Section A – Criterion 3

Question 1

Solutions

a.

i. Species of bacteria (1), type of bacteria (1), bacteria (½).

ii. Amount of catalase present in different bacteria species (1) OR, rate of reaction/reaction rate (½) OR, bubbles (½) OR, oxygen gas produced (½).

b. Full mark response: Species of bacteria (IV) (1) with the higher amount of catalase (DV) (1) will produce a more vigorous reaction than those that have less (clear direction) (1).

Partial mark response: One bacterium discussed (½), all species discussed (1) / catalase amount for one discussed (½), catalase trend discussed (1) / reaction direction for ONE or TWO discussed (½), reaction direction for all (1).

c.

i. Temperature (reactants or agar plates) (½), volume/mass of bacteria (½), recording time/timestamp (½), CO_2 concentration (½), pH (½), medium of agar (½).

ii. Full mark response: identify chosen controlled variable, then describe the impact on the experiment specifically (1). E.g., Temperature affects enzyme activity, thus high temperatures could speed up the catalase reaction (1), OR, if bacteria numbers were not controlled, the extra bacteria in different samples could contribute to extra catalase activity thus skewing the results (1).

Partial mark response: identifies one factor and provides an association but no experiment-specific explanation, e.g., Temperature speeds up chemical reactions (½).

d. To ensure the observed changes in the DV are caused by the IV (1). This allows for clear, accurate, conclusions about cause-effect relationships, improving validity of results by confounding factors (½). With more than one IV, you can't definitively determine which variable caused the change in the DV (1).

Comments

a.

i. Many students thought that the bacteria listed are all types of *E. coli*, not that *E. coli* was the first bacteria tested, followed by a range of other types.

ii. Most students were conflating the dependent variable (catalase concentration) with the data collection method (bubbles, gas produced, reaction rate).

b. A large number of students did not follow the 'effect of IV on DV, with direction' formula. Many didn't have any direction, saying it would 'change', or, 'increase or decrease', or, 'effect'. The most common issues came from students not understanding the question, and therefore not having the appropriate IV and DV, but if there was direction and a general understanding they were still able to gain marks (see marking criteria above).

c.

i. Students either did not consider the stem of this question (potentially due to it sitting above where the question was written) or felt it was reasonable to repeat the constants provided.

ii. Poor-scoring answers consistently made broad statements that did not address the question. No marks given for broad statements that are not specific: 'may alter results', or 'ensures validity and reliability', or 'will affect the results making them invalid'. A significant number chose to describe how the oxygen was to be collected; this is conflating factors (variables) with experimental design (overall plan to conduct experiment) and methodology (e.g., techniques and procedures).

d. Generally, very well answered.

Question 2

Solutions

a. The results of the placebo group can be compared to the results of the AZT/treatment group (½), therefore acting as the control group (½), to see if AZT does in fact reduce the chances of babies being infected with HIV (1) OR to see whether the effects of AZT/treatment /drug are caused by the treatment itself (1).

b.

i. The group of mothers receiving the placebo were placed at higher risk of having a baby infected with HIV (1). The placebo provides no treatment and doesn't minimise harm to the baby or mother (1).

OR

If an effective standard treatment already exists, assigning some participants to a placebo group means they don't receive drug/care that is known to help their condition (1). This can put them at risk of worsening health or prolonged suffering/poor health outcome for baby, which raises ethical issues about patient welfare (1).

ii. Two of any of the following. **Answers which related to thread and in general were accepted.**

- Informed consent must clearly explain the possibility of receiving a placebo and or the possible impact of being in the placebo group (1).
- Ensure participants are not deprived of effective existing/next best treatments (1).
- Researchers should obtain approval from an independent ethics committee (1).
- Placebo use should be justified only when no proven therapy exists or when withholding treatment does not pose significant risk (1).
- Every participant—including those in the placebo group—must be assured access to the best proven treatment identified by the study once the study ends (1).

- Mothers should be offered extra follow up medical treatments for their babies to minimise harm (1).

General answers

- Participants should be randomly assigned to treatment or placebo groups to reduce selection bias (1).
- In some cases, a large sample size may be unnecessary or wasteful and so a small sample size is required to avoid exposing too many participants to unnecessary risks (1).
- Double-blinding (½) – where neither participants nor researchers know who receives the placebo – helps minimize measurement bias, strengthening the validity of the trial's results (½).
- Large sample size (½) smaller margins of error, and stronger, more reliable results (½).

Comments

a. The majority of students gained 1.5 to 2 marks for this question if they related their answer to the need for a control as a comparison to treatment group. Marks were not awarded for answers relating to the placebo effect as a psychological bias affecting babies in utero does not apply here. Some students answered this question without any inclusion of the name of or reference to the drug AZT and instead just gave a definition of a placebo which did not gain the full 2 marks. It's important for students to read the question carefully.

b.

i. Students who answered scientifically about the challenges of a placebo group where humans/babies can be harmed gained 2 marks. However, overall, this question was poorly answered. The question could have been interpreted as being generic and so there were a mix of responses with some students relating their answer back to the thread and many who did not, so a mix of responses were accepted. Unfortunately, a large percentage of students reconciled that placebos were included in human clinical trials as a form of deception or some type of trickery and so struggled to gain marks. It is important that students learn to write scientifically about human clinical trials. It would be beneficial for students to be taught the Declaration of Helsinki (2000) which states 'When a proven effective treatment exists, new interventions must be tested against that treatment, not against placebo'.

ii. This question could also have been interpreted as being generic and not related to the thread so most sensible answers relating to human clinical trials gained marks here. As a result, this question was answered well by the majority as there were so many options that could be included. Students lost marks when their answers lacked detail. Simply writing 'informed consent' or 'have a large sample size' or 'double blind trial' only attracted ½ mark.

Question 3

Solutions

a. X (1) Largest zone/radius of inhibition (½) where bacteria growth was prevented (½).

b. W (1) Has largest zone of inhibition across both Bacteria A and B (½) and compared to other antibiotic discs OR Y has similar effectiveness against both A and B shown by size of

inhibition zone but not as big a zone of inhibition as W; OR antibiotic X was most effective against Bacteria A but ineffective against Bacteria B so not as effective as W (½).

c. Need 2 ways to improve reliability (1) plus outline how each works to improve (1).

- Repeat experiment (½) to see consistency of result (½).
- More replicas of each plate A and B (½) to calculate a mean and eliminate outliers (½).
- Measure the zone of inhibition (½) to improve accuracy and gain results to compare and data to analyse (½).
- Measure zone of inhibition with a precise instrument (½) e.g. sliding micrometre or digital sliding micrometre to get more accurate data to compare (½).
- Use a control disc (½) to see if the zone of the zone of inhibition was due to the action of the antibiotic (½).
- Have a separate agar plate for each antibiotic disc (½) so that there was no interference between antibiotics as there was in Figure 1 with antibiotic X and W zone of inhibition (½).
- Control the temperature of the petri dishes to 37°C (½) to mimic the condition of the human body and make it more valid (½).

Comments

a & b. Both these questions required students to be able to interpret the image of the bacterial plates and interpret the zones of inhibition – skills of visual literacy. It would help if students had practical experience in microbiology and using antibiotic discs to inhibit the growth of bacteria and how this is conducted and measured. Some students had misconceptions about the antibiotic effect on the bacteria's growth, and many misread the image believing that the dark zone of inhibition was the growth of the bacteria.

c. The reliability of the investigation was mostly well answered. It may have helped if students knew that they needed to **identify** the strategy and **discuss** how it would improve the reliability. Some students wrote about follow up experiments – this was not relevant for this question.

Question 4

Solutions

a. Group 1 (1) was most precise because there was no variance in the results compared with other groups (½) with all being 16°C (½).

b. Group 4 (1) was most accurate as it was closest (½) of all the results to the electronic thermometer at 22.7°C (½).

c. Group 1 or A (1).

Group 4 or D (1).

Group 1 is most precise (½) Group 4 was most accurate (½), together they make the most reliable results (1) OR group 4 as results were closest to the electronic thermometer (1).

Comments

This question was well answered by many students, helping students to gain marks which positively impacted their results overall in this section.

Students were confused about the terms accuracy and precision. Marks were given for the correct answer in the wrong section for question a. or b. (but not if the same answer was given twice).

Full Marks were not given if there was no explicit reference to the actual temperature 16 or 22.7.

The students did not perceive the results for Group 1 as correct due to the results not matching the electronic value, and hence completely discounted it in answering Q4a or 4b. Reasons included thinking it was an equipment or human error, or laziness on the groups part, or a rounding bias saying having a decimal of 0.0 was not showing a real result at the one decimal point level. A few tried to make a numerical case for Group 4 being accurate/ precise by averaging all group's results and looking for the least difference to the electronic measurement. They would then demonstrate some understanding of the concept, applying it to the results for Group 4. This was not given full marks as Group 1 was the obvious choice.

Students also were not specific enough in their wording of the answer, leaving the reader to infer meaning. They said that the temperature was close to the 'real answer' (meaning electronic thermometer) or close to the 'thermometer' but not specifying which one, i.e. the electronic one.

Question 5

Solutions

a. Randomly select 10 bees from the same hive to place in the respirometer one at a time, to measure their rate of oxygen consumption (½).

   Controlled variables – e.g., soda lime, size of test tube, location of gauze, diameter of pipette (1).

   Record the rate (mm/minute) at which the coloured liquid moves left in the respirometer in a table, being the measure of individual oxygen consumption of each bee (½).

   Repeat steps 1 and 2 each week for a month at the same time of day. Take averages and compare data over time for the hive of interest (½).

   To compare the data from the hive of interest with other hives, steps 1-3 should also be completed at the same time of day and year for two more hives (½).

   Compare the results of all the hives to help determine the health of each hive using each set of hive results as an inbuilt control for the other hives (1). Follow up with repeats at a later date (½). Ensure all variables are controlled or accounted for where possible (1). Write a hypothesis (½). Obtain ethical permissions and plan for humane handling (½).

   OR marks could be gained if students explained how the equipment was set up.

   Prepare a measured amount of soda lime, syringes, tubing, respirometer, etc and calibrate system (½). Add fixed amount of soda lime in the tube and a standardised amount of gauze (½). Place a single bee into the tubing and seal with a stopper that holds the glass tubing and three-way tap (½). Open the three-way tap to allow equilibrium between syringe and

respirometer (½). Allow the bee to acclimate before recording for a set time (½). Close the three-way tap (½). Record displacement of coloured liquid at regular intervals (½). Repeat each bee measurement (½). Coloured liquid in the glass tube would move towards the bee/to the left (½).

b. Bees may behave differently/stressed and therefore consume different levels of oxygen in a respirometer compared to a hive (1).

   If the sample size is too small, then the oxygen consumption results may not represent the health of the hive population well (1).

   One bee is not representative of the whole hive (½) and does not consider individual variation (½). Small sample size (½). Limited oxygen supply could change the bee's behaviour and respiration (½). Lab conditions are not representative of hive health as there are other factors that come into play (temperature, lack of other bees, etc) (½). Lack of control group (½).

Comments

a. Due to the ambiguous wording of the question, half the students interpreted the question as being about the methodology of how to perform the experiment i.e. “set up” the experiment, and the other half took it to be about designing an experiment – state the variables, describe the procedure in terms of sample sizes, replicas, control; analysis of results and repetitions. Due to this, the marking of both was considered with half marks being given for a range of points. Not many students were able to get full marks for this section due to the range of answers provided. There was confusion between what was being measured – oxygen use or carbon dioxide production as they potentially did not know that function of soda lime. There was also some confusion with which direction the coloured liquid in the tube was pushed – half a mark was awarded for those who wrote that it would move towards the bee/left. Students chose arbitrary lengths of time for which the experiment was performed e.g. 15 minutes. Students did not know what soda lime was, and some thought it was ‘lime soda’ and providing a food source for the bees. Arbitrary numbers of bees per hive was also incorrectly stated with numbers from thousands to millions of bees living in a single hive (approximately 50 000 bees in a healthy hive).

b. Most students answered this part of the question well achieving 1–2 marks. Often only an answer was given with no explanation (outline as mentioned in the question).

Section B – Criterion 5

Question 6

Solutions

a. Matrix for Krebs cycle (½) and inner membrane for electron transport chain (½).

b. Anaerobic respiration doesn’t require oxygen but aerobic does (1). Aerobic respiration occurs in the mitochondria and anaerobic respiration occurs in the cytosol (1). Aerobic respiration (including the anaerobic part) produces a net 36+ ATP/glucose molecule whilst anaerobic respiration produces a net 2 ATP/glucose molecule (1).

Comments

a. Most students put matrix and inner membrane but in the wrong locations. Majority of students thought cristae was the location for electron transport chain and likely did not know the difference between the inner membrane and cristae.

b. This question was not marked. Incorrect Information sheet provided advantage to students.

Question 7

Solutions

a.

Base	A	C	G	T
DNA Template Strand	19	**23**	**32**	26
DNA Complementary Strand	26	32	**23**	**19**

(½) a mark per square completed - in bold.

b. Enzyme A: Helicase (½), Enzyme B: DNA Polymerase (½).

c. Parent strands are separated during DNA replication (½). Parental strand becomes template for new daughter complementary strands (1). Half of the old parental DNA is conserved in the daughter DNA (½).

d. Introns are removed/spliced (½) and exons are joined together to become mature RNA (½).

e. This is translation (½). mRNA attaches to a ribosome (½). mRNA has codons (½). tRNA has an anticodon that is complementary to mRNA codon (1). tRNA carries an amino acid (½). Amino acid delivered is specific to mRNA codon (½). Amino acids have peptide bonds form between them (½). Termination occurs when a stop codon is read, and the polypeptide chain/protein is released (½).

Comments

a. Majority of students got G and T bases (32 and 19), receiving 1 mark, but half of students struggled with C and G bases (23 and 23). Most students put that there would be the same number of C and G bases but got the numbers incorrect.

b. Majority of students got both enzymes correct. Students did not lose marks for failing to mention DNA in front of enzymes (given this question was in relation to DNA replication) but lost marks if RNA was written in front of the listed enzymes.

c. Majority of students received 1-1.5 marks for the question. Most students failed to mention that parental strand was the template for the new daughter DNA strand. A few students read the question wrong and wrote about mitosis or meiosis, or about the process of DNA replication and the enzymes involved.

d. Majority of students wrote that introns are removed to receive ½ a mark and that this leads to mature mRNA, but they did not mention exons. Very few students wrote that exons are joined together.

e. Majority of students got 3-3.5 marks for this question, as students failed to mention either that the process was translation, that peptide bonds between amino acids, or that termination occurs at the stop codon for full marks. The degree of explanation varied greatly between students. A few students who received full marks mentioned all relevant information and it was very concise and straightforward, with minimal irrelevant information, whilst others provided information that contradicted what they had previously written or irrelevant information, leading to loss of marks or no marks. A few students thought stage II was transcription or DNA replication and received no marks. This question was not attempted or minimally attempted by quite a few students, although other questions had been, indicating that students might have not understood the question.

Question 8

Solutions

Amino acid sequences:

Original DNA sequence	Met (start)	Ser	Arg	Gln
Mutated DNA sequence	Met (start)	Ser	Trp (mutation)	Gln

(½) a mark per column completed. (1) mark maximum if both Arg and Trp (4th column) were missed.

Impact: This is a missense mutation (½) which may cause a change in the folding/structure of the protein (½), altering its function or causing it to become non-functional (½).

The genetic code is degenerate, meaning several amino acids can be coded for by multiple codons (½), such as leucine (½ for valid example). This causes some mutations to become silent (½), meaning they have no impact on the protein made (½). Thus, organisms are protected from potentially harmful mutations (½).

OR

Twenty (20) amino acids can be coded for by combinations of the four (4) bases: A, T (or U), C and G (½). Codons are three (3) bases long as this provides 64 possible combinations (½), which is more than the minimum needed to code for each of the 20 amino acids (½). If codons were shorter at two (2) bases long, there would only be 16 combinations which is not enough to code for the 20 amino acids (½).

Comments

Most students were able to gain between 1 and 3 marks for this question, with few awarded the full 5 marks on offer.

Amino acid table:
Around half of candidates completed this part of the question successfully. A common misinterpretation was that many candidates either wrote the complementary mRNA sequences or simply re-stated the DNA sequences already given and didn't translate the codons into amino acids using the codon chart. These responses were able to gain some credit by demonstrating their understanding that a mutation had occurred (Arg -> Trp) in the 'Impact' part of question 8a.

Impact:
Many candidates simply re-stated that the third amino acid in the sequence (Arg) had been replaced by (Trp) because of the mutation, without outlining the effects of that change to the structure and function of the resulting protein. Some excellent answers used an enzyme as an example protein, discussing the effects of changing the amino acid sequence on the enzyme's active site.

Candidates overwhelmingly preferred to analyse the redundancy/degeneracy of the genetic code rather than giving mathematical explanations, although some exceptional answers did address both perspectives. Whilst many candidates were able to identify that the genetic code is degenerate (i.e. a single amino acid can be coded for by multiple codons), relatively few were able to discuss the reasons why this might be beneficial to an organism in minimising the impact of mutations. Candidates were also given credit for mentioning that the STOP codon did not code for an amino acid.

Question 9

Solutions

a. Competitive inhibitor was B (½).

   Non-competitive inhibitor was A (½).

b. Folic acid and the competitive inhibitor compete for the same active site (½). With more folic acid and the same amount of competitive inhibitor B in solution, folic acid will having a greater chance of entering active sites in enzyme DHFR (½) thus less inhibitor reaches the active site (½) reducing the action of inhibitor B (½).

c. pH of 8 (½), temperature of 37°C/36 to 38 accepted (½).

   Other marks: (½ marks) if they listed "optimum temperature and optimum pH". Some marks were earned where candidate included other relevant limiting factors such as excess substrate, excess enzyme.

d. The strong acid reduced the pH and denatured enzyme DHFR (½). This means that the enzymes unravelled and lost their shape, specifically the shape of the active site (½). They could no longer catalyse folic acid. The refrigeration of the solution would have slowed the reaction (½) due to molecule moving more slowly at lower temperatures but not changed the shape of the active sites (½).

Comments

Candidates had minimal issues with this question.

Some candidates mentioned Folic Acid causing the DHFR enzyme to denature. Generally, candidates lost marks for not explicitly mentioning this. There were several submissions that included the folic acid actively removing the inhibitor from the active site.

Generally answered well.

Majority of candidates were able to explain the impact of either low temperature or low pH but a significant number did not address both factors. Most were able to identify that a low pH denatured the active site. A large proportion of candidates who addressed low temperature explained that this resulted in denaturing the DHFR protein. A smaller number of candidates were able to explain how the low pH impacted on the active site (changing the 3-dimensional structure).

Question 10

Solutions

a. Measuring CO_2 output (1), O_2 input (1) or H^2O production (1). Measuring CO_2 or measuring O_2 (½). Valid experimental protocol (½) with explanation of results (½).

b. The plant is photosynthesising at a rate equal to the respiration rate (1). All the 5 units of CO_2 being released from respiration are being used up by photosynthesis (1). No extra CO_2 is required from outside the plant at point M (½).

c. Plant has reached the saturation point/has encountered a limiting factor (½) such as temperature or humidity (½). All chloroplasts/enzymes/stomata (½) are working at their fastest rate (½). Increasing reactant concentration will not increase reaction rate beyond this point (½).

Comments

a. Candidates found this question very challenging. Most scored 1 out of 3 or below, with many scoring 0. Many candidates answered CO_2 input or light intensity for 10a, clearly having just read the axis of the photosynthesis graph above and copied over the y axis label, this error was more frequent than the correct answer.

b. This question was not marked. Incorrect Information sheet provided advantage to students.

c. Answers to part c) varied greatly. Many students identified that there was a limiting factor, but did not give any additional information, listed limiting reagents despite the fact the question states these are all in excess or discussed light intensity dropping or remaining the same. There was also clearly confusion about the difference between an optimum and a maximum rate, with many candidates discussing that the plant was in optimum conditions and did not need any more CO_2. Good answers identified an appropriate limiting condition and discussed what why this prevented photosynthesis from increasing any further.

Question 11

Solutions

a. The Lac I gene codes for the lac repressor protein (½), which in the absence of lactose fits to (½) and binds to the operator site (½), physically blocking (½) RNA polymerase (½) from transcribing the structural genes.

b. Lac I gene produces the lac repressor protein. Allolactose (form of lactose) attaches to the lac repressor (½) triggering a conformational shape change to the Lac repressor (½). The Lac repressor cannot attach to the operator region (½) and so RNA polymerase is able to transcribe the Lac Z gene (½). The Lac Z structural gene codes for an enzyme (B-galactosidase) (½) that decomposes lactose into its monomers, one of which is glucose (½), making glucose available for respiration.

c. Allows for the transport of lactose into the cell (1), transport protein (½), increases membrane permeability (½).

Comments

Candidates either found this question straightforward and answered it well, summarising processes at the lac operon thoroughly, or struggled and showed little understanding of the process. Many students did not attempt this question or tried to gain points by simply rewording the questions into vague statements. The overlap between the processes in parts a) and b) meant that candidates who answered one part well generally also did well in the other. Points were lost due to a lack of detail (a mention of the physical blocking of RNA polymerase was important to gain full marks in part a) and this was often missed) or a small misunderstanding in the process (mixing up the operator and the promoter). Candidates that did well had clearly done a good job committing this process to memory and understanding the mechanics. One common misunderstanding was discussing the repressor being denatured by lactose binding. Candidates either knew the role of permease or did not, with some showing a good understanding of the etymology of enzyme naming and making solid attempts to deduce its role from its name.

Section C – Criterion 6

Question 12

Solutions

a. Box 1 – Hypothalamus detects (½), thermoreceptors/receptors detect (½), thermoreceptors signal the hypothalamus (½), hypothalamus acts as a receptor (½).

   Box 2 – Nerve impulses signal sweat glands (½), nerve impulses signal skin (½), signals sweat glands (½), sweat glands open (0).

   Box 3 – Greater blood flow to the skin (½), blood moves to the surface of the body (½), more blood closer to the external environment (½), increased blood flow (0), radiation of heat (0).

   Box 4 – Body temperature falls (½), body temperature returns to normal (½).

b. Negative feedback occurs when a rise in body temperature (stimulus) (½) is detected by the hypothalamus (receptor) (½) causing blood vessels/ sweat glands (effectors) (½) to counter

the change (½) and decrease the temperature (½) back to 37°C (½), back to a set point (½), back to normal body temperature (½).

Negative feedback is where a stimulus produces a response that reduces the stimulus (½).

Comments

a. Some candidates found this part of the question challenging. Information provided prior to, and after each response needed to be considered as well as the information provided in adjacent boxes describing alternative feedback pathways. In several boxes, structures and processes needed to be mentioned in a single box for a complete response. However, most candidates who attempted this question gained two or more marks with 10% of candidates gaining full marks.

b. The majority of candidates who attempted this question gained between 2.5 and 5 marks. Candidates were required to relate negative feedback to temperature regulation, stating at least part of the mechanism necessary for negative feedback to occur, as well as relating negative feedback to temperature homeostasis. Candidates who used the definition of negative feedback from the information sheet (Negative feedback – a change which reverses the effect of a particular stimulus to maintain stability) without providing links to temperature regulation, a mechanism and homeostasis, only received half a mark. Many candidates used the terms 'homeostasis' and 'negative feedback' interchangeably, instead of referring to negative feedback as the mechanism used to achieve stability within an organism.

Question 13

Solutions

a. Transpiration (1), evaporation (½), evapotranspiration (½), diffusion (½), guttation (½).

b. Sunken stomata (½) or epidermal hairs (½), trap moist/humid air outside of each stomate (½), decreasing the concentration gradient between inside the plant and the environment (½), decreasing the diffusion rate of water out of the plant (½).

Sunken stomata (½) or epidermal hairs (½) or stomata mainly on the underside of the leaf (½), protect the stomata from exposure to the sun/wind (½) preventing heat/wind from evaporating/removing the water from outside the stomata, increasing the concentration gradient (½) and increasing the transpiration rates (½).

Sunken stomata (½) or epidermal hairs (½), catch the water before it can leave the plant (0).

Possess a thick, waxy cuticle (½) that is hydrophobic (1) impenetrable to water (1), acts as a barrier (½), decreasing the amount of water that is lost from the leaf surface due to diffusion/transpiration/evaporation (½).

Possess a thick, waxy cuticle (½) increasing the diffusion distance of water from the epidermal cells to the environment (1) decreasing water loss by decreasing diffusion rates (½).

Rounded leaf shape (½) or thicker leaves (½), increasing diffusion distances (½), decreasing the diffusion rate of water from the surface of the leaf (1) or decreasing SA: Vol (½), reducing the SA through which water can be lost via transpiration/evaporation/diffusion (1).

Smaller leaf size (½) reducing the total SA (1) or reducing the number of stomata (1) through which water could be lost through transpiration/evaporation/diffusion (½).

Possess guard cells/stomata that can open and close if under water stress (½).

Comments

a. The majority of candidates used the correct term 'transpiration' and received full marks. If multiple terms were mentioned, marks were given for the term which best described the loss of water vapour from the leaf.

b. Most candidates could identify two features (shown in the diagrams) that could help either of the plants minimise water loss. Some candidates identified more than two adaptations, but often their explanations of each feature were incomplete. Responses from candidates who tried to explain multiple features at once often lacked the necessary detail in their responses for each adaptation. For those candidates who identified more than two features, only the best explanations for two of the mentioned features contributed to their overall mark. The question required candidates to explain how each feature minimised water loss – candidates who stated a feature and that it minimised water loss, without explaining how (such as increasing humidity/ decreasing light/minimising evaporation), only received half a mark for each feature. Candidates are expected to understand structural adaptations that allow xerophytes to survive in arid environments. The ability of guard cells to open and close stomata is common across all plants with stomata – candidates who suggested this as a feature were only awarded half a mark.

Question 14

Solutions

a. Water moves passively from the soil, into the roots, up the stem, into the leaves (1) where it is used in photosynthesis or transpired out of the plant (½). As water molecules move into the root, the existing water molecules in the root are 'pushed' further into the xylem under a process called root pressure (1), and water molecules are moved upwards (½). Water molecules are polar molecules meaning that they are sticky (½). Cohesion refers to water molecules sticking to each other. As a water molecule is drawn upwards it 'pulls' water molecules directly below up with it (1). Adhesion: water molecules sticking to walls of xylem assist in water movement (½).

b. Increase in light intensity: Leads to an increase in photosynthesis, which means stomata are open (½) and transpiration rates are increased (½).

Decrease in humidity: Less water vapour around stomata (½), so the water level inside the leaf is higher than outside the stomata (½) or steeper concentration gradient (½). OR decrease in transpiration to conserve water (½) inside the leaves and stomates close/become flaccid'(½).

Comments

a. This question was not marked. Incorrect Information sheet provided advantage to students.

b. Increase in light intensity: Overall this question was answered well by the majority of students. Many students understood that an increase in light intensity increases transpiration

rate but did not gain the full two marks as they failed to include information about stomata opening due to an increase in photosynthesis.

Decrease in humidity: Many students did not include an understanding of concentration gradient, that there is 100% humidity inside the leaf and with decrease in humidity the concentration gradient increases i.e. drier air outside leaf.

Question 15

Solutions

Please note: the question does not ask students to include information about glucagon – the question referred to insulin only. However, less than 1% of the students attempted to answer the question in relation to insulin only. Most students approached this question by contrasting the roles of insulin and glucagon in their control of varying blood sugar levels. Because of this, the marking scheme was adjusted to reflect the role of glucagon and to ensure students were not penalised.

Increase in blood sugar: Pancreas detects increase in blood sugar (stimulus) (½) and produces the hormone insulin (½). Insulin travels in the blood to the effectors – liver and body cells (½). Insulin enables glucose to be taken up from the blood into the body cells (½). The liver stores glucose as glycogen (½) or glucose is used in respiration (½). This reduces the blood sugar levels back to the set point (½). **Decrease in blood sugar** (stimulus): Pancreas detects decrease in blood sugar (stimulus) (½) and secretes less insulin into the bloodstream (½).

Alternative response for decrease in blood sugar: Pancreas detects decrease in blood sugar (stimulus) (½) and secretes the hormone glucagon into the bloodstream (½). Glucagon travels to the effectors (liver and muscle cells) (½). This enables stored glycogen to be released into the bloodstream as glucose (½). This increases the blood sugar levels back to the set point (½).

Comments

45 % of all students scored at or above 3 out of 5 marks which showed a sound understanding of blood glucose regulation. Those students that scored highly were able to clearly describe the role of insulin and glucagon in controlling glucose levels in the blood. There was consistent confusion in the spelling and use of the terms glycogen and glucagon. The pituitary gland, hypothalamus, brain and kidneys were described as receptors and/ or control centres by a large percentage of students who scored below 3/5, indicating that students are confusing the mechanisms of temperature and water regulation with glucose regulation. The pancreas and hormones (insulin and glucagon) were often mentioned as being effectors with the pancreas “releasing” alpha and beta cells into the bloodstream. Students confused the roles of the liver and pancreas often reversing their function. If the marking scheme had not been adjusted to include the role of glucagon the maximum score for this question would have been 3.5 marks.

Question 16

Solutions

a.

i. -55 (½) mV (½).

ii. Voltage gated sodium channels in the neuron membrane open (½) allowing positive sodium ions to enter the cell (½), thus changing the membrane potential from negative to positive (½) (30/40mV) (½).

The potassium channels remain closed initially (½).

Marks were gained for describing the change in membrane potential, e.g. inside neuron becoming more positive (½).

iii. The sodium potassium pump uses 1 ATP (½) to actively transport (½) 3 positive sodium ions out of the cell and bring 2 positive potassium ions (½) into the cell to restore the negative resting (½) state to -70mV (½).

Leak channels are open allowing K+ ions to move in (½).

More sodium moved out than potassium ions moved in (½).

Sodium/ Potassium pump moves ions to maintain resting potential (½).

Some students noted the cell was hyperpolarised and needed to become less negative and explained this with Na+/ K+ pumping 2Na out and 3K in, this is incorrect but was awarded (1).

b. Action potential/electrical stimulus reaches axon terminal (½) which triggers the opening of the voltage gated calcium channels (½). Calcium ions move into the axon terminal (½). Calcium ions activate the synaptic vesicles (½) to fuse with the membrane of the axon terminal (½). This releases neurotransmitters into the synaptic cleft (½) and they dock onto the target cell (½) /attach to receptors stimulating another action potential (½). Ligand gated channels in the post synaptic neuron opening (½) triggering another action potential (½). Opening sodium channels in the post synaptic neuron (½). Reaching the threshold in the post synaptic neuron (½).

Comments

a.

i. Be sure to include units.

ii. Well answered by the majority.

iii. Students needed to discuss the sodium potassium pump, most identified that it moved sodium and potassium. The majority omitted that the Na+/K+ pump uses active transport and requires ATP to pump against the concentration gradient.

The question was difficult in that it asked how did the Na+/K+ pump take the membrane potential from -80mV to -70mV (more positive) when the pump actually makes the membrane more negative by reducing the charge by -1 (3Na+ out 2K+ in).

A complete explanation of this requires discussion of the potassium leak channels which cause the membrane to become more positive.

Question 17

Solutions

a. 285 mOs/kg (1). 1 mark also awarded for '284 mOs/kg' / 286 mOs/kg.

b. ADH is a hormone therefore part of the endocrine system (1). Endocrine messages are usually slower than nerve messages therefore ADH slower than nerve impulses (1).

   OR Chemical transmission of the hormone ADH is the slowest (1) as vesicles containing ADH are required to diffuse through the magnocellular neuron, and ADH then needs to diffuse across the synaptic cleft and dock on the target cell (1). This causes a delay which is not present in nerve impulse transmission of the osmoreceptor.

c. ADH is a hormone that acts upon the kidneys, specifically the collecting ducts (1). Increase in ADH causes the collecting duct to become more permeable to water (1). This allows more water to be reabsorbed back into the blood from the filtrate (1). Less water ends up in the urine as it is returned to the body to help maintain water homeostasis (1).

Comments

a. This part was overall answered well by the students. Half a mark was deducted if units were not included in the answer.

b. This question was not marked. Incorrect Information sheet provided advantage to students.

c. This part was overall answered well by the students. More than 60% students scored 2.5 out 4 marks. Some of the students included an understanding of aquaporins in response to ADH, which also gained marks. Aquaporins is not in the Biology Level 3 course document so is not essential for students to learn. Some students confused kidney tubules with Liver. A few students answered the question in the form of diagrammatic representation of osmoregulation and kidney functions which could gain full marks if the anatomical and physiological words were mentioned correctly.

Section D – Criterion 7

Question 18

Solutions

a. Vector (1).

b. Similarities: any of the following (1) – both contain genetic material; both can or may cause disease; both can or may be pathogenic; both may cause harm to the host/humans; both can be transmitted via contaminated food/water; both can remain dormant in host for a period of time before causing harm or disease; both can be introduced or carried by a vector.

   Differences: any of the following (1) – parasites are considered 'living' or 'cellular' or 'contain living cells' whereas viruses are considered 'non-living' or 'non-cellular' or 'not containing living cells'; parasites are larger in size than viruses; parasites are macro – can be seen with naked eye most of the time – whereas viruses are microscopic – cannot be seen with naked eye; parasites are capable of own metabolic processes without relying on a host whereas viruses rely on a host to carry out metabolic processes/replication etc.

c. Physical barrier against preventing malaria infection – any of the following were accepted (1): nets or clothing which prevented the mosquito from biting the skin; skin or epidermal is thickened or tough due to increased keratin so mosquitos cannot penetrate the skin easily; excess oils or sweat on skin makes it more difficult for the mosquito to bite.

   Chemical barrier against preventing malaria infection – any of the following were accepted (1): repellent will kill the mosquito therefore the rate of infection decreases; low pH of the skin or [enzymes] present on the skin can deter mosquitos; taking anti-malarial tablets to deter mosquitos, body odour on some individuals can repel mosquitos, carboxylic acid [fatty acids] produced by skin bacteria act as a natural repellent; lactic acid in sweat can repel mosquitos; excess dead skin cells can prevent mosquitos from biting.

d. Any two of the following were accepted – named example (½) and discussion about how they transmit an infectious disease (1) x 2 examples:
   - Airbourne – droplets with disease/pathogen can be coughed/sneezed by an individual and another inhales the droplet.
   - Waterborne – drinking contaminated water (i.e. drinking from source that is not clean and not boiling water prior to drinking).
   - Foodborne/Contaminated food – eating contaminated food (i.e. undercooked chicken or using unhygienic practices in food preparation).
   - Direct contact – transmission of saliva, mucus, blood etc. that contains a disease via kissing, sharing needles, sexual intercourse etc.
   - Indirect contact – touching a source that has been contaminated such as an individual sneezing on a bench and then the second person touching the bench and then touching their mouth or having a shower where a person that has tinea/athletes foot – fungal infection – had a shower before and the second person picks up the infection.

Comments

a. Almost all candidates were able to correctly identify that the mosquito was a vector. Those who identified 'transmitter' or primary host were incorrect and did not score any marks.

b. Many candidates only gained 1 mark as they could identify differences between the parasite and virus but not accurately identify similarities. If candidates mentioned that they both always cause disease or an infectious or pathogenic only ½ mark allocated because they are not always infectious etc. – this was an example that terminology i.e. word 'always' or 'must cause' etc. played a role in determining marks. Candidates that could identify that they both 'might', 'may', 'could' were rewarded a mark. If candidates mentioned that they 'must' invade a host or rely on a host to carry out processes or reproduction did not receive a mark as parasites, especially facultative parasites do not rely on a host.

   Candidates that didn't make a full comparison i.e., only stated that viruses were non-living cells, without providing that parasites were considered living did not gain a full mark.

c. The majority only gained ½ mark as they only stated skin or using nets or wearing clothes etc for physical without answering the question which required candidates to outline how.

   Also, many candidates didn't gain any marks for chemical barrier as they simply listed or explained how stomach acid with low pH, or lysozomes in tears, or mucus membranes of nose, respiratory organs etc. prevent/overcome malaria. This demonstrated that candidates provided regurgitation of knowledge of first line of defences without consideration of the scenario which was a mosquito bite that can cause malaria infection.

Overall, this question was not well answered by candidates.

d. Many candidates only gained 1-2 marks as they either did not provide a named example of the mode of transmission and/or they did not provide an explanation how the disease would be transmitted from one individual to another. Candidates that gained full marks clearly provided two named examples and detail as to how this would be transmitted from one individual to another. Several candidates did not gain any marks for stating 'food' or 'eating food' as this was too vague. Also, if candidates provided a 'vector' as an example no marks were awarded as the question stated not to use the answer from part (a).

Question 19

Solutions

a. Example A demonstrates Passive Natural Immunity (½) because the mother's antibodies are passed to offspring (½). No Memory cells produced with this type of immunity (½) and therefore there is no immunity for future infections/ different pathogens (½). Example B demonstrates Active Natural Immunity (½). This immune response due to exposure to the pathogen (½). It provides long lasting immunity as memory cells are created (½). This type of immunity enables a quick effective response to future infections (½).

   A further ½ mark may be allocated for stating that both types of immunity are naturally occurring.

b. Artificial (½) Passive (½).

Comments

a. Most students were able to gain some marks in this section. Identification of passive immunity and active immunity was good and differences between the two were often articulated well, especially regarding memory cell production. Quite a few students wasted time rewriting the information they were given which received no marks. Lots of students did not refer to the snakes that were being asked about and referred to similar processes in humans or chickens. Full marks could not be achieved unless the correct reference was used.

b. Most students were able to correctly identify that the anti-venom serum was an artificial, passive form of immunity.

Question 20

Solutions

a. Stage 1: Cell recognises pathogen as non-self, due to presence of specific antigens on surface of pathogen using appropriate receptors (½). Cell engulfs pathogen using pseudopodia (½).
   Stage 2: Pathogen is encapsulated with membrane-bound phagosome (½).
   Stage 3: Lysozome migrates and fuses with phagosome (½), releasing lysozymes into phagosome (½).
   Stage 4: Pathogen is broken down/digested by lysozymes (½).
   Stage 5: Debris/pathogen fragments are released from cell as phagosome membrane fuses with phagocyte membrane (½).

b. Full marks could only be gained in this question if the signs of inflammation shown in the diagram were included in the answer.

   When the body tissue is injured, damaged cells release cytokines (½) which stimulate mast cells (½) to release histamine (½). Histamine causes vasodilation of capillaries (½) and makes capillary walls more permeable (½). Vasodilation allows greater blood flow (½) and moves capillary walls closer to the skin surface, visible as redness and warmth (½). Increased permeability allows white blood cells and plasma to move into tissue creating swelling (½) and warmth (½). Swelling can compress and activate pain receptors (½).

Comments

a. Almost all candidates scored some marks on this part of the question with many achieving 2½ or 3 marks. The most common omission was not detailing the recognition of the pathogen by the macrophage. A number of candidates discussed the role of different white blood cells or the adaptive immune system which was not rewarded.

b. This question was very well answered. Most candidates addressed this question in detail and provided many, or all, of the points detailed in the model answer. Many scored full marks. A number of candidates described the first line of defence or repeated the stem of the question which was not rewarded. Similarly, a number of candidates described the adaptive immune system response which was not required for the question.

Question 21

Solutions

Cell R is likely to have the greatest response (½). This is because it has the largest number of non-self-identifying antigens/markers (½) which are complementary to/match the shape of the receptors for non-self on Immune Cell X (½). This would consequently trigger an immune response/ or correct and brief description the immune response (½). Cell Q is likely to have the least immune response (½). This is because it has no non-self-antigens on its cell membrane/or could state only has self-antigens (½). The four antigens (triangles) on Q will be identified as self and no immune response will be triggered (½). Cell Q would be recognised by cell X as part of the body and not amount an immune response (½).

A reasonable justification for the response of Cell P compared to the other two cells could be awarded a ½ mark. For example, Cell P initiates a smaller response than Cell R as it has two shapes (crosses) that match the receptors for non-self on X, hence a slower response (½).

Comments

Most candidates gained 2 or 2.5 marks for this question with very few gaining full marks. Many were able to identify Cell R as having the greatest response and Cell Q as having the least response but were unable to identify the reason why and expand on their answer for full marks by commenting on the complementary shape of the receptors for non-self on immune cell X, and the consequent immune response.

Candidates commonly confused the words receptors, antigens and antibodies in their response thus were unable to adequately justify their answer. A lot of candidates were able to identify Q as having the least immune response but thought P would have the greatest response.

Question 22

Solutions

a. ½ for each correct answer

Immune Cells shown in Figure 23	Names of Immune Cells
Antigen presenting cell	Dendritic cell
Cell Type 1	T lymphocyte
Cell Type 2	Cytotoxic (killer) T cell
Infected cell	Human tissue cell

b. An antigen presenting cell, such as a dendritic cell, travels to the lymph/lymph nodes (½) and presents the antigen on its surface/MHC markers (½) to a naïve/immature T cell (½) which activates into a helper T cell (½). The helper T cell produces cytokines (½) which stimulates the clonal differentiation/production (½) of helper T cells, and cytotoxic T cells (and memory and regulatory/suppressor T cells) (½). Cytotoxic (killer) T cells, identify infected cells that display antigens of pathogen (½2), inject cytotoxic chemicals/perforins/granzymes (½) and destroys cell/apoptosis (½) and virus within (½). Memory T cells are created and stored in the lymph node (½) to detect future infection with the same pathogen/antigen (½). Regulatory/suppressor T cells stop/suppress the immune response when infection cleared (½).

   Answers which simply indicated the function of cells from the information sheet but did not provide any links to the cell-mediated response were not awarded any marks.

Comments

Based on marks, students either had a clear understanding of the cell mediated response or had no knowledge at all. Many students explained in detail the humoral response (proliferation of B cells and production of antibodies), but it was clearly stated in the question that the cell mediated response was the required process. It was also reasonably common for students to mis-identify Cell Type 1 as either a neutrophil (not an antigen presenting cell) or as a memory cell (which although is an APC, the diagram clearly shows a dendritic cell).

Question 23

Solutions

a. D (1).

b. Primary exposure to the antigen for Student Y. Immature B-cells must be located, activated, and differentiated into plasma B-cells (½) and memory cells (½), causing a time lag in antibody increase (½). Figure 24 shows that levels do not reach 1000 mg L^{-1} (½). Therefore, blood sample must be below 1000mg L^{-1}.

   Secondary exposure to the antigen for Student X. Memory cells already present (½) rapidly activate into plasma B-cells (½). Figure 24 shows a quick response (½) with levels peaking above 1500 mg L^{-1} (½). Therefore, blood sample ‘D’ the most likely result.

Comments

a. Most candidates correctly identified ‘D’ as the appropriate blood sample. Because sample ‘B’ showed the correct antibody concentration for Student X (1500 mg L^{-1}) and was higher than the value for Student Y, responses selecting ‘B’ were awarded ½ mark.

b. Most candidates achieved some marks for this question; however, very few gained full marks. Many responses simply repeated information from the question, such as noting that Student X had been previously vaccinated and Student Y had not. No marks were awarded for restating this. Many candidates referred only to the blood samples in the table and did not mention Figure 24, despite the question explicitly instructing them to do so. Conversely, some candidates referenced the figure but failed to describe the roles of memory B-cells and plasma B-cells. A small number of candidates incorrectly stated that Student X would have a lower concentration of antibodies than Student Y because their memory cells had already overcome the pathogen. In addition, some students confused the terms antibody and antigen.

Section E – Criterion 8

Question 24

Solutions

a.

i. ½ mark each.

Order of Stage	Name of Stage
3	Anaphase
4	Telophase
1	Prophase
2	Metaphase

ii. Mitosis – one division, meiosis – two divisions (½).

Mitosis – identical daughter cells, meiosis – variation in daughter cells (½).

Mitosis – forms somatic cells, meiosis – forms gametes (½).

b. Cell is likely to be bigger in stage 4 (½). A cell will divide when it has grown too big to maintain efficient exchange with its environment (1). Mitotic division follows stage 4 directly whereas stage 2 is after cytokinesis when the daughter cells are likely to be smaller (½). By G2 (Stage 4), the cell has created more proteins, undergone DNA replication and added more organelles (1).

Comments

a.

i. This question was relatively well answered. Some students mistook prophase for the whole of interphase, and some students were able to provide the order and not the names of the stages or vice versa. Students were at least able to obtain half of the available marks for this question.

ii. Another question that was well answered but not all students could come up with two differences, or they confused the two processes. Some student answered that mitosis only happens in plants. This was not given marks. A full mark was given where the student responses were clear differences or a comparison and one difference.

b. Students that achieved full marks in the question were able to identify the correct stage, use the correct terminology and mention the creation of more proteins, DNA replication and more organelles and that stage 4 or G2 was before mitosis. PMAT was also accepted for mitosis.

Marks were not given for responses such as split in two, cell division, or in stage 3 DNA replication being the reason the cell was large.

Most students did not mention that stage 2 was after cytokinesis and a number believed that the cell was at its largest in stage 2.

Question 25

Solutions

a.

X	S	s
s	Ss	ss
s	Ss	ss

Punnett square (1). ½ marks for >=4 of 8 squares correct. Genotypes and phenotypes linked (1). For example: Ss = syndactyly (½) and ss = doesn't have syndactyly (½), labelling of the Punnett square or genotype next to 'Ruby' and 'Jonah' in the text of the question. Baby has a 50% chance of having syndactyly (1).

No marks lost for using a different letter of the alphabet or X missing in top left square of Punnett. No marks if genotypes and phenotypes were not clearly linked. Only ½ marks for half a statement, e.g. 50% syndactyly.

b.

X	C^w	C^w
C^B	C^w C^B	C^w C^B
C^B	C^w C^B	C^w C^B

Punnett square (1). ½ marks for >=4 of 8 squares correct. Genotypes linked to colour phenotypes black, white and grey (1). For example: C^B C^B / BB / bb = black, C^w C^w / WW / ww = white (½) and C^w C^B = grey (½). Or labelling the Punnett square or Figure 27 in the question.

This is incomplete dominance when neither allele is (completely) dominant so a new phenotype is formed as a mix of the parents' phenotypes (1). Only ½ marks for two of the three bold statements.

Only ½ marks if used upper and lower case of same letter (e.g. BB and bb) in Punnett Square. No marks lost if didn't use superscript or X missing in top left square of Punnett Square. No marks if not genotypes and phenotypes was not clearly linked.

c.

X	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

Punnett square (1). ½ marks for >=4 of 8 squares correct. Genotypes to phenotypes linked (0.5): I^AI^B (blood type AB), I^Bi (blood type B), I^Ai (blood type A), ii (blood type O). Also scored the ½ marks if linked in their written explanation or by labelling the Punnet square. Parents are heterozygous A and B blood types (½). Also scored the ½ marks if depicted in the Punnett square. I^A and I^B / A and B are codominant and both expressed in the phenotype (½). i / O is recessive to both I^A and I^B and is only expressed in the homozygous recessive (½).

No marks lost if A, B and O used in the Punnett square or if X missing in top left square of Punnett.

Comments

a. Answered well by most students. Marks were lost by not explicitly linking genotypes to phenotypes and not clearly stating the chance a baby could have syndactyly.

b. This was the lowest scoring of the three parts. Many students incorrectly stated it was an example of codominance and/or the alleles are both dominant/recessive, and many students did not link genotypes to phenotypes. When teaching, perhaps the same (hypothetical) example could be used to show the difference in resulting phenotypes when incomplete dominance occurs compared to when codominance occurs? E.g. grey versus black and white.

c. This was also answered well, with a lot of students receiving 2 marks for a correctly completed Punnett square and linking genotypes to phenotypes. Some students provided incorrect phenotypes (e.g. blood type AO) and some did not explain codominance or that the I^i allele is recessive.

Question 26

Solutions

The most likely mode of inheritance for this genetic condition is sex-linked (1), recessive (1). There are two pairs of unaffected parents (II-1 and II-2, II-5 and II-6) who have affected children (III-2 and III-6) (1) which supports the idea that this is a recessive condition. As individuals II-1, II-4 and II-6 have no family history of the condition, it is likely that they are homozygous for the condition (½). If this is the case and the mode of inheritance was autosomal, it would mean that II-1 and II-2, II-5 and II-6 would be unable to have an affected child because the fathers of these couples do not have a recessive allele to pass on to their offspring (½). It is therefore likely that the mode of inheritance is sex-linked (specifically x-linked).

Comments

Most students attempted this question and gained some marks. Students who offered 'skips a generation' as evidence for a recessive pattern of inheritance were given ½ mark if no further explanation or specific detail from the pedigree was given. Students who said that the trait was uncommon in the pedigree and therefore recessive were not given any marks. Evidence that the trait only affects males in the pedigree was given ½ mark when offered as an explanation for an X-linked pattern of inheritance. This is not a strong piece of evidence, especially given the small sample size. Many students fell short of full marks because of their inability to offer a reasonable justification as to why the condition was either sex-linked or autosomal. A number of students tried to answer this question by eliminating possibilities. Most were unsuccessful with this method of working. Many students gave an account of how their chosen mode of inheritance could have played out in the pedigree rather than providing evidence from the pedigree to support their choice.

Question 27

Solutions

a. Homologous means a pair (½) of chromosomes having the same genes in the same location (½). eg: D and d alleles for the same gene are in the same position at the top (½).

b. It results in variation in the gametes (½) and ultimately variation in the offspring (½). The significance of crossing over ensures that genetic diversity is maintained in the population (½) which may be an advantage to the populations survival if the environment is changing (½). As Jack jumpers only have one chromosome, crossing over is even more important as a source of genetic diversity as there is no independent assortment of chromosomes (1).

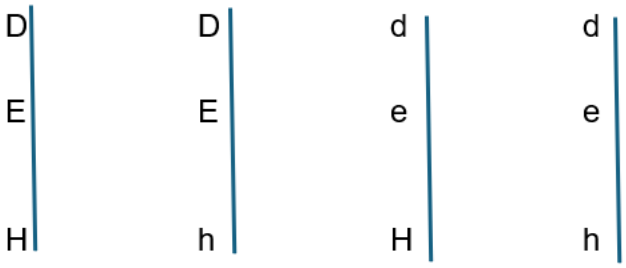
c. Sexually reproducing organisms: <u>independent assortment</u> (½).

   Asexually reproducing organisms: <u>mutation</u> (½). ½ mark also paid for students that identified that asexually reproducing organisms don't produce gametes.

d. (½) For one chromosome in each gamete.

(½) For haploid chromosomes.

(1) For four unique allele combinations with alleles represented in the correct place on the depicted chromosomes.



Comments

This question was answered moderately well with the majority of students scoring some marks for it, and most students attempting the question. In part (a) a dictionary definition of homologous attracted a half mark at best if the definition did not relate specifically to homologous chromosomes. In part (b) answers did not attract full marks if it was not made clear that genetic diversity was significant for populations of jack jumper ants rather than individuals. In part (d) if students didn't know what the question was asking of them then drawing a picture that looked a bit like an image of meiosis or a picture of a chromosome did not attract more than a half mark. Many students missed that these were gametes or did not know that gametes are haploid.

Question 28

Solutions

a. There are two different alleles present within the mosquito population, sensitive and resistant (or allele 1 and allele 2) (½). The DDT acts as a selective pressure (½) on the mosquito population. The mosquitoes with the sensitive allele were unlikely to survive the spray (1) therefore the population plummets.

b. The homozygous resistant population decreased after spraying was reduced (½). As the selective pressure of the DDT was reduced, the sensitive allele (allele 2) frequency increased through the increase in both homozygous sensitive and heterozygous mosquito populations (1). The reduction of the homozygous resistant population could demonstrate that allele 1 had a disadvantage prior to the introduction of DDT (½).

Comments

a. Most (~ 90%) students correctly identified that the DDT caused the percentage of homozygous sensitive mosquitoes to plummet. About half of the students identified the effect, that the homozygous sensitive mosquitoes died, and only the strongest performing students identified the additional effect of the increase in homozygous resistant mosquitoes. If students identified that the DDT/insecticide/spray was the cause of the population plummeting, they received ½ a mark. If the students identified that there was both a resistant and a sensitive strain, they received ½ a mark and if they correctly identified that the selective mosquitoes/allele would die out due to the spraying they received 1 mark.

b. Most students (80%) identified that the homozygous resistant population decreased after DDT spraying was reduced. However the analysis has quite a vast range: talking about the changes in population percentage over time (about 35% of students), linking the decrease in population to the removal of the selection pressure of DDT on sensitive mosquitoes (about 25%), linking the decrease in population to the release of a new pesticide/chemical (about 5%). The stronger students were able to link the decrease in population percentage with the removal of the selection pressure, the increase in population of both heterozygous and homozygous sensitive mosquitoes, and theorise reasons for the decrease such as increased competition for resources, unfavourable traits when not faced with DDT as a selection pressure, the introduction of different pest management solutions to combat the resistant mosquitoes or a combination of them all. If students identified that the population decreased, they received ½ a mark. If the students identified that the populations of homozygous sensitive and/or heterozygous mosquitoes increased, they received ½ a mark. If they linked the increase to those populations to the reduction of the DDT spraying, they received a ½ mark. If they linked the increased populations of homozygous sensitive and/or heterozygous populations to the reduction of homozygous resistant populations due to any of the following reasons, they received ½ a mark:

- increased competition for resources
- non-advantageous (or advantageous – depending which population was being described) traits with the removal of DDT
- introduction of new chemicals.

Question 29

Solutions

a. Only a small subset of the population established on Pearson Island, therefore the founder effect could have an impact on genetic diversity (½). The further impact of genetic drift (½), random extinction of alleles through chance events (bottleneck effect) (½), and limited genetic variation due to a smaller gene pool (½) would all contribute to lower genetic diversity.

b. Answers could include:
- reduced selection pressures (1)
- no competition (1)
- well-adapted to the environment (1)
- excellent food sources (1)
- no predators (1)
- minimal predation (1).

c. Natural selection would select for favourable traits/alleles and then these favourable traits/alleles will be passed on to offspring (1). After millennia, changes in the allele pools of both the mainland wallaby populations and the Pearson Island Rock Wallaby population in response to their environments (½) would produce differences in behavioural, structural and physiological adaptations (½). This could see speciation occur, especially as no gene flow (1) between geographically isolated wallaby populations would lead to the sharing of these new alleles.

Comments

a. Most (90%) students could identify that there was a limited gene pool within the population due to its smaller size, which led to inbreeding and an already reduce genetic diversity. About half of the students were able to identify that the reduced gene pool was a result of genetic drift, or that it was a result of the founder effect/bottleneck effect when the sea levels rose. Very few students were able to identify a random extinction of alleles as a cause. The top students were able to identify at least four of the above points as a reason for lower genetic diversity within the population. Most students could identify 1 or 2 reasons. Students received ½ a mark for each reason correctly identified and used in the correct context, to a maximum of 2 marks.

b. This question was mostly answered correctly. Only a small percentage of students got this question wrong or left this question unanswered (less than 10%).

c. This question was not marked. Incorrect Information sheet provided advantage to students.