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Examiners' Report
June 2019

GCE Biology 9BN0 03

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Introduction

The 9BN0/03 Biology paper focused on the general and practical application of the Pearson Edexcel GCE Biology Specification A. Aspects of all topic areas were considered and the paper included a series of question items linked to a pre-release scientific article. The paper included questions that targeted the conceptual and theoretical understanding of experimental methods, including mathematical analysis of experimental data.

The summer 2019 paper offered a wide diversity of question styles which gave candidates many opportunities to display their knowledge and understanding of material from across the whole specification. It allowed candidates to make connections from throughout the specification.

It was pleasing to see candidates offering a host of encouraging responses which demonstrated their good understanding of the material and much thanks should go to those who have taught them, as well as to the candidates themselves.

Whilst there were many clear and unambiguous responses, there were some candidates who could not be awarded marks due to the quality of their expression.

Successful candidates:

- demonstrated a familiarity with practical work and could devise investigations based on procedures they had carried out themselves;
- had studied the pre-released scientific article and read up on the aspects of biology within the article which they had encountered in their A-level Biology course;
- answered questions within the context set, showing that they had read the question;
- had learnt how to interpret the newly introduced command words – such as 'determine', 'devise' and 'evaluate';
- provided specific, relevant details to their answers;
- attempted every question;
- worked through calculations in a logical sequence, showing their working.

Less successful candidates:

- re-wrote information from the question, using up time and space;
- did not answer questions within context, missing both the command word and the context;
- did not understand how to interpret the command words and, therefore, misinterpreted questions;
- left out vital details or wrote vague answers lacking relevant facts;
- did not attempt some questions – some answer spaces were left blank;
- made errors in calculations by not checking significant figures or the numbers in the data already provided;

- did not write clearly or legibly; there were occasions where marks have been lost due to indecipherable handwriting;

- wrote answers with poor grammatical construction that lost marks where the meaning was unclear.

Implications for future teaching, learning and exam preparation:

Ensure that students carry out all of the core practicals and are involved in planning the procedures where there are variables that can be controlled or taken into account as well as evaluation of the results. Statistical analysis of data collected will allow students to become familiar with the reasons for selecting and using particular tests and how the results can be interpreted. The pre-released scientific article has to be studied well, in advance of the examination; however, regular reading of articles from scientific journals and magazines will help students become familiar with how the style of writing differs from that in textbooks or revision guides.

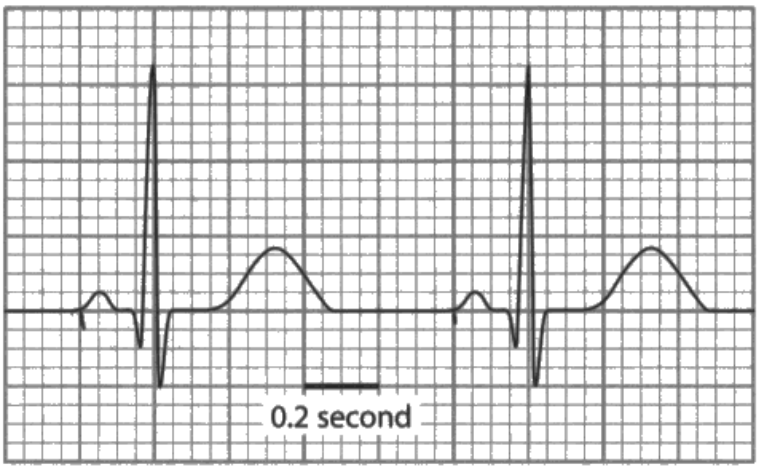
Question 1 (a)

Most candidates could calculate the heart rate. Unfortunately, many did not provide any units with their answer and did not gain the mark.

1 Many animals possess a heart and a circulatory system.

(a) Changes in the cardiac cycle can be observed by recording an electrocardiogram (ECG).

The ECG for a resting person is shown in the diagram.



Calculate the heart rate for this person.

(1)

5 x 0.2secs = 1 second

1 x 1x60 = 60

Answer 60bpm.

ResultsPlus
Examiner Comments

Correct answer with units gains the mark.

ResultsPlus
Examiner Tip

If there are no units on the answer line then you will be expected to provide appropriate units to gain full marks.

Question 1 (b) (i)

The command word in this question is 'determine' which requires a quantitative element in the answer. Many candidates gained the first marking point for a description of steroid use reducing the ventricular fraction. The second marking point, for quantitative use of the data, was less frequently awarded. Some candidates did not provide a full comparison; stating that 10 steroid users had ventricular fractions below the healthy value was not enough. To gain the second marking point they needed to use the phrase: '10 out of 12 users had ventricular fractions below the healthy value'.

(b) Anabolic steroids stimulate muscle development.

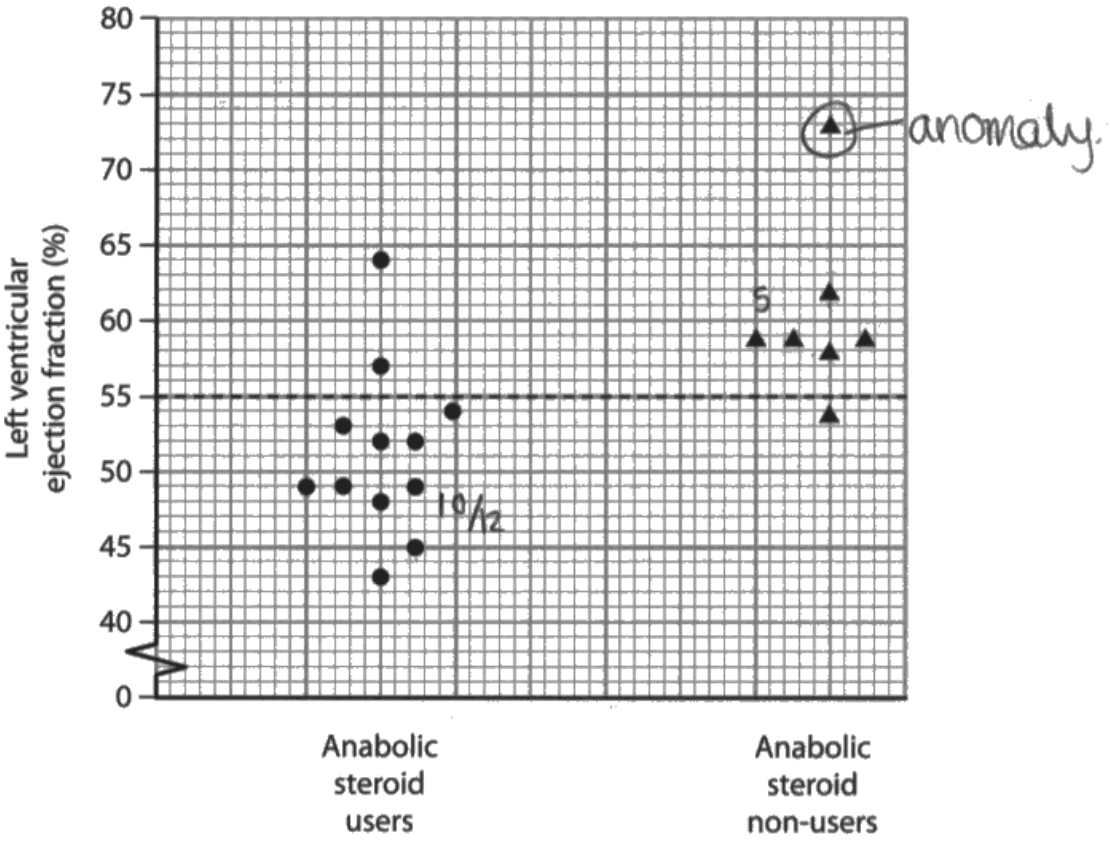
Some athletes use anabolic steroids in an attempt to improve their performance.

The effect of long-term anabolic steroid use on heart function has been investigated.

The left ventricular ejection fraction is the percentage of blood that leaves the left ventricle when it contracts.

The left ventricular ejection fraction for a healthy heart should be greater than 55%.

The results of a small study are shown in the graph.



(i) Analyse the data to determine the effect of anabolic steroid use on heart function.

(2)

prolonged use of

Anabolic steroids decreases the amount of blood that leaves the heart as 10 out of 12 steroid users had a less than healthy ejection fraction compared to 1 out of 7 ~~of~~ non users, showing anabolic steroids damage the ventricles and decrease effectiveness.

ResultsPlus
Examiner Comments

This response gained both available marks in the first three lines.

ResultsPlus
Examiner Tip

When you see the command word 'determine' in a question this means that your answer needs to include a quantitative element.

Question 1 (b) (ii)

The question was about testing a drug with a known side effect. Many candidates ignored the context of the question and described in detail a typical drug testing regime. These candidates generally gained the first two marking point having missed the third marking point for describing the establishment of an effective dose rather than the dose of the drug that does not have side effects.

(ii) Some drugs used to treat cancer have also been shown to reduce the ventricular ejection fraction.

Describe how the safe dose of a cancer drug could be determined.

(3)

test drug given to ~~beg~~ begin a small population of ~~test~~ healthy individuals. Then larger number of patients. Last ~~ph~~ phase is a large population of patients with use of a placebo. Double blind trial could also take place.

ResultsPlus
Examiner Comments

This response was awarded 2 marks; marking points one and two. The candidate has ignored the context of the question, however, of 'finding a safe dose'. Marking point three was only available to candidates who made correct reference to finding a dose which did not cause side effects, or did not cause a reduction in ventricular ejection fraction.

ResultsPlus
Examiner Tip

Read questions carefully; especially if you think you have seen a similar question before.

Question 2 (a)

Candidates were asked to calculate the percentage increase in the cross-sectional area of the *vena cava* compared to the aorta. Many candidates were able to calculate the cross-sectional area of the *vena cava* gaining 1 mark. A number of candidates went on to complete the calculation and gained both available marks, however, many did not finish the calculation correctly. This was often because they calculated the decrease in area of the aorta from the *vena cava*.

2 The largest blood vessels in the body are the aorta and the vena cava.

(a) For one person, the cross-sectional area of the lumen of the aorta is 193.6 mm^2.

The diameter of the lumen of the vena cava is 22.0 mm. Calculate the percentage increase in the cross-sectional area of the lumen of the vena cava compared with that of the aorta.

(2)

$\left(\frac{22}{2}\right)^2 \times \pi = 380.13$

$\frac{380.13}{193.6} = 1.96$

$1.96 \times 100 = 196\%$ so 96% increase

Answer 96.3 %

ResultsPlus
Examiner Comments

This response gained both available marks for a correct answer.

ResultsPlus
Examiner Tip

Note that the working for the calculation is neatly laid out. If the final answer had been incorrect it would be straightforward for examiner to award the mark for calculating the cross-sectional area of the *vena cava*.

aorta 193.6 mm^2.

vena cava : $\pi 11^2$ = 380.13 mm^2

$$\frac{380.13 - 193.6}{380.13} \times 100 = 49.1\%$$

Answer 49.1% (3 sf)

ResultsPlus
Examiner Comments

This response gained 1 mark for correctly calculating the cross-sectional area of the vena cava. The candidate then calculated how much smaller the aorta was than the vena cava; the opposite of what they were asked to do. This meant marking point two could not be awarded.

ResultsPlus
Examiner Tip

Read questions carefully and with calculation questions check that you have done what you were asked to do.

Question 2 (b)

(b) The wall of the aorta is thicker than the wall of the vena cava.

Explain why there is a difference in the thickness of the walls of the aorta and the vena cava.

(2)

The aorta has to withstand higher pressures than the vena cava as blood is needed to be pumped over larger distances to the whole body rather than just to the lungs. Aorta contains more smooth muscle, collagen and elastic fibres.

ResultsPlus
Examiner Comments

This is an example of a typical response. The candidate has been awarded 1 mark; marking point two. Although the candidate makes reference to elastic fibres, smooth muscle, and collagen, these structural features are not linked directly to function. Marking point two was allowed for the general statement that the difference is in thickness, because the aorta needs to withstand a higher pressure, together with 'more collagen' at the end of the response.

The aorta wall is thicker to withstand the higher blood pressure because it needs to pump blood to the whole body whereas the vena cava wall is thinner because it does needs lower blood pressure in order to pump blood to the heart

ResultsPlus
Examiner Comments

Marking point two was allowed for stating that the aorta walls are thicker in order to withstand higher pressure as alternative to marking point two.

This response scored 1 mark.

Question 2 (c)

To answer this question, candidates needed to apply their learning from the tensile strength core practical to a novel context. Many candidates provided a partial answer, gaining the third marking point only. Relatively few candidates made reference to measuring the dimensions of the piece of aorta used for the second marking point, or how tensile strength would be calculated for the fourth marking point.

(c) In some individuals, the wall of the aorta splits. This can result in rapid blood loss and death.

It has been suggested that this splitting is a result of a loss of tensile strength in the wall of the aorta.

Describe how the tensile strength of the aorta wall can be determined.

(3)

You need a Sample of the aorta. You need to Calculated it's cross Seetional area using a micrometer. You will keep adding masts to do this in 3 different areas to calculate average. In 100g increments Until the breaking point is reached, do this 5 times to create an average. to calculate the force Multiply the mass by gravitational acceleration.

Tensile strength = $\frac{\text{Max force}}{\text{Cross Sectional area}}$, $= \frac{mg}{\pi r^2}$

maximum mass Withstood (g before breaking mass)

radius of aorta



This response gained 3 marks; marking points two, three and four. Marking point one would not have been awarded for 'take a sample'. It needed to state 'taking a strip' or 'ring of aorta' to gain the first marking point.

Question 3 (a)

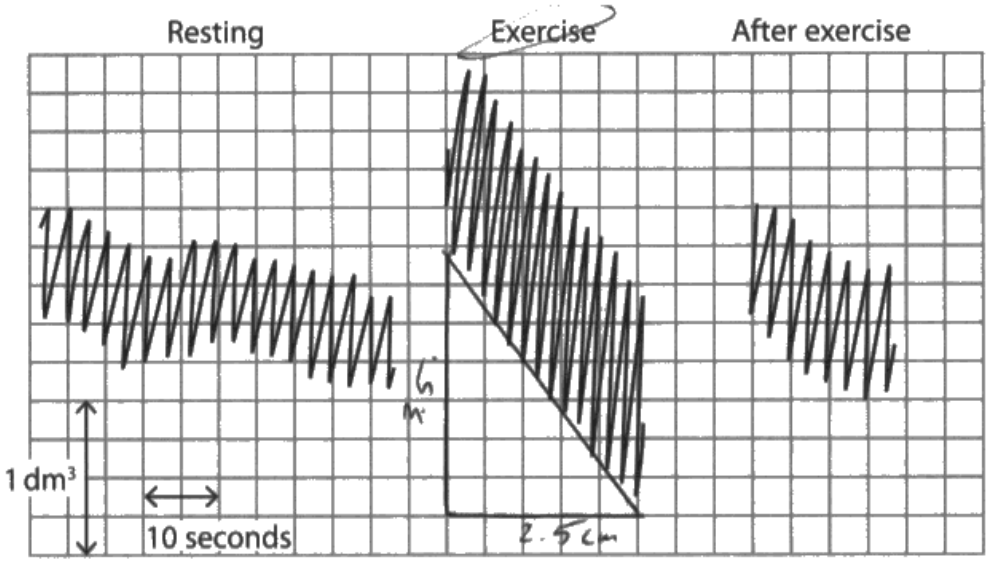
Many candidates struggled to calculate the rate of oxygen consumption. This skill would be covered in core practical 17.

3 The demand for oxygen changes during exercise.

The change in demand affects the breathing rate.

(a) Changes in breathing can be investigated using a spirometer.

Spirometer traces taken from the same individual before, during and two minutes after exercise are shown.



Calculate the rate of oxygen consumption during exercise.

(2)

2 cm = 1 dm³

1 cm = 10 secs.

T = 2.5 s.

V = 3.5 cm

2.5 = 25 s.

1 cm = 0.5 dm³

3.5 = 1.75 dm³.

1.75 / 25 = 0.07

0.07 dm³ s⁻¹

ResultsPlus
Examiner Comments

This response demonstrates a good understanding of how to calculate the rate of oxygen consumption and gained both available marks.

Question 3 (b)

Many candidates gave the answer to Q03(c) then either crossed out and rewrote the correct answer or decorated the paper with arrows in hope that the examiner would see both questions and attribute marks appropriately. Candidates should be made aware that questions are marked as independent clips. Work outside the answer space may not be seen by an examiner.

Many candidates were able to provide complete answers to this question. Marking point one was most frequently seen. Marking point two was for increased aerobic respiration, however, many candidates did not mention aerobic and so did not gain this mark. For marking point three it needed to be clear the ATP was required for muscles. To gain marking point four candidates needed to link oxygen consumption to the conversion of lactate to pyruvate or glucose. 'Oxygen is required to break down lactate' was not accepted.

(b) Explain the effect of exercise on the changes in oxygen consumption.

(4)

- Oxygen consumption ~~de~~ increases during exercise.
- This is because during exercise, muscle contraction increases, leading to an increase use of ATP.
- Therefore more respiration must take place in order to produce ATP via oxidative phosphorylation.
- Oxygen consumption increases because oxygen is required for respiration.
- The breathing rate increases in order to achieve this.

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Examiner Comments

This response gained 2 marks; marking point one in line 1, and marking point three in lines 2 and 3.

Marking point two was not awarded in lines 4 to 7 because the candidate refers to 'respiration' and not 'aerobic respiration'.

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Examiner Tip

Take care with 'respiration', you will usually need to make it clear whether you mean aerobic or anaerobic respiration.

Exercise increases the amount of oxygen consumed because more oxygen is needed for increased aerobic respiration of muscle cells in the production of ATP for muscle contractions. Therefore breathing rate and depth increases in order to increase amount of oxygen consumption. After exercise oxygen consumption is still higher than normal as there is an oxygen debt from cells having to carry out anaerobic respiration, O_2 is needed to ~~buffa~~ breakdown lactate produced.

ResultsPlus
Examiner Comments

This response gained 4 marks; marking point one in line 1, marking point two in lines 2 and 3, marking point three in lines 3 and 4, and marking point five in lines 6 and 7. Marking point four would not be awarded for 'oxygen being required to breakdown lactate'.

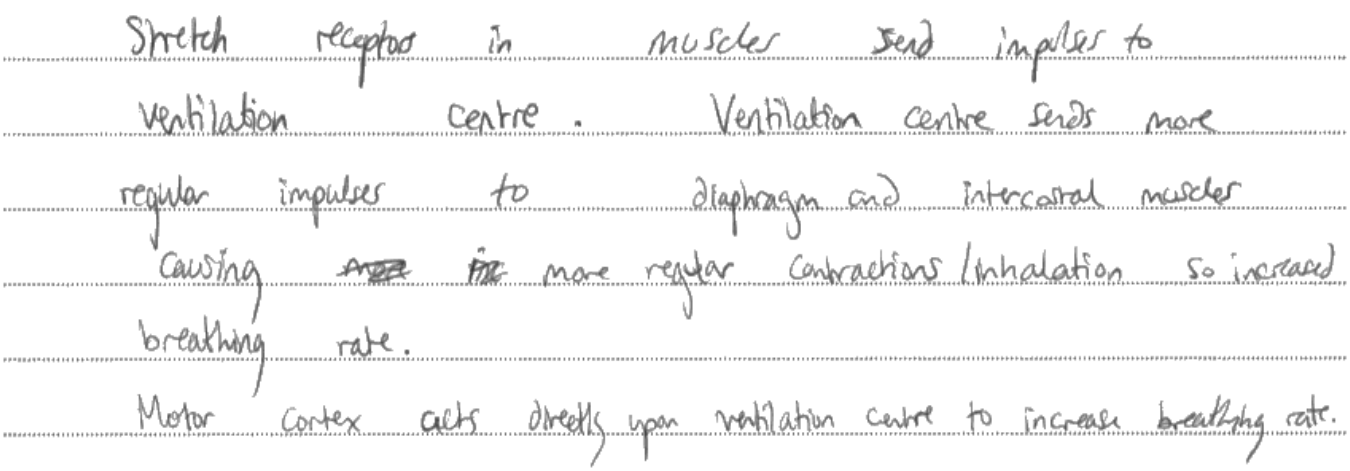
Question 3 (c)

Most candidates ignored reference to 'starting to exercise' in the question. Instead, they assumed exercise had been taking place for long enough for blood CO_2 concentration and pH to change. These candidates did not gain the first marking point. Marking point three needed 'increased' or 'more frequent impulses' to the intercostal muscles or diaphragm and not simply 'sending impulses' to these muscles.

(c) At the start of exercise, breathing rate increases.

Explain how starting to exercise causes an increase in breathing rate.

(3)



ResultsPlus
Examiner Comments

This response gained 3 marks; marking point one in lines 1 and 2, marking point two in lines 3 and 4, and marking point three in lines 4 and 5.

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Examiner Tip

Read questions carefully and take a little time to plan your answer. Ask yourself: does what you plan to say answer the question?

Question 4 (a)

The 'deduce' command word directs students to draw or reach conclusions from the information provided. Most candidates were able to partially describe the results, gaining marking points one and two. Relatively few candidates gained marking point three or made relevant deductions about the rate of reproduction and competition for resources for marking points 4 and 5.

(a) Deduce the effect of pH on the number and mass of earthworms in these two types of soil.

(4)

- An increase in pH (more alkaline conditions) have a higher number of earthworms than acidic soil
- Alkaline soil showed 5750 more earthworms than acidic soil
- The total mass is also higher in alkaline soil
- However the individual mass of each worm is higher in acidic soil (average of 1.96 g) than alkaline soil (average of 1.52 g)

ResultsPlus
Examiner Comments

This response gained marking points one, two and three for the first, third and fourth bullet point respectively. Unfortunately, the candidate has ignored the 'deduce' command word and has not attempted to draw any conclusions from the data.

ResultsPlus
Examiner Tip

The 'deduce' command word requires you draw or reach conclusions from the data provided. It does not mean the same as the 'describe' command word. In this question you need to 'deduce the effect of pH on the number and mass of earthworms'. There are more worms in alkaline soil; so a reasonable deduction would be that they reproduce more in alkaline soil. The average mass of a worm in alkaline soil is less than in acidic soil and there are more of them, so a reasonable deduction is there is more competition for resources in alkaline soil.

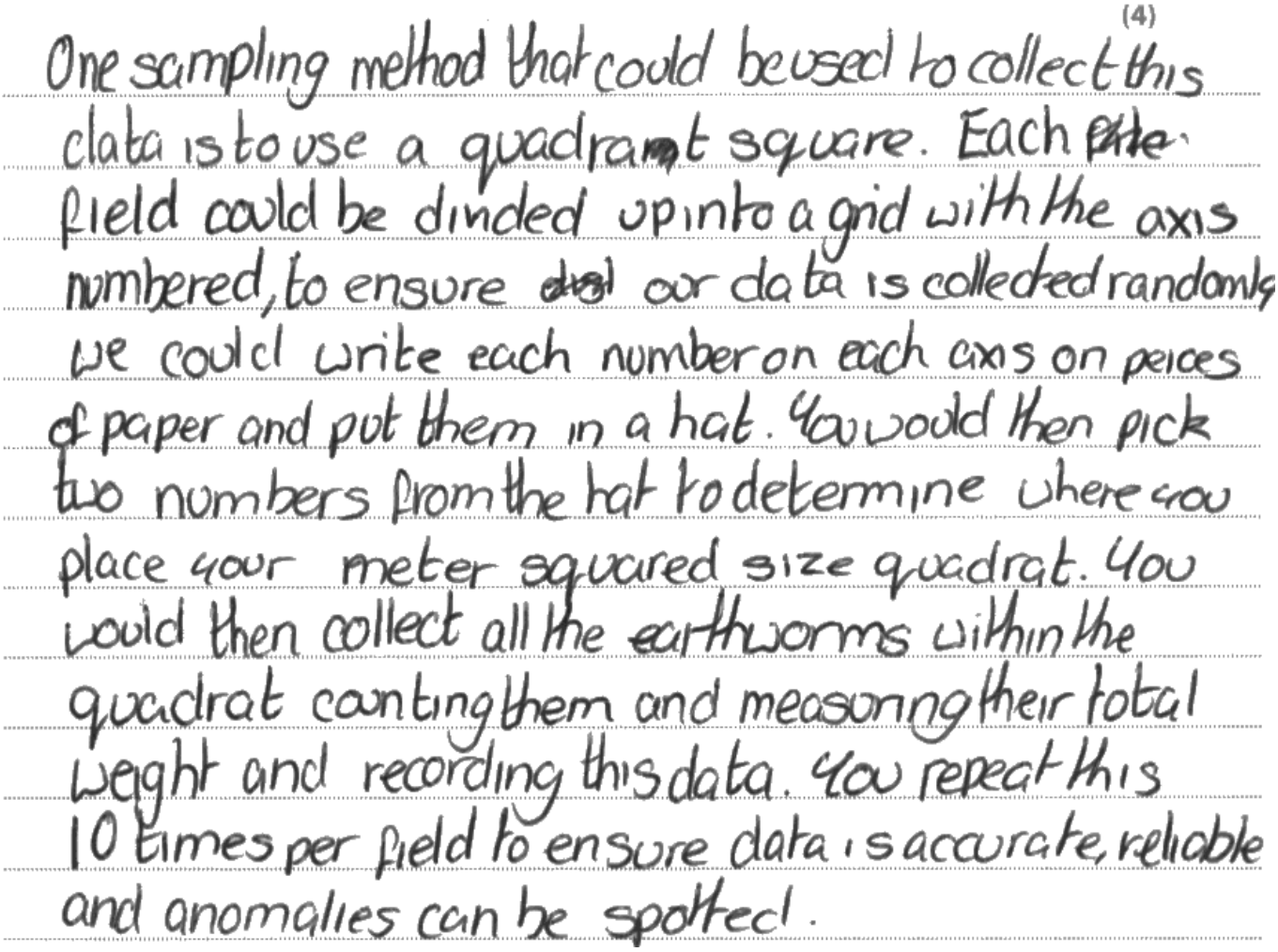
Question 4 (b)

Many candidates recognised that they were being asked to apply their learning from the ecological study core practical. Although candidates often recognised that random sampling using quadrats was required for marking point three, few gave a size for the quadrat for marking point two, made any reference to other variables which should be monitored for marking point one, or gave an indication of how they would control sample size for marking point four.

Standing in a field and throwing the quadrat, even after closing one's eyes and spinning around, was not accepted as a method of randomly distributing a quadrat.

(b) Describe a sampling method that could be used to collect the data in this table.

(4)


One sampling method that could be used to collect this data is to use a quadramt square. Each field could be dinded upinto a grid with the axis numbered, to ensure our data is collected randomly we could write each number on each axis on peices of paper and put them in a hat. You would then pick two numbers from the hat to determine where you place your meter squared size quadrat. You would then collect all the earthworms within the quadrat counting them and measuring their total weght and recording this data. You repeat this 10 times per field to ensure data is accurate, reliable and anomalies can be spotted.

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Examiner Comments

This response gained 3 marks; marking point three in lines 1 to 8, marking point two in line 8, and marking point five in lines 9 to 11.

systematic sampling through the use of quadrats. this means quadrats should be placed at the same locations of either soil sample (acidic or alkaline) with around 10 quadrats in total for each soil type. then the frequency and mass from each quadrat should be compared to the corresponding quadrat of the other soil type and collected in a table. however, other variables must be controlled like temperature to ensure validity and that the pH is the only dependent variable. repeat the experiment for validity.

ResultsPlus
Examiner Comments

In this response the candidate suggests systematic sampling, which would not be appropriate and does not gain a mark. Although the candidate makes reference to a quadrat, they do not give a size for the quadrat and so marking point two was not awarded. Similarly, the candidate makes reference to comparing the frequency and mass but does not mention earthworms so marking point five could not be awarded. The candidate has made reference to controlling other named relevant variables so marking point one was awarded.

Question 4 (c)

A pleasing number of candidates could provide good description of the use of the student t-test. Other appropriate tests, for example, the Wilcoxon signed rank test, were credited, although it was not required to learn these for this specification. References to Chi-squared and spearman rank correlation were ignored.

(c) Explain how differences between the mass of earthworms in these two soils could be shown to be statistically significant.

(3)

1 We use a t-test to compare means.
2 If result is lower than critical
3 value, accept null hypothesis.
4 If result is equal to or greater
5 than critical value reject null and
6 accept alternative hypothesis. Null
7 hypothesis shows there is a significant
8 difference between 2 means. Alternative
9 suggests there isn't and the result is
10 due to chance.

(Total for Question 4 = 11 marks)

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Examiner Comments

In this response the candidate shows a good understanding of how the t-test could be used. 3 marks were awarded; marking point one and two in lines 1 and 2, and marking point three in lines 4 to 7. The answer could have been improved by including a reference to the use of a probability value eg p = 0.05.

The two result tables can be compared using spearmen's rank which would work with the seperate data collected for the mass and quantity of the earth worms.

ResultsPlus
Examiner Comments

In this response the candidate suggests using a correlation test and seems to imply comparison of mass with number of earthworms. No marks were awarded.

ResultsPlus
Examiner Tip

Read questions carefully. Try to avoid jumping to conclusions about what you are being asked to do. This candidate may have seen two columns of data and assumed they were being asked to test for the correlation between the columns.

Question 5 (a)

Most candidates chose to only use one aspect of the information provided to them. Either using the descriptive data, for marking points one and two, or the results of a chi-squared test for marking point three and four.

Justify the conclusion that the weary phenotype was inherited as a recessive trait.

(3)

- The F1 generation were all upright, as the upright (A) and the weary (a) were crossed, it means upright was dominant as all F1 had the upright phenotype
- The F2 generation has both weary and upright, this means many of F1 were carriers of the weary gene showing that weary is recessive
- The ratio of weary to upright show weary is recessive as there are less weary

F1 =

	A	A
a	Aa	Aa
a	Aa	Aa

→ F1 upright but Aa

F2 =

	A	a
A	Aa	Aa
a	Aa	aa

→ F2 carriers or weary

25% chance weary

ResultsPlus
Examiner Comments

In this response the candidate has focused on the description of the crosses, ignoring the data and the statistical test result. Marking points one and two were awarded.

(4c)

The null hypothesis is that the weary phenotype is a recessive trait.

To carry out a hypothesis test, the critical value needs to be determined. Carrying out the test at a 5% significance level and degrees of freedom = 1 (number of rows - 1 x number of columns - 1, as we have 2 generations, 2 - 1 = 1) we obtain the critical value 3.84.

By comparing x^2 to the critical value, x^2(2.31) is less than 3.84 (the critical value) and so there is not sufficient evidence to reject the null so we accept that the weary phenotype is recessive.

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Examiner Comments

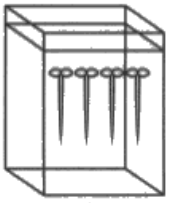
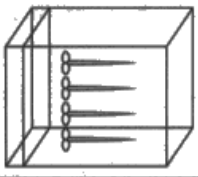
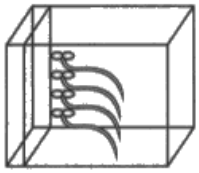
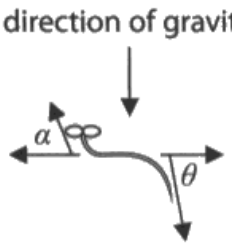
In this response the candidate has ignored the description of the crosses and has focused on the statistical test. Marking points three and four were awarded.

Question 5 (b) (i)

Candidates frequently noted that plants were phototrophic, for marking point one, however, they often then struggled to gain either marking point two or three. Marking point two was for clearly stating that light needs to be excluded to allow the effect of gravity to be studied. Marking point three was for explaining that this was because light would otherwise have an effect on the direction of growth.

(b) The effect of gravity on the growth of lettuce plants with either upright or weary phenotype was investigated.

The diagram shows the stages in this investigation.

Stage A 	Lettuce plants were grown until their stems were 15 cm long.
Stage B 	The lettuce plants were then placed in complete darkness and rotated so that they were at 90° to the direction of gravity.
Stage C  	The curvatures of the stems (α) and roots (θ) were measured for the next 23 days.

(i) Explain why the plants were placed in a box in complete darkness.

(3)

because light affects the direction of growth through phototropism. In shoots, auxins move towards the shaded side and cause cell elongation, meaning shoots grow towards light. In roots the ~~a~~ auxins on the shaded side inhibit cell elongation, meaning roots grow away from the light and are negatively phototrophic. When placed in darkness, light can't affect direction of growth.

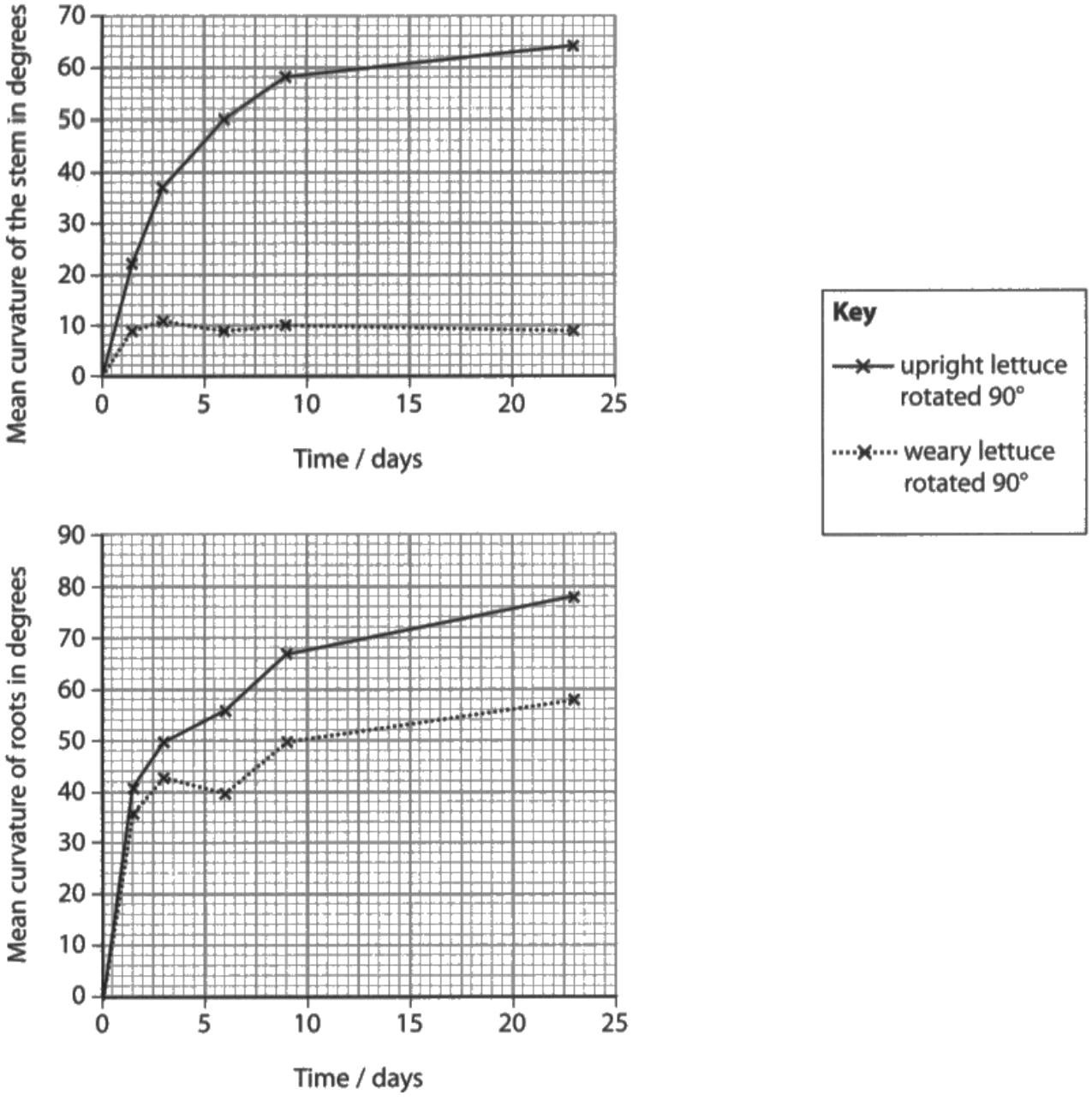
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Examiner Comments

This response gained 2 marks; marking point one in the first two lines and marking point three in the last two lines.

Question 5 (b) (ii)

While many candidates managed to correctly determine the degrees curvature for stem (8°) and root (58°) many were then unable to carry out the calculation. A number of candidates simply calculated a difference and ignored the rate element to the calculation. Some candidates did not provide units and did not gain the second mark.

(ii) The mean curvatures of the stems and the roots are shown in the graphs.



Calculate the difference in the mean rate of curvature of the stems and roots of the weary lettuce plants over 23 days.

(2)

23 days stem - 9° roots - 58°

$58° - 9° = 49°$

$\frac{49°}{23} = 2.13°$ per day (3.s.f)

Answer $2.13° d^{-1}$

ResultsPlus
Examiner Comments

This clearly presented response gained both marks.

Question 5 (b) (iii)

Many candidates ignored all the information about weary phenotype being an inherited trait; these candidates did not gain marking point one. In contrast, a large number of candidates recognised a role for auxin for marking point two although they did not provide any detail about how this might take place for marking point three.

(iii) Explain why the stems of weary lettuce do not respond to gravity.

(2)

Under normal conditions, weary lettuce stems droop and don't seem to respond to light intensity or gravity. This suggests that weary lettuce doesn't produce auxins that stimulate growth in the stem, ~~which~~ which would cause it to grow against gravity. IAA allows stems to grow against gravity, but this doesn't happen in weary plants.

ResultsPlus
Examiner Comments

This was a fairly typical response which gained 1 mark. Marking point two was awarded for reference to a lack of auxin.

ResultsPlus
Examiner Tip

Consider all the information provided in the question when formulating your answers. From the earlier parts of this question you can determine that the weary phenotype is inherited, leading to marking point one.

Question 6 (a)

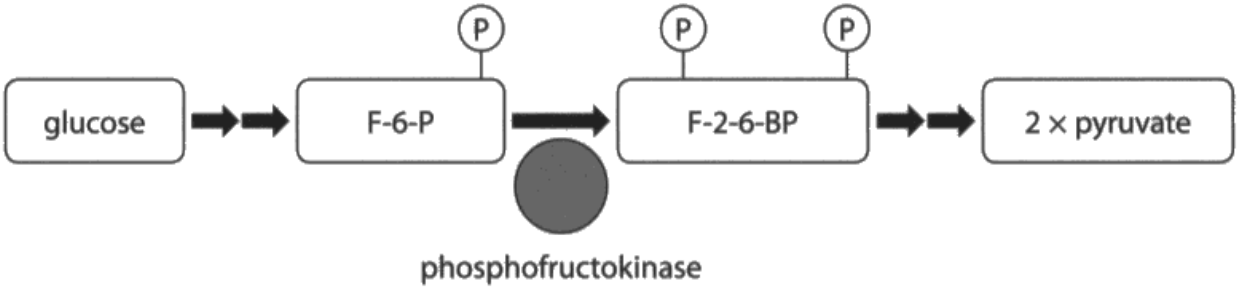
Most candidates were able to provide a good explanation of the term enzyme.

Question 6 (b) (i)

Many candidates recognised that the ATP would provide energy for the reaction, for marking point two, and the phosphate for phosphorylation of F-6_P, for marking point three. Candidates, however, often did not make reference to the hydrolysis of ATP required for the release of energy and the provision of inorganic phosphate, so did not gain marking point one. Use of terms such as 'splitting' or 'breaking' of ATP were not accepted in place of hydrolysis.

(b) Phosphofructokinase is an enzyme that uses ATP to convert fructose-6-phosphate (F-6-P) into fructose-2,6-bisphosphate (F-2,6-BP).

The conversion of F-6-P by this enzyme is a rate-determining step in glycolysis. This is shown in the diagram.



(i) Explain why ATP is required for this reaction.

(3)

The f-2-6-BP molecule has two organic phosphates whereas the F-6-P only has one. This means a phosphate must come from breaking down ATP into ADP and an organic phosphate molecule. This phosphate molecule then binds to the f-6-P to create F-2-6-BP

ResultsPlus
Examiner Comments

This response gained 1 mark; marking point three. The candidate ignored the fact that the ATP is hydrolysed, for marking point one, to release the inorganic phosphate and energy, for marking point two.

ResultsPlus
Examiner Tip

Although the information provided in the question is there to help you answer the question, you should always be thinking about how you can apply your own knowledge and understanding. In this case that ATP is hydrolysed to releases energy for chemical reactions.

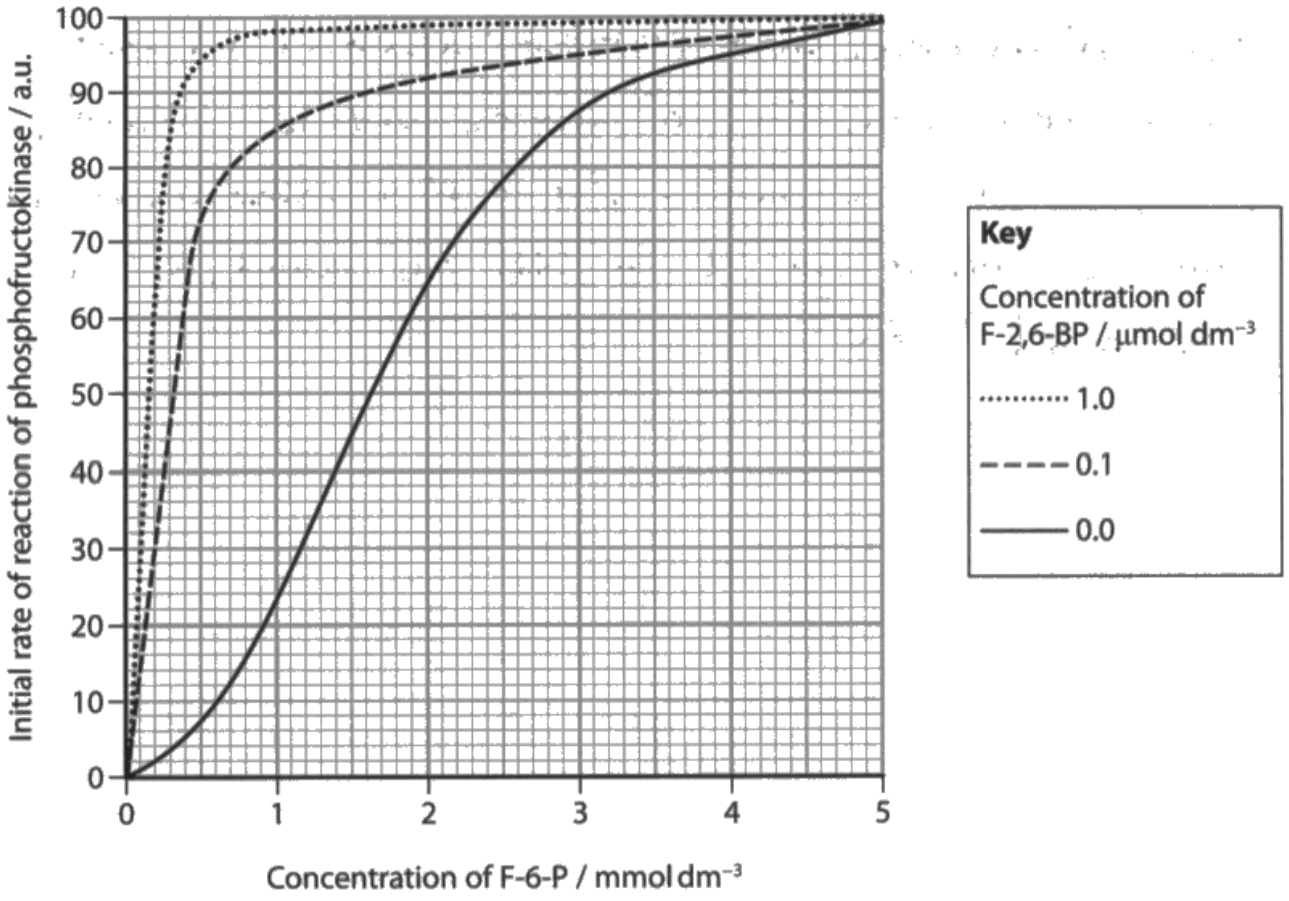
Question 6 (b) (ii)

Many candidates correctly described the effect of F-6-P and F-2,6-BP on enzyme activity for marking point one. Many of these candidates then failed to extend this to describe the effect on glycolysis for marking points two and four.

(ii) The effect of substrate concentration on the initial rate of reaction of phosphofructokinase was investigated.

This investigation was repeated with the addition of two concentrations of F-2,6-BP.

The graph shows the results of this investigation.



Comment on the effects of F-6-P and F-2,6-BP concentrations on the rate of glycolysis.

(3)

An increase in F-6-P is shown to increase initial rate of phosphofructokinase, which increases rate of glycolysis as for all 3 concentrations of F-2,6-BP increasing F-6-P increases initial rate up to 100 AU. For all 3 concentrations of F-2-6-BP at 5 $mmol\,dm^{-3}$ of F-6-P. Increasing F-2-6-BP concentration also is shown to increase rate as for a concentration of 1 $mmol\,dm^{-3}$ the max rate of 100 is achieved quickly at over 90 by 1 $mmol\,dm^{-3}$ of F-6-P, at 100 by 4 $mmol\,dm^{-3}$.

ResultsPlus
Examiner Comments

This response gained 3 marks. Marking point one and two were awarded in the first two lines. Marking point three was allowed in lines 2 and 3. The last four lines would have gained marking point four if the candidate had linked the explanation to the rate of glycolysis.

Question 6 (c)

Many candidates found it difficult to apply their learning from the enzyme core practicals to this question. Marking point one required reference to the use of pH buffers to maintain different pH values, not just a description of using solutions of different pH values. Marking point two was for recognition that ATP concentration should not be rate limiting; for example, ATP needs to be present in excess. Marking point three was for the selection of an appropriate concentration of F-6-P based on the data earlier in the question. Marking point five required candidates to suggest measuring F-2,6-BP after a particular time or at regular time, allowing the determination of a rate of reaction.

Question 7 (a)

Many candidates demonstrated a good understanding of how different species evolve. For marking point one it needed to be clear that the mutations occurred at random. A number of candidates suggested that the mutations took place in response to the different environments/ selection pressures and did not get the mark. Many candidates ignored the information provided and did not gain marking point three. Similarly, many candidates made reference to allopatric or sympatric speciation but did not link the phrase to the context of fish in different lakes or the same lake and were not given marking point six.

(a) Describe how different species of cichlid fish have evolved in lakes and rivers in Africa.

(5)

Variation mayhave happene Variation and a diffent allele frequency was present in the population at the start due to a mutation. - Shapes of mouth.

. Due to a geographical Barrier which isolated the fish in the lakes from those in the River, a selection pressure was created and as a result the fish with the advantagious alleles were able to survive and passon these alleles to their offspring, those that Couldnot of this died. (Natural selection - survival of the fittest)

. Allopatric speciation took place - where ~~both~~ types of fish in the rivers and lakes became so different that they couldn't no longer inter breed. ie. Some Resource were made available which allowed them to become omnivores
. This is made clear by the visible changes to the fish, those in the Rivers are mostly bigger in size, mainly herbivores who also lay eggs in gravel. This suggests that the geographical changes present ~~has~~ may have lead to these changes in their appearance and behaviour.
↓ Contrasts hugely with those in the lake who have different eating habits and appearance.
. The Mouth shape of those in the river is far ~~more~~ broader than those in the lake, suggesting the change in environment.
. ~~Also~~ They feed on different things, ~~whereas~~ those in the river are mainly herbivores, some in the lakes are Carnivores, suggesting this change in environment.

ResultsPlus
Examiner Comments

This response gained 5 marks; marking point one in lines 1 to 3, marking point six in lines 4 and 5, marking point two in line 5, marking point four in lines 6 to 8, and marking point three at the end of the response.

The response could have been improved by including reference to reduced gene flow between populations for marking point five.

Question 7 (b)

The level based question proved accessible to the majority of candidates. Candidates were provided with some data about changes in the genomes of cichlid fish in African lakes and rivers. The level of the candidates' response was determined by the quality of candidates' use of the data. Responses that were essentially descriptions of the data were given a level 1. Those responses in which candidates had described some consequences of the data given but with limited interpretation in terms of evolution were considered to be at level 2. Candidates who provided a good description of the data, with a sensible explanation of the consequences, and then providing good linkage of this to processes involved in evolution were given a level 3.

Analyse all the data provided to discuss how several species of cichlid fish have evolved over a short period of time.

(9)

From the Phylogenetic tree, it shows the species evolution has started since 50 millions ago since divergence. But the species are then evolved in different times. The most similar among these species are M. Zebra and P. nyererei. M. Zebra has the highest rate of rate of gene duplication and the second more mutations in transcription factors, compared to O. niloticus P. nyererei has lower rate of gene duplication and less mutuation to O.niloticus than the M. Zebra. However the greatest mutations number in N. brichardi which means O. niloticus and N. brichardi are become more different to each other since 50 million year ago. However, the rate of mutation of N. brichardi is only 0.037 a.u which is the 4th. The P. nyererei has the highest rate of mutations in changing amino acids 0.044 a.u and the second is the M. Zebra. These two are similar. The slowly evolving fish stickle back is 10 a.u gene duplication and number of mutation compared to O. niloticus is 0, which means O. niloticus could be derived from stickle back. Its rate is much more less tan other species, especially with M. Zebra. The evolution time between M. Zebra and P. nyererei is likely to take the least time where the seperate of O. niloticus and N. brichardi is the oldest and longest. The other evolution is occured around 25 million year before. The rate of gene duplication and mutation does increase the rate of evolution from the common ancestor but it also takes millions time to be classified as fully become a different species when they cannot interbreed fertile offspring.

(Total for Question 7 = 14 marks)

ResultsPlus
Examiner Comments

This response was judged to be a level 1 response and was awarded 2 marks. The candidate has provided a good description of the data, however, there is no discussion of the consequences of the data. For example, there is no comment on high mutation rates resulting in new alleles or a larger gene pool, or enzymes with different specificities. Very little attempt was made to link the data to relevant evolutionary points such as the ability to survive in a different niche or being better able to survive different selection pressures.

ResultsPlus
Examiner Tip

For a level based question such as this one, take time to plan your answer. The command word 'discuss' requires you to go beyond a simple description. You will need to use reasoning to explore the situation or issue. In this question you were expected to explain how the genetic changes described could account for the rapid evolution of cichlid fish.

Cichlid fish have evolved over a short period of time as they have a higher rate of gene duplication compared to the slowly evolving Stickleback fish. The species M. zebra has the highest rate at 60 au compared to 10 au of the Stickleback. This evidence shows that the DNA is replicated rapidly where additional copies of genes are also produced at the chromosome. This gives rise to more of a range of alleles on a chromosome increasing genetic diversity within the species.

Also, cichlid fish have a greater rate of mutations changing compared to the stickleback. The highest was P nyererei at 0.044 au compared to the lowest being 0.015 for the stickleback. The change in amino acids gives rise to more different proteins being produced. This means the structure and function of proteins will be changed at a greater rate. These proteins could cause changes in phenotypes helping the cichlid fish to adapt to their environment quickly.

ResultsPlus
Examiner Comments

This response was judged to be a good level 2 response. 6 marks were awarded. The candidate has focused on two pieces of data; gene duplication and rate of amino acid changing mutations. The consequences of both pieces of data are explained and an attempt has been made to link these consequences to evolution; for example, 'change in phenotype helps cichlids adapt to environment quickly'.

• Rate of gene duplication, producing additional copies of genes is significantly higher for all 5 fish than stickleback e.g. stickleback at 10au meanwhile, O nilotcus at 45au - which is the smallest rate. This means that there is a larger gene pool hence lots of genetic variation and larger number of possible phenotypes hence evolution can be quick.

• Number of mutations in transcription factor binding sites is high in 4 of fish compared to stickleback at 0. For example N. Brichardi has a number of 214 mutations mutations are change in order of bases of DNA - transcription factors are needed for transcription and translation of proteins. mutations may change the shape of binding sites hence can't bind - no transcription inhibition complex - This results in no transcription of mRNA or translation of proteins, meaning some functions are not shown. could lead to differences in behaviour leading to speciation.

• Rate of mutation changing amino acid is high for P nyerei at 0.04 compared to O nilotcus at 0.02 hence as more species of fish have formed, there has been increased rate of mutation, according to phylogenic tree hence resulting in differences in proteins produced resulting in different phenotypes + behaviour

(Total for Question 7 = 14 marks)

ResultsPlus
Examiner Comments

This response was judged to be at level 3. In this response the candidate has described and linked three pieces of data to consequences and has then linked these to processes leading to evolution; for example, gene duplication increases the gene pool which then results in a wider range of phenotypes, allowing for faster evolution; mutations in transcription factor binding sites results in a change in the expression of genes which results in altered behaviour of fish, leading to speciation; mutations in amino acid coding sequences result in different proteins and, therefore, different phenotypes and behaviours.

ResultsPlus
Examiner Tip

The levels-based question in this paper is worth up to 9 marks. The space provided in the examination paper is sufficient for an answer to gain all 9 marks. Take time to read the question carefully and then plan your answer.

Question 8 (a)

Many candidates described the ability of stem cells to differentiate for marking point two, however, candidates often forgot to mention the ability of stem cells to self-renew, also for marking point two.

8 The scientific article you have studied is adapted from *The Biologist*.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) State the meaning of the term stem cell (paragraph 1).

(2)

Stem cells are unspecialised cells that have the ability to differentiate into specialised cells. Stem cells will always continue to divide.

ResultsPlus
Examiner Comments

This response gained both marks.

a cell that hasn't been specialised and can undergo mitosis to produce more undifferentiated cells

ResultsPlus
Examiner Comments

In this response the candidate gained marking point one, however, the candidate has not actually mentioned that stem cells can differentiate. Marking point two was not awarded.

ResultsPlus
Examiner Tip

Check your answers carefully. Have you written down what you intended to write?

Question 8 (b)

Many candidates produced good responses to this question. Reference to mitosis was required to gain marking point one; just describing cell division was not enough. To gain marking point three it needed to be clear that the different proteins synthesised determined either cell structure of function. A simple statement that different proteins are synthesised would not be sufficient.

(b) Describe how a 'single fertilised egg' can produce many different cell types (paragraph 2).

(3)

A single fertilised egg has a blastula with ~~with~~ unspecialised cells. The unspecialised cells can differentiate into many different cell types because some genes are activated and others switched off due to transcription factors. RNA polymerase binds to the promoter region and transcribes the genes which produce mRNA which gets translated into proteins which permanently modify the cell.

ResultsPlus
Examiner Comments

This response gained 3 marks; marking points two, three and four.

· ~~the~~ when an egg is fertilised, it then divides to form a blastocyst - a mass of undifferentiated cells.

· ~~the fertilised e~~. Embryonic stem cells form from an egg cell, which are pluripotent stem cells - they can differentiate into most cell types.

· stem cells respond to different signals and so will differentiate into different cell types. They respond to different transcription factors. Differential gene expression occurs where different genes are switched on and off in different cell types.

ResultsPlus
Examiner Comments

This response gained 2 marks; marking points two and four.

Question 8 (c)

The majority of candidates correctly stated myogenic.

Question 8 (d)

Many candidates ignored the difficulty in identifying heterozygous or carrier mice, for marking point one, and simply described a cross between heterozygous mice, subsequently crossing the homozygous recessive offspring for marking points two and three. To gain marking point four it had to be clear that only homozygous recessive offspring were used for all subsequent generations; not just a single cross.

(d) Mice used in research have a number of limitations (paragraph 6). Mice that are homozygous for a recessive trait are rare in the population, but can be produced in genetic crosses.

Explain how genetic crosses could be used to generate a mouse line expressing a recessive trait.

(3)

- ~~No~~ heterozygous individuals are bred together.
- the offspring phenotypes are observed.
- the offspring are bred together, and their phenotypes observed.

ResultsPlus
Examiner Comments

This response gained 1 mark; marking point two.

ResultsPlus
Examiner Tip

This response gained 1 mark; marking point two in line 1. Lines 2 to 4 do not describe what genotypes are being crossed and no additional marks can be awarded.

Analyse / the alleles present in the mice, to find the ones with most recessive alleles / carriers. Proceed to only breed the recessive trait carriers with eachother, to increase the chance of them. both the recessive alleles being passed onto the offspring, and causing the offspring to have the recessive trait. Continue breeding these recessive trait mice to increase the number of the recessive trait in the mouse line.

ResultsPlus
Examiner Comments

This response gained all 3 available marks. All four possible marking points are present in the response.

Question 8 (e)

Many candidates produced a complete response to this question and all marking points were frequently seen.

(e) Retinoic acid affects the expression of genes in embryonic stem cells (ESCs) leading to the development of neural tissues (paragraph 11).

Explain how chemicals such as retinoic acid could affect gene expression.

(3)

Retinoic acid could act as a transcription factor. When the ~~food~~ molecule binds to the promoter region, RNA polymerase also binds ~~ca~~ and causes active mRNA to be produced. This then produces active proteins, expression of the gene. It's also possible for the ~~red~~ retinoic acid to bind to a repressor molecule. This prevents it from binding to the promoter region, allowing RNA polymerase to bind and active mRNA to be produced.

ResultsPlus
Examiner Comments

This response gained all 3 available marks; marking points one, two and three.

Question 8 (f)

Candidates who realised that the virus must be infecting neural cells could apply their understanding of how viruses work to answer this question. A number of candidates described the infection of T cells and this was not accepted for marking points one and four. These candidates could still gain marking points two and three.

(f) The Zika virus can cause microcephaly. This condition is a result of brain tissue not developing in the foetus (paragraphs 20 and 21).

Explain how the Zika virus can cause microcephaly.

(3)

The zika virus can cause microcepnaly by meaning that brain tissue doesnt fully develop in the brain, this is due to it targeting neural cells.

ResultsPlus
Examiner Comments

This response gained 1 mark; marking point one. Targeting neural cells was allowed for binding to neural cells.

The Zika virus attaches to [redacted] receptors on cells of the brain tissue, and inserts its viral genome into the cell. The protein coat [redacted] then breaks down in the cell, releasing the viral nucleic acid, which replicates inside the cell, and new protein coats form around the replicated nucleic acid to form new viral genomes inside the cell. This causes the cell to swell, and then cell apoptosis occurs where the cell bursts and dies, meaning brain cells die. New viral genomes go on to infect new brain cells, so brain cells can't divide and replicate to produce new cells which form tissue, again leading to microcephaly.

ResultsPlus
Examiner Comments

This response gained 3 marks from four marking points; marking point one on line 1, marking point two on line 2, marking point three on lines 4 and 5, and marking point four on line 6.

Question 8 (g)

Many complete responses were seen for this question, however, candidates seem to find this topic difficult and there were many examples of responses in which the different cell types were confused, for example, antigen presenting T cells phagocytic B cells. Some candidates described non-specific or inflammatory responses rather than a specific immune response to the transplant tissue.

(g) Tissue rejection can occur in organs transplanted from other individuals (paragraph 22).

Explain how the immune system is involved in tissue rejection.

(4)

The immune system recognises foreign tissues as non-self antigen. This activates immune response as the macrophage and B cells engulfs the foreign tissue, and presents the antigen on its cell surface in conjunction with MHC (II) protein, forming an antigen presenting cell (APC). This activates T helper cells which is complementary and binds to the APC, releasing cytokines in the process. B cells can hence t.. divide and differentiate into plasma cells, secreting antibodies. Antibodies eliminates foreign tissue by agglutination.

ResultsPlus
Examiner Comments

In this response the candidate has gained 4 marks; marking point one in line 1, marking point two in lines 4 and 5, marking point three in line 7, and marking point four in line 10. Although agglutination may not be the correct context, the idea of antibodies eliminating the foreign tissue would have been just sufficient for marking point five.

Question 8 (h)

A significant part of the article revolved around the use of tissue culture systems to grow organoids and gastruloids to replace the use of animals. This question was about assessing the effect of temperature on the growth of a cell culture. Many candidates appeared to have little idea of how to answer this question and were unable to apply their learning from the culture of microorganisms. All of the marking points other than marking point six could be achieved by applying ideas from the culture of microorganisms.

Marking point one was awarded for considering how temperature would be controlled; for example, 'keep cell cultures at a set temperature in an incubator' would gain the mark. In contrast, 'incubate the cells at a set temperature' would not.

Marking point six was given for deciding how growth would be measured. To gain this mark, candidates need to suggest recording an appropriate parameter at the start and end of the culture or at regular intervals during the culture. Counting the number of cells at the end was not enough unless the number of cells at the start was also counted.

(h) Human cells can be grown in monolayers using tissue culture (Figure 1).

D.= No of cells in the monolayer

Devise a procedure to investigate the effect of temperature (I.D) on the growth rate of a monolayer of human cells.

(5)

1. prepare 5 human cultures* containing only one somatic cell from same part of body with same age.
2. prepare 5 incubators with different temperatures (5, 10, 15, 20, 25, 30°)
3. place each culture into each incubator and leave them for a week.
4. keep all effective factors constant such as volume of nutrients and type available for each culture, pH (by using a buffer solution.
5. count the number of cells ~~present and thickness~~ present in the monolayer and measure depth of each monolayer and note your results.
6. Repeat the process and calculate the mean depth to increase reliability of your practical
7. carry out statistical test to make sure whether there is a significant difference in data.

ResultsPlus
Examiner Comments

This response gained 5 marks; marking point six for bullet points 1 and 5, marking point one for bullet point 2, marking point five for bullet point 3, and marking points two and three for bullet point 4. The only marking point not seen in this response was marking point four for the idea of using aseptic technique.

Question 8 (j)

Candidates were directed to describe two ethical issues surrounding the use of human embryonic stem cells in research. Many candidates found this task straightforward and gained both available marks; usually for marking points one and two.

(j) Describe two ethical issues concerning the use of human embryonic stem cells in research (paragraph 32).

(2)

One ethical issue is that since embryos that aren't used are destroyed is unethical because each embryo could develop into a human which has a right to life.

ResultsPlus
Examiner Comments

This response gained 1 mark, marking point one, for describing one ethical issue.

The embryos are destroyed after the stem cells are taken which could be seen as destroying a potential life. The embryo can't consent to it.

ResultsPlus
Examiner Comments

This response gained 2 marks for marking points one and two.

Question 8 (k)

Many candidates repeated their answer to Q08(j) and generally gained 1 mark for marking point one. Candidates thinking beyond ethical issues often gained marking point two for the idea that the transplant material from iPSCs will be genetically identical or have the same antigens. To gain marking point two candidates had to say something more than the transplant will not be rejected; the minimum requirement was that the transplant would not trigger an immune response. The preferred answer was that the transplant would be genetically or antigenically identical. Very few candidates made reference to the ease or difficulty of obtaining iPSCs vs embryonic stem cells, for marking point three, or the greater potential of embryonic cells to proliferate or cause cancer, for marking point four.

(k) Explain the advantages of using iPSCs compared to ESCs for the production of transplant material (paragraphs 33 and 34).

(3)

No rejection as iPSCs are from the persons body

Less waiting time for patient an not waiting for ESCs transplants

Less painful, iPSCs ~~are~~ can be taken from skin cells

Idea that you aren't taking away a life

ResultsPlus
Examiner Comments

This response gained 2 marks; marking point three in lines 3 and 4, and marking point one in the last line. Marking point two was not awarded for 'no rejection'. To gain this mark the candidate needs to suggest a reason for no rejection, such as: 'material from iPSCs is antigenically identical' or 'material from iPSCs will not trigger an immune response'.

Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- be prepared to apply what you have learnt from core practicals when answering questions in the exam;
- read all the information provided – especially where practical procedures are being described in unfamiliar contexts;
- learn the command words and the types of answers expected;
- read the whole question and identify the command word and the context. Take care with 'Explain why' and 'Explain how' questions;
- set out calculations carefully; show each stage of your working in case a mistake is made at the final step;
- attempt every question. Time permitting, always at least make an educated guess and read the stem of the question carefully as there is often helpful information in there that might help.

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