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June 2025

GCE Biology A 9BN0 02

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Introduction

This paper enabled candidates to consider aspects of the course via a range of different question types. Many offered clear, considered responses that illustrated a most pleasing level of knowledge and understanding. Congratulations should go to them for this, along with those who have both taught them and those who have helped prepare them for this examination.

Question 1(a)(i)

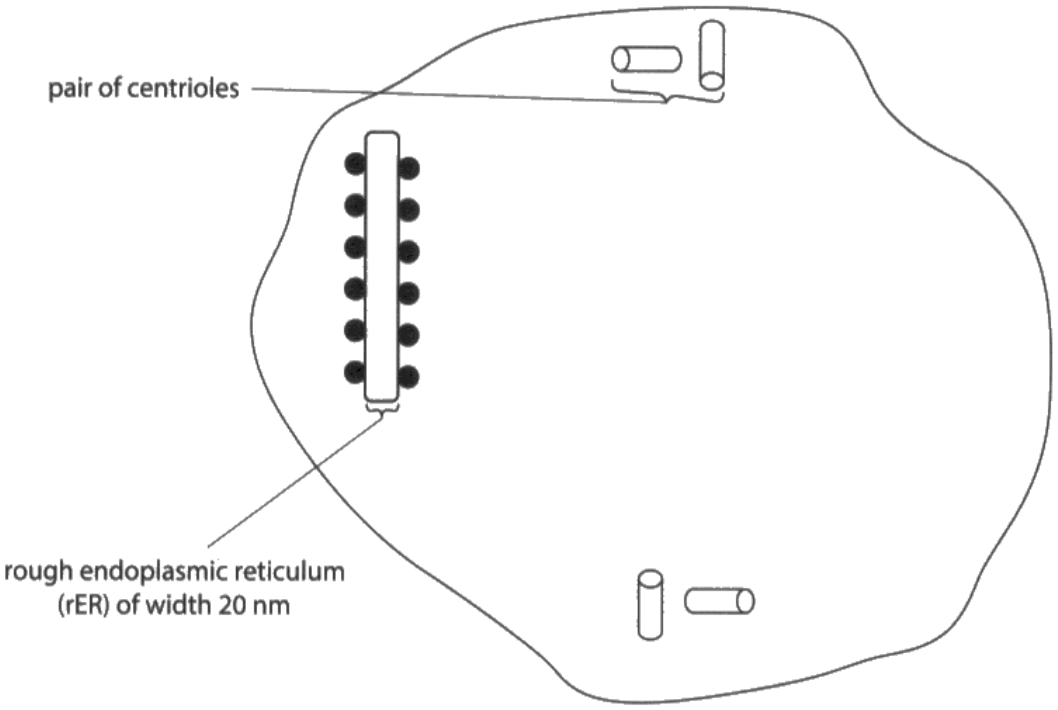
This first item of the paper required candidates to use the given true width of rough endoplasmic retirculum (rER) to calculate the magnification. This involved both measuring the rER width on the diagram and converting units. Many candidates tackled this with aplomb. The most common aspects that stopped candidates gaining full marks are given in the examples below.

This response illustrates the two most common errors that inhibited candidates from gaining marks in this calculation.

1 The pancreas is an organ found in the human body.

The pancreas is made up of a number of different cell types including beta cells and acinar cells.

(a) The diagram shows a beta cell from a human pancreas.



(i) Calculate the magnification of this diagram.

(2)

I
A M

~~20m~~ ~~2m~~ cm
cm
mm
µm
nm 20

÷10
×1000
×1000

~~12.1~~ cm

4cm / 20nm

4cm / 2×10^{-6}

$= 2,000,000$

2×10^{-6}

Answer 2,000,000×

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Examiner Comments

The diagram shows what is meant by the width of the rER by using a bracket. However, this candidate has measured the length of the rER on the diagram. The division suggests that the candidate has looked to convert 20 nm into cm which should work. However, the conversion is incorrect. It should have been 20 x 10^{-7} cm.

ResultsPlus
Examiner Tip

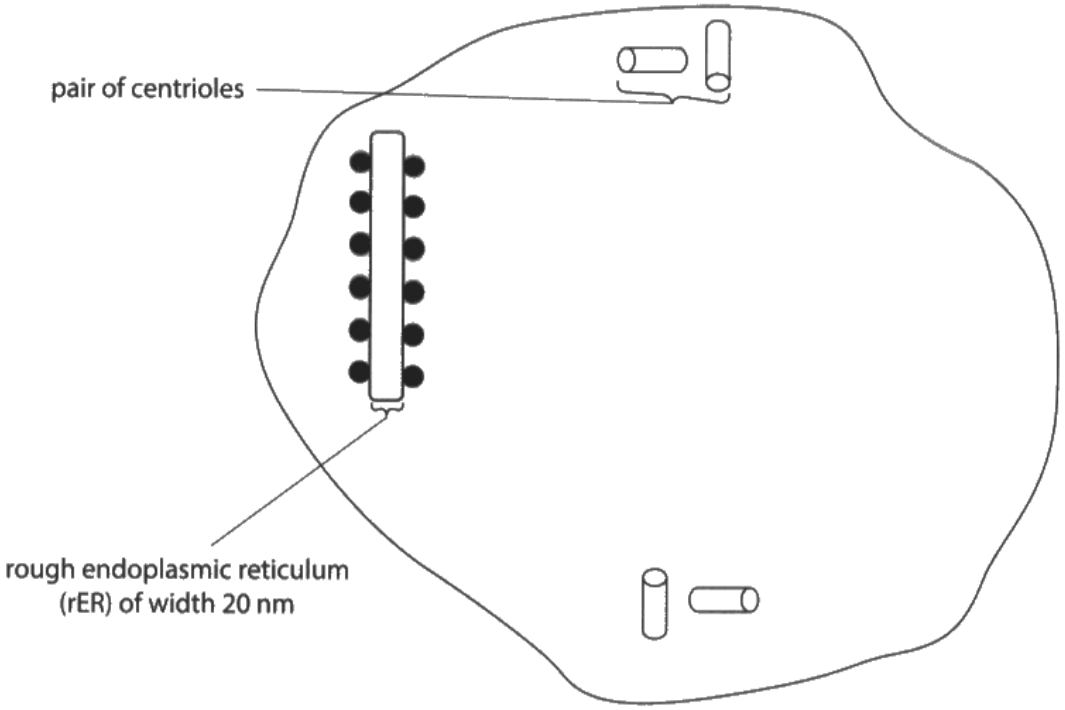
Make sure that length unit conversions such as between m, cm, mm, um and nm are fully appreciated.

This answer uses a correct technique to calculate magnification. However, the unit conversion for the diagram width of the rER is incorrect.

1 The pancreas is an organ found in the human body.

The pancreas is made up of a number of different cell types including beta cells and acinar cells.

(a) The diagram shows a beta cell from a human pancreas.



(i) Calculate the magnification of this diagram.

(2)

5mm = 5000nm

$\frac{5000}{20} = 250$

Answer 250

ResultsPlus
Examiner Comments

The calculation suggests that there was confusion with regard to micrometers and nanometers, hence the candidates magnification answer was a 1000 times lower than it should have been.

ResultsPlus
Examiner Tip

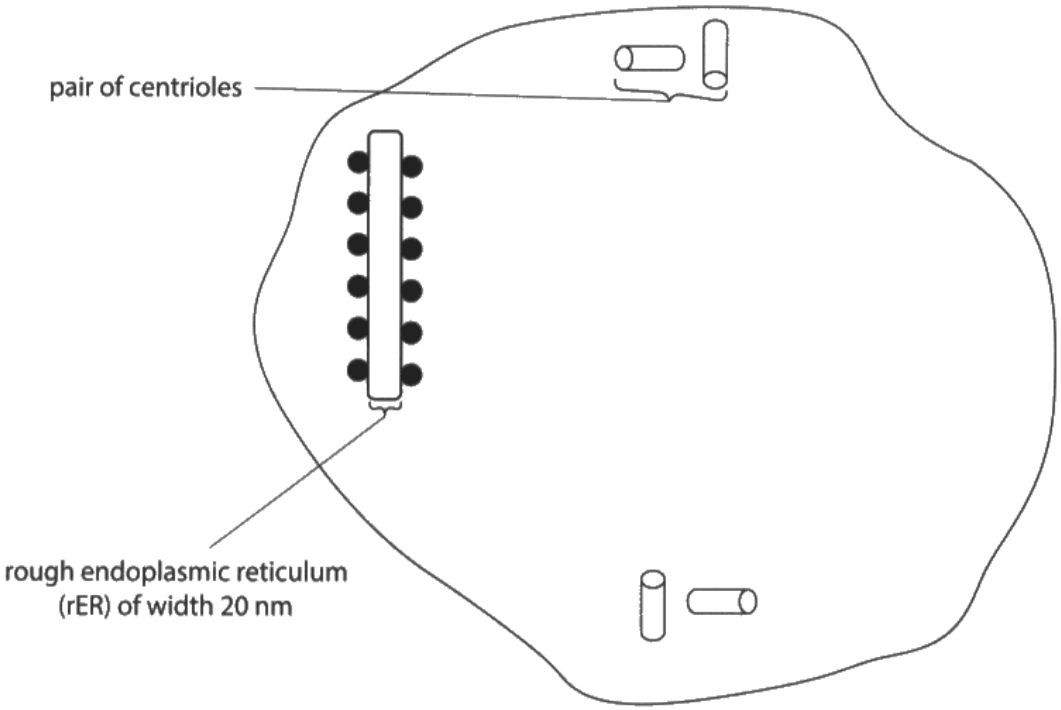
Make sure the difference between micrometers and nanometers is fully known.

This answer suggests a transfer error and then, sadly, a copying error.

1 The pancreas is an organ found in the human body.

The pancreas is made up of a number of different cell types including beta cells and acinar cells.

(a) The diagram shows a beta cell from a human pancreas.



(i) Calculate the magnification of this diagram.

(2)

I
A M

×1000 mm
×1000 µm
nm

$M = \frac{0.5\text{ mm}}{20\text{ nm}}$ $M = \frac{500000\text{ nm}}{20\text{ nm}}$

$M = 25000$

Answer 2500

ResultsPlus
Examiner Comments

It appears as though the candidate has correctly measured the width of the rER on the diagram as 0.5cm, but then written it down as 0.5mm. The conversion for 0.5mm to nm is correct.

This gave a magnification of x 25 000 which is worth one mark. However, despite the candidate writing this, the final answer the candidate offered was x2500, so no marks can be awarded.

ResultsPlus
Examiner Tip

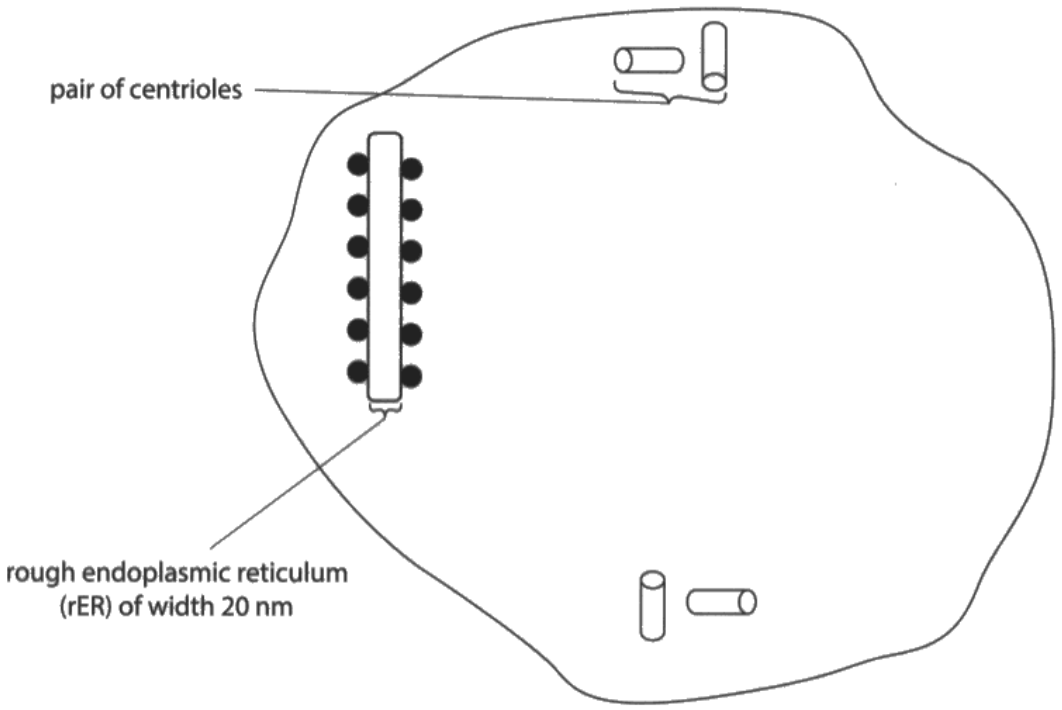
If you have the time, check your answers carefully.

A clear answer in which the candidate gains both marks.

1 The pancreas is an organ found in the human body.

The pancreas is made up of a number of different cell types including beta cells and acinar cells.

(a) The diagram shows a beta cell from a human pancreas.



(i) Calculate the magnification of this diagram.

(2)

I = 5mm = 5,000 µm

M A = 20nm = 0.02 µm

$$M = \frac{5,000}{0.02} = 250,000$$

Answer 250,000

ResultsPlus
Examiner Comments

The candidate has correctly converted both the true rER width, and the rER diagram width to micrometers and then tackled the calculation to deliver the correct answer.

Question 1(a)(ii)

Q01(a)(ii) required candidates to recognise which features of mitosis the diagram diagram showed. There were three choices for a maximum of two marks.

This response correctly identifies one of the features but the second suggestion would require more information to be accepted for the second mark.

(ii) A student viewed the diagram and stated that the cell was undergoing mitosis.

Give **two** reasons why this statement is correct.

(2)

1 Centrioles are present at either side of the cell

2 Cell membrane has grown in preperation for division

ResultsPlus
Examiner Comments

The candidate has correctly referred to the migration of centrioles to the opposite poles of the cell for the second marking point. However, for the candidate's second point to be awarded, a diagram of the same cell in interphase would be required.

ResultsPlus
Examiner Tip

As the question referred to using the diagram present, all the necessary information is present in the diagram.

This answer gains both marks by offering the two marking points not seen in the other candidate response.

(ii) A student viewed the diagram and stated that the cell was undergoing mitosis.

Give **two** reasons why this statement is correct.

(2)

1 There are two pairs of centrioles present, as centrioles have doubled

2 There is no membrane-bound ~~nucleus~~ nucleus present

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Examiner Comments

The candidate not only refers to pairs of centrioles but gives an explanation as to why there are two pairs present as their first correct answer.

ResultsPlus
Examiner Tip

The first response identifies that there are two pairs of centrioles present. The second mark is awarded for the absence of a nucleus.

Question 1(b)

In the context of acinar cells secreting elastase as a glycoprotein, this question required candidates to consider the processes that occurred from when the rER bound ribosomes made the polypeptide to the release of the glycoprotein from these cells.

A number of candidates did not take note of the limits of this question and started their responses with transcription. This was not necessary but, being irrelevant to the question, was simply ignored.

This is a strong, and thorough answer, that gains all four marks.

(b) Acinar cells produce the digestive enzyme elastase. Elastase is secreted from the acinar cells as a glycoprotein.

The polypeptide chain for elastase is formed on the ribosomes of the rER.

Describe how this polypeptide is processed to form a glycoprotein and then released from the cell.

(4)

The protein chain enters the rough endoplasmic reticulum where it folds and assumes its 3D shape. Then it travels in a vesicle to the golgi aparatus where the protein is modified, e.g. a carbohydrate group is added. The modified protein is then packaged into vesicles that are pinched off the golgi aparatus. The vesicles travel to the cell membrane and fuse with the cell membrane, releasing the protein by exocytosis.

ResultsPlus
Examiner Comments

The candidate has immediately referred to the polypeptide entering the rER lumen where it is folded in the first sentence. They then gain the next three marking points in order.

ResultsPlus
Examiner Tip

As this question is asking about a sequential process, it is a good idea to answer it in sequence as this reduces the risk of missing out an important stage.

This response has several elements of the process of converting a polypeptide into a glycoprotein but are not followed through sufficiently to be awarded marks.

(b) Acinar cells produce the digestive enzyme elastase. Elastase is secreted from the acinar cells as a glycoprotein.

The polypeptide chain for elastase is formed on the ribosomes of the rER.

Describe how this polypeptide is processed to form a glycoprotein and then released from the cell.

(4)

Polypeptide chain is in the Secondary Structure with R-groups branched off each Amino acid. This Polypeptide chain is folded using bonds between the R-groups of each Amino Acid causing it to become the tertiary Structure of a 3D-Shape where it is then modified to contain a glycogen bo~~t~~ packaged by the ~~rER~~ RER into ribosomal Subunits to be delivered to wherever the glycoprotien is needed within the cell.

ResultsPlus
Examiner Comments

The second sentence would need a correct reference to location to gain the first marking point. The reference to modification cannot be awarded, both for a lack of location and also by naming an incorrect carbohydrate.

ResultsPlus
Examiner Tip

This response does not cover the whole of the question which also included exocytosis. Always check the extent of a question.

Question 2(a)

This question essentially asks candidates to explain the effect of inhaling air with a raised carbon dioxide level. The context was in relation to using a spirometer without soda lime present. Many candidates were able to deliver thoughtful and complete answers, including going into the details of how breathing rate is controlled and altered by a raised blood carbon dioxide level.

This is a clear and succinct answer that gained the candidate full marks.

2 A spirometer can produce a trace used to study breathing.

(a) When using a spirometer, the same air is repeatedly inhaled and exhaled. Before the air is inhaled from the spirometer, it passes through soda lime to remove carbon dioxide.

Explain the effect on breathing if the inhaled air is **not** passed through soda lime.

(3)

If the inhaled air is not passed through soda lime, the carbon dioxide is not removed, the presence of the carbon dioxide increases blood CO_2 and therefore decreases blood pH. Chemoreceptors detect this change, causing the rate of breathing to increase so that CO_2 can be removed more quickly from the body and replaced with oxygen, and therefore the rate of respiration increases as more impulses are sent to intercostal muscles in the lungs.

ResultsPlus
Examiner Comments

The first sentence explains the effect of air not being passed through the soda lime, so gains the third marking point. It then links this to the effect within the body for the fourth marking point. As the reference to change is in the context of a decrease in blood pH, the reference to 'causing the rate of breathing to increase' is the second marking point.

ResultsPlus
Examiner Tip

Initially the candidate repeats the question which is not necessary.

This candidate response lacks the necessary detail to elicit the marks.

2 A spirometer can produce a trace used to study breathing.

(a) When using a spirometer, the same air is repeatedly inhaled and exhaled. Before the air is inhaled from the spirometer, it passes through soda lime to remove carbon dioxide.

Explain the effect on breathing if the inhaled air is **not** passed through soda lime.

(3)

This can result in the participant inhaling the ~~carbox~~ carbon dioxide they had just previously exhaled rather than oxygen needed for bodily function. This may lead to health risks such as shortness of breath as we are unable to respire properly as well as gas exchange in the blood being affected and no longer efficient p, reducing the oxygen to vital organs like the heart. If this is continued it may lead to serious heart concerns and breathing ~~rate~~ would significantly get worse.

ResultsPlus
Examiner Comments

The start of the first sentence refers to the participant inhaling carbon dioxide. However, the lack of soda lime whilst using a spirometer would lead to the participant inhaling increasing levels of carbon dioxide, and it is this what is required for the third marking point. The first two marking points are specific effects on breathing, so the final part of this response referring to breathing getting significantly worse, is insufficient.

This is an example of a thorough and excellent response that achieved three marks.

2 A spirometer can produce a trace used to study breathing.

(a) When using a spirometer, the same air is repeatedly inhaled and exhaled. Before the air is inhaled from the spirometer, it passes through soda lime to remove carbon dioxide.

Explain the effect on breathing if the inhaled air is **not** passed through soda lime. **(3)**

CO2 is not removed from air. carbon dioxide concentration increases in alveoli, and in blood, so pH of blood decreases, which is detected by chemoreceptors located in aortic arch, medulla oblongata and carotid artery. more frequent impulses sent to ventilation centre in medulla oblongata via sympathetic neurones, which sends more frequent impulses* to diaphragm and intercostal muscles which contract more, and so breathing rate is increased

* down parasympathetic neurones

ResultsPlus
Examiner Comments

The candidate offers the third, then fourth and finally the second marking point, for full marks.

Question 2(b)(iii)

This devise an investigation question focused on using a spirometer to compare the rate of oxygen uptake during exercise with the rate at rest. Whilst a pleasing number offered answers in relation to oxygen uptake, many limited themselves to breathing rate.

This answer offers some elements of spirometer use but does not describe how to find the oxygen uptake. It is typical of many seen.

(iii) Devise an investigation, using a spirometer, to find the change in the rate of oxygen uptake of a person during exercise compared with at rest.

(3)

Make sure to keep the weight, gender and athletic ability of the people in the experiment the same for more accurate results.

Use the spirometer on the person at rest first, to find the rate of O_2 uptake over a period of 5 minutes.

Let the person exercise for 5 minutes before using the spirometer to find the rate of O_2 uptake over a period of 5 minutes.

Repeat this experiment using different people.

Keep temperature and humidity the same.

Use results to calculate change in rate of O_2 uptake in a person during exercise compared to at rest.

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Examiner Comments

The first marking point focuses on some form of spirometer readings taken at both rest and during, or immediately after, exercise. As such the second and third paragraphs together achieve this point. The next paragraph starts to consider repeats but needed to then consider what should be done with that data.

ResultsPlus
Examiner Tip

If referring to repeats, consider whether a mean should then be calculated.

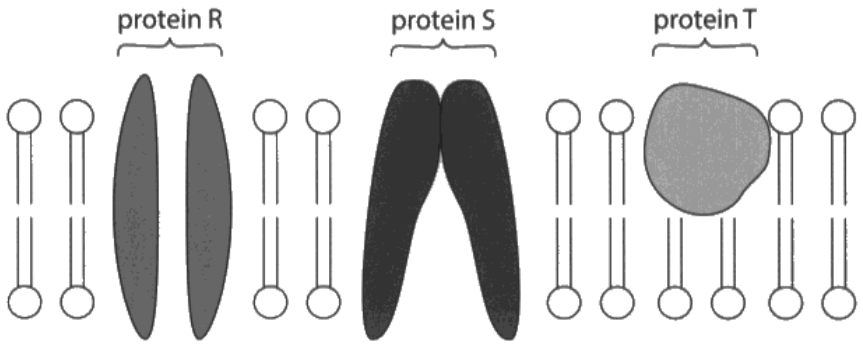
Question 3(a)

Candidates were presented with a labelled cholesterol diagram and asked to describe how it is positioned within a phospholipid bilayer. There were many excellent answers, but also a sizable minority who confused the terms hydrophilic and hydrophobic.

A strong and detailed answer that makes it very clear where the two labelled regions of cholesterol are located.

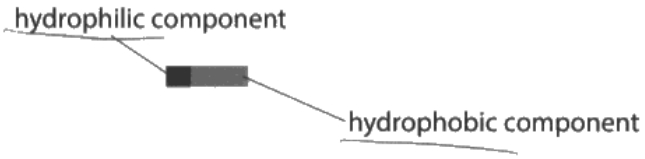
3 All cells have a cell surface membrane that allows some ions to move across.

The diagram shows the fluid mosaic model for the cell surface membrane.



(a) The cell surface membrane also contains cholesterol.

This diagram represents cholesterol.



Describe how the cholesterol is positioned within the phospholipid bilayer.

(2)

hydrophilic component of cholesterol is polar, associates with hydrophilic, polar, phosphate head of a phospholipid

hydrophobic component of cholesterol is non-polar and associates with the hydrophobic, non-polar, fatty acid tails of phospholipid in the middle of phospholipid bilayer cell surface membrane

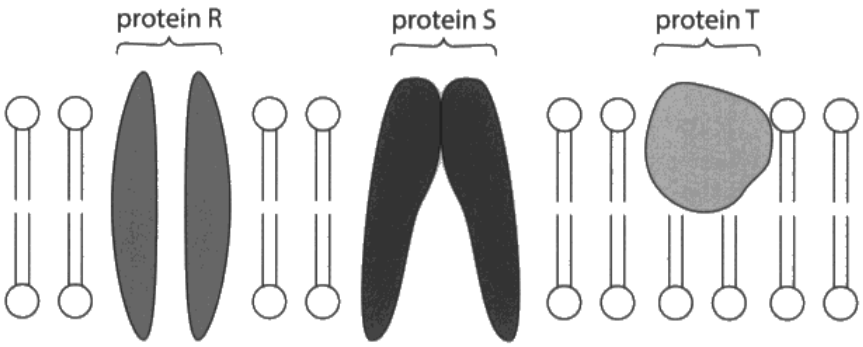
ResultsPlus
Examiner Comments

The first paragraph gains the first marking point, whilst the second paragraph is awarded the second marking point.

The first lines of this response essentially reflect the question, whilst the second line offers a role of cholesterol.

3 All cells have a cell surface membrane that allows some ions to move across.

The diagram shows the fluid mosaic model for the cell surface membrane.



(a) The cell surface membrane also contains cholesterol.

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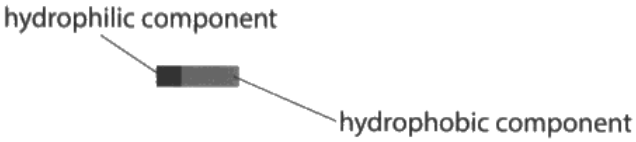

Describe how the cholesterol is positioned within the phospholipid bilayer.

(2)

cholesterol is embedded in the phospholipid bilayer
this causes the fluidity of the membrane.

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Examiner Comments

No marks can be awarded for this answer.

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Examiner Tip

Make sure that the answer offered links to the question being asked.

Question 3(b)

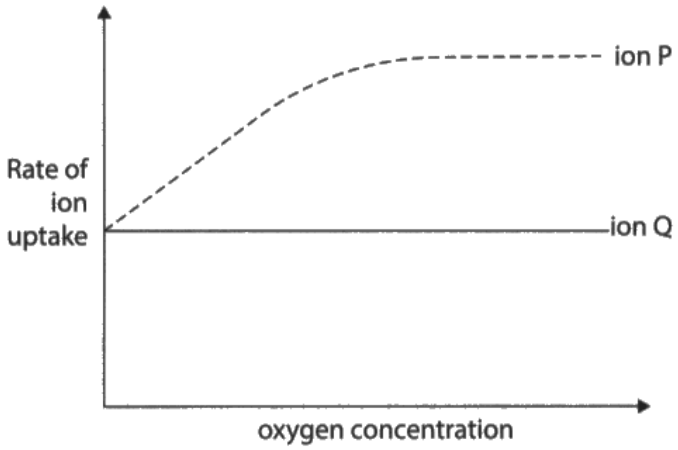
This question required candidates to consider the fluid mosaic model diagram, some text above a graph and also the graph. It was pleasing to note that the majority were able to do this, though a number did not seem to distinguish between rate of ion uptake and ion uptake on the vertical axis of the graph.

This candidate answer gains the two most commonly awarded marking points.

(b) An animal cell, containing proteins R, S and T in its cell surface membrane, was placed in a solution containing two ions, P and Q.

The rate of uptake of both ions was measured as the cell was supplied with an increasing concentration of oxygen.

The results are shown in the graph.



Only one of the proteins labelled R, S and T on the diagram on page 8 allows the uptake of ion P.

This protein changes shape to move ion P.

Explain which protein allows the uptake of ion P.

(4)

protein S which is a carrier protein, as it changes its shape to be able to bind the ion and transport it into the cell by facilitated diffusion. Protein R as it is a channel protein and does not change shape

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Examiner Comments

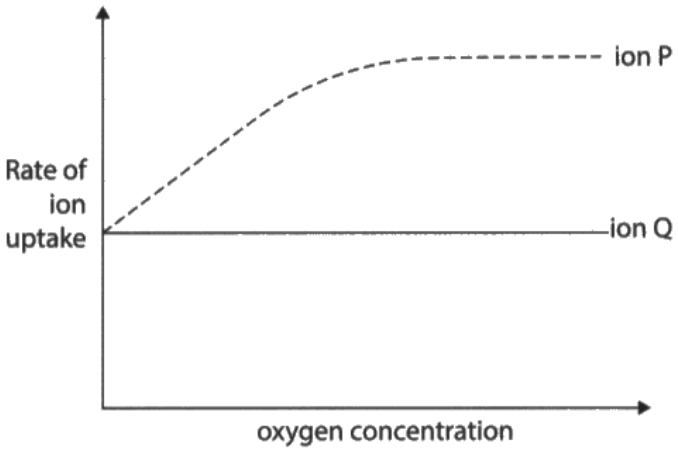
The first line achieves the first two marking points in sequence.

A short answer that gains a quarter of the available marks.

(b) An animal cell, containing proteins R, S and T in its cell surface membrane, was placed in a solution containing two ions, P and Q.

The rate of uptake of both ions was measured as the cell was supplied with an increasing concentration of oxygen.

The results are shown in the graph.



Only one of the proteins labelled R, S and T on the diagram on page 8 allows the uptake of ion P.

This protein changes shape to move ion P.

Explain which protein allows the uptake of ion P.

(4)

Protein S allows the uptake of ion P

ResultsPlus
Examiner Comments

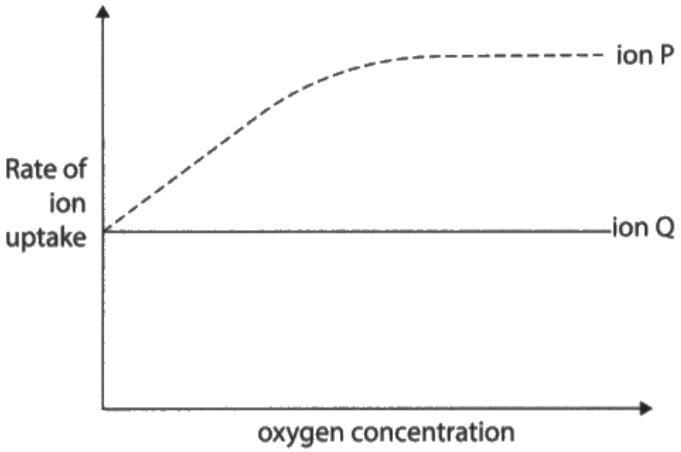
The candidate has correctly identified the protein that actively transports ion P into this animal cell, so the first marking point is achieved.

A pleasing response that achieves most of the marks.

(b) An animal cell, containing proteins R, S and T in its cell surface membrane, was placed in a solution containing two ions, P and Q.

The rate of uptake of both ions was measured as the cell was supplied with an increasing concentration of oxygen.

The results are shown in the graph.



Only one of the proteins labelled R, S and T on the diagram on page 8 allows the uptake of ion P.

This protein changes shape to move ion P.

Explain which protein allows the uptake of ion P.

(4)

Protein S, it is a carrier protein and uses active transport to move ion P across the membrane. Protein R is a channel protein which do not change shape. Carrier proteins like S require energy for active transport, as they are regularly working against a concentration gradient, this energy comes from ATP which needs oxygen to be synthesised.

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Examiner Comments

The first sentence delivers the first, second and fourth marking points.

Question 4(a)

This item required candidates to describe the pathway a nerve impulse travels from the back of the eye to the visual cortex of the brain. Many candidates displayed a good grasp of this material.

A sound answer that gains two thirds of the marks. They were the most commonly seen points.

4 The human eye can detect both images and a change in light intensity.

(a) Describe the pathway taken by nerve impulses from sensory cells in the eye to the part of the brain that forms the images.

(3)

sensory cells in the ↓ the retina in the eye detects the stimulus, sends impulses along the optic nerve to thalamus. Thalamus the [illegible] then sends the impulse to the visual cortex in the occipital lobe of the brain.

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Examiner Comments

The reference to optic nerve in the second line gains the third marking point. The final marking point is seen in the final sentence.

ResultsPlus
Examiner Tip

Look to expand on the question rather than repeat it. For example, the question refers to sensory cells in the eye, whilst the first marking point requires the sensory cells to be named and the photosensitive layer in the eye to be identified. Whilst the reference to the part of the brain that forms the images needs to be stated for the final marking point.

This response did not quite answer the question being asked.

4 The human eye can detect both images and a change in light intensity.

(a) Describe the pathway taken by nerve impulses from sensory cells in the eye to the part of the brain that forms the images.

(3)

- sensory cells in the retina detect the stimulus.
- Action potential is triggered and delivered to the hypothalamus delivering a wave of depolarisation.
- Na^+ and K^+ channels open allowing the ions to diffuse through.
- Action potential is sent to the effector.

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Examiner Comments

No marks could be awarded for this answer.

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Examiner Tip

Look carefully to try and ascertain the thrust of the question.

Question 4(b)

Given appropriate data, candidates were asked to calculate the maximum number of cones in the fovea. This item was tackled effectively by many, though a few failed to present their answer to three significant figures as requested.

This answer illustrates the good practice of showing the various stages in the calculation, and gains most of the available marks.

(b) The fovea is part of the retina.

In one study, the mean density of photosensitive cells in the fovea was found to be 164 000 ± 24 000 per mm^2.

The mean radius of the fovea is 0.8 mm.

Calculate the maximum number of photosensitive cells present in the fovea.

Give your answer to 3 significant figures.

(3)

$\pi \times 0.8^2 = 2.01 mm^2$

$164000 + 24000 = 188000$

$\frac{188000}{2.01} = 93532.33$

Answer 93500

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Examiner Comments

The candidate has correctly calculated the fovea area (as 2.01 mm^{-2}) and also the maximum density of photosensitive cells in the fovea (as 188 000). Each of these gained a mark. Unfortunately, these two figures should have been multiplied together rather than a division being performed.

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Examiner Tip

Whilst there is no requirement to show working for a calculation, as shown in this example,

it can be advantageous to do so.

A nicely laid out calculation culminating in the correct answer and then delivering this to three significant figures.

(b) The fovea is part of the retina.

In one study, the mean density of photosensitive cells in the fovea was found to be 164 000 ± 24 000 per mm².

The mean radius of the fovea is 0.8 mm.

Calculate the maximum number of photosensitive cells present in the fovea.

Give your answer to 3 significant figures.

(3)

188000 per MM^2

diameter = 1.6 MM

area = 2.01 MM^2

188000 × 2.01 = 377996.4281

Answer 378000

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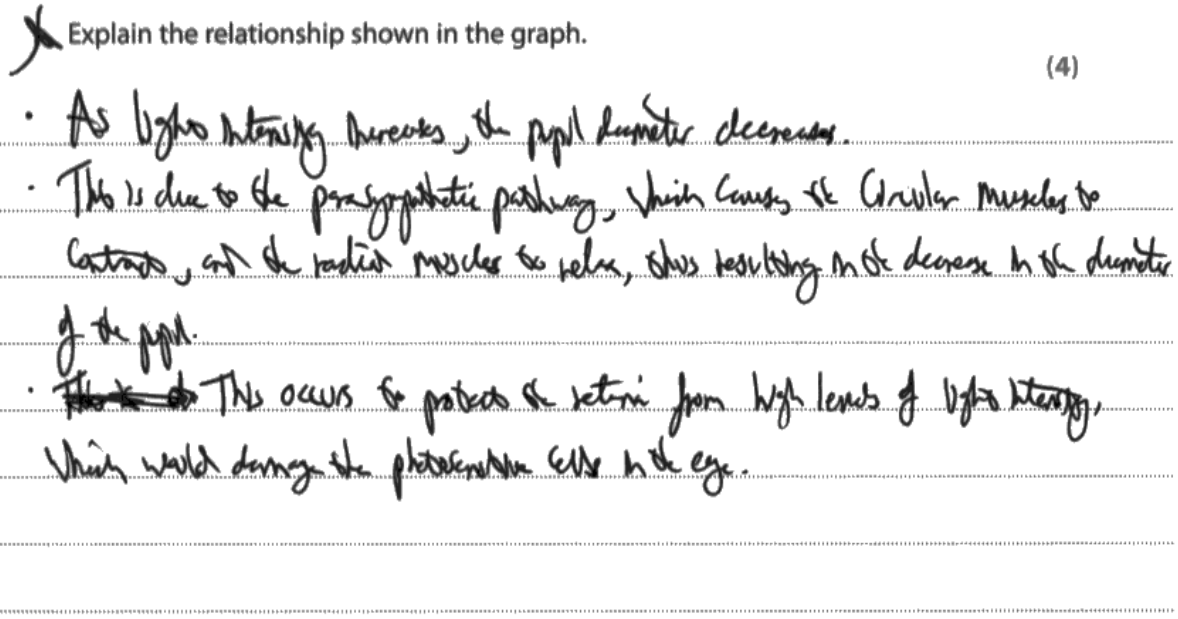
All three marks were awarded for this answer.

Question 4(c)

The candidates were presented with a graph showing the effect of light intensity on pupil diameter. They were asked to then explain the relationship shown.

A succinct answer that targets all four marking points.



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Examiner Comments

The first bullet point detailed the relationship between light intensity and pupil diameter.

The second bullet point delivers the second and third marking points.

The final bullet point, links protecting the retina from damage with high light intensity for the fourth marking point.

ResultsPlus
Examiner Tip

When asked to explain a relationship, and the relationship has not already been stated, look to offer this.

A detailed response that was awarded three marks.

Explain the relationship shown in the graph.

(4)

As light intensity increases, pupil diameter decreases in size, suggesting a negative correlation. This is because the pupil adjusts to allow light in. When there is bright light, radial muscles relax and circular muscles contract, causing pupil to constrict in the presence of light. This explains why as light intensity increases, pupil diameter decreases when there is low light, radial muscles will contract and circular muscles will relax causing pupil to dilate and and allow eye to detect more light, explaining why at the start when light intensity is low, pupil diameter is high.

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Like many responses, this one starts with suitably giving the relationship in the first two and a half lines, for the first marking point.

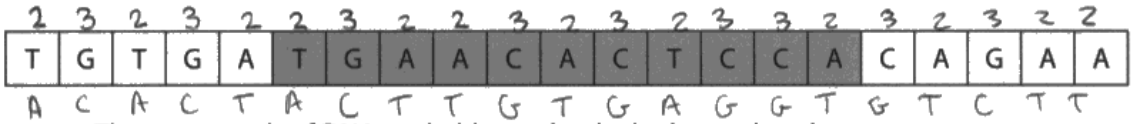
The answer then describes the behaviour of the antagonistic muscles in the iris for the second and third marking points. These marking points could have been awarded for when considering increasing light intensity or decreasing light intensity. This response considered both.

Question 5(a)(ii)

This question initially required candidates to recall the DNA nucleotide base pairings, and then to apply this to perform a calculation relating to a myostatin mutation in Belgian Blue cattle. It was most encouraging to see many tackle this percentage reduction calculation effectively.

This response gained one mark for correctly finding the total number of hydrogen bonds between the base pairs in the shown section of the myostatin gene without the deletion.

(ii) The bases shaded are deleted from one strand in the mutated gene (Stage 1).



The two strands of DNA are held together by hydrogen bonds.

There are two hydrogen bonds between adenine (A) and its complementary base and three between the other pair of bases.

Calculate the percentage reduction in the number of hydrogen bonds in this part of the myostatin gene due to the mutation.

Give your answer to one decimal place.

(3)

61 H bonds
- 28 H bonds

$\frac{23}{51} \times 100$
= 45.1

45.1 %

ResultsPlus
Examiner Comments

Looking at the annotations given by the candidate with the mutated strand, the numbers are correct for the hydrogen bonds. However, in the calculation, there appears to have been a summation error for the number of hydrogen bonds in the deleted section.

ResultsPlus
Examiner Tip

If time is available, look to check through answers carefully.

This response gained full marks.

(ii) The bases shaded are deleted from one strand in the mutated gene (Stage 1).

The two strands of DNA are held together by hydrogen bonds.

There are two hydrogen bonds between adenine (A) and its complementary base and three between the other pair of bases.

Calculate the percentage reduction in the number of hydrogen bonds in this part of the myostatin gene due to the mutation.

Give your answer to one decimal place.

(3)

27 lost

51

51 × x = 27

x = 27/51

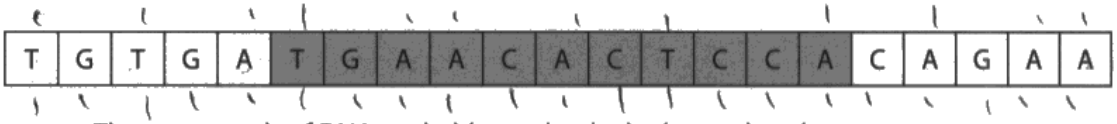
47.1 ..... %

ResultsPlus
Examiner Comments

This answer offers one of the two acceptable percentage reductions, ie 47.1%.

Whilst full marks can be awarded for this response as the answer is correct, the candidate has set out the various stages in their calculation to help.

(ii) The bases shaded are deleted from one strand in the mutated gene (Stage 1).



The two strands of DNA are held together by hydrogen bonds.

There are two hydrogen bonds between adenine (A) and its complementary base and three between the other pair of bases.

Calculate the percentage reduction in the number of hydrogen bonds in this part of the myostatin gene due to the mutation.

Give your answer to one decimal place.

(3)

A=T
C≡G

Non mutated
A = 8 x 2 = 16
T = 4 x 2 = 8
C = 5 x 3 = 15
G = 4 x 3 = 12
} 51

mutated
A = 4 x 2 = 8
T = 2 x 2 = 4
C = 1 x 3 = 3
G = 3 x 3 = 9
} 24

$\frac{51 - 24}{51} \times 100 = 52.9$

52.9 %

ResultsPlus Examiner Comments

The answer of 52.9% is the other acceptable percentage reduction result, given to one decimal place for all three marks.

Question 5(b)

The context of this question relates to non-functioning myostatin protein produced from the mutated myostatin gene. Candidates had to explain why the product of the mutation does not function. Many candidates appeared to have a thorough understanding of this.

This answer gains all three marks but includes unnecessary material.

(b) Explain why myostatin produced from the mutated gene does not function (Stage 2).

(3)

Mutation is a change in DNA base sequence of a gene. This changes the ~~base~~ complementary base sequence of mRNA is produced in transcription. This changes tRNA molecules with amino acid and complementary anti-codon to the codons on mRNA. This changes the sequence of amino acids produced in translation. The amino acids will have different R groups present which changes how the polypeptide chain will fold into tertiary structure. Different bonding (Hydrogen, ionic, disulphide) holding 3D shape. Therefore, protein cannot function and it's active site will not be complementary to the substrate.

ResultsPlus
Examiner Comments

The fourth sentence can be awarded the first marking point, whilst the fifth sentence gains both the second and third points respectively.

ResultsPlus
Examiner Tip

As the question asks for why the already made myostatin protein (from the mutated gene) does not work, the first three sentences considering how this protein is made are beyond the scope of the question. Therefore, they were not required. Look carefully to see where a question offers the starting point for an answer.

Question 6(a)

This recall question required candidates to offer the type of muscle antagonistic to a flexor muscle. Whilst most gave the right answer, some also gave the name of the specific antagonistic muscle involved. A few looked to describe the muscle.

This response gives one of the more common incorrect answers seen.

6 Antagonistic muscles interact to control the movement of the legs.

Sprinters need to respond rapidly to the starting signal in a race.

In an investigation, the response time for a group of athletes was studied.

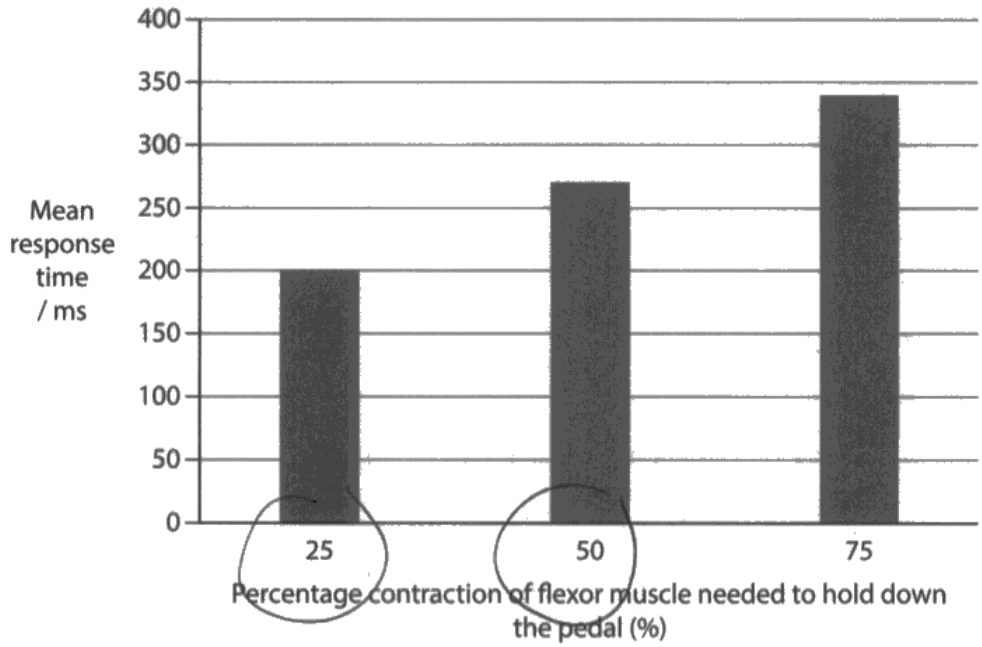
Each athlete contracted a flexor muscle in the leg to hold a pedal down.

When a light was switched off, the athlete released the pedal. Flexor

The response time for the flexor muscle to fully relax was recorded.

The investigation was repeated except the percentage muscle contraction needed to hold the pedal down was changed.

The results are shown in the graph.



(a) State the type of muscle that works antagonistically with a flexor muscle.

(1)

relaxor.

ResultsPlus
Examiner Comments

The mark could not be awarded.

This answer shows one of the other common incorrect responses.

6 Antagonistic muscles interact to control the movement of the legs.

Sprinters need to respond rapidly to the starting signal in a race.

In an investigation, the response time for a group of athletes was studied.

Each athlete contracted a flexor muscle in the leg to hold a pedal down.

When a light was switched off, the athlete released the pedal.

The response time for the flexor muscle to fully relax was recorded.

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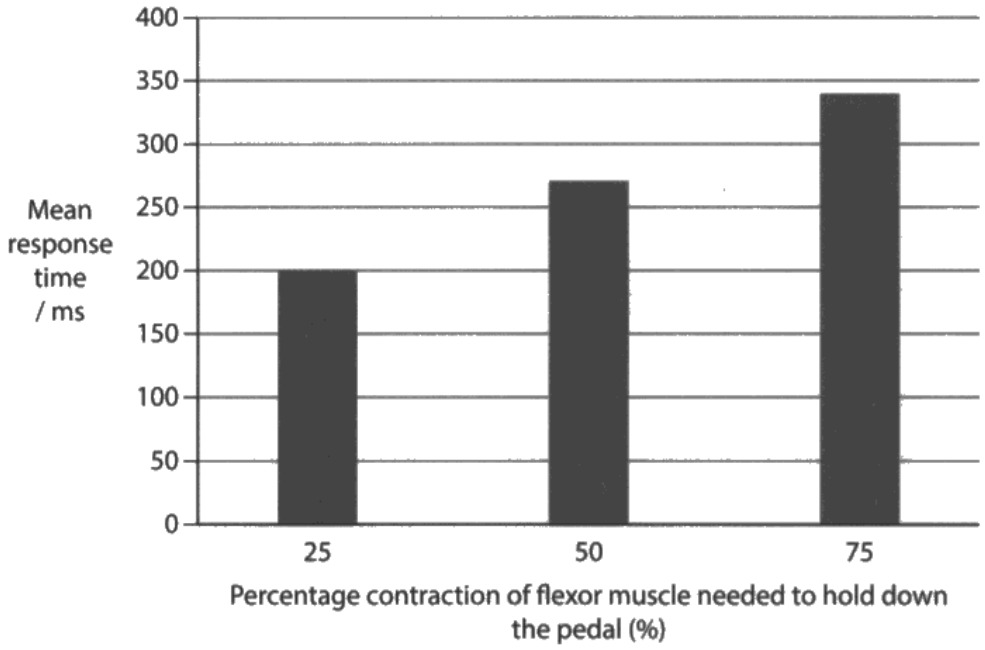


(a) State the type of muscle that works antagonistically with a flexor muscle.

(1)

Refer

ResultsPlus
Examiner Comments

The mark cannot be credited for this answer.

The correct answer for one mark.

6 Antagonistic muscles interact to control the movement of the legs.

Sprinters need to respond rapidly to the starting signal in a race.

In an investigation, the response time for a group of athletes was studied.

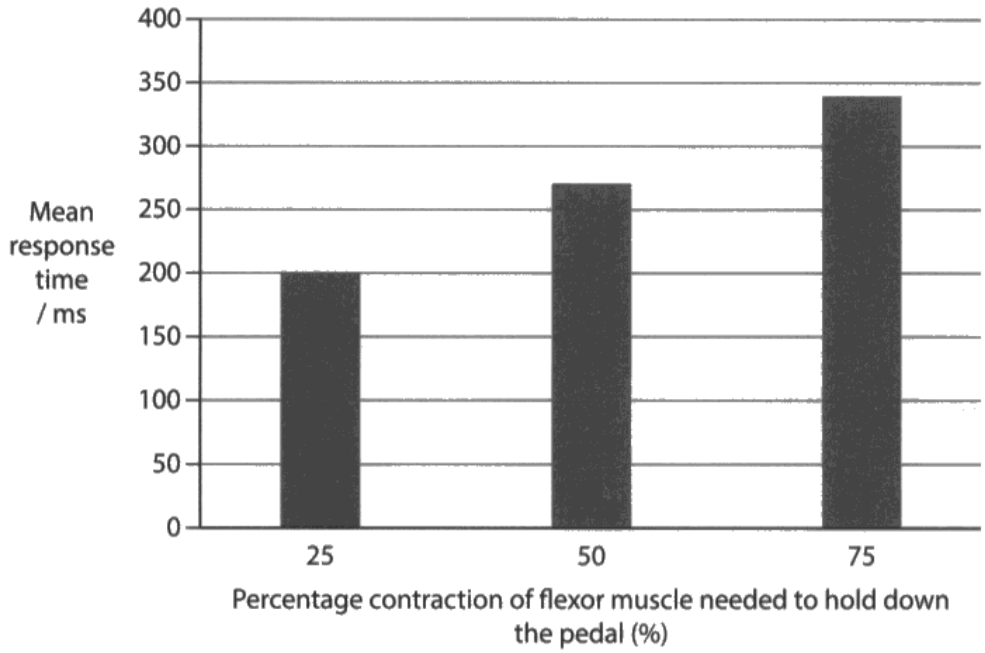
Each athlete contracted a flexor muscle in the leg to hold a pedal down.

When a light was switched off, the athlete released the pedal.

The response time for the flexor muscle to fully relax was recorded.

The investigation was repeated except the percentage muscle contraction needed to hold the pedal down was changed.

The results are shown in the graph.



(a) State the type of muscle that works antagonistically with a flexor muscle.

(1)

Ie extensor muscle

ResultsPlus
Examiner Comments

As the question asks for which muscle type, the mark would have been given for just extensor.

Question 6(b)

Q06(b) required candidates to explain the phrase 'the difference being significant at the 0.05 level', in the context of the question. Many delivered encouraging answers.

This response appears to be giving a statement relating to the graph.

(b) The difference in the mean response time for the 25% contraction and the 50% contraction was significant at the 0.05 level.

Explain what is meant by this difference being significant at the 0.05 level.

(2)

There was a large and clear difference between the mean response time for 25% and 50%.

ResultsPlus
Examiner Comments

No mark was awarded.

This response essentially repeats the question, a commonly seen answer.

(b) The difference in the mean response time for the 25% contraction and the 50% contraction was significant at the 0.05 level.

Explain what is meant by this difference being significant at the 0.05 level.

(2)

The difference in mean responses was significant after carrying out a Stats test at ~~0.05~~ 5% significance level.

ResultsPlus
Examiner Comments

No marks can be given for this answer.

This answer shows that the candidate appreciates that being significant at the 0.05 level means the null hypothesis can be rejected.

(b) The difference in the mean response time for the 25% contraction and the 50% contraction was significant at the 0.05 level.

Explain what is meant by this difference being significant at the 0.05 level.

(2)

A significant correlation and so rejects a null hypothesis.

ResultsPlus
Examiner Comments

The second marking point is achieved.

ResultsPlus
Examiner Tip

In such questions always consider whether a comparison between the calculated value and critical value should be given, and the effect of whether the null hypothesis should be accepted or rejected.

Whilst this answer showed some appreciation of the importance of the phrase, no marks could be awarded.

(b) The difference in the mean response time for the 25% contraction and the 50% contraction was significant at the 0.05 level.

Explain what is meant by this difference being significant at the 0.05 level.

(2)

there was a large difference ~~between~~ in the mean response time for the 25% contraction and the 50% contraction meaning that you accept the null hypothesis.

ResultsPlus
Examiner Comments

The first part of this answer relates to the graph, whilst the latter part recognises that the phrase to be explained is linked to the null hypothesis. Unfortunately, it would be the alternative hypothesis that would be accepted for the second marking point.

Question 6(d)

Q06(d) was one of the two six-mark indicative content questions in the paper.

Candidates were required to use the investigation results to explain why there was a delay between when a stimulus was given and when the contracted muscle was fully relaxed. Most candidates appreciated that at least one of the following was involved: how the stimulus affected the eye, the delay due to the nerve pathway, or/and the delay because of the mechanism of flexor muscle relaxation (or extensor muscle contraction).

This response starts to tackle the question and gives a level 1 explanation for two marks.

*(d) When the investigation was carried out, it took time between the athlete seeing the light switch off and the flexor muscle being fully relaxed.

Explain why there was a delay between the light being switched off and full relaxation of the flexor muscle in this investigation.

Use the results of the investigation and your own knowledge to answer this question.

(6)

The photoreceptor in the eye detects a decrease in light. This stimulates an action potential in the sensory ~~neuron~~ neurone. The nerve impulse is carried by the sensy neuron to the CNS and the brain (specifically the occipital lobe). The sensy neurone synapses with a relay neurone. The relay neurone then synapses with a moto neuron which causes the flexor muscle to to relax. The greater the percentage contraction of flexor muscle needed to hold down the peddle the greater the time delay. This is because more nerve impulses have to be sent to the flexor muscle to get it to relax fully.

ResultsPlus
Examiner Comments

Throughout the passage there is some consideration of the location of the delay, namely the nerve pathway. The latter part of the second page of the candidate's answer correctly refers to the trend seen in the data.

This is a level 2 response which covers one possible area for the delay between stimulus and completing the response.

*(d) When the investigation was carried out, it took time between the athlete seeing the light switch off and the flexor muscle being fully relaxed.

Explain why there was a delay between the light being switched off and full relaxation of the flexor muscle in this investigation.

Use the results of the investigation and your own knowledge to answer this question.

more recruited fours + fatigue.

(6)

There was a delay between the light being switched off and full relaxation of the flexor as the of the people had to first process the stimulus of the light being switched off. There is a delay as the impulse had to travel from the retina of the eye to the optic nerve and then to the occipital lobe of the brain so that an impulse could be generated to travel down the motor neurones to the effector muscle in the leg to carry out the response. As the percentage contraction increased, more muscle fibres were recruited to hold down the pedal so more impulses were required to relax the whole muscle. Increased response time (delay) may also have been effected by fatigue of the participants as they have to focus more on keeping the pedal down so attention is drawn away from the light. There is no information on how long they had to hold down the pedal or the fitness of the participants which may effect their reaction times. If they are trained athletes they would have quicker reaction times. Partial relaxation of the flexor may have taken place but only the time for full relaxation was recorded so some time was just the flexor relaxing.

ResultsPlus
Examiner Comments

The candidate makes reference to two locations where a delay could occur: the nerve pathway and the muscle. However, they offer sufficient details in relation to the nerve pathway for three marks.

This is a level 2 answer which considers the role of the extensor muscle in causing the delay.

*(d) When the investigation was carried out, it took time between the athlete seeing the light switch off and the flexor muscle being fully relaxed.

Explain why there was a delay between the light being switched off and full relaxation of the flexor muscle in this investigation.

Use the results of the investigation and your own knowledge to answer this question.

(6)

The more force applied to the pedal the longer it took to release it. When the light is switched off the rod cells in the eye must recieve this stimulus and ~~generate an actio bleacht~~ so bleaching occure. This will generate an action potential

and an image will be generated. After this the brain will send an action potential to the flexor muscle to relax and the extensor muscles to contract. For the extensor muscle to contract an action potential causes an influx of calcium ions. This will cause troponin to chang shape pulling tropomyosin out of actin myosin binding site on actin. This will allow the globular heads on myosin to bind to actin pulling itself causing contraction. This takes time so a delay can be seen as at 25% response time was the least (200 ms) and at 75% it was the highest (around 290ms) This is due to more contraction of the extensor having to occur at 75% than at 25%. This is also due to the flexor muscle taking more time to relax at 75% than 25% as it is more contracted so it takes time for it to completely relax.

ResultsPlus
Examiner Comments

At the top of the second page, the candidate makes it clear that the relaxation of the flexor is linked to the contraction of the extensor muscle. They then describe in detail the mechanism of muscle contraction and culminate in stating that this can lead to the time delay. However, as only one aspect is given in detail, three marks are achieved. Towards the bottom of the second page, the candidate refers to the data presented.

This is also a level 2 answer, but gains four marks.

*(d) When the investigation was carried out, it took time between the athlete seeing the light switch off and the flexor muscle being fully relaxed.

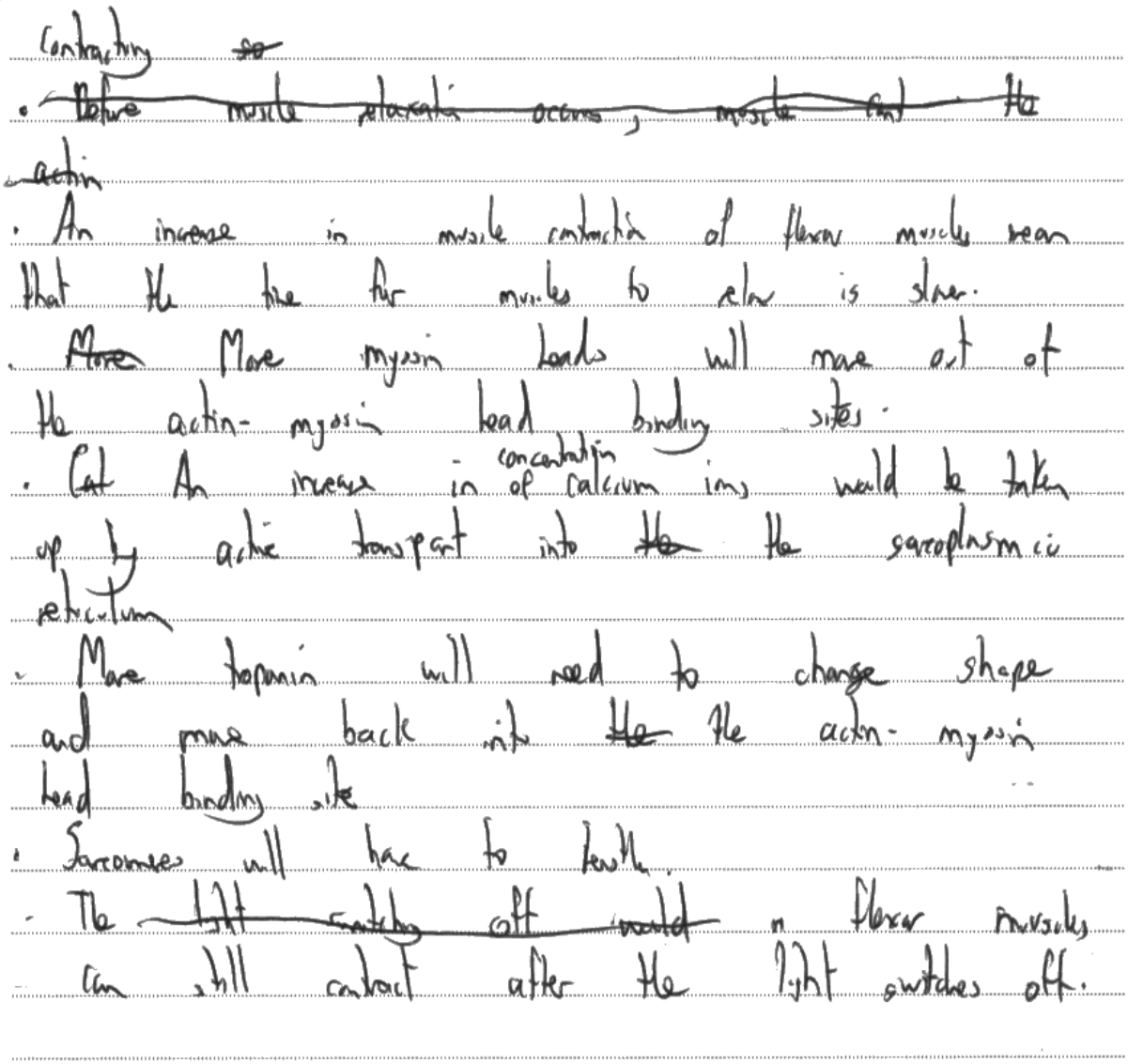
Explain why there was a delay between the light being switched off and full relaxation of the flexor muscle in this investigation.

Use the results of the investigation and your own knowledge to answer this question.

(6)

• An increase in percentage of the flexor muscle needed to hold down the pedal increased the mean response time in ms

• The response time increases as the percentage of flexor muscle needed to hold down the pedal increases because more muscles are



ResultsPlus
Examiner Comments

The candidate initially refers to the data and considers the muscles as the location of the delay. These two would gain both marks for level 1. However, the candidate then considers that the delay could be due to the number of myosin heads that need to decouple from actin. In addition, consideration has also been given to the time taken to import calcium ions back into the sarcoplasmic reticulum. These are two different details relating to one process, hence four marks.

Question 7(a)

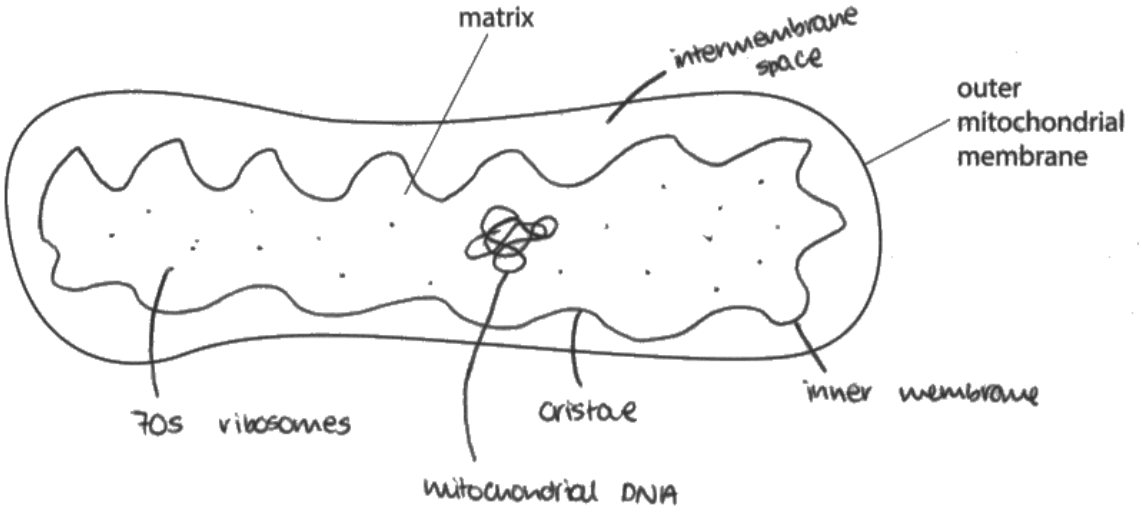
Candidates were asked to complete a diagram of a mitochondrion by adding its internal structures and then labelled each added structure. Whilst many gained full marks, there was confusion between mitochondrial and chloroplast structures amongst some candidates.

An excellent answer that gained all three marks.

7 Aerobic respiration in eukaryotic cells occurs in mitochondria.

(a) Complete the diagram of a mitochondrion to show the internal structure. Label each structure that is added.

(3)



ResultsPlus
Examiner Comments

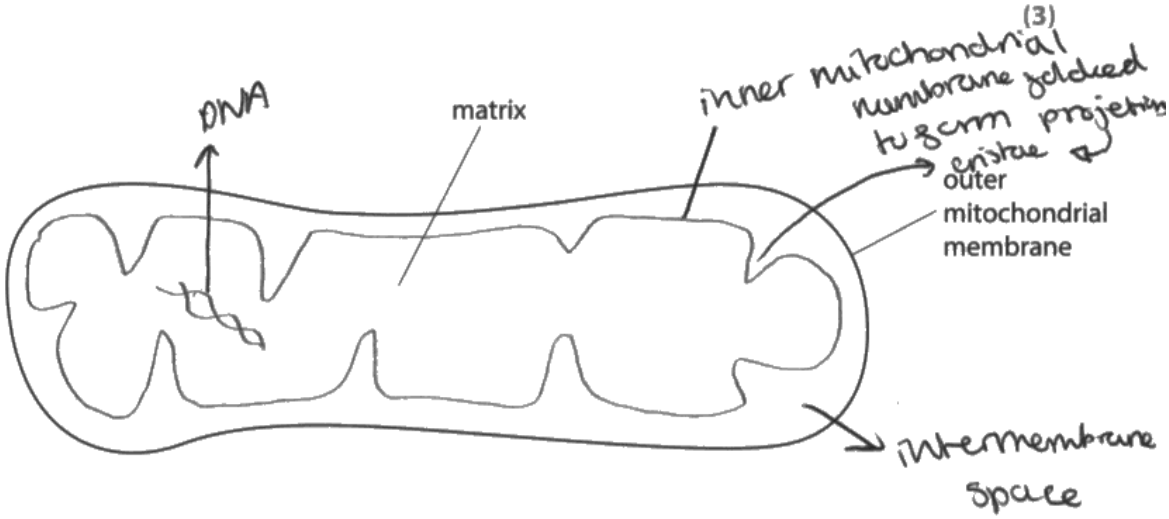
The marks were awarded for suitably drawn and labelled DNA loop, crista and ribosomes. The intermembrane space was not considered a structure that was added.

This response gained two marks.

7 Aerobic respiration in eukaryotic cells occurs in mitochondria.

(a) Complete the diagram of a mitochondrion to show the internal structure. Label each structure that is added.

(3)



ResultsPlus
Examiner Comments

The inner membrane is suitably drawn and the label on the top right can be awarded two marks. The DNA aspect was not given as the DNA is not shown as a loop.

Question 7(b)

Candidates were asked to describe the role of enzymes in the link reaction. Many were able to effectively tackle this question, but it was not uncommon to see confusion between enzymes and coenzymes.

This partial answer gains half of the available marks.

(b) The matrix of a mitochondrion contains a range of enzymes.

Describe the role of enzymes in the link reaction.

(4)

In the link reaction acetyl is combined with co-enzyme A. This forms acetyl co-enzyme A which can then be taken to ~~undergo~~ the electron transport chain to undergo oxidative phosphorylation.

ResultsPlus
Examiner Comments

The first sentence can be awarded the fourth marking point for the addition of coenzyme A. The start of the second sentence refers to the formation of acetyl CoA as a product of the link reaction for the fifth marking point.

A sound response that achieves four marks.

(b) The matrix of a mitochondrion contains a range of enzymes.

Describe the role of enzymes in the link reaction.

(4)

- Allows the krebs cycle to take place.
- acetyl Co enzyme A is formed when the Co enzyme A binds to the acetate.
- Pyruvate is decarboxylated which produces acetate.
- The enzyme allows the 2 carbon acetate to bind to the 4 carbon compound
- Allows ATP to be synthesised.
- Allows NAD to become reduced NAD.

ResultsPlus
Examiner Comments

The second bullet point suitably describes the formation of acetyl CoA by the addition of coenzyme A for the fifth and fourth marking points respectively. The third bullet point states the process one of the enzymes carries out for the second marking point. The final sentence can be awarded the third marking point as it is offered in the context of describing link reaction enzyme roles.

A clear and focused answer that gained a maximum of four marks.

(b) The matrix of a mitochondrion contains a range of enzymes.

Describe the role of enzymes in the link reaction.

(4)

~~enzyme A~~ enzymes catalyse decarboxylation of pyruvate 3C → 2C compound and enzymes catalyse dehydrogenation pyruvate, removing 2 hydrogen atoms, ~~reducing~~ oxidising pyruvate. Enzymes lower the activation energy. Coenzyme A takes up 2 carbon compound forming acetyl CoA which ~~is~~ then enters kreb cycle.

ResultsPlus
Examiner Comments

The very start of the first sentence states the general function of enzymes in that they catalyse reactions for the first marking point. The remainder of this sentence then achieves the second and third marking points.

The second sentence then reaffirms the general role of enzymes, including those involved in the link reactions.

The final sentence suitably describes the binding of coenzyme A to a 2-carbon compound to form acetyl CoA, which are the two final marking points.

Question 7(c)

Q07(c) required candidates to explain the role of proton pumps in aerobic respiration. There were many splendid answers, but some, unnecessarily also gave details about the transport of electrons from carrier to carrier. The latter was ignored and full marks could, and were, often still awarded.

A short response which could not be awarded any marks.

(c) Proton pumps are found in mitochondria.

Explain the role of proton pumps in aerobic respiration.

(5)

Proton pumps allow the mitochondria to receive more oxygen, which is needed for aerobic respiration. They allow transport of ions across the mitochondrial membrane like glucose,

ResultsPlus Examiner Comments

The reference to ion movement across a membrane needs a direction.

An answer that offered some aspects of the role of proton pumps, but would have benefitted from a little more detail and precision.

(c) Proton pumps are found in mitochondria.

Explain the role of proton pumps in aerobic respiration.

(5)

Proton pumps are used in the electron transport chain. After splitting NADH and FADH into protons and electrons, the electrons move down the electron transport chain, releasing energy as they pass each one. This ~~one~~ energy is then used to create an electrochemical gradient for the proton pumps, causing an increase in protons moving into the inter-membrane space of the mitochondria. This increases the concentration of protons in the it inter-membrane space. After the electrons have left the ETC, the electrochemical gradient stops, allowing protons to pass back through the proton pumps into the matrix of the mitochondria.

ResultsPlus
Examiner Comments

The reference to electrochemical gradient in the second sentence, nor in the final sentence is not in the correct context for the third marking point. However, the second marking point can be awarded in the second sentence.

The movement of protons back into the matrix in the final sentence was not given the fourth marking point as the process was not included (ie either via diffusion or down the gradient).

One mark was awarded for this response.

ResultsPlus
Examiner Tip

Look to restrict the response to the parameters of the question. For example, details relating to the electrons were not required in this question item.

A complete answer in which the candidate offered a sequential approach to the role of proton pumps supported with good detail. Full marks were awarded.

(c) Proton pumps are found in mitochondria.

Explain the role of proton pumps in aerobic respiration.

(5)

Proton puumps are used in oxidative phosphorylation. When reduced NAD and reduced FAD are oxidised they release hydrogen atoms which splits into H^+ and electrons in the mitochondrial matrix. The electrons travel down the electron transport chain, losing energy as they go. This energy is used by the protons pumps to move H^+ from the matrix into the intermembrane space. As more H^+ ~~protons~~ is moved the concentration increases which creates an electrochemical gradient. The H^+ then go down their electrochemical gradient back into the matrix via ATPsynthase. This movement drives the formation of ATP by combing ADP and P_i. In total 34 ATP molecules are made. The electrons from the electron transport chain then combine with the ~~H^+~~ hydrogen and O_2 oxygen to form water. This makes oxygen the final electron acceptor.

ResultsPlus
Examiner Comments

About a third of the way through the answer, there is a reference to the protons moving into the intermembrane space. This gains the second marking point.

Then the candidate describes marking points three, four, five and then six in the next three sentences.

Question 8(a)(i)

Most candidates offered two ways that the active form of phytochrome is converted to the inactive form as requested.

A short and targeted answer that gains both marks.

8 *Arabidopsis thaliana* is a plant that uses phytochromes and auxin to respond to changes in the environment.

(a) (i) State **two** ways that the active form of phytochrome (P_{FR}) can be converted to the inactive form (P_R).

(2)

1 When P_{FR} absorbs far - red light

2 In darkness or absence of light.

ResultsPlus
Examiner Comments

The candidate gained the first, and then the second, marking point.

This response gained one mark.

8 *Arabidopsis thaliana* is a plant that uses phytochromes and auxin to respond to changes in the environment.

(a) (i) State **two** ways that the active form of phytochrome (P_{FR}) can be converted to the inactive form (P_R).

(2)

1 in dark PFR converts to PR high

slowly amount of PFR converts slowly to

PR

2 in daylight PFR can be absorbed and

converted to PR which quickly converts

to PFR.

ResultsPlus
Examiner Comments

A good, detailed response offered for the first way that the active form of phytochrome is converted to the inactive form. However, the reference to P_{FR} rather than far red light inhibited the awarding of a second mark.

ResultsPlus
Examiner Tip

Try to revisit an answer to check it, if time allows.

This answer also gains one mark.

8 *Arabidopsis thaliana* is a plant that uses phytochromes and auxin to respond to changes in the environment.

(a) (i) State **two** ways that the active form of phytochrome (P_{FR}) can be converted to the inactive form (P_R).

(2)

1 Pfr ⟶ Pr rapidly in the light

2 Pfr ⟶ Pr slowly in the dark

ResultsPlus
Examiner Comments

The mark was awarded for the second statement. For the first mark, a reference to exposure to far red light was required.

Question 8(a)(ii)

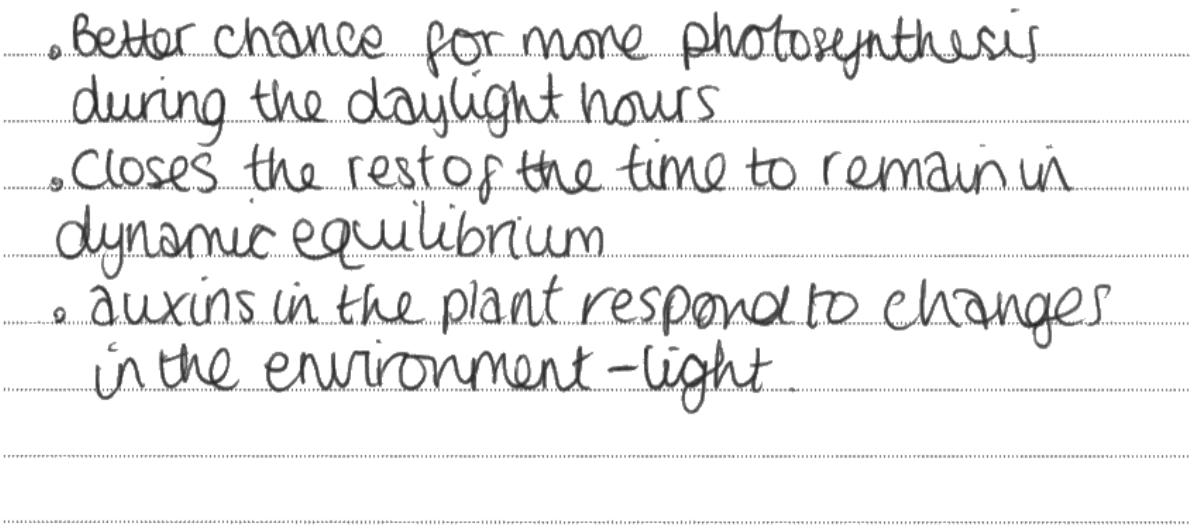
Candidates were told that *Arabidopsis* is a long day plant, and were then asked to explain why it would flower in the presence of 16 hours of light. Whilst there were a pleasing number of thorough responses, many limited themselves to one or two marking points.

This answer illustrates a common approach offered by a minority of candidates.

(ii) *Arabidopsis* is known as a long-day plant.

Explain why *Arabidopsis* will flower when each day has 16 hours of light.

(3)



ResultsPlus
Examiner Comments

A number of candidates considered the need for sufficient time of light exposure for enough photosynthesis to occur for flowering. No marks could be awarded.

This response achieves the two most commonly awarded points.

(ii) *Arabidopsis* is known as a long-day plant.

Explain why *Arabidopsis* will flower when each day has 16 hours of light.

(3)

16 hours of daylight gives long hours of daylight. This means that Arabidopsis is exposed to lots of red light. This means that more P_R will be converted to P_{FR} than P_{FR} converted to P_R. This means that there will be more P_{FR} in the plant than P_R. This means that the flowering of Arabidopsis will be promoted by the high concentration of P_{FR}.

ResultsPlus
Examiner Comments

The combination of the first three sentences is a good answer for the first marking point. The second marking point could not be awarded for the reference to the low P_{FR} to P_R conversion, as this has to be tied into short nights.

The final two sentences link high P_{FR} with the idea of stimulating the flower process to occur for the fourth marking point.

Question 8(b)(ii)

Candidates were asked to explain how neighbouring plants competing for light would lead *Arabidopsis* to respond by growing taller. The full mark range was seen, and a number of outstanding responses were offered.

This is a level 1 answer that achieves two marks.

Explain how neighbouring plants competing for light result in *Arabidopsis* plants growing taller.

Use the information provided and your own knowledge to answer the question.

(6)

Since the neighbouring plants are reducing the level of active phytochrome by taking in some of the available sunlight. This means that there is not enough P_{fr} to cause restricting of transcription factors, so the the transcription factors bind to DNA. This causes the Synthesis of TAA and Yuc enzymes due to the change in the triplet code due to the transcription factors. The TAA and Yuc enzymes catalyse the change of Molecule Q into auxine the growth hormone. Auxin stimulates the growth of the Arabidopsis according to phototropism - meaning it stimulates the shoots growth towards the light. This growth allows the Arabidopsis plant to grow tall enough that enough light is taken in to increase the levels of P_{FR} to a point that transcription factors are restricted and growth up stops.

ResultsPlus
Examiner Comments

The answer offers some basic information which can be credited. For example, the link between the neighbouring plants absorbing sunlight so less is available to *Arabidopsis*, so the latter has less P_{FR} (given in the first four lines).

Later the candidate links the production of TAA and YUC enzymes catalysing the production of auxin. However, the description of auxin function needed to reference elongation.

This is an encouraging level 2 response that scores four marks.

Explain how neighbouring plants competing for light result in *Arabidopsis* plants growing taller.

Use the information provided and your own knowledge to answer the question.

(6)

According to the diagram, a decrease in light absorption of a plant, close to neighbouring plants blocking sunlight leads to a reduction of phytochrome. This triggers ~~transcription factors~~ the production of TAA and YUC. This enzymes can then convert molecule Q into IAA. The more ~~plants~~ neighbouring plants ~~blocking~~ absorbing sunlight, the greater the decrease in active phytochrome and so the greater the number of enzymes produced and thus IAA. Auxin or IAA triggers the acidification of the cell wall in plants by drawing H^+ ions from cytoplasm to the cell wall. The low pH activates an enzyme that breaks the cellulose bonds maintaining the wall together, making it more permeable. The increased H^+ ions concentration on the cell draws water by osmosis into the cell which becomes more turgid and due to the loosened cell wall, it expands the cell, elongating it. This leads to the shoots growing taller. when neighbouring plants are competing for light, as if it weren't for them, the phytochrome would still be active and no or less IAA would be produced.

ResultsPlus
Examiner Comments

After a general introduction, the candidate offers a range of basic information relevant to the question. For example, a greater decrease in P_{FR}, so more TAA and YUC enzymes synthesised leading to IAA production.

The answer then progresses to a detailed consideration of how IAA affects the stem of *Arabidopsis*.

ResultsPlus
Examiner Tip

Look to consider, and link, several areas of biological knowledge in such questions.

Question 9(a)(i)

This describe question required candidates to state how stem cells can be made to differentiate into different specialised cells. Much of the candidature had an excellent appreciation of this material.

A detailed and logical answer that achieves four marks.

9 The picture shows a thylacine (Tasmanian tiger), a mammal believed to have become extinct during the twentieth century.

(Source: © JOHN SIBBICK/SCIENCE PHOTO LIBRARY)

Some scientists are hoping to produce living thylacines. The scientists are planning to use preserved thylacine DNA, stem cells from closely-related species and gene technology.

(a) (i) Describe how stem cells can be made to differentiate into different specialised cells.

(4)

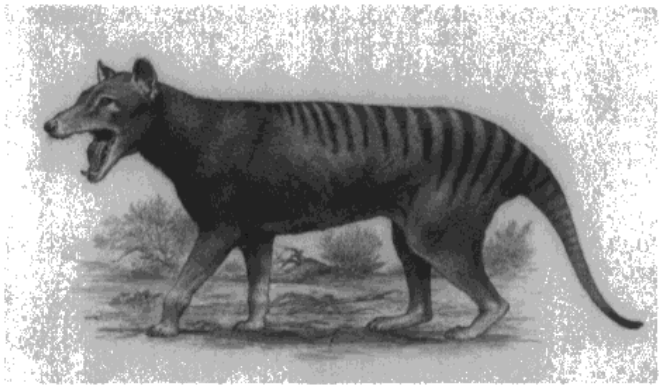
the stem cell are stimulated by a chemical signal. this can be some gene to be activated and others to be deactivated. the activated genes will be transcribed, to form mRNA. the mRNA is translated to form ~~a protein~~ proteins. these proteins modifies the ~~the~~ cell and determine the cell structure and function, making them specialised.

ResultsPlus
Examiner Comments

The first sentence and a half suitably achieves the second marking point. The remainder of the second sentence offers the third marking point. The next two sentences deliver marking points four and five respectively.

This candidate's answer gains three marks.

9 The picture shows a thylacine (Tasmanian tiger), a mammal believed to have become extinct during the twentieth century.



(Source: © JOHN SIBBICK/SCIENCE PHOTO LIBRARY)

Some scientists are hoping to produce living thylacines. The scientists are planning to use preserved thylacine DNA, stem cells from closely-related species and gene technology.

(a) (i) Describe how stem cells can be made to differentiate into different specialised cells.

(4)

Particular signals cause different genes to be activated or deactivated by affecting the ability of transcription factors to bind to the DNA.

mRNA is only transcribed for the activated gene which is translated into proteins.

These proteins will modify the cells in different ways determining its structure and function, producing specialised cells.

ResultsPlus
Examiner Comments

The initial paragraph details the activation of some genes. However, the second marking point was not awarded as the signal needed to be referenced as chemical.

The subsequent paragraph can be awarded the third and fourth marking points, whilst the final paragraph gains the final marking point, for three marks.

Question 9(a)(ii)

The thrust of this explain question is why stem cells from species closely-related to thylacines are planned to be used. Candidates generally appreciated the idea of there being many genes in common or many similar genes.

This response offered two commonly seen ideas that did not elicit marks.

(ii) Explain why the scientists plan to use stem cells from closely-related species.

(2)

The DNA is more similar between closely related species therefore there is a reduced risk of the stem cells being rejected by the body.

ResultsPlus
Examiner Comments

The DNA is the same in all organisms in that it comprises a sequence of bases and repeating sugar-phosphates in the 'backbone'. The idea of not being rejected was ignored, so no marks were seen in this answer.

The first half of this answer is creditworthy.

(ii) Explain why the scientists plan to use stem cells from closely-related species.

(2)

closely-related species stem cells will have a greater similarity of genes allowing the binding of the DNA and transcription to occur more efficiently

The reference to greater similarity of genes would be an acceptable alternative for the second marking point.

This one mark response focused on the third marking point.

(ii) Explain why the scientists plan to use stem cells from closely-related species.

(2)

It requires less ~~not~~ genetic modification and less ~~other~~ stimulated differentiation will be required due to pre-existing similarities in the ~~species~~ ~~contain~~ ~~species~~ organs.

The reference to requiring less genetic modification is the Additional guidance alternative for the third marking point.

Question 9(a)(iii)

This question required the candidates to explain why the source of the stem cells should be from more than one individual. The majority considered the first explanation rather than the second.

This response displays a good appreciation of the question for two marks.

(iii) Explain **one** reason for using stem cells from more than one individual of the same species to produce a population of thylacines that can survive for a long time.

(2)

• this increases the genetic diversity of the population, as more alleles are present in gene pool. This reduces the risk of inbreeding depression, as random mutations are more likely to develop allowing the thylacines population to survive new selection pressures.

ResultsPlus
Examiner Comments

The candidate starts by identifying that it could lead to greater genetic diversity, and reaffirms this with the gene pool comment. The first marking point is awarded.

The first part of the second sentence gains the second marking point for its reference to reducing the risk of inbreeding depression.

This two mark answer focuses on the idea of being able to adapt to changing environmental conditions for its two marks.

needed editing.

(iii) Explain **one** reason for using stem cells from more than one individual of the same species to produce a population of thylacines that can survive for a long time.

(2)

More than one individual ensure here will be genetic variation in population of thylacines, thus thylacines are able to adapt more easily to changes in their environment, greater chance of survival.

ResultsPlus
Examiner Comments

The first line and a half gains the first marking point, whilst the third to fifth lines gain the second marking point with their reference to ability to adapt.

Question 9(b)(ii)

In this determine question, candidates were expected to state the number of condensation reactions that form when a single gene is added to a plasmid. The candidates also had to justify their value. For some, this appeared to highlight the misconception that plasmid DNA is single-stranded.

This response offers the most usually awarded mark.

(ii) Determine the number of condensation reactions that occur when ligase joins a single gene to a bacterial plasmid. (3)

ligase enzyme join ~~mutually together~~ nucleotids together in an condensation reaction forming phosphodiester bonds

ResultsPlus
Examiner Comments

The phosphodiester comment gains a mark. No other marks can be given here, hence a score of one mark.

This answer gains no marks, but the idea of a single condensation reaction occuring was quite commonly seen.

(ii) Determine the number of condensation reactions that occur when ligase joins a single gene to a bacterial plasmid.

(3)

One condensation reaction will occur when ligase binds to the gene to the plasmid. This is because in order to remove the gene it uses hydrolysis and only uses ligase a condensation reaction when combining it with a bacterial plasmid.

ResultsPlus
Examiner Comments

No marks.

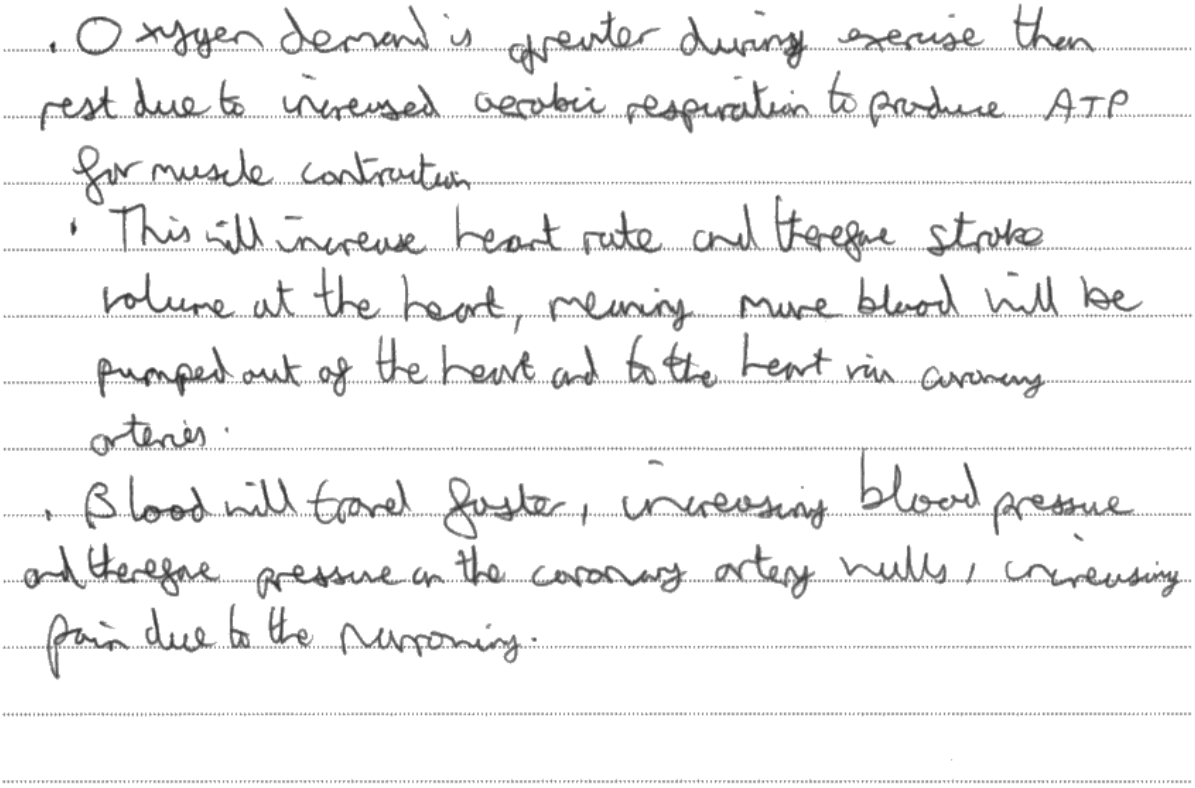
Question 10(a)(ii)

Candidates were informed that angina is caused by narrowed coronary arteries and were told the function of these arteries. They were then asked to explain why angina was likely to be more painful during exercise, than at rest. There were a number of excellent answers but it was not uncommon to read responses that focused on physical pressure being put on the heart causing the pain.

A sound answer that offered the two most commonly awarded marking points.

(ii) Explain why angina is likely to be more painful during exercise than when at rest.

(3)



ResultsPlus
Examiner Comments

The second bullet point refers to the raised heart rate. This can gain the first marking point as the context of the question is about exercise.

The final bullet point correctly refers to the narrowing of the coronary arteries for the third marking point.

Two marks, out of three, are given for this answer.

This answer gains the most often awarded mark.

(ii) Explain why angina is likely to be more painful during exercise than when at rest.

(3)

During exercise heart rate increases as demand for oxygen increases for aerobic respiration heart muscle needs more oxygen more blood flow through coronary arteries to deliver oxygen leads to being more painful

ResultsPlus
Examiner Comments

The first line gains the first marking point.

A pleasing answer that gains all marks.

(ii) Explain why angina is likely to be more painful during exercise than when at rest.

(3)

• During ~~rest~~ exercise, the ~~heart~~ muscles contract ~~at a higher~~ more frequently ~~rate~~, meaning more oxygen is required in order to supply enough energy for the increased ~~energy~~ aerobic respiration

• This causes the heart rate to increase, and also increases the oxygen requirements of the heart muscle

• However, since the coronary arteries are restricted, not enough oxygen can reach the tissue, causing the cells to respire anaerobically, producing lactic acid, and eventually dying, causing pain

• This is more painful than at rest, since it is easier to meet oxygen ~~supply~~ demands at rest

ResultsPlus
Examiner Comments

The first bullet point sets the scene. The second one gains the first marking point.

The reference to tissue in the third bullet point can be assumed to be related to the heart due to the second bullet point so gains the second marking point. The context in which the candidate refers to the coronary arteries as restricted enables the third marking point to be awarded. However, the remainder of this bullet point considers the respiratory outcome for the heart tissue for the fourth marking point.

Question 10(a)(iii)

In this question, many candidates showcased their excellent understanding of the events that lead to atheroma formation in an artery.

A succinct response in which each of the three bullet points gains a mark, for a total of three marks.

(iii) Describe the events that occur in a coronary artery that lead to the formation of an atheroma.

(3)

- Endothelium damaged
- Inflammatory response of white blood cells.
- Cholesterol and other fats build up into fatty streaks which harden to form the atheroma plaque.

ResultsPlus
Examiner Comments

The bullet points, in order, gain marking points one, two and then three.

In this answer, the candidate considers two aspects of the process and then writes about a blood clot forming.

(iii) Describe the events that occur in a coronary artery that lead to the formation of an atheroma.

(3)

High blood pressure cause damage to the endothelium lining of the artery. This causes collagen to be exposed and to react with platelets in the blood. This results in an inflammatory response which produces thrombin. Thrombin then catalyzes the conversion of fibrinogen to fibrin which is a mesh-like substance that forms blood clots. This results in substances being trapped and to which leads to them hardening which forms an atheroma.

ResultsPlus
Examiner Comments

In the first sentence, the endothelial damage is creditworthy, whilst the second sentence suitably refers to the inflammatory response for the second marking point. No further marking points were found, so the score is two marks.

Question 10(b)(ii)

This devise an investigation question required candidates to employ their knowledge and experience of the *Daphnia* core practical in a novel situation. Whilst there were many encouraging answers, it was rare to see candidates taking note of the significance of the concentration units for the substance under investigation.

This response offered two creditworthy aspects and a number that did not quite offer sufficent detail to gain further marks.

(ii) Devise an investigation to find the mean minimum concentration of this substance that will lower the heart rate in *Daphnia*.

(5)

Prepare a range of doses from 15mg to 5mg decreasing at increments of 5mg per test for 3 tests.

Use a different daphnia for each test, but keep the daphnia to be from the same species and ~~theme~~ habitat location.

Place a small amount of cotton onto a slide the use a pipette to drop a few distilled water droplets onto the cotton.

Pick a daphnia from your source using a micro pipette, carefully handling it so it does not get hurt.

Then

View the first Daphnia with no substances as a control, counting the heartbeats for ~~a minute~~ 20 seconds using a pencil, paper and dotting when a heart beat occurs.

Repeat with the other daphnia, decreasing concentration throughout tests.

Place daphnia on microscope stage, & locate the heart.

finally multiply all results by 3 to calculate the heart rate per minute then compare.

The lowest heart rate shows the minimum dosage concentration of the substance.

When done with each daphnia carefully use a micro pippette to return them to their natural habitat.

ResultsPlus
Examiner Comments

The first sentence is encouraging in that the candidate recognises that the substance being investigated should range from 15 downwards. However, it cannot get the marking point as the dosage should be mg per kg of body mass.

The second sentence elicits the fourth marking point due to the reference to controlling species as a biotic factor.

Subsequently, the description relating to finding the heart rate as counting heart beats in 20 seconds, gains the third marking point. Unfortunately, the repeats sentence applies to using the same procedure at different concentrations of the substance, rather than repeats at each concentration.

This response was awarded two marks.

ResultsPlus
Examiner Tip

Consider the importance of carrying out repeats and then finding a mean from those repeats.

This response also gains two out of five marks.

Students t-test.

(ii) Devise an investigation to find the mean minimum concentration of this substance that will lower the heart rate in *Daphnia*.

(5)

- Place ~~the~~ a daphnia on a glass slide and immobilise with cotton fibres.
- Remove the water and replace with distilled water.
- Place the ~~number~~ daphnia under a ~~microscope~~ light microscope and count the number of heart beats in 20 seconds and then multiply by 3 to find the BPM of the daphnia without any of the substance.
- Repeat 3 more times and calculate a mean and standard deviation.
- Repeat the experiment, using a 0.1 mol dm^{-3} ~~of~~ solution of the substance instead of distilled water.
- Repeat for concentrations: 0.2, 0.3, 0.4, 0.5 and 0.6 mol dm^{-3}
- Use a students t-test to determine when the mean BPM has decreased by a significant amount at the 5% significance level.
- Ensure daphnia are taken from the same population and are returned to their habitat after being used in a trial to avoid causing them harm.

ResultsPlus
Examiner Comments

The third bullet point gives a suitable description of finding the heart rate for the third marking point.

The fourth bullet point refers to carrying out repeats and finding a mean. Whilst it can be assumed that the reference to repeats here is for the control situation (because it comes immediately after the previous bullet point which refers to heart rate in the absence of the substance), the next bullet point makes the situation clear. Therefore, the sixth bullet point can be awarded.

The concentrations suggested do not relate to the context of the question so the second marking point cannot be given.

ResultsPlus
Examiner Tip

This candidate has noted, and underlined, mean in the question stem. The presence of the word mean indicates that a description of how a mean can be found, in context, is likely to elicit a mark.

This candidate's response has gained three marks.

(ii) Devise an investigation to find the mean minimum concentration of this substance that will lower the heart rate in *Daphnia*.

(5)

* Daphnia should originally be kept in the same environment. They should all be of the same source and age; they should also be kept at the same temperature.

1. Carefully extract the Daphnia and place them on cotton wool on the microscope slide so they are easier to observe by restricting their movement.
2. Add the ~~same concentration~~ and volume of the substance to the daphnia ~~by distribute the~~ and concentrations of 0%, 1%, 2%, 3% and 4%
3. Count the number of heart beats per minute at each concentration
4. Return the Daphnia to their natural habitat.
5. Measure control for all Daphnia so for each Daphnia measure heart rate at at 0% concentration and again at one of the concentrations.
6. Calculate the change in heart rate between ~~for~~ the different concentrations of the substance.
7. Determine the lowest concentration that showed a decrease in heart rate.

ResultsPlus
Examiner Comments

The preliminary sentence at the top of the candidate's answer offers both a biotic and abiotic factor to be controlled for marking points four and five respectively.

The sentence numbered 3 achieves the heart rate marking point, so three marks for this answer.

(ii) Devise an investigation to find the mean minimum concentration of this substance that will lower the heart rate in *Daphnia*.

(5)

~~[illegible]~~ Use pipette to remove daphnia and add to cavity slide containing distilled water. ^ Allow 5 minutes to acclimatise Use microscope to determine ~~*~~ heart rate by counting heart beats in ~~[illegible]~~ 20 seconds by dots on paper, multiplying by 3 to calculate base heart rate in beats per minute. Use cotton wool to keep daphnia in place repeat experiment, increasing concentration of Hibiscus sabdariffa in solution in cavity slide ~~each time~~ each time, using daphnia of same size and species, until heart rate decreases. Repeat and calculate a mean heart rate, using at least 3 daphnia at each concentration of solution. Use a heat shield to control temperature. Reduce stress of daphnia by minimising time that light is left on, turning off when not in use.

ResultsPlus
Examiner Comments

The third and fourth lines gain the third marking point.

It is not clear in the sixth line whether the repeats are per concentration or at different concentrations. However, this is suitably clarified in the bottom third of the passage for the sixth marking point.

Approximately half way through the answer, there is a reference to size and species being controlled. The latter can be given the fourth marking point.

Four lines up from the bottom is a suitable description of controlling an abiotic factor: temperature, for the fifth marking point.

This answer, therefore, gains four marks.

Paper Summary

Whilst many candidates displayed excellent subject knowledge, the following may help with regard to fully targetting their answers to the specifics of the question being asked:

- Command word appreciation. Candidates should look to gain a thorough knowledge of what each command word requires them to deliver. This is given in an appendix in the specification.
- Showing working out in calculations. Whilst full marks can be awarded for a correct answer on its own, an incorrect answer with correct working may gain some, or even most, of the available marks.
- Know your units. For example, how many nanometers there are in a micrometer?
- Level of answer detail. An appreciation of the detail required to elicit the marks can be gleaned from the mark allocation for each item.
- Question context. Careful consideration should be given to the context surrounding a question. For example, why is angina pain likely to be greater during exercise should focus on the situation relating to exercise.
- Handwriting. A minority of answers were insufficiently clear to be credited.

Grade boundaries

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