Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2022

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

The paper was the fifth cycle of the new specification and tested respiration, internal environment, coordination, and gene technology.
The scope of the questions provided a good opportunity for candidates to demonstrate their knowledge and understanding of these topics.
There was an equal balance between topics 7 and 8.
The questions on this paper yielded a very wide range of responses with some excellent answers given. This resulted in an excellent spread of marks, across the full range (range 13 – 77)
There were some parts of questions that were left blank particularly at the end showing some evidence that candidates might have had insufficient time to complete the paper. Many candidates tried at questions on the article which was the final question. However, there were more blank questions for the article possibly indicating the lack of time for detailed analysis and preparation of the article due to time and preparation constraints over the last two years.

There were some straightforward questions demanding recall that yielded high marks across the cohort and some more demanding questions that discriminated well. Multi choice questions were well answered and proved to be a good source of marks. There were many responses which were well articulated showing excellent use of biological technology in context. However, it is still evident that some candidates do not pay sufficient attention to the command word used in the question. This is particularly true of 'determine' questions where descriptions failed to gain the full marks.

Graphs relating to novel situations continue to be problematic for candidates. Many candidates did not refer to the data provided in the graphs and often failed to appreciate the units for axes of the graphs. Responses needing calculations were very varied. However there does seem to be an area that is improving as candidates become more aware of the nature and demands of this type of question. Clearly this has been a focus of both teaching and practice. Unit conversion and conversion to standard form still present problems to many candidates.

'Suggest' questions offered candidates the opportunity to show their knowledge and understanding from across the specification.
Questions which demanded analysis, explanation, and application of knowledge to unfamiliar contexts were seen to be more challenging to candidates and proved to be excellent for discrimination.
Many centres are clearly using our mark schemes and examiner reports to prepare candidates. This is particularly evident where similar mark points have appeared on previous papers. eg. Q7ai genetic modification. However, care must be taken not to just use the points from previous mark schemes without relating it to the context of the current question.

Q1 The multichoice questions did not present a problem.

Q1b The description of how chemiosmosis was involved in the synthesis of ATP was more of a challenge to candidates. Responses were often muddled and inexact. For mp1 details of how the proton gradient was set up was required. Also, there was some confusion between active and passive processes.

(b) Describe how chemiosmosis is involved in the synthesis of ATP.

(2)

Electrons from $NADPH_2$ are carried in the electron transport chain. ~~H^+ ions are pumped~~ H^+ ions are pumped ~~&~~ to the intermembranal space. ~~H^+~~ Energy is released when H^+ ions are pumped back into the mitochondrial matrix ~~by~~ through chemiosmotic channels. This energy is used to produce ATP from ADP and Pi by ATPase.

(b) Describe how chemiosmosis is involved in the synthesis of ATP.

(2)

⇒ H^+ ions carried into intermembrane space using energy produced from series of redox reactions where ~~a~~ electron is transferred from electron carrier to electron carrier.

⇒ More H^+ ~~inside~~ in the intermembrane space, so H^+ diffuses out into mitochondrial matrix down concentration & electrochemical gradient.

Q2a The multichoice questions here proved to be a good source of marks for candidates. They clearly knew muscles, tendons, and ligaments.

Q2bi In this question candidates need to explain how the knee joint could be held in this position whilst drinking. Candidates were clear about muscles working as antagonistic pairs. A few candidates did confuse the function of ligaments and tendons.

Some candidates tried to name the muscles involved but often focussed on biceps and triceps which did not gain credit.

(i) Explain how the knee joint can be held steady in this position as the giraffe drinks.

(2)

Bicep muscles relax and tricep muscles contract. The bones are ~~connect~~ joined to eachother using ligaments. Antagonistic pair of muscles work together to achieve steady position.

Q2bii Here candidates needed to describe the role of ATP in the sliding filament theory. Many candidates understood the sliding filament theory but got the order jumbled. In order to gain credit, the response needs to be in logical order.

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

(3)

ATP binds to myosin and detaches it from actin. Hydrolysis of ATP into ADP and inorganic phosphate energises the myosin head and return to its upright position. When ADP and Pi is released myosin head nods forward causing the ~~act~~actin to slide and muscle contraction occurs.

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

(3)

ATP binds to myosin heads. Hydrolysis of ATP into ADP and Pi energises the myosin head and makes the myosin head knock forward. Again, ~~AT~~ ATP binds to the myosin head and causes it to detach from actin, so that another contraction of the muscle can occur.

Q3ai The labelling of the relay neurone was not done well. Candidates rarely were able to name all four parts correctly. Some confusion between cell body and axon.

(a) (i) Complete the table by filling in the names of each labelled part.

(2)

Label	Part
L	dendrites
M	cell body
N	axon
O	axon terminals

Q3bi Surprisingly many candidates were not able to name the type of microscope used to get the image shown in the photograph. Often incorrect responses included electronic, electric, and electrical. A few candidates thought it was a transmission electron microscope and many gave light microscope as their response even though the magnification was given as x 3300.

Magnification × 3300

(i) State the type of microscope used to produce this image.

(1)

electron microscope

(Source: © Science Photo Library/Alamy Stock Photo)

Magnification × 3300

(i) State the type of microscope used to produce this image.

(1)

SEM

Magnification × 3300

(i) State the type of microscope used to produce this image.

(1)

Electronic microscope

Q3bii Many candidates measured the thickness X-Y accurately. (11mm). However, the conversion to μm proved to be more challenging. There is a clear need for candidates to practice unit conversions.

(ii) Calculate the thickness of the connective tissue layer between the points X and Y.

Give your answer in micrometres (μm). **(2)**

2 = real life
4 = image
2 = 2

1cm = 10mm
1m = 10

1.1 cm   11 mm
↓
11000 μm) ×10) ×1000) ×1000

A   M

$\frac{I}{M \times A}$ $\frac{I}{A} = m$

$\frac{11000}{3300}$ m = 3300

Answer 3.33 μm

(ii) Calculate the thickness of the connective tissue layer between the points X and Y.

Give your answer in micrometres (μm). **(2)**

cm 100 m

$M = \frac{\text{observed}}{\text{Actual}}$ 1.1cm

$3300 = \frac{0.011}{x}$

$x = 3.3 \times 10^{-6}$ m

=

Answer 3·33 μm

(ii) Calculate the thickness of the connective tissue layer between the points X and Y.

Give your answer in micrometres (μm).

(2)

x-y = 1cm · 10 mm · 100 nm = 1000μm

1000 x 3300

Answer 33 μm

Q3biii The majority of candidates could clearly explain why a myelinated neurone conducts an nerve impulse faster than a non-myelinated neurone of the same diameter. Many candidates achieved full marks here.

Explain why a myelinated neurone conducts an impulse faster than a non-myelinated neurone of the same diameter.

(3)

myelinated neurones are covered in a myelin sheat which acts insulating. more specifically the myelin sheats are arranged in schwann cells with not myelinated places between called node of ranvier. Thus the action potential jumps from one node to another and doesn't have to depolarise all parts of the neurone like the non-myelinated neurone has to, thus conducting impulses faster.

(Total for Question 3 = 9 marks)

Q4ai Most candidates were able to describe the relationships between the resting heart rate and the data shown in the table. Some weaker candidates merely repeated examples of the data provided in the table without describing any relationship.

(i) Describe the relationships between resting heart rate and the data shown in the table.

(2)

The higher the resting heart rate the lower the mean mass of the organism (correlation) The ~~highter~~ higher the resting heart rate the lower the mean resting metabolic rate (correlation)

(i) Describe the relationships between resting heart rate and the data shown in the table.

(2)

the resting heart rate is most high for humming bird, and, the lowest and least resting heart rate is for elephants. ~~th~~ the ~~the~~ least the resting heart rate has the highest mean ~~rate~~ metabolic rate. And the lower the resting heart rate has the lowest mean mass and mean resting metabolic rate.

Q4aii Another calculation question using the data from the table. Many candidates were able to calculate the volume of oxygen but did not give the answer in standard form.

(ii) Calculate the volume of oxygen produced each hour by a resting elephant with a mass of 4500 kg.

Give your answer in standard form.

(3)

~~5780~~ 1400 rate in 5780 kg

$\frac{70}{289}$ rate in 1kg

0.11×10^4 O_2 per hr^{-1}

$\frac{70}{289} \times 4500$

$= 1089.965398$

Answer 1.09×10^3

(ii) Calculate the volume of oxygen produced each hour by a resting elephant with a mass of 4500 kg.

Give your answer in standard form.

(3)

$dm^3 O_2$ / Mass x Time

5780 → 1400

4500 → x

$\frac{1089.96}{1} = \frac{x}{4500 \times 1}$

$\frac{6300000}{5780} = 1089.96$

Answer $1090\ dm^3$

(ii) Calculate the volume of oxygen produced each hour by a resting elephant with a mass of 4500 kg.

Give your answer in standard form.

(3)

$1400 \times 4500 = 6300000$

$= 6.3 \times 10^6$

Answer 6.3×10^6

Q4bi Most candidates could clearly explain how the heart rate of a cheetah can be increased to 250 bpm during a chase. Many candidates achieved full marks here. A significant number of responses contained references to signals / messages rather than impulses. Recent PE reports have highlighted this as no credit will be given.

(i) Explain how the heart rate of a cheetah can be increased during a chase.

(4)

During chase, muscles use up oxygen and remove CO_2. More amount of O_2 is required by body cells for aerobic respiration. CO_2 concentration in blood increases. ~~pH~~ This causes blood pH to decrease. Low blood pH is detected by chemoreceptors in medulla and carotid artery. Impulse is sent to ~~medulla~~ cardiovascular centre in brain. ~~Medulla~~ Brain sends impulse to ~~diaphragm~~ ~~cardiac muscle~~ SAN node to increase frequency of waves of depolarisation. This causes increased heart rate in cheetah.

(i) Explain how the heart rate of a cheetah can be increased during a chase.

(4)

~~to~~ During a chase ~~a~~ cheetah moves very faster. It would increase it's speed. Hence ~~there~~ the muscle contraction per second will increase than before so more blood is needed for the muscles, ~~which the~~ so muscles will get oxygen to respire. When this is detected by chemoreceptors impulses are sent to medulla oblongata. Medulla oblongata send impulses to the SAN node of heart therefore both atrium contract (blood goes to ventricles), SAN node send impulses to AVN node, and from AVN node to purkinje fibres through bundle of His so the ventricles contract. ~~so pass blood~~ ~~Hence~~ So the ~~heartrate~~ heart rate increases.

Q4bii A suggest question which gave candidates the opportunity to suggest reasons why the cheetah can only maintain a heart rate of 250 bpm for a short time. Only a few candidates referred to homeostatic mechanisms not occurring fast enough. The majority achieved full marks by referring to anaerobic respiration and the build-up of lactate.

(ii) Suggest why a cheetah can maintain this heart rate and speed for only a short period of time.

(2)

The oxygen gets eventually used up as heart cannot meet the demand of oxygen needed by muscles. So muscles start respiring anaerobically, producing lactic acid in muscles. Latic acid causes the muscle to be fatigue.

Q5bi In this calculation candidates had to calculate the difference in volume of water used in a day by the buffalo and camel. Candidates needed to give the answer in dm^3 and to two significant figures. Again, the conversion from $cm^3\ kg^{-1}\ day^{-1}$ to $dm^3\ kg^{-1}\ day^{-1}$ proved to be a significant

source of errors. Answers were either out by a factor of 10 or the answer was not given to two significant figures. A common response was 56.1

Give your answer in dm^3 to two significant figures.

(2)

~~150 − 57 = 93 $cm^3/kg \cdot d$ = 93 cm^3/kg~~

150 ≈ 100

57 ≈ 50

100 $cm^3/kg \cdot d$ = 150 $cm^3/kg \cdot d$

150 · 697 = 104550 cm^3

= 104.55 dm^3

57 · 850 = 48450 cm^3 = 48.45 dm^3

104.55 dm^3 − 48.45 dm^3 = 56.1 dm^3 ≈ 56 dm^3

Answer 56 dm^3

Q5bii This was a very open-ended question where candidates had to suggest two reasons why there was no correlation between water use and mean mass for the species listed in the data table. The weakest candidates mere repeated examples from the data table without commenting on the lack of correlation.

(ii) Suggest two reasons why there is no correlation between water use and mean mass for the species given in the table.

(2)

Because all of the animals live in different regions and so have a different water uptake method: Some (camel) might live in biomes where it's very hard to actually find and drink water so they have adaptations that ~~to~~ get them live with much less water consumption (like concentrated urine) than an animal which originally lives in another biome.

(ii) Suggest two reasons why there is no correlation between water use and mean mass for the species given in the table.

(2)

- Water use depends on the metabolic rate of the animal
- Water use depends on the enviornment the species live

Q5c A significant number of candidates did not read the question as they had to determine the type of water given on the mean mass of the kangaroo rat. This meant referring to fresh and sea water. The pattern in the graph was understood by most candidates. Only a very few used data from the graph to compare the effect of fresh and sea water.

Determine the effect of the type of water given on the mean mass of the kangaroo rats in this investigation.

Use the information in the graph to support your answer.

(3)

Both ~~Fresh~~ type of water slightly increases the mean mass of the kangaroo rats. Within the 16-day period the mass of kangaroo rats were increased ~~the~~ by 1 grams, when frew water was used. They increased their mass by 0.5 g when sea water used. So fresh water has greater effect on their mass. When no water is used, their mass drops by 5g.

Determine the effect of the type of water given on the mean mass of the kangaroo rats in this investigation.

Use the information in the graph to support your answer.

(3)

⇒ Fresh water and salt water both cause an overall increase in mass with fresh water having a greater effect.

⇒ Body mass increases by 1 gram for ~~Sa~~ fresh water and 0.3 g for salt water.

⇒ lack of water drastically decreases mean mass as kangaroo rats started at 120 kg, and ended with 115 kg ~~bec~~ without water.

Q5d Candidates have a better understanding of the mechanisms and structure of the kidney. Most candidates could explain how the nephrons in the kidneys of the kangaroo rat are able to produce very concentrated

urine. Many could clearly explain how an increase in ADH led to increased water reabsorption using aquaporins.

(d) The kangaroo rat's kidneys play an important role in the process of conserving water.

Explain how the nephrons (kidney tubules) in the kidneys of the kangaroo rat are able to produce very concentrated urine.

(2)

the nephrons have a ~~too~~ long loop of Henle, so more water is reabsorbed, they produce ~~less AD~~ more ADH so that more water is reabsorbed in distal tubule and collecting duct

Explain how the nephrons (kidney tubules) in the kidneys of the kangaroo ~~rat are~~ able to produce very concentrated urine.

(2)

- they have very long Loop of Henle to increase concentration of medullary fluid allowing for more reuptake of water in collecting duct by diffusion
- The collecting duct is containing many aquaporins for reabsorbtion of water
- ~~it~~ higher rate of reuptake in PCT and DCT

Q6b Most candidates explained how auxins produced a phototrophic response. The diagrams shown in the question helped candidates focus their explanations. The most common point missed was that plants bend towards light. Growth towards light was the preferred response in the mark scheme.

A phototropic response is the growth response by the shoot to the change direction of light. When the light is shone at an angle to the shoot, auxins are redistributed in such a way that it moves away from the light (left side) auxins (IAA) then diffuse down to the zone of elongation and binds to specific receptors, allowing hydrogen ions to be actively pumped into the primary cellwall of the cells on the left side of the shoot. This provides optimum pH for enzymes to break bonds between the cellulose microfibrils, making the cell wall flexible. Water moves into the cells by osmosis. The cell swells and elongates. The left side of the shoot elongate and so, the shoot bends towards the light. ~~The shoot is~~ this is the phototrophic response of shoot: ~~to change in direction of light~~

Auxin IAA has negative tropism, as it moves away from light when it is produced in the shoot. IAA is a growth factor which moves into cell nucleus and causes transcription initiation complexes at promoter region of gene to code for genes related to shoot growth. So transcription rate increases, more translation occurs and thus more proteins are made in the shoot, causing it to grow towards the sunlight. As IAA moves away from light, it stimulates growth on shaded part of shoot causing it to bend and grow towards sunlight. Uneven distribution of IAA causes uneven growth.

Q6c Gibberellins continue to be an area where candidate's knowledge is sketchy. Too many believed that it was the gibberellins that broke down the starch to glucose. This question is more about gene activation. The best candidates gave the full picture from gibberellin binding to a receptor, initiating the gene for amylase production resulting in the hydrolysis of starch to glucose. A few candidates did use amylose as the enzyme which did not gain any credit.

Explain how gibberellins can produce this effect on the seed.

(4)

Gibberellin is a transcription factor for production of enzyme amylase: When water enters a seed, seed becomes activated and release gibberellin. The gibberellin acts as transcription factor and forms transcription initiation complex with the gene responsible for production of amylase. The gene is then transcribed to mRNA and translated in ribosomes which results in amylase. Amylase then converts starch to maltose in presence of water. The more gibberellins released, the more amylase produced and the more starch hydrolyzed.

the embryo absorbs water by osmosis. This causes gibberellin to be released from the embryo. Gibberellin diffuses to the aleurone layer, where it acts as a transcription factor and bind to the promotor region of DNA along with DNA polymerase forming transcription initiation complex. The gene for amylase is switched on, and from this active gene an mRNA is transcribed which is translated to form the enzyme on the ribosome. The enzyme amylase hydrolyses starch into glucose. This glucose is used by the embryo in respiration to release energy ~~for~~ cell required for cell divisions and for germination.

Q6d Candidates were able to relate which concentrations were optimum for the IAA and NAA. However, many did not use the terms growth / number of cells. Consequently, some of the descriptions of the data was hard to interpret. Greater care is need in the use of terms like increase / decrease / frequency.

*Both auxins increase the number of cells between 24 to 72 hours compared to control.
*Most growth is by IAA is when the lowest concentration 0.1 Mmol dm^{-3} is used and least ~~concentration~~ growth is due to highest concentration, 10 µmol dm^{-3}.
*Most growth by NAA is when 1 Mmol dm^{-3} is used and least growth by using 0.1 Mmol dm^{-3}.
*Using IAA is more effective than using NAA according to graph.
*IAA needs to be used in low concentrations to maximise growth while NAA needs a moderate concentration.
*IAA cause most growth between 24-48 hours at all concentrations but NAA cause most growth between 48 and 72 hours at all concentrations.

Comment on the effect of these auxins on the growth of *Chlorella*.

(4)

→ In IAA the growth of chlorella is effected by auxin but the lower the concentration of the auxin the greater the growth. In a 72 hour time frame chlorella will grow to 21×10^6 per cm^3 (in control) in 10 µm mol dm^{-3} auxin IAA it will be 24×10^6 per cm^3 and at 0.1 µmol dm^{-3} it will be 33.5×10^6 per cm^3
⇒ In NAA 1 µmol dm^{-3} produces 26×10^6 per cm^3 of ~~cholerra~~ chlorella.
⇒ However 0.1 and 10 produces 22 and 23 $\times 10^6$ per cm^3 of chlorella respectively
⇒ It can be deduced that for NAA in chlorella a specific exact value of concentration will give satisfactory results

Q7ai There has been a question on genetic modification on several recent papers. Candidates have used previous mark schemes in their revision. However, candidates must use the context of the question in their answer. Correct reference to human for the rHE gene and the suitably named target cell of tissue in sheep was required. Too often responses were given in vague terms. Many stated that the rHE gene was isolated from the sheep.

Isolate the rHE ~~protein~~ gene by using restriction endonucleases - cut plasmid using same restriction endonuclease to get sticky ends. Add isolated gene into plasmid and seal using DNA ligase by forming phosphodiester bonds to get the recombinant plasmid. Insert plasmid into the zygote from a sheep using a micropippete. The genetically modified zygote is then placed in the udder of the sheep. The sheep ~~formed from~~ formed will produce rHE in their milk as this gene is present.

The gene that codes for rHE can be isolated by the use of restriction enzymes. The isolated gene must be inserted into a vector such as a virus. The virus must be inserted by injection into the udders of lactating sheep. You can repeat this process in many sheep and all their udders to have a greater supply of ~~RH~~ rHE.

Q7aii Most candidates were able to accurately calculate the percentage increase in the mean blood haemoglobin concentration as a result of the rHE treatment. As the calculation did not involve any conversion or a specific answer requirement e.g. standard form nearly all candidates got the mark here.

Q7aiii This question was not well answered. There were too many vague responses often sequentially inaccurate. Many could explain about the differentiation of plasma cells leading to the release of rHE antibodies.

Describe how these antibodies may be produced.

(4)

Macrophage identifies rHE as foreign antigen and engulfs it. It presents the antigen on its cell membrane. It forms APC to T helper cell. T helper cell releases cytokines and activates B cell. B cells differentiate into plasma cells which forms antibody for rHE antigen.

(4)

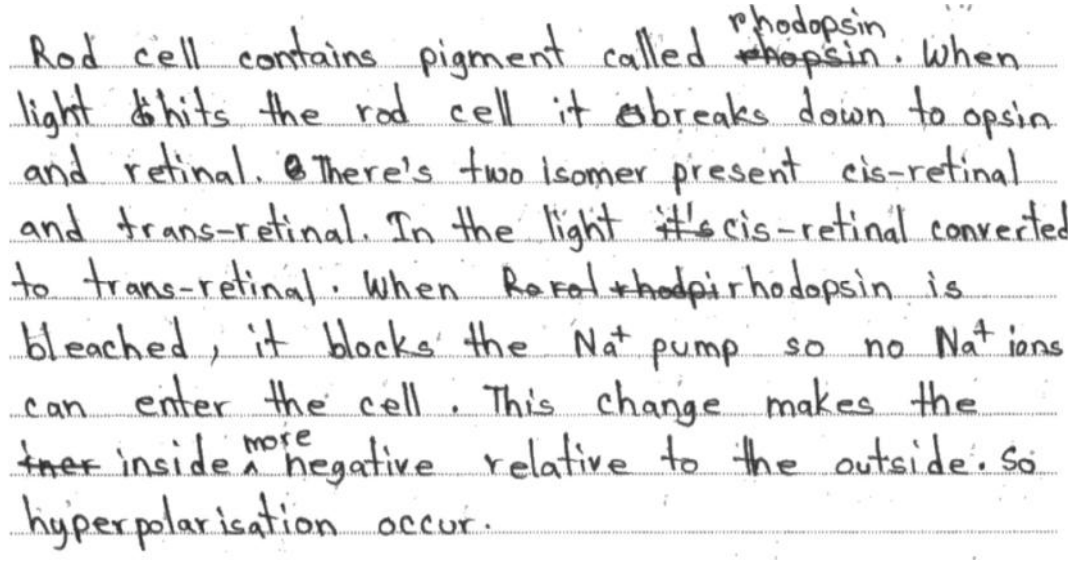
The ~~protein~~ rHE had ~~foreign~~ ~~recog~~ proteins on its body so was deduced as a foreign antigen by the immune system which then caused humoral response to occur where T-helper cells released cytokines after the CD4 receptors were bound to by the APC and thus B-cells differentiated into B-memory cells and plasma cells. The plasma cells produced specific antibodies for the rHE protein, causing opsonisation as defence.

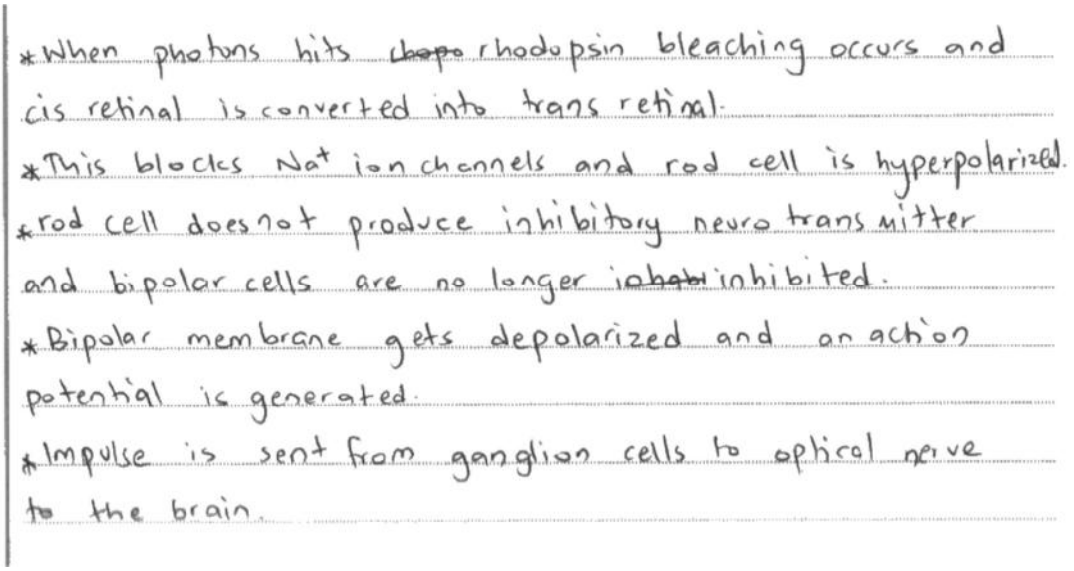
Q7b Candidates have been getting better at the level-based question over recent sessions. There were fewer 0 scores and more 5/6 marks. Candidates showed a good comprehension of the benefits and risks of genetic modification. However, many did not gain credit for comments about indicative content as they did not refer to either the graph or table. It clearly specifies in the question' use all the data and your own knowledge to support your answer'.

Question 8 was based on the article 'How we perceive the world' by Julius D and Patapoutian that candidates should have studied. Generally, the responses were very varied and clearly showed that some candidates had studied it in detail while others had not.

Q8a In this question candidates had to describe how light is detected in the eye by rod cells. This was well done by most candidates and achieved full marks. Their descriptions were full of appropriate. Some went too far as

the question is only about how light is detected in the rod cells. Details of transmission of an impulse through optic nerve to the brain was not required.


Rod cell contains pigment called ~~rhopsin~~ rhodopsin. When light hits the rod cell it breaks down to opsin and retinal. There's two isomer present cis-retinal and trans-retinal. In the light ~~it's~~ cis-retinal converted to trans-retinal. When ~~Ro rod + hodpi~~ rhodopsin is bleached, it blocks the Na^+ pump so no Na^+ ions can enter the cell. This change makes the ~~ner~~ inside more negative relative to the outside. So hyperpolarisation occur.


* When photons hits ~~chopo~~ rhodopsin bleaching occurs and cis retinal is converted into trans retinal.
* This blocks Na^+ ion channels and rod cell is hyperpolarized.
* rod cell does not produce inhibitory neuro transmitter and bipolar cells are no longer ~~inhabi~~ inhibited.
* Bipolar membrane gets depolarized and an action potential is generated.
* Impulse is sent from ganglion cells to optical nerve to the brain.

Q8b Suggest questions offer candidates to use their knowledge from other areas of the specification. Here candidates need to suggest how the genes expressed in a sensory neurone could be identified. Many knew the terms microarray and bioinformatics. However detailed understanding was largely absent. Very few candidates could explain the detail particularly about the use of fluorescent dyes. Many suggested the use of PCR but lacked details of the full process to gain more than one mark.

(b) Suggest how the genes expressed in a sensory neurone could be identified (paragraph 4).

(3)

The genes expressed can be identified using a microarray taken from sensory neurones. ~~using~~ using mRNA that is then reverse transcripted to form cDNA. Fluorescent labels can be added to observe the results of the expressed genes.

(b) Suggest how the genes expressed in a sensory neurone could be identified (paragraph 4).

(3)

which has thousands of spots ~~wit~~ which contain specific DNA sequences (cDNA probes) using microarrays. The mRNA is extracted and converted to ~~ed~~ cDNA ~~and~~ & by reverse transcriptase enzyme and applied to the microarray after giving a fluorescence label. Hybridisation occurs. The microarray is then scanned with UV light and the genes that are expressed ~~with~~ will show up.

when injected with rHE, the immune system may identify it as a ~~foreg~~ foreign substance. An immune response occurs where macrophages engulf the protein and present them to T helper cells. T helper cells release cytokine which activates B cells. B cells differentiate into plasma cells and then into antibodies.

Q8c A vast number of candidates could explain how capsaicin could activate nerve cells leading to a pain sensation. Explanations included capsaicin binding to a receptor leading to opening of ion channels resulting in depolarisation. However few candidates were able to explain the involvement of relay neurones in the transmission of the impulse to the brain where it is perceived as pain. Many candidates achieved full marks here.

(c) Explain how capsaicin could activate nerve cells causing a pain sensation (paragraph 4).

(3)

When the temperature reaches 40°, capsaicin binds to the receptors TRPV1 which results in TRPV1 protein to open, and Na^+ ions to ~~the nerve cell~~ enter the cells. Influx of sodium ions and threshold potential being reached results in an action potential to be generated, which results in a nerve impulse to be sent to the ~~sensory~~ brain by sensory neurone.

(3)

The capsaicin molecules have tertiary structure that's complementary to a binding site on the TRPV1 protein channel. The binding causes a shape change that allows Na^+ to ~~rapt~~ rapidly enter neuron, as the ligand gated channels are opened. This depolarises the neurone and if threshold potential reached, neurotransmitters released into synapse with relay neurons that pass on the impulse. The nerve cells have dendritic receptors complementary to shape of capsaicin, this allows their TRPV1 channels to open once bound. The released transmitters bind to complementary-shaped ligand-gated Na^+ channels on post-synaptic membrane.

8d Candidates generally responded well. Marks were mainly awarded for opening ion channels leading to an influx of ions resulting in a depolarisation. When students failed to gain marks, it was often because they were referring to signals / messages rather than impulses (still common in many similar responses regarding the nervous response).

(d) Explain how changes in ion channel protein can result in nerve impulses in the nervous system (paragraph 5).

(3)

The sodium channels open causing Na^+ to influx in to the nerve cell, making the inside less negative. So an action potential is generated as more Na^+ channels open. Ca^{2+} channels of presynaptic membranes also ensures this.

(3)

The ion-channel proteins regulate the amount of Na^+ ions entering the axon membrane. A conformational change in the channel protein, eg. due to changes in voltage of application of stimulus / binding of a substance. The binding / stimulus causes a change in shape of protein that allows the cell to become more permeable to Na^+ ions. Since lower Na^+ ion concentration inside the cell, they rapidly diffuse ~~into~~, depolarising the membrane, and if threshold potential reached, releases neurotransmitters into the ~~gap~~ synapse with ~~cell~~ a relay neurone that carries the impulse to the central nervous system (via the dorsal root into the spinal cord).

8e with most candidates' explanations were clear about ion channels opening leading to an influx of sodium ions resulting in depolarisation. Fewer candidates referred to the change in shape of the membrane.

(e) Explain how mechanical stimuli, e.g. pressure, are converted into electrical signals in cells (paragraphs 5 and 7).

(3)

*When a stimuli of more than threshold voltage (-50mV) is recieved, Na^+ channels open and Na^+ enter the inner ~~ne~~ membrane of nerve which makes inside membrane more positive ~~than~~ (+5 +30v) than outside membrane.
*This generates an action potential and is propogated throughout entire axon.

(e) Explain how mechanical stimuli, e.g. pressure, are converted into electrical signals in cells (paragraphs 5 and 7).

(3)

Pressure causes mechanosensitive ion channels to open as membrane is stretched. Ions move into the membrane through open ion channels and depolarise the membrane as increased potential difference causes threshold to be reached. Action potential is generated and moves along neurone as an electrical impulse.

(e) Explain how mechanical stimuli, e.g. pressure, are converted into electrical signals in cells (paragraphs 5 and 7).

(3)

Pressure causes mechanosensitive ion channels to open as membrane is stretched. Ions move into the membrane through open ion channels and depolarise the membrane as increased potential difference causes threshold to be reached. Action potential is generated and moves along neurone as an electrical impulse.

8f This question was not well done although many candidates gained credit for reference to similar structure and both piezo 1 and piezo 2 were activated by pressure / same stimulus.

(f) Explain what is meant by the phrase 'Based on its similarity to Piezo 1, a second ion channel was found (Piezo 2)' (paragraph 7 and Figure 3).

(2)

The ~~DNA seq~~ ~~protein~~ protein structure is similar and ~~the~~ DNA is ~~de~~ also similar. This resulting the channels to have a similar function

(f) Explain what is meant by the phrase 'Based on its similarity to Piezo 1, a second ion channel was found (Piezo 2)' (paragraph 7 and Figure 3).

(2)

Piezo 1 and Piezo 2 has similar shape of R groups and base sequence of gene.

(f) Explain what is meant by the phrase 'Based on its similarity to Piezo 1, a second ion channel was found (Piezo 2)' (paragraph 7 and Figure 3).

(2)

piezo is the greek word for pressure. So this ion channe piezo 1 and 2 are ~~pressure detecting~~ channels that convert pressure stimuli to into electrical impulses. The ~~phare~~ phrase means to bothe piezo 1 and 2 has similar functional and structural features.

8g Another suggest question. Most responses gained credit for TRPV1 being sensitive to temperature and an impulse being transmitted to the hypothalamus. There were few specific descriptions of what the hypothalamus initiates when the TRPV1 channel is stimulated. A definite action was required eg. more sweating.

(g) Suggest the role of TRPV1 in maintaining core body temperature (paragraph 9).

(2)

· TRPV1 detects changes in (increase in core body) temperature · and send impulses (via sensory neurone) to the thermoregulatory centre in hypothalamus. which then sends impulses to the effectors ; ⊳ sweat glands are activated, hair erector muscles relaxes , and vasodilation occurs.

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 on an appropriate manner. Appendix 7 in the specification lists all the command words and their meaning. This is particularly true for explain, describe, and comment on command words.
- in graphs candidates need to check the labelling of the axes and scales.
- in level-based question the tables and graphs need to be used as well as relevant knowledge and understanding.
- in calculations it is better to show the workings as well as an answer as if the answer is incorrect candidates may gain some credit for correct working. Care needs to be taken in the interconversion of units – eg cm^3 to dm^3, and mm to μm.
- also, in calculations care needs to be taken to ensure that the answer is in the required format eg. two significant figures, standard form and the number of decimal places.
- Candidates must ensure that their responses are legible. There was a clear increase in very tiny writing.