

Examiners' Report

June 2025

Int Advanced Level Biology WBI15 01

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Introduction

This paper tested the knowledge, understanding and application of material from the topics 'Respiration, Internal Environment, Coordination and Gene Technology.

The range of questions provided ample opportunity for students to demonstrate their grasp of these topics and apply their knowledge to novel contexts.

The questions on this paper yielded a wide range of responses and some very good answers were seen. The paper appears to have worked very well with all questions achieving the full spread of marks.

Question 1(a)

In this question candidates were required to label a diagram of a motor neurone. The diagram was clearly labelled A,B and C. For each label alternatives were accepted, eg. plurals, scientifically correct terms. In some cases the candidate put down 2 or 3 responses in the space provided. In this case the first response was taken. Phonetically correct responses were acceptable.

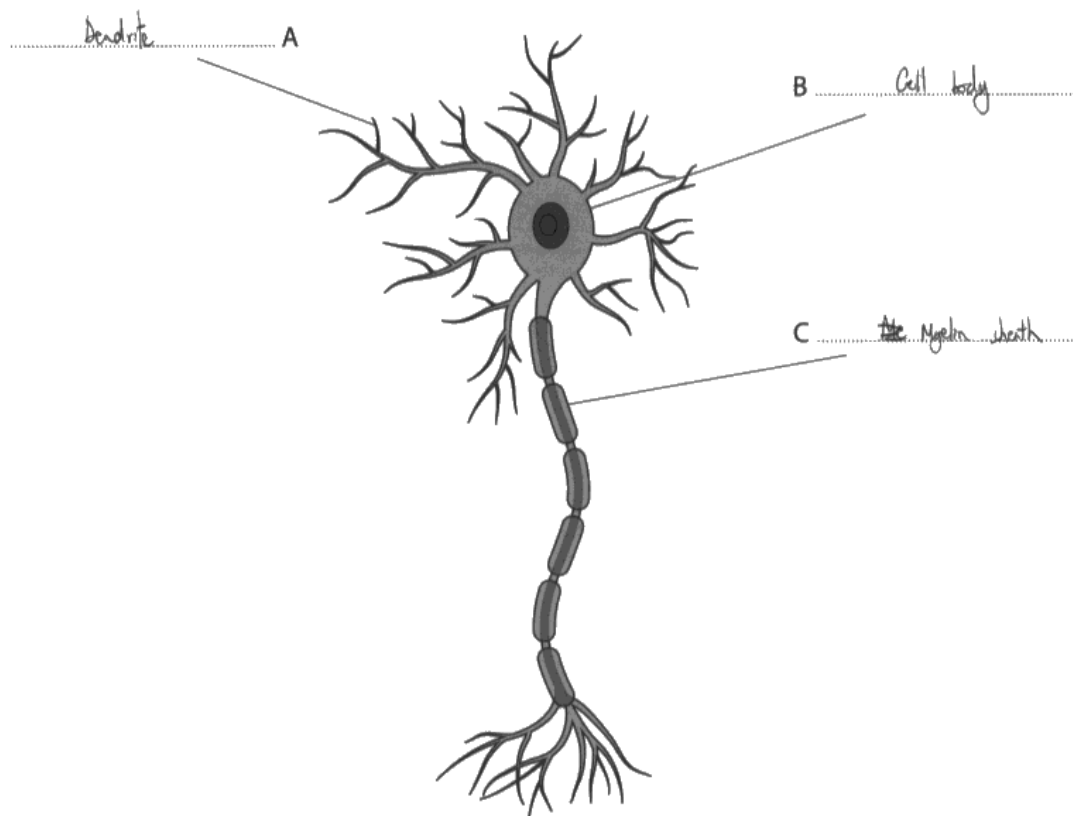
Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1** The nervous system is involved in coordination in animals.

The diagram shows a motor neurone.



(a) Complete the diagram by naming the parts labelled A to C.

(2)



3 correct labels and in the spaces provided.



Here to gain 2 marks all 3 labels had to be correct.

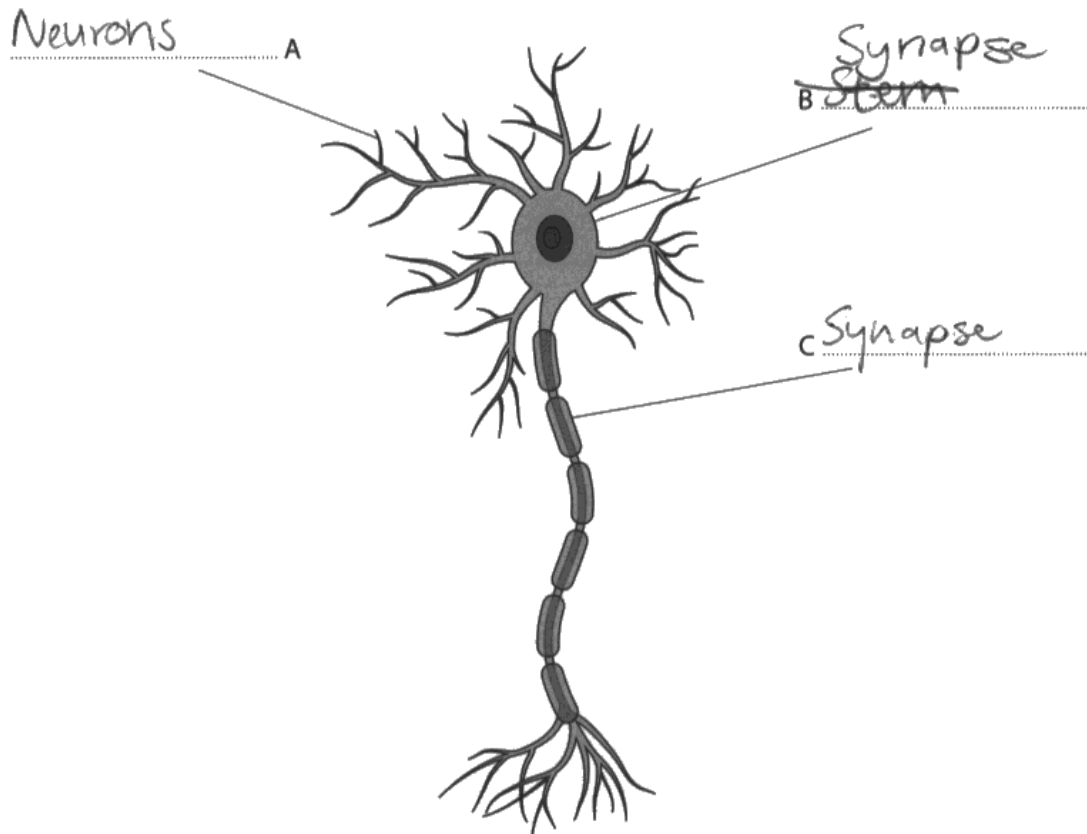
Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 The nervous system is involved in coordination in animals.

The diagram shows a motor neurone.



- (a) Complete the diagram by naming the parts labelled A to C.

(2)



This is one of very few examples where none of the labels A, B or C were acceptable.



It is important from the specification point 8.1 to know the structure of the three types of neurones and the appropriate labelling.

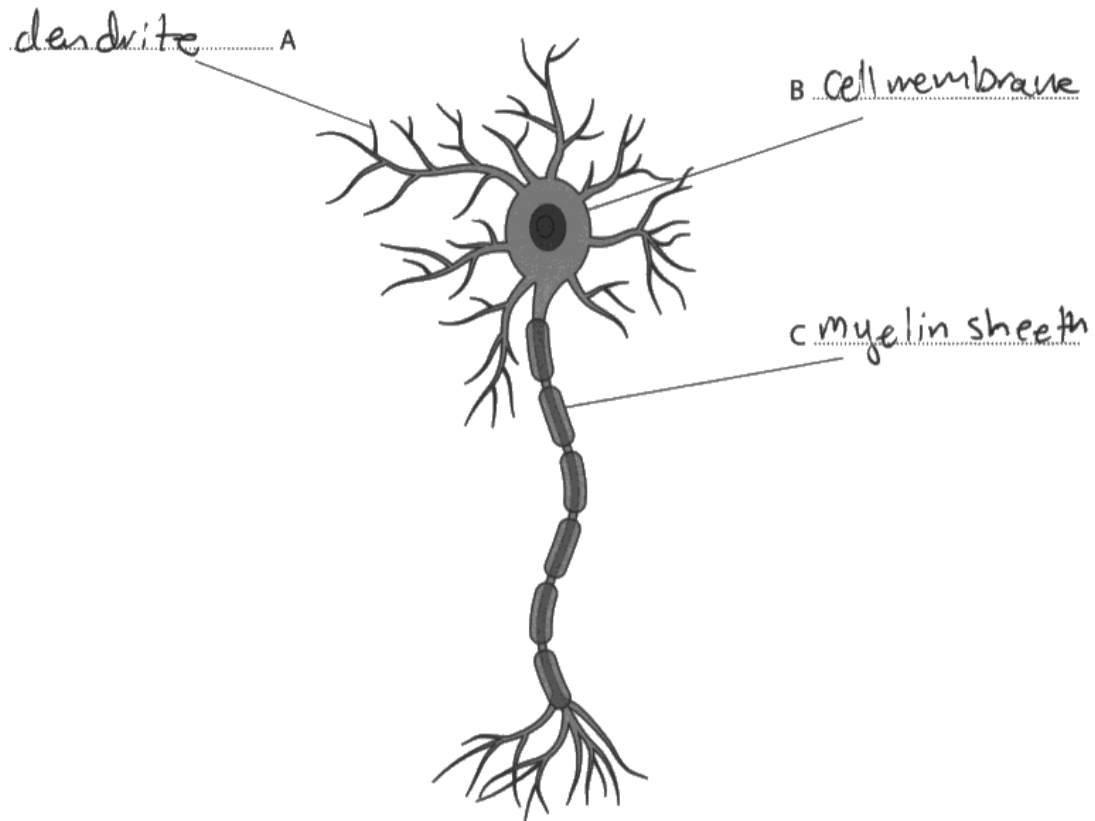
Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 The nervous system is involved in coordination in animals.

The diagram shows a motor neurone.



- (a) Complete the diagram by naming the parts labelled A to C.

(2)



There were alternative responses that were acceptable for each of the labels. A - dendrite(s) or dendron B - cell body, soma, cell membrane or centron. C - myelin (sheath), fatty sheath, lipid sheath, Schwann cell, glial or axon.



In each case try and answer as fully as possible - eg. just sheath on its own was not deemed creditworthy.

Question 1(b)

In this question candidates had to describe how a nerve impulse is conducted across the synapse between neurones. There was a total of 3 marks for a correct description.

(b) Describe how a nerve impulse is conducted across the synapse between neurones.

(3)

Calcium ions enter presynaptic neurone by calcium ion ~~channel~~ channels, vesicles containing neurotransmitters fuse with the cell membrane, neurotransmitters are released into the synaptic cleft, and diffuse down their concentration gradient and binding to post synaptic receptors, causing sodium ion channels to open and an action potential to be generated in the post synaptic neurone due to influx of sodium ions that cause depolarisation.

(Total for Question 1 = 5 marks)



There were lots of 3 mark responses showing candidates had learnt this aspect of the specification. Most gained mp1 and 2. A few didn't include the idea of diffusion for mp3, or the idea of receptors/post synaptic for mp4. In this example as the candidate had already referred to the presynaptic neurone, 'neurotransmitter fusing with the cell membrane' was accepted.



It is very important to make it clear which membrane the candidate is talking about.

(b) Describe how a nerve impulse is conducted across the synapse between neurones.

(3)

When a nerve impulse arrives at the axon terminal, there will be a sudden increase in the permeability of the axon membrane to calcium ions. The voltage gated calcium ion channels ^{on the axon membrane} will open up and allow Ca^{2+} ions to enter the neurone. The influx of Ca^{2+} ions into the axon terminal will stimulate the vesicles that contain the neurotransmitter to move to and bind to the pre synaptic membrane and release the ~~nerve~~ neurotransmitter into the ^{synaptic} cleft via exocytosis. The neurotransmitter will ~~bind~~ move down the concentration gradient and diffuse (Total for Question 1 = 5 marks) across the synaptic cleft via diffusion and bind to the specific ~~recepter~~ receptors on the post synaptic membrane. This will cause the voltage gate Na^{+} ion channels on the post synaptic membrane to open up and allow for the influx of Na^{+} ions into post synaptic neurone, triggering action potential in post synaptic neurone.



A very comprehensive response showing good use of the correct scientific terms, eg diffuse. This response gained all the marking points from the mark scheme for a maximum of 3 marks.



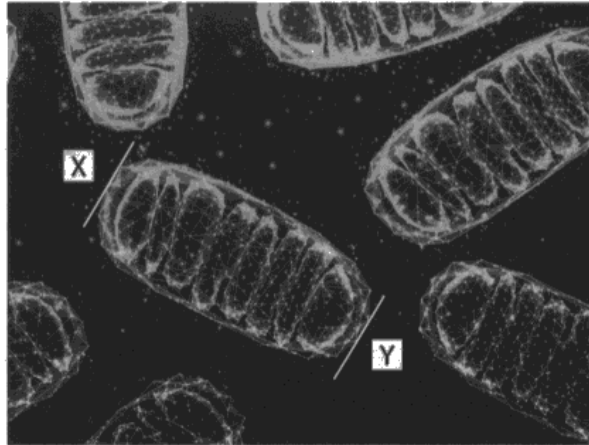
Try and make the writing as clear as possible.

Question 2(a)i

In this question candidates had to name a structure formed by the folding of the inner mitochondrial membrane. Generally this was well answered although even with the generous spellings allowed a few candidates mistook the photograph for a chloroplast and responded appropriately, eg. lamellae or the wrong part of the mitochondrion.

2 Some stages of aerobic respiration take place inside mitochondria.

The photograph shows some mitochondria.



(Source: © Inkoly / Shutterstock)

- (a) (i) Name a structure formed by the folding of the inner mitochondrial membrane.

(1)

Matrix



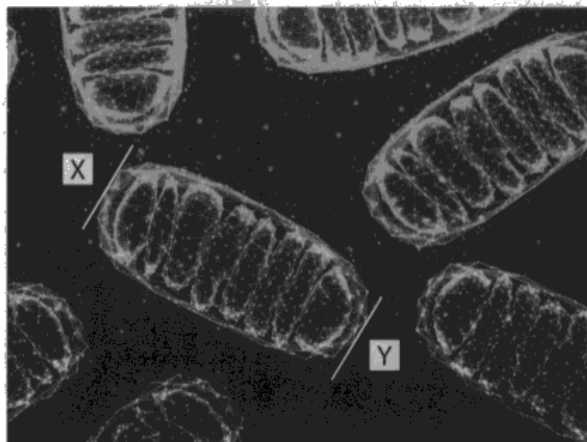
No marks here as the wrong part of the mitochondrion was labelled.



From the specification point 3.3 candidates should be able to recognise the named structures and be able to either label or draw them.

2 Some stages of aerobic respiration take place inside mitochondria.

The photograph shows some mitochondria.



(Source: © Inkoly / Shutterstock)

(a) (i) Name a structure formed by the folding of the inner mitochondrial membrane.

(1)

cristae



Correctly named and in the singular.



Phonetic spellings eg. christae, chistae,/ cristea/ christie etc were accepted, although the correct spelling is preferred.

Question 2(a)iii

In this question candidates were told that the actual length of the mitochondrion between X and Y in the photograph was $2.7\mu\text{m}$. They had to calculate the magnification of this mitochondrion and give the answer in standard form.

Once again as in previous sessions candidates struggled with converting between units and giving the answer in the correct format.

- (iii) The actual length of the mitochondrion between X and Y in the photograph is $2.7\mu\text{m}$. $2.7 \times 10^{-6} \text{ m}$

Calculate the magnification of this mitochondrion.

Give your answer in standard form.

(2)

$$x - y = 4.4 \text{ cm}$$

$$\frac{4.4 \times 10^{-2}}{2.7 \times 10^{-6}} = 16296.2963$$

Answer $\times 1.6 \times 10^4$



The distance between X - Y was accurately measured. Both cm or mm measurements were accepted. The correct answer to the division had then be put in the required format.



It is always worth showing all the calculation workings as if the answer on the answer line is incorrect some credit may be gained for appropriate workings.

- (iii) The actual length of the mitochondrion between X and Y in the photograph is $2.7 \mu\text{m}$.

Calculate the magnification of this mitochondrion.

Give your answer in standard form.

$$M = \frac{\text{Image}}{\text{Actual}}$$

(2)

$$4.4 \text{ cm} \times 10^4 = 4.4 \times 10^4 \mu\text{m}$$

$$\frac{4.4 \times 10^4}{2.7} = 1.63 \times 10^4$$

~~2.7~~

$$\times 1.63 \times 10^4$$

Answer



Some degree of tolerance was acceptable in the measurement of the distance between X - Y. In this case 43 - 45 mm. This means that an acceptable answer in correct standard form in range of 1.59×10^4 to 1.7×10^4

- (iii) The actual length of the mitochondrion between X and Y in the photograph is $2.7 \mu\text{m}$.

Calculate the magnification of this mitochondrion.

Give your answer in standard form.

(2)

$$4.4 \text{ cm} \quad \mu\text{m} = 10^{-6} \text{ m}$$

$$\text{MAG} \quad \frac{44\,000}{2.7} = 16\,296.3$$

Answer 16 296.3 ×



Here the measurement was within an acceptable tolerance but the answer on the answer line was not given in standard form. This only got 1 mark for the correct measurement.



Candidates need to check what the requirements for the answer are.

Question 2(b)

In this question candidates were required to describe how reduced NAD was involved in the production of ATP.

This was surprisingly low scoring as few gained mp3 as they needed to link a lot of ideas and many only gave 1 aspect. Only a few gave the concentration gradient aspect for example. There were lots of ATPase rather than ATP synthase which was rejected.

(b) Describe how **reduced** NAD is involved in the synthesis of ATP inside a mitochondrion.

(3)

Reduced NAD transfers electrons to the ETC which produces energy to pump protons on one side of the membrane causing a concentration gradient. ATP synthase allows the movement of ~~the~~ these protons to the other side of the membrane which releases energy.



Produces energy is a reject as it has been since the new specification began. The only mark here is for reduced NAD providing electrons.



In the synthesis of ATP candidates need to know how ATP is generated.

(b) Describe how **reduced** NAD is involved in the synthesis of ATP inside a mitochondrion.

(3)

a reduced NAD releases the hydrogen in the inner mitochondrial matrix, this hydrogen atom is split into a hydrogen ion (proton) and an electron, hydrogen ion remains in the matrix, electron passes through the ETC releasing energy for the active ~~moving~~ transport of protons from matrix to intermembrane space where they accumulate, they then diffuse down concentration gradient through ATP synthase enzyme releasing energy for the joining of ADP and P_i forming ATP by chemiosmosis, the whole process is known as oxidative phosphorylation, reduced NAD is then oxidised



Here all the marking points except marking point 3. This mark point is targeted at grade A and has multiple components. (this energy) is used to pump protons across a {membrane / inner mitochondrial membrane}, {creating / against} an {electrochemical / proton/ concentration} gradient.



Candidates need to be accurate in the use of the key terms - ie. along, through, down the electron transport chain and ensure that it s=is clear about the difference between pump and diffuse.

Question 3(c)

In this question candidates were told that tetrodotoxin (TTX) was a toxin found in puffer fish and this toxin works by binding to ion channels in neurones.

Candidates had to suggest how TTX could inhibit the nervous control of breathing.

Mp1 was usually awarded and most gained mp2. Those that didn't gave less action potentials, or referred to signals. There were fewer references to signals or messages than usual. Hopefully candidates are getting the message. Few related it to the context of the question so mp3 was less commonly awarded.

(c) The photograph shows a puffer fish.



(Source: © ImageBROKER on Offset / Shutterstock)

Tetrodotoxin (TTX) is a toxin found in puffer fish.

This toxin works by binding to ion channels in neurones.

Suggest how TTX could inhibit the nervous control of breathing.

(3)

TTX binding ~~with~~ to ion channels so action potential cannot occur.

Impulse produced ~~by~~ cannot be transported.

Reflex cannot occur.

Breathing cannot ~~control~~ be controlled by nervous.



Here only mp2 for no action potentials. Credit is not given for a repeat of the question stem - ie. toxin works by binding to ion channels in neurones. It was necessary to state which ion channel is blocked and the effect of that blocking.



Candidates need to be clear about which ion channel is blocked and the effect of that blocking.

(c) The photograph shows a puffer fish.



(Source: © ImageBROKER on Offset / Shutterstock)

Tetrodotoxin (TTX) is a toxin found in puffer fish.

This toxin works by binding to ion channels in neurones.

Suggest how TTX could inhibit the nervous control of breathing.

(3)

Binding to ion channels would inhibit the influx & efflux of Na^+ & K^+ . Therefore no action potential takes place at neurones so the respiratory center in the medulla oblongata can't send impulse to respiratory muscles such as the diaphragm & the intercostal muscles. Therefore, nervous control of breathing is inhibited.



No clear statement that the Sodium ion or Calcium ion channels are blocked. Just inferring it is not sufficient to gain credit. However marking points 2 and 3 are clear. Mp2 would not have been given if reference to fewer action potentials had been made.



Candidates need to be clear and precise. Also contradictions will not gain credit, eg. Sodium ions moving in the wrong direction or both directions.

(c) The photograph shows a puffer fish.



(Source: © ImageBROKER on Offset / Shutterstock)

Tetrodotoxin (TTX) is a toxin found in puffer fish.

This toxin works by binding to ion channels in neurones.

Suggest how TTX could inhibit the nervous control of breathing.

(3)

TTX Binds and Blocks sodium voltage gated ion channels so upon nerve transmission from synapse no opening of sodium ion channels and less sodium ion influx into the cell so by diffusion so less increase in membrane potential and depolarisation of membrane is 'nt enough to reach or exceed threshold value as membrane potential is low so no action potential generated and nerve impulse transmission inhibited so less nerve impulses to and from ventilation centres in Brain to lungs so slower and insufficient contraction of diaphragm and intercostal muscles and less air intake leading to death.



Clear and concise response hitting all three marking points.



Be careful when referring to nervous transmission. It is an all or nothing response so it is no action potentials / depolarisation rather than less.

Question 3(d)i

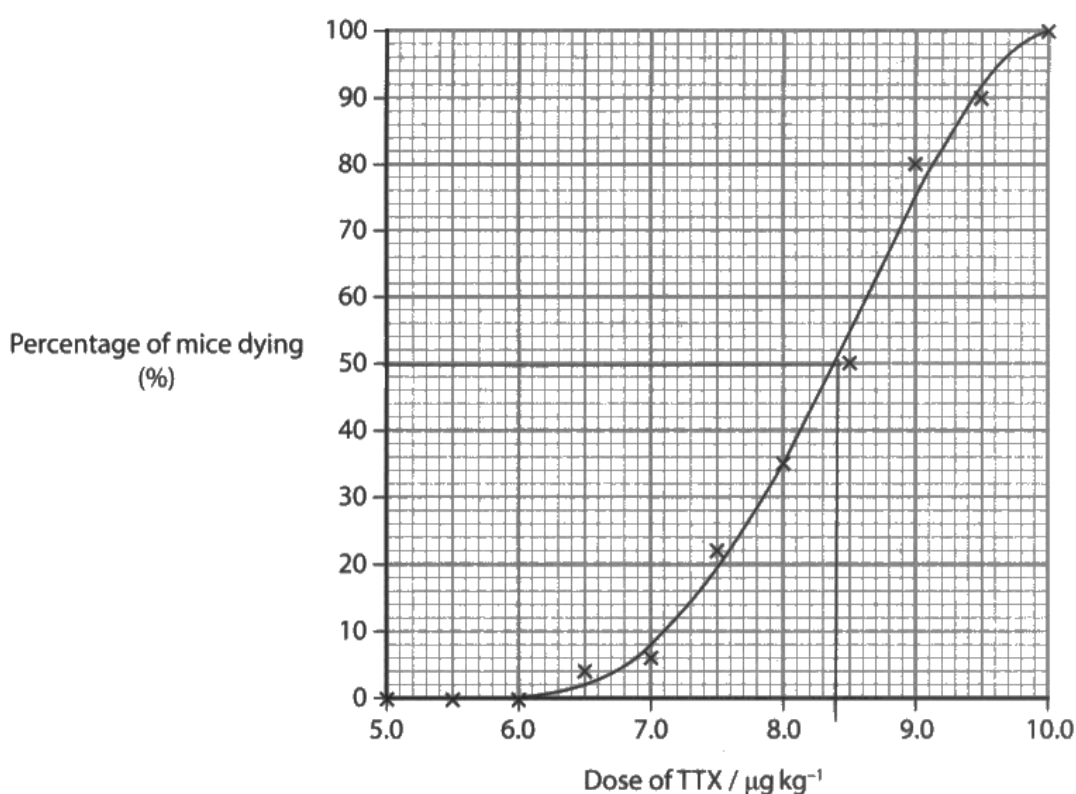
In this question candidates were required to give the meaning of $LD_{50} = 8.4 \mu g kg^{-1}$. They were expected to use the information in the graph to support their answer.

Generally this was well answered by candidates who had met the idea of LD_{50} before. Clearly some had not had previous experience of it.

(d) The toxicity of TTX in mice was investigated.

Groups of mice were given different doses of TTX. The percentage of mice dying at each dose was recorded.

The graph shows the results of this investigation and a line of best fit.



(i) The LD_{50} obtained from this graph is $8.4 \mu g kg^{-1}$.

Give the meaning of $LD_{50} = 8.4 \mu g kg^{-1}$.

Use the information in the graph to support your answer.

(1)

the dose of TTX in $\mu g kg^{-1}$ when the percentage of mice dying is 50%.



A clear and concise answer that contained reference to both the elements required in the mark scheme, namely a reference to dose of TTX and 50% of the mice dying.



When candidates are advised to use the graph to support their answer they should do so.

Question 3(d)ii

In this question candidates were required to comment on the toxicity of TTX in mice.

The command word here is 'comment on'. This requires the synthesis of a number of factors from the graph to form a judgement. At least two factors need to be synthesised.

(ii) Comment on the toxicity of TTX in mice.

(3)

The graph shows that as TTX dose increases,
the percentage of mice dying also increases,
showing a dose-dependent response.
At doses above $8.1 \mu\text{g}$, more than 50% of
the mice die with 100% mortality at $9.5 \mu\text{g kg}^{-1}$.
This indicates that TTX is highly toxic even in small
doses.

(Total for Question 3 = 9 marks)



Here the candidate has only made reference to 'increasing death with increasing dose of TTX'. This only gets mp2.



It is very important that if numerical data is used in the response the data has to be correct. In this case $9.5 \mu\text{g kg}^{-1}$ is incorrect.

(ii) Comment on the toxicity of TTX in mice.

(3)

- As concentration of TTX increase, greater Percentage of Mice dying.
- No effect on Mice dying up to $6 \mu\text{gkg}^{-1}$ of TTX.
- Also No information on Error bars or Age & Sex was given.
- $10 \mu\text{gkg}^{-1}$, Shows 100% mice dying.

(Total for Question 3 = 9 marks)



Here the candidate has included all four possible marking points for a maximum score of 3 marks.



Where possible answers should be set out clearly. There is no need to bullet point answers but here it does make the response clear.

Question 4(a)

In this question candidates needed to explain why L-Dopa, given orally in tablet form reduces the symptoms of Parkinson's disease. There 'given orally in tablet form' was emboldened in the stem of the question to point candidates towards where their response should start.

4 (a) Parkinson's disease arises from decreased dopamine production in the brain.

Explain why L-Dopa, **given orally in tablet form**, reduces the symptoms of Parkinson's disease.

(4)

Dopamine cannot cross blood-brain barrier, but L-Dopa can, as L-Dopa is taken orally it is absorbed into blood stream, until it reaches ~~brain~~ the brain, it crosses blood-brain barrier where it is converted into Dopamine by enzymes, and as Dopamine is a neurotransmitter it binds to receptors on post synaptic membrane depolarising and producing an action potential, preventing death of neurones and maintaining neurone and nervous activity and enabling proper muscle contraction and preventing shivering.



The candidate here has started with stating that L-Dopa can cross the blood-brain barrier. Then the focus has been on the L-Dopa being absorbed into the blood and finally once it has crossed this barrier into the brain it is converted into dopamine.



The last 5 lines of the response try to explain how dopamine reduces the symptoms of

Parkinson's disease. However the fourth marking point had two elements - increasing the level of dopamine to replace that which had been lost by the death or destruction of the dopamine producing neurones. This mark point was targeted at grade A.

4 (a) Parkinson's disease arises from decreased dopamine production in the brain.

Explain why L-Dopa, given orally in tablet form, reduces the symptoms of Parkinson's disease.

(4)

L-Dopa given orally will pass through oesophagus and reach small intestine eventually, where it is absorbed into the blood stream, ~~by~~ in small intestine. L-Dopa ~~can~~ is transported in the blood to the brain, where L-Dopa can cross blood brain barrier and enter brain. L-Dopa is converted into dopamine in brain, increasing levels of dopamine in brain. Parkinson's disease is caused due to damage of neurones secreting dopamine, which is a neurotransmitter, causing decrease in dopamine levels in brain. Increased dopamine levels in brain due to L-dopa conversion causes transmission of impulses from motor control center, so less loss of motor control, and so symptoms like ^{hand} shaking / tremor are reduced due to increased motor control.



A well organised response with all the required marking points, including the fourth marking point that had two elements - increasing the level of dopamine to replace that which had been lost by the death or destruction of the dopamine producing neurones.



If possible follow the guidance from the stem of the question and focus on the command word.

Question 4(c)

This was the level based question. Candidates were given graphs as stimulus material comparing healthy and unhealthy ageing with pathogenic bacteria, protective bacteria and inflammation.

Level one could be achieved by just describing the information in the graphs on bacteria and extent of inflammation.

Level two needed to relate some knowledge to explain facts about the protective bacteria and pathogenic bacteria with details about the inflammatory process.

Level three required details about how lifestyle impacted on the unhealthy and healthy ageing.

There were hardly any blank responses to this question so the majority of candidates found this question accessible.

Discuss the role of bacteria, inflammation and lifestyle in ageing.

Use the information in the graphs and your own knowledge to support your answer.

(6)

ⁱⁿ
~~As~~ unhealthy ageing occurs, pathogenic bacteria is greater by $\pm 100\%$ than healthy ageing as age increases and number of protective bacteria is less than in healthy ageing and extent of inflammation is greater in unhealthy ageing. In unhealthy ageing, more damage occurs to alveoli decreasing its surface area so surface area of lungs decreases and less diffusion occurs so less oxygen is available, less aerobic respiration, less energy released and more cells die. As pathogenic bacteria increases and protective bacteria decreases, more antibodies are released from lymphocytes and more side effects occur and swelling increases, but in unhealthy ageing, immune system is weakened faster so lifespan is decreased and chance of infection increases. Less exercise and high fat diets lead to unhealthy ageing and may cause diabetes, obesity and atherosclerosis (less blood flows). No error bars are displayed so no indication of significant differences and no information is given about age or gender.

(Total for Question 4 = 11 marks)



This response had indicative content 1,2,5,4,6 and 7 for a total of 6 marks. The biological content is generally correct and there is a degree of linkage.



Keep thoughts logical and ensure what is written is biologically correct. If candidates do go over the space provided it is important that they state where the extra answer is. Page number is best.

Discuss the role of bacteria, inflammation and lifestyle in ageing.

Use the information in the graphs and your own knowledge to support your answer.

(6)

- In inflammation the number of bacteria increases as age increases and is high in unhealthy ageing the pathogenic bacteria can cause disease.
- The number of protective bacteria decreases as increase in age gradually but immediately in unhealthy ageing due to the gut system being damaged.
- which can also relate to pathogenic bacteria increase and unhealthy lifestyle and lower age expectancy.
- In unhealthy ageing there is also high inflammation and exposure to pathogen and decrease in protective bacteria causing harm to life style.
- The risks are high in unhealthy ageing and aged the lifestyle in bad way causing diseases and functional issues to the body.

(Total for Question 4 = 11 marks)



This response gained credit for indicative content 1 and 2. There is no detail about the effects of pathogenic bacteria or protective bacteria nor details about the inflammatory response. There is no detail about the specific effects of lifestyle on the body systems. Just referring to 'damage' or 'affects' is not sufficient for indicative content 5 and 6.

Discuss the role of bacteria, inflammation and lifestyle in ageing.

Use the information in the graphs and your own knowledge to support your answer.

(6)

Unhealthy aging has a faster increase in number of pathogenic bacteria and gain a larger amount of than younger than healthy people.

Unhealthy aging causes a decline in the number of protective bacteria than healthy ageing faster than in healthy ageing. Unhealthy ageing causes a faster and steeper change in inflammation than healthy ageing and unhealthy ageing reach it younger. One of the reasons for changes in inflammation being ~~more~~ faster in Unhealthy ageing is oxidative stress causing endothelial damage. This is caused by free radicals. In healthy individuals, the likelihood of oxidative stress decreases because more antioxidants are present in the body which donate an electron to free radicals. Protective bacteria form the skin flora which defend the ~~our~~ body from pathogens by releasing toxins and outcompeting them for food and space. As the number of protective bacteria decreases through age, this allows for more pathogenic bacteria to infiltrate and thrive and

(Total for Question 4 = 11 marks)

reproduce as there are less protective bacteria to compete with them. Inflammation can be caused by mast cells producing histamines which dilate the blood vessels. This is a non-specific immune response. An increase in pathogenic bacteria may increasingly trigger an inflammatory response throughout age. Protective bacteria are required to maintain healthy ageing so by healthy eating and exercising you can prevent cardiovascular disease and atheroma formation and fibrosis.



Here the candidate had indicative content 1,5,3,4,and 6. Indicative content was not given as the direction of change was not given. This is a well organised response with details that are linked and biologically correct.



In most level based questions it is worth making a comment on the methodology or the presence or absence of appropriate statistical methods.

Question 5(a)i

In this question candidates were given a graph comparing systolic blood pressure, diastolic blood pressure during exercise and post exercise rest / recovery. It was a graph with three axes. Candidates had to describe three conclusions from the investigation.

(i) Describe **three** conclusions from this investigation.

(3)

Diastolic Blood Pressure is almost constant throughout the period of exercise and period after exercise.

The heart rate has an overall increase during exercise and decreases after exercise.

Systolic blood pressure also increases during exercise and decreases after exercise.



This response includes details of the effects during exercise and during rest / recovery. All three elements, diastolic and systolic blood pressure and heart rate are described.



Avoid just describing part of the investigation, eg. during exercise. Also ensure when looking at the complex graph you are aware of which line refers to diastolic blood pressure, systolic blood pressure and heart rate. Many candidates confuse the two types of blood pressure in their response.

(i) Describe **three** conclusions from this investigation.

(3)

- Systolic blood pressure is throughout higher than diastolic blood pressure
- Diastolic blood pressure remain relatively constant at 80 kPa throughout the 14 minutes of investigation
- When person is exercising, the heart rate will increase and also cause the systolic blood pressure to also increase.
- During period of rest, the heart rate and systolic blood pressure both decrease as time after exercise increases.



A very well organised response. There is no compulsion to bullet point answers but some candidates find it easier to organise their thoughts and hence their response.



By stating 'throughout the investigation' the candidate includes both during exercise and recovery.

(i) Describe **three** conclusions from this investigation.

(3)

- ~~The heart rate of the group of people have no significant change.~~
- Systolic is gradually increasing to provide enough blood to be pumped to the heart therefore heart rate and increases up to 128 beats per mins. And slowly decrease as they stop exercising.
- ⇒ → Heart ~~rate~~^{rate} of the group of people increase upto 8 mins and sudden decrease to 70 from 121 beats per min.
- ~~Systo~~ Diastolic blood pressure is same almost same in all.



In this response the candidate has tried to explain why the systolic blood pressure behaved in such a way.



Candidates need to be much clearer about the demands and expectations of the command words. On page 69 of the specification there are detailed explanations of the requirements of all the command words used. Key ones are the difference between describe and explain.

Question 5(a)ii

In this question candidates had to describe how the systole and diastole parts of the cardiac cycle are controlled during the exercise. This was targeted at grades ECCA. This question was deemed very challenging by candidates. Most candidates gained mps1 and 2. Higher level answers included the comparative increase in mps 3 and 4. There were lots of answer describing the role of the SAN and AVN and systole. Context is key here – effect of exercise. Many candidates described details of how the heart is controlled, which did not gain credit.

- (ii) Describe how the systole and diastole parts of the cardiac cycle are controlled during the exercise.

(4)

Chemoreceptors detect decrease in blood pH due to production of CO_2 , so send impulse to cardiovascular control centre, which send impulse to SAN, results in more frequently contract for heart muscles involved in systole and diastole parts, and greater contraction for heart muscles involved in systole part, so cardiac output increase to supply sufficient oxygen.



This was the standard response. Candidates described the increase in blood carbon dioxide or decrease in blood pH followed by chemoreceptors sending impulses to the cardiovascular centre. Only the most able candidates were able to relate the consequent effects which included increased impulses going to the SAN along the appropriately named pathway and the resulting increase in the force of contraction of the cardiac muscle.



In any question about increasing heart rate it is essential to state that there are increased impulses from the cardiovascular centre or medulla to the SAN.

- (ii) Describe how the systole and diastole parts of the cardiac cycle are controlled during the exercise.

(4)

the chemoreceptors in medulla oblongata detect drop in blood pH due to CO_2 released during exercise, so medulla oblongata sends ^{increased} nerve impulses along ~~stems~~ ^{motor} neurones via sympathetic nerve to the SAN to increase depolarisation and increase waves of excitation through the atrial walls to increase ^{frequency of} atrial systole and increase force of contraction, and AVN receives electrical impulse from SAN and delays it by 0.1 s then transmits the electrical impulse and waves of excitation to the bundle of His and Purkinje fibres so increase contraction of ventricles from apex of heart and increase force of contraction so increase stroke volume and increase cardiac output



Here the candidate gets all the marking points except a comment about the diastolic blood pressure remaining constant as the cardiac muscle is relaxing.



Candidates must be clear that they are referring to cardiac muscle and not just muscle.

Question 5(b)

In tq In this question candidates had to calculate the stroke volume. They were given the equation: cardiac output = heart rate $\times$ stroke volume. The answer had to be in cm^3 and to two significant figures.

- (b) At rest, a heart pumps $5 \text{ dm}^3 \text{ minute}^{-1}$ of blood and has a heart rate of $72 \text{ beats minute}^{-1}$.

Calculate the stroke volume.

Use the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$



Give your answer in cm^3 and to **two** significant figures.

① $CO = 5 \text{ dm}^3 \text{ min}^{-1}$
 $HR = 72 \text{ min}^{-1}$
 $1 \text{ dm}^3 = 1000 \text{ cm}^3$
 $5 = 5 \times 1000$
 $5 = 5000 \text{ cm}^3$

② $SV = \frac{CO}{HR}$
 $= \frac{5000}{72}$
 $= 69.44$
 ≈ 70

Answer 70 cm^3

(Total for Question 5 = 9 marks)



Here the candidate converted dm^3 to cm^3 correctly. However in the calculation which was correctly calculated they did not convert their answer to two significant figures correctly.



Practice inter-converting all the units given in the specification and learn the rules for significant figures, eg. 69.0 is not to two significant figures.

- (b) At rest, a heart pumps $5 \text{ dm}^3 \text{ minute}^{-1}$ of blood and has a heart rate of $72 \text{ beats minute}^{-1}$.

Calculate the stroke volume.

Use the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Give your answer in cm^3 and to **two** significant figures.

(2)

$$5000 \text{ cm}^3 \text{ min}^{-1}$$

$$\frac{5000}{72} \approx 69.44 \text{ cm}^3$$

Answer 69 cm^3

(Total for Question 5 = 9 marks)



A correct calculation with the answer on the answer line to two significant figures.



Always include the workings in a calculation. Here if the answer on the answer line was incorrect credit would have been gained for the conversion to cm^3 .

- (b) At rest, a heart pumps $5 \text{ dm}^3 \text{ minute}^{-1}$ of blood and has a heart rate of 72 beats minute^{-1} .

Calculate the stroke volume.

Use the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Give your answer in cm^3 and to two significant figures.

$$\text{stroke volume} = \text{cardiac output} \div \text{heart rate}$$

(2)

$$5 \text{ dm}^3 = 5000 \text{ cm}^3$$

$$5000 \div 72 = 69.44$$

Answer 69.44 cm^3

(Total for Question 5 = 9 marks)



In this response the conversion to cm^3 was correct. However the answer on the answer line was not to two significant figures.



Read the question stem carefully and check that the answer on the answer line does what has been asked for.

Question 6(b)

In this question candidates were given graphs to show the growth of peanut plants in low and high light intensities in red, blue and white light. They were asked to determine the effect of light on the growth of the seedlings in this investigation.

Key to this question is the command word 'determine'. From the specification p69 for 'determine' candidates must have an answer that has an element that is quantitative from the stimulus material provided, ie. in this case the graphs.

Determine the effect of light on the growth of the seedlings in this investigation.

(4)

Red light has most increase in height of seedlings both in low light intensity and high light intensity.
Greater difference ~~for~~ between height of seedlings in red light and other lights for high light intensity than low light intensity.



Here the candidate has stated that red light gives the greatest growth in both light intensities and that high light intensities give the greater growth (when compared to low light intensities).



Look at the mark allocation and command word. For four marks it is expected that there are four marking points.

Determine the effect of light on the growth of the seedlings in this investigation.

(4)

~~Higher the light intensity, longer the seedling will survive.~~ Red light caused the highest growth at both intensities while white light caused the least growth. The most growth was by red light at high light intensities which caused an increased of 121% in height over 55 days. Seedling survived for a longer time at high light intensity than low light intensity. Light maybe needed for germinate photosynthesis of seedling. Longer the seedlings were exposed to high light intensity, taller the height of the seedling.



Here three relevant comments have been made - red light giving greater growth, and white light the least. A calculation was given (which was correct) about the growth increase over 55 days in red light.



If there is a 'determine command' word there must be some calculation from the data provided. It is not sufficient just to read off the graph, eg. 9 cm growth in 32 days.

Question 6(c)

In this question candidates were given some information about auxins.

Auxin stimulates:

- the release of hydrogen ions that disrupt cellulose microfibrils
- the uptake of potassium ions by cells.

Candidates needed to explain how auxin causes cells to increase in size.

(c) Auxin stimulates:

- the release of hydrogen ions that disrupt cellulose microfibrils
- the uptake of potassium ions by cells.

Explain how auxin causes cells to increase in size.

(4)

Auxin causes H^+ ions to disrupt cellulose microfibrils to loosen/weaken the cellulose cell wall, $\therefore$ water can enter the cell by exerting a greater osmotic pressure on cell wall osmosis, enabling the cell to elongate and become larger. $\therefore$ the cell ~~will not~~ ~~be~~ accommodate a larger volume of water as cellulose cell walls are weakened (as hydrogen bonds between microfibrils are broken by enzymes that work optimally in low pH). Uptake of K^+ ions into cell increases the cell solute concentration and decreases the water potential so water enters cell by osmosis from area of high (outside cell) to low (inside cell) water potential down a steep water potential gradient. water can enter by a faster rate.



In this question there were unusually seven marking points for a total of four marks maximum. Some of the marking points were linked. It had to be clear that the cell elongation was the result of the water absorption.



There is no credit for just repeating parts of the question stem.

(c) Auxin stimulates:

- the release of hydrogen ions that disrupt cellulose microfibrils
- the uptake of potassium ions by cells.

Explain how auxin causes cells to increase in size.

(4)

Auxins activate a proton pump to pump hydrogen ions (protons) into cell wall spaces of microfibrils, decreasing pH which activates an enzyme to break down hydrogen bonds between ~~microfibrils~~ cellulose microfibrils, so cell walls become more flexible + take up more water by osmosis causing plant cells to elongate, leading to stem elongation.

When more potassium ions are taken up, ion concentration in plants increase + water potential decreases, stimulating plant to take up more water by osmosis, increasing water potential per cell, leading to cell + then stem elongation.



Again a response that gained full marks. It is important that it is the hydrogen bonds in the cellulose molecule / microfibrils that is broken. Just repeating the stem-disrupting the microfibril gains no credit.

Question 6(d)i

In this question candidates were given the results of an investigation comparing the concentration of gibberellin and the resultant number of seeds germinating.

They had to calculate the percentage change in germination between 200ppm and 400ppm gibberellin concentration. The answer had to be a whole number.

- (d) The effect of different concentrations of gibberellin on seed germination of the ashoka tree was investigated.

The photograph shows the leaves and flowers of an ashoka tree that grows in parts of Asia.



(Source: © Roberto Pascual Gomez / Shutterstock)

Samples containing 200 seeds were each treated with different concentrations of gibberellin.

The table shows the results of this investigation.

Gibberellin concentration / ppm	Number of seeds germinating
0	26
100	92
200	114
300	66
400	46

- (i) Calculate the percentage change in germination between 200 ppm and 400 ppm gibberellin concentration.

(2)

Give your answer as a whole number.

$$114 \frac{46}{200} = 46$$

~~40.35~~

~~100 - 40.35 = 59.65~~

$$x = 40.35\%$$

$$100 - 40.35 = 59.65\%$$

Answer 59.65 %



Here the candidate had correctly identified the number of seeds germinating at 200 and 400ppm. However the answer was not given as a whole number nor was there any indication of the change.



Candidates need to read the stem of the question carefully. Here they were asked for the 'change' so it was necessary to state whether it was an increase or decrease.

- (d) The effect of different concentrations of gibberellin on seed germination of the ashoka tree was investigated.

The photograph shows the leaves and flowers of an ashoka tree that grows in parts of Asia.



(Source: © Roberto Pascual Gomez / Shutterstock)

Samples containing 200 seeds were each treated with different concentrations of gibberellin.

The table shows the results of this investigation.

Gibberellin concentration / ppm	Number of seeds germinating
0	26
100	92
200	114
300	66
400	46

- (i) Calculate the percentage change in germination between 200 ppm and 400 ppm gibberellin concentration.

(2)

Give your answer as a whole number.

$$\frac{46 - 114}{114} \times 100$$

$$-59.6$$

Answer -60 %



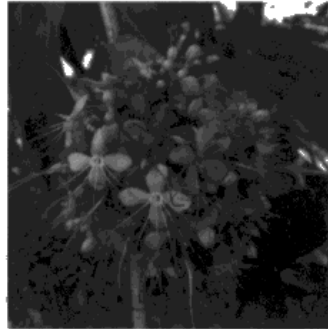
A correct response with clear working. The answer showed the correct change. (-) is acceptable as decrease.



Always show your working in any calculation.

- (d) The effect of different concentrations of gibberellin on seed germination of the ashoka tree was investigated.

The photograph shows the leaves and flowers of an ashoka tree that grows in parts of Asia.



(Source: © Roberto Pascual Gomez / Shutterstock)

Samples containing 200 seeds were each treated with different concentrations of gibberellin.

The table shows the results of this investigation.

Gibberellin concentration / ppm	Number of seeds germinating
0	26
100	92
200	114
300	66
400	46

- (i) Calculate the percentage change in germination between 200 ppm and 400 ppm gibberellin concentration.

(2)

Give your answer as a whole number.

$$\begin{array}{rcl}
 & 114 & 114 - 46 \\
 & 100 & \downarrow \\
 & & 7 = 59.6\% \\
 & & \approx 60\%
 \end{array}$$

Answer 60 %



Here the candidate had correctly identified the number of seeds germinating at the concentrations of gibberellin and carried out the calculation correctly. However their whole number answer did not show the direction of the change.



Candidates must read the stem of the question carefully.

Question 6(d)ii

In this question candidates were given the results of an investigation comparing the concentration of gibberellin and the resultant number of seeds germinating.

Candidates had to use the results from the investigation to explain how gibberellins affect germination.

(ii) Explain how gibberellins affect germination in this investigation.

(2)

At first, increasing gibberellin concentrations increases seed germination. However, over 200ppm the effect begins to decrease.

This is because gibberellins stimulate the breakdown of the endosperm for energy for growth. And if the endosperm is broken down too fast not enough will remain for germination to take place.

(Total for Question 6 = 13 marks)



The candidate has used the data from the results table to come to a relevant statement. They could use up to 200ppm, or after 200ppm or 200ppm has the highest germination.



Candidates must be clear that gibberellins do not directly act as transcription factors. However they do play a crucial role in regulating gene expression by influencing the activity of transcription factors. This point has been made in several recent examination reports.

Question 7(a)ii

In this question candidates were told that growth hormone (GH) is a peptide hormone that stimulates the synthesis of protein in muscle. They had to explain how GH stimulates the

synthesis of protein in muscle. Most candidates gained mps 2 and 3. If they understood the question higher level answers related it to given context, ie. muscles. However most just gave a stock answer without making reference to the situation given in the question stem. Many candidates thought erroneously GH was the transcription factor.

- (ii) Growth hormone is a peptide hormone that stimulates the synthesis of protein in muscle.

Explain how GH stimulates the synthesis of protein in muscle.

(3)

G.H. binds to receptors on cell surface membrane of muscle ~~causing~~ ~~cont~~ as they cannot pass through membrane. this will cause conformational change in shape of receptors activating a group of enzyme-controlled reaction that leads to formation of secondary messenger called cyclic AMP that binds to another chemical and enter nucleus through nuclear pores, where they act as T.F., binding to promoter region, causing gene expression and activation by binding of RNA Polymerase to promoter so gene is transcribed into mRNA produces protein



This candidate response had taken some note of the specifics mentioned in the question stem ie. muscle.



Stereotypical responses that take no notice of the specifics given in the question gain little credit. Candidates are required to apply their knowledge of the specification to novel situations.

- (ii) Growth hormone is a peptide hormone that stimulates the synthesis of protein in muscle.

Explain how GH stimulates the synthesis of protein in muscle.

(3)

As a peptide hormone, it'll use / Activate cyclic
Amp to diffuse into cells & cause a chain
reactions. Act as Transcription factors, More muscle
proteins transcribed & translated.



A common error - GH acting as a transcription factor. This has been referred to in several recent examination reports. Credit is given here only for reference to a second messenger.

Question 7(b)

In this question candidates were given a graph showing how the concentration of GH in the blood changes at different ages. Candidates had to comment on the changes in the concentration of GH in the blood of males. They had to use the data in the graph to support their answer.

Comment on the changes in the concentration of GH in the blood of males.

Use the data in the graph to support your answer.

(3)

Concentration of GH decreases with age sharply ~~at 20 years~~ from 10 to 18/20 years as this is when puberty occurs. This decrease levels off after 20 and ~~becomes almost~~ becomes almost insignificant around age 50. ~~Errors &~~ Many error bars overlap, eg: 18, 24 at 28; 24, 28, 32, 41. This indicates the differences in concentration may not be significant. Size of error bars vary significantly, largest at 28 at ~~smallest~~ smallest at age 86. There is no indication on sample size, lifestyle and diet or pre-existing medical conditions / steroid use. No data at 97+ years.



Here the candidate had correctly identified that there is a sharp decline in GH levels between 10 - 20 years. There is an appropriate comment on error bars linked to correct ages taken from the graph. Furthermore there is comment on methodology, ie. no indication of sample size.



If candidates are going to use data from a graph it is essential that the data is correct. This means accurate use of the scales to give accurate numeric values.

Comment on the changes in the concentration of GH in the blood of males.

Use the data in the graph to support your answer.

(3)

As age of male increases the concentration of GH in blood decreases. decrease is less steep after 30 years. concentration becomes almost constant after 60 years at $8-6 \text{ ng dm}^{-3}$. error bars are too big and at 18, 24, 28, 34 years they overlap so there is no significant difference, and no data given about sample size.



There are four marking points here for a maximum of three marks. The numeric values for the ages and error bars are correct, and there is an appropriate comment on methodology.

Comment on the changes in the concentration of GH in the blood of males.

Use the data in the graph to support your answer.

(3)

As age increases, conc. of GH in blood decreases. The biggest rate of decrease (steepest gradient) is seen in ages between 10 and 20. SD bars overlap so the difference is not significant.



Here there are two marking points - GH decreases as age increases and steepest decline in GH between 10 - 20 years. The comment on SD error bars overlapping is not creditworthy as there are no ages given. Some error bars do not overlap, eg. between ages 24 and 86 years.



Do not just use a generic statement regarding error bars / SD values and a non significant difference. Furthermore be careful about the difference between significant difference, repeatability, reliability and validity.

Question 7(d)i

In this question candidates had to describe how mouse cells can be genetically modified to synthesise human GH. It is important to be accurate and use the information provided in the question introduction.

(d) Synthetic GH can be produced from genetically modified mouse cells.

(i) Describe how mouse cells can be genetically modified to synthesise human GH.

(4)

- Use a restriction enzyme to isolate the gene coding for GH in a healthy individual.
- Use the same restriction enzyme to cut open the DNA of a virus (the virus acts as a vector).
- Use DNA polymerase to form the recombinant DNA, with the gene coding for GH inserted into the viral DNA.
- Reinsert the ^{viral} DNA to the virus, and inject the virus into the mouse cells using a microinjection.
- The mouse ^{cells} will transcribe mRNA's from the gene coding for GH and translate them ^{to give a polypeptide in the golgi to} then modify ~~the~~ ^{the} polypeptide to produce GH.



Here the candidate correctly stated that the GH gene could be isolated by the enzyme restriction enzyme. They also then go on using the same enzyme to cut the DNA of a virus. It is more usual to use a plasmid but some viruses do have DNA so it is biologically correct. The recombinant DNA was inserted into the mouse using microinjection.

(d) Synthetic GH can be produced from genetically modified mouse cells.

(i) Describe how mouse cells can be genetically modified to synthesise human GH.

(4)

Cut the desired bit of gene coding for GH with restriction enzyme, and then use the same restriction enzyme to cut the gene from the mouse cell to produce sticky ends. Use DNA ligase to join the two cut bits to produce recombinant DNA and then ^{place} it in mice and allow it to divide to produce more cells.



Here the candidate correctly cut the desired gene coding for GH using restriction enzyme. This obtained two marks. There is no credit for then cutting the DNA from a mouse cell.

(d) Synthetic GH can be produced from genetically modified mouse cells.

(i) Describe how mouse cells can be genetically modified to synthesise human GH.

(4)

Isolate the gene that synthesises GH in humans using restriction endonuclease. Use the same restriction enzyme to add it to a mouse DNA, using ligase and sticking the sticky ends together. Then, using heat shock or a gene gun, insert the DNA into the mouse for it to be able to synthesise human GH.



The candidate here obtained 3 marks - for isolating the GH gene using restriction endonuclease and then using heat shock or gene gun to add the recombinant DNA into the mouse cell.

Question 7(d)ii

In this question candidates had to suggest one advantage and one disadvantage of using genetically modified mouse cells rather than *E. coli* bacteria to produce human GH. This was a very open ended question and as long as candidates justified their answer often it was creditworthy.

- (ii) Suggest **one advantage** and **one disadvantage** of using genetically modified mouse cells rather than *E. coli* bacteria to produce human GH.

(2)

One advantage would be that the cells are animal cells versus bacteria, so it is easier to use them.

One disadvantage would be the ethical issues of using a mouse and possibly causing harm.

(Total for Question 7 = 14 marks)



Ethical issues was acceptable as a disadvantage, but just being mammal cells unqualified did not gain credit.



In a response always clarify points to make it as clear as possible what the advantage or disadvantage is.

- (ii) Suggest **one advantage** and **one disadvantage** of using genetically modified mouse cells rather than E. coli bacteria to produce human GH.

(2)

~~E. coli~~ Advantage is mouse cells would not result in infection and producing GH this way is faster.
Disadvantage is it is deemed unethical as mouse cells ~~are~~ may be harmed it also required more work and maintenance.

(Total for Question 7 = 14 marks)



A clear advantage and disadvantage. This scored full marks.



Make it clear which is the advantage or disadvantage.

- (ii) Suggest **one advantage** and **one disadvantage** of using genetically modified mouse cells rather than *E. coli* bacteria to produce human GH.

(2)

One advantage is that the mouse cell is not pathogenic like the *E. coli*. However, one disadvantage is that the long term effects are unknown.

(Total for Question 7 = 14 marks)



One clear advantage stated. However the disadvantage has not been qualified. The long term effects of 'what' are not known.

Question 8(a)i

Question 8 was based on the two articles on genetics generally and the Y chromosome specifically. In this question candidates had to name the type of microscope that would be used to produce the image of the chromosome (before paragraph 1).

This question should have been a given as candidates were told the magnification.

- 8** The scientific document you have studied is adapted from the articles *Risk of heart failure may increase with age due to Y chromosome loss* and *Essence of man: Y size doesn't matter* in the New Scientist.

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

- (a) (i) Name the type of microscope that would be used to produce the image before paragraph 1.

(1)

SEM



The initials SEM were acceptable as it is recognised abbreviation standing for scanning electron microscope.



Generally it is better to write the answer in longhand.

- 8 The scientific document you have studied is adapted from the articles *Risk of heart failure may increase with age due to Y chromosome loss* and *Essence of man: Y size doesn't matter* in the New Scientist.

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

- (a) (i) Name the type of microscope that would be used to produce the image before paragraph 1.

(1)

electron



This is acceptable as the question stem asked for 'name the type of microscope'.



Be careful with the spelling to ensure that what is written cannot be misconstrued for any other biologically recognised term.

- 8 The scientific document you have studied is adapted from the articles *Risk of heart failure may increase with age due to Y chromosome loss* and *Essence of man: Y size doesn't matter* in the New Scientist.

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

- (a) (i) Name the type of microscope that would be used to produce the image before paragraph 1.

(1)

light microscope



Unfortunately the wrong type of microscope. Surprisingly there were a number of candidates that gave this response.



Use all the information provided to make a realistic choice. Light microscopes only give a magnification up to about $\times 1500$. The chromosome in photograph 1 has clearly been magnified more than this.

- 8 The scientific document you have studied is adapted from the articles *Risk of heart failure may increase with age due to Y chromosome loss* and *Essence of man: Y size doesn't matter* in the New Scientist.

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

- (a) (i) Name the type of microscope that would be used to produce the image before paragraph 1.

(1)

Electron microscope



A correct response gaining the one mark.

Question 8(a)ii

In this question candidates needed to calculate the ratio of the length of the X chromosome to the Y chromosome in the image. The answer had to be given to one decimal place.

- (ii) Calculate the ratio of the length of the X chromosome to the Y chromosome in this image.

Give your answer to **one** decimal place.

length of X = 9cm

(2)

length of Y = 3.7cm

9 : 3.7

2.43 : 1

Answer 2.43 : 1



An answer within the acceptable range. However this candidate had not followed the requirements from the question stem - namely to one decimal place.



Candidates need to read the question stem carefully and do as asked. The requirement 'to one decimal place' had the one emboldened.

- (ii) Calculate the ratio of the length of the X chromosome to the Y chromosome in this image.

Give your answer to **one** decimal place.

$$\begin{array}{l} \text{X : Y} \\ 3.9 : 9.3 \\ 0.419 \\ 0.42 \end{array} \quad (2)$$

Answer 0.4 : 1



Here the ratio had been calculated for Y : X. This only got credit for the accuracy of the measurements which were within tolerance.

- (ii) Calculate the ratio of the length of the X chromosome to the Y chromosome in this image.

Give your answer to **one** decimal place.

(2)

$$9.4 \div 3.7$$

$$1.25$$

Answer 2.5 : 1



A correct answer within the acceptable range.



Candidates need to ensure that they include the measurements in their answer. Should the answer on the answer line be incorrect then they may gain credit for appropriate measurements.

Question 8(b)

In this question candidates had to suggest why the loss of the Y chromosome may lead to higher rates of heart disease in men than women. The article paragraphs 4 and 5 contained relevant information. The command word here was 'suggest'. This means that the candidate needs to apply their knowledge from the specification to unfamiliar areas.

(b) Suggest why the loss of the Y chromosome may lead to higher rates of heart disease in men than women (paragraphs 4 and 5).

(2)

Due to presence of Oestrogen hormone in women so less risk of heart disease. Men have high rates of heart disease due to absence of oestrogen. till 50 years or after meno paus woman become equalized with men as oestrogen decreased. Maybe no Y in woman XX, Men XY so losing Y chromosome cause high rate of heart.



In this response the candidate has made reference to no Y chromosome in women. However there is no reference to loss of genes and the effect that this loss may result in.



No credit is gained for repeating the content of the question stem. Many candidates referred to 'heart disease'.

(b) Suggest why the loss of the Y chromosome may lead to higher rates of heart disease in men than women (paragraphs 4 and 5).

(2)

Loss of y chromosome causes lower elasticity in heart tissue so heart muscle scars and develops fibrosis which damages endothelium and causes more inflammatory response hence higher risk of atherosclerosis and cardiovascular disease. Men are more likely than women as they do not have oestrogen hormones



This response gained two marks for reference to scarring of the heart and a greater inflammatory response, ie. increased inflammation or increased atherosclerosis.

(b) Suggest why the loss of the Y chromosome may lead to higher rates of heart disease in men than women (paragraphs 4 and 5).

(2)

loss of Y chromosome resulted in scarring of heart muscle, therefore reducing elasticity of muscle and so the heart will not be able to withstand high pressure properly. loss of Y chromosome in immune cells may ~~also~~ trigger inflammation of arteries, therefore causing formation of an atheroma and so increasing the risk of developing heart problems. women will not be affected as they do not have Y chromosome.



This candidate gave three clear marking points - scarring of heart muscle, causing atheromas and the lack of Y chromosome in females.



Ideally when discussing the loss of Y chromosome it should 'clue' candidates into the loss of genes.

Question 8(c)

In this question candidates had to describe the roles of nucleic acids and enzymes used in CRISPR gene editing to remove some of the Y chromosome genes. CRISPR is not a topic in the specification. However as it is clearly referred to in the article and is a current topic of interest in genetics. Candidates should have been directed to have done some study or research about the technique. This question is targeted at the higher grades and clearly discriminated between candidates.

(c) Describe the roles of nucleic acids and enzymes used in CRISPR gene editing to remove some of the Y chromosome genes (paragraph 5).

(2)

enzymes like DNA polymerase help the complementary binding
Reverse Transcriptase allows mRNA to be converted to
cDNA.
Restriction endonuclease can be used to cut the gene.



Although the first two enzymes referred to are not in the correct context, the candidate does make reference to restriction endonuclease being used to cut the gene. Ideally the candidate should make reference to the Y chromosome but as it is in the question stem this response gained one mark.



Candidates need to make sure that the enzymes referred to in the specification are known and more specifically what they do.

(c) Describe the roles of nucleic acids and enzymes used in CRISPR gene editing to remove some of the Y chromosome genes (paragraph 5).

(2)

A guide RNA is used to match and target the specific DNA sequence on the Y chromosome. ~~Then~~ an enzyme (restriction) cuts the DNA at that location allowing the gene to be removed.



The candidate here was credited with two marks - for the guide RNA matching a DNA sequence and the restriction enzyme cutting the gene.



Candidates need to make it clear that they are referring to RNA rather than DNA.

Question 8(d)

In this question candidates had to describe how the cardiovascular health of participants in the UK Biobank study could have been assessed. Many candidates were able to gain mark points 2 and 3 as they gave an appropriate physiological measurement. Few candidates came up with the idea of using a questionnaire either about lifestyle or family history.

Once again several candidates did not give their response in the context of the question. Using bioinformatics was a common generic theme. There was few reference to comparisons with national data or to an appropriate named statistical test. Calculating the mean was not creditworthy.

(d) Describe how the cardiovascular health of participants in the UK Biobank study could be assessed (paragraph 6).

(3)

The heart rate, cardiac output and stroke volume of the participants should be regularly monitored, for example it should be monitored every 6 months over the 12 year period. A questionnaire should be given to the participants containing questions which asks for their diet and lifestyle habits. For example because a diet rich in cholesterol can raise the blood pressure and cause CVD. Also smoking, high intake of alcohol can also accelerate progression of CVD. The questionnaire should also be provided every 6 months.



Here the candidate referred to heart rate, cardiac output and stroke volume. These were creditworthy. They also referred to the use of a questionnaire.



Ensure that the answer is specific to the context of the question. Too often answers became generic.

(d) Describe how the cardiovascular health of participants in the UK Biobank study could be assessed (paragraph 6).

(3)

~~A study can be conducted where men are split into two groups~~

The blood pressure of the men could be measured.

The cardiac output of the men could be measured.

The glucose concentration in the blood can be measured.

The oxygen content level of the blood can be measured.

The heart rate of the men could be measured.



Two named physiological measurements stated so two marks awarded. There is no reference to a questionnaire nor a comparison with national data.

Question 8(e)

In this question candidates had to explain how an antibody could block the effects of an inflammatory signalling molecule (ISM).

As it is based on the article candidates were directed to the appropriate paragraph(s) within the article.

(e) Explain how an antibody could block the effects of an inflammatory signalling molecule (ISM) (paragraphs 7 and 8).

(2)

antibodies have an active site that is complementary to the inflammatory signalling molecule and will bind to it and opsonise it. Or the antibody will neutralise ^{pathogen} bacteria/virus that ~~can~~ activates the inflammatory signalling molecule.



This response clearly states that the antibodies will bind with the inflammatory signalling molecule. This is creditworthy. Antibody causing opsonisation would also have been accepted.



Candidates need to be able to apply their knowledge about antibodies and inflammatory response to novel situations.

(e) Explain how an antibody could block the effects of an inflammatory signalling molecule (ISM) (paragraphs 7 and 8).

(2)

Antibody contains receptor that has
complementary ~~receptor~~ ^{receptor} & on ISM, antibody
binds to it and causes it to
agglutinate or marked by opsonins to be
engulfed by phagocytosis.



Here the candidates referred to the binding of the antibody to the ISM leading to it being engulfed by phagocytosis. Two marks credited.

(e) Explain how an antibody could block the effects of an inflammatory signalling molecule (ISM) (paragraphs 7 and 8).

(2)

less ISM available to cause inflammation, so less histamines produced & less ~~inflamm~~ inflammatory response triggered. This is because the antibody binds to ISM and facilitating opsonisation & phagocytosis of ISM by macrophages.



Three clear points here for a maximum two marks.



Candidates need to be careful to ensure that their writing is legible.

Question 8(f)

In this question candidates had to explain how environmental factors such as temperature could determine the sex of an animal. This question proved to be very challenging for candidates. Many just repeated the stem of the question - 'to determine the sex of an animal'. This would not gain credit.

Most candidates referred to temperature affecting the activity of an enzyme. A few candidates named the enzyme aromatase.

Very few candidates made reference to the activation of genes for steroid/protein/enzyme or sex hormones.

An explanation of how sex was determined was needed for mark point four, eg. initiates the development of sex organs/genitalia.

(f) Explain how environmental factors such as temperature could determine the sex of an animal (paragraph 14).

(2)

1. the temperature as the selective pressure.
2. the ^{nature} ~~notional~~ selection occurs.
3. the individual has ^{the allele advantaged} ~~Y~~ chromosome survive and pass it to the ~~the~~ offspring.
4. the proto - Y swap gene with proto X - chromosome.



Temperature acting as a selection pressure gained no credit.



Candidates must be careful not to fall back on generic responses. Selection pressures come up regularly, especially in unit wbi12.

(f) Explain how environmental factors such as temperature could determine the sex of an animal (paragraph 14).

(2)

Temperature activates genes for one gender and switches off genes for another gender. Activated genes transcribed to produce mRNA, mRNA translated to produce protein responsible for development of sex organs of one gender, while enzymes for another gender are deactivated.



The candidate here has made reference to activation of genes for protein which are responsible for the development of sex organs. Two marks gained here.



The answer here is well linked together and clear for the examiner to see what is being explained.

Question 8(g)

In this question candidates had to calculate the percentage of genes that have been lost from the original Y chromosome. They had to extract the information from paragraph 15 in the article.

This was targeted at grade E.

- (g) Calculate the percentage of genes that have been lost from the original Y chromosome (paragraph 15).

(1)

$$\begin{array}{r} 600 - 0.100010 \\ \hline 78 - 0? \end{array}$$

Answer 13 %



The wrong calculation. Here the candidate has calculated the percentage of genes that remain on the Y chromosome.

- (g) Calculate the percentage of genes that have been lost from the original Y chromosome (paragraph 15).

(1)

$$\frac{600-78}{600}$$

Answer 87 %



A correct answer with clear working. One mark.



Always put the working in a calculation question. It is of no benefit here but it is a good practice to get into.

Question 8(h)

In this question candidates had to explain how epigenetic changes could ensure that the 'gene output' from the X chromosomes in females is the same as in males.

This was generally well answered. Candidates are clearly aware of the different epigenetic techniques and how they suppress the activity of genes.

It was important that candidates referred to all the genes on the Y chromosome rather than a gene or most genes.

(h) Explain how epigenetic changes could ensure that the 'gene output' from the X chromosomes in females is the same as in males (paragraph 19).

(2)

Epigenetic changes can reduce gene output from the two X chromosomes by inactivating one of them to match the gene output of XY chromosome. This is done through epigenetic control such as histone modification ^{and} DNA methylation ^{and} ~~DNA acetylation~~ which would ^{by reducing transcription} switch off the genes so no genes are made as no transcription.



Appropriate epigenetic technique named and that genes would not get transcribed.



Candidates need to try and keep their response within the space provided.

(h) Explain how epigenetic changes could ensure that the 'gene output' from the X chromosomes in females is the same as in males (paragraph 19).

(2)

~~Ex~~ Differential gene expression where DNA methylation of one of the X chromosomes occurs in females. Hence ~~the~~ ^{genes in this} 1 X chromosome ~~is~~ ^{are} deactivated and only the ~~other~~ genes in the remaining ~~of~~ X are activated & expressed resulting in single production of ~~a~~ each protein



Both marking points given here. DNA methylation being used to deactivate the genes on the X chromosome.

Question 8(i)

In this question candidates had to explain why elderly men who have lost their Y chromosome have a higher risk of cancer.

Most candidates could explain how this resulted in a reduced immune system/response and thus there was less or no destruction of the cancer cells.

Few candidates stated that the bone marrow contained stem cells that differentiate into immune cells.

- (i) Explain why elderly men who have lost their Y chromosome have a higher risk of cancer (paragraphs 2, 3 and 20).

(3)

Losing the Y chromosome can cause the immune system of the elderly men to weaken. This decreases the ^{effectiveness} ~~ability~~ of cancer cells to be identified and destroyed by lymphocytes and T-killer cells. Additionally, losing Y chromosome can cause the loss of some important regulatory genes so it can increase the risk of random mutations in cells to form tumours and cancer.

(Total for Question 8 = 20 marks)

TOTAL FOR PAPER = 90 MARKS



This is typical of a common response to this question; weakened immune system leading to a decrease in the identification and destruction of cancer cells.



Candidates need to use the information in the article to answer the question. That is why it is given as an advance article prior to the examination. However there is no credit for just copying out sections from the article as the answer.

- (i) Explain why elderly men who have lost their Y chromosome have a higher risk of cancer (paragraphs 2, 3 and 20).

(3)

lost Y chromosome in bone marrow lead to ~~production~~ production of not functioning immune cells (immune cells like macrophage is produced in bone marrow). The Y cells do not kill the ~~cells~~ cancer cells because their antibodies ~~it~~ does not let the macrophage recognize it. Also, the immune cells like T killer cells or ~~are~~ lymphocytes may falsely attack the normal cells, leading to inflammation, and potential cancer.

(Total for Question 8 = 20 marks)

TOTAL FOR PAPER = 90 MARKS



This response gained three marks. There is reference to loss of Y chromosomes in the bone marrow, production of non-functioning immune cells which do not destroy the cancer cells.

Paper Summary

A few suggestions for improving candidate performance are given below.

- Candidates need to have time study the article.
- Candidates need to refer to the command word used in the question and focus their answer in an appropriate manner. Appendix 7 in the specification lists all the command words and their meaning. This is particularly true for 'explain', and 'comment' on 'command' words.
- In graphs candidates need to check the labelling of the axes and scales, and when taking data from a graph numeric values need to be accurate.
- In level based questions the graphs need to be used as well as relevant knowledge and understanding.
- In calculations it is better to show the workings as well as an answer, as if the answer is incorrect candidates may gain some credit for correct working. Care needs to be taken in the interconversion of units – eg cm³ to dm³
- Instructions in calculations need to be followed, eg. three significant figures two decimal places, whole numbers.
- Finally writing needs to be clear – in a few cases it was extremely challenging to decipher key words in the answer.

Grade boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
<https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html>

