribosome

D Thylakoid

Your answer ☐ **[1]**

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The following information is needed to answer questions **8** and **9**.

A class compared the number of chloroplasts in the leaves taken from plants of the same species growing in two areas. One area had a high light intensity, the other had a low light intensity.

8 One student examined a cross section of a leaf under a light microscope.

They counted the number of chloroplasts in each cell in the field of view. Their results are shown in the table.

Cell number	1	2	3	4	5	6	7
Number of chloroplasts	13	14	13	21	14	13	17

Which option gives the correct values for mean, median and mode?

A Mean = 13, median = 14, mode = 15

B Mean = 14, median = 15, mode = 13

C Mean = 15, median = 14, mode = 13

D Mean = 15, median = 13, mode = 14

Your answer ☐ **[1]**

9 Which option is the correct procedure for statistical analysis of the data collected by the class?

A Calculate the mean number of chloroplasts per cell in the high and low light intensity areas and use a paired t-test.

B Calculate the mean number of chloroplasts per cell in the high and low light intensity areas and use an unpaired t-test.

C Calculate the median number of chloroplasts per cell in the high and low light intensity areas and calculate Spearman's rank correlation coefficient.

D Calculate the median number of chloroplasts per cell in the high and low light intensity areas and use a chi-squared test.

Your answer ☐ **[1]**

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10 Which process is an example of cell signalling?

A Binding of a virus to a receptor on the cell surface membrane of an epithelial cell in the upper respiratory tract

B Binding of acetylcholine to cell surface receptors on sodium ion channels in the post-synaptic neurone

C Co-transport of glucose and Na^+ ions across the cell surface membrane of an epithelial cell in the proximal convoluted tubule

D Operation of the Na^+/K^+ pump in the cell surface membrane of the axon

Your answer ☐ **[1]**

11 Which statement describes an aspect of homeostasis?

A Effectors detect a change and cause release of hormones that bind to target cells.

B Homeostasis maintains the internal body temperature of animals at a constant level.

C Homeostasis involves both positive and negative feedback.

D Receptors coordinate nervous and hormonal responses.

Your answer ☐ **[1]**

12 Linoleic acid is a fatty acid found in sunflower oil.

The equation for oxidation of linoleic acid is:

Linoleic acid: $C_{18}H_{32}O_2 + 25\ O_2 \rightarrow 18\ CO_2 + 16\ H_2O$

What is the respiratory quotient (RQ) of linoleic acid?

A 0.33

B 0.72

C 1.00

D 1.39

Your answer ☐ **[1]**

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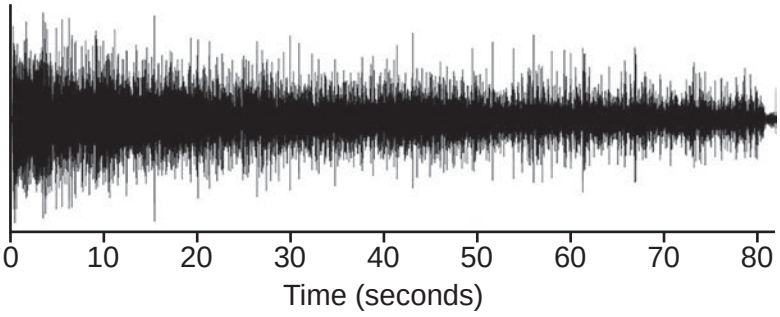
13 An electromyogram (EMG) records the electrical activity of a muscle.

The figure shows an EMG trace of a muscle undergoing fatigue.



Which of the statements about muscle fatigue is/are correct?

1 Increased acidity in the muscle during long periods of contraction is a cause of muscle fatigue.
2 There is a decrease in the frequency of the signal on an EMG trace as the muscle becomes fatigued.
3 There is an increase in amplitude of the signal on an EMG trace as the muscle becomes fatigued.

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 the relationship between photosynthesis and aerobic respiration in plants is/are correct?

1 During the day, photosynthesis produces all the ATP that cells in the leaves require.
2 Carbon dioxide produced in respiration can be used as a carbon source in photosynthesis.
3 Oxygen produced in photosynthesis can be used in aerobic respiration.

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]**

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15 Erythrocytes are formed from bone marrow stem cells. During this process they lose most of their organelles.

Which statement about respiration in erythrocytes is correct?

A Oxygen bound to haemoglobin is used by erythrocytes in aerobic respiration.

B They do not respire because their cell surface membrane is impermeable to glucose.

C They respire aerobically because they always have adequate supplies of oxygen.

D They respire anaerobically because they do not have mitochondria.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 Dicotyledons are a large and diverse group of multicellular plants that includes oak trees and dandelions.

(a) Explain, using examples of transported substances, why multicellular plants need transport systems.

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(b) **Fig. 16.1** is a light micrograph of a transverse section through the leaf of a dicotyledon.

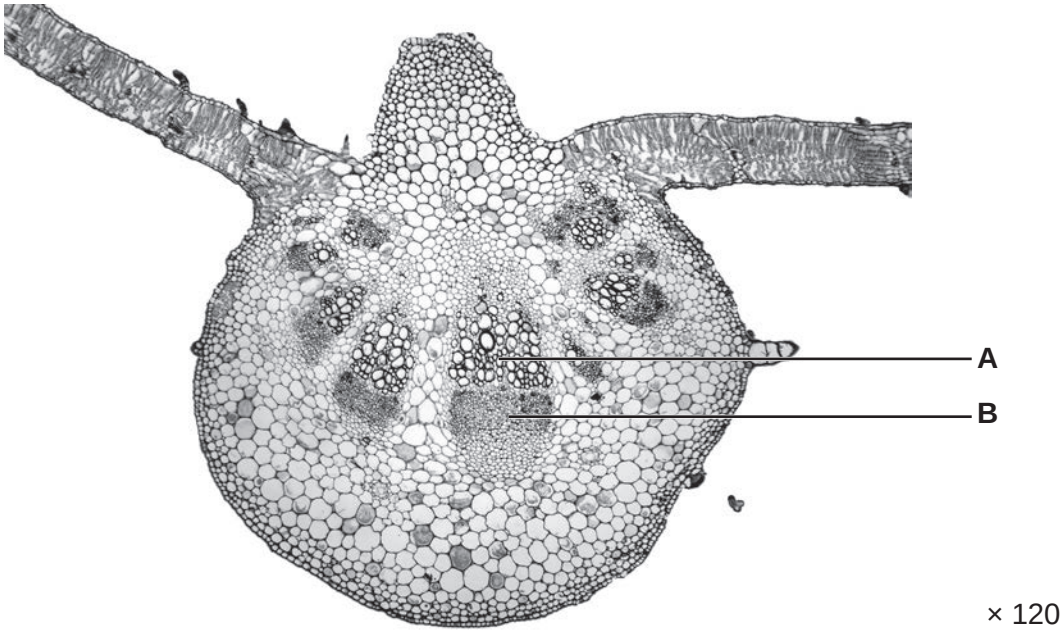

Fig. 16.1

(i) Identify the tissue labelled **B** in **Fig. 16.1**.

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

(ii) State **two** functions of structure **A**.

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2 .....

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[2]

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(c) **Fig. 16.2** on the **insert** is a coloured scanning electron micrograph (SEM) of a longitudinal section through vascular tissue in the stem of a dicotyledon.

Explain how **two** features, visible in **Fig. 16.2**, show that this tissue is adapted to its function.

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2 .....

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[4]

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(d) A mycorrhiza is mutualistic association between a fungus and a plant. The fungus penetrates root cells and assists with uptake of water and nutrients.

A group of scientists investigated the role of mycorrhiza in the uptake of phosphates by plants.

Wild type barley plants produce root hairs. Mutant (*brb*) barley plants do not produce root hairs.

brb mutant and wild type plants were grown in pots and half of each group had mycorrhiza fungus added. After 28 days, the dry mass and phosphate content of the plants was measured.

The results are shown in the table.

Plant type	**Mycorrhiza fungus added**	**Dry mass ($g\,pot^{-1}$)**	**Phosphate content ($mg\,plant^{-1}$)**
brb mutant	no	0.84 ± 0.10	1.22 ± 0.13
brb mutant	yes	1.23 ± 0.16	2.15 ± 0.25
Wild type	no	3.57 ± 0.16	4.72 ± 0.23
Wild type	yes	2.97 ± 0.36	3.91 ± 0.52

The scientists concluded that the mycorrhiza compensated for the absence of root hairs in the mutant (*brb*) barley plants.

Evaluate this conclusion.

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17* The thermal properties of water allow organisms to live in an environment with relatively small changes in temperature. These properties also make water efficient as a coolant, e.g. in sweating or by absorbing large amounts of heat.

Outline how **other** properties of water are essential for sustaining life on Earth.

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Additional answer space if required.

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18 A student investigated osmosis in plant cells.

They used cylinders of potato cut with a cork borer and measured the change in length of the cylinders after they were placed in sucrose solutions and left overnight.

(a) The student was given 100 cm^3 of a solution of 1 mol dm^{-3} sucrose and asked to prepare 30 cm^3 of each dilution.

(i) Complete **Table 18.1** to show how the student should prepare the solutions.

Final concentration of solution (mol dm^{-3})	**Volume of 1 mol dm^{-3} sucrose solution (cm^3)**	**Volume of distilled water (cm^3)**	**Final volume (cm^3)**
1.0			30.0
0.8			30.0
0.6			30.0
0.4			30.0
0.2			30.0
0.0			30.0

Table 18.1

[3]

(ii) The solution given to the student was prepared using 34.23 g of sucrose in 100 cm^3 water.

The sucrose was measured on an electronic balance using the following procedure:

- mass of weighing boat empty = 10.55 g
- mass of weighing boat plus sucrose = 44.78 g.

The balance recorded masses to two decimal places with an uncertainty of ± 0.01 g.

Calculate the percentage uncertainty in the mass of sucrose.

Uncertainty = ... % **[2]**

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(b) The student's results are shown in **Table 18.2**.

Concentration of sucrose ($mol\,dm^{-3}$)	Length of potato cylinder (mm)			Percentage change in length (%)	Mean percentage change in length (%)
	initial	final	change		
1.0	49.5	48.0	–1.50	–3.0%	–3.4%
	50.5	49.0	–1.50	–3.0%	
	49.0	47.0	–2.00	–4.1%	
0.8	49.0	48.0	–1.00	–2.0%	–2.6%
	50.5	49.5	–1.00	–2.0%	
	51.0	49.0	–2.00	–3.9%	
0.6	50.0	50.5	0.50	1.0%	0.3%
	51.0	51.0	0.00	0.0%	
	50.5	50.5	0.00	0.0%	
0.4	50.5	51.5	1.00	2.0%	0.7%
	49.5	51.0	1.50	3.0%	
	51.0	49.5	–1.50	–2.9%	
0.2	50.0	52.0	2.00	4.0%	4.3%
	50.5	52.5	2.00	4.0%	
	49.5	52.0	2.50	5.1%	
0.0	49.5	52.0	2.50	5.1%	4.4%
	49.0	51.0	2.00	4.1%	
	50.0	52.0	2.00	4.0%	

Table 18.2

The student was told that one of their results was anomalous.

(i) Identify the anomalous result.

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

(ii) State **one** variable that should be controlled in this experiment and give a reason for your choice.

Control variable .....

Reason .....

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[2]

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19 **(a)** The table lists structural and functional differences between different types of muscle.

Place a tick (✓) in each box where the structure or function applies to that type of muscle.

The first row has been completed for you.

	Skeletal	**Cardiac**	**Involuntary**
Contraction speed is slow			✓
Fibres are multinucleate			
Fibres are branched and interconnected			
Under conscious control			

[3]

(b) **Fig. 19.1** and **Fig. 19.2** are transmission electron micrographs (TEMs) of striated muscle.

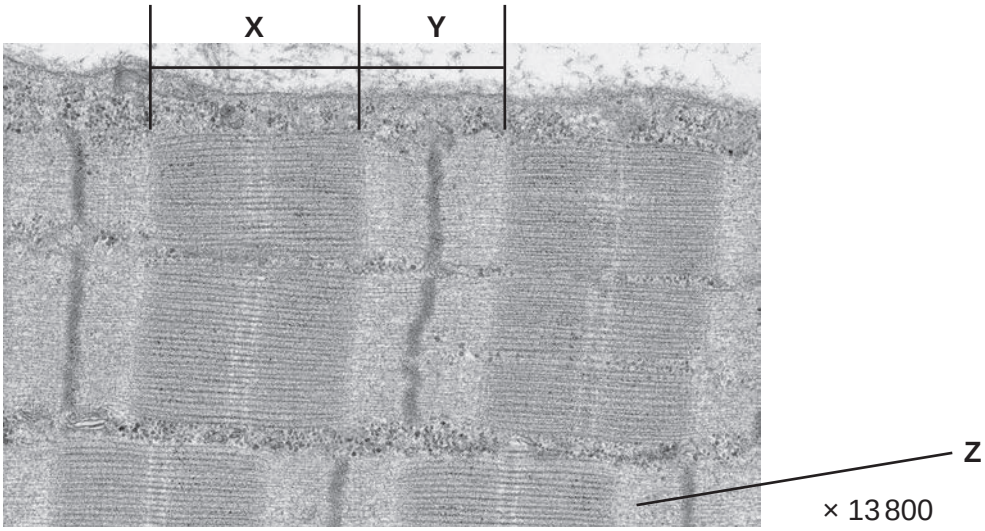

Fig. 19.1

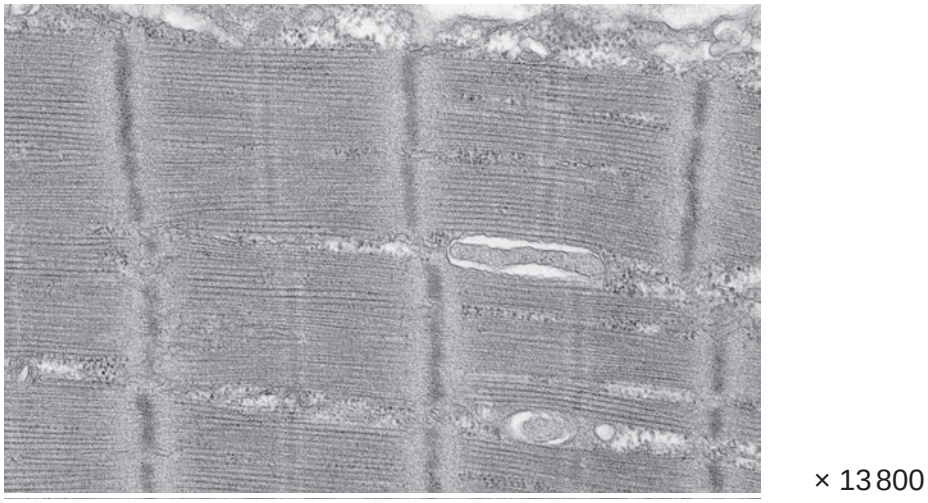

Fig. 19.2

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(i) Identify **three** proteins that make up the filaments labelled **Z** on **Fig. 19.1**.

1 .....

2 .....

3 .....
[3]

(ii) Labels **X** and **Y** in **Fig. 19.1** indicate two distinct bands.

Explain why the two bands look different.

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(iii) Use your knowledge of the sliding filament model of muscle contraction to explain why **Fig. 19.2** represents contracted muscle.

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(c) After death, the concentration of ATP in muscle cells decreases. During this time, the muscles become rigid in a process called rigor mortis.

Suggest why a lack of ATP leads to muscle rigidity.

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(d)* Muscle contraction requires energy in the form of ATP.

Describe the different sources of the ATP that is used in muscle contraction during strenuous exercise.

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Additional answer space if required.

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20 **(a)** *Oplegnathus insignis* is a fish species that lives in salt water. It may be suitable for use in fish farming.

Scientists investigated the growth of *O. insignis* at different temperatures to help decide on the optimum temperature for farming.

Fig. 20.1 shows a diagram of the respirometer the scientists used.

The diagram shows a single fish, but the respirometer is large enough to hold many.

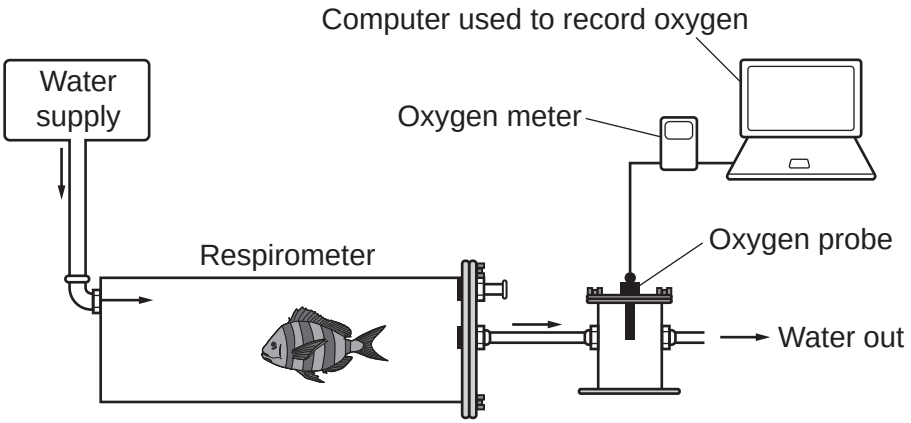

Fig. 20.1

(i) Suggest **two** modifications the researcher would need to make to this apparatus to investigate the effect of temperature on the rate of respiration.

1 .....

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2 .....

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[2]

(ii) Suggest **one** advantage of using a computer to collect data.

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

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(iii) A constant flow of water past the oxygen probe allows continuous monitoring of oxygen concentration.

Explain **one** other reason why it is necessary to maintain a constant flow of water in the respirometer.

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

(iv) Suggest and explain **one** other precaution that the scientists should take to ensure that the results obtained using this apparatus are valid.

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(b) The scientists studied the effect of living at different temperatures on respiration in young fish at different stages of growth.

High oxygen consumption in fish is associated with a fast growth rate.

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

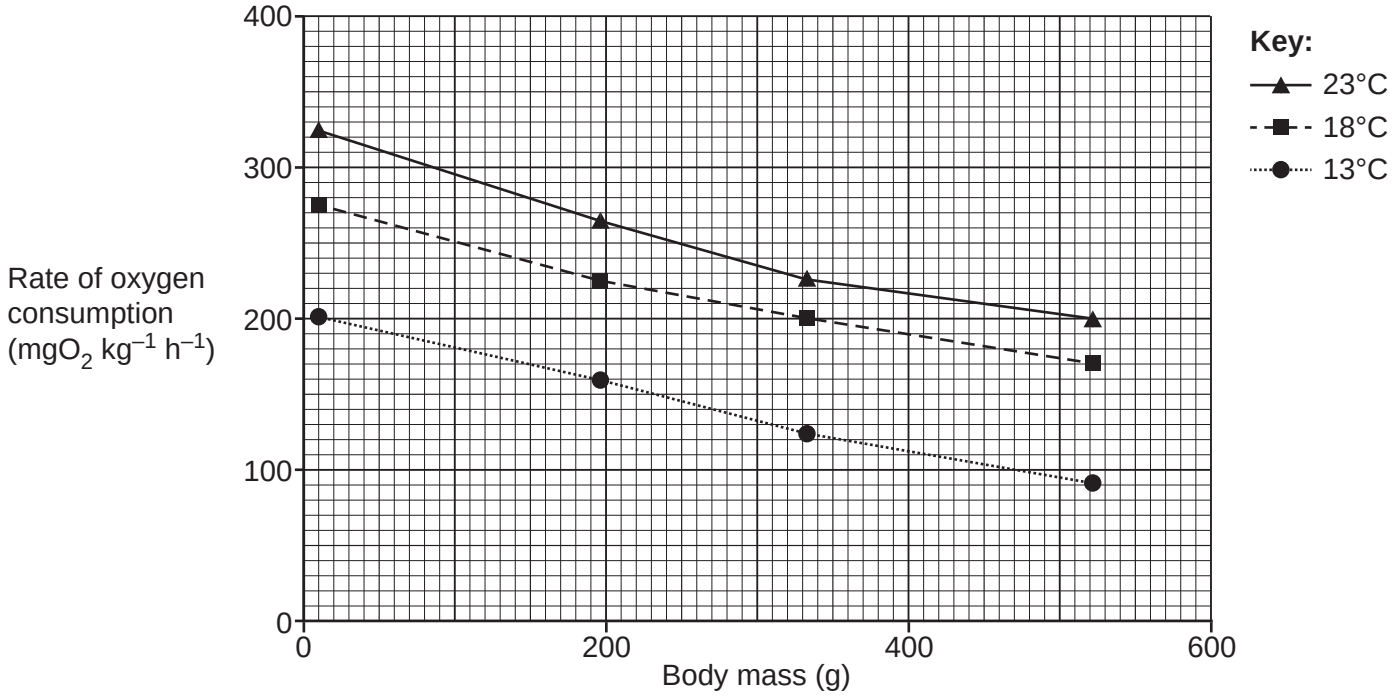

Fig. 20.2

(i) Calculate the Q_{10} for respiration in the largest fish.

Give your answer to **3** significant figures.

Q_{10} = ... **[2]**

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(ii) The scientists concluded that the best temperature for farming of *O. insignis* was 18 °C.

Evaluate their conclusion.

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21 **(a)** Glands can be either endocrine or exocrine.

(i) Describe what is meant by an endocrine gland.

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(ii) The pancreas contains endocrine glands such as the Islets of Langerhans. It also contains cells that produce digestive enzymes.

Suggest why the cells that produce digestive enzymes are described as exocrine rather than endocrine.

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

(b) Hormones can be classed as either steroid or non-steroid. Steroids are lipid soluble.

Suggest the location of the receptors for steroid hormones and state a reason for your suggestion.

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

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(c) The Society for Endocrinology has produced a booklet about adrenal failure to help patients understand their illness.

The following statements are adapted from this booklet.

- Adrenal failure is caused by inability of the adrenal glands to produce sufficient amounts of cortisol and aldosterone.
- In healthy people, the hormone ACTH is produced by the pituitary gland and causes the adrenal cortex to release more cortisol and aldosterone.
- A pituitary tumour can stop ACTH production by the pituitary. This leads to adrenal failure.
- Symptoms of adrenal failure include severe fatigue and weakness, weight loss, low blood pressure and salt craving.

(i) Explain the symptoms of adrenal failure.

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

(ii) Explain why patients with a pituitary tumour have adrenal failure but still respond normally to situations of danger or excitement.

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

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(d) Hypothyroidism (underactive thyroid gland) is treated by taking thyroxine tablets.

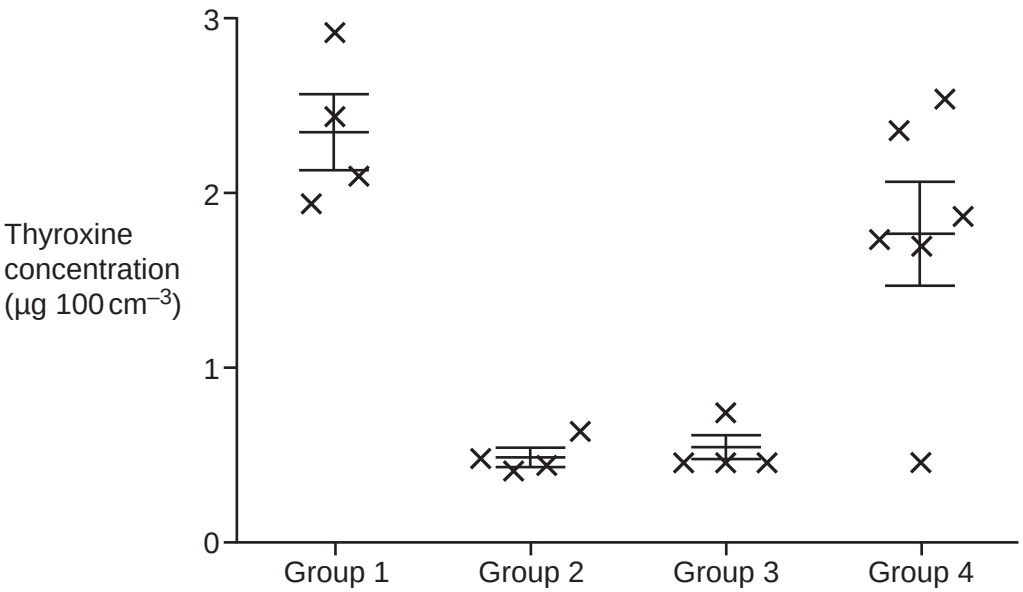
Scientists are investigating the use of stem cell transplants to treat hypothyroidism in which the thyroid glands of mice are destroyed using radioactive iodine.

The scientists obtained mouse embryonic stem cells (ESCs) and incubated them in culture with or without a mixture of growth factors for 30 days before transplanting them into the mice.

They divided the mice into four groups as shown in the table.

Group	Thyroid gland destroyed	ESCs transplanted into mice
1	No	No
2	Yes	No
3	Yes	Yes, incubated in culture without growth factors
4	Yes	Yes, incubated in culture with growth factors

After eight weeks they measured the thyroxine concentration in the four groups of mice. Their results are shown in the graph. Each cross represents a single mouse and the mean ± 2 standard deviations is shown for each group.



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(i) The ESCs are described as pluripotent.

Explain what is meant by pluripotent.

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(ii) The scientists concluded that growing the ESCs with growth factors caused them to differentiate into functional thyroid tissue.

Evaluate this conclusion.

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(iii) The scientists then repeated their experiments with adult stem cells taken from the skin of patients with hypothyroidism. These cells were artificially transformed into pluripotent stem cells (iPSCs).

The scientists concluded that use of human iPSCs would be **safer** than using human ESCs to treat hypothyroidism.

Use your knowledge of stem cells to suggest one reason that supports and one reason that does not support the scientists' conclusion.

Supports .....

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Does not support .....

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[2]

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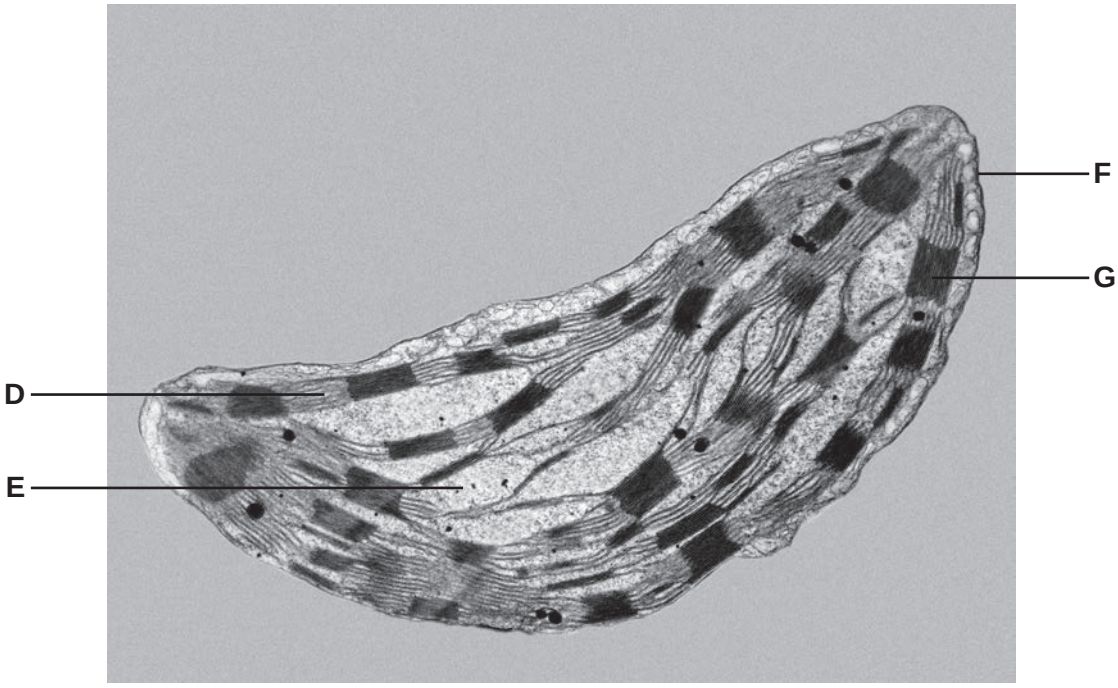
22 **(a)** The image is a transmission electron micrograph (TEM) of a chloroplast.



Complete the table using the letters from the TEM which identifies the structure or function. Each letter may be used once, more than once or not at all.

Structure or function	**Letter**
Chloroplast envelope	
Site of light independent reactions	
Inter-granal lamellae	
Contains starch grains and lipid droplets	

[4]

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(b) Complete the sentences using the most appropriate terms.

Carbon fixation occurs in the Calvin cycle when CO_2 combines with the five-carbon molecule ..... . This forms an unstable six-carbon molecule that immediately breaks down into two molecules of ..... . These are reduced to triose phosphate using ..... and ..... that are formed in the light-dependent stage of photosynthesis. Triose phosphate is used to form hexose phosphates which can be converted to ..... for transport elsewhere in the plant.

[5]

END OF QUESTION PAPER

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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).

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