



Examiners' Report Principal Examiner Feedback

October 2023

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

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October 2023

Question Paper Log Number P75619RA

Publications Code WBI15_01_ER_2310

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The paper was the eighth cycle of the new specification and tested respiration, internal environment, coordination, and gene technology.

The scope of the questions provided a good opportunity for students 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 14 – 76)

There were some parts of questions that were left blank particularly at the end showing some evidence that students might have had insufficient time to complete the paper. Many students made an attempt 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 few years. There is clear evidence that some students are studying the article in detail while others only have a brief experience of it. As it accounts for 22% of the total paper mark time needs to be allocated to study it.

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 particularly for grade E students. There were many responses which were well articulated showing excellent use of biological technology in context.

However, it is still evident that some students do not pay sufficient attention to the command word used in the question. This is particularly true of 'determine', 'deduce' and 'comments' questions where descriptions failed to gain the full marks. A greater range of command words were used in this paper.

Graphs relating to novel situations continue to be problematic for students. Many students 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 students 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 students. Students need to be careful to follow the instructions in the stem of the question eg. the number of significant figures, or the number of decimal places.

'Suggest' questions offered students 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 students and proved to be excellent for discrimination.

A large number of centres are clearly using our mark schemes and examiner reports to prepare students. This is particularly evident where similar mark points have appeared on previous papers. eg. Q4ciii cardiac output. 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.

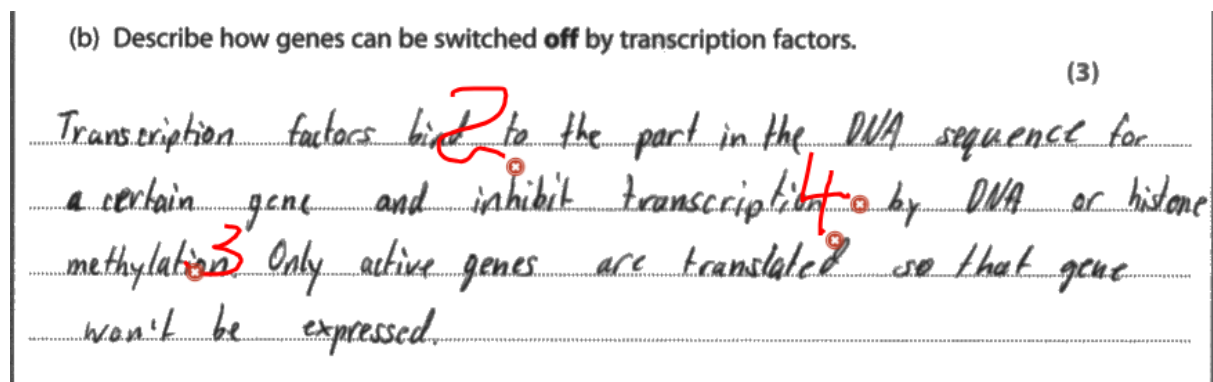
Q1ai Nearly every student was able to state correctly which enzyme is used in the production of recombinant DNA.

Q1aii Targeted at grade E, most students correctly identified where DNA was to be found in bacterial cells.

Q1aiii Again targeted at grade E, nearly every student correctly identified the bond which joined nucleotides in a single strand of DNA.

Q1b In this question students were asked to describe how genes can be switched off by transcription factors. Many responses tried describing how genes were switched on and off without reference to transcription factors. This limited the number of marks that could be obtained.

This is an example of a response which scored 3 marks:



This is an example of a response which scored 3 marks:

Q2a In this question students were asked to describe how the pupil of the eye dilates and contracts in response to changes in light intensity. Some students did not describe what the change in light intensity could be. Most responses correctly indicated the effect of high / low light intensities on the size of the pupil. However several got the contraction and relaxation of the radial and circular muscles the wrong way round. Many students did not state that the muscles involved were antagonistic.

This is an example of a response which scored 4 marks:

(a) Describe how the pupil of an eye dilates and contracts in response to changes in light intensity.

(4)

change in light intensity is detected by rod cells, where an impulse is sent to the brain indicating an increase in light intensity. The brain will then impulses to the muscles of the iris through the sympathetic nervous system, where the circular muscles will contract and radial muscles will relax in case of bright light. ^{contracting pupil.} And in case of darkness, circular will relax and radial will contract dilating & pupil.

This is an example of a response which scored 4 marks:

(a) Describe how the pupil of an eye dilates and contracts in response to changes in light intensity.

(4)

As light enters the ^{pupil} retina, the muscle of the iris contracts. The circular muscle of the pupil contracts and radial muscle relax. The diameter of the pupil becomes smaller. Circular muscle and radial muscle works antagonistically. As light intensity lowers, the radial muscle contracts and circular muscle dilates and the diameter of the pupil expands.

Q2bi This multi choice question was answered correctly by the majority of students. Centres are reminded of the importance of ensuring that answers to MCQ items are clear and ambiguous. Students must ensure they follow the instructions of how to change their answers to ensure their answer can be marked.

Q2bii This question asked students to identify which drugs would increase nerve transmission. Most responses were correct.

Q2biii In this calculation students were tasked with calculating the increase in diameter of the pupil when moving from direct sunlight to complete darkness. The most common error here was not converting the radius from the area calculation to the diameter. Some students just put an answer down without any workings. This is fine if the answer is correct but leads to 0 marks if the answer on the answer line is incorrect. Centres are reminded of the importance of giving working out in questions, especially in longer calculations.

This is an example of a response which scored 2 marks:

Calculate the increase in diameter of the pupil when moving from direct sunlight to complete darkness. (2)

$$\text{Area in sunlight} = \frac{4\pi^2}{4} = 12.57 \text{ mm}^2$$

$$38.75 - 12.57 = 26.18 \text{ mm}$$

$$\sqrt{\frac{38.75 \times 4}{\pi}} = 7.02$$

$$7.02 - 4 = 3.02 \text{ mm}$$

Answer 3.02 mm mm

This is an example of a response which scored 1 mark:

Calculate the increase in diameter of the pupil when moving from direct sunlight to complete darkness.

(2)

$$\pi r^2 = 38.75$$

$$r^2 = \frac{38.75}{\pi}$$

$$r^2 = 12.33$$

$$r = \sqrt{12.33}$$

$$r = 3.51 \text{ mm.}$$

$$= (4 - 3.51) \text{ mm}$$

$$= 0.4879 \text{ mm.}$$

Answer 0.4879 mm

Q3ai In this question students had to calculate the volume of the lesion in the brain. They were provided with the formula for the volume. Again, conversion between diameter and radius was missed by many students. As π could be a range of figures depending on the source eg. scientific calculator there was a range of acceptable answers. Many students did not take careful note of the instruction to give their answer to two decimal places.

This is an example of a response which scored 2 marks:

This is an example of a response which scored 2 marks:

Give your answer to 2 decimal places.

(2)

$$\begin{aligned} V &= \frac{4}{3} \pi r^3 \\ &= \frac{4}{3} \pi \times \left(\frac{1.97}{2} \right)^3 \\ &= 4.003 \text{ cm}^3 \end{aligned}$$

Answer 4.00 cm

This is an example of a response which scored 1 mark, due to not giving their answer to 2 decimal places:

Give your answer to 2 decimal places.

(2)

$$V = \frac{4}{3}\pi(0.985)^3$$

$$= 4.0031$$

$$d = \frac{1.97}{2}$$

$$= 0.985$$

Answer 4.0031 cm³

Q3aii in this question students needed to calculate the actual width of the lesion labelled B between points X and Y. and give the answer to 2 significant figures. Relatively few students here obtained full marks due to either inaccurate measuring or not giving the answer to 2 significant figures.

This is an example of a response which scored 2 marks:

0.6 cm

S-T = 1.3 cm

$$mag = \frac{1.97}{1.97 \div 1.3} = 1.51 \times$$

(2)

$$0.6 \times 1.51 = 0.91$$

Answer 0.91 cm

This is an example of a response which scored 1 mark: Answer not given to 2 significant figures.

Give your answer to 2 significant figures.

(2)

$$S-T = 1.3 \text{ cm} = 1.97 \text{ cm} \\ \div 1.3 \quad \div 1.3 = 1.515384615$$

$$X-Y = 0.6 \text{ cm} \\ 0.6 \times 1.515384615$$

Answer 0.909 cm

Q3b This question asked students to suggest why a dye might be given during the MRI scan. As this was a suggest question which was very open ended a wide variety of responses were accepted. The majority of students gained credit here. The most common errors were the result of mixing MRI up with CT scan or PET scan. No credit was given where the suggestion was about the MRI process.eg. to make scanning easier.

This is an example of a response which scored 1 mark:

Suggest why a dye might be given during the MRI scan.

(1)

so that the location of the brain tumor can be identified

This is an example of a response which scored 1 mark:

Suggest why a dye might be given during the MRI scan.

(1)

to identify dye the brain tumour cells so that
it would be easier to identify the tumor.

Q3c In this question students were asked to explain why ADEM causes problems with walking. Many responses achieved full marks. However several responses stated the destruction of myelin sheath but then did not go on to explain the outcome of this and how it affects walking.

This is an example of a response which scored 2 marks:

Explain why ADEM causes problems with walking. (2)

- Demyelination of the axon results in loss of insulation of the nerve impulse.
- It also causes the loss of nodes of Ranvier, meaning that the nerve impulse (action potential) is unable to jump between the nodes for saltatory conduction.
- This means that the impulse is unable reach ~~the~~ the CNS or the effectors, ~~as~~ resulting in a loss of function in that area.

(Total for Question 3 = 7 marks)

This is an example of a response which scored 1 mark with mark point 2:

Explain why ADEM causes problems with walking. (2)

The ~~s~~ ~~k~~ lesion ~~b~~ is formed in cerebellum. This ~~were~~ the body balance ~~area~~ and vision is controlled. So damage to this part causes problem in walking.

Q4a Students were given a table showing the mean resting heart rate and mean lifespan for seven mammals. They were asked to describe two conclusions that can be drawn from these data. Surprisingly, many students did not get full marks here as they focused on the size of the mammals and the effect on heart rate and lifespan.

This is an example of a response which scored 2 marks:

(a) Describe **two** conclusions that can be drawn from these data.

(2)

* AS the mean resting heart rate decreases the mean lifespan increases

* The only exception here are humans who have a higher mean lifespan

Compared to all other mammals.

This is an example of a response which scored 2 marks:

(a) Describe **two** conclusions that can be drawn from these data.

(2)

The larger an animal is in size the lower the heart rate.

The more the mean lifespan the lower the heart rate, with the exception of humans.

This is an example of a response which scored 1 mark:

(a) Describe **two** conclusions that can be drawn from these data.

(2)

As mean resting Bigger mammals with complex respiratory system has low mean resting heart rate.

Life span for humans are the longest compared to other mammals.

Small mammals has shorter life span.

Q4bi This MCQ asked students to correctly identify the heart rate from the trace given in the question. Although the majority correctly identified the answer a significant number calculated it incorrectly from the trace.

Q4bii Here students needed to describe two differences shown between trace A and trace B. In the trace diagram the ECG was labelled to show PQRST and students were expected to use these labels in their answer.

It is important to take careful note of the command word, as many students tried to explain why there was a difference between trace A and B and what was happening at respective points, whereas a description was required.

Centres are reminded of the importance of using comparative language in these types of questions.

This is an example of a response which scored 2 marks:

(ii) Describe **two** differences shown between trace A and trace B. (2)

Trace A shows normal ECG graph whereas trace B shows abnormal heart rhythm. In A, there is ~~only~~ ^{with one peak at R} a normal QRS rhythm, whereas in B ~~it is more~~ there are more peaks at QRS. In normal heart rhythm^A, the T waves are bigger ~~than~~ and in B, the T wave is smaller. In A, the S is smaller but in B, the S wave is bigger.

This is an example of a response which scored 2 marks:

(ii) Describe **two** differences shown between trace A and trace B. (2)

~~There are two R peaks in~~ ^{Every} The R peak has two separate peaks in trace B whereas trace A only has one. In trace B there is a dip ~~the~~ before the T peak which isn't there in the A trace. The T peak is also higher in trace A than trace B.

Q4ci In this question students had to suggest two reasons why humans can have a different lifespan from other mammals. As this was a 'suggest' command word a wide variety of responses were acceptable.

The most common error was stating about the higher intelligence of humans with a better heart and circulatory system. Ideally what was being looked for is what the human could do for itself to extend their lifespan and secondly what others could do for them to extend their lifespan.

This is an example of a response which scored 2 marks:

(i) Suggest **two** reasons why humans can have a different lifespan from other mammals.

(2)

• Humans have access to medicine that can treat ^{this} diseases & increase their lifetimes.

• Humans have invented surgical procedures that can save their lives when encountered with a serious health problem.

This is an example of a response which scored 2 marks:

(i) Suggest **two** reasons why humans can have a different lifespan from other mammals.

(2)

Because humans can use devices like pacemakers to keep the heart beating for longer. Humans can also train/exercise in order to keep their cardiac muscles healthy in order to live longer.

This is an example of a response which scored 2 marks:

(i) Suggest **two** reasons why humans can have a different lifespan from other mammals.

(2)

→ Due to having the ability to treat themselves when they get sick.

→ Humans can alter heart and fix it by medical intervention.

Q4cii Here students needed to state why cardiac output provides more information than the resting heart rate. This was very well done with the majority gaining one mark. The most common response was the formula for cardiac output, with correct references to stroke volume also frequently seen. The most frequent error related to oxygenated blood.

This is an example of a response which scored 1 mark:

(ii) State why cardiac output provides more information than the resting heart rate.

↳ (CO)

(1)

• $CO = \text{Stroke Vol} \times \text{Heart Rate}$

• This shows both factors → volume of blood that's pumped, and how quickly it is pumped throughout the body.

This is an example of a response which scored 1 mark:

(ii) State why cardiac output provides more information than the resting heart rate.

cardiac output = cardiac volume \times heart ^{beats} ~~rate~~ per minute. (1)

This is an example of a response which scored 0 marks:

(ii) State why cardiac output provides more information than the resting heart rate.

(1)

cardiac output shows how much oxygenated blood is produced

Q4ciii In this question students were asked to describe how the nervous system affects cardiac output to enable the giraffe to run at this maximum speed. Similar question have appeared in recent papers and as a result this was well answered with many students gaining full marks. Centres are reminded that terminology such as 'signals' is not creditworthy at this level.

This is an example of a response which scored 4 marks:

The ~~as~~ nerve ~~nerve~~ send when the giraffe starts
 to run, the nerve send impulses to the brain
 and when the blood is filled in the aorta the
 stretch receptors also send impulses to the brain in
 medulla ~~oblongata~~ oblongata³ and the medulla oblongata⁴
 in the brain ~~center~~ send impulses through sympathetic
 nerve in the SAN in the heart to increase the frequency
 of excitation⁵ and so ~~more~~ the heart contract faster
 and harder to supply oxygen that the ~~respiring~~
~~muscle~~ muscle needs to ~~respire~~ respire and so the
 stretch ~~receptor~~ receptors stretch more and more impulses
 from the brain is send so ~~more~~ ^{more} (Total for Question 4 = 12 marks)
 contraction and more volume of blood is supplied and so
 increases the cardiac output. ¹

This is an example of a response which scored 4 marks:

Describe how the nervous system affects cardiac output to enable the giraffe to run at this maximum speed.

(4)

- When running at high speeds only the aerobic pathway cannot keep up so anaerobic respiration occurs, producing CO_2 and lactic acid.
 - This decrease blood pH and this change is detected by chemoreceptors² which send impulses to the cardiovascular control centre in the medulla oblongata³ and from here impulses are sent to the SAN via the sympathetic nervous system⁴
 - Frequency of depolarisation ~~increases~~, so of the SAN increases, thus increasing heart rate⁵
 - Strength of contraction ^{of ventricles} also increases, increasing stroke volume.
- So cardiac output increases. ¹

Q5a Here students had to describe how a neurotransmitter allows an impulse to be transferred to an adjacent neurone. Again a common focus of question in recent sessions. Students have clearly learnt this well and most answers reflected this. Key elements that were missed by some students included not specifying pre or post synaptic membrane and the diffusion of the neurotransmitter.

This is an example of a response which scored 4 marks:

(a) Describe how a neurotransmitter allows an impulse to be transferred to an adjacent neurone.

(4)

An influx of calcium ions in the pre synaptic knob caused by the arrival of an axon potential causes the vesicles with the neurotransmitter to move to the pre synaptic membrane and fuse with it. The neurotransmitter are secreted into the synaptic cleft where they attach themselves to receptors on the post synaptic membrane and stimulate the formation of a new action potential.

This is an example of a response which scored 4 marks:

When impulse arrives at the presynaptic neurone Ca^{2+} channels are opened so Ca^{2+} diffuse into the presynaptic membrane and bind to vesicles containing neurotransmitter and activating them so they diffuse with the cell membrane and release the neurotransmitter into the synaptic cleft which are diffused into the post synaptic membrane and bind to receptors found on the surface of post synaptic membrane. Na^+ channels open and influx of sodium ions causes ^{to reach} action potential ~~to~~ ^{at} threshold level and as a result action potential and depolarisation of neurone takes place.

Q5b In this question students were tasked with describing how *E.coli* could be genetically engineered using the Madagascar periwinkle to produce serotonin. Genetic engineering has frequently appeared in past papers. Students clearly have an idea of the concept and the methods involved. However the context is new and unless the response focused to the specific context full marks could not be obtained.

This is an example of a response which scored 4 marks:

Describe how *E. coli* could be genetically engineered using the Madagascar periwinkle to produce serotonin.

(4)

The desired genes from the Madagascar periwinkle are isolated and cut using a restriction endonuclease. The plasmid of the *E. coli* bacteria is cut using the same restriction enzyme. and The genes from the Madagascar periwinkle are inserted into the *E. coli* and the DNAs ~~are~~ bind together using DNA ligase. The When the DNA is now transcribed and translated enzyme A and enzyme B will be synthesized and help in the production of serotonin.

This is an example of a response which scored 4 marks:

Samples of DNA will be taken from the Madagascar periwinkle. Then the sample will be replicated. ~~Then Using~~ ~~Poly~~ PCR. The DNA will then be cut using restriction endonuclease and the DNA segment for the Enzyme A and Enzyme B will be isolated. The new enzyme will be attached to an ~~E~~ *E. coli* plasmid using DNA ligase. Then the plasmid will be attached to the *E. coli* bacteria. The modified bacteria will replicate to produce more bacteria with the genes to create Enzyme A and Enzyme B. The bacterium will be grown in a fermenter ~~where they will release the~~ ~~enzyme. Which will then be purified and distributed.~~

Q5c In this question students were provided with a graph showing the concentrations of serotonin and tryptophan in a culture over a 50 hour period. Students were asked to discuss the changes shown in the graph and to use the information in the question to support their answer. The lower grade marks were obtained by most students describing the relative concentration changes for serotonin and tryptophan. The higher-grade marks seemed to be less attainable as few students made reference to enzymes A and B or suggested why the rate of serotonin started to level off.

This is an example of a response which scored 4 marks:

(4)

• as time increase from 0-50 hours,
Tryptophan concentration has a steady decrease
up to 50 hours, and serotonin has an increase
in concentration non stop from 0-50 hours
• This is because ~~as~~ as time passes, the
E coli now has enzymes A @ B, so now
Tryptophan is being broken down into 5HTP using
enzyme A, then 5HTP is broken down to serotonin
using enzyme B, thus as time increases the
concentration of serotonin increases, but the
concentration of tryptophan decreases

This is an example of a response which scored 4 marks:

Use the information in the question to support your answer.

(4)

with time, the concentration of serotonin increases where as
the concentration of Tryptophan decreases. This maybe because
~~at~~ Tryptophan have been changed to serotonin with the help of
Enzymes A and B. At time = 20 hours the concentration of
serotonin is equal to the concentration of tryptophan. this is where
the product 5HTP is maximum.

This is an example of a response which scored 4 marks:

(4)

- As time increases, concentration of Serotonin increases while concentration of tryptophan decreases.
- Because tryptophan was being converted to 5HTP by enzyme A & 5HTP was being converted to Serotonin by enzyme B.
- As time increases, the rate of decrease in tryptophan concentration decreases.
- Because ~~less~~ as more tryptophan converted, there is less tryptophan available to bind to active site of enzyme A.
- Therefore fewer enzyme-substrate complexes formed, reducing rate of reaction.

Q6ai In this MCQ students had to suggest which row in the table shows the effect of an increase in adrenaline in a mammal on breathing rate and heart rate. The majority of responses were correct.

Q6aii Students were given a table showing the changes in heart rate of Daphnia in differing concentrations of nicotine and adrenaline. They were asked to deduce the effect of the combination of these chemicals on the heart rate of Daphnia.

It was clear that most students did not take careful note of the key idea in the question 'combination of these chemicals'. As a result, full marks were seldom obtained. Students need more practice in the command word 'deduce'.

This is an example of a response which scored 3 marks:

(3)

- A combination of $0.001 \text{ mmol dm}^{-3}$ of nicotine and 0.1 mmol dm^{-3} of adrenaline caused the highest mean heart rate. 3
- Decreasing nicotine concentration causes heart rate to ~~decrease~~ ^{increase} and increasing adrenaline concentration causes heart rate to increase. 1
- At all concentrations of nicotine, using a higher adrenaline concentration causes a higher heart rate. 2

This is an example of a response which scored 3 marks:

Deduce the effect of the combination of these chemicals on the heart rate of Daphnia.

(3)

Mean heart rate is greatest for the combination ~~with~~^{of} a control group with a $0.00 \text{ mmol dm}^{-3}$ of nicotine and $0.001 \text{ mmol dm}^{-3}$ of adrenaline. Increasing the concentration of Adrenaline increases the mean heart rate rate ~~while~~^{and} less concentration of nicotine increases the mean heart rate.

Q6b Another MCQ that was well done. Students could accurately identify the description of a gibberellin.

Q6c The level based question. Students were provided with data on short and long day plants flowering and a graph detailing the effect of gibberellin on mean number of flowers. Students were asked to discuss how phytochromes and gibberellins affect flowering in plants. They had to use their own knowledge and the information in the question to support their answer.

Students are becoming more experienced in the demands of this level based question format. Responses are improving with many more level 3 responses. For some reason several responses detailed the effects of gibberellin on seed germination.

This is an example of a response which scored 6 marks:

At gibberellin concentration increases from $0.3 \mu\text{mol dm}^{-3}$ to $1.5 \mu\text{mol dm}^{-3}$ (6)
 the mean number of flowers increase by 2.8. But the decrease in the mean number of flowers decreased from 1.5 to $4.6 \mu\text{mol dm}^{-3}$ the mean number of flowers decreased by 2.2. This shows that at specific concentrations of gibberellin ($1.5 \mu\text{mol dm}^{-3}$) there is a maximum number of flowers that can be increased as gibberellin is a plant hormone that acts as a growth regulator.

(Gibberellin can act as a disruptor factor that binds to promoter sequences of genes causing ^(activating it) more proteins to be produced for flower formation to be made by mRNA synthesis). For short day plants (SDP) they require more Pfr to stimulate flowering as they need to be in winter type of darkness for longer the critical ^{photo} period so the more plants in dark for longer \Rightarrow more Pfr absorb for red light to be converted to Pr. And in ^{long} day plants (LDP) the the Pfr is needed to stimulate flowering as they ^{have to} stay in darkness for less time in the 24 hours for the to flower. So more Pr absorb more red light to make ^{more Pfr} Pr. If flash of far red or red light occur the phytochrome can get ^{inter converted to} one another. For eg: If only one flash of red light is given, the ^{50% red light}

This is an example of a response which scored 6 marks:

Short day plants have more P_r than (phytochrome red) than P_{fr} (phytochrome far red). ~~When they absorb more red light in~~ Short day plants, P_r stimulates flowering by absorbing when introduced to red light, the P_r absorbs the P_r stimulates flowering in short day plants. When exposed to red light, the P_r absorbs the red light to convert into P_{fr} hence flowering is inhibited in SDP. However, when far red is introduced to the plants after red light, the P_{fr} absorbs the far red light is converted back into P_r , far ~~then~~ stimulating flowering.

Long Day (Short night) plants (LDP)

~~in~~ In LDPs, P_r stimulates flowering. P_r absorbs red light and converts into P_{fr} to stimulate flowering during night time and during daytime. However, when far red light is introduced, the P_{fr} absorbs far red and gets converted into P_r thus inhibiting flowering of LDPs.

Gibberellins

As Gibberellin concentration increases from $0.3 \mu\text{mol dm}^{-3}$ to $1.5 \mu\text{mol dm}^{-3}$ the mean number of flowers also increase. However from $1.5 \mu\text{mol dm}^{-3}$ to $4.4 \mu\text{mol dm}^{-3}$ (Total for Question 6 = 11 marks) the mean number of flowers decrease. Secretion of Gibberellins stimulates the release of amylase from the aleurone layer of seeds to break down starch into glucose. By using the glucose, the embryo undergoes cell division to produce root and shoot. At first, as gibberellin concentration increases, the effect is seen, mean number of flowers increase. However, above $1.5 \mu\text{mol dm}^{-3}$ the almost all starch has been broken down thus, no more glucose is produced for flowering.

This is an example of a response which scored 6 marks:

Active phytochromes (P_{fr}) and gibberellins act as transcription factors that cause plants to activate flowering, or branching and leaf growth.

Phytochromes are activated by red light which can be inferred from the diagram graphs as in presence of red light plants behave as tho its in photo period. Active phytochromes become inactive, according to graphes diagram, in presence of far red light or slowly become inactive in absence of red light. Short day plants flower when night length is longer than critical night length as then there is no active Phytochromes in plants inhibiting plants from flowering. If far red light is introduced however phytochromes get activated so short day plants start flowering even tho night is longer than day. Long day plants flower when phytochrome concentration is high so day length must be longer than critical night length or to activate P_{fr} or red light must be introduced at night to activate P_{fr}.

Gibberellin is a transcription factor and it stimulates flowering up to a certain concentration. If gibberellin concentration increases beyond 1.5 a number of flowers decreases. As this data has no overlap in range bars it is considered valid.

Q7ai In this MCQ students needed to correctly identify the row in the table which shows the energy use in muscle contraction. The majority of students answered correctly.

Q7aii This question wanted the students to describe the sliding filament theory of muscle contraction. It did not matter where in the sliding filament model cycle the student started, however the events had to be in the right sequence to gain credit. A few of the descriptions were very muddled. Many students showed a detailed knowledge of the events leading to muscle contraction, and gained full marks.

The most common mistake made by students was to confuse the power stroke with the myosin head returning to its upright position.

This is an example of a response which scored 4 marks:

- An action potential arrives at the neuromuscular junction.
- Travels across the sarcomere and through T-tubules.
- Ca^{2+} ions are released from the Sarcoplasmic Reticulum (SR) and flood into the myofibrils.
- They bind to troponin via the calcium binding sites. This results in a conformational change that causes the myosin binding sites to be exposed.
- Globular myosin heads attach to the sites on the actin filament and pull forward in a powerstroke.
- This causes the actin filaments to slide closer together; H-Band disappears and thus the sarcomere shortens, resulting in muscle contraction.
- ATP binds to the globular myosin heads and causes them to detach. Sarcomere lengthens again.
- ATP hydrolysed: $\text{ATP} \rightarrow \text{ADP} + \text{P}_i$. Energy released stimulates myosin heads to bind again. Cycle repeats.

This is an example of a response which scored 4 marks:

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

(4)

Calcium ions bind to troponin, causing tropomyosin to change shape and move revealing the myosin head binding site on the actin filament. Myosin binds forming actin myosin bridge. Myosin head binds to site releasing ADP and P_i and pulls the actin filament forward in a sliding motion, then ATP breaks the actin myosin bridge releasing the myosin head using energy from ATP.

Q7b In this question students were provided with a table comparing muscle mass in different muscles of two ostrich species. This question asked the students to come up with two conclusions about the mean mass of muscles from the data. This was done fairly well by

the majority of students. Occasionally students did not gain the second mark point because they merely repeated their first statement but in a different way. Students are reminded of the importance of comparative language.

This is an example of a response which scored 2 marks:

(i) State **two** conclusions that can be drawn about the mean mass of muscles shown in the table. (2)

◦ For each muscle type, the Zimbabwean Blue ostriches ^{↙ (ZB)} have a greater mean muscle mass than the South African Black. (SAB)

◦ muscle T has the greatest mean muscle mass ~~for~~ in both types of ostriches.

This is an example of a response which scored 2 marks:

(i) State **two** conclusions that can be drawn about the mean mass of muscles shown in the table. (2)

Type T mus

~~All types of muscle~~ Mean mass of muscles of all types are higher in Zimbabwean blue than South African black. Type T muscles have a greater mean mass than ~~all 3 to the~~ G and F.

Q7bii This question was about the validity of conclusions drawn from the data. Students were asked to make relative comments. Some students did not refer to validity in their answers. Some gave both high and low validity reasons while others concentrated on just low validity. Comments were made on the size of error bars / SDs but often not linked to significance difference / variability. Centres are reminded that students need to practice making precise answers rather than general statements. Most students obtained one mark, but few got both marks available.

This is an example of a response which scored 2 marks:

(ii) Comment on the validity of conclusions drawn from the data for these two groups of ostrich.

(2)

The ~~mean mass~~^{mass} of muscle for South African Black ostriches for muscles T and G ^{error bars} overlap, which reduces the validity of the data. ~~The average for~~ This can be said for Zimbabwean Blue as well but not as much as South African Black ostrich. However, in Zimbabwean Blue the ~~average~~^{mean} mass was only taken by two ostriches whereas in South African Blue ostriches it was taken by ~~an~~ ²⁴ ostriches. This reduces the validity of the comparison as ~~more equal~~ ^{more} number of samples should be taken.

This is an example of a response which scored 2 marks:

(ii) Comment on the validity of conclusions drawn from the data for these two groups of ostrich.

(2)

The standard deviations overlap so it is invalid. ~~However, as~~ Different sample size of ostriches were used so ~~it is not~~ data lacks accuracy and reliability. Other factors that might affect mean mass of muscle (age, sex, health, dietary habits) were not taken into consideration, so it is unreliable.

Q7biii This calculation involved the calculation of percentage difference. Students were provided with the formula and asked to give their answer to two decimal places. This final point for the answer was often missed. Surprisingly a number of students made no attempt at the calculation even though they were provided with the formula.

This is an example of a response which scored 2 marks

(2)

Give your answer to **two** decimal places.

$$\frac{0.74 - 0.59}{\left(\frac{0.59 + 0.74}{2} \right)} \times 100 = \frac{0.15}{0.665} \times 100 = 22.56$$

(2)

Answer 22.56 %

This is an example of a response which scored 2 marks

(2)

Give your answer to **two** decimal places.

$$\text{Percentage difference} = \frac{0.74 - 0.59}{\left(\frac{0.74 + 0.59}{2} \right)} \times 100 \% = 22.556 \sim 22.56 \%$$

(2)

Answer 22.56 %

This is an example of a response which scored 1 mark

(2)

Give your answer to **two** decimal places.

$$\frac{0.74 - 0.59}{\left(\frac{0.74 + 0.59}{2} \right)} \times 100 = 22.5$$

(2)

Answer 22.5 %

Q7c In this question students were tasked with describing the role of the hypothalamus in maintaining a steady internal temperature. This question was not answered well for several reasons.

The context of being ostrich thermoregulation was unfamiliar to students and students did not describe the link between the hypothalamus and the response. Clearly students knew what happened to return the body temperature back to normal when temperature raised or lowered, with marking point four being the most commonly awarded.

This is an example of a response which scored 3 marks:

Describe the role of the hypothalamus in maintaining a steady internal temperature.

(3)

• Thermal receptors will indicate an imbalance in internal temperature, sensory neurons carry an impulse through relay neurons to the hypothalamus, from here the relevant motor neurons receive impulses to effectors bringing a response, for example, internal temperature being high results in more sweating as sweat glands are effectors.

(Total for Question 7 = 14 marks)

This is an example of a response which scored 3 marks:

Describe the role of the hypothalamus in maintaining a steady internal temperature.

(3)

thermoreceptors in the hypothalamus detect changes in ~~tem~~ core temperature.

- when core temperature decreases, impulses are sent to the thermoregulatory centre which sends impulses to hair erector muscles contract, increasing insulation layer and also impulses are sent to the arteriovenous shunt causing arterioles to constrict and reducing heat loss by radiation.
- When core temperature rises, arterioles ^{dilate} ~~constrict~~ and hair erector muscles relax, due to impulses from the thermoregulatory centre in the hypothalamus. The changes increases heat loss by radiation, conduction, etc.

This is an example of a response which scored 2 marks:

Describe the role of the hypothalamus in maintaining a steady internal temperature.

Thermoregulation
-ve Feedback (3)

- Thermoreceptors located in the hypothalamus detect any changes in the internal body temperature. If the body temperature is too high or too low, a negative feedback loop is initiated to return the deviation to normal levels, to maintain a state of dynamic equilibrium:
- (overheat) - Vasodilation, ~~the~~ heat loss from skin
 - Sweating - kinetic energy lowers as water evaporates
 - Pili muscles lie flat, lessens insulation
 - (too cool) - Vasoconstriction: Decrease heat loss through vessels from skin
 - Shivering - rapid muscle contraction, heat released during contractions
- (Total for Question 7 = 14 marks)

Q8a The first question based on the articles that were studied. In this question students were asked to give the meaning of the term 'sensory organ'. The first point was often seen as responses contained reference to group of tissues working together. However the second mark point was often missed as many students started to give the meaning of a sense organ.

This is an example of a response which scored 2 marks:

(a) Give the meaning of the term 'sensory organ' (paragraph 2).

(2)

- "Sensory" - detects an external stimulus and sends an impulse to the Central Nervous System (Brain & Spinal Cord)
- "organ" - A group of specialised tissue that perform the same function

This is an example of a response which scored 2 marks:

(a) Give the meaning of the term 'sensory organ' (paragraph 2).

(2)

A group of tissues that have the same function which is in this case to ~~determine~~^{res} detect stimuli through receptors.

Q8b In this question students had to complete a table comparing the features of the fascia and ligaments. This was generally well done. The question stem asks students to use ticks and crosses. However, two key errors that were seen were leaving boxes blank or giving a hybrid tick and cross. Neither were creditworthy.

This is an example of a response which scored 2 marks

Use ticks and crosses to complete the table comparing types of connective tissue found in the human body (paragraphs 3 to 7).

(2)

Connective tissue	Contains collagen	Rich in nerves	Surrounds muscle
fascia	✓	✓	✓
ligaments	✓	✗	✗

This is an example of a response which scored 2 marks

Use ticks and crosses to complete the table comparing types of connective tissue found in the human body (paragraphs 3 to 7).

(2)

Connective tissue	Contains collagen	Rich in nerves	Surrounds muscle
fascia		✓	✓
ligaments	✓		✓

Q8c Students had to describe how the fascia generates a 'diffuse pain'. Only a minority of students achieved full marks here. Many students struggled to put the 3 elements together – stimulus reception – impulses generated – pain perceived by the brain.

This is an example of a response which scored 3 marks

(c) Describe how the fascia generates a 'diffuse pain' (paragraphs 8 and 9).

(3)

when a stimulus is received by the pain receptors in fascia, it causes ion channels to open and sodium ions enter into the fascia which causes depolarization and hence an ^{neurone} action potential is generated. This is received by the brain in the part where pain is detected.

This is an example of a response which scored 3 marks

(c) Describe how the fascia generates a 'diffuse pain' (paragraphs 8 and 9).

(3)

chemical released due to change in pressure on fascia.
chemical binds to sodium ion channels on presynaptic membrane. sodium channels open, causing an influx of sodium ions which causes depolarisation. therefore an action potential is generated ~~in the~~ and the impulse ^{is} ~~are~~ carried to the brain where its perceived as pain.

Q8d In this question students were asked to explain how inflammation in the fascia is caused. There was a mixed response to this question. Many students explained in general terms how inflammation is caused and the nature of the immune response, without any reference to the fascia. Answers which do not relate to the given context will not achieve full marks.

This is an example of a response which scored 3 marks

(d) Explain how inflammation in the fascia is caused (paragraphs 8 and 9).

(3)

- Inflammation is the swelling, redness and soreness of tissue. This is a non-specific response to injury or infection.
- If the fascia is damaged, then the non-specific immune response is triggered. T-cells stimulate the production of B-cells & T-Killer cells to fight off pathogens. Cytokines are released & more white blood cells are called to the site.
- Constant inflammation makes the body more receptive to pain as the soreness increases.

This is an example of a response which scored 3 marks

(d) Explain how inflammation in the fascia is caused (paragraphs 8 and 9).

(3)

- When the connective tissue is damaged specialised cells, basophils and mast cells release histamines.
- histamines causes arterioles to dilate and cause local heat and redness.
- histamines also make the capillary walls to become more permeable, so more WBCs and platelets are driven out of capillaries causing swelling and often pain.

Q8e This question asked the students to describe how fibroblasts within the fascia could be transformed into myofibroblasts. This question proved to be challenging to a large number of students.

Some students had taken careful note of similar questions in recent years on gene expression and translation of proteins causing changes in cells. However, application to the context of myofibroblasts was essential to get full marks. Many responses were very generalised.

This is an example of a response which scored 4 marks

During the fight or flight response adrenal glands are stimulated to release adrenaline, which travels through the blood and binds to surface receptors on fibroblasts, causing a series of membrane bound reactions and triggers the formation of a secondary messenger in the cell.

- The secondary messenger goes into the nucleus and acts as a transcription factor and it binds to the promoter region of DNA.
- The transcription factor causes some genes to be activated and others inactivated, and mRNA is transcribed from active genes.
- The mRNA is then translated at ribosomes and the protein produced can change the structure and function of these fibroblasts to become myofibroblasts.

This is an example of a response which scored 4 marks

(e) Describe how fibroblasts within the fascia could be transformed into myofibroblasts (paragraph 13).

(4)

- impulse arrive & via parasympathetic nervous system to fascia
- activating transcription factor in fascia cell
- transcription factor bind to gene and activates it via Histone acetylation
- mRNA transcribed from that gene which is translated to form protein
- this protein changes shape of fasci.
- fibroblasts forming myofibroblasts

Q8f In this question students needed to explain how lymph is moved in one direction in the lymphatic system. This question was well answered by most students as many responses related knowledge of blood vessels to the lymph vessels. This is an example of a response which scored 3 marks

(f) Explain how lymph is moved in one direction in the lymphatic system (paragraphs 15 and 16).

(3)

The lymph is moved in one direction by valves that open and close to ensure that the lymph is ~~passed~~ moved in one direction and not goes in any other direction and also by the ~~the~~ autonomic nervous system in ~~the~~ smooth muscle that moves the lymph in one ~~direction~~ direction and contracts slowly and also fatigues slowly.

This is an example of a response which scored 3 marks

(f) Explain how lymph is moved in one direction in the lymphatic system (paragraphs 15 and 16).

(3)

- Valves in lymphatic vessels prevent the backflow of fluid
- Due to the elastic nature of lymph vessels, the contraction of skeletal muscles surrounding the vessels can cause compression, moving the ~~the~~ fluid in the lymph vessel.
- Some lymph vessels also contain actin and myosin, so they can contract autonomously when stimulated by the sympathetic nervous system and cause the movement of fluid.

Q8g The final question asked students to suggest how aging may have an adverse effect on the structure of the lymphatic system. Again the best responses related student knowledge to the blood vessels and included specific references to the article. This question was generally well answered by the majority of students.

This is an example of a response which scored 3 marks

(g) Suggest how aging may have an adverse effect on the structure of the lymphatic system (paragraph 17).

(3)

- o Tissue weakens, & elastic tissue weakens and breaks easily. The tearing of tissue results in blood vessels ~~become~~ blocking up and bursting → aneurysms.
- o The number of blood vessels decreases :- blood flow decreases.

This is an example of a response which scored 3 marks

(g) Suggest how aging may have an adverse effect on the structure of the lymphatic system (paragraph 17).

mechanical
compression
(3)

The lymphatic system loses its elasticity and creating aneurysms over time. and there's a decrease in the number of blood vessels lymphatic vessels are supported by a nervous system of vagal ~~and~~ cholinergic type and sympathetic type so ~~are~~ able to modulate. These thin nerves reach the external layer of lymphatic vessel and reach the deepest endothelial layer and this deteriorates in elderly people.

SUMMARY

A few suggestions for improving student performance are given below.

- students need to have time study the article and give sufficient time to answering these questions in an exam.
- students 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, describe, deduce, and comment on as command words.

- in level-based questions the diagrams 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. If the answer is incorrect, students 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.
- students must ensure that their responses are legible. There was a clear increase in writing that was very difficult to read.
- If a student puts part of an answer in a place somewhere else on the paper it is vital that the student indicates this.
- many 'suggest' questions refer to novel situations. Students need to use knowledge from the specification and apply it to this situation in specific terms rather than in generalisations.

