Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2020

Pearson Edexcel Advanced Level
In Biology A Salters Nuffield (9BN0)
Paper 03 General and Practical Applications in Biology

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Question 1

The focus of question one is a graph showing the correlation between blood velocity and blood vessel lumen diameter. Many candidates ignored the graph when answering the different question parts and this often resulted in the award of no marks.

1(a)
Most candidates found this question straightforward. A few students suggested it was a positive relationship. This was not accepted as being equivalent to a positive correlation.

1(b)(i)
There were two marks available. The first marking point was for the idea that with CVD atheromsa form and reduce the lumen of arteries. Reference to blood vessels or named blood vessels other than arteries was not accepted for MP1. Many candidates ignored the graph and suggested that CVD would result in high blood pressure and that this would increase blood velocity. Descriptions of CVD or atheroma causing arteries to constrict was not accepted for MP1.
This response gained one mark, MP2.

To gain MP1 student needed to describe reduction in lumen of arteries. Blood vessels is not sufficient.

(b) (i) **Explain how the development of cardiovascular disease (CVD) could affect the velocity of blood flow.**

(2)

Development of CVD can lead to atheromas being formed in the lumen of blood vessels. This results in the lumen diameter decreasing in the blood vessel. which would in turn lower the velocity of blood flow as their is less diameter to flow through. And by looking at data in the graph.

This response gained both available marks.

(b) (i) Explain how the development of cardiovascular disease (CVD) could affect the velocity of blood flow.

(2)

- CVD is the blockage of arteries / blood vessels due to atherosclerosis
- This will reduce the diameter of the lumen resulting in reduced velocity of blood flow

1(b)(ii)

Students using the graph in (i) found this question accessible and often gave answers that gained both marks. In contrast, students ignoring the graph when answering (i) often struggled to produce sensible answers. Increased frequency of heart muscle contraction was allowed as an alternative in marking point 2, for these candidates.

All three marking points are seen in this response and it was awarded both available marks.

(ii) Explain why a change in the velocity of blood flow will affect the function of the heart muscle.

(2)

Reduction in velocity of blood flow means less oxygen can be delivered to heart muscles for aerobic respiration which can cause the muscles to go into anaerobic respiration and die due to lactic acid build up. As a result in reduction of overall blood flow.

This response did not gain any marks. The second sentence was not accepted as an alternative to causing heart muscle to contract more frequently (MP2 additional guidance).

(ii) Explain why a change in the velocity of blood flow will affect the function of the heart muscle.

(2)

change in blood flow means that the heart will need to pump blood accordingly to the blood velocity. This may mean blood ~~reaches~~ leaves and reaches the heart quicker, so the heart must pump blood at a faster rate.

1(c)

A surprising number of students suggested that blood velocity in capillaries was high. Often going on to suggest that this was necessary to allow effective transport and exchange of materials. Students with a better understanding of capillary function found this question straightforward and generally gained both marks. It was sometimes not possible to award marking point two if the response did not clearly make reference to either diffusion or exchange between blood and tissue fluid e.g. '...allowing glucose to leak out of the blood' is not sufficient for MP2.

This response gained both available marks.

(c) Explain the importance of the relationship, shown in the graph, to capillary function.

(2)

Capillaries have small lumen diameter and as such the velocity of blood flow is low in capillaries. This is important for gas exchange at the alveoli and substrate and gas exchange at cells. The ~~slow~~ lower velocity of blood flow allows for gas exchange to occur as the blood cells are travelling more slowly.

This response gained no marks. Many students described damage to capillaries caused by high pressure, ignoring the question which is about capillary function.

(c) Explain the importance of the relationship, shown in the graph, to capillary function.

(2)

if the Velocity inside a capillary is to high it can cause damage as they are only one cell thick

Question 2

This question was based on variation observed in the banded snail.

2(a)
Most students were able to describe the difference between niche and habitat.

Most often this was by giving a description of each term.

2(b)
For this question students were provided with a pedigree diagram and some information about the allele for colour in banded snails. Many candidates were able to determine that C^Y was recessive to C^B or / and C^P. These students gained marking point 1. To gain marking point 2 students also needed to deduce that C^B was dominant to C^P.

This student gained both marks in the first sentence.

Deduce the dominance of the alleles for shell colour.

(2)

C^B is dominant over pink and yellow while pink is dominant over yellow. Yellow is recessive. As heterozygous for brown and yellow shows brown, yellow and pink shows pink and brown and pink shows brown.

This response only gained marking point 1. There is no comparison of C^B and C^P.

Deduce the dominance of the alleles for shell colour.

(2)

The allele C^B is dominant than C^Y so the colour is brown. The allle C^Y is dominant than C^P so the colour is pink.

2(c)(i)

For this question, students were asked to explain the distribution of snails with different shell patterns in two different habitats. Many candidates gained marking points 2 and 3 for suggesting the shell patterns provide camouflage therefore reducing predation. Some candidates then went on to link this to the chance of the snails surviving to reproduce (MP4). However, just surviving by itself is not sufficient for MP4. Very few students referred to this being an example of adaptation (MP1).

In this response, the student gained all three available marks for marking points 2, 3 and 4.

(i) Explain the importance of the different shell patterns in these two habitats.

(3)

There is a much higher percentage of yellow shell snails in the meadow habitat. This is most likely due to the meadow habitat be much lighter. so yellow shell snails are disguised int the habitat so less likely to be eaten by predator. Resulting in the yellow shell allele surviving and reproducing more in this environment. Woodland had much higher percent of shells with zero bands. this is would also be due to the shells with zero bands being more camouflaged in woodland habitat than yellow shells which are easier for ~~grey~~ predator to see.

This is another example of a response that gained three marks. This time for marking points 1, 2 and 3. Surviving into adulthood would not be accepted for marking point 4.

(i) Explain the importance of the different shell patterns in these two habitats.

(3)

Shell patterns are very important as they can be advantageous adaptations in meadow habitats yellow shells are largely distributed whereas in woodland areas here are less banded shells. This can camouflage the snails and improve its survival into adulthood. It can protect the snails from environmental ^pressures like predation. selection

2(c)(ii)

For this question students were asked to explain how a statistical test can be used. Based on the data provided, in the question, students needed to suggest use of a t-test for the first marking point. The second marking point was for an explanation of how the result could be shown to be statistically significant. The second mark was awarded for description of a comparison of the test value to a critical value at p=0.05. Alternatively, if they did not compare the test and critical value students could suggest using a critical value at p=0.05 and a suitable number of degrees of freedom (they don't need to state a number).

This response gained both marks.

(ii) Explain how a statistical test could be used to determine if the number of shells with zero bands is significantly different in these two habitats.

(2)

(t-test)

a statistical test would produce a value that can be compared to the critical value at a specific degrees of freedom at 5% significance. If the value produced from the test is bigger than the critical value at 5% significance the null hypothesis (which state there is no significant difference) can be rejected.

(Total for Question 2 = 9 marks)

Question 3

The question was based around photosynthesis.

3(a)(i)
Most students were able to identify the location of the Calvin cycle as the stroma. Some students suggested chloroplasts which was considered to be not sufficiently precise and was not accepted.

3(a)(ii)
Many students found this question straightforward and gained all three available marks. The main reasons that some students lost marks was either confusing GALP and GP e.g. suggesting ATP is used to produce GP from GALP or suggesting reduced NAD rather than reduced NADP as a product of the light dependent reactions.

This response gained all three marks.

(ii) Describe the roles of the products of the light-dependent reactions in the Calvin cycle. → ATP → NADH.

(3)

ATP produced in electron transport chain, is hydrolysed to produce energy for the conversion of GP into GALP. 2ATP is used. NADPH goes through oxidation to ~~pr~~ provide $4H^+$ to GP, for the conversion of GP into GALP. ~~FFA~~ ATP for phosphorlyation, and energy for conversion of GALP to ~~RUBIS~~ RuBP.

This response was given one mark, marking point 1. $NADPH_2$ was accepted for reduced NADP. Reference to NAD and reduced NAD later in the response was ignored for this marking point. ATP and $NADH_2$ used to convert GALP to GP is back to front so marking points two and three cannot be awarded. Marking point 2 could not be awarded for 'reduced NAD … in conversion of GALP to RuBP' needs to be reduced NADP.

OICLLG (ii) Describe the roles of the products of the light-dependent reactions in the Calvin cycle. $NADH_2 + O_2 + ATP$

(3)

* $NADPH_2$ is oxidised (dehydrogenated to NAD whilst ATP is dephosphorylated (ATP → ADP + Pi) in the conversion of 2× 3 carbon compound GALP into GP.
* ~~NA Oxygen from light independent reaction combines with~~
* Reduced NAD ~~further~~ dehydrogenated also in conversion of GALP into RuBP.
* RuBP essential to keep Calvin cycle going

3(b)(i)

Many students struggled to explain what an ecosystem is. Most frequently, forgetting that an ecosystem includes abiotic factors as well as biotic factors.

3(b)(ii)

The majority of students completed this calculation correctly and gained both marks.

3(b)(iii)

Students using the data provided were able to access all the marking points available. However, those students that ignored the data often produced vague answers that did not score well.

This response gained three marks, marking points 4, 1 and 3.

(iii) Comment on the impact of these different types of ecosystem on global warming.

(3)

Tropical rainforests ~~are~~ makes more of a contribution to global warming because more of it's gross producitivity is used in respiration which releases more carbon dioxide into the atmosphere. The salt marsh ecosystem converts more energy into biomass.

3(c)

Most students appeared to be aware of the importance of RUBISCO in carbon fixation and gained marking point 1 and sometimes marking point 2. Relatively few students went on to explain its importance to productivity of an ecosystem i.e. transfer of energy between trophic levels or conversion to biomass (MP3).

This is a fairly typical response that gained two marks (MP1 and 2).

(c) Explain the importance of RUBISCO to the productivity of an ecosystem.

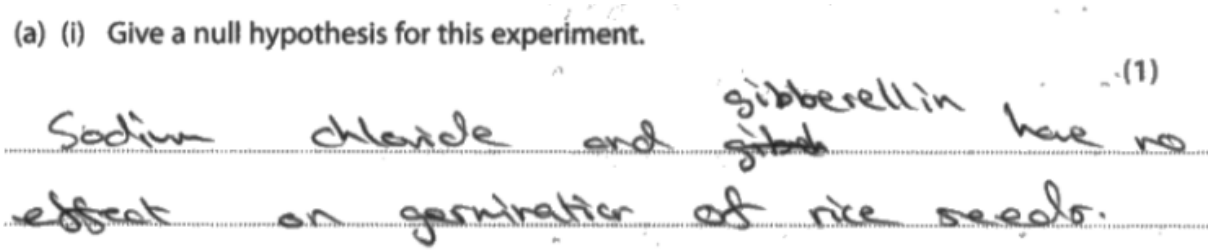
(2)

RUBISCO is an enzyme used for carbon-fixation. ~~Here~~ Photosynthesis can therefore occur (Calvin Cycle) to produce more hexose sugars used in plant growth and thereby reduce CO_2 levels and intake more CO_2 for photosynthesis

Question 4

This question is framed around the role of amylase in germination.

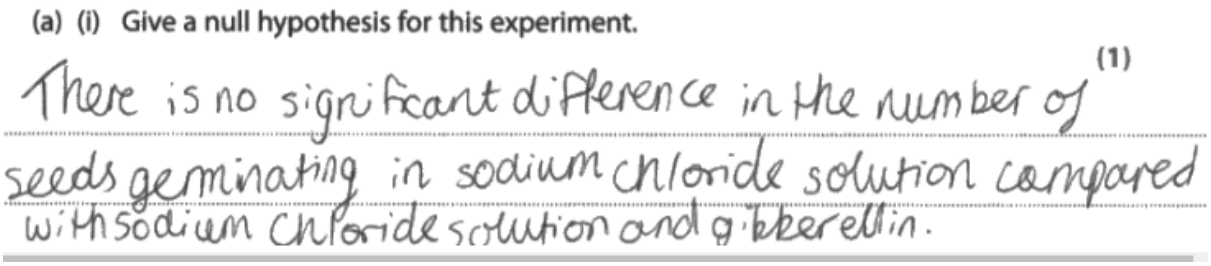
4(a)(i) To gain the mark for this question students needed to make reference to a comparison of the sodium chloride and sodium chloride and gibberellin groups. In this response the student compared sodium chloride and gibberellin and did not gain the mark.


(a) (i) Give a null hypothesis for this experiment.

(1)

Sodium chloride and gibberellin have no effect on germination of rice seeds.

In this, second, example the student has made the correct comparison and gains the mark.


(a) (i) Give a null hypothesis for this experiment.

(1)

There is no significant difference in the number of seeds germinating in sodium chloride solution compared with sodium chloride solution and gibberellin.

4(a)(ii)

Many students found this chi squared calculation straight forward. Three alternative answers were allowed depending on how students determined an expected value. The expected value assuming treatments have no effect is equal to the mean number of seeds germinating in the three groups = 42. However, candidates might reasonably think that the expected value for germination is 48 (number germinating in the control group) or 50 (total number used in each group. Therefore, on this occasion three alternative answers were accepted.

In this example the student used 48 as the expected value and carries out the correct calculation. Unfortunately, the student carried out incorrect rounding and gave an incorrect final answer. The response gained two marks.

(ii) Calculate the chi-squared (χ^2) value for these results, using the formula provided.

(3)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$\frac{(33 - 48)^2}{48} = 4.6875$

$\frac{(45 - 48)^2}{48} = 0.1875$

Answer 4.86

$4.6875 + 0.1875 = 4.875$

This response shows the correct calculation to gain all three marks.

(ii) Calculate the chi-squared (χ^2) value for these results, using the formula provided.

(3)

$\frac{126}{3} = 42$

$E = \frac{126}{3} = 16.67$

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$$\chi^2 = \frac{(48 - 42)^2 + (33 - 42)^2 + (45 - 42)^2}{42}$$

Answer 3

$\chi^2 = 3$

4(a)(iii)

Many candidates struggled to use the chi-squared value and the table to deduce the statistical significance of the results. Students needed to identify the appropriate probability level (0.05) and number of degrees of freedom (2). Then used these to make a statement about the significance of the results. Many students struggled to identify appropriate values.

In this response the student has identified the probability level and degrees of freedom but has not made a statement so gains MP2 only.

Deduce the statistical significance of the results of the second experiment.

(2)

Degree of freedom would be 2. Probability level would be 0.05%.
And the critical value would be 5.991.

In the second example, the student has identified a p value of 0.05 and the number of degrees of freedom as 2 and has then correctly compared the critical value and calculated value. This response gained both marks.

Deduce the statistical significance of the results of the second experiment.

(2)

At 2 degrees of freedom and P = 0.05
the calculated value = 6.635 and critical
value = 5.991
The calculated is greater than critical.
95% sure there is a significant difference
between observed and expected results.

4(b)

Many students find it difficult to devise investigations. Often, students do not read the context in which the question is set. In this question the investigation was to investigate the effect of gibberellin on amylase activity. Many students described investigation of the effect of gibberellin on germination or plant growth and did not gain many marks.

This response gained four marks. MP3 (line 3), MP1 (lines 4 and 5), MP4 (line 6 and 7) MP5 (line 9 for colorimeter or better for last three lines).

Devise an investigation to demonstrate the effect of gibberellin on amylase activity in rice seeds treated with sodium chloride.

(4)

* Independent variable: ~~Seeds treated with NaCl~~. Concentration of gibberellin
* Dependent variable: amylase activity
* Obtain rice seeds from a genetically identical plant of same age.
* Place seeds in test tube containing ~~water~~ sodium chloride and ~~to soak for~~ different concentration of gibberellin (x5)
* ~~Remove seeds~~, add iodine at set volume to test tube ~~containing~~ - indicator for starch prescence - solution turns blue back.
* As starch is hydrolysed to maltose - blue black colour disappear.
* Using colourimetry, take samples from reaction mixture and record absorbance at regular intervals e.g. 30 seconds.
* Plot results for each conc on graph ~~as~~ absorbance (au) vs. Time (s)
* Calculate initial rate and compare between each concentration of gibernellin.

(Total for Question 4 = 10 marks)

Question 5

This question is based around the role of the G20210A allele in CVD.

5(a)(i)

For this question, data was provided about the presence of an allele G20210A and the risk for DVT. Most candidates recognised that the presence of the allele increased the risk of DVT (MP1). Only a small number of candidates used the risk values to quantify the increase in risk associated with one or two G20210A alleles. A number of students subtracted one risk factor from another which is not an appropriate manipulation, e.g. 'the increase in risk for homozygous G20210A compared to homozygous wild type is 19 (20 -1)'. The command word 'Determine' tells students that they need to include a quantitative element in their answer.

This response gained one mark (MP1).

(i) Determine the effect of the allele G20210A on the risk of an individual developing DVT in this population.

(2)

The allele G20210A would increase the risk of an individual developing DVT as ~~it~~ more people ~~are~~ have DVT per 1000 individuals if they are positive for the allele.

This response gained both marks. 'Being heterozygous … increases your chance by 250% …' was a suitable quantitative statement for MP2.

(i) Determine the effect of the allele G20210A on the risk of an individual developing DVT in this population.

(2)

Being homozygous for G20210A gene puts you most at risk of developing DVT. Being heterozygous for the allele increases your changes by ~~250~~ 250% in comparison to being homozygous for the wild type.

5(a)(ii)

This question asked students to determine the number of heterozygous individuals in a population. Many candidates struggled to find a value for p^2 and, if they did, often did not find the square root to obtain a value for p.

In this example, the student found a value for p^2 (5×10^{-3}). The values for p and q were then correctly determined (MP2). However, students should be aware that examiners may not be familiar with the use of SURDS and this second mark expressed in this way could easily be missed. The student gets the final answer wrong by using pq rather than 2pq to determine the number of heterozygous individuals.

Advice to students' is that intermediate marks in a calculation can only be awarded if the examiner can follow the working. For example, if an examiner sees 0.005 they can only award MP1 if the 0.005 was clearly labelled as p^2 e.g. $p^2 = 0.005$.

$p^2 + 2pq + q^2 = 1.0$

(3)

$p^2 = \frac{50}{10,000} = 5 \times 10^{-3}$

$p = \sqrt{p^2} = \sqrt{5 \times 10^{-3}}$

$p + q = 1$

$q = 1 - p$

$q = 1 - \sqrt{5 \times 10^{-3}}$

$q = \frac{20 - \sqrt{2}}{20}$

$q^2 = \left(\frac{20 - \sqrt{2}}{20}\right)^2 = 0.86358$ (5 s.f)

$p^2 + 2pq + q^2 = 1$

$pq = \frac{1 - p^2 - q^2}{2}$

$pq = \frac{1 - 5 \times 10^{-3} - 0.86358}{2}$

$pq = 0.06571$

$10,000 \times 0.06571 = 657.1$

Answer 657

In this example, the student has completed the calculation correctly and gains all three marks.

$p^2 + 2pq + q^2 = 1.0$

(3)

$\frac{50}{10\,000} = \frac{1}{200}$

$q^2 = \frac{1}{200}$

$q = \frac{\sqrt{2}}{20}$

Answer 1314

$p + q = 1$

$p = 1 - \frac{\sqrt{2}}{20}$

$= \frac{20 - \sqrt{2}}{20}$

$2pq = 2\left(\frac{\sqrt{2}}{20}\right)\left(\frac{20 - \sqrt{2}}{20}\right)$

(b)

Part (b) of this question is based on the presence of a restriction enzyme cutting site in the G20210A allele but not the wild type allele. Few students read the question sufficiently carefully to appreciate this.

5(b)(i)

The majority of students were unable to explain the role of primers in a PCR reaction. Many described the primers binding to complementary bases but did not convey the idea that these binding sites identify the part of the DNA molecule to be amplified. A relatively small number of students seemed to be aware that the binding of primers to separated DNA strands provides a site for DNA polymerase to bind and begin transcription of a new DNA strand.

5(b)(ii)
Many students suggested that the DNA sequence of the two alleles were different. However, they then failed to link this to the presence or absence of the restriction enzyme cutting site and did not access marking points 2, 3 or 4.

5(b)(iii)
A number of students produced complete response with all marking points frequently seen. For marking point 1 reference to one or more key reagents than need to be controlled or in excess was required. For marking point 2 it needed to be clear that the student was referring to each of the temperatures or each or the step lengths in the cycle, being kept constant. A statement such as 'temperature should be kept constant' was not sufficient.

In this response, the student described using different numbers of cycles (MP3), the use of gel electrophoresis to examine the DNA (MP4) a method of how to identify the optimum number of cycles (MP5) and appropriate reagents (primers and reaction mix) (MP1). 'Ensure … temperature is same each time' would not have been quite enough for (MP2).

(iii) Devise an investigation to determine the optimum number of cycles for the polymerase chain reaction used to amplify the DNA for this test.

(4)

~~For the three DNA samples, all~~ For one of DNA sample allow it to go through, the polymerase chain reaction a different number of times, like ~~two, four~~ 2, 4, 6, 8 and 10 number of times. Seperate the DNA fragments using gel electrophoresis. ~~and~~ Compare the DNA profiles created under UV light to see which cycle produces the clearest and ~~easiest to~~ easiest to read bands of DNA.

Ensure the primers ~~and~~ reaction mixture, and temperature are the same each time. Repeat the investigation with the other DNA samples to see what number of PCR is optimum number of cycles.

Question 6

This question is focussed on the role of ions and ion transport in biological processes and includes the 9-mark levels-based question.

6(a)
Many students were able to provide complete answers that gained both available marking points. Some students describe ions as charged molecules and did not

gain marking point 2, others suggested that ions formed hydrogen bonds with water molecules and did not gain marking point 3.

6(b)

Students engaged well with this levels-based question. Many students met the criteria for level 2. A number of students produced responses that demonstrated comprehensive knowledge and understanding in a well-developed discussion meeting the criteria for level 3 responses. A small number of students did little more than describe the stimulus material provided and were restricted to level 1. Another group of students did not address the role of ions transport in both health and disease and again this restricted them to level 1.

This response met all the criteria for a level 2 response and some of those for a level three response it was awarded 7 marks.

Discuss the importance of ion transport across membranes in human health and disease.

(9)

Ion transport is extremely important in human health and disease, we need it for transmitting nerve impulses, we need them in blood clots, they are needed in muscle contraction, they are needed in the resting potential and they are needed in the mucus for maintaining viscosity. These are few processes in which ions are essential in the body; without them lots of functions in humans would not work.

· When impulses are needed for an action potential ~~muscle contraction~~, the membrane cannot depolarise itself. Sodium ion channels are needed to close and Na^+ has to build up on the outside. There has to be a potential difference across the membrane for threshold to be reached and this is created by a concentration of k^+ on the inside. Impulses are ~~need~~ needed around the body to/from the brain to control actions such as ~~muscle contraction~~ breathing rate, heart rate or muscle contraction.

· In muscles, in order for tropomyosin to move and change shape Ca^{2+} have to bind to troponin. If this doesn't ~~troponin~~ happen then actin-myosin bridges cannot form and the muscle cannot contract. ~~Alth~~ ~~Although in the~~

It is also needed to maintain viscosity of the mucus. Na^+ and Cl^- flow across basal membrane to draw water out of the cells by osmosis. ~~This~~ due to the high concentration of salt. However, mutations in the CFTR protein can cause diseases such as cystic fibrosis. CF, is when the ENaC (sodium) channels are open and the water is being drawn out of cell by osmosis out of tissue fluid. ~~there a~~ This causes thick sticky mucus. Transport using carrier proteins and channel proteins in cell membranes is essential for cell functionality and active transport is needed in many cell functions, there are 81. So to conclude, ~~the~~ ions are important in humans but they can cause problems ~~when~~ when mutations occur.

(Total for Question 6 = 11 marks)

This second response addresses all the level 1 criteria and meets some level two criteria. This response was given 4 marks.

Discuss the importance of ion transport across membranes in human health and disease.

(9)

Approximately 5400 genes code more membrane proteins. This is because proteins in the cell Membrane proteins are important in human health. For example, the CFTR protein is a channel protein which allows movement of chloride ions into mucus. Without a properly functioning CFTR protein, like people with cystic fibrosis, have chloride ions couldn't move out in such quantity and therefore water also wouldn't move out and we're left with thick and sticky mucus which can cause respiratory, digestive and reproductive problems. In addition, Ion transport across membranes is also important in synapses. Without transport of calcium ions in a presynaptic membrane, neurotransmitter wouldn't cross the synaptic cleft and then sodium ions couldn't be transported channels couldn't be opened in order to send the impulse. Muscles couldn't contract with calcium ions flooding in through channels to bind to troponin because tropomyosin would never move to open up the myosin-actin binding site. However,

Question 7

All the question parts in question 7 are based on the pre-released scientific article

7(a)

Many students produced complete responses that gained 4 or 5 marks. Marks were often lost when students confused the sequence of events or used the term signals to describe the impulses or action potentials generated in the optic nerve. This response gained four marks (MP1, MP3, MP5 and MP6).

(a) Describe how 'eyes relay visual information' to the brain (paragraph 2).

(5)

Light stimulus is absorbed by rods and cones to determine colour. Rods contain rhodopsin. In light, rhodopsin breaks down into retinal + opsin. Opsin causes a cascade of events; ~~Voltage~~ Na^+ diffuses out of axon (inner segment); this generates negative charge inside ~~axon~~ inner segment. No glutamate is formed.; action potential can then pass down to neighbouring neurone. This has a generated action potential; This action potential then is received by optic nerve which then sends impulse from both eyes to brain (occipital lobe) and ~~person~~ reaction is coordinated.

7(b)

Many students provided good responses that gained both marks. Some students suggested that L-dopa acts in place of dopamine so did not gain marking point 2.

7(c)

Students struggled to provide responses that gained many marks. Often referring to blood vessels rather than arteriole (MP2) or capillaries (MP1). To gain marking point 4 students needed to describe the movement of white cells from the blood into the tissue space. Many described increased permeability and leaking of plasma without making any reference to white blood cells and did not gain the mark. Relatively few students suggested that cytokines or chemicals attracted the white blood cells to the site (MP5).

This response gained all four available marks (MP1, MP2, MP3 and MP5).

(c) 'Innate immunity initiates the inflammatory response, in which white blood cells swarm the site of infection' (paragraph 5).

Explain how white blood cells 'swarm' to accumulate at the site of inflammation.

(4)

→ Damages to white blood cell causes histamines to be released from mast cells
→ This causes arterioles to dilate, thus resulting in a larger amount of blood travelling to site of inflammation
→ Capillary walls become more permeable, causing cell separation, therefore more fluids leave the capillary, forming tissue fluid that could result in odema.
→ ~~Blood~~ White blood cells arrive at site of infection when there is a pathogen present and is presented on an APC, releasing chemicals that attract these cells to the site of infection.

This response gained two marks (MP1 and MP4).

(c) 'Innate immunity initiates the inflammatory response, in which white blood cells swarm the site of infection' (paragraph 5).

Explain how white blood cells 'swarm' to accumulate at the site of inflammation.

(4)

• White blood cells (mast cells) at the site of inflammation release a chemical called histamine.
• Histamine causes capillaries at the site of injection to become 'leaky'.
• Monocytes that are in the blood are able to squeeze through the 'leaky' capillaries and reach the site of injection.
• Monocytes grow into macrophages once they monocytes leave the capillaries.

7(d)

A number of students gained both available marks usually for marking points 1 and 2. Very few students tried to suggest why attaching to the endothelial cells would allow white cells to cross the blood-brain barrier (MP3 and 4).

This response gained two marks (MP1 and MP2).

(d) The protein α4β1 integrin projects out from the cell surface membrane of white blood cells.

Deduce how molecules such as α4β1 integrin help immune cells cross the blood-brain barrier (paragraph 8).

(2)

- Molecules such as a 4β1 integrin can bind to receptors on the endothelial cells that make up the blood-brain barriers.
- This allows the immune cells to cross the barrier and enter the brain.

7(e)

A disappointing number of students suggested that an ethical argument in favour of animal experiments was that humans have more rights than animals. These responses did not gain a mark. The most frequently seen correct answer was that benefits outweigh any harm (MP1). Marking point 2 was for the idea that the rats and mice have a well-developed CNS or a CNS similar to humans.

7(f)

Most students have a reasonable understanding of the process of antigen presentation. However, many students did not gain marking point 1 because they framed their answer in terms of pathogens, bacteria or viruses. Marking point 1 was for reference to phagocytosis of antigen and not phagocytosis of a pathogen. This response gained two marks (MP1 and 2).

(f) 'The lymphatic vessels also ferry antigens—substances capable of inducing an immune response—from the tissues into tissue-draining lymph nodes, where they are presented to immune cells' (paragraph 15).

Describe how these antigens are presented to immune cells.

(3)

Phagocytes detect antigens and engulfs them. This causes antigen to be destroyed by phagocytosis and presented on surface of phagocyte cell, ∴ phagocyte becomes an antigen presenting cell.

This second response also gained two marks (MP2 and MP3).

Describe how these antigens are presented to immune cells.

(3)

The macrophage engulfs the bacteria that contains antigens on its surface so that the macrophage becomes an antigen presenting cell (APC). This APC then binds to a complementary CD4 receptor on T-helper cells so that T memory cells are made. This can also happen to B cells as B cells can bind to antigens so they become APCs and this they then they bind to a T-helper cell to release cytokines and this stimulates the B cell so B effector cells are made and plasma cells are made.

7(g)

Many good responses were seen to this question. Interestingly, many students suggested that cytokines act to prevent the release of neurotransmitter rather than act as a neurotransmitter. However, students frequently completed the answer well describing a sequence of events that affect the generation of an action potential in the post-synaptic neurone. Answers in terms of either an increased or a decreased likelihood of an action potential were accepted.

7(h)
Student struggled to provide complete answers to this question. Many students gained two marks (MP2 and MP4). Mark point one required the idea that both neurones have a cell body that contains a nucleus. Most students made no reference to a nucleus. Very few students referred to dendrites and terminal branches (MP2).

7(i)
Many students demonstrated some understanding of what is meant by the term critical period. Unfortunately, responses often lacked the detail required to obtain marks. In marking point one it needed to be clear that the critical period is a period of time in development or early in life. For marking point two the response needed to refer to strengthening synapses not neurones.

7(j)
One of the main points of this article is that the immune system might be considered as a sense organ and that it may play a role in normal development of the CNS. Few students seemed to appreciate this and the answers to this question often focussed just on development of the immune system rather than the CNS. As a result, marking point two was only infrequently awarded.

This response gained one mark (MP2).

Explain how this critical period could be investigated using animal experiments. (2)

testing their sentes such as smell, touch, taste, sight and hearing by seeing how they react to changes in environment of stimuli at different stages in development.

This second response also gained one mark (MP1).

Explain how this critical period could be investigated using animal experiments. (2)

They could use young newborn animals who have not yet been vaccinated against certain diseases and compare to newborn animals who have been vaccinated. They could then analyse the no. of immune cells reaching the brain.

7(k)
Many students had a good understanding of the process of producing a recombinant protein such as a cytokine and produced answers that gained all four marks. For marking point 1 candidates needed to make reference to the cytokine gene. For marking point 3 both the DNA containing the cytokine gene and the plasmid needed to be cut with the same restriction enzyme.

7(l)
Many students gained both marks for correctly suggesting that bone marrow contains stem cells that can differentiate into white blood cells. Very few students appreciated that the transplant would need to come from a donor, and not the affected individual, in order to restore the defective component.

Paper Summary

Performance in this paepr was significanlty below that of previous series. This is probably the result of disruption to teaching and learning associated with the covid pandemic.

Based on candidate performance on this paper, candidates are the offered the following advice:

- Make sure you fully understand the command words being used so that you tailor your answers to the questions being asked
- Read the whole question so you appreciate the context of the question
- When provided with data in a question, make sure you consider it carefully
- Use the mark allocation as a guide to the detail you need to offer in your response
- Make sure you show clear working in calculation questions in case you make a mistake in your final answer
- As the question relating to the article is worth about 30% of the marks on this paper, give the article due consideration
- Consider carefully the 9-mark question
- Time permitting, read through your answers to make sure they are unambiguous
- Make sure your writing is legible at all times.

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