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IAL Biology WBI15 01

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Introduction

This paper includes multiple-choice, short-open, open-response, calculations and extended-writing questions to test the following topics of biology:

- Respiration, Muscles and the Internal Environment
- Coordination, Response and Gene Technology

This paper will include a minimum of 9 marks that target mathematics at Level 2 or above (see Appendix 6: Mathematical skills and exemplifications). Candidates will be expected to apply their knowledge and understanding to familiar and unfamiliar contexts. This paper may contain some synoptic questions which require knowledge and understanding from units 1 and 2.

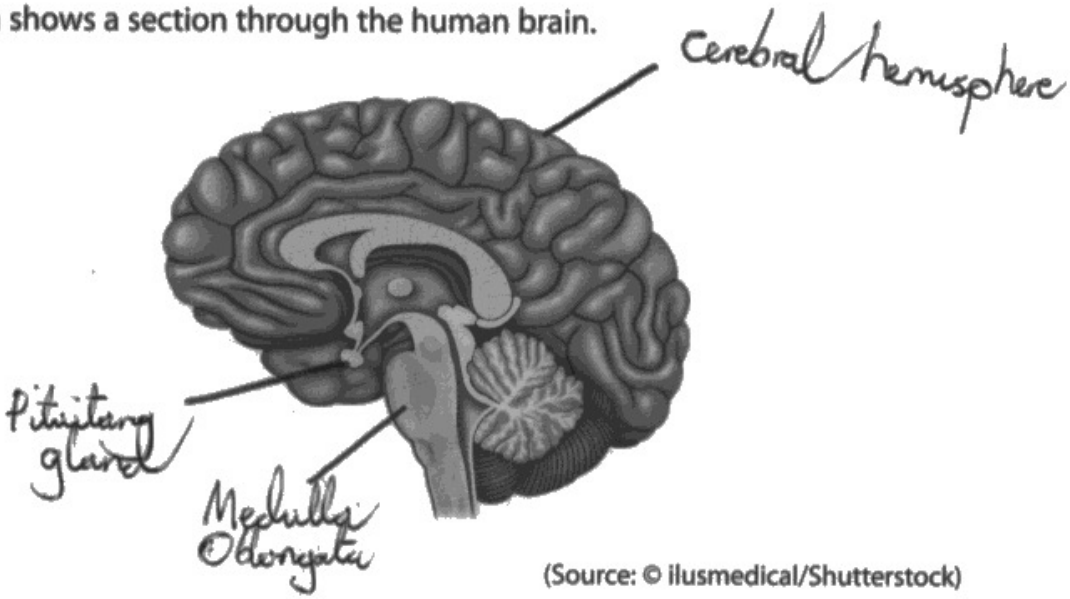
Question 1 (a)

In this question, candidates were given a diagram of the human brain. They had to label the cerebral hemispheres, pituitary gland and medulla oblongata.

Candidates were good at labelling the cerebral hemispheres and the pituitary gland. However the medulla oblongata was often misplaced. It was often placed in the pons.

1 The brain is made up of more than 1×10^{11} neurones.

(a) The diagram shows a section through the human brain.



(Source: © ilusmedical/Shutterstock)

Label the diagram to show the location of the following:

- pituitary gland
- medulla oblongata
- cerebral hemisphere (cerebrum)

ResultsPlus
Examiner Comments

This response was awarded 2 marks.

ResultsPlus
Examiner Tip

The ability to label diagrams accurately is an important skill. Label lines need to be clearly identified in the answer.

Question 1 (b)

Candidates had to complete a table naming the medulla oblongata and list the function of the cerebellum and cerebral hemisphere. This type of question is a good way of focussing candidates' knowledge succinctly.

(b) Complete the table to show the parts of the brain and their functions.

(2)

Part of the brain	Function
cerebellum	control of posture
medulla oblongata	control of heart rate
cerebral hemisphere (cerebrum)	control of rational thought and memories

ResultsPlus
Examiner Comments

This response was awarded the full 2 marks.

ResultsPlus
Examiner Tip

Care needs to be taken not to 'hedge ones bets' by putting down several functions and hoping the examiner marks the correct one.

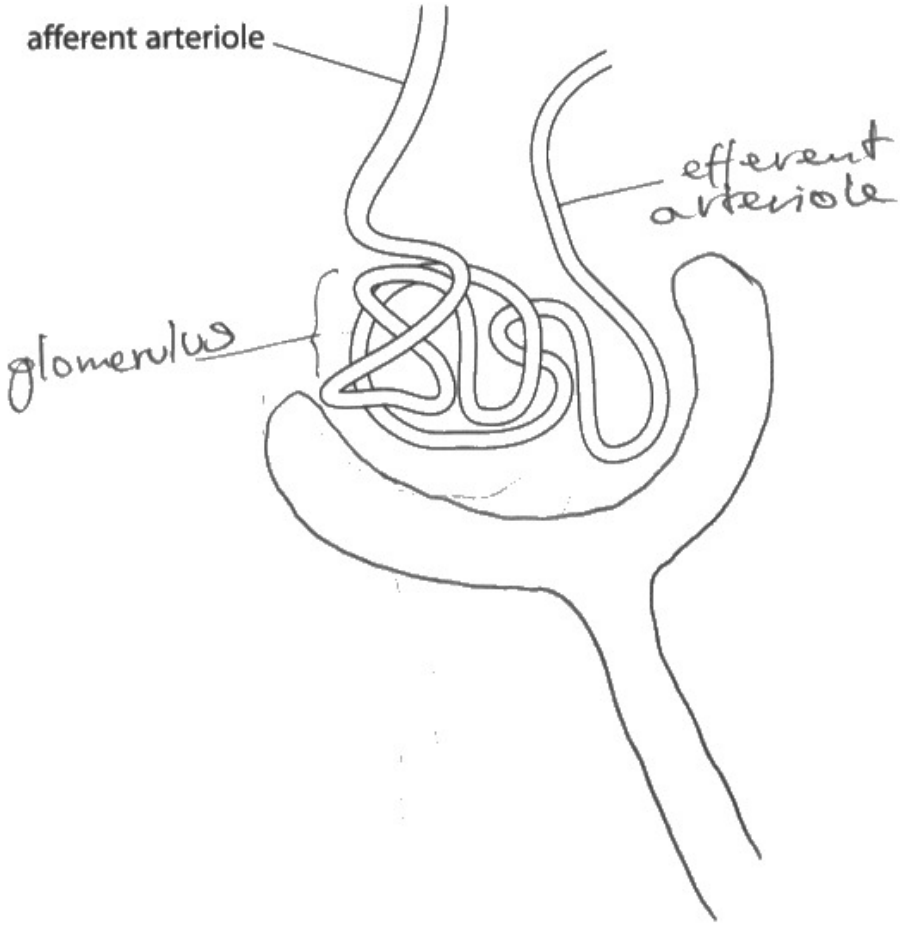
Question 2 (a)(i)

In this question, candidates were required to complete a diagram of a Bowman's capsule and label two structures.

There were some very good diagrams with clear labelling. The proximal convoluted tubule needed to be present, although not necessarily labelled. There was no credit for the labelling of Bowman's capsule as it was in the stem of the question.

2 The kidney is an organ that is involved in the removal of waste metabolites from the blood.

(a) The drawing shows the blood supply inside a Bowman's capsule (renal capsule).



(i) Complete the diagram to show the Bowman's capsule and label **two** structures in this diagram.

(3)

ResultsPlus
Examiner Comments

This response was awarded the full 3 marks.

ResultsPlus
Examiner Tip

Accurate drawing is a skill that needs to be practised.

Accurate labelling is very important, particularly to where the end of the label is directed.

Question 2 (b)

In this question, candidates were asked to explain how glucose reabsorption takes place in the nephron.

The better responses were able to explain the process of glucose reabsorption very accurately, including all the relevant marking points. Most candidates were clear on the proximal convoluted tubule as the site. However, the details of the mechanism involving transport molecules and co-transport with sodium ions were less clear.

(b) Describe how glucose reabsorption takes place in the nephron.

(3)

It is selectively reabsorbed in the proximal convoluted tubule (PCT). Na^+ ions ~~are~~ move out of PCT by active transport and co-transport glucose. Glucose is then able to be reabsorbed. This movement results in water moving out by osmosis

ResultsPlus
Examiner Comments

This response was awarded the full 3 marks. The candidate has presented the answer in a clear logical form.

ResultsPlus
Examiner Tip

It is important that sodium ions are referred to rather than sodium.

Question 3 (a)(iv)

In this question, candidates had to name the receptor that detects plasma concentration. The only acceptable answer was osmoreceptor. Many candidates named chemoreceptor as the detector.

(iv) Name the type of receptor in the body that detects changes in the plasma concentration.

(1)

Osmoreceptors

ResultsPlus
Examiner Comments

This is an example of a response awarded the 1 mark.

ResultsPlus
Examiner Tip

Only name one receptor. If a wrong one is written down it needs to be clearly crossed out and the correct answer written down.

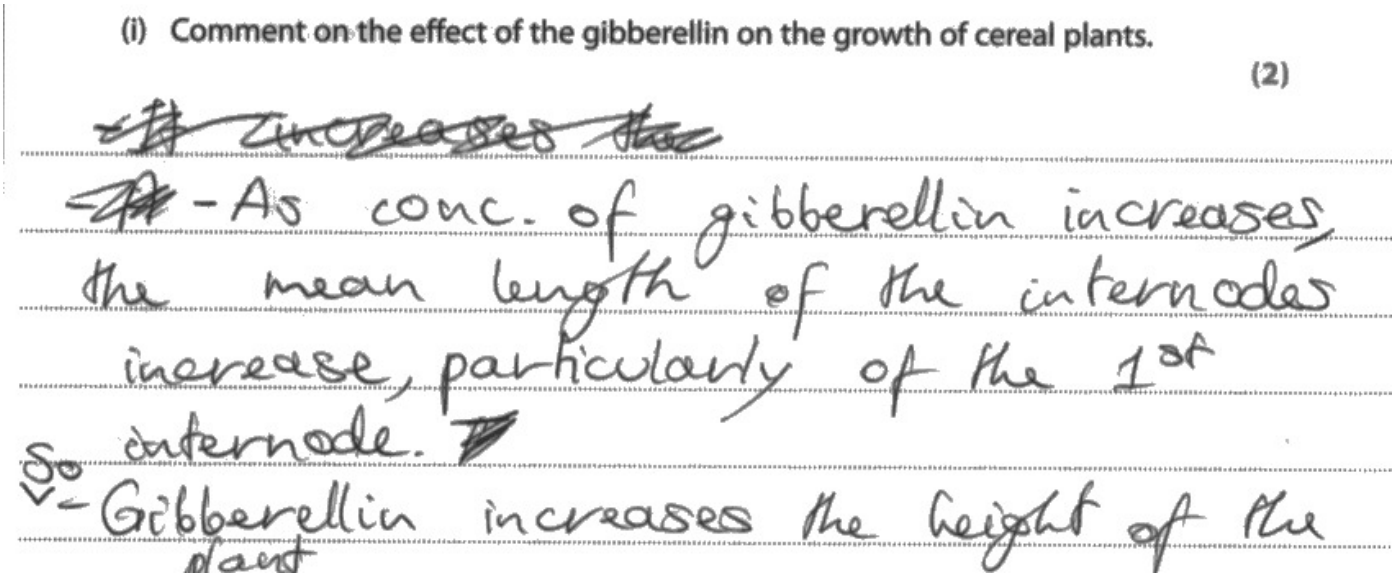
Question 3 (b)(i)

In this question, candidates were given experimental results of internode growth following the application of IAA.

The majority of candidates were able to make appropriate general comments from the data. The focus was that increasing concentration of gibberellin increased the length or growth of the internode. Some of the better responses described the effects separately for each of the three internodes.

A general comment was needed that specified the effect of increasing gibberellin concentration. In addition, a comparison on the greatest or least effect on the internode. The majority of candidates were good at commenting on the effect of the concentration of gibberellin on the growth of internodes and which had the most or least growth.

Some of the better responses provided a positive correlation together with an appropriate statement relating the increase in gibberellin concentration to greater growth, plus a statement that the first internode affected most and the third internode affected least. However, only one is actually required for the mark point.


(i) Comment on the effect of the gibberellin on the growth of cereal plants.

(2)

~~- Increases the~~

- As conc. of gibberellin increases the mean length of the internodes increase, particularly of the 1st internode.

So

- Gibberellin increases the height of the plant

ResultsPlus
Examiner Comments

This response was awarded the full 2 marks.

(i) Comment on the effect of the gibberellin on the growth of cereal plants.

(2)

Positive correlation the higher the concentration of the gibberellin the bigger the mean length. The first internode is the most susceptible to gibberellin as its the one which grows the most. The least sucesceptible is the third internode because its mean length grouth doesnt nearly vary although the gibberellin concentration increases

ResultsPlus
Examiner Comments

This response was awarded the full 2 marks.

Question 3 (b)(ii)

In this question, candidates were asked to explain how gibberellins caused elongation of the internodes.

The command word in this question is 'suggest' and there are many acceptable ways that a candidate could approach the answer. The majority of candidates explained that gibberellins caused cell elongation and many went into great detail about the mechanism behind this. Some of the better responses suggested that gibberellins bind to cell surface receptors and acted as transcription factors.

(ii) Suggest how the gibberellin causes this effect.

(3)

gibberellin causes growth, as it ~~eat~~ could stimulate the production of growth proteins in the plant, it may also stimulate cell elongation of the plant, causing a quick increase in the mean length of the plant. ~~Than~~ Both of these instances could happen through the intake of the gibberellin by the plant through its roots and it either acts as a transcription factor for the production of a protein from a gene or directly stimulates cell elongation.

(Total for Question 3 = 9 marks)

ResultsPlus
Examiner Comments

This response was awarded the full 3 marks. The candidate made a relevant comment about acting as a transcription factor.

Question 4 (a)

In this question, candidates were asked to explain why Co-beneldopa would be more effective that L-dopa used on its own in the treatment of Parkinson's disease.

There were many varied responses with some weaker responses not using the information given in the question. The better responses not only used this information but also used their own knowledge about dopamine from the specification. However, weaker responses which gave descriptions about how increased dopamine would help a Parkinson's sufferer were often too vague to meet the mark point.

The majority of candidates showed a good knowledge of the blood brain barrier.

4 Parkinson's disease is caused by a loss of neurones in part of the brain called the substantia nigra.

Co-beneldopa is used to treat Parkinson's disease.

Co-beneldopa is a mixture of L-dopa and a drug that prevents the conversion of L-dopa into dopamine in the blood.

(a) Explain why using Co-beneldopa will be more effective than using L-dopa alone to treat Parkinson's disease.

(3)

This is because Co-beneldopa contains a drug that prevents the conversion of L-dopa into dopamine in the blood. L-dopa is able to pass through the blood-brain barrier, where as dopamine can't. This means that more L-dopa will make it to the brain, as it is not converted into dopamine in the blood where it is useless. The L-dopa can then be converted into dopamine in the brain where it will counteract the effects of Parkinson's disease.

ResultsPlus
Examiner Comments

This is an example of a response that was awarded the full 3 marks.

Question 4 (b)(i)

In this question, candidates were given data about genes that affect the production of L-dopa. They were asked to explain the effects demonstrated in the results table.

Overall, candidates responded well to this question. The majority of candidates were able to accurately describe the data shown in the table and compare the results of the control gene, MYB12 and CYP76 genes. The use of data was generally good. However, very few responses expanded on the reason why MYB12 gene and CYP76 gene used together produced the best results. Most of the weaker responses were too vague.

(b) In an investigation, tomato plants were genetically modified to convert the amino acid tyrosine into L-dopa.

Three genes were used in this investigation:

- a control gene that is not involved in the production of L-dopa
- MYB12, a plant gene that produces a transcription factor
- CYP76, a gene found in beetroot that codes for an enzyme that converts tyrosine into L-dopa.

The table shows the concentration of L-dopa in the tomato fruit from genetically modified plants.

Genes used to modify the tomato plants	Concentration of L-dopa in the tomato fruit / mg 100 g^{-1}
none	1.2
control gene	1.2
MYB12	1.5
CYP76	10.2
CYP76 and MYB12	14.6

(i) Explain the effects of these three genes in this investigation.

(4)

MYB12 gene increases a little the concentration of L-Dopa (from 1.2 to 1.5) as it is a transcriptional factor, so more transcription of the genes can take place ~~and more~~ increasing the concentration/amount of L-dopa

CYP76 gene ~~increases~~ has a big increase of concentration of L-DOPA as it codes for an enzyme that converts tyrosine into L-dopa, so all of the tyrosine can be converted into L-dopa increasing ~~its~~ its concentration.

It increases L-dopa concentration from 1.2 mg100g^{-1} to 10.2 mg100g^{-1} (9mg100g^{-1})

CYP76 and MYB12 together ~~have~~ have the biggest effect on the concentration of L-dopa (1.2 mg100g^{-1} to 14.6 mg100g^{-1}). This happens due to the fact that if MYB12 acts as a transcriptional factor, it can

transcribe enzyme gene CYP76 so more enzyme is produced meaning more tyrosine turned into L-dopa.

ResultsPlus
Examiner Comments

This response was awarded 3 marks. The candidate has given a good comparison of the control gene, MYB12 and CYP76 genes. The data used from the table is accurate and the candidates has used relevant figures.

(b) In an investigation, tomato plants were genetically modified to convert the amino acid tyrosine into L-dopa.

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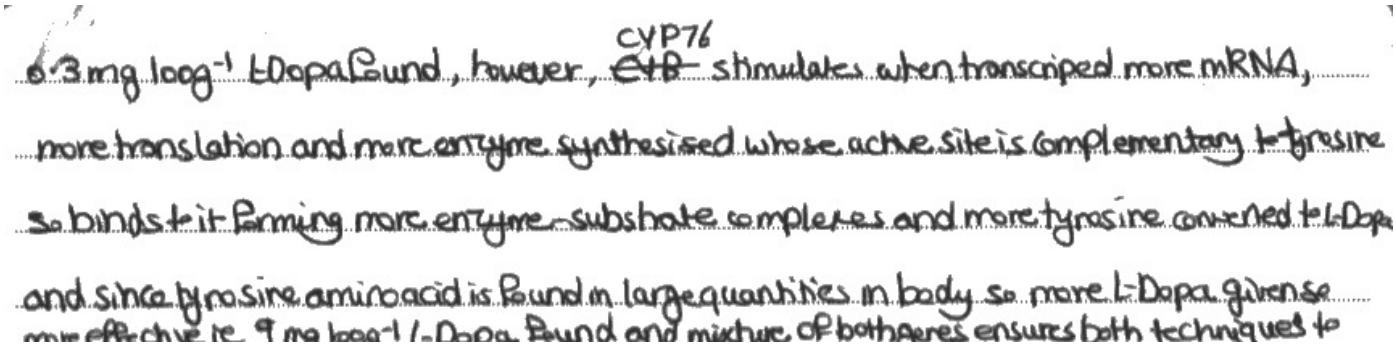
CYP76	10.2
CYP76 and MYB12	14.6

(i) Explain the effects of these three genes in this investigation.

(4)

a control gene has no effect on concentration of L-Dopa in tomato fruit as it is the same as the one without any genes as it doesn't get involved in L-Dopa production, however both MYB12 and CYP76 cause an increase in L-Dopa concentration in tomato fruit with most effect for both combined causes 13.4 mg 100g^{-1} more L-Dopa in tomato fruit, where MYB12 produces a transcription factor which passes through nuclear pores in nuclear membranes of cells producing L-Dopa and bind to specific regions of DNA at promoter sequence of genes involved in L-Dopa production (at TATA box) switching them on so stimulate more transcription of these genes by stimulating more RNA polymerase binding at promoter sequence so more mRNA produced, more translation and more proteins produced so more L-Dopa synthesised so it is least effective only



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Examiner Comments

This response was awarded the full 4 marks. The candidate has given the comparison between the control gene, MYB12 and CYP76 accurately. There is also an explanation as to why MYB12 and CYP76 used together produced the most L-dopa. In this example, the mark point was looking for the transcription factor increasing the production of the CYP76 protein / enzyme which leads to more L-dopa.

Question 4 (b)(ii)

Candidates were asked to explain how tomato plants could be genetically modified to make the enzyme that converts tyrosine to L-dopa. This genetically modified (GM) question has appeared in several recent exam sessions.

Unfortunately, the majority of responses provided a generalised GM answer rather being specific to the tomato and L-dopa. Often both beetroot and tomato were missing from the responses.

Several responses referred to the gene for L-dopa while others referred to getting the gene from the tomato. Some restriction enzyme was clearly stated together with an appropriate method of insertion into the tomato.

(ii) Describe how tomato plants could be genetically modified to make the enzyme that converts tyrosine to L-dopa.

(3)

Isolate desired gene coding for enzyme. Cut gene using Restriction Endonucleases. Using same restriction enzyme, cut plasmid of a bacterium. This will act as a vector as it can enter the host cell. Join gene coding for enzyme and bacterium & vector using DNA ligase, producing recombinant DNA. Insert this into tomato plant cell using a gene gun. Allow tomato plants to grow and harvest, select those containing highest concentration of enzyme.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate has stated the starting point of isolating the gene coding for the enzyme.

Question 5 (a)(ii)

In this question, candidates were asked to compare and contrast the function of sensory and motor neurons.

Overall, candidates seemed more confident with the use of the 'compare and contrast' command words in the question. However, the expectation is for the comparisons to be in the same sentence. This question is also about function and several candidates went into great detail comparing structure.

(ii) Compare and contrast the function of a sensory neurone and a motor neurone.

(3)

A sensory neurone is responsible for receiving ~~sign~~ impulses from receptors, ~~which while motor neurones are respons~~ and sending them to relay neurones, while motor neurones receive impulses from relay neurones and send impulses to an effector, usually skeletal muscle. Both neurones are part of the same reflex arc responsible for carrying out a response to a stimuli. Both neurones synapse with a relay neurone to send or receive impulses.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate has made a good comparison of function. Relay neurones are an acceptable alternative to CNS.

ResultsPlus
Examiner Tip

In a nerve question, impulse needs to be used rather than signal or message.

(ii) Compare and contrast the function of a sensory neurone and a motor neurone.

(3)

sensory neurone : receives an impulse from a stimulus and sends it to the CNS it has long dendrites an it cell body is found in the middle of the axon

motor neurone : receives impulse from CNS or relay neurone and sends it to the effector normally a muscle to carry out a contraction it has many short dendrites.

Both are mylinated an both carry nerve impulses both neurones related by relay neurones.

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Examiner Comments

This is a response that was awarded 1 mark. The candidate has not followed the command words 'compare and contrast' correctly. There are separate paragraphs for sensory neurone and then motor neurone. The only mark point awarded is in the last sentence where there is evidence of compare and contrast with a similarity in function.

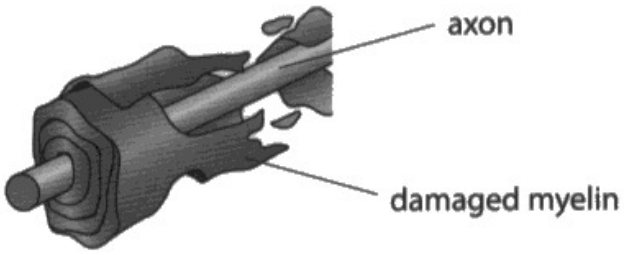
Question 5 (b)

In this question, candidates were given details of the symptoms of Guillain Barre disease. An image of the neurone of a sufferer was given which showed demyelination. Candidates were asked to suggest the reasons why the sufferer would have these symptoms.

The majority of candidates used the information provided in the question and they were able to explain how the loss of myelin caused a decrease in spread of nerve transmission. The better responses stated loss of impulse speed, lack of saltatory conduction and that depolarisation no longer only occurs at the nodes of Ranvier. However, impulses being lost was not an acceptable response. In addition, candidates found it more of a challenge to explain why the symptoms occurred.

(b) Guillain-Barré syndrome is a disorder of the nervous system.

The immune system damages the myelin sheath surrounding the axons of individuals with Guillain-Barré syndrome.



Symptoms of this disorder include:

- inability to maintain steadiness when walking → less impulse to cerebellum
- inability to feel any sensations in the limbs → ~~receptors~~ impulse from receptor cant transmit continu ously
- loss of reflexes such as knee jerk. → slow impulse

Suggest why a person with Guillain-Barré syndrome will suffer from the symptoms of this condition.

(3)

The inability to maintain steadiness when walking is due to less impulses reaching the cerebellum and fewer impulses being ~~conducted~~ propagated ~~throug~~ to the muscle fibres for muscle contraction. The inability to feel any sensations in the limbs is due to the loss of conduction of impulse from the sensory receptor to the parietal cortex due to damaged myelin. ~~whir~~ The loss of reflexes such as knee jerk is due to slower impulses travelling to the neuromuscular juction, hence lesser Ca^{2+} is released resulting to loss of fast and rapid contraction of muscle.

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Examiner Comments

This is a response that was awarded the full 3 marks.

ResultsPlus
Examiner Tip

Use the information given in the question to help with the answer. It is there for a reason to help guide the answer.

In nerve questions use 'impulse' rather than 'signal' or 'message'.

Question 5 (c)

In this question, candidates were tasked to explain how mutations in voltage-gated calcium ion channels could cause these neurological conditions.

The majority of candidates could explain how a mutation resulted in the change in shape of the calcium ion channel and the effect that it would have on the influx of calcium ions. However, many candidates went for the absolute, ie, there would be no fusion of vesicles. As the symptoms list were still the result of some impulses travelling, the mark scheme was looking for fewer vesicles and less transmitters released.

(c) Mutations in the genes coding for voltage-gated calcium ion channels have been linked to neurological conditions.

Explain how these mutations might cause these neurological conditions.

(4)

Mutations cause a change in base sequence which ultimately affects the amino acid chain, shape, folding and R bonds present on a protein that is synthesised which means that calcium ion channels are less effective possibly as they are not the right shape to allow calcium ions to enter a presynaptic knob. This means less neurotransmitters travel to the presynaptic membrane and less enter the synapse so less bind to receptors which means less action potentials occuring

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. The candidate has made clear reference to the effect of the mutation on the gated channel shape plus reference to fewer/less transmitters leading to less action potentials.

Question 6 (b)(i)

In this question, candidates had to calculate the cardiac output for an individual when provided with the equation and data for heart rate and stroke volume. The answer needed to be to two significant figures.

The calculation did not present a problem to most candidates. However, some weaker responses failed to give the answer to the required two significant figures.

(b) The heart responds to adrenaline by increasing cardiac output.

Cardiac output = heart rate × stroke volume

(i) Calculate the cardiac output for a person who has a heart rate of 77 bpm and a stroke volume of 70 cm^3.

Give your answer to two significant figures in dm^3 $hour^{-1}$.

(2)

77 bpm

1 min → 77

60 min → 4620

1 hour → 4620 beats

70 cm^3 x 10^{-3} = 0.07

4620 x 0.07

Answer 320 dm^3 $hour^{-1}$

ResultsPlus
Examiner Comments

This response was awarded the full 2 marks. The candidate has given the correct answer to two significant figures. However, had the answer been wrong the workings are clear to enable the candidate to gain some marks.

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Examiner Tip

In calculation questions it is crucial to check how to give the answer and whether units are required. Many candidates are doing the calculation on calculators and only writing down the answer. This is perfectly acceptable if the answer is correct. However, if the answer is incorrect candidates will not gain any marks if there are no workings.

Question 6 (b)(ii)

In this question, candidates were asked to calculate the cardiac output and cardiac index for two patients. The units for cardiac index was also required.

Candidates had no trouble doing the calculations for cardiac output and cardiac index. However, some of the weaker response failed to state the units for the cardiac index calculation.

(ii) The formula shows how to calculate the cardiac index. This is a method of adjusting cardiac output values for the body surface area of an individual.

$$\text{cardiac index} = \frac{\text{cardiac output in dm}^3\ \text{min}^{-1}}{\text{body surface area in m}^2}$$

The table shows some information for cardiac output, body surface area and cardiac index for two individuals.

Individual	Cardiac output / $dm^3\ min^{-1}$	Body surface area / m^2	Cardiac index / $dm^3\ min^{-1}\ m^{-2}$
A	6.7	1.92	3.5
B	4.2	1.49	2.8

Complete the table to show the units for cardiac index, the cardiac index for individual A and the cardiac output for individual B.

(3)

$\frac{6.7}{1.92} = 3.5$

$2.8 \times 1.49 = 4.2$

→ $dm^3\ min^{-1}\ m^{-2}$

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate has given the answer in the table and in the space below the table. There is a clear numerical calculation and units.

Question 6 (b)(iii)

This was the levels-based question where candidates were required to interpret three sets of graphical data on the effects of differing concentrations of adrenaline on heart rate, cardiac index and blood pressure for young and old patients.

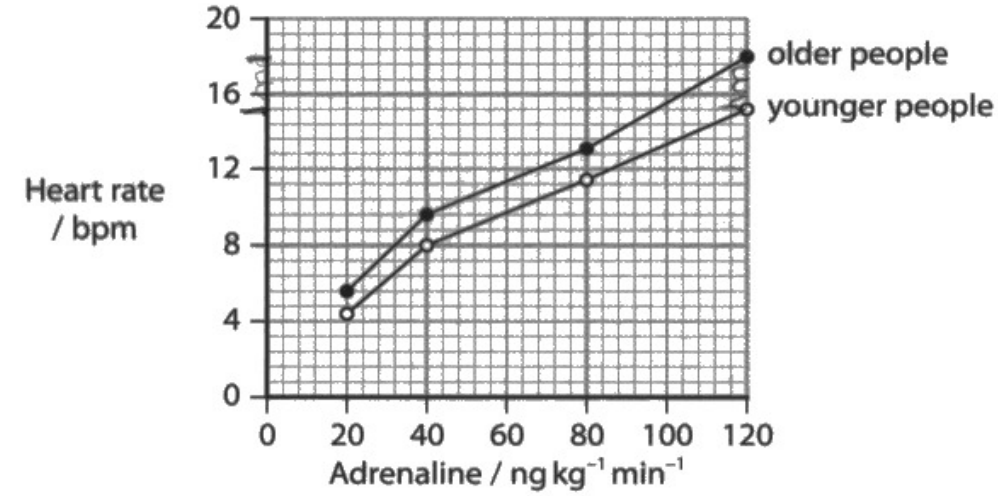
Some candidates often discussed the graphs but without relating the outcomes to the concentrations of adrenaline. However, it was pleasing to see that many candidates achieved level 3 through detailed comments on the graphs and using their knowledge and understanding of the differing effects of adrenaline on the young and old.

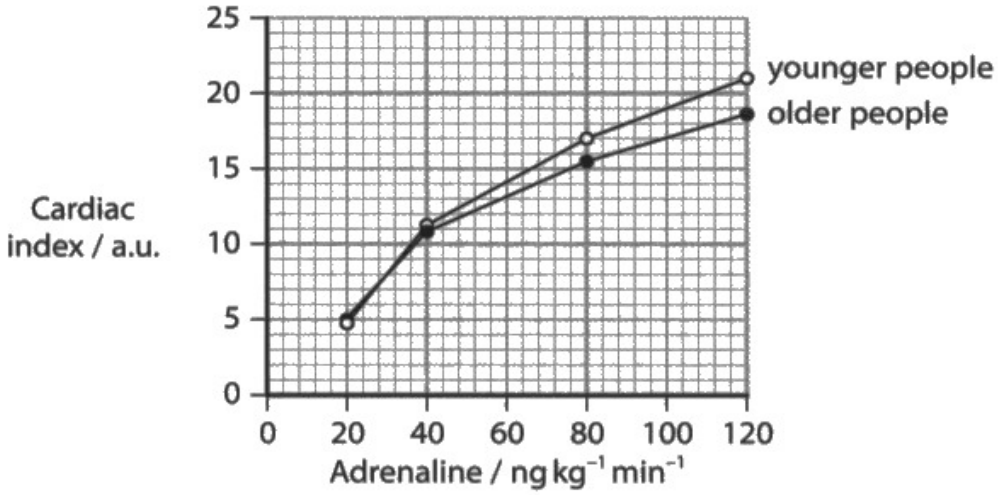
Some of the weaker responses stated the effects of the change in adrenaline on heart rate, cardiac index and blood pressure but there was no real attempt to explain the reason why they differ in the old and young, or any significance comment about the data.

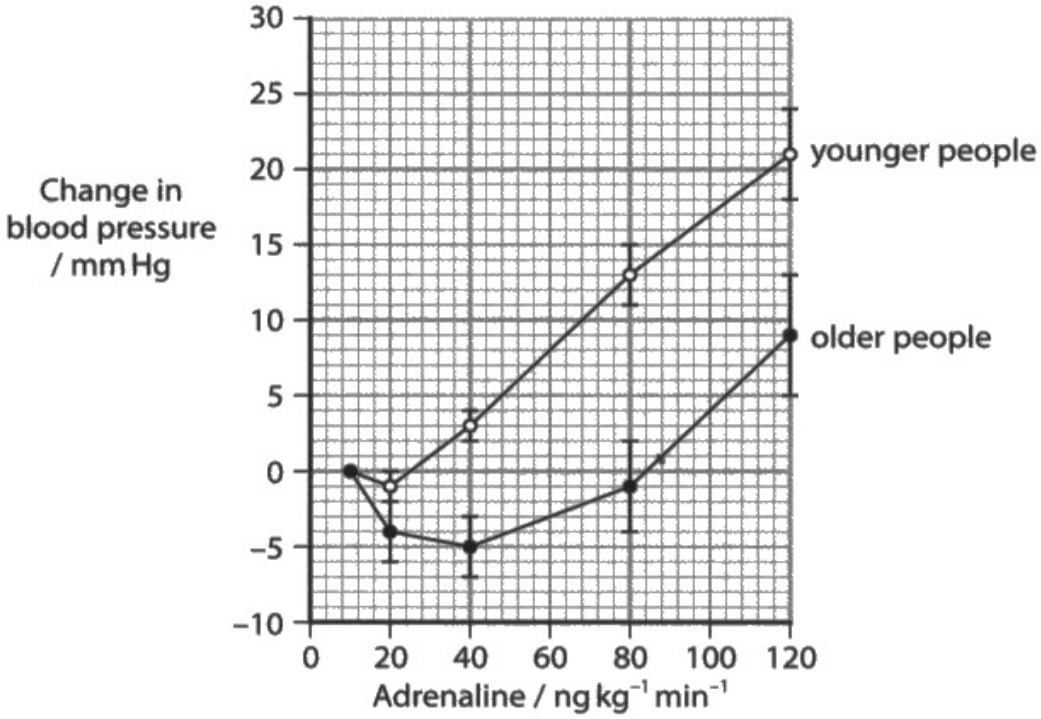
*(iii) Ageing is associated with changes in the way the heart responds to adrenaline.

In an investigation, the effects of adrenaline on the hearts of young people and old people were recorded.

The graphs show the results of this investigation.







Discuss the effect of ageing on the response of the heart to adrenaline.

Use the information in the graphs to support your answer.

(6)

- Ageing raises the heart rate in bpm in response to adrenaline compared to when a person is young and ageing is reduced (e.g. at 120ng kg^{-1} min^{-1} of adrenaline, older people had a mean heart rate 2.8 bpm higher than younger people). This heart rate trend is similar for other adrenaline concentrations between older and younger people, although the differences in heart rate between the 2 groups is not very large.
- The effect of adrenaline on the cardiac index of older and younger people is similar, suggesting that ageing has little to no effect on the cardiac index in response to adrenaline concentrations of 20-40ng kg^{-1} min^{-1}. However, the difference in cardiac index between the 2 groups steadily increases between 40 and 120ng kg^{-1} min^{-1} with ageing causing the cardiac index to decrease in response to adrenaline.
- Ageing causes blood pressure to fall in response to adrenaline compared to it continuously rising in younger people as adrenaline conc. rises. BP in older people only begins to rise after an adrenaline conc of 40ng kg^{-1} min^{-1} is surpassed.

(Total for Question 6 = 12 marks)

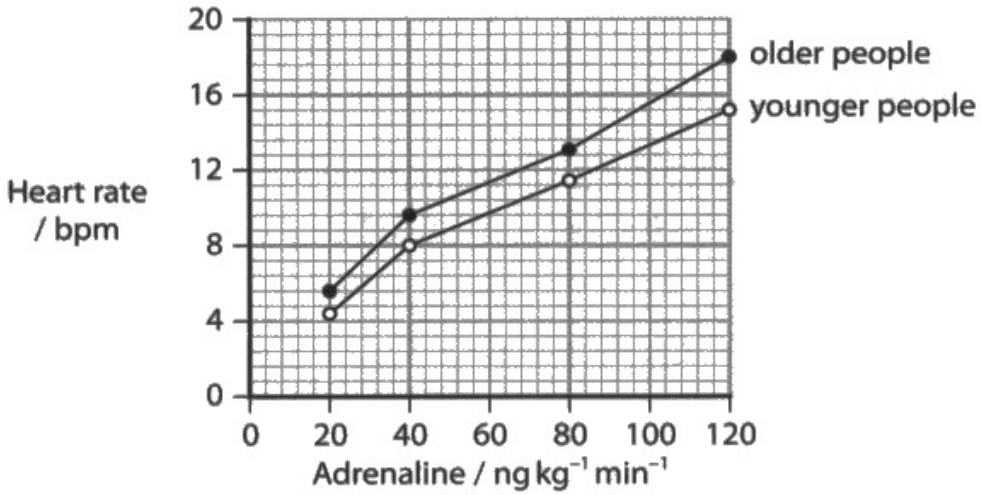
ResultsPlus
Examiner Comments

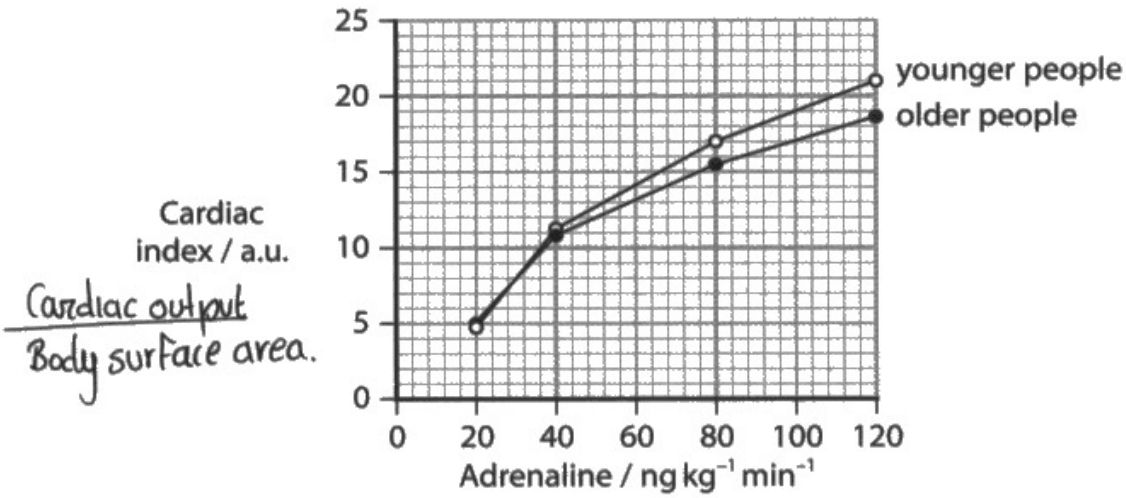
This is an example of a response that was awarded 3 marks.

*(iii) Ageing is associated with changes in the way the heart responds to adrenaline.

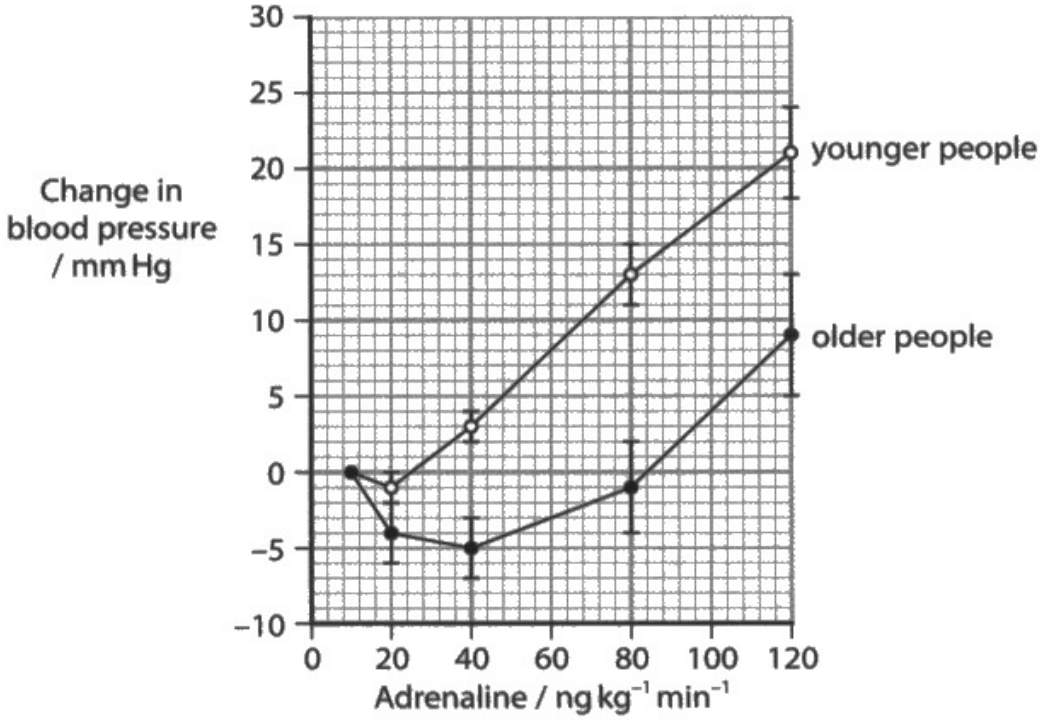
In an investigation, the effects of adrenaline on the hearts of young people and old people were recorded.

The graphs show the results of this investigation.





Cardiac output / Body surface area.



Discuss the effect of ageing on the response of the heart to adrenaline.

Use the information in the graphs to support your answer.

(6)

Adrenaline causes the blood vessels to ~~co~~ widen up to increase the heart rate and the pressure at which the blood is pumped out.
The heart rate of both younger people and older people increase with adrenaline to be able to supply the body with its needs, in older people the heart rate is higher as the muscles in the heart are older and need greater effort to supply the body.
The cardiac index is lower in older people as the cardiac output also decreases, less blood is pumped out of the heart per min as the heart muscles aren't that strong anymore. The body surface area can be higher as older people tend to gain more weight. therefore the outcome is a lower cardiac index, even though there is not much of a difference between younger and older people.
The greatest change is seen in blood pressure, this is due to the loss of elasticity and strength of the arteries and ~~veins~~ veins in old people. blood pressure cannot be maintained. In young people blood is carried through the body faster due to increased blood pressure, body still has strength in muscles.
older people would need a bigger Adrenaline supply to reach the young individuals blood pressure.

(Total for Question 6 = 12 marks)

ResultsPlus
Examiner Comments

This is a response that was awarded 5 marks. The candidate not only compares the effects on both old and young but makes realistic suggestions as to why. This is a level 3 response but it was not awarded a mark of 6 as there is no statement on significance.

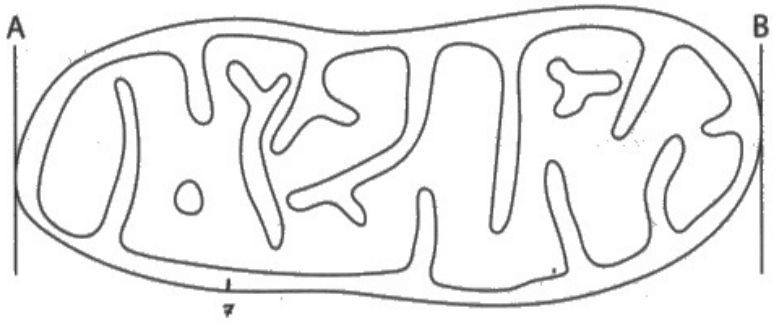
Question 7 (a)

In this question, candidates were required to measure a mitochondrion and then calculate the magnification. The answer was required to be in standard form.

The calculation proved more challenging than expected. The measuring of the mitochondrion was generally accurate. However, the calculation to give the magnification was frequently inaccurate and many failed to give the answer in standard form. A common error was to put the power of 10 in a negative, eg 10^{-5}

7 In eukaryotic organisms aerobic respiration takes place in mitochondria.

(a) The diagram shows a mitochondrion.



9.8

The actual length of the mitochondrion between A and B was 0.75 µm.

Calculate the magnification of the mitochondrion shown in the diagram.

Give your answer in standard form.

(2)

9.8 mm
~~9800~~ 980 mm
9800 µm

$\frac{9800}{75} = \sim 130$

Answer ~130x magnification

ResultsPlus
Examiner Comments

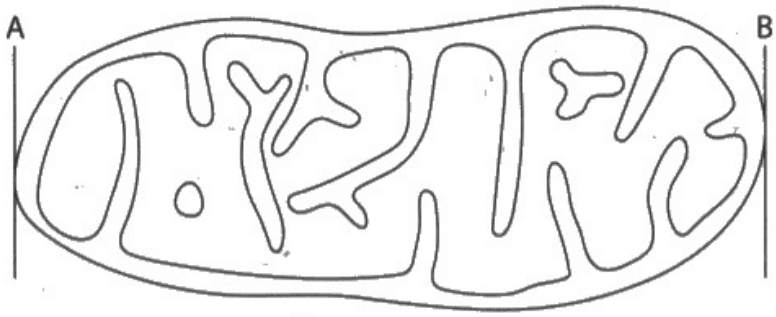
This an example of a response that was awarded zero marks. The candidate has given the correct measurement but magnification was incorrect and not in standard form.

ResultsPlus
Examiner Tip

Read the question to find out how to show the answer. Make sure the workings are clear. Practice doing conversions of units.

7 In eukaryotic organisms aerobic respiration takes place in mitochondria.

(a) The diagram shows a mitochondrion.



The actual length of the mitochondrion between A and B was 0.75 µm.

Calculate the magnification of the mitochondrion shown in the diagram.

Give your answer in standard form.

9.8cm : 0.75µm (2)

9800000 : 0.75

1.3×10^7

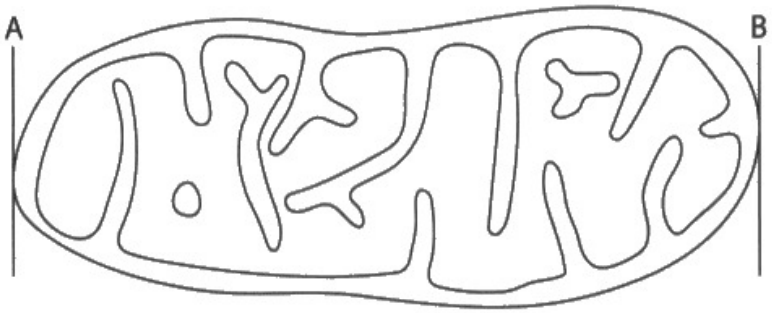
Answer 1.3×10^7

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. The candidate has given the correct measurement and the calculation of magnification was going well. However the conversion of units was incorrect. A mark was awarded for the correct numerical value.

7 In eukaryotic organisms aerobic respiration takes place in mitochondria.

(a) The diagram shows a mitochondrion.



9.8 cm

The actual length of the mitochondrion between A and B was 0.75 µm.

Calculate the magnification of the mitochondrion shown in the diagram.

Give your answer in standard form.

(2)

$$\frac{9.8 \times 10^{-3}}{0.75 \times 10^{-6}} = 1.3 \times 10^{5}$$

Answer 1.3×10^{5}

ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. The candidate has given the answer correctly in standard form. Clear workings are evident and a very clear calculation.

Question 7 (b)(ii)

In this question, candidates were provided with experimental data from using different substrates in respiration reactions. They were asked to use the information in the table and their knowledge about Krebs cycle to explain the results.

The majority of candidates have a basic understanding of aerobic respiration. However, matching that knowledge to the results given in a novel form from the experiment proved challenging. The majority of candidates could explain why the pyruvate transport inhibitor stopped Krebs cycle/link reaction. Some of the weaker responses gave precise details of both link reaction and Krebs cycle but without referring to any of the data provided from the experiment.

(ii) Explain the results of this investigation.

Use the information in the table and your own knowledge of the Krebs cycle to support your answer.

(4)

Pyruvate will have to enter link reaction before Krebs cycle.
Pyruvate will be converted to Acetyl CoA which will then enter Krebs cycle.
Pyruvate enters Krebs cycle to produce CO_2 and reduced NAD and reduced FAD for oxidative phosphorylation.
Sample 1 pyruvate enter krebs cycle and perform normal reaction into CO_2
Sample 2 Krebs cycle gains ADP which will bind with P_i to form ATP energy for respiration. Rate of respiration increases and more pyruvate will be converted into CO_2.
Sample 3 has pyruvate transport inhibitor so pyruvate is unable to perform link reaction. Less Acetyl CoA go into Krebs cycle. Less CO_2 produced.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. It is clear as to what data from the table the candidate is referring. All mark points are clearly laid out and very succinctly.

(ii) Explain the results of this investigation. Krebs Cycle

Use the information in the table and your own knowledge of the Krebs cycle to support your answer.

(4)

By adding pyruvate the rate of CO_2 production increases as more pyruvate can be used to convert CoA into acetyl coenzyme A releasing CO_2. This acetyl coenzyme A produced can then go into the Krebs cycle releasing 2 more molecules of CO_2. By adding both pyruvate and ADP the Krebs cycle can more readily convert a 5 carbon compound into a 4 carbon compound as ADP + Pi will be synthesised into ATP and so the rate of carbon dioxide production increases even more than with just pyruvate. When the pyruvate transport inhibitor is present the rate of CO_2 production decreases as less pyruvate is converted into acetyl coenzyme A and so the Krebs cycle cannot continue.

ResultsPlus
Examiner Comments

This is another example of a response that was awarded the full 4 marks. Although there is no reference to the sample, it is clear as to which sample the candidate is referring. A good knowledge of the reactions in aerobic respiration is well related to the data from the experiment.

Question 7 (c)(i)

In this question, candidates were required to explain the difference in the number of mitochondria in slow and fast twitch muscle fibres.

The majority of candidates coped very well with this question. Slow and fast twitch muscle fibres have appeared in several papers since the new specification was introduced. Therefore, candidates have a good understanding, although a few response did get the slow twitch more mitochondria the wrong way around. To gain full marks candidates needed to relate more mitochondria to sufficient oxygen supply.

(c) Fast twitch and slow twitch muscle fibres contain different numbers of mitochondria.

(i) Explain the difference in the number of mitochondria in these two types of muscle fibre.

(3)

In slow twitch muscles there are many mitochondria to supply muscle with enough ATP. they appear ~~red~~ dark red due to increased supply of blood vessels for oxygen to be used in the ~~mitoch~~ mitochondria, Aerobic respiration. In fast twitch muscles there aren't many mitochondria. mainly used for anaerobic respiration, why they appear lighter in colour. they use creatine phosphate to produce ATP from ADP.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. Although this candidate does not use the words more/less it is clear that slow twitch 'being many' and fast twitch being 'aren't many' implies this. This response also has relevant increased oxygen supply.

(c) Fast twitch and slow twitch muscle fibres contain different numbers of mitochondria.

(i) Explain the difference in the number of mitochondria in these two types of muscle fibre.

(3)

slow twitch fibres have a greater number of mitochondria than fast twitch. This is because they contain a large amount of myoglobin (O_2) & therefore respire mainly aerobically. The mitochondria are involved in fate the site of aerobic respiration (inner mitochondrial membrane & greater amount would be needed mitochondrion being the site of e^- transport chain). Thus more mitochondria are in slow twitch muscle fibres to accomodate for the greater amount of aerobic respiration.

ResultsPlus
Examiner Comments

This is another example of a response that was awarded the full 3 marks. The candidate has given a well thought out and clear response. Greater number in slow twitch, large amount myoglobin and respiration aerobic.

Question 7 (c)(ii)

In this question, candidates need to explain the role of ATP in muscle contraction. Candidates have a good understanding of the sliding filament theory for muscle contraction. Many gave the full details of the theory from the initial innervation to relaxation. However, the question was more specific, only focussing on ATP.

(ii) Describe the role of ATP in muscle contraction.

(4)

When myosin binds to actin - a molecule of ADP + Pi is released from y myosin head. This causes a change in shape of myosin thus it pushes actin filament forward & muscle contracts. Then another molecule of ATP binds to myosin & this breaks the cross bridge between actin & myosin, thus actin returns to it's normal position & the muscle stops contracting. (~~As long as there is a supply of ATP - muscle can contract.~~) ~~ATP is hydrol~~ ATP attached to myosin head is hydrolysed into ADP + Pi & this returns myosin to it's original position. As long as ATP is supplied - muscle contraction can occur.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. Although the candidates starts with the formation of the actin myosin cross bridge, all aspects of the markscheme are covered.

(ii) Describe the role of ATP in muscle contraction.

(4)

During muscle contraction the myosin head binds to the binding sites of the actin, then the ADP + Pi group of the myosin head is released and the myosin head and actin filaments move forward. Free ATP binds the myosin head which causes the myosin - actin bridge to break. ATP is hydrolysed to ADP + Pi to move back the myosin head back to its original position, so the contraction can happen again

ResultsPlus
Examiner Comments

This is another example of a response that was awarded the full 4 marks. The candidate has started with the formation of the actin myosin cross bridge and all mark points are covered. Important that the candidate makes reference to 'myosin head' not just myosin.

Question 8 (a)

In this question, candidates needed to describe the role of the autonomic nervous system in the control of breathing while resting. This question proved to be a challenge for many candidates. Candidates clearly know the function of chemoreceptors and where impulses go. However precise details about the autonomic nervous system and the ANS were often lacking or inaccurate. In addition, many candidates did not refer to resting that was mentioned in the question and only gave details about breathing.

8 The scientific document you have studied is adapted from articles in *StatPearls: Anatomy, Autonomic Nervous System, British Journal of Cardiology: Postural Orthostatic Tachycardia Syndrome (POTS)* and *Cellular and Molecular Life Sciences: The enteric nervous system in gastrointestinal disease etiology.*

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

(a) The autonomic nervous system regulates aspects of respiration (paragraph 1).

Describe how the autonomic nervous system regulates the breathing rate when a person is resting.

(4)

When a person is resting, the concentration of carbon dioxide in blood is low, so the pH increases. The chemoreceptors in the carotid arteries detect this change of pH and send impulses to the respiratory centre in the medulla oblongata. The medulla sends impulses to the intercostal muscles through the parasympathetic nervous system. This causes the rate of contraction and relaxation of the muscles to decrease, so the rate of breathing decreases while resting.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. The candidate has very succinctly described the idea of chemoreceptors with impulses going to the respiratory centre in the medulla, together with the role of the parasympathetic system in relaxing the intercostal muscles.

ResultsPlus
Examiner Tip

Make sure there is ample time to study the article. Much help for this question can be found reading around the article.

8 The scientific document you have studied is adapted from articles in *StatPearls: Anatomy, Autonomic Nervous System, British Journal of Cardiology: Postural Orthostatic Tachycardia Syndrome (POTS)* and *Cellular and Molecular Life Sciences: The enteric nervous system in gastrointestinal disease etiology.*

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

(a) The autonomic nervous system regulates aspects of respiration (paragraph 1).

Describe how the autonomic nervous system regulates the breathing rate when a person is resting.

(4)

When a person is resting, blood pH increases as CO_2 level in blood drop. This is detected by chemoreceptors in carotid arteries which send nerve impulse to ventilation centre in medulla oblongata. This sends nerve impulse to diaphragm and intercostal muscles via parasympathetic nerve to contract less frequently and stngly, which regulates breathing rate.

ResultsPlus
Examiner Comments

This is another example of a response that was awarded the full 4 marks. A very focussed and succinct response gaining full credit.

Question 8 (b)

In this question, candidates were asked to explain how neurones could respond to different neurotransmitters.

Candidates could explain about receptors on the post synaptic membrane and describe a suitable response once the transmitter had bound to the receptor. The better responses commented on the different specificity of the three-dimensional shape of the receptor.

(b) Explain how neurones can respond to different neurotransmitter substances (paragraph 4).

(3)

The post synaptic membrane contains different receptors on its surface, all of which can only bind to a specific neuroreceptor, as the shape of the receptor attachment active site is specifically shaped to induce fit for a specific neurotransmitter. Therefore, when an excitatory neurotransmitter is attached, an ~~action~~ the membrane is depolarised and an action potential is produced, and when an inhibitory is attached, membrane is hyperpolarised and no action potential is produced.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate referred to the post synaptic membrane with clear reference to specific shape. It is important that reference is to membrane not neurone.

Question 8 (c)

In this question, candidates were asked to suggest how the sympathetic nervous system in immune organs could regulate inflammation. Candidates mostly referred to the release of histamine or cytokines and missed the initial innervation through neurotransmitters.

(c) Suggest how the activity of the sympathetic nervous system in immune organs could regulate inflammation (paragraph 7).

(2)

It Sends impulses to spleen & lymph nodes to release histamine from cells then redness takes & symptoms of inflammation to occur.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 2 marks. This response starts at action on the spleen and lymph nodes leading to release of histamine. However, it misses the point where the SNS could release neurotransmitters (or a named neurotransmitter) acting on the spleen, thymus or lymph node.

Question 8 (d)

In this question, candidates had to suggest how the ECG could be used to identify that a patient was suffering from POTS. This question proved more of a challenge than expected. Many responses missed the idea of recording the ECG before and after changing position. The description of POTS was given in the article, '*heart rate will increase by 30bpm or the heart rate will exceed 120 within 10 minutes of changing position*'.

(d) **Explain how an electrocardiogram could be used to show that a person has postural orthostatic tachycardia syndrome (POTS) (Box 1).**

(2)

POTS has a heartrate above the norm. In an ECG this would be observed in an increase of the R peak frequency. The number of peaks in a given period of time could be counted & divided by the time (if this was in seconds then multiply by 60 to get beats per min). If bpm is greater than 120 then that would indicate POTS.

ResultsPlus
Examiner Comments

This response was awarded the full 2 marks. The candidate has given a clear reference to the calculation of heart rate and to the heart rate of 120 bpm.

Question 8 (e)

Candidates found this the most challenging question. Most candidates were able to suggest that the bolus acted as a stimulus but then failed to suggest how the impulse stimulated the smooth muscle.

Candidates had an idea of reflex muscle action but found it difficult to relate it to peristalsis in the gut. This was particularly true where the muscle contraction/relaxation occurred. The weaker responses had sections of text copied from the article, which gained no credit.

(e) Explain how reflex circuits in the gut cause a bolus to move (paragraphs 10 and 11).

(4)

the presense of bolus is detected by receptor (baroreceptor) causing an impuls to sensory neurone then to ~~inter-node~~ interneuron to send impulses to ~~Smoth~~ muscles (inhibitory signals) ~~radiat~~ longituclinal to relax and circular muscles (excitatory signals) ~~excitatory~~ to contract reducing diameter of the lumen in the propulsive segment pushing bolus forward, at same time, interneurone sends (signals) to longituidinal muscles to contract and circular to relax in recieving segment causing lumen to increase in diameter.

ResultsPlus
Examiner Comments

This is a response that was awarded the full 4 marks. The candidate has written a well thought out and logical response. Bolus acting as a stimulus being detected by receptors, leading to innervation through smooth muscles. This is followed by contraction of circular muscle in the propulsive segment and then longitudinal muscles contract with circular muscles relaxing in the receiving segment.

(e) **Explain how reflex circuits in the gut cause a bolus to move (paragraphs 10 and 11).**

(4)

Presence of bolus acts as a stimulus initiating a nerve ~~causing the activation~~ impulse which passes from sensory neurone to motor neurone to effector. Sympathetic nervous system produces neurotransmitters ~~which causes ligand gated sodium ion~~ as ~~ligand gated~~ voltage gated sodium ion channels open ~~in pre~~ which causes influx of sodium and depolarisation in circular muscles causing circular muscles to contract, while the parasympathetic nervous system causes ~~salt chloride ion~~ releases neurotransmitters ~~ie~~ that cause chloride ion channels to open in membrane of longitudinal muscles causing hyperpolarisation and relaxation of longitudinal muscle in propulsive segment. While in recieving segment, the sympathetic nervous system causes contraction of ~~&~~ longitudinal muscles ~~by opening and pores~~ and parasympathetic causes relaxation in circular muscles.

ResultsPlus
Examiner Comments

This is another example of a response that was awarded the full 4 marks. The candidate has written a well thought out and logical response. Bolus as a stimulus, leading to neurotransmitters released. This causes circular muscles to contract and longitudinal muscle to relax in the propulsive segment. This is followed by correct contraction of longitudinal muscles and relaxation of circular muscles in receiving segment.

Question 8 (f)

In this question, candidates were required to explain the meaning of the term *ischaemia* used in the article. Few candidates gave a response even close to the expected answer. The idea of an inadequate blood supply to a tissue or organ was required.

(f) State what is meant by the term ischemia (paragraph 12).

(1)

It is a pathological condition that causes the digestive system to go through reflex activities.

ResultsPlus
Examiner Comments

This is a response that was awarded zero marks. It is an example of a typical response where a section of the article text has been copied, in the hope that it contains the right answer.

(f) State what is meant by the term ischemia (paragraph 12).

(1)

Ischemia happens when not enough oxygen arrives to a specific area, because there is no blood supply there.

ResultsPlus
Examiner Comments

This is a response that was awarded the 1 mark. The candidate has given a thorough answer that fits in with the context of the article.

Question 8 (g)

In this question, candidates were asked to explain why embryological ENS cells fail to colonise the bowel. There were few answers other than to suggest that it was the result of a mutation. There were no comments related to the lack of surface receptors.

(g) Suggest why embryological ENS cells may fail to colonise the bowel in a developing embryo (paragraph 13).

(1)

A mutation might happen causing this

ResultsPlus
Examiner Comments

This is a response that was awarded the 1 mark. It is an example of the most common response.

Question 8 (h)

Candidates were asked how the interaction of microbial and other factors could lead to IBD. Candidates expressed ideas about the release of histamine and how it caused an inflammatory response extremely well. A few candidates tried to explain how bacterial action or products could impact the gut.

(h) Explain how the interaction of microbial and other factors could result in gastrointestinal inflammation such as IBD (Box 2).

(3)

mucosal layer of the
microbes infect the gastrointestinal tract ~~cau~~ causing the immune response. Damage to the tissue by these microbes causes increased blood flow to the site ~~sight~~ of infection. (*)1 The blood contains macrophages which perform phagocytosis to destroy the microbes. ~~The infection results~~ leading to inflammation. (*)2
(*)1 This is because microbes cause a release of histamines which cause vasodilation of blood vessels.
(*)2 This narrows the GIT causing IBD.

(Total for Question 8 = 20 marks)

ResultsPlus
Examiner Comments

This is a response that was awarded the full 3 marks. The candidate has related infection by microbes leading to release of histamine and subsequent vasodilation.

(h) Explain how the interaction of microbial and other factors could result in gastrointestinal inflammation such as IBD (Box 2).

(3)

Conditions such as Crohn's disease and ulcerative colitis may damage the gut flora.* As a result, it becomes weaker and less successful at fighting off pathogenic microorganisms. Because of this, there is competition for resources with the microbes being more successful at competing. The microbes infect the gut, initiating an immune response, resulting in inflammation of the gastrointestinal tract.

*or make it less effective.

ResultsPlus
Examiner Comments

This is a response that was awarded 1 mark. The candidate has not referenced infection by pathogen to an immune response as this is not in the context of microbial toxins or chemicals released by the pathogen.

Paper Summary

Following the performance from this series, the following are a few suggestions for improving candidate performance:

- Candidates need to have time to study the articles in depth.
- Candidates need to refer to the command word used in the question and focus their response in an appropriate manner. Appendix 7 in the specification lists all the command words and their meanings. This is particularly true for differentiating between 'describe', 'explain' and 'comment' command words.
- In graphs, care needs to be taken with axes and scales.
- In the levels-based question, the resource material needs to be the focus together with candidates own knowledge and understanding.
- In calculations, it is better to show the workings as well as the answer. If the answer is incorrect some credit may be gained by the workings.
- The interconversion of units needs to be practised.

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

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