BIOLOGY (315116)

FEEDBACK FOR STUDENTS AND TEACHERS

Overall the feedback provided on the final examination paper was positive. The exam was recognised as one that generally had a good range of questions, in most sections, to give the candidates a chance to show their abilities. Some parts of the exam were considered lengthy and students needed time management skills to finish the paper on time. All parts were generally well attempted by the 800 candidates who sat the 2018 Biology exam.

SUGGESTED MARKING SCHEME AND COMMENTS

Suggested answers with mark allocations for each question are given in the following section along with comments on candidates' performance in the exam. Marking examiners have provided specific comments on aspects such as how the question was assessed, where candidates gained and lost marks and where candidates misinterpreted questions. Comments on the open-ended questions may necessarily be limited to general comments rather than specific details.

The suggested answers are by no means prescriptive and a number of them go into greater detail than would be required to gain full marks. Candidates providing different but valid answers were given credit for any points that addressed the criterion and relevant to the question.

PART 1

QUESTION 1

a) B (1)

b) A: Contents need enzyme and substrate to work (1)

C: temperature is not constant for different pH levels/ two independent variables (1)

D: pH is not varied and it is the independent variable for the hypothesis (1)

COMMENTS

Many candidates received full marks (4 marks was the modal score), and only a few received no marks.

In part A, around 30% of candidates incorrectly identified the most appropriate design as 'A', because they did not mention that a substrate needs its enzyme to catalyse the reaction. This meant that they were also penalised one mark in part B, as they needed to identify the three designs that were unsuitable.

Some candidates lost half marks by providing only part reasons for why each design was unsuitable. e.g.*: 'Design C was unsuitable because temperature is not constant'* received half marks.

QUESTION 2

a) Include some or all of the following:

DV: Average number of beats per minute as measured by a computer/camera/observer. (1)

IV: Water temperature (oC) as measured by a thermometer/controlled water bath attached to a computer. (1)

Control: The control group would have been the group at 10OC as this is their normal temperature (1/2) and provides a baseline comparison for the other groups. (1/2).

OR

The data collected at each temperature can be used to compare to the data at different temperatures (in-built control) (1/2 mark) to see whether the number of beats increased with an increase in water temperature (1/2 mark).

Sample Size
Each group would be made up of a suitably large number of crayfish (20+) (1/2 mark), which would help avoid errors due to chance variation (1/2 mark).

b) Set-up
The groups could be picked randomly from a larger group (1/2), or selected in such a way to avoid variations between groups (1/2) due to size, age, sex, health etc. (1/2) to minimise impact of differences due to these variables (1/2).

Alternatively, you could use the same group and gradually change the temperature (1/2), giving them time to get settled in the changed temperature (1/2), this would avoid any variables between groups that could adversely affect the results (1/2).

Replication of more than one water tank/bath at each temperature increment (1/2) could be used to verify data collected (1/2).

Fixed variables

Temperature baths would be set up and maintained at a constant temperature for each test group (1/2).

The other fixed variables in the temperature baths would be maintained at a constant level as much as possible (1/2), e.g. water used, salt concentration, light, size of the baths (1/2). In particular oxygen concentration should be measured (1/2) and extra air bubbled through as needed to make sure that the water is kept as close to the same concentration as possible (1/2).

Data Collection

Observations would be made of gill beats over a period of around 10 minutes and averaged (1/2) or measured at different intervals of a minute over a period of time and averaged (1/2) to limit chance variation (1/2), any outlier results could be discarded (1/2).

c) Results support the hypothesis (1/2) up to around 30 degrees as the beats increase from 16 to 64 (1/2)); at 30 to 40 it remains constant at 64 beats per minute (1/2) which doesn't support the hypothesis. At 50 degrees, there is a sudden decrease to zero (1/2), where presumably the crayfish have died (1/2). Overall the results negate the hypothesis. (1/2)

d) The conditions used should not overly stress or harm the crayfish, certainly not kill them, so the maximum temperature should be limited to 40 degrees or less (1).

Start a lower temperature, say 5 degrees, to see if any difference is found at a temp that is lower than their normal temp (1).

Test the effect of changing oxygen concentrations at the different temperatures. e.g. Go up in 5o C or 2 o C increments (1)

COMMENTS

a) Candidates found it difficult to write a sound method. Many candidates stated that the experimenter should have included a control, fixed variables, sample size but failed to explain or define what they should be. Other candidates identified the control was the normal water temperature, but failed to identify the significance of the control. Similarly, fixed variables were listed with no reference to the importance of why they needed to be kept constant. The average mark was 3 – 3 ½.

b) Very few candidates discussed the data by referring to the table and then linked it to the hypothesis.

c) This part was well done, with a majority of candidates choosing to remove the 50° C water temp due to ethical concerns. Some credit was given to candidates who wanted to increase sample size or introduce a control if they had not mentioned these experimental design aspects in part a.

QUESTION 3

a) Dependent variable: Rate of photosynthesis

Independent variable: Light intensity

(Candidates who wrote photosynthesis or light were given ½ mark).

b) Increasing the Light Intensity will increase the rates of P/S differently for the two species due to differences in compensation points (or different chlorophyll or etc.)

(1 mark IV 1 mark DV and 1 for reason)

c) Species A photosynthesises better at lower light conditions up to point X (½), but not at the higher light intensities (½) as its rate of photosynthesis drops to zero. Species B, rate of photosynthesis increases steadily with increased light intensity up to point Y (1).

The optimum level for species B cannot be confirmed with the data provided, however, it is likely to be beyond point Y on the graph.

COMMENTS

Overall question 3 was answered well with the majority of candidates receiving more than 3 out of 6 marks. Candidates showed a solid understanding of the relationship between dependent and independent variables and a basic ability to write a scientific hypothesis.

A mistake in part (a) by some candidates was the variables being written in the wrong order. Most candidates however gained the full mark.

Part (b) required candidates to give a reason for the cause and effect between photosynthesis rate in plant species A and B and the light intensity. A large number of responses compared species A and B without giving a reason or a link to light intensity. A lot of hypothesis written by candidates were too simple and simply stated that photosynthesis is dependent on light. Majority of responses gained 1.5 to 2 marks.

Part (c) A common issue in this question was candidates trying to relate the graph to enzymes denaturing rather than focussing on the differences between optimum light levels. Candidates who simply stated A had an optimum light level of X and B had an optimum light level of Y were given half marks as they needed more detail.

QUESTION 4

a) Process: Cellular respiration or aerobic respiration (1). Respiration was given ½ mark.

b) The 4 minute period is to allow the set-up to stabilise at 30°C (½) to make sure that the temperature, O_2 and CO_2 levels were accurate for the start of the experiment (½).

c) Ensure that the oxygen, CO_2 & temperature levels are the same level at the start of each trial each day, allowing comparability of results.

- Build in a control with identical conditions without the cockroach for comparison
- Test using a number of cockroaches and get an average to account for individual variation.
- Keep the cockroaches' diet constant so they have equal capacity for cellular respiration
- Use an electric cooler instead of ice packs to avoid variation in the cooling process

- Run each experiment at the same time each day in case the activity of the cockroaches varies on a daily rhythm

Extensions to the experiment (such as use other temperatures or use other species of cockroaches) were given ½ mark.

Not given credit: Measure each temperature for the same length of time. This is not an improvement as the gradient of the graph, which indicates the rate of cellular respiration, can be calculated over a short or long period of time.

(½ mark for identification and 1 mark for explanation of each measure)

d)

(i) The level of carbon dioxide rose more steeply (from 0.04 to 0.07 over a 10 minute period) when the temp was constant at 30 degrees than at decreasing temperatures (from 0.07 to 0.09 over a 20 minute period). The consumption of oxygen was at a higher rate also at the higher temperature and decreased as the temperature fell.

(ii) A maximum of 2 marks was given for: the data supports cellular respiration (use of O_2 and production of CO_2) is occurring (½) and that the rate of respiration decreases with decreasing temperature (1) as shown by:

- At 30° C the CO_2 increases by 0.03% in 10 minutes while the O_2 decreases from 22.5 – 17.5% (½)
- At 10°C over 10 to 30 minutes the CO_2 levels increased by 0.02% and the O_2 levels decreased by 2% (½)

However, while the experiment was repeated six times, only one cockroach was used, which could be argued is not a representative sample (1). Sample size should be larger (replicas should be included) (½); one cockroach does not consider any genetic variation in the species (½).

No negative control (no cockroach) for each temperature range (1).

COMMENTS

a) The majority of candidates wrote cellular respiration, some wrote respiration.

b) Very few candidates realised that Pat recorded for four minutes until the setup stabilised. Most said it was to collect more data which made the results more reliable, with increased validity and to allow an average to be calculated. No credit was given for these suggestions.

c) Many candidates did well but many did not offer suggestions for improvements to the experimental design which would make the results more reliable.

A lot of candidates wrote suggestions for which they received ½ mark but they did not write an explanation of how it makes the results more reliable.

d)

(i) The majority of candidates received 2 marks for this question, having written clear descriptions of the four sections of the appropriate graphs. Some candidates received one mark for describing the graphs either at 30°C or when the temperature was decreasing.

(ii) Very few candidates scored full marks for this question. Few stated that the rate of cellular respiration was higher at 30°C than when the temperature was decreasing even though they stated it in their answer to Part (i). Also, few candidates mentioned the points from Part (c) as problems with the experimental design or the validity of Pat's data.

QUESTION 5

Any 4 points from the following (or other logical responses):

- Sample size needs to be much larger and represent a suitably wide cross section of people, so other factors need to be considered, such as age, diet, health, gender, genetic background (1).
- A control group of people who don't smoke but have the same average backgrounds need to be included. (1) To give a definitive link between smoking and cancer (i.e. lung cancer is not caused by other factors or naturally occurring in normal populations) (1)

- Exposure to passive smoke or other carcinogens needs to be taken into account (1) as well as the level number of cigarettes smoked currently as well as length of time smoking needs to be factored in, to show whether the effect of smoking on lung cancer is dose related. (1)
- Conclusions regarding cause can't be drawn from one small study when there are so many other variables involved, it would need to be repeated (1)

COMMENTS

This question was done very well with a large number of candidates scoring full marks. Those who did not, either stated ways the investigation could be improved without giving any explanations or they filled their writing space by providing too much detail on only one or two improvements.

PART 2

QUESTION 6

a)

(i) Process: cellular respiration (only ½ mark for either aerobic OR anaerobic respiration). Some oxygen is consumed as levels drop from 21 to 18% suggesting some aerobic respiration (1) however ethanol is an end product of anaerobic respiration in plants and as this goes from 0 to 4 % anaerobic respiration must be occurring (1).

The airtight lid means restricted oxygen supply, so when this runs out the respiration will be predominately anaerobic (1).

Full marks for noting that both aerobic and anaerobic respiration have occurred and referring to the table to show the decrease in oxygen and increase in ethanol.

(ii) Gas: Carbon dioxide *(½ mark)*

Increase or decrease: Increases *(½ mark)*

b)

(i) **Factor A** (Graph A): Temperature or pH (1) or Light at time of Day (1)
Reason: Temperature - Photosynthesis increases until the temperature gets too high and the stomata close (to prevent water loss) and CO_2 availability decreases. Or Low temp – slow molecular movement so enzyme substrate collisions are low. As temp increases, collision rate increases, but eventually denaturing reduces effectiveness of collisions until no collisions effective and so P/S ceases.

Similar argument for pH

Light/Time of day – Photosynthesis with available light (intensity) during the day and will not occur in the dark.

Factor B (Graph B): Carbon dioxide or a substrate/reactant in P/S or light (in laboratory conditions)

Reason: increases in CO_2 or light initially result in an increased rate of photosynthesis until other factors become limiting so it plateaus out.

If candidates choose light for both factor A and B they then need to discriminate that A is due to normal conditions and B is under laboratory conditions.

(ii) Measuring the inputs and/or outputs of photosynthesis, so the change in carbon dioxide and oxygen could be measured in an enclosed container holding the plant or the increase in plant tissue could be measured as new growth comes from photosynthesis (2). Both gases need to be measured with the plant in the dark to give a baseline comparison for cellular respiration's effect (1).

COMMENTS

a)

(i) Most candidates only chose either aerobic or anaerobic respiration and ignored the other information from the table. Others noted the two substances changing but still only chose one type of respiration. Many candidates may have thought that the words "main specific process" meant they could ignore the 3% change in oxygen in favour of the 4% change in ethanol.

(ii) Almost all candidates got this question correct.

b)

(i) Factor A - Most candidates chose temperature as the factor and used the explanation that the enzymes worked slowly at low temperature etc. Others used the argument that the increasing temperature caused water loss and so the leaves' stomata closed and so there was not enough CO_2 to sustain P/S.

Factor B – Most candidates chose CO_2 concentration or Light Intensity and gave a satisfactory explanation. Overall this question was done well, but the spelling of the word plateau was extremely varied.

(ii) This question was only partly answered by most candidates as they gave a good explanation of the quantities that could be measured to determine the rate of P/S but most candidates ignored the second part (including how you could ensure that you were determining the rate of photosynthesis alone). This meant that they didn't talk about a baseline measurement of R/S in the dark so they would know how much O_2 was being used up or CO_2 being released by the R/S process that was continually occurring even while P/S was occurring.

Some candidates recognised the need to account for the CO_2 produced by R/S but didn't find a satisfactory method to account for it. A few candidates tried a respiratory inhibitor to stop it and others removed all the oxygen from the plant's atmosphere to stop R/S.

QUESTION 7

a) An enzyme is specific because it has a conformational and chemical attraction between the active site and one substrate.

A link between specific enzyme and specific substrate (1/2)

Enzymes active site binding to a specific substrate (1).

b) This specificity is achieved by the unique shape of the active site formed in the protein structure (1), which induces a fit with the substrate (1),

Protein structure – enzymes active site – substrate – induced fit.

(link between these, ½ mark each).

c) 2 marks for lemon juice explanation; ½ mark for each suggested treatment (explanation not required)

Lemon juice being an acid, lowers the pH in the area of the cut (1), as enzymes rate of reaction varies with pH and adding acid means that it is no longer at the optimum pH and therefore the rate of reaction is greatly reduced (1).

Two other treatments would be heating/cooking OR cooling/freezing which would mean that the temperature in no longer optimal for enzyme function (1).

Alternatively you could add an enzyme inhibitor that would block or compete with the active site (1).

Treat with a non-toxic alkaline solution, such as sodium bicarbonate (or another food acid such as vinegar) (1).

½ mark for each treatment.

2 marks for explanation.

d) Shape: B (1)

Reason(s): Shape B is shaped so that it could be induced to fit in the active site and so block / compete with the normal substrate (1).

½ mark for block/compete/etc. ½ mark for induced fit.

COMMENTS

About 50 candidates were below 2 marks, and approx. 80 between 6 -8 marks (3 achieving full marks). In 7 d most candidates answered B and could say the drug blocked/prevented/competed with the substrate, however only a few referred to it as an induced fit. 7b many received 1-1.5 marks as they wrote about the active site and substance, but also required induced fit and reference to protein structure.

QUESTION 8

a) Process: TRANSCRIPTION (1).

Description: DNA (unlabelled) is located inside the nucleus. DNA is a double helix polymer of nucleic acids containing the GENETIC CODE. The DNA strands partially separate and one strand acts as a TEMPLATE to produce many small strands of MESSENGER RNA (labelled Q). The gene coded by a short segment is transcribed into mRNA. COMPLEMENTARY BASE PAIRING (A-T or A-U & G-C) ensures the FIDELITY of the genetic code. The mRNA then LEAVES THE NUCLEUS through the pores in the nuclear membrane. (1).

b) Process: TRANSLATION (1).

Description: TRANSFER RNA (labelled E) carries a specific AMINO ACID (labelled F) dependent upon the ANTICODON (labelled G) they possess. The anticodon on the tRNA COMPLEMENTS the CODON (unlabelled) on the mRNA between the large and small sub-units of the RIBOSOMES (labelled S). As tRNA binds to its complementary codon, the amino acid it carries adds to the lengthening POLYPETIDE chain. Ultimately, the code found in the gene of the DNA translates into a polypeptide (protein). The protein produced possesses some biological function. Complementary base pairing of codon to anticodon again ensures fidelity of coding and a specific polypeptide is made according to the genetic code found within the DNA. (2).

c) MITOCHONDRIA produce ATP to supply the energy needed for the production of protein on the ribosomes of the Rough Endoplasmic Reticulum (RER).

RER can channel and package protein into vesicles. (1)

GOLGI BODIES modify protein by the addition of carbohydrates and lipids. (1)

CHLOROPLASTS form glucose to act as the energy source. (1)

QUESTION 9

a) Reaction 1: Oxidative phosphorylation or respiration (1/2) takes energy from glucose and stores it in the phosphate bond to form ATP from ADP (1). Anaerobic respiration yields 2 ATP while Aerobic respiration yields 36 (1/2).

Reaction 2: DE phosphorylation of ATP or cell metabolism (1/2) occurs when the phosphate group is removed, releasing energy (1). This energy is used for cell processes such as active transport, cell repair and mitosis etc. (1/2). The resulting ADP from this reaction can then be recycled and used over and over again (1).

b) GLUCOSE (1) is a SMALL, SOLUBLE, molecule that PASSES cell membrane. Respiration of glucose produces simple waste products of carbon dioxide and water. Alternatively, respiration of amino acids would produce TOXIC nitrogenous waste and lipids such as triglycerides and fatty acids are POORLY SOLUBLE in water (1).

c) For building and repairing chemical structures e.g. Calcium is essential for building bones and teeth (1).They can be important for chemical reactions, as to assist enzyme function, as well as for other things like nerves firing, blood clotting (1).

OR

Other logical substances and relevant reasoning:

- Water for transport of ions/substances/dissolving of gases/thermoregulation
- Ions for concentration gradients in osmosis (i.e. Kidney ultrafiltration)

Candidates needed to state the inorganic substance with the process to clarify they knew what inorganic substances were.

COMMENTS

The vast majority of candidates attempted this question with most showing some knowledge of the energy pathway. There was a mean score of 2.5 achieved in this part. Candidates should be reminded that even though the information sheet is available they will not gain many marks by copying information from it.

Other points to note:

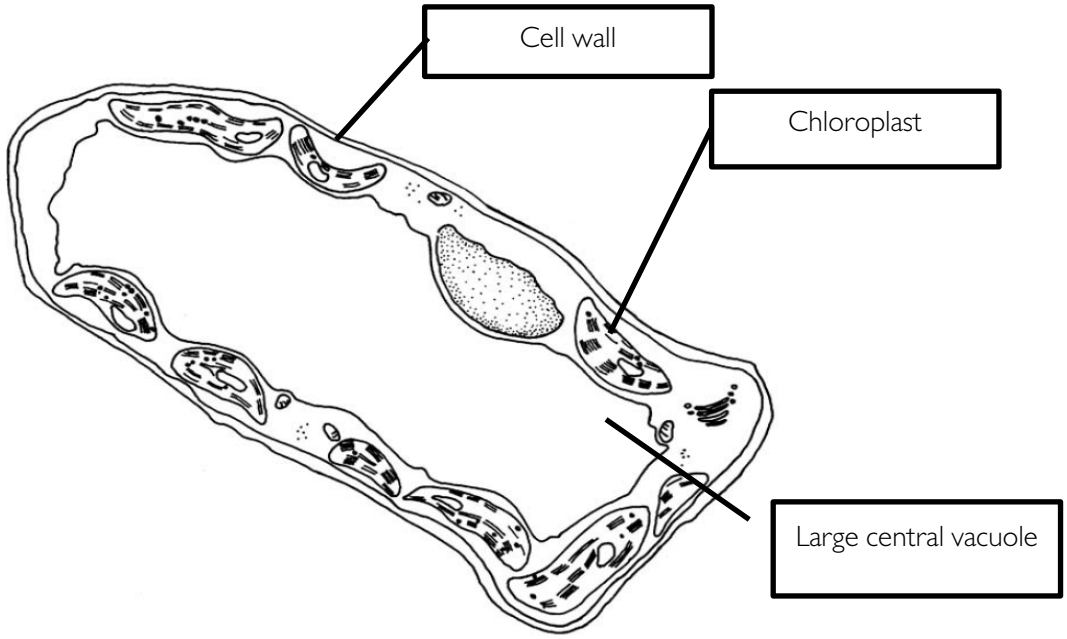
- About half of the candidates failed to mention that the ATP molecule is reused
- Lack of understanding of the role of glucose in joining phosphate molecules
- Candidates thought ADP was the storage molecule for energy
- Candidates were including unnecessary information about the kerb cycle and electron transport chain
- More specific examples were required to gain marks when discussing the importance within the cell.

25% of candidates did not attempt the questions and approx. 25% did not achieve a mark. There was confusion between inorganic and organic. Candidates wrote down a process but did not relate it to an inorganic substance. Many candidates talked about the importance of glucose making energy, but omitted the importance of oxygen and phosphate.

PART 3

QUESTION 10

a)



b) ½ mark for tissue type; ½ mark for type of organism; ½ mark for the reason why

(i) Cell W: Cell tissue/type: mesophyll Type of organism: green plant
Reasons: cell wall indicates plant cell and chloroplasts indicate photosynthetic tissue in a eukaryotic plant

(ii) Cell X: Cell tissue/type: muscle Type of organism: vertebrate animal
Reasons: animal cell as it lacks cell wall, and requires energy as it has many mitochondria

(iii) Cell Y: Cell tissue/type: NA /single celled organism Type of organism: bacteria
Reasons: lacks nucleus and membrane bound organelles so prokaryotic, has cell wall therefore most likely a bacteria.

(iv) Cell Z: Cell tissue/type: root/epidermal cell Type of organism: plant
Reasons: more passive processes in cells indicated by few mitochondria, non-photosynthetic eukaryotic plant cell as it lacks chloroplasts but has a cell wall.

QUESTION 11

a)

(i) Process: Endocytosis (1)

Explanation: the substance involved is too large to be able to be taken through the membrane (1)

OR

Process: Diffusion (1)

Explanation: Diffusion is a passive process (1/2) where substances (solutes) move down a concentration gradient into cells (1/2).

(ii) Process: Active transport

Reason 1: is being transported against its concentration gradient (from low concentration to high concentration)

Reason 2: a charged particle unable to be moved across the membrane OR structure is incompatible (e.g. not fat soluble) and therefore unable to pass the membrane

Reason 3: substance Y is too large to pass through the phospholipid bilayer.

(iii) Structure C are either glycolipids or carbohydrate chains that act as receptors for the cell. (1).

b)

(i) Diffusion is occurring (1) Salt will move from high to low concentration (net movement being along the concentration gradient) (½) i.e. left to right, in order to achieve an equilibrium (½). It is a passive process (½). Any 2 of the last 3 points would be sufficient for the second mark.

(ii) Osmosis is occurring (1) There will be a net movement of water molecules across the membrane from right to left by osmosis (1), i.e. from areas of low osmotic concentration (high water potential) to areas of high osmotic concentration (low water potential) in order to achieve an equilibrium (1).

(iii) Osmosis is responsible for the change of water levels as there is a net movement of water from right to left (1).

c) Animal cells only have a cell membrane around them that is incapable of withstanding the osmotic pressure (½), however plant cells also have a cell wall that can withstand it (½).

COMMENTS

There was only one student in the state who made no attempt to answer this question.

a)

(i) Many candidates thought that they needed to justify their choice of process whereas the question asks them to explain the process. Any mention of aspects of the process (e.g. diffusion is a passive process) given in this justification were given credit, even though the answer may not have strictly addressed the question that was asked.

(ii) The common answer of '…may require energy to move across the membrane…' did not attract any marks. Reasons needed to go beyond this to say why the energy was necessary to move the substance across the membrane – e.g.: moving against a concentration gradient. A number of candidates thought that the mode of transport was facilitated diffusion, presumably because of the involvement of the protein channel in the passage of substance Y. They failed to notice that energy was expended in its movement. Worryingly, there were quite a high number who equated active transport with facilitated diffusion.

(iii) This part was poorly answered because candidates assumed that the reason that structure C was located on the outside of the membrane was to do with transport processes rather than membrane structure and function. There were a lot of answers to the effect that structure C was too big to move across the cell membrane to enter the cell. The question does not ask for identification of the molecule and therefore this was not given any credit in the allocation of marks.

b) Many candidates missed the information in the question about the fact that the membrane was permeable to both salt and water. This led to erroneous answers to part (i) of this question. Candidates were required to mention equilibrium, at least indirectly, to gain full marks in part (ii). This was also desirable as part of the answer to part (i). Answers to part (iii) which gave 'osmosis' as well as some information about the movement of water were given full marks.

c) There was a common misconception that plant cells are isotonic to distilled water while animal cells are hypotonic to it and thus this is why plants cells do not lyse while animal cells do when placed in distilled water. A further common misconception was that the vacuole in plant cells was a contractile vacuole and was used for osmoregulation.

QUESTION 12

a) As cells get bigger, the volume increases at a greater rate than the surface area.

OR

As the cell size grows the surface area to volume ratio decreases.

OR

Any correct statement expressing this relationship.

b) Cells need to exchange materials such as nutrients and waste products with their environment through their cell membrane (1). A cell with a larger volume must support this with more metabolic activity. (1) A large SA:V means more capacity for material exchange as there is more surface area supporting the volume (1), with smaller diffusion distances (1).

This is particularly important for cells that have a secretory role (such as those secreting enzymes) or absorption role (intestinal epithelium) that have higher metabolic rates (1). A small SA:V would be more beneficial to cells storing substances (such as fat/adipose cells), with a lower metabolic rate, as they need to contain material and not exchange it (1).

At least two examples of cells needed to be included for full marks.

COMMENTS

Common mistakes: giving examples of organisms or organs rather than cells, e.g. elephant VS mouse, surface area of lungs and digestive system. Equating metabolism and efficiency with the need to keep warm rather than the rate of cellular respiration required in the cell, or how effective the cell is at supplying its needs.

Overall most candidates scored 2-4/6, with about 5% scoring 0 and 5% scoring close to full marks. Most candidates attempted this question although some just included statements taken from the information sheet, which did not address the question and received no/little credit.

QUESTION 13

a)

(i) One full set or diploid or 2n, doubled (1)

Also accepted: 2 sets or 46/48 chromosomes (1/2)

(ii) Twice (1)

(iii) Meiosis (1)

b)

- Crossing over (1)
- Sections/parts of homologous chromosomes (0.5) (or sister chromatids) are exchanged/swapped in meiosis (0.5)
- This enables/creates genetic variation/diversity of the gametes (1)

OR

The alleles from maternal and paternal lines are exchanged and creates genetic variation of the gametes (1)

COMMENTS

a)

(i) Many candidates presumed the stages depicted in the division of a cell were human thus focussed on the amount of chromosomes relevant to human. Some misread the question and noted that the division was meiosis thus thought it would be half a set or 23 chromosomes – however, at stage 4 on the image this would not be the case.

Many candidates only gained 1/2 for this question.

(ii) This part of the question was very well answered – although common errors included a range of answers from 1 time, 3 times and multiple times.

(iii) The majority of candidates got this answer correct (only a few said that the process was mitosis). Candidates were not penalised for incorrect spelling, as long as it was evident they were trying to write meiosis.

b) Most candidates could identify that this was a process that occurs in meiosis and correctly name the event as 'crossing over'. Although a common term was 'swapping or swap of chromosomes'- this is not an accurate name. Another error candidates made was to say that a mutation was occurring or that the event was random assortment/independent assortment.

The second aspect of this question – describing the event occurring was not well answered. Very few candidates could identify and accurately describe that homologous chromosomes exchanged segments. Many candidates just mentioned chromosomes rather than homologous chromosomes, and/or that chromatids are swapped rather than a section of. Just mentioning chromosomes switch or switch parts is not enough specific detail. It was very common that candidates did not address this aspect of the question.

Many candidates could also identify the biological significance of this event in terms of increasing genetic diversity/variation of gametes and gained 1 mark. However, only 0.5 mark was given if a candidate simply said to increase diversity/variation without linking back to gamete (as this response was too broad).

PART 4

QUESTION 14

a) Alternative: B (1)

Explanation: Arteries have thick muscular walls as they carry blood under pressure from the heart (1)

Veins carry blood at lower pressure and need valves to assist the return of blood to the heart, thin walls (1)

Capillaries are one wall thick to maximise the efficiency of exchange of materials to cells (1)

Candidates may also gain marks for ruling out why other statements are incorrect.

b)

(i) Oxygen percentages drop by over 4% as this is being used in the body for aerobic respiration (1), this is equivalent to the increase in CO_2 which is the waste product of the same process and is to be expected (1).

Nitrogen is almost unchanged, which is to be expected as it is neither absorbed nor excreted by the body (1).

Water vapour will normally be saturated by the time the air is breathed out as the exchange surfaces in the lungs have to be moist for gas exchange to take place (1).

(ii) The amount of gas exchange depends on the rate of diffusion and the surface area that it is exchanged over (1). 375 million alveoli (with high SA: V ratio) means a very large surface area for gas exchange to occur across (1). Having less than 1mm thickness between the blood in the capillaries and air in the alveoli means a small diffusion distance, creating a rapid rate of diffusion (1).

COMMENTS

a) In general this question was answered well. The majority of candidates detailed structures to functions. Some candidates established why not to use the alternative options and gained some marks.

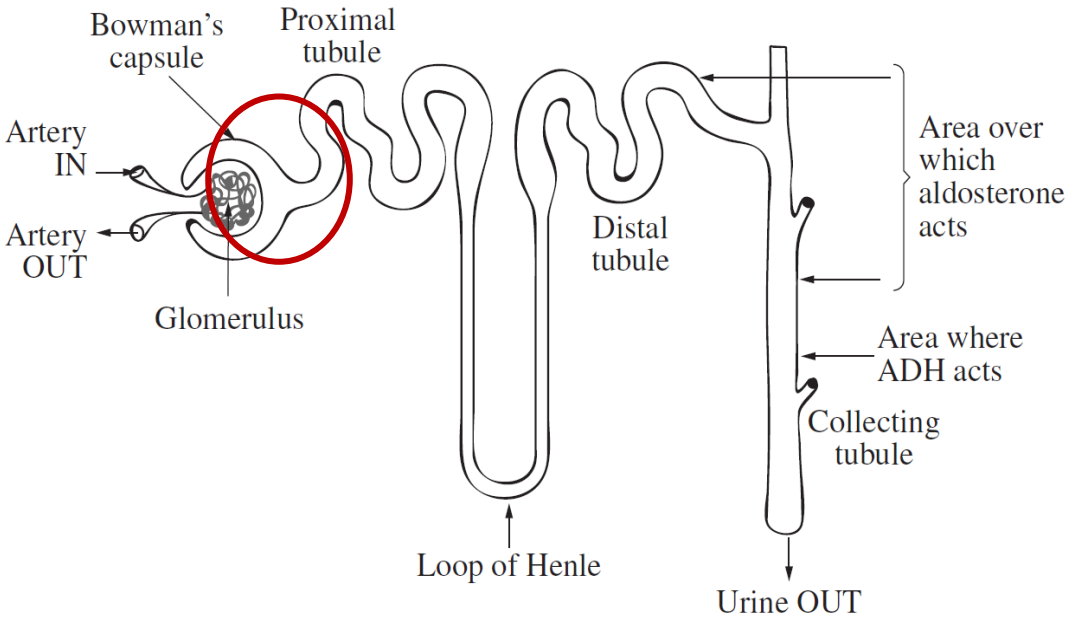
b)

(i) Few full marks were awarded on this question. The majority of candidates repeated the information given in the chart. Few actually related the information with the actual question: to "relate to the links that appear to exist between the gases". Some candidates related the change in % to the function of cellular respiration, while others related to human alveoli exchange in respiration. Half of candidates were confused about the Nitrogen content and assumed it was exhaled as waste. Half of the candidates related the water vapour as a product of cellular respiration.

(ii) Generally well answered by most candidates.

QUESTION 15

a)



b) ADH is important in regulating blood concentration. If blood concentration is too high (not enough water), then more ADH is released from the pituitary gland (1). This increases the permeability of the collecting tubules so more water is absorbed into the blood, which brings the blood concentration back to normal (1). This is a negative feedback mechanism for osmoregulation (1).

c) The loop of Henle reabsorbs water and salt, by maintaining a salt gradient.

COMMENTS

a) Answered very well by most candidates, however about 5% missed the question.

b) Answered reasonably well, but not many candidates received full marks because they missed that ADH is part of the negative feedback for osmoregulation.

c) Answered well by most candidates.

QUESTION 16

a) Each correct letter worth ½ a mark.

Pathway element	Corresponding Letter
Negative feedback response	E/F
Stimulus	A/F
Effector	D
Receptor	B
Control Centre	B
Message	C

For first two, 1 or 2 correct letters both worth the same, ½ a mark.

Markers approached this question in this way: if 1 correct letter and 1 wrong letter present, still give ½ a mark for the correct letter. If many letters in any one spot, no marks for that spot.

b) If the changes happen rapidly it is more difficult for the system to adjust. (1)

Takes time for the system to respond and adjust, levels may have varied again by the time response is enacted. (1)

Response continues until levels too low which acts as another stimulus to trigger another response, continues to vary within a range around the norm. (1)

System requires a variation in levels to begin the adjustment process, system cannot predict changes. (1)

The environment (stimulus) is not stable, therefore there will always be change to counteract by the body. (1)

Varying levels of cellular respiration (aerobic or anaerobic) produces varying levels of CO2 in the body. (1)

Varying levels of breathing and taking in various gases causes differing levels in body. (1)

Body undertaking different levels of activity will have different levels of CO2 due to different levels of pulmonary / cellular respiration. (1)

Body requires some CO2 for concentration gradient/ maintaining blood pH levels. (1)

Body can cope with some small variation, without needing to respond. (1)

Levels of CO2 vary in the body (½).

System efficiency can be affected by disease. (½)

Too many signals can lead to one being missed (½)

System can over compensate / overshoot in response to stimulus. (½)

It is a short term response (½)

System can only do so much, levels could get too high to counteract (½)

COMMENTS

Most candidates got around 2 ½ to 3 ½ out of 5 marks for this question. Only a very small number candidates did not attempt the question or got 0. The marks showed a normal distribution, with 3 being the most common mark. Not many candidates achieved the full 5 marks.

It was easy for candidates to pick up a couple of marks in the first part of the question. Most students would get the first two elements correct, as there was 2 possible answers for each. Many students also got the last two correct. The effector and receptor seems to be the hardest to get right, preventing many candidates from getting the full 3 marks.

It was also fairly easy for candidates to pick up another mark in the second part as most could think of at least 1 reason. However it was very rare for candidates to get full marks for the whole question because most would only put one reason in the second part.

QUESTION 17

a) NOTE: ½ mark for correctly named feature and 1 mark for explanation linked to minimisation of water loss. Any 2 of the following (or other reasonable response):

(i) Stomata (or Guard Cells) (½) when water availability is low will close to prevent water loss by evaporation/transpiration (1)

(ii) Stomata in sunken pits (or on the bottom of the leaf) (½) stomata are not exposed directly to sun and wind reducing water loss from evaporation (1).

(iii) Stomatal hairs (½) trap moisture leaving the stomata creating humidity therefore changing the concentration gradient to reduce water loss (1)

(iv) Waxy cuticle (½) is a layer impervious to water that retains moisture in the leaf (1)

b) February (summer): there is more available light so stomata are open at 5am for photosynthesis until 10am and again from 4pm to 6pm (½). When stomata are open, a transpiration stream occurs leading to a water loss of 4 units (1). Thus in the hottest part of the day (from 10am to 4pm) stomata close to preserve water (½).

June (winter): there is less available sunlight, so to maximise photosynthesis, stomata are open from 10am-4pm in the hottest part of the day (1). This is when up to 6 units of water are lost through transpiration (more than summer) (½), however as there is usually a high rainfall in winter, high rates of water loss can be maintained (½).

c)

(i) The phloem has been removed (½) EITHER as this tissue transports sugars from photosynthesis (½) OR only phloem transport downwards and the swelling is above the cut (it would be below if it were xylem/water) (½).

(ii) By removing phloem, the glucose made from photosynthesis in the leaves (½) cannot be transported below this point to the roots (½) to be used in cellular respiration (½) for active transport, growth and repair in roots/all cells → death.

COMMENTS

a) Candidates made mistakes in either being unable to identify features or explanations only 'because they stop water loss rather than the how/why. Some candidates thought spongy mesophyll soaked up water or wrote about xylem, phloem, cell walls and chloroplasts or identified features not shown on the diagram.

b) Candidates needed to mention stomata opening/closing, photosynthesis linked to transpiration and use data to gain full marks. Most candidates attempted this question and could gain a few marks.

(i) Most candidates identified phloem, but then did not say why. Those that indicated xylem were given 0 here, but then awarded marks in (ii) if they linked xylem to what would have occurred.

(ii) Most candidates just stated 'glucose couldn't travel anywhere' or similar without linking to the bigger picture.

QUESTION 18

K. subrubrum is an example of a wholly aquatic species that produces a high of quantity ammonia. By producing the most toxic waste, ammonia, turtles use no extra energy. Ammonia needs to be diluted with water and excreted quickly which is well suited to aquatic turtles.

K. erosa lives in damp places and they excrete mainly urea. This requires some energy to be converted from ammonia, but is less toxic. Excreting urea has a moderate water loss, but this is not a problem as they frequently enter water.

T. elegans lives in a dry desert like environment, where they must conserve their water. They mainly excrete uric acid, which requires little water. However, uric acid takes the most energy of all the waste products to produce and is also the least toxic.

COMMENTS

Answered reasonably well by candidates. Many candidates didn't explain all the advantages and disadvantages. Some candidates only obtained 1.5 out of 5 because they only related the turtle species correctly to the nitrogenous waste.

PART 5

QUESTION 19

a) The process involved is natural selection (1). Artificial selection was also acceptable (1) if the candidates noted human deployment of the poison.

Random mutation (½) leads to variation in the resistance of rats to warfarin (½).

Warfarin acts as a selective agent (½), causing increased mortality in less resistant rats (½).

The rats that have a higher resistance to it have a greater chance of breeding (½) and passing on their resistant genes to the next generation (½).

As resistant rats become more numerous in the population there is a shift in allele frequency (½) increasing numbers in the population to close to 100% (½).

b)

(i) There is genetic variation in the population of finches (1)

The different conditions across the various islands mean that there are different selection pressures that is different types of food sources favouring different beak shapes (1). So natural selection will favour different variations of beak type which increase chance of survival of the finch and the ability to pass on this favourable characteristic to their offspring (1).

Geographical isolation as finches nest on different islands which leads to reproductive isolation restricting gene flow (1) between populations, so these alleles and any mutations are not passed between populations leading to markedly different population in regard to beaks (1).

NOTE: A combination of any 3 marks that address the question were acceptable but candidates needed to state that variation already exists within the original finch population to gain the full 3 marks.

(ii) The different beak shape is a variation that exists within the finch population but this variance does not determine whether the finches are different species (1). To be a new species they would no longer be able to interbreed with other populations to produce fertile offspring (1).

COMMENTS

a) Overall, this was a relatively straightforward evolution question with clear selective agent (Warfarin poison) leading to change in phenotype of the rats. Most candidates scored at least 2 marks with the majority scoring 3½ or 4.

There was a considerable cohort of about 60 candidates who scored 0 marks despite writing a full answer to the question. Most of these incorrectly identified the change in resistance as a result of acquired immunity and subsequent antibody production.

b)

(i) Most candidates did not mention anything about variation existing in the original population of Sharp-beaked finches and so many candidates failed to gain 3 full marks. Many candidates did not identify that the selective agent or pressure was the food type on the islands and just gave general differences about climate.

A large proportion of candidates found it very difficult to describe evolutionary theory and reverted to a more Lamarckian approach. Comments such as: "finches will change their genes to fit the food type"; "beaks had to change to suit the environment"; "beaks developed due to different diet", did not gain any marks.

No marks were given if candidates simply stated what each bird ate by copying the diagram. Very few marks were gained by candidates who simply copied the definition of speciation from the information pages.

(ii) The majority of candidates did not read the question carefully and ignored the first part of the question completely and could therefore gain only 1 mark. This was a shame as most candidates could explain what determines a species in regard to producing fertile offspring. Only ½ marks were gained if candidates only stated that they couldn't interbreed or reproduce without mentioning fertile offspring.

A common error was to state that the finch populations were in fact still the same species, even though it was quite clearly stated in the stem of the question that speciation had occurred. Clearly some candidates did not read the opening paragraph.

QUESTION 20

a) Cloning is an example of asexual reproduction and means that the banana plants produced will be genetically identical (1).

Normal propagation are taken from a more varied range of plants than the clones and preserve more diversity (1).

The issue of limited diversity in the laboratory developed clones means that if environmental factors change then the bananas may not have the diversity to be able to adapt to those changes (1).

Other marks awarded:
Genetic diversity will be reduced/limited/decreased (1).
Appropriate impact on the genetic diversity of banana cropping in Australia (1); other impacts on banana cropping (1/2).

b)

(i) Long stems would appear dominant (1/2), allele represented by L, short stems l
The two long stems rose must have been heterozygous (1/2) to give roughly a 3:1 ratio in the new generation as shown below.
Ll X Ll

	L	l
L	LL	Ll
l	lL	ll

(1/2)

Other marks awarded:

It was expected (for full marks) that students would state that this was an autosomal inheritance pattern (1/2).

(ii) You would expect half heterozygous long stemmed (1) (Ll) and half homozygous short stemmed (ll) as shown below

	L	l
l	Ll	ll
l	Ll	ll

(1)

Half marks (1/2) were awarded to students who did not use autosomal representations in their Punnett Square. Other appropriate representations of portions were awarded full marks e.g. 50%, 1/2, 2/4 etc.

COMMENTS

a) Many students received 2 or 2.5 out of 3 as they did not address the impact on the diversity of Australian bananas. Several students completely misinterpreted the question and referred to aspects of the immune response. Some students recognised that planting the sucker and cloning were both asexual reproduction but only two students recognised that more than one disease-free banana plant could be used to clone bananas.

Common mistakes included a generalised belief that natural disasters (the ones identified were fire, flood and cyclones) would wipe out the entire banana population and cause extinction. Many students stated that a disease would wipe out the cloned disease-free bananas. Marks were awarded to those students who recognised that a **new** disease could impact the bananas. Some students referred only to a single plant not a population of plants. A small group of students did not attempt the question, the majority, however, wrote something relevant about cloning and/or asexual reproduction.

b)

(i) Many students did this question well. Some concerns about the letters chosen in their Punnett Squares are worthy of note. Many students used L and S.

(ii) The majority of students did this question well, but as noted above, struggled with appropriate letter choice to represent alleles in the Punnett Square.

QUESTION 21

a)

(i) Autosomal recessive (1/2)

As both parents II-1 or II-2 are unaffected (1 mark), but their offspring is affected III-1 (1/2) (or use other example).

Marks also given for "not dominant as II-1 and III-1 would both (1) need to have at least one parent affected." (1/2)

½ mark given for skipped generations or not very common in the pedigree.

To get full marks – needed to specifically relate to individuals in the pedigree.

(ii) If the gene is X linked then the sons of an affected female should show the trait and this is not the case in individual II-3 (1).

For a female to show an X linked trait her father should also show the trait and this is not the case with either individuals II-3 or III-1m (1).

If X-linked recessive more males would be affected from carrier mothers, this is not shown in this pedigree (1).

To get full marks – had to relate specific example to pedigree, could not simply state the fact without the evidence.

(iii)

A. I – 2 Heterozygous or Hh (or other appropriate letter) (1 mark) (1/2 mark given if X^HX^h)

B. III – 2 Heterozygous or homozygous dominant or Hh and HH (1/2 mark each) (1/2 mark given if X^HX^h and X^HX^H)

b) This is an example of incomplete dominance (1) where in the heterozygous combination neither allele is recessive to the other (1) and there is neither black nor white offspring but a mixture/average of both colours giving grey offspring.

Other marks awarded: Co-dominance inheritance (1), a Punnett Square showing an appropriate version of an incomplete dominance/co-dominance cross (1), if candidates used an autosomal dominant/recessive cross (1/2) a mark was awarded if it demonstrated their point. If the student's words clearly indicated that they understood the appropriate response then marks were awarded for words like "blend", "mixed" etc. There were more ways of achieving full marks than candidates needed and so the majority of candidates received full marks on this question.

If candidates were having a guess – e.g. co-dominance or incomplete? – without further explanation, (1/2) a mark was awarded.

COMMENTS

a)

(i) Most candidates attempted and were able to correctly identify the mode of inheritance as autosomal recessive, providing general evidence for their conclusion. Marks were deducted if candidates did not state a specific example on the pedigree to support their hypothesis. To receive the full 2 marks, more information was needed then simply "it skips generations or it's not very common". Full marks were awarded to candidates who identified the presence of heterozygous carriers producing an affected individual (II-3, and III-1).

(ii) This question was generally attempted by most candidates. Full marks were awarded to candidates who supplied two distinct pieces of evidence as seen in the pedigree. Mentioning the two affected daughters with unaffected fathers only yielded 1 mark in total as this was not considered as two separate pieces of evidence, but rather 1 repeated in another part of the pedigree. Candidates lost marks for not clearly indicating where the evidence was in the pedigree for example – "affected mothers will always have affected sons due to the son's X-chromosome only being inherited from the mother" This answer needed to have the caveat "this is evident in II-3 and III-5" to obtain full marks.

(iii) This question was attempted by most candidates. Most candidates who attempted the question were able to correctly identify that I-2 was heterozygous or Hh. Candidates lost mark for not identifying III-2 as being able to be both heterozygous and homozygous dominant, but rather just as one or the other. Both genotypes were needed for full marks. Many candidates who lost marks wrote their genotypes as if they were on the sex chromosomes, due to this being an autosomal condition, marks were deducted for this indication, however if they had the dominant/recessive gene combination correct part marks were awarded.

b) Some candidates did not recognise that this was incomplete/co-dominance. Some mentioned X-linkage, autosomal dominance and mutations. A few stated that it was sexual reproduction. Many left it blank.

QUESTION 22

a) Mast cells release histamines/chemicals (½) which increase the blood supply to the area by vasodilation (½) causing it to become red, hot and swollen (½). Vasodilation also increases permeability of capillaries (½) which allows fluid and macrophages to escape from blood vessels into surrounding tissues (½). This also brings and mobilises phagocytes or other white blood cells (monocytes/neutrophils) (WBC'S) (½) that seek and destroy the invading bacteria that are in the wound by phagocytosis (½), the increased activity and resulting build-up of dead bacteria/WBC's as pus (½) can also cause the wound to swell as well as feeling hotter (½). Complement proteins (½) may bind to the bacterial surface and release cytokines to attract phagocytes (½).

NOTE: Any 6 reasonable points, but must include at least one point referring to the effects on the bacteria for full marks.

b) With the first vaccination a new antigen enters the body, antigen-presenting cells (e.g. dendritic cells) display antigens on their surface (½), activating helper-T cells which release cytokines (½) to stimulate the immune system to produces B-cell (plasma cells) that make antibodies (½) and T-cells that then specifically deal with the antigen presented (½). This means there is a 'lag' phase before antibody production increases (½). Memory B- and T-cells are also produced that can recognise the particular antigen (½).With the second vaccination the antigen is recognized (½) instantly so B and T cell production begins immediately (½) OR time course of

response is much quicker (½). Overall antibody production reaches considerably greater concentrations (½) and, once the pathogen has been dealt with, their concentration remains higher (½).

c) Physical barriers: initially such barriers as the skin, mucus etc. normally prevent the bacteria from entry into body tissue (1/2). However, once breached (the site of infection), these barriers are non-specific have no further role in defence (1/2). Very effective at providing protection from pathogens continuously until barrier is breached (1/2).

Innate (non-specific) Immunity: Involves the inflammatory response (1/2) where (macrophages/mast) cells that are disrupted caused chemicals/histamines to be released which leads to vasodilation of blood vessels, increase in capillary permeability and influx of phagocytes responding to destroy bacteria (1/2). This is also non-specific occurring close (1/2) to site of initial infection and an immediate/fast response hence the sharp gradient in the graph (1/2). If this response is not enough to destroy all pathogens (which may then invade other tissue/blood/lymph) (1/2) then bacterial antigens can then be presented by phagocytes (macrophages and dendritic cells) to helper T cells (1/2).

Acquired (adaptive/specific) Immunity: Helper T-cells would then become active to seek B-cells (or B/T memory cells) with an antibody match to the antigen (1/2) → cloning of these cells to facilitate a response. It takes at least 5 to 7 days to produce enough plasma B cells to produce enough antibodies (1/2) to fight the pathogen so response is initially slow (1/2) compared to the innate. Production of killer T-cells is also initially slow but proliferate to kill already infected cells (1/2). Any B/T cells that recognise antigens will be further cloned to fight infection increasing the response rapidly, but also leaving behind a memory to fight the pathogen should it be encountered again (1/2). Proliferation of B and T cells occurs in the lymph nodes which can be a much larger distance from the original entry point of the pathogen (1/2). Specific immunity provides a much greater level of protection than the innate system as it identifies the actual pathogen and produces an abundance of cells that work together to fight the specific pathogen (1/2). Therefore, the further away from the site of initial infection the pathogen becomes, the more specific the immune response becomes (1/2).

COMMENTS

a) This was a very well-answered question, with most candidates scoring 2½ or 3 marks and almost all candidates that attempted the question getting at least 1 mark.

Common mistakes included confusion about the function of red blood cells as opposed to white blood cells and the immobile nature of basophils and mast cells.

b) This was also a generally well-answered question with most candidates scoring 2 or more marks. The most common error was not addressing the specifics of the question, particularly describing only one difference between the responses, rather than two. Another common error was to only describe the differences without providing any explanation about the underlying mechanism involving the B- and T-cells of the specific immune system.

c) The majority of candidates found this question difficult with many of candidates not attempting the question at all.

There were many marks to be gained from this question. However, majority of the candidates did not read the question completely and realise the many components in regard to time periods and distance from infection site.

COMMON ERRORS INCLUDED:

- Mistaking innate immunity for passively acquiring antibodies from mother to child
- Mistaking innate immunity for the humoral response and B cell proliferation and antibody production
- Mistaking acquired immunity for actively acquired immunity through vaccination
- Suggesting that B and T cells both produce antibodies and lumping them together as if they do the same thing
- Stating that physical barriers don't offer much protection and they are useless compared to the other systems – in fact physical barriers are the reason why we keep pathogens out so effectively

- Misinterpretation of the graph – suggesting the y axis represents level of antibodies and the innate and acquired responses were the primary and secondary response after vaccination/exposure to pathogen.

Those candidates who understood the graph gained marks by just explaining what the three systems do. However, many candidates made no reference to time periods and physical distance from the site of infection and could therefore not gain the full 5 marks.