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Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Biology (WBI15)
Paper 01: Respiration, Internal Environment,
Coordination and Gene Technology

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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.

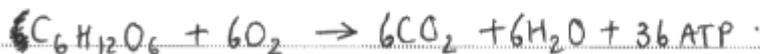
Question 1(b)

This question required students to write a balance equation for the complete oxidation of glucose. Students needed to write the correct formulae for the components and then balance the equation. The commonest error was the formula for glucose e.g. $C_6H_{12}O_2$. With balancing the equation many students put a 6 in front of the glucose formula e.g. $6 C_6H_{12}O_6$.

Leeway was given in the writing of the compounds - so CO_2 was accepted. However care must be taken to ensure that the arrow is going in the right direction.

(b) Write a **balanced** equation for the complete oxidation of glucose in aerobic respiration.

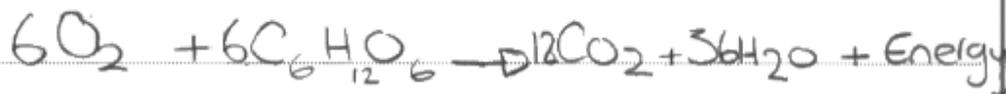
(2)



2

(b) Write a **balanced** equation for the complete oxidation of glucose in aerobic respiration.

(2)



1

Question 1(c)(ii)

This question required students to calculate the percentage of energy in the lipid molecule that could be converted to energy in ATP. The answer was required to three significant figures.

The majority of student calculated the percentage correctly and gave the answer to the required three significant figures. However 30.40% was seen sufficiently to remind student to look carefully as to how the answer needs to be presented.

Most candidates were able to calculate the energy in ATP using the data in the question.

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

(2)

$$122 \times 30.51 = 3722.22 \text{ KJ}$$

$$\frac{3722.22}{12244} \times 100 = 30.4 \%$$

Answer 30.4 % 2

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

(2)

$$122 \times 30.51 = 3722.22$$

$$12244 - 3722.22 = 8521.78 \text{ KJ}$$

$$\% = \frac{8521.78}{12244} \times 100 = 69.6 \%$$

Answer 69.6 %

1

Give your answer to three significant figures.

(2)

$$122 \times 30.51 = 3722.22 \text{ kJ}$$

∴ % of energy converted from that liquid

$$= \frac{3722.22}{12244} \times 100 = 30.39 \%$$

Answer 30.39 %

(Total for Question 1 = 6 marks)

1

Question 2(a)(ii)

This question required students to explain what happens during the repolarisation of a neurone. Students showed a clear knowledge of the events that occur during an action potential. Most correctly stated that the sodium ion channels close, and that potassium gated channels opened. However several got the direction of movement of the potassium ions wrong - moving into the neurone. The majority gave a correct statement about the inside of the axon becoming negatively charged (-70mV was often stated)

(ii) Explain what happens during repolarisation in a neurone.

(3)

The voltage gated Na^+ channels close and the voltage gated K^+ ions open, leading to an efflux of the K^+ outside, leading to decrease in membrane potential ~~as~~ from +30mV to -70mV. as there are more positive ions outside than inside.

3

(ii) Explain what happens during repolarisation in a neurone.

(3)

1. Sodium channels closed while potassium channel open;
2. K^+ ions flow into ~~the~~, so the electro potential start to decrease;
3. The electric potential decrease ~~at~~ until less than normal potential, potassium channel closed.

1

Question 2(b)(i)

This question required students to calculate the magnification of the sciatic nerve. Most students measured the size of the scale bar and then proceeded to calculate the magnification. A degree of tolerance was accepted in the measurement. The actual size was 9.5mm (a range of 9 - 10mm was allowed.) It is pleasing to note that candidates are manipulating equations more effectively and coming up with the expected answers. However they still must put the answers in the required format - in this case standard form. Several gave the answer as 200x and a few even gave units e.g. 200 μm . This was not creditworthy.

(i) Calculate the magnification of this photograph.

Give your answer in standard form.

$$1 \text{ cm} = 10 \text{ mm}$$

$$10 \text{ mm} = 10,000 \mu\text{m} \quad (2)$$



$$1 \text{ cm} \approx 50 \mu\text{m}$$

$$\frac{10000}{50} = 200$$

Answer 2×10^2

2

(i) Calculate the magnification of this photograph.

Give your answer in standard form.



$$M = \frac{D}{A} = \frac{10,000}{50} = 200x \quad (2)$$

$1\text{cm} \times 10 = 10\text{mm} \times 1000 = 10,000\mu\text{m}$

Answer 200x

1

(i) Calculate the magnification of this photograph.

Give your answer in standard form.

$8.4\text{cm} = 84\text{mm} = 84000\mu\text{m} \quad (2)$

$$\frac{50.0\mu\text{m}}{8400\mu\text{m}} = 5.95 \times 10^{-3}$$

Answer 5.95×10^{-3}

0

Question 2(b)(ii)

This question required students to name the type of microscope that would be used to obtain the image of the sciatic nerve. Given that the calculated magnification was 200x it was expected that students would name the light microscope as the correct type. However a significant number suggested the electron microscope was the type.

As the term microscope was in the stem of the question 'light' on its own was acceptable. As was the rarely seen 'optical microscope'

(ii) Name a type of microscope that would be used to obtain this image.

(1)

light microscope

1

(ii) Name a type of microscope that would be used to obtain this image.

(1)

electron microscope

0

(ii) Name a type of microscope that would be used to obtain this image.

(1)

Optical microscope.

1

Question 2(b)(iii)

This question required students to explain how myelinated neurones enable a greater speed of transmission in a neurone. It was pleasing to see that a significant number of students achieved full marks here. Students needed to make it clear that it was the myelin that acted as an insulator rather than just stating the myelinated neurone was the insulator.

(iii) Explain how myelinated neurones enable a greater speed of transmission in a neurone.

(3)

Myelin sheath covers axon and acts as an insulator. Action potential only occurs at ~~nodes~~ nodes of Ranvier. Impulse jumps from node to node in saltatory conduction so faster speed of ~~more~~ impulse transmission in myelinated than non-myelinated axon.

3

(iii) Explain how myelinated neurones enable a greater speed of transmission in a neurone.

(3)

Myelinated neurones are involved in saltatory [✓] conduction so instead of the impulse moving through the entire neurone the impulse will jump between the myelins making the movement of the impulse ~~throughout~~ faster. This is called saltatory conduction.

1

(iii) Explain how myelinated neurones enable a greater speed of transmission in a neurone.

(3)

~~Myelin~~ myelin cover the axon act as electrical insulator. ✓

~~The~~ myelinated neurone has gap on it called node of Ranvier where the action potential occur. ✓

The neurone "Jump" from one node to next ~~node~~ to transmit impulse, which is called ~~saltatory~~ saltatory conduction.

2

Question 3(a)(ii)

This question required students to describe the structures that a nerve impulse would travel through from the skin to the central nervous system. Many students tried to explain how the nerve impulse was initiated rather than going into detail about the structures. Detail was only required up to the central nervous system so reference to motor neurones and effectors gained no credit.

(ii) A reflex arc carries a nerve impulse from receptors in the skin to the central nervous system in a human.

Describe the structures that a nerve impulse passes through from the skin to the central nervous system.

(3)

The nerve impulse is transmitted from skin receptors to sensory neurone. Sensory neurone ^{→ in dorsal ganglia} generates the nerve impulse to the relay neurone in the grey matter of CNS.

3

- (ii) A reflex arc carries a nerve impulse from receptors in the skin to the central nervous system in a human.

Describe the structures that a nerve impulse passes through from the skin to the central nervous system.

(3)

- The receptors in the skin detect any stimuli
- The sensory neurones transmit nerve impulses through sensory neurones, through the relay neurone which is in the grey matter (of brain), sensory neurones have a cell body in between of the axon (intermediate) with dendrites extending.

3

- (ii) A reflex arc carries a nerve impulse from receptors in the skin to the central nervous system in a human.

Describe the structures that a nerve impulse passes through from the skin to the central nervous system.

(3)

- by Sensory neurones which is myelinated.
- as it has long dendron relatively to motor neurone.
- cell body at side of neuron at axon and it is located in spinal cord (Central nervous system)
- it has short axon need for an impulse to move
- at end it has synaptic knobs to synapse with relay or motor neuron.

1

Question 3(b)(i)

This question required students to read figures from the graph and calculate the percentage difference between the number of roundworms that changed direction. Students were given the equation to calculate percentage difference. A significant majority of students did this correctly.

- (i) Calculate the percentage difference between the number of roundworms in group 1 and group 2 that changed direction 30 minutes after habituation.

Use the equation:

$$\text{percentage difference} = \frac{\text{difference between two values}}{\text{mean of the two values}} \times 100$$

$$\frac{20-12}{16} \times 100 \quad \text{mean: } \frac{20+12}{2} = 16$$

Answer 50 %

- (i) Calculate the percentage difference between the number of roundworms in group 1 and group 2 that changed direction 30 minutes after habituation.

Use the equation:

$$\text{percentage difference} = \frac{\text{difference between two values}}{\text{mean of the two values}} \times 100$$

$$= \frac{20-12}{\frac{20-12}{2}} \times 100 \quad (2)$$
$$= \underline{\underline{200\%}}$$

Answer 200 %

Question 3(b)(ii)

This question required students to describe three conclusions that could be made from the experimental results about recovery times after habituation. This question expected students to analyse the information provided and then comment on the results of the investigation.

This question proved to be a very good differentiator and the full range of marks was seen.

Some students misinterpreted the given information confusing the terms recovery and habituation in their responses and as such gave incorrect details for the groups 1 and 3. Few students commented on the relative steepness of the graph before 10 minutes and after 10 minutes to 30 minutes.

(ii) Describe **three** conclusions about recovery times after habituation. (3)

- 1) The group ~~with~~ which had ^{the} least time interval between the taps ~~with~~ had the most number of roundworms changing direction ^{at all times after} ~~at~~ ^{0-5 minutes.} ✓
- 2) As the time after habituation increased, the number of roundworms changing ^{direction} ~~direction~~ increased ~~and~~ ✓
- 3) At 0.5 minutes after habituation ~~the~~ no roundworm changed direction so it means recovery time starts after 0.5 minutes. ✓

3

(ii) Describe **three** conclusions about recovery times after habituation. (3)

most roundworms changing direction are from group 1 [✓] ~~and~~ at least one from group 3. as all roundworms ~~change~~ change direction most from 0-10 mins than less no. of roundworms change direction / constant for all groups. recovery time of group 1 fastest and group 3 slowest. as group 2 become more habituated than 1 group.

Question 4(a)(ii)

This question required students to comment on the extent to which the evidence supported the statement. This question expected students to analyse the information provided and then comment on them relative to the statement 'nociceptors are better than thermoreceptors at preventing serious damage to tissues at high temperatures'

This question also proved to be a very good differentiator and the full range of marks was seen.

Students are getting much better at making relevant comments on the methodology.

However care needs to be taken when using numbers from the graph that they are accurate. In several cases they were not and as such the mark was not obtained. eg. the number of action potentials from thermoreceptors stay constant after 42.C

(ii) Nociceptors are better than thermoreceptors at preventing serious damage to tissues at high temperatures.

Comment on the extent to which the results of this investigation support this statement.

(4)

graph shows that thermoreceptors generate action potentials from 34°C to 44°C then ^{number of action potentials} levels off onwards, ^{until below} where nociceptors do not generate any action potentials from 42°C. ¹ But increase in the number of action potentials is steeper ⁴ for nociceptors from 42°C onwards. ~~And number of~~ So nociceptors are more sensitive to higher temperatures than thermoreceptors so statement is correct. Also number of action potentials generated by nociceptors is greater than that of thermoreceptors ~~at~~ at temperatures higher than 45.6°C. ¹

4

Comment on the extent to which the results of this investigation support this statement.

(4)

Thermoreceptors ~~do~~ respond with a lower amount of action potentials than noci receptors at temperatures ¹ over 46°C. While noci receptors ~~do~~ not respond to any temperatures below 42° with an action potential, their response rapidly increases ~~from~~ from 42° on. At 46° noci receptors respond with 15 action potentials per second, whereas thermo receptors only respond with 13. From then on thermoreceptors maintain a response of ² 13 action potentials /s, whereas noci receptors ~~are~~ still increase their action potentials ^{in the graph} per second, the highest amount of action potentials being 37 action potentials per second at 50.4°C.

2

Question 4(a)(ii)

This question required students to explain the results of the investigation using nicotine. This question expected students to analyse the information provided and then explain on the results of the investigation.

This question proved to be a very good differentiator and the full range of marks was seen.

There were some very clear responses describing the results and then explaining why it happened. Some students merely described the results with no explanation. Others were not clear what nicotine did and how it worked often suggesting that nicotine acted as a neurotransmitter.

Explain the results of this investigation.

Use your own knowledge and the results in the graph to support your answer.

(4)

before nicotine was given, all groups had about same number of action potentials in postsynaptic neurone.

Nicotine / group A increased number of action potentials in ~~post~~ postsynaptic neurone as it mimics acetylcholine, binds to receptor molecules and depolarise post synaptic membrane

Group C showed no change in number of action potentials since there is no acetylcholine receptor for nicotine to bind to, hence it will remain in synaptic cleft and broken down by enzymes and taken to presynaptic neurone.

So no depolarisation or action potential in post synaptic neurone

Group B acted as a control group for comparison

4

Explain the results of this investigation.

Use your own knowledge and the results in the graph to support your answer.

(4)

- nicotine mimicks acetyl cholin and binds to its receptors.
- group B were not given nicotine so no stimulus were sent triggering action potentials
- group C do not produce acetyl choline receptors so such nicotine has no place to bind so it does not trigger ^{more} action potentials
- group A were given nicotine and have acetyl choline receptors so the nicotine will bind and continuously trigger action potentials.

2

Question 5(a)

This question required students to explain how active genes could be identified. Most students were aware of microarrays but were less clear about how they are used. Students need to more specific when referring to fluorescent / fluorescence as to gain the mark reference was needs to fluorescent tags/ labels/ probes.

5 Small variations in DNA sequences and activation of genes can explain why individuals respond differently to diseases and the drugs used to treat them.

(a) Describe how active genes could be identified.

(2)

Using microarrays. When an array dish is prepared with DNA probes known as cDNA which is complementary to the DNA sequence we are using, they ~~are~~ both join and are washed and fluorescented to be able to view it, the check ~~the gene~~ the whole genome ~~is~~ active gene by checking which genes are expressed/transcribed/turned on. Using bioinformatics we can ^{check} ~~compare~~ whole genomes and compare the disease gene with normal.

2

(a) Describe how active genes could be identified.

(2)

genes have to be extracted and isolated
using microarray technique identifies these genes
then bioinformatics can be used to analyse them

Question 5(c)(i)

This question required students to explain why these changes in the chromosomes of the individual would lead to Prader Willi syndrome. This proved a challenge to many students as both reference to the maternal and paternal chromosome was required to fully explain the outcome. It is clear that students have some awareness of methylation but often details are lacking especially where the methyl groups are added on the DNA.

(i) Explain why these changes in the chromosome of this individual would cause Prader-Willi syndrome.

(3)

deletion mutation in chromosome of father involves removal of some DNA bases thus causing change in all the DNA base sequences (frame shift backwards) which will be transcribed and translated to different amino acid sequence causing different non functional proteins.

DNA methylation for mother silences (switches off gene) where methyl group added to DNA blocks and prevents binding of RNA polymerase so the genes in this mother chromosome cannot be transcribed producing mRNA or translated too so for both homologous chromosomes the genes cannot be translated to functional proteins.

(i) Explain why these changes in the chromosome of this individual would cause Prader-Willi syndrome.

(3)

genetic deletions will cause certain bases to not be present so a different protein would be formed through their translation, DNA methylation will deactivate certain genes on the DNA sequence resulting in a different protein being formed. These different proteins will be unable to perform the functions the normal protein is supposed to perform.

2

Question 5(c)(ii)

This question required students to describe how HGH could be produced using E coli bacteria. In recent sessions similar questions have appeared and it is clear that many students have used past papers and mark schemes. However it is crucial that responses are applied to the specific situation given in the question as a generic response eg. not mentioning HGH will not attain full marks.

Generally this question was well done.

Describe how *Escherichia coli* bacteria can be used to produce human growth hormone.

(4)

By genetic engineering
isolate gene for production of HGH from pituitary glands cells,
cut using restriction ^{endonuclease} enzymes forming sticky ends.
Extract plasmid which will act as vector from E. coli bacterial cells and cut part of it using the same restriction endonuclease forming ^{complementary} sticky ends. Insert isolated gene for HGH into plasmid (vector) by joining complementary sticky ends using DNA ligase, then E. coli bacterial cells would take up plasmids (vector) by heat shock inside them, so that gene for HGH is transcribed and translated producing HGH.
Culture E. coli in large fermentors and extract pure HGH produced by them.

4

Describe how *Escherichia coli* bacteria can be used to produce human growth hormone.

(4)

Firstly obtain a sample of human DNA and using restriction enzymes cut the gene responsible for insulin production, then using the same restriction enzymes cut a piece from the plasmid of the bacteria then using DNA ligase combine the insulin gene to the plasmid, then by the use of a micro injection implant the insulin plasmid to the bacteria and allow to reproduce and produce insulin.

3

Question 6(a)(i)

This question required students to name the type of muscle fibre being used in the leg muscles of a sprinter. Most students correctly identified the fibre. We also would have accepted correct alternatives to fast twitch e.g. type 2 / type II / type Ila / type IIb / type IIx.

(a) (i) Name the main type of muscle fibre that is being used in the leg muscles of a sprinter.

(1)

~~Fast slow~~ Fast twitch fibres.

1

(a) (i) Name the main type of muscle fibre that is being used in the leg muscles of a sprinter.

(1)

~~twitch~~ twitch muscle.

0

(a) (i) Name the main type of muscle fibre that is being used in the leg muscles of a sprinter.

(1)

actin and/or myosin

Question 6(a)(ii)

This question required students to describe what happens to the lactate at the end of a sprint race. Most students gave a clear account of the stages and events. We accepted 'linked' for link reaction. Some students went down the 'oxygen debt' route and went into detail about breathing and oxygen being used to remove the lactate.

Describe what happens to the lactate at the end of the race. (3)

The lactate is carried by ~~the~~ blood to the Liver where it is oxidised to pyruvate, this pyruvate would either diffuse into the mitochondrial matrix to continue krebs cycle and link reaction or it will be ~~stored~~ stored in the liver as pyruvate.

3

Describe what happens to the lactate at the end of the race. (3)

Lactate is a product of anaerobic respiration. Because when runners run, they use up the ^{ATP} oxygen available. So the ^{amount of} oxygen ATP made is not sufficient, as more is being used. Lactate provides ATP so after race, ADP and P_i join back and lactate is dissolved into the muscle tissue.

0

Question 6(c)(ii)

This was the only level-based question on this paper.

Students were given information regarding athletes and non athletes. Comparing various aspects including heart rate oxygen usage and the power generated with oxygen usage.

Most students came up with relevant responses.

Students usually achieved level 1 by giving correct statement from the information in the table or graph together with an attempt at an explanation. An example:

Discuss the differences in the results for the athletes and non-athletes in these two investigations.

Use your knowledge and information in the table and graph to support and explain your answer.

(6)

From the two investigations the graph results show a positive correlation as the table shows more of a decrease towards heart rate but increase in oxygen usage. As non athletes are more have higher heart rates in both investigations and their oxygen consumption is higher. For athletes their oxygen usage are controlled to a certain amount as they use a lesser amount of power during the exercise. This shows that athletes have controlled and adapted to consume oxygen when the duration of exercise as they consume energy and power for a longer duration.

Students usually achieved level 2 by either giving two correct statements from the table and graph together with a biological valid reason for each statement, or two statements and a comment about the methodology. An example:

Use your knowledge and information in the table and graph to support and explain your answer.

(6)

Non-athletes had greater resting heart rate and peak heart rate but less O_2 used in both conditions than athletes. standard deviation is not given so cannot tell if the difference is significant and same number of individuals for both groups not used so data in table may not be valid.

In graph, power generated generally increased as O_2 consumption increased in both groups. But athletes has more power generated than nonathletes. The data is scattered and there are no error bars so data seems unreliable.

Level 3 was awarded when students gave a clear, coherent and detailed response using both the table and graph. Biological detail on cardiac / respiratory system or muscles or biochemistry was expected to be correct and in detail. An example:

athletes have greater resting heart rate than non athletes with difference 5 bpm, and greater peak heart rate than non athletes with difference 6 bpm, and greater maximum volume of O_2 used in anaerobic conditions with difference $15 \text{ cm}^3 \text{ kg}^{-1} \text{ minute}^{-1}$ and greater maximum volume of O_2 used under aerobic conditions with the greatest difference between athletes and non athletes $18 \text{ cm}^3 \text{ kg}^{-1} \text{ min}^{-1}$.

because athletes have stronger ^{cardiac} heart muscle that pumps blood more forcefully so have greater stroke volume and hence less resting and peak heart rate, they also have greater lung capacity so more O_2 can be carried in blood during aerobic conditions and used, and more myofibrils storing more O_2 during rest aerobic conditions than non athletes, and also more slow twitch muscle fibres using more O_2 .

Graph shows as power generated by muscle increases, oxygen used increases (positive correlation) ^{for both} between athletes and non athletes, because more force requires more muscle contraction, that require more ATP so more aerobic respiration needed to meet ^{energy} requirements, so more O_2 used in aerobic respiration as last electron acceptor in ETC to produce more ATP by oxidative phosphorylation. Graph shows athletes have greater power generated and greater O_2 used than non athletes. (Total for Question 6 = 12 marks)

6

Non-athletes are not able to generate more than 3.8 W kg^{-1} as their maximum volume of oxygen used is around 50. Athletes however can generate maximum 5 W kg^{-1} as they are able to use more bigger volumes of oxygen. So on average non-athletes generate more power and use more oxygen than non-athletes. The reason why non athletes have a lower usage of oxygen than athletes is because athletes have a larger lung capacity ^(therefore a larger diffusion surface area), ~~a bigger~~ so more air (oxygen) is being diffused into the blood and muscles. Aerobic conditions last longer than ~~or~~ in non-athletes. Athletes have bigger hearts so a larger volume of oxidised blood is pumped around the body. It is proven because non-athletes have a higher resting heart rate and peak heart rate than athletes. This means that (Total for Question 6 = 12 marks)

5

Question 6(a)(ii)

This question required students to explain how the temperature of the kangaroo rat was kept within a particular range during exercise. Most candidates were aware of thermoreceptors and the effect of the hypothalamus / thermoregulatory centre. Many students suggested how the temperature was maintained eg. more sweat produced without adding how the effectors were stimulated. Signals and messages were not acceptable alternatives for impulses.

(4)

During exercise the body temperature increases. This increase in ^{core} body temperature is detected by thermoreceptors in the skin which send nerve impulses to the thermoregulatory center in the medulla oblongata which responds by sending more impulses to the ~~ass~~ superficial arterioles causing them to vasodilate so causing loss of heat energy by radiation. The hair erector muscles relax causing the hair strands to lie, so no air trapped, as air is an insulator of heat. Increased panting to lose more heat energy also takes place. This keeps the body temperature regulated between 38.5°C and 40°C by negative feedback mechanism.

4

Explain how the body temperature can be regulated to stay between 38.5°C and 40°C .

(4)

- ~~- ~~Some~~ ~~Some~~ thermoreceptors in the brain detect the change in temperature of the body and so send signals to the effectors to cause changes such as retaining water ~~by~~ ~~vasodilation~~ ~~or~~ ~~vasodilation~~.~~
- Thermoreceptors in the brain detect the changes in temperature of the body, so send signals to effectors to reduce the change, this can be done in many ways such as water retention and vasodilation.

1

Question 7(b)

This question required students to suggest how kangaroo rats are adapted to survive in areas with little drinking water and dry seeds. Students described clearly how water was conserved and the resultant production of concentrated urine. A few students got lower water potential or solute concentrations the wrong way round. A few candidates described behavioural adaptation which were creditworthy.

Suggest how kangaroo rats are adapted to survive in areas with little drinking water and dry seeds.

(3)

Kidney nephrons of kangaroos have very long loops of Henle, allowing more (maximum) water reabsorption from filtrate back to blood, and production of very little concentrated urine so minimising water loss in urine.

Also medullary tissue in kangaroos may have very high concentration of solutes (e.g. Na^+ and Cl^- ions) thus drawing maximum (greater) amount of water from filtrate to ~~blood~~ ^{by osmosis} tissue to be reabsorbed into blood back.

So water/osmotic potential of blood remains ^{constant} as high as possible.

3

Suggest how kangaroo rats are adapted to survive in areas with little drinking water and dry seeds.

(3)

Kangaroo rats have greater loop of Henle. Low blood water potential is detected by osmoreceptors which send impulse to hypothalamus which causes posterior pituitary gland to release ADH whose target receptors are on collecting duct. ADH binds to receptors on vesicles in collecting duct and causes signalling cascade which allows more water to be reabsorbed by collecting duct.

1

Question 7(c)(i)

This question required students to calculate the difference in urine output by the kangaroo rat and human. The answer needed to be in standard form. Acceptable units were cm^3 or dm^3 . However many students did not add units. As a general rule if there are no units provided at the end of the answer line students need to ensure units are added. Again several students did not present the answer in the correct format.

(i) Calculate the difference in urine produced over seven days by the kangaroo rat and by the human.
Give your answer in standard form.

Handwritten work:
 $0.45 \xrightarrow{\text{cm}^3 \text{ urine in rats}} 0.45 \times 7 = 3.15 \text{ cm}^3$ (2)
~~0.45~~
 $1500 \text{ urine in humans} \rightarrow 1500 \times 7 = 10500 \text{ cm}^3$
~~1500~~
 $10500 - 3.15 = 10496.85$
 Answer $1.05 \times 10^4 \text{ cm}^3$

2

(i) Calculate the difference in urine produced over seven days by the kangaroo rat and by the human.
Give your answer in standard form.

Handwritten work:
 Kangaroo rat $\rightarrow 0.45 \times 7 = 3.15 \text{ cm}^3$ (2)
~~0.45~~
 human $\rightarrow 1500 \times 7 = 10500 \text{ cm}^3$
 $10500 - 3.15 = 10496.85 \text{ cm}^3$
 $= 1.05 \times 10^4$
 Answer 1.05×10^4

1

Give your answer in standard form.

Handwritten work:
 KR - 0.45
 H - 1500
 $0.45 \times 7 = 3.15 \text{ cm}^3$ (2)
 $1500 \times 7 = 10500 \text{ cm}^3$
~~1500~~
 $10500 - 3.15 = 10496.85$
 Answer

1

Question 7(c)(ii)

This question required students to compare the water balance of the kangaroo rat and human which was given in pie charts and numbers. Students were credited with appropriate answers if they use the proportions or the actual figures. Basically what was required was a comparison with a clear statement about the reason. Some students detailed many comparisons from the data without giving any reasons.

Use your knowledge and information in the diagram to support and explain your answer.

(4)

Humans gain most water through liquids, kangaroo rats don't at all because humans and kangaroo rats live in different climates. Kangaroo rats live in deserts where no/little water is available. Kangaroo rats gain most water from metabolism and humans gain the least from metabolism because kangaroo rats ^{have to} conserve more. *Water loss in kangaroo rats is the most from evaporation and least in humans. Because kangaroos have to keep their body temperature down as they live in hot climates and have to maintain temperature. Water is lost (Total for Question 7 = 13 marks)

the most in urine in humans as there is an excess amount of water so it's not reabsorbed. Kangaroos don't have excess water so very little is lost in urine.

Use your knowledge and information in the diagram to support and explain your answer.

(4)

a kangaroo rat will ~~use~~ ^{he} excrete highly concentrated urine to retain as much water as possible whereas a human will have more diluted urine. ~~kangaroo rats take in a bigger amount of water~~ kangaroos lose the main amount of water through evaporation which is used to cool down the body, whereas humans lose the main amount through urine. Desert ~~animals~~ ^{has} have more cortical nephrons than the kangaroo rat for water retention than humans

(Total for Question 7 = 13 marks)

2

Question 8(a)

This question required students to give a definition of the term sarcopenia. This was in the article. A significant proportion of students correctly identified the two components - muscle loss and aging.

(a) Give a definition for the term **sarcopenia** (paragraph 1).

(1)

is the involuntary loss of muscle mass, strength, function by aging

1

(a) Give a definition for the term **sarcopenia** (paragraph 1).

(1)

It is the involuntary loss of muscle mass, strength and function.

0

Question 8(b)

This question required students to explain how muscle cells are produced from stem cells. Students had a good knowledge of the stimulus and the activation of muscle cell genes. However although translation was often referred to, reference to synthesis of named proteins required by the muscle cells was missing. Often students stated that translation led to proteins which caused muscle cells to specialise which was not quite enough for a grade A response.

(b) Satellite cells are stem cells (paragraph 2).

Explain how a specialised cell such as a muscle cell is produced from a stem cell.
^{are undifferentiated, can self divide continuously differentiating to different types}
^{respond}
stem cells ⁽³⁾ are given a chemical stimulus or transcription factors or stimulus like damage to muscle cells and are stimulated to differentiate. Through differential gene expression, some genes are switched ^(activated) on while others are switched off. This is controlled by epigenetic modification and transcription factors, ~~acti~~ transcription can only happen at active genes producing active mRNA, which is translated to specific proteins that permanently modify the cell and determine their structure and function e.g. genes for actin and myosin production are switched on because ~~to~~ that these proteins ~~are~~ are needed in a specialised muscle cell.

3

Explain how a specialised cell such as a muscle cell is produced from a stem cell.

(3)

- Differential gene expression occurs, as there's a stimulus ~~the~~ (hormones, (eg. hormone, transcription factor, chemical) that reaches the cell causing epigenetic modification where addition of an acetyl group or methyl group ~~occurs~~ to the histone proteins occurs leading to switching on some genes and switching off other genes and only switched on genes' mRNA is transcribed and translated into specific proteins which cause permanent alteration to the cell, so the cell is ~~specialised~~ specialised.

2

Question 8(c)

This question required students to describe how less testosterone would lead to reduced muscle protein. Many responses merely referred to how testosterone led to muscle protein formation omitting reference to less either in testosterone or muscle protein. There were some very good answers here.

Describe how reduced production of testosterone in the male testes can result in reduced muscle protein (paragraph 5).

Testosterone produced in testes is absorbed into blood and carried by (a) blood to muscle cells. Testosterone enters the muscle cell and binds to a receptor inside cell forming testosterone-receptor complex. The testosterone receptor complex enters the nucleus and acts as a transcription factor. It binds to promoter region of the gene which codes for ~~muscle protein~~ muscle protein. The binding of the complex allows RNA polymerase to bind so more mRNA can be synthesised so more mRNA is translated at ribosomes to produce more muscle protein. If there is less testosterone produced from testes to muscle cell by blood so less testosterone will undergo above process so less protein is produced. Because less testosterone produced so less testosterone will be absorbed by blood and transported to muscle cell and form a ~~hormone~~ testosterone receptor complex. So less testosterone will enter the muscle cell and testosterone receptor complex will bind to promoter region of gene which makes muscle is involved in synthesis of muscle protein so less RNA polymerase will be able to bind so less mRNA produced so less mRNA translated at ribosomes so less muscle protein produced.

4

Describe how reduced production of testosterone in the male testes can result in reduced muscle protein (paragraph 5).

(4)
Testosterone increases muscle protein synthesis, muscle mass and strength. So a reduction of testosterone leads to less muscle protein as testosterone is a hormone. Which activates protein synthesis which is ^{transcription} translation and translation. When there is less translation, less amino acids are made therefore less proteins which decrease proteins in muscles and overall in the body.

1

Question 8(d)

This question required students to explain how negative feedback could maintain a system in narrow limits. Student responses could be generic or directly focused on one aspect eg. glucose concentration. However with either two aspects were required. Firstly detection by a receptor and it had to be the correct receptor if specific aspect named and how the effector is stimulated causing the counteracting change. Often student responses only had one aspect.

Explain how negative feedback can maintain a system within a narrow limit. (2)

Negative feedback is the mechanism in which a change in the variable ~~is~~ which caused it to get away from normal value is ~~is~~ brought back to normal value. This works by producing ^{an effect} ~~a change~~ that opposes the change in the variable. For example, if ~~temperature~~ ^{blood glucose concentration} ~~level~~ increases, so this is detected by the chemoreceptors and they send nerve impulse to pancreas to produce and release more insulin and insulin released causes ~~decrease~~ ^{in blood glucose concentration} decrease.

2

Explain how negative feedback can maintain a system within a narrow limit. (2)

Insulin helps decrease the concentration of glucose when it is high and glucagon helps increase the concentration of glucose when it is ~~low~~ low meaning the glucose ~~levels~~ will remain in a narrow limit and won't go higher or lower.

1

Question 8(e)

This question required students to suggest how insulin increases the uptake of glucose by muscle cells. A key element here is that insulin binds to receptors on the muscle cell membrane. Membrane was frequently missing in responses. Students also hedged their bets on the method of glucose uptake stating active transport and facilitated diffusion. In a list generally it is the first response that is taken.

(e) Suggest how insulin increases the uptake of glucose by muscle cells (paragraph 7).

(2)

Insulin ~~binds to~~ is released by pancreas. It travels in blood and is transported to ~~liver~~ ^{muscle cells.} It binds to a ^{specific} receptor on the muscle cell. ~~Insulin~~ ^{triggers} acts as a transcription factor and ~~causes~~ a series of chain reactions which result in production of a channel protein ~~in~~ inside muscle cell. The channel protein fuses with the membrane and provides a polar channel for glucose to ~~flow~~ enter. So glucose enters the muscle cell by facilitated diffusion.

2

(e) Suggest how insulin increases the uptake of glucose by muscle cells (paragraph 7).

(2)

Insulin binds to receptors on muscle cell membrane. This causes formation of 2nd messenger which acts as TIC. TIC binds to promoter region of certain gene activating it and switching genes on. This allows RNA polymerase to bind, increasing transcription causing mRNA to be formed. mRNA is then translated at ribosome forming proteins e.g. glucose channel proteins which bind to cell membrane surface, allowing diffusion of glucose into muscle cell down concentration gradient which increases uptake of glucose.

2

(e) Suggest how insulin increases the uptake of glucose by muscle cells (paragraph 7).

(2)

insulin hormone that binds of receptors on muscle cells forming TIC binds to promoter region of DNA activating genes to be transcribed and translated into proteins (channel proteins) leading to increased uptake of glucose.

1

Question 8(f)

This question required students to describe how CT scans could be used to measure increases in muscle size following aerobic exercise. There are two components here - firstly a description of how CT scans produce a cross sectional / 2D / 3D image and secondly a statement that the scan would be taken before and after the exercise and the muscle size compared. Several students mixed up CT scans with fMRI scans.

Describe how computed tomography (CT) scans can be used to measure these increases in muscle size in older individuals (paragraph 9).

(2)

x-rays from rotated source is emitted to the muscle cell, density of tissue determine amount of x-rays absorbed and used by computer model to produce 2D image.

1

Describe how computed tomography (CT) scans can be used to measure these increases in muscle size in older individuals (paragraph 9).

(2)

CT scans use X-rays to form a 2D image of the body, so it can be used to scan a muscle of the body such as leg muscles, then carry out aerobic exercise for a period of time (e.g. 2 months) carry out another CT scan and compare both.

Question 8(g)

This question required students to explain why aerobic exercise increases mitochondrial activity and density. Many students correctly linked more mitochondria to more ATP. However relatively few students linked the use of ATP to a particular function. A few students went into detail about division of mitochondria and the biochemistry of respiration within the mitochondria.

(g) Explain why aerobic exercise increases mitochondrial density and activity (paragraph 9).

(3)

During aerobic exercise there is an increase in muscle contraction so we require more ATP. So mitochondria is the site of aerobic respiration so when we do more muscle contraction ATP required increases as muscle contraction requires ATP. So the activity of mitochondria increase as aerobic respiration increase and mitochondria is site of aerobic respiration. And aerobic respiration produces ATP needed for muscle contraction. As there is an increased demand of ATP, so our body adapts by producing more mitochondria so more ATP can be produced so mitochondrial density increases.

(g) Explain why aerobic exercise increases mitochondrial density and activity (paragraph 9).

(3)

Aerobic exercise increases muscle protein synthesis which means more proteins and protein synthesis needs a lot of ATP so more protein synthesis, more ATP needed. Mitochondria produces ATP. So if more ATP needed this increases mitochondrial density and activity.

2

Question 8(h)

This question required students to explain why diets rich in whey and egg protein may not be ideal for the treatment of sarcopaenia. A key error here was stating that these proteins are non essential amino acids rather than they contain non essential amino acids. Many students clearly explained that these non essential amino acids could be converted into fats leading to an increased risk of cardiovascular disease.

Explain why diets rich in these proteins may not be ideal for the prolonged treatment of sarcopenia (paragraph 11).

(3)

Because these proteins provide an excessive amount of calories in the form of nonessential amino acids. This could lead to more fat gained than muscle in the long run. And fat leads to many health problems such as CVD.

3

Explain why diets rich in these proteins may not be ideal for the prolonged treatment of sarcopenia (paragraph 11).

(3)

Since nonessential amino acids don't appear to be necessary for acute stimulation of muscle protein anabolism in older people especially ~~protein~~ which means that the intake of amino acids (Protein monomers) will not cause a change so it will just be used.

1

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.
- in level based question the graph and table 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 cm^3 to dm^3
- instructions in calculations need to be followed eg. three significant figures two decimal places.
- finally writing needs to be clear - in a few cases it was extremely challenging to decipher key words in the answer.

