BIOLOGY (BIO315116)

The feedback from the final examination paper was positive and seen as one that generally had a good range of questions to give the candidates a chance to show their abilities. All parts were generally well attempted by the 793 candidates who sat the Biology exam in 2017.

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 a 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 I

QUESTION 1

(a) (i) Grass grows faster in the springtime. Valid hypothesis- No. Reason if no: Observation only, non-clearly defined independent variable.

   OR   No causal relationship between IV and a DV.

(ii) Snake venom once injected inhibits respiration because it inhibits key enzymes and blocks vital nerve functions. Valid hypothesis- No. Reason if no: Explanation, contains more than one dependent variable.

(iii) The high temperatures associated with a bush fire increases the germination rate of Blackwood seeds. Valid hypothesis- Yes.

(iv) If the earth had no moon, all life on earth would die. Valid hypothesis- No. Reason if no: Untestable, no clear IV.

(½ for each correct No, ½ for explanation, 1 for correct Yes)

(b) (i) Group 1 (1/2) is the control group as it provides a baseline level treatment (1/2) that provides a comparison for the other treatments with Vitamin C (1). (Also acts as a placebo)(1)

(ii) Large number of participants, reduces individual variation and increases reliability/validity Volunteers grouped randomly, reduces statistical bias.

Extended period over a year, reduces influence of normal fluctuations in people’s health and gives time for exposure to colds.

Variation in levels of Vitamin C, allows testing to see if effect, if any, is dosage related.

Consistent dosage at the same time of day, allows for consistent absorption.

(iii) Dosage needs to be possibly as much as 9 grams to reduce the rate of developing colds beyond the control/placebo level by 10%.
Comments
This question was answered well by most candidates. Very few scored less than 3½ marks, with the majority scoring between 5½ and 7½.

(a)  
(i) The main error here was describing it as “too vague”, or overstating it as “no clearly defined independent and dependent variables”.

(ii) Many candidates recognised this as an explanation, or as having more than one dependent variable.

(iii) This was well done, with the majority of candidates recognising it as a valid hypothesis.

(iv) Well done, with most realising that this was untestable.

(b)  
(i) This was very well answered, with most scoring at least one mark, and many scoring 2. Only 2 candidates incorrectly identified the control group.

(ii) Many candidates correctly identified 2 strengths, but failed to give a brief explanation, scoring 1 mark overall.

(iii) Candidates needed to mention 9g to gain the full mark. Those who wrote “more than 3g”, or “large dose” with some explanation were given ½ mark.

QUESTION 2

(a)  
Independent variable: sucrose in solution  (1)
Dependent variable: ethanol concentration in water (OR oxygen concentration)  (1)
Hypothesis: Sucrose available to yeast results in ethanol production.  (2)
OR: When sucrose is available to yeast, it results in decreased oxygen levels in the water (if candidates have identified oxygen levels as the DV).  (2 marks)

(b)  
The air concentration of oxygen in the sealed containers
The temperature was kept constant.
The length of time before testing was constant
The same species of yeast was used
OR same amount of yeast was used (implied)
Initial levels of ethanol were all zero (½ each).

(c)  
Group 2 the % of Oxygen is 8.Clearly a recording measurement error (½ ) as the percentage of oxygen at the end of the experiment is much higher (½) oxygen to get into the solution in the sealed jar (1) unless the seal failed (½ ) and even then the change in concentration couldn’t happen that quickly by diffusion alone (½ ). Max 2 marks

(d)  
Ethanol is produced from anaerobic respiration of yeast cells (1) at a rate of 4% per hour when 0.1M of sucrose solution is used (1), which can be seen as when no sucrose is applied, the yeast cells are unable to undertake fermentation (i.e. no ethanol is produced) (1).

OR
The yeast is consuming oxygen through aerobic respiration (½ ) as shown by the decrease in oxygen concentration in three out of the four groups (½ ) from 21-22% to 18% on average and also producing ethanol through anaerobic respiration (½ ) as shown by the production of ethanol in all of the four groups (½ ) from zero to 4% on average (½ ). (1 mark reserved for quoting of figures).
Comments

2a) There was a very even spread of marks from 1 to 3½ for this question, with relatively few scoring outside these limits. Many identified sucrose as the independent variable, with the most common error being oxygen. The dependent variable was not well identified, with many saying it was oxygen and ethanol, and many others saying cellular respiration. Part marks were awarded for these answers.

Very few gained full marks for the hypothesis. ½ mark was deducted for including increase in ethanol or increase in anaerobic respiration rate. Only a small number of candidates chose the second form of the hypothesis which used oxygen as the dependent variable.

Answers which involved statements such as “sucrose is required by yeast cells to undergo anaerobic respiration” gained 0 marks.

2b Common error was stating sucrose concentration or volume as one of the variables to be kept constant. Most candidates got 3 or 4 of the 4 required variables.

2c This question was done very well with most candidates gaining 2/2. The commonest error was not applying this to question 2d as the faulty Oxygen reading in group 2 gave an inaccurate average for oxygen % before.

2d Most candidates tried to address their hypothesis from question 2a. If their hypothesis was incorrect as they chose the incorrect IV or DV they still received part marks if they addressed it in the correct way. Those candidates who focused on the DV oxygen % needed to apply the information from 2c so that they ignored the average and worked with individual group results or calculate a new average with group 2 deleted.

QUESTION 3

<table>
<thead>
<tr>
<th>1 mark</th>
<th>Identify IV</th>
<th>The colour of light</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mark</td>
<td>Identify DV</td>
<td>The angle to which the stem bends toward the light</td>
</tr>
<tr>
<td>2 marks</td>
<td>Describe treatment of groups</td>
<td>Tomato plants grown in healthy conditions (½ mark), light restricted to one direction from the side (½), experimental groups each given different colour spectrums of light (½). Suitable length of time to allow stems to bend towards light, e.g. 2 weeks (½). All other conditions to be maintained identically between groups and control (½).</td>
</tr>
<tr>
<td>1 mark</td>
<td>Sampling</td>
<td>100 tomato plants were used to provide a sample that lends itself to statistical analysis and validity (½). 100 tomato plants were chosen and allocated to the treatment groups at random to avoid bias and to help account for the effects of individual variation (½)</td>
</tr>
<tr>
<td>1 mark</td>
<td>Identify control group</td>
<td>The tomato plants grown in normal white light form the control group, which will be compared to the other experimental groups</td>
</tr>
<tr>
<td>2 marks</td>
<td>Identify the main controlled (fixed) variables</td>
<td>In order for the results to be valid, many variables that would affect the DV need to be controlled. e.g. light intensity (½), CO₂ levels (½), wind direction (½), temperature (½), same species (½), same size plant (½), same soil type/pH (½) etc.</td>
</tr>
<tr>
<td>1 mark</td>
<td>Describe how DV will be measured</td>
<td>Measurement of the angle of bending (½), using a protractor or similar (½) OR measure distance top of plant has moved from a vertical stake placed behind stem (½)</td>
</tr>
<tr>
<td>1 mark</td>
<td>Treatment of results</td>
<td>Determine the average bending angle/distance for each of the groups (½) and compare in a table/graph to see if there is a significant difference in the amount of bending between the control group and the experimental groups (½)</td>
</tr>
<tr>
<td>1 mark</td>
<td>Replication</td>
<td>The experiment should be repeated (½) several times to validate results (½). Replicates of the environments for each colour treatment would deserve ½ a mark</td>
</tr>
</tbody>
</table>
(b) Repeat the experiment (½), increase the sample size (½), do it again but extend the time (1) or spectrum range (1); repeat using a different kind of plant (1) or 1½ if a reason is given; repeat but look at the effect of colour on another DV – e.g. yield of tomatoes (1½) or 2 if a reason is given; expose the plants to the colour which produced the most/least bending and see what the effect of changing another IV (e.g. light intensity) is (1½) or 2 if a reason is given.

Where candidates provided multiple suggestions, they all received marks, up to a maximum of 2 marks total.

Comments
a) Candidates who understood that “design an experiment” means identifying IV/DV/fixed variables etc. were easily able to get 4-6 marks in (a). To get more than 6 marks, candidates needed to describe how the DV was measured and how the results were treated.

A large number of candidates designed experiments to test the effect of factors other than colour (e.g. light intensity) on bending. They still received marks for their understanding of the elements of experimental design. Some unrealistic time frames were suggested (e.g. bending occurring in 10 minutes). The question specified that a procedure had to be described. Candidates were not penalised for describing unworkable/invalid procedures (e.g. placing plants directly under lights). “No light” rather than “white/natural light” was a common suggestion for the treatment of the control group.

**QUESTION 4**

Any 5 valid points that include a challenge, strength and a weakness such as:

**Challenges:** Comparing studies over a long period of time (½), using a lot of different treatments (½), in different places and on different groups of people (¼). The data from each study may have been collected differently (difficult to correlate results) etc. (1) Medications may have changed over 35 years with different production methods etc. (1)

**Strengths:** random subject selection for each treatment minimises bias by the experimenter. (1)

Control groups are given placebos and people are unaware of what treatment they are getting therefore reducing the impact of psychological bias (1) PERHAPS….Mention of double blind (¼)

Extremely large numbers involved. Which increases the reliability of the results by minimizing the effect of individual variation (genetic and lifestyle differences). (1)

A range of dosage levels were studied, which would help see if the effect was dosage related (1)

Analysed a number of significant studies data that were collected over a long time frame giving more reliable information (1)

Use of sophisticated statistical analysis to allow comparisons between different studies that used different combinations of treatments etc. that increases reliability of the results (1)

**Weaknesses:** Pain is very subjective and impossible to measure quantitatively as it is not clear how this data was collected in each of the studies (1)

People may be on a combination of other treatments/medications that may impact their pain levels (1).
Comments

4. There were some common misunderstandings. The outline of the was brief and many candidates assumed that all the trials were only 100 patients, that there was no consistency between trials, that some individuals were tested for 35 years, that the trials were NOT double blind etc. Use what you do know to comment on rather than guess about the unknowns.

Another common error was to summarize the trials results and comment on the effectiveness of the drugs. From our point of view we were looking for whether the study was carried out to produce valid findings rather than whether NSAIDS were better than paracetamol. A doctor would look at the trial and say I will prescribe ... We look at the trial and comment on whether it was carried out in a proper scientific manner.

PART 2

QUESTION 5

(a) CTACAAAAGCTAGATTGA

(-½ mark per mistake in the sequence, only 1 mark if have U instead of T).

(b) CUACAAAAGCUAGAUUGA

(-½ mark per mistake up to 2 mistakes, sequence is from original DNA in the question stem)

(c) Messenger RNA conveys the genetic information from the DNA by producing a complimentary copy of the original strand of DNA (1) and transporting it out of the nucleus to the ribosomes (1/2) where it forms a template for amino acid sequence in the production of proteins (1/2)

(d) 6

(e) An amino acid is determined by its codon (1) therefore a change in codon produced by point mutation/chemical/environmental damage DNA during replication OR an error in transcription in the mRNA nitrogen bases OR an error in translation when codon and anticodon are not a correct match resulting in a changed amino acid/protein. (Need to have any two of those – 1 mark each).

Comments
The majority of candidates scored 2 marks and above for this question.

(a) Very well answered

(b) Well answered also, candidates who got it wrong was because they used their answer in part (a) to complete part (b).

(c) Most candidates obtained some marks for this question but there was confusion in describing mRNA role. For example candidates stated that mRNA was going into the nucleus to collect the RNA strand, while others gave a complete process of protein synthesis. The candidates that obtained 2 marks described both what mRNA did inside the nucleus and well as what its role outside the nucleus.

(d) Candidates found this part hard to obtain full marks in. The vast majority of candidates only gave one cause (e.g. mutation) but giving two effects (e.g. addition and/or deletion). There was not enough detail on when the mutations were happening (e.g. in translation and/or during the transcription process).
QUESTION 6
(a) Factors: light intensity, water availability, carbon dioxide, temperature, colour, light duration

Light intensity: light is needed for photosynthesis, particularly at the red and blue ends of the spectrum which green plants use. (½) Balance between maximising photosynthesis and not overheating the plants & /or drying them out. (½). Placing the greenhouse so that it maximises the light availability and not in the shade could optimise the growth of the plants (½). Using artificial lights at night (½).

Water availability is needed for photosynthesis. Humidity levels need to be controlled to help restrict excess water loss, while not promoting mould etc. (½) for either. Optimising by using sprinklers or some other irrigation method to ensure correct amount (½)

Carbon dioxide is needed for photosynthesis. It is required for the production of glucose that is used to produce ATP for metabolic processes (1). Increasing carbon dioxide levels can therefore increase growth rates (½). Could be pumped into a closed greenhouse. (½)

Temperature: all metabolic processes are affected by temperature, including photosynthesis, so needs to be optimised. (1). Too hot and the plants enzymes may denature (½) or the rate of transpiration may increase → closing of stomata (½) which will reduce the rate of p/s

½ mark for each correct factor, 1 mark for the explanation of how each of the two factors could be optimised.

(b)

<table>
<thead>
<tr>
<th>Aerobic Respiration</th>
<th>Photosynthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Releases stored energy from glucose</td>
<td>1. Stores energy in glucose</td>
</tr>
<tr>
<td>2. Uses oxygen as an input</td>
<td>2. Releases oxygen as a product</td>
</tr>
<tr>
<td>3. Releases carbon dioxide as a product</td>
<td>3. Uses carbon dioxide as an input</td>
</tr>
</tbody>
</table>

Difference: Energy is captured by photosynthesis in form of light, but released by respiration as ATP and heat. (1); Photosynthesis has 2 stages, light & dark and aerobic respiration 3; Respiration occurs in the mitochondria photosynthesis occurs in the chloroplasts.

(c) i) Aerobic cellular respiration (1)

ii) ATP (½)

• Energy can be obtained easily through breaking the phosphate bond (ATP → ADP + P)
• Is a recyclable molecule ADP + P + energy → ATP and vice versa
• Small convenient amounts of energy that can be delivered to where the energy is required in the cell (avoids waste)
• ATP is a ‘quick’ usable form of energy compared to aerobic respiration of glucose (only one bond needs to be broken to release useable energy).

½ to 1 mark each depending on amount of explanation

iii) No (½). ATP can be produced by anaerobic respiration at times of low oxygen conditions to maintain energy supply (1). Involves breakdown of Pyruvic acid to lactic acid (animals) or alcohol (plants) (½), but less ATP produced. Anaerobic respiration produces less ATP than aerobic respiration (½) 36 vs 2 ATP anaerobically (½). (A combination of any of these, only up to 2 marks)
Comments
(a) Candidates could identify four factors easily, but had trouble then following up with an explanation as to how these factors could be optimised. Very few full marks were realised for this part as a result.

(b) Most candidates were able to identify three factors that were the reverses of each other in the table. The last part led to confusion due to the wording of the question. Whilst the question was asking for one way in which they can be considered different, some candidates read the question as to one way the processes could be considered similar. Credit was given to sensible answers in these cases.

(c) Candidates demonstrated sound knowledge and understanding in all three parts to this section.

QUESTION 7

(a) i) River buffalo 30°C cf. bacteria approx. 60°C.

ii) They both have a different level of pH where the activity of the enzyme is optimal as River buffalo enzyme being efficient within pH 7 – 8 (½), while the bacterial enzyme is efficient at a lower pH range 5 – 6.6 (½). This is because the organisms live in different environments, the bacterium lives in hot springs that are likely to be acidic (½) and the water buffalo has a stable internal environment of approximately pH 7 (½).

(b) Correct graph: M (½)

Explanation: The initial response is very rapid (½) as there is plenty of substrate to collide effectively/bind with the active site of enzyme (½), but the rate of conversion plateaux as the amount of enzyme becomes a limiting factor when all the active sites are full and the enzyme is operating at maximum rate (½).

(c) In the induced fit model the exposure of the enzyme to the substrate causes the active site of the enzyme to change shape (1) in order to allow the enzyme and substrate to bind and form enzyme–substrate complex (1/2). This lowers the activation energy required for conversion of substrate to product/s reducing the time it would otherwise take (1) OR → this then allows the enzyme to be free to catalyse another reaction in an incredibly short time (1/2).

Comments

7(a) (i) Most candidates could identify the temperature at which the enzyme reacted at its maximum rate. Candidates who did not get this read their values off the Y-axis.

(ii) Most candidates could identify and quote the pH at which the enzyme was reacted at its maximum rate. Many said that the reason for this was that the two enzymes operated in different environments and hence they were active at different pHs. Many realised that the hot springs would be acidic but few candidates could state that the internal environment of the buffalo was neutral. A common misconception was that the enzyme operated at pH 7 because this was the pH of the water in which the buffalo lived.

(b) Most candidates could identify M as the correct graph. Many candidates described the shape of the graph as the reason for their choice rather than explaining that this was the correct graph in terms of enzyme function. The candidates who did answer in terms of enzyme function usually concentrated on the fact that the graph levelled off when all the active sites were operating at maximum capacity. Few candidates mentioned the reason for the increase prior to this in terms of the increased number of collisions. A number of candidates chose option K because it resembled an enzyme function versus temperature graph.

(c) Candidates found this a challenging question. Many candidates left this question blank and many thought this question was linked to Part b. A few candidates made the mistake of describing co-factors and inhibitors. A worrying error was that many candidates were writing about the lock and key system which is no longer in the course.
Candidates described the induced fit model very well but failed to elaborate on the following points:

- How this model aids in binding and releasing substrates/products.
- How enzymes lower the activation energy required.
- How the substrates are put under strain when in the active site causing them to break or join.

There was also confusion with the word Catalysis, with many candidates using this word out of context. Other common errors included thinking that substrates were attracted to the active site and that enzymes can catalyse many different substrates.

**QUESTION 8**

(a) All organisms require essential amino acids that cannot be made by the body/must be provided via digestion/diet (1). These are needed to produce proteins, which have a wide range of essential functions within the body and the cells (1), e.g., in cell membranes, enzymes, muscles, etc. (1-2 marks depending on explanation). Without getting enough essential amino acids and the body would suffer from this deficiency (1 for connection to appetite response).

(b) People need to ensure they eat enough protein in their regular diet (½) so they don’t have to keep eating extra food with extra kilojoules to meet their essential amino acid requirements (1). This will reduce the amount of carbohydrates and fats they feel they need to eat (½) and reduce the likelihood of obesity with its consequent health issues (½)

**Comments**

8a) Candidates who read the question and explained why proteins were important in the diet and then went on to discuss the significance of the findings with locusts performed quite well in this section.

b) Candidates who outlined the biological molecules that constitute a balance diet and then went onto to apply the findings of the locust research, that increasing the proportion of protein would reduce the need to eat excessive amounts of carbohydrates and lipids did well. Many candidates wrote information dumps from the information sheet or quoted information from Food and Nutrition or Sports Science.

**PART 3**

**QUESTION 9**

(a) i) Identify the organelles indicated by the arrows Y and Z (1)

Y: Nucleus. Also accepted was nuclear membrane or cytoplasm

Z: Rough ER or Ribosomes (½ mark for each)

ii) Identify two features that indicate this is an animal cell (1)

- Lack of cell wall in which an animal cell would not have or lack of chloroplasts in which an animal cell would not have but a plant cell would

OR either of the following:

- No large central vacuole in which a plant cell would have but not an animal cell.

- The cell contains a membrane bound nucleus in which a bacterial cell would not. (½ mark each)
iii) The large number of mitochondria indicate that the cell is undergoing a lot of active processes, given that mitochondria are involved in cellular respiration/production of ATP (I). The large number of rough endoplasmic reticulum/ribosomes indicates that the cell is involved in a lot of protein synthesis (I). Therefore, the large number of X and Z indicates the cell plays a role in protein production such as enzymes and uses the energy of X to power Z. The cell is highly active. (I).

(b) 2 marks per row, ¼ mark lost per mistake

<table>
<thead>
<tr>
<th>Cell component</th>
<th>Name</th>
<th>Function</th>
<th>Present in</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animal cells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formation of vesicles involved in packaging and refining materials for export/transport around and out of the cell</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site of photosynthesis. Contains chlorophyll which can absorb light energy.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Centrioles</td>
<td>Involved in cell reproduction/spindle fibre formation during cell division</td>
<td>Y</td>
</tr>
</tbody>
</table>

Comments

(i) Most candidates were able to identify that structure Y was part of the nucleus although as the image was a little unclear both nuclear membrane and cytoplasm were also accepted. However, many candidates thought that structure Z was Golgi apparatus (if candidates had referred to the information sheet they should be able to see from the animal cell that this structure was the same as the Rough endoplasmic reticulum). Ribosomes were also accepted but saying smooth ER was not accepted.

(ii) This question was well answered but a common error with this question was saying that the cell had membrane bound organelles or it had a nucleus – which are both true to an animal cell but they can be also true to a plant cell. So, you needed to distinguish why having a certain feature made the portion of the cell from that of an animal cell.

(iii) Most candidates attempted this question however many candidates gained 1 or 2 marks. It was common that candidates could say that the cell having organelle X meant that energy was being produced and having organelle Z was involved in protein synthesis but then could not link the two and suggest a function of this cell as per the suggested answer above. The majority of candidates wanted to provide a guess at the type of cell i.e. muscle but did not read the question which asked for a suggestion about the function of the cell.
If candidates wrongly identified organelle Z as Golgi apparatus (thus lost ½ mark in part i) but could identify the function of Golgi apparatus in conjunction with organelle X and the overall function of the cell they were scored full points.

Several candidates mentioned that X and Z show that the cell requires energy—but this was not enough detail and they would only score 1 point for that.

9(b) Many candidates made mistakes in identifying the structures. Common mistakes included suggesting that the first cell component was endoplasmic reticulum— if this was suggested then the function was incorrect too. That the second cell component was either mitochondria or lysosome —thus all follow-on aspects of the component was incorrect too. Most candidates that attempted the third image and could identify it as centrioles but within the function thought that it was involved in cell respiration not reproduction (perhaps due to rushing the table & wrote the incorrect function). Also with this image many candidates thought that both animal and plant cells would contain centrioles when it is only animal cells.

The biggest error was that candidates did not put N/No or X in the column—they only put Yes-Y or ✓ and left out any NO/N/X thus did not gain ½ mark for this lack of detail.

QUESTION 10

(a) i) Structure Z is a protein channel (½) that can be used for active transport or facilitated diffusion of substances across the membrane (½). Its structure includes a channel to transport ions or large substances such as proteins (1), OR it has no charge to allow large charged molecules to pass through the membrane (1). OR it spans the phospholipid bilayer to allow large charged molecules to pass through the membrane (1).

ii) Cell’s need to be able to regulate their own internal environment to survive, by both active and passive transport of substances. Some substances are too large to diffuse (½) or substances need to be moved up their concentration gradient (½).

• Active transport (½), where energy is used to move ions/substances against a concentration gradient (½).

• Phagocytosis (½), where large particles are engulfed by the cell membrane and moved in or out of the cell (½).

• Pinocytosis (½), where liquids are encircled by the cell membrane and moved in or out of the cell (½).

• OR Endocytosis and Exocytosis can be explained in a valid way or for any other valid mechanism (e.g.; contractile vacuole).

(b) The statement is overall quite true: The smaller the cell the higher the surface area to volume ratio, which means more rapid exchange across the membrane (may be shape dependant) (1), by process such as diffusion or active transport. Smaller cells also have a smaller diffusion distance allowing for a more efficient exchange of materials. The cell still needs certain structures and organelles to operate properly related to the function of the cell, e.g. mitochondria, nucleus etc. which limits how small the cell can be (1). However, specialised cells range in sizes and that doesn't necessarily have any bearing on how active they are. (1)

The statement is fairly true if: The SA: V gets too small then substances won’t be able to enter the cell fast enough to fuel the reactions and waste products would start to accumulate within the cell. Thus, cells tend to be small to overcome this disadvantage. (1) A high SA: V is common to smaller cells which enables faster/efficient exchange across the membrane. Smaller cells have a smaller distance for diffusion allowing for efficient exchange of materials. (1). However, the statement is not true in terms of activity of cells—as some cells such as neurons are large and quite active whereas small cells i.e. epithelial cells as less active. (1)
Comments
10 (a) Most candidates attempted the question. Few got full marks in part 10 but many got full marks for part 11.

(b) A range of answers was accepted for this question. Overall it was marked on candidates providing 3 different points addressing the question and quote/statement. Mostly this included referring to SA: V ratio, structure/function of the cell and shape and size in comparison to activity and/or organelles needed. Candidates that provided an example especially of RBC within their answer to demonstrate the truth or otherwise of the statement were credited with points.

Many candidates did not attempt this question at all. And a lot of candidates who attempted it gained zero marks as they just repeated the question/statement quote without providing any further information/detail. Of the candidates that attempted to answer the question they received either 1 or 2 points as only one or two ideas were identified in relation to the statement. This was a challenging question for candidates.

QUESTION 11

(a) Osmosis (½) is taking place across a selectively permeable membrane (½) The 1% salt solution is a hypotonic/less concentrated environment (½) so there is a net movement of water (½) into the worm from areas of low salt concentration (hypotonic) in the solution to high salt concentration inside the worm (hypertonic) (1). The water is moving down its concentration gradient (½). The worm is increasing in mass (½) due to the movement of water (½)

(b) It is equivalent to 3.2% salt solution (1), as interpolated from the graph (½), which is the isotonic (½) point where mass of the worms hasn’t changed as there is no net movement of water (1).

(c) The worms are unable (1/2) to regulate their internal osmotic concentration. They are osmoconformers (1/2). The graph shows a linear relationship (1/2) as the concentration of salt increases (1/2) the mass decreases (1/2). When the worms are at a concentration above 3.2% salt they are in hypotonic solutions (1/2) and water enters their bodies (1/2) through osmosis (1/2). They gain up to 55% mass (1/2). At a salt concentration of 5% they lose (1/2) mass up to 40% (1/2) as they are in hypertonic solutions (1/2). The worms may attempt to regulate by actively transporting ions to maintain a constant internal concentration (1). If the worms were osmoregulators the graph would show a horizontal line or curve at the concentration at which they could osmoregulate/ or they would have no/ little change in mass (1).

(d) As there is already enough data in the linear trend line to extrapolate the result (1). At 1% the worms have gained 55% mass (1/2), as the solution below 1% would be very hypotonic to the worms (1/2) then the mass gain would be greater than 60% (1/2) as water moves in (1/2) by osmosis (1/2). Worms do not have a cell wall (1/2) so the membrane would burst/ lyse (1/2), killing the worms (1/2).

Comments
11 (a-b) Some credit was given when candidates mixed up terms like hypo/hypertonic but still demonstrated understanding of which direction water was moving and why.

(c) A number of candidates did not attempt this question, yet were able to answer part d. If candidates said “worms do not have a contractile vacuole so they can’t…” or “worms use a contractile vacuole to attempt to regulate…” they were awarded some marks depended on the context. To gain full marks candidates had to refer to data from the graph, and answer the part about “to what extent can” – in most cases this was they can’t, but it had to be referred to in the answer.

(d) While there are no ethical restraints on experimenting on worms if candidates said it was unethical to put them in a solution which would knowingly cause them to burst they were awarded (1/2) mark.
QUESTION 12

(a)  
(i) K
(ii) J

(b) Meiosis (1/2)

Crossing over (1/2) which involves the exchange of sections of chromatids (1/2) and hence the mixing of alleles (1/2) increasing the variation / recombination of the chromatids (1/2)

Independent assortment of chromatids (1/2) as they randomly align (1/2) and move to separate daughter cells (1/2) this increases variation.

Meiosis produces 4 (1/2) haploid gametes (1/2) through the process having two divisions (1/2). As a new cell is diploid the production of gametes increases diversity.

In mitosis the daughter cells produced are identical so there is less variation than in meiosis (1/2)

(c)  
J

Comments

12. Quite well answered with most errors occurring in part (a) or candidates not giving complete answers in part (b) e.g. “crossing over” without elaborating on how that increased variation.

PART 4

QUESTION 13

(a)  
(i) A: Oxygen

B: Carbon dioxide ½ mark each

(ii) The folded structure of the alveoli increases the surface area of the alveolus hence increasing the amount of absorption by diffusion (1).

Continual blood flow due to close proximity of the capillary network to the alveolus and ventilation of lungs increases concentration gradient of oxygen and carbon dioxide gases around the alveolus (1/2) & hence rate of diffusion of carbon dioxide into the air to be expelled and rate of diffusion of oxygen into the blood from the air inhaled. (1/2)

Moist thin membrane of cells lining the alveoli also enhances the rate of exchange by diffusion and allows oxygen to be dissolved so that it can be diffused (1).

(b)  
(i) Ultrafiltration (1) filtration (1/2).

(ii) Difference: Glucose and or amino acids/vitamins present at X not present at Y (1/2)

Reason: nutrient/valuable molecules are actively transported back into bloodstream (1/2)

Difference: Urea/nitrogenous waste present at X and present at Y however urea concentration higher at Y (1/2)

Reason: concentration of waste by osmotic removal of water into bloodstream, lowering filtrate volume. The amount of urea in the filtrate can increase or decrease to help maintain water balance (1/2)
Difference: Water volume higher at X and lower at Y (1/2)

Reason: osmosis of water from the filtrate in the Loop of Henle (1/2)

(iii) Stimulus of high blood salt concentration detected by osmoreceptors in hypothalamus (1); Pituitary triggered to release anti-diuretic hormone (ADH) into the bloodstream (1); ADH travels via bloodstream to the kidneys and increases the permeability of the collecting tubule membranes (1); Increasing water diffusion by osmosis from the filtrate to the bloodstream as a consequence (1); Low volume of concentrated urine produced (1); Further loss of water minimised however the concentration of blood does not returned to normal, this will only occur when subject drinks water (1).

OR

Stimulus of low blood salt concentration detected by osmoreceptors in hypothalamus (1); Pituitary prevented from releasing anti-diuretic hormone (ADH) into the bloodstream (1); because ADH is present in reduced concentrations the permeability of the collecting tubule membranes subsequently reduce (1); more filtrate flows through the tubules to the bladder, increasing urine volume and decreasing urine urea concentration (1); blood volume is reduced, the blood salt concentration is increased, which removes the original stimulus (1).

Comments
(a) (i) It was well answered.

(ii) Candidates lost marks for not giving complete answers e.g. stating a feature but not explaining on how it increased the rate of diffusion.

(b) (i) Most candidates answered Bowman’s capsule (as this is how the diagram is labelled on the information sheet). The question asks for a “process” not a label.

(ii) Some candidates answered this question well and received full marks.

(iii) A significant number of candidates answered this question extremely well and received full marks.

QUESTION 14

(a) (i) Most organic food molecules are too large (½) to be absorbed through the cell membranes lining the digestive system so must be broken down to their simple forms first (½).

OR:

Mechanical breakdown increases the surface area (½) for enzyme action (½).

(ii) Mechanical breakdown into smaller particles by the teeth/tongue (½). In the mouth (½)

Mixing of the food with saliva that lubricates for easy swallowing (½) contains buffers and enzymes (amylase) to begin chemical digestion (½)

Further mechanical breakdown by churning (½) in the stomach (½). Further chemical digestion by stomach acid and pepsin (½).

Emulsification of fats in the small intestine/doddenum (½) using bile produced by gall bladder (½) and chemical breakdown of fats by lipase (½) produced by the pancreas (½)
(a)  (i) Small intestine/duodenum (½), presence of villi (½) or long narrow shape (½) or intestine due to presence of villi or long, narrow shape (½).

(ii) The main way of absorbing nutrients is through diffusion (½) and the structures all help in maximising the efficiency of this diffusion (½).

- The concentration gradient (½) of nutrients is maintained at a high level by a “constant flow” of new nutrients moved along by peristaltic action of the muscles (½) in the gut and the moving on of the absorbed materials by the capillaries and veins (½).
- The concentration gradient (½) is also maintained by short distance between the gut contents and the capillaries (½).
- The capillary network (½) inside the villi provides a large surface area for the absorption of nutrients into the blood stream (½).
- Production of enzymes (trypsin/lipase/amylase) for further chemical breakdown of biomolecules (½).
- The amount of diffusion is increased by the increased surface area of the villi (½) with their finger like projections/long narrow shape (½) & further increased by the micro villi on the epithelial cells (½).
- The nature of the moist (½) selectively permeable membrane allows nutrients to diffuse through (½).
- The peristaltic action also helps bring the villi into contact with food in the middle of the gut and be able to absorb it better (½).
- There is an ample blood supply to the muscles for peristalsis too (½).
- Production of mucous for lubrication/neutralisation of stomach acid (½).
- The lacteal (½) in the centre of the villi help absorb and carry away the products of fat digestion/fatty acids and glycerol (½).
- Abundant mitochondria in epithelial cells (½) to generate ATP (½) for active transport of glucose (½).

Comments
Overall, this question was well-answered with the majority of candidates getting ≥6 marks out of 11.

In (a) (i) many candidates lost ½ mark for not explaining the significance of small molecules or increased surface area. Part (a) (ii) was extremely well-answered with the majority of candidates explaining mechanical & chemical digestion well and getting all 3 available marks. Many candidates explained in far more detail than was needed and a number discussed irrelevant material that was not asked for in the question such as water absorption in the large intestine. Part (b) (i) was also well answered – those who lost marks here were either not specific enough (e.g. intestine) or misidentified the section of the digestive system. Some candidates pointed out that the diagram on the information sheet showed that the area had to be the duodenum. Most candidates got some marks in part (b) (ii). Common mistakes included not relating structure to function or only mentioning one or two of the structural adaptations shown.
QUESTION 15

(a) (i) Surface A (I)

Reasons: The epidermis is more likely to have a thick waxy cuticle to prevent evaporation of water (I). The palisade layer, cells contain chloroplasts to conduct photosynthesis needs to be facing the light (I). The stomata are more often found on the underside of the leaf away from the heat of the sun, to reduce water loss (I).

(1 mark for each valid reason with explanation)

(ii) Water (I)

Capillary action in the thin/narrow xylem tubes (facilitated by adhesion and cohesion forces), transpirational pull due to evaporation of water pressure, changes to the osmotic gradient in the roots/soil (at least 2, ½ mark each).

(b) (i) The rate of oxygen release is a direct indicator of the rate of photosynthesis in a plant (I). For p/s to happen the stomata need to be open for gas exchange, which also means losing water through transpiration at the same time (I). The graph indicates that oxygen is released is at a high rate at first light at 6am (therefore a high rate of p/s) (I). The rate of oxygen release/p/s is lowest at noon where maximum light is available, but high temperatures increase transpiration (I) so to reduce water loss means that the plant has to close its stomata and therefore the requirements for p/s are no longer accessed, p/s ceases or slows and less oxygen released (I).

OR

The rate of oxygen release is a direct indicator of the rate of photosynthesis in a plant (I). For p/s to happen the stomata need to be open for gas exchange, which also means losing water through transpiration at the same time (I). The graph indicates that the highest rate of photosynthesis was just after first light—around 7am (1/2). The rate declined after this time, perhaps due to increased cloud cover which led to lower light intensity (1/2). While the stomata may have remained open during this time, water loss by transpiration would have been reduced due to lower light intensity and therefore temperature in the environment (I).

(ii) Any of:

• First light was at 6am and last light at 6pm implying

• The time of year must be around the equinox

• There is a limited water supply for the plant as the amount of transpiration is reduced steadily from early in the day

• There is drying conditions, hot, low humidity and / or windy that increases the rate of water loss

• Highest light intensity was around 7am and then the day became cloudy

1 mark each for any two reasonable answers
Comment
Most candidates gained some marks on the first part of this question. The most common mistake was where candidates assumed that the stomata had to be indirect sunlight in order for the opening and closing mechanism to work. They therefore chose Surface B as the surface which was facing towards the sun.

A number of candidates misread part (a) ii and gave the transport process for the products of photosynthesis rather than for a substance required for photosynthesis. There was quite a lot of excessive and irrelevant information given in answer to this question with candidates giving details of both xylem and phloem transport and all substances and processes involved.

Fewer than 10 candidates gained full marks on the graph question. Commonly, candidates assumed that the graph was showing water loss rather than Oxygen release. Many also responded to the question by simply describing the graph. The most common misconception was that, because water is used for photosynthesis, that water loss would be inversely proportional to the level of oxygen release.

In order to get full marks for part (b) ii, candidates must give 2 reasons that have an apparent link to the information in the graph. Vague answers about environmental conditions gained no credit if they appeared to be mere guesses.

PART 5

QUESTION 16

(a) 1. Sexually – production of gametes by meiosis leads to genetic diversity (1/2) for the Hydra which is an advantage as Hydra are more likely to survive a change in environmental conditions (1/2)

2. Asexually –

- no need to produce gametes (1/2) – therefore less energy used (1/2)
- No need to find a mate to continue increasing population (1/2) – important for sessile animals/ uses less energy (1/2)
- Fast method of reproduction (1/2)- increase numbers in stable environment quickly (1/2)
- Take advantage of a successful variation (1/2) that is well adapted to a given environment in a time of little to no environmental variation (1/2)

Must explain advantage for sexual reproduction and at least two from asexual for 3 marks

(b) (i) Candidates needed to give an example from the pedigree – there were four possible answers:

- F in gen II has albinism – if it was sex linked, for her to have two copies of the recessive allele, her father A in gen I would also have to have a recessive allele on his X chromosome (1). The father is not affected therefore not sex linked (1).

- This is the same for K in gen III and O in gen IV (2)

- G in gen II has albinism which means she has two copies of the recessive allele (1), one of which she would pass on to her son K in gen III – he is not affected therefore not sex linked (1).

- M in gen III has albinism however her father H is not affected – to pass on one recessive allele to his daughter he would have to have albinism (1) as he only carries gene for albinism on his X chromosome with no comparable allele on the Y chromosome (1).
(ii) **Autosomal recessive** (1/2) — as A and B in gen I do not have albinism but their daughters do (1/2) — therefore they must be both heterozygous/ carry recessive allele for albinism to pass on one recessive allele each to their daughters (1) — this is the same for J and K in gen IV.

OR

**Cannot be dominant** (1/2) as both parents A and B in gen I would have to be recessive aa X aa (1) — but F and G would have the dominant allele for albinism which is not possible as the parents would have to have a dominant gene to pass on (1/2) — this is the same for N and O in gen IV with their parents not having a dominant allele to pass on.

(iii) Genotypes of parents J and K = Aa X Aa The probability of producing a child with albinism is 25%, or ¼ or 1 in 4. I mark for punnet square and 1 mark for stating probability.

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(c) Correct alternative: K (1)

Parental genotypes: Type A = TA i Type B = TB i (1/2 each)

**Comments**

(a) Many candidates simply listed advantages without stating whether it was related to sexual or asexual reproduction. Only ½ marks were gained if candidates did not explain the advantage.

(b) (i) On the whole this question was answered well. Candidates need to be very careful not to make blanket statements like ‘only males can get recessive X-linked diseases’ which is incorrect. Many candidates failed to give enough detail regarding the recessive allele on the X- chromosome and that males can only have one copy of the allele. It was not enough to simply state – ‘G would have given it to K’ (only ½ marks were awarded). Many candidates stated person was ‘infected with albinism’ instead of affected.

(ii) Candidates gained more marks if they could provide detail about recessive alleles and parents being heterozygous/ carrier/ skipping generation.

(iii) Many candidates carefully stated it was autosomal recessive in (ii) but then went on to use incorrect notation X and Y to show their working (iii)

(c) Most candidates found it difficult to use the correct notation even though it was given in the thread and their answers showed confusion about the expectations of the question

**QUESTION 17**

(a) (i) Mitchell grass (½) as it is the only one in its own Class (½).

(ii) 1 mark each, up to a max of 2 marks

- They group organisms with the same features together.
• They provide unique names for organisms (binomial nomenclature)/use scientific language ➔ ease of communication.

• They have names that often are descriptive, so provide useful information.

• They correspond to evolutionary relationships as we understand them.

• It helps to clarify if certain organisms are related according to common characteristics – differences. (iii) 1 mark each, up to a max of 2 marks

• New information on evolutionary relationships may alter groupings

• New light may be shed on species capability of interbreeding, populations may be given separate species status or two species be recognised as one.

• Names may be changed to eliminate confusion with similar names, or with ones that better fit the conventions

• New species are being discovered and need to be fitted in, some of which are so different that they may need their own Genus or Family.

• New technologies to analyse properties of organisms might change the arrangement in the classification scheme.

(d) A million years ago conditions were wetter, this suited the widespread forests and woodlands that were interconnected (½), and suited the common ancestor across an extensive area (½). Drying climate meant that other plant communities displaced the forest/woodlands in many areas leaving areas of forest more and more isolated from one another (1). This meant these spider populations became effectively reproductively isolated from one another because of this ecological barrier (1), preventing any gene flow between populations (½). With differing environments and selection pressures affecting the different populations different adaptations that best suit the local conditions would be survive better and pass on the favourable genes for that area (1) causing changes in gene frequency (½). Given the extended periods of time and different selection pressures genetic drift would occur (½) to the point where the spider populations became so different from one another that when re-introduced they would be incapable of producing fertile offspring and hence be classified as different species (1).

Comments
17(a)(i) Well answered.

(ii) Often candidates repeat one concept using other words. In general well answered.

(iii) Some candidates misunderstood the question and the answer was in reference to evolutionary changes and not in reference to the classification changes. Majority answered well.

b) Some candidates recalled facts about speciation without making reference to the spider case. Some candidates answered as the spider accommodating to the desert environment instead of the change in the environment and spiders moving to reduced woodland and forest areas. Some candidates addressed the mitochondrial DNA as part of the explanation of speciation. Many candidates wrote definitions of genetic drift of gene flow but not applying it to the spider case.
QUESTION 18

(a) Any two digestive tract features involved in non-specific defence that were outlined:

- Saliva contains lysozyme (½) which can digest bacterial cell walls (½) (targets peptidoglycan)
- Stomach acid (½) has a low pH that kills most bacteria (denatures proteins) (½)
- Rapid pH changes moving through the digestive tract (½) from the mouth to stomach acidity and then neutralised again in the small intestine make it difficult for pathogens to survive. (½)
- The microflora in the small intestine (½) that form a barrier to bacteria by outcompeting them for resources (½)
- Some credit for other responses such as vomit/diarrhoea flushing response to contaminated food; mucus trapping bacteria.

(b) Any two reasonable points:

- That the infective organisms are being filtered out be the lymph nodes (1)
- Increased volume of lymph fluid causing an increase in volume of the lymph nodes (1).
- Increased numbers of lymphocytes and pathogens cause swelling due to sheer numbers (1)
- The filtered pathogens are being attacked and destroyed by lymphocytes that invade the gland to deal with the infection. (1)
- Some credit given for a response including the inflammatory response (due to wording of question).

(c) (i) Need to outline a disease caused by a parasite using a reasonable example (as it needed to address a life cycle disruption):

Malarial parasites are spread by mosquitoes thus spraying for (using insecticides) on mosquitoes to reduce their numbers (1), will mean less mosquitos, less chance of being bitten, less chance of contracting malaria (1).

Hydatid disease (tapeworms) in sheep can be reduced by controlling the spread via dogs - dogs can be wormed with medication (1). This reduces the chance they will be picked up by sheep from the faecal matter → reduction of sheep contracting disease (1).

Treating swimming/drinking water (e.g. with chlorine or by filtration) would lead to either disruption of cellular function or removal of the pathogen thus disrupting the spread of waterborne pathogens.

(ii) A high rate of immunisation can lead to herd immunity (½). This means that more people are resistant/cannot contract the disease therefore the spread is reduced protecting those who are not immunised (½).

Comments
Candidates generally found this question difficult which appeared to be due to the concepts within the question changing. However, the question was really well attempted.

In particular:

18a) Majority of candidates did not adequately suggest first line defence OR digestive system defences.
I8b) The term ‘swollen’ pointed the majority of candidates towards the inflammatory response, which was not what the question was asking, but allowances were made.

I8c(i) The word ‘pathogen’ in the question meant candidates did not focus on parasites. This then saw many candidates responding about hygiene and vaccination instead of giving examples of disease with intermediate hosts where the cycle might be easily disrupted. The majority of candidates did not give an example at all.

I8c(ii) Very well addressed.

QUESTION 19

(a) Influenza is a virus, so the main response is the specific immune response (½). B cells produce a specific proteins called antibodies (¼), which bind to a specific part the influenza virus (½) to inactivate it/stop it replicating, trap by sticking together/clumping (¼). It also tags viruses so that T cells can find and destroy them (1).

The cell-mediated immunity by T lymphocytes, covers several roles, some act to detect invading viruses and stimulates other parts of the immune system to respond (¼). E.g. Helper T cells release cytokines that activate B cells to produce antibodies (½). Cytotoxic or Killer T cells can kill cells infected with the virus to stop it replicating (1).

Once the infection is cleared, a small number of B & T cells remain as memory cells (¼), which are capable of rapid response to a future infection of the same variety of influenza. (1)

(b) The body produces B & T memory cells when exposed to the flu based on exposure to a specific flu antigen (1). Strains of the ‘flu’ vary from year to year (i.e. Have different surface antigens) due to mutation and natural selection (¼) and the memory cells will not have the corresponding antibodies for the new antigen. (1)

(c) Antibiotics are only effective for bacterial infections, and don’t work for viral infections. (1).

Comments

Generally, this question was extremely well attempted.

Candidates scored well as they could almost completely use the information sheet to answer the first two parts of this question (which was recognised my most), and difficult to deduct marks in this case for ‘information dumping’ as there is not many other ways to get this information across.

The main issue was with part (iii), many candidates were unaware of what antibiotics are, and confused them with antibodies/acquiring passive immunity.