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Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/01 Summer 2022 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 1 series overview

H420/01 is one of three components of the GCE A level Biology A specification assessed during this examination session. For H420/01 candidates needed to demonstrate breadth and depth of knowledge across modules 1, 2, 3 and 5 with 15 multiple choice and two Level of Response questions included in the 100 marks.

Mathematical and practical skills continue to be embedded within the multiple choice questions in section **A** and the longer responses of section **B**. The exam paper appeared to be accessible to candidates across the ability range, and there was no evidence to suggest that candidates were under any time constraints towards the end of the paper.

Overall, candidates demonstrated a wide range of ability with more successful candidates giving succinct responses and appearing more adept at coping with the demands of the paper's mathematical and practical content to gain higher level marking points. Disruption to education and reduced access to centre laboratories due to COVID 19 pandemic had a likely impact on the ability of candidates to respond to practical-based questions. However, the provision of pre-release material would have enabled candidates to focus their learning and revision. Less successful candidates were able to demonstrate their ability to learn and recall facts.

Candidates who performed less well appeared unable to apply their knowledge or use information provided, e.g., diagrams, graphs or figures included in the questions, to support their answers.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• applied knowledge to new situations • demonstrated mathematical skills and practical skills where possible • were able to analyse data • evaluated conclusions effectively to give balanced arguments.	• used information to describe scientific terms • completed tables and gap fill questions • provided responses to short answer questions.

Section A overview

As in previous years, this section of the examination consisted of 15 multiple choice questions covering a range of topics across the assessed modules for this component. Only **AO1** and **AO2** were assessed in section **A**. Some questions involved recall, while others required the use of mathematical, practical and/or analytical skills; some questions needed more time than others.

Section **A** achieved a good spread of marks across the range of abilities. More successful candidates were able to demonstrate knowledge of the subject content without being distracted by the alternative options offered alongside the correct response.

Candidates had been advised to spend no longer than 20 minutes on this section and most candidates appeared to have managed their time effectively with very few omissions.

Candidates are advised not to change multiple choice answer by writing over the top of a previous answer, but instead to re-write the letter fully. Letters changed from one to the other do not scan well, and it is not always obvious which is the intended response meaning that a mark cannot be given.

Question 1

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]**

Candidates who performed well on this question paper recognised that cholesterol is used to produce steroid hormones and chose option C as the correct response. Option A was the most common incorrect response with candidates associating cholesterol with membrane fluidity, without understanding that at high temperatures cholesterol **decreases** membrane fluidity to stabilise the phospholipid bilayer.

Question 5

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]**

This is an example of a multiple-choice question that asks candidates to identify the option that is **not** correct. Higher ability candidates understood that organisms living in hot environments would require enzymes that could control reactions at temperatures above 40°C and correctly identified option A as the only incorrect statement. It was evident that some candidates eliminated correct statements to produce a response.

Question 7

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

A Cristae

B DNA

C Ribosome

D Thylakoid

Your answer ☐ **[1]**

This question required knowledge of chloroplast structure. Most candidates understood that they had to choose the component that was **not** part of a chloroplast and correctly identified option A. However, some candidates seemed unaware that chloroplasts contain their own DNA and ribosomes, incorrectly choosing either option B or C.

Question 9

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]**

Use of mathematical skills and data analysis is a requirement of A level Biology, although statistical analysis remains challenging for some candidates. Many candidates demonstrated their knowledge by choosing the unpaired *t*-test in option B as the appropriate statistical test to use in this context. Distinguishing between a paired and an unpaired *t*-test proved the biggest challenge with option A being the most common incorrect response.

Question 12

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

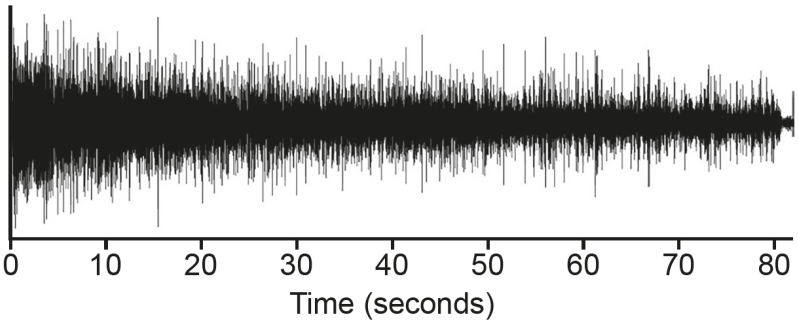
Your answer ☐ **[1]**

Knowledge of the respiratory quotient (RQ) as being the ratio between the carbon dioxide used and the oxygen consumed during the oxidation of a substrate was required to produce a response for this question. Many candidates were able to recall RQ and calculate 18/25 = 0.72 giving option B as the correct response. It was a common error to calculate 25/18 =1.39 giving option D as an incorrect response

Question 13

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]**

This question is an example of a statement-style multiple-choice question. Candidates needed to use the information in the diagram of an electromyogram (EMG) and their knowledge to process information in the three statements about muscle fatigue. Many candidates understood that lactic acid in muscles would cause fatigue and identified statement 1 as being correct. Those who were then able to apply their knowledge of the specification to the EMG deduced that frequency does not change and amplitude decreases, thereby realising that statements 2 and 3 were incorrect giving option D as the only correct response.

Section B overview

Mathematical and practical skills were embedded throughout the structured questions in section **B**.

Assessment objectives **AO1**, **AO2** and **AO3** were addressed throughout **Q16** to **Q22** with concepts from across the specification including the transport systems in plants, structure and function of muscle, photosynthesis and respiration. **Q20** proved the most challenging for candidates possibly due to lack of laboratory time or opportunities to complete PAGs.

Question 16 (a)

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

Generally, this question was well answered, with the majority of candidates able to gain 1 or 2 marks for explanations. Candidates demonstrated their knowledge of transport systems in plants and why they were needed, but examples often lacked required detail about the substance being transported or its source or destination, e.g. water transported from roots to leaves. Some candidates stated that glucose, not sucrose, is transported in the phloem and others made incorrect reference to multicellular plants having a **large** surface area to volume ratio.

Assessment for learning

Candidates should be encouraged to learn how to distinguish between specific organs that have an increased surface area, such as the leaf, and an entire multicellular organism which has a much lower SA:V.

Question 16 (b) (i)

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

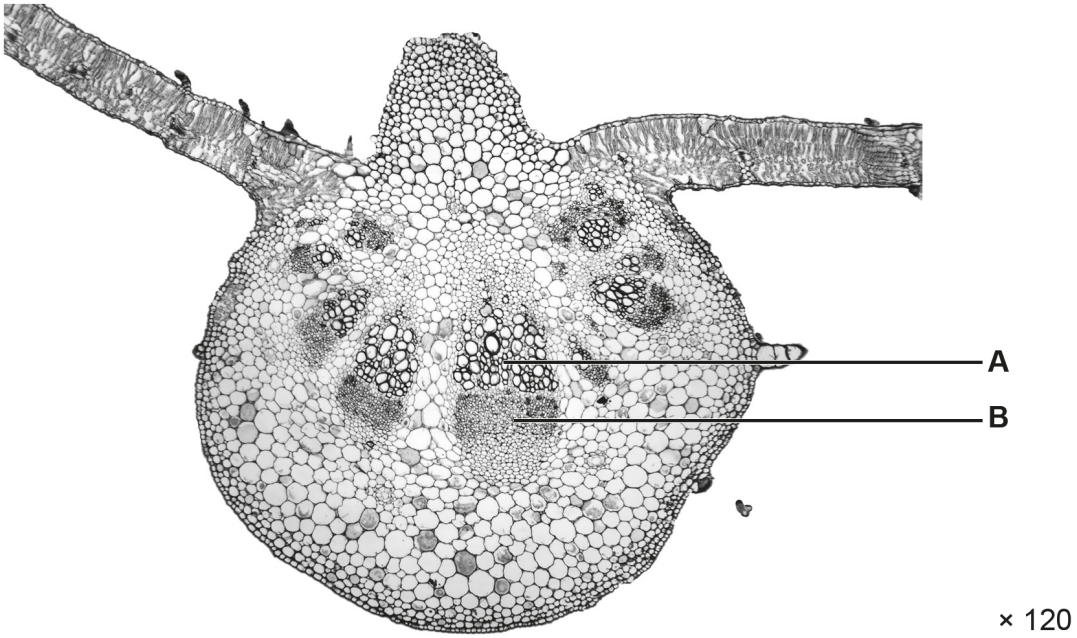

Fig. 16.1

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

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

The majority of candidates were able to identify phloem tissue from **Fig. 16.1**.

Question 16 (b) (ii)

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

1 .....

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2 .....

.....

[2]

Good responses stated two distinct functions, i.e. transport and support, to gain both marks. Some candidates considered transport of water and transport of mineral ions as two separate functions, thereby only gaining 1 mark.

Question 16 (c)

(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.

1 .....

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2 .....

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[4]

Many candidates clearly understood the role of lignin in supporting xylem vessels, waterproofing them and preventing collapse under tension. Responses referring to spiral thickening providing flexibility and hollow tubes facilitating free flow of water were less commonly seen by examiners. Some candidates incorrectly identified the tissue in **Fig. 16.2** as phloem or thought that both xylem and phloem were present. Other candidates misidentified the pits in the xylem vessel walls as plasmodesmata found in phloem tissue.

Assessment for learning

When comparing pits in xylem vessels with plasmodesmata in phloem, it is interesting to note that the role of plasmodesmata is to avoid passage through membranes, whereas bordered pits have 'pit membranes' through which water and dissolved ions travel.

Question 16 (d)

(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.

Item removed due to third party copyright restrictions

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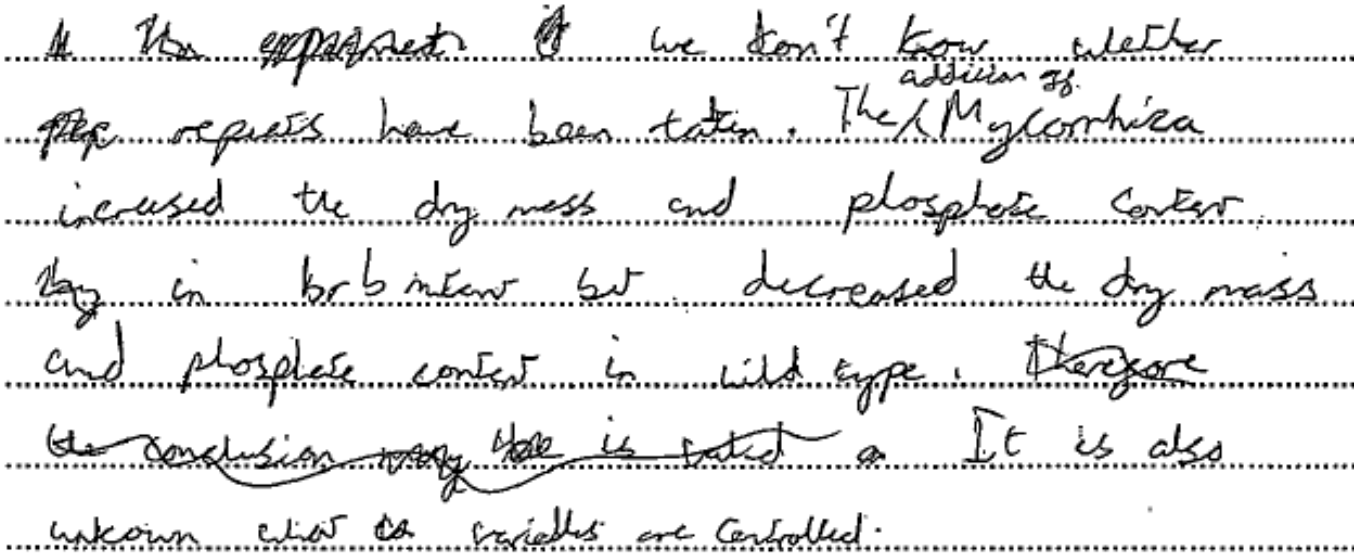
..... **[3]**

Candidates found the evaluation questions on this exam paper challenging and it was important to give a balance of supporting and non-supporting arguments to gain full marks. Good responses looked at the data for the *brb* mutant with fungus and compared it with the other plants in turn, giving their answer in a logical sequence. A few candidates over-complicated their responses when giving supporting data by trying to convert phosphate content to mg per gram of dry mass and therefore not realising the significance of the increase with the fungus in the *brb* mutant plants. Some candidates lost marks because they only mentioned increase in either dry mass or phosphate for MP1.

Assessment for learning

Evaluation is an important skill in A level Biology and candidates should be taught to take an analytical approach to interpreting experimental data. Candidates should also be encouraged to think about information not provided in the experimental detail, such as control variables or statistical analysis because these almost always offer opportunities to gain marks.

Exemplar 1



A good response is shown by this exemplar. The candidate provides a statement in support of the conclusion and two statements that would not support the scientists' conclusion.

Question 17*

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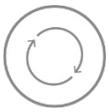
..... **[6]**

This question was generally very well answered. The chemical properties of water were less well covered than the physical properties and candidates who showed an understanding of the polarity of water molecules and/or the hydrogen bonding between molecules nearly always gained Level 3.

There was a good spread of answers concerning both physical properties and examples. There were very few examples given relating to hydrostatic skeleton, lubricant or cytosol. Most popular examples habitat for aquatic organisms and polar bears in reference to ice floating and insulating the water below, as were pond skaters.

The most common mistakes were to write about question stem references especially the thermal properties of water, sometimes at great length, or to confuse cohesion and adhesion or to refer to ice as being more dense than liquid water. There were some candidates who simply mentioned hydrogen bonds without making it clear that they were between water molecules or between water and other molecules. Other responses gave incorrect reference to charges on the water molecule.

Assessment for learning



Candidates often write too much for LoR questions with some completing several extra pages. Examiners appreciate how candidates want to demonstrate their knowledge, but they should be aware that marks are not given in proportion to the amount they write. It is important that candidates understand that a concise answer often achieves maximum marks. A good lesson in exam technique could be to encourage candidates to see if they can write a response and gain all 6 marks using only the space available.

Misconception

It is a common misconception that ice (water in solid form) is more dense than liquid water.

Exemplar 2

Water is polar and therefore makes a good solvent for polar substances and transport medium. For example, the liquid part of the blood is primarily composed of water. Water is able to carry dissolved substances such as glucose and amino acids and bring them to cells. Water is also able to remove waste products, such as urea. Water is able to dissolve toxic substances. As well as this, water is used as a medium in chemical reactions. ~~Water is used in~~ Water is used in photosynthesis and water is also used in hydrolysis reactions to break bonds. Water also has the property ice is less dense than liquid water. This means that in ponds and lakes, the water doesn't freeze from the bottom up, enabling aquatic organisms to survive. Furthermore, the [6]

Additional answer space if required.

cohesive forces between water molecules allow small insects to walk on water and also aid for the transport of water in the xylem of plants as the column of water can travel up the xylem to the leaves without breaking.

A good Level 3 response is shown by this exemplar. The candidate completes their response in the space available.

Question 18 (a) (i)

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]

Many candidates had the appropriate mathematical skills to work out dilutions correctly. Candidates should be reminded to keep their data in the same mathematical format provided in the question, in this case recording their answers to 1 decimal place.

Question 18 (a) (ii)

(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]**

The broad range of values seen by examiners demonstrated a lack of confidence in how to carry out this calculation, with few candidates stating the correct answer, 0.06, to the correct number of decimal places. Some candidates realised that they did need to double the uncertainty but could not correctly progress the calculation any further. Some responses seemed random with very large values and candidates should be encouraged to apply logic to such responses.

OCR support

The Maths skills handbook can be found on the qualification webpage to support candidates preparing for assessment.

Question 18 (b) (i)

(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]**

Most candidates correctly identified the value, with many highlighting it in the table as well, which is good practice. Some candidates were not specific enough in regard to which replicate value they were referring to, e.g., stating '-1.50' or '49.5', which were repeated in several different concentrations in the table so could not be given.

Question 18 (b) (ii)

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

Control variable .....

Reason .....

.....

.....

[2]

Many candidates correctly stated that temperature should be controlled and were able to give a suitable explanation in terms of increased kinetic energy, increased rate of osmosis or effect on membrane permeability. Some candidates noted that the age or species of potato should be controlled but were less sure as to why that was, with only the more able candidates mentioning that different potatoes could have a difference in water potential. Candidates should be reminded that it is important not to give a variable which had already been controlled. Several candidates stated length or surface area of potato cylinders as variables that should have been controlled, despite the procedure for preparing the cylinders being described in the question and percentage change in length being shown in the table of data.

Question 19 (a)

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]

Many candidates identified the correct options for the rows in the table and correctly entered ticks rather than a combination of ticks and crosses in their tables. Some responses did not gain marks as more than one tick per row had been entered. Most candidates knew that skeletal muscle was under conscious control, but several thought that cardiac fibres were multinucleate and that skeletal fibres were branched and interconnected.

Question 19 (b) (i)

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

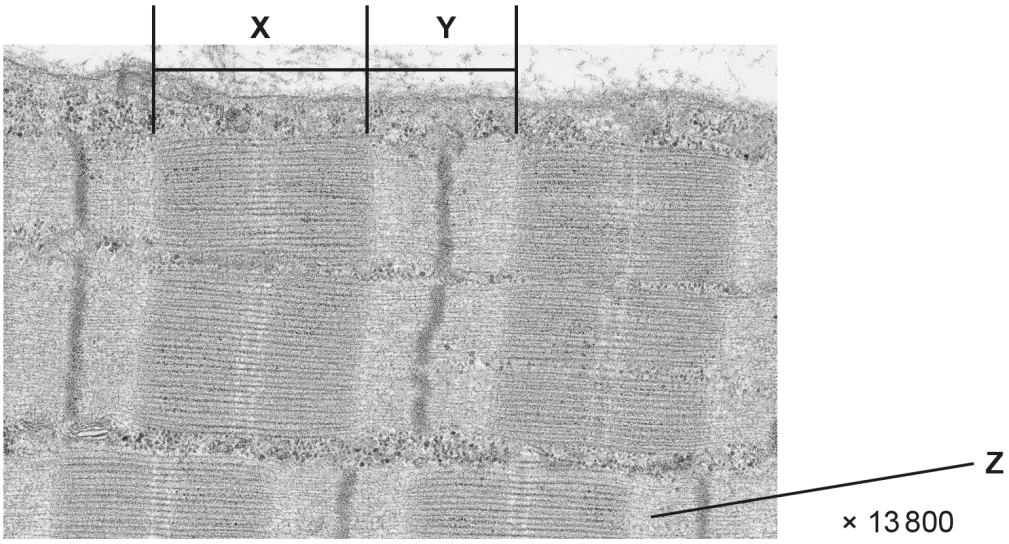


Fig. 19.1

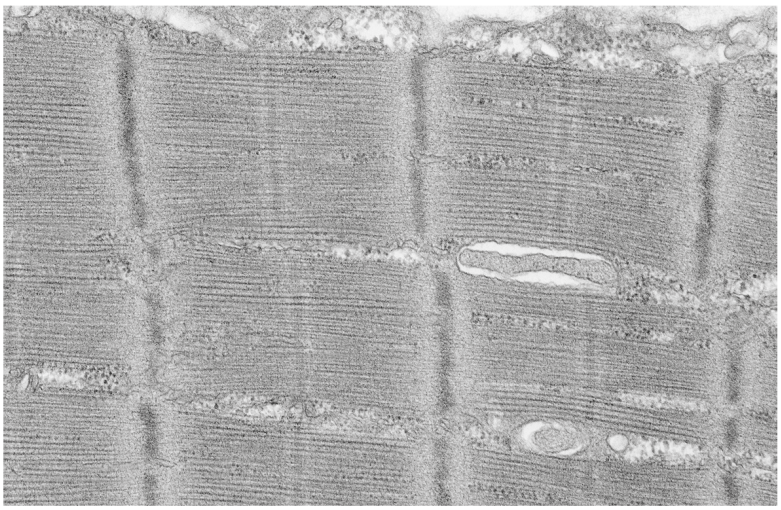


Fig. 19.2

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

1 .....

2 .....

3 .....

[3]

Most candidates gained at least one mark for including 'actin' as one of the proteins in the filament labelled **Z** on **Fig. 19.1**. Many also incorrectly included 'myosin'. Other incorrect answers given included a range of key terms related to muscles or proteins, e.g., sarcoplasm, collagen, keratin and myofibril.

Question 19 (b) (ii)

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

Explain why the two bands look different.

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

This question was answered well by the majority of candidates, although some candidates confused myosin with actin. less successful responses just stated that the difference was due to them having different proteins but didn't develop the response any further.

Question 19 (b) (iii)

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

Candidates who linked their responses to evidence that could be seen in the micrographs usually scored well, with correct reference made to the H- zone, I band and A band. However, many candidates simply described the sliding filament mode of muscle contraction in great detail with very little or no reference to the image provided in **Fig. 19.2**.

Question 19 (c)

(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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.....

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

Good responses described how ATP was required for breaking the cross-bridges between the actin and myosin, so the myosin could not detach if ATP was lacking, and the muscle would say contracted. However, several candidates stated that ATP was required to move the myosin head back to its original position or that it was required to form the cross-bridges, and so the muscle would not contract. Some candidates only described ATP as the energy currency of a cell, and so a lack of ATP would prevent muscle contraction as there is less energy available.

Misconception

The role of ATP in muscle contraction is commonly misunderstood with many candidates thinking that it is needed to attach myosin heads to the actin-binding site.

Question 19 (d)*

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

Many candidates gave good descriptions of aerobic, anaerobic respiration and the formation of ATP using creatine phosphate, briefly describing and comparing the main points of each ATP source as required by this LoR style question. However, several candidates frequently included a lot of unnecessary detail about aerobic respiration and wrote at length describing the biochemical details, which would been time-consuming. As with Question 17*, many candidates used extra pages to provide their response. Some candidates left out reference to aerobic respiration completely, possibly due to the reference to strenuous exercise in the question and went straight to discussing the role of anaerobic respiration and sometimes creatine phosphate.

Question 20 (a) (i)

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.

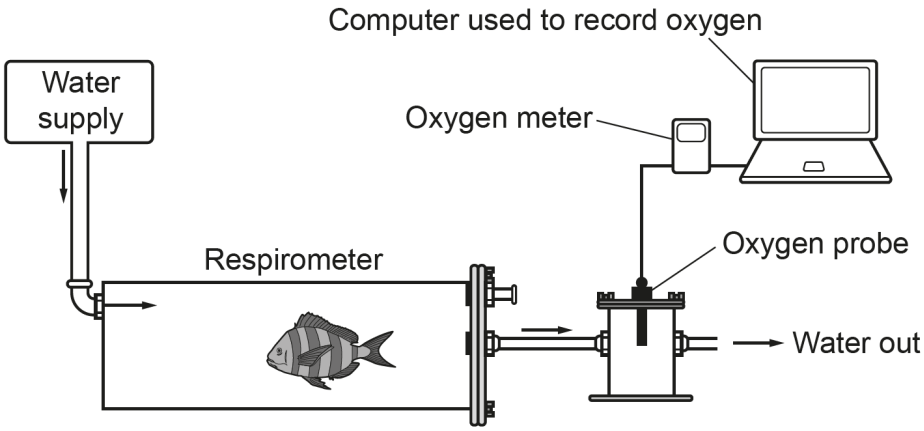

Fig. 20.1

(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 .....

.....

2 .....

.....

[2]

Most responses suggested a thermometer. Examiner's reports have stressed that use of a water bath is not considered sufficient. Some suggested use of a heater but didn't say that this was to achieve the required temperature. Some referred to use of a stop clock to measure rate, but this is not a modification to this apparatus. Some candidates suggested adding a carbon dioxide probe or referred to controlling other variables such as pH.

Question 20 (a) (ii)

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

.....

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

This question was well answered with reference to human error the most common answer. Several candidates gave accuracy or precision as their response. Only a few candidates referred to the idea of continual data collection or easier data analysis. Some candidates mistakenly thought that an advantage of a computer was that quantitative results could be obtained.

Question 20 (a) (iii)

(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]**

There were some excellent answers to this part question, including reference to the need for a supply of oxygen to allow gas exchange across the counter current flow system of the gills linked to respiration. Fewer candidates opted for the alternative of removing waste products such as carbon dioxide.

Question 20 (a) (iv)

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

This question was not very well answered, and most candidates did not gain any marks for their responses. Many did not seem to understand what 'precautions' meant and talked about use of controls, the number of fish or repeating and taking a mean. Common answers that did not gain marks were those referring to sealing leaks, so the oxygen content of the water was not affected, placing soda lime in the water to absorb carbon dioxide or references to size, number and health of fish. Testing the probes was also sometimes given as an answer.

Question 20 (b) (i)

(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**.

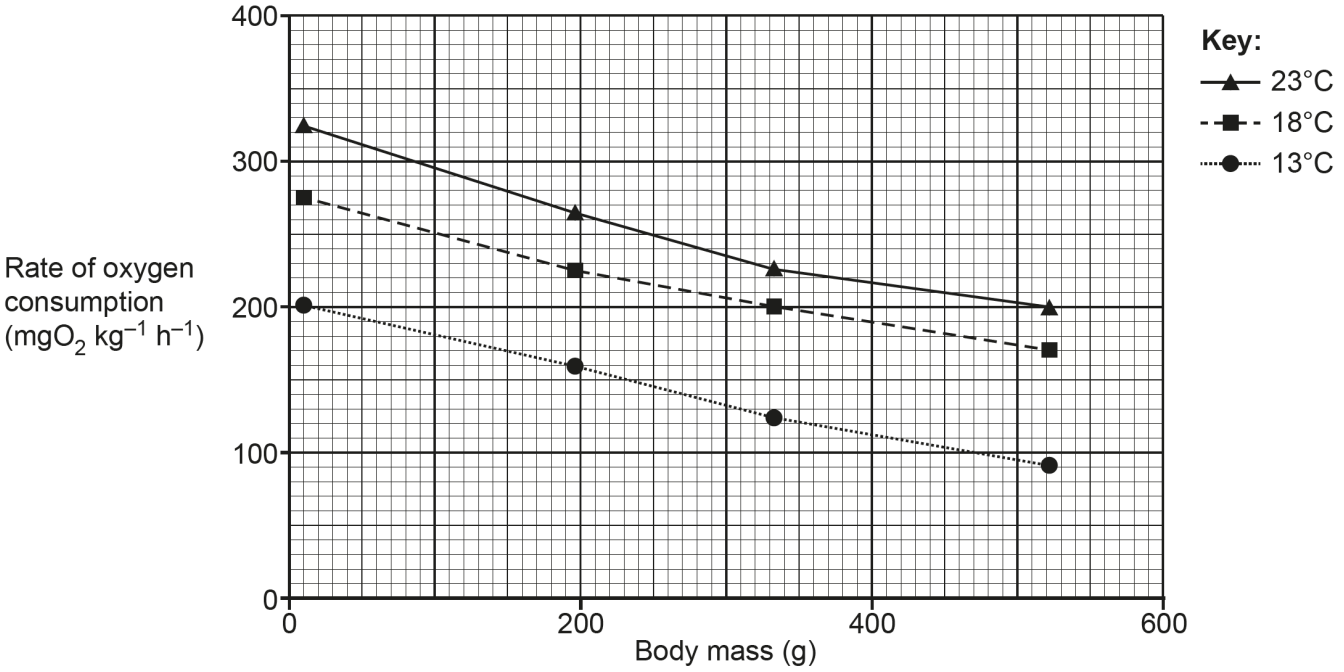

Fig. 20.2

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

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

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

It was encouraging to see candidates calculating Q10 correctly. The rate of reaction doubles for a 10°C rise in temperature for enzyme-controlled reactions. Q10 = 2. Candidates were given 1 mark for reading the correct values of 200 and 90 from the graph then 200/90 = 2.22 was a straightforward calculation.

Question 20 (b) (ii)

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

Evaluate their conclusion.

.....

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.....

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

Candidates should be encouraged to read the detail of the experiment and the results provided and be more critical of experimental methods that are presented to them. Some candidates were able to spot that only three temperatures had been used, and others that no statistical tests had been carried out. Some were able to suggest that warming to the highest temperature may not be economically sound; a question that is often asked in the context of photosynthesis and greenhouse temperatures. Candidates should be encouraged to give responses and critiques that both support and do not support the stated conclusion.

Question 21 (a) (i)

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

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

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.....

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

Most candidates knew that hormones were produced by endocrine glands to gain one mark. Good responses were seen where candidates extended their response to include information about hormones directly entering the bloodstream or glands being 'ductless'. There were some less successful responses that mentioned excretion, or release of hormones inside the cell.

Question 21 (a) (ii)

(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.

.....

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

Some candidates knew that enzymes were secreted into ducts, but a number described that digestive enzymes were secreted from cells or become active outside them.

Question 21 (b)

(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.

.....

.....

.....

.....

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

This question was generally well answered. Some candidates suggested that the receptor would be on the membrane despite also describing those steroid hormones could pass through. Other candidates incorrectly concluded that being lipid soluble meant they would not be able to pass through and stated the receptors would be on the surface of the plasma membrane. Some just referred to the 'cell membrane' or 'bilayer' instead of the plasma membrane, cell surface membrane or phospholipid bilayer.

Question 21 (c) (i)

(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]**

Most candidates found this question challenging. Some candidates did link cortisol to the regulation of metabolism but omitted to say that it is specifically 'carbohydrate' metabolism. Other candidates correctly attributed low blood pressure to the absence of aldosterone but did not develop their answer to link this to regulation of ion concentration, or just talked about salts rather than ions. Less successful responses confused the effects of each hormone, or attributed them both to each symptom or effect, e.g. cortisol and aldosterone are responsible for low blood pressure.

Question 21 (c) (ii)

(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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.....

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.....

.....

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

This question was generally answered well, and most candidates were able to gain 1 or 2 marks. Many responses included the idea that adrenaline was produced by the adrenal medulla, and linked the fact that adrenaline was responsible for the fight or flight response. Several candidates made reference to the sympathetic nervous system but did not develop their answer to include that it is also responsible for the flight or fight response.

Question 21 (d) (i)

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

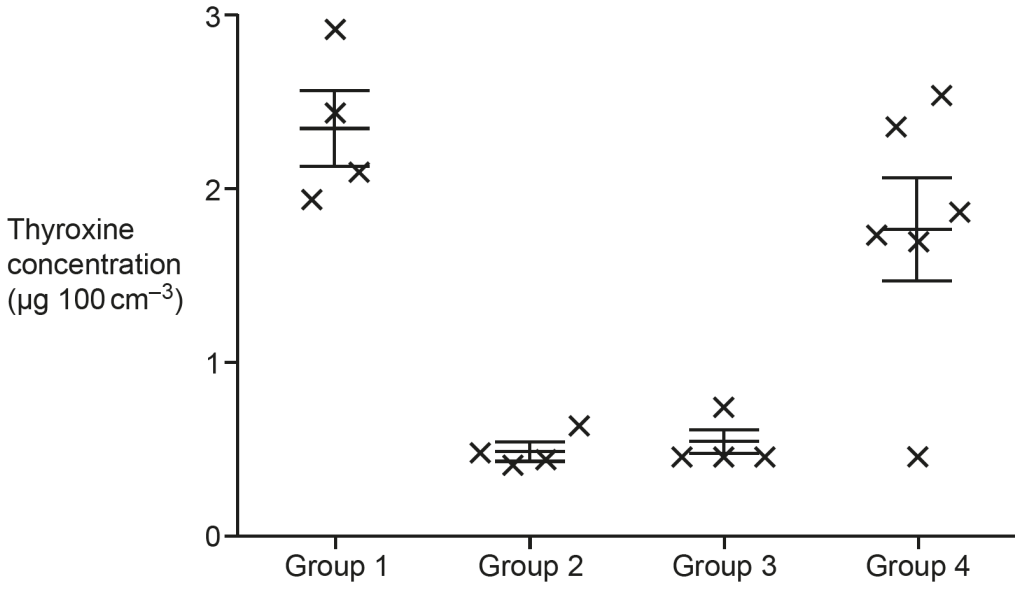
Scientists are investigating the use of stem cell transplants to treat hypothyroidism in which the thyroid glands of mice are destroyed using radioactive iodine.

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.



(i) The ESCs are described as pluripotent.

Explain what is meant by pluripotent.

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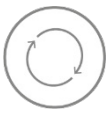
.....

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

Many candidates did not know the definition of 'pluripotent' and commonly gave the definition of multipotent stem cells. Several candidates did not refer to 'types' of cell or tissue. Few candidates developed their answer to refer to them as not being able to form a whole organism or extra-embryonic tissues.

Assessment for learning



It is evident that despite having knowledge of the terms pluripotent and multipotent many candidates still struggle to distinguish between them in context. Learning definitions for key terms is a good learning strategy.

Question 21 (d) (ii)

(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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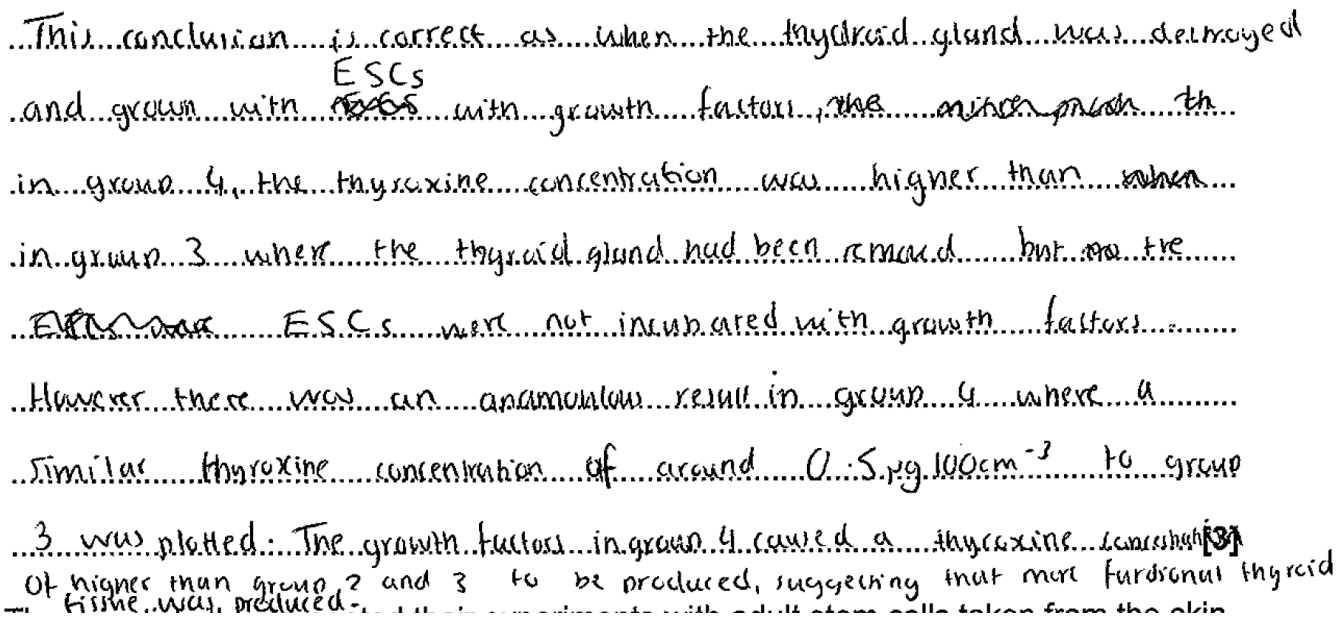
.....

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

As with other questions that required 'evaluation', this proved challenging for many candidates. Some candidates scored well by organising their response into 'supporting' statements and 'non-supporting' statements and referred to groups by number rather than by long descriptions. They compared one group directly with another rather than just making general descriptive comments about the results. Few candidates challenged the validity of the data. Those candidates who did spot the mouse with an unexpectedly low value did not refer to it as an anomaly or outlier or even specify which group it was in. Few candidates used the error/SD bars to look for any overlap and thus compare the groups, nor did they refer to mean values.

Exemplar 3


This conclusion is correct as when the thyroid gland was damaged and grown with ~~ESCs~~ ESCs with growth factors, the mitosis rate in group 4, the thyroxine concentration was higher than when in group 3 where the thyroid gland had been removed but no ESCs were not incubated with growth factors. However there was an anomalous result in group 4 where a similar thyroxine concentration of around 0.5 pg $100cm^{-3}$ to group 3 was plotted. The growth factors in group 4 caused a thyroxine concentration of higher than group 2 and 3 to be produced, suggesting that more functional thyroid tissue was produced. [3]

A good response is seen in this exemplar where supporting and non-supporting statements for the scientists' conclusion were provided for a balanced argument.

Question 21 (d) (iii)

(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 .....

.....

.....

Does not support .....

.....

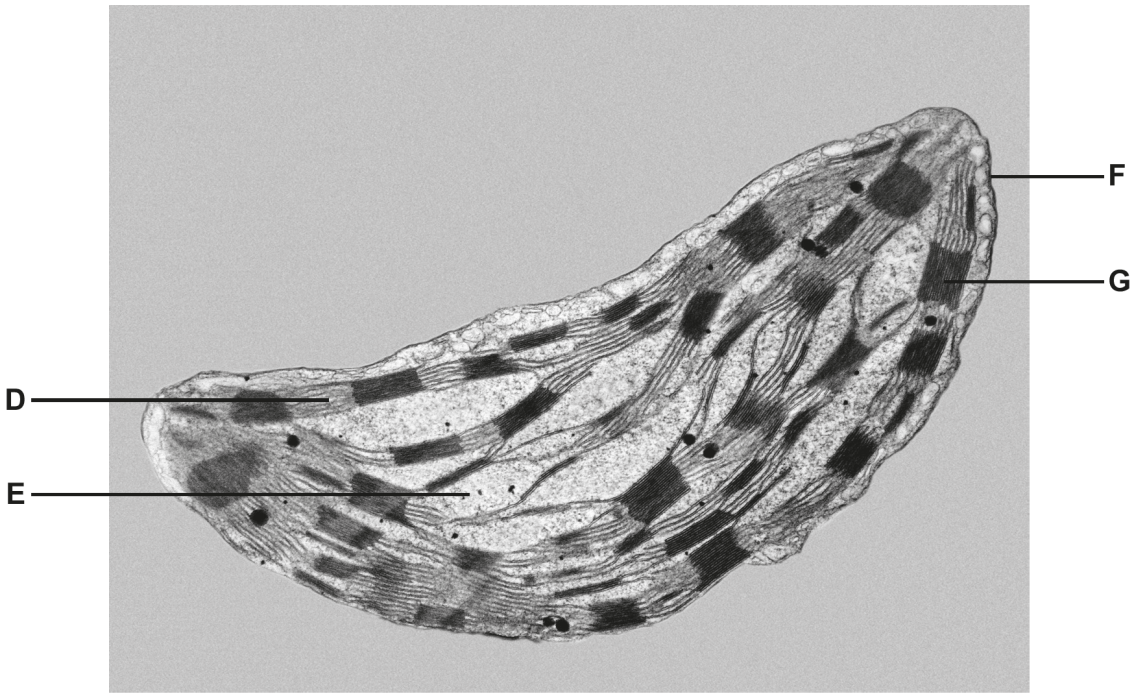
.....

[2]

Some candidates were able to describe the lower risk of rejection for the iPSCs to gain 1 mark, but very few went on to describe a reason for why the use of iPSCs might not be supported. Several candidates made statements regarding the ethics of using embryos as a source of stem cells despite the question being about the use of iPSCs.

Question 22 (a)

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]

A very straightforward end to the exam paper providing most candidates the opportunity to gain several marks. Many candidates were able to identify the chloroplast envelope correctly but the site of the light - independent reaction was often incorrectly identified as the thylakoids. The inter-granal lamellae proved the most difficult for candidates to identify.

Question 22 (b)

(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]**

As with Q22(a), this was quite a high scoring question, although few candidates gained full marks. Common errors seen included ribulose biphosphate or a confused version of glycerate phosphate, commonly glycerol-phosphate. Candidates may find it easier to use the abbreviation RuBP and GP and not the full words, as these have much less opportunity for error. Some candidates also confused RuBP with the enzyme, RuBisCO. Other errors included NADH (i.e. missing the phosphate) for NADPH or using the oxidised version, NADP. Very few candidates spotted the reference to transport meaning that sucrose was the expected answer, not glucose.

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