ASSESSMENT REPORT 2020

BIO315116 – BIOLOGY

PART 1

Question 1

(a) Hypothesis examples:

- wearing a copper bangle will reduce the level of joint pain associated with arthritis.
- copper bangles reduce arthritis pain.
- arthritis sufferers who wear a copper bangle will suffer less joint pain than those who don't wear a copper bangle.

(1 mark for the Independent Variable, 1 mark for the Dependent Variable and 1 mark for a statement that can be tested by experimentation).

(b) (i) Level/Amount of joint/arthritis pain (1 mark)
Pain (½ mark)

(ii) Patients could be asked to rate their pain (½ mark) on a scale of 1-10 (½ mark). Patients should record their pain at regular intervals (e.g. – daily / 4 hourly) (1 mark). Pain levels should be recorded before the trial so that there is baseline data for comparison (control) (1 mark). Pain is subjective and therefore difficult to measure (1 mark).

Apart from a pain scale, other suggestions of how to measure pain levels were given some credit (generally ½ mark for each suggestion and up to 1 mark for a well explained suggestion):

- use of MRI imaging to identify areas of brain associated with joint pain
- using a machine/monitor to detect pain signals from nerves and brain
- compare amounts of pain medication required by the same patient

The suggestion that pain ratings be taken simply 'before and after' the experiment was given ½ mark.

(c) The use of false copper bangles act as a placebo/single-blind experiment/prevent the placebo effect (½ mark). This acts as a control to compare the results with the group wearing copper bangles (½ mark). This deception should identify whether any improvement in pain levels is due to the psychological impact of wearing a bangle, or if it is due to the copper present in the bangle (1 mark).

Marker Comments

Overall, Question 1 was well answered, with most candidates scoring 5.5 or more out of 8.

(a) This was completed very well, with the majority of candidates able to write a clear hypothesis, scoring at least 2.5 marks out of three. Some candidates commonly lost half a mark for not being specific enough (e.g. not mentioning arthritis in their hypothesis). Some candidates misinterpreted the question and did not write a hypothesis but rather explained whether the information in the question stem was in the form of a testable hypothesis. ½ to 1 mark was awarded for this, depending on the accuracy of the response.

(b)(i) This was generally well-answered, but many candidates did not specify 'level' of pain, simply answering with 'pain'.

(b)(ii) Showed an array of creative responses, with most acknowledging that the results should be quantified. The most common suggestion was a 1-10 scaled rating of pain. Many candidates described how they would design an experiment to test the hypothesis, rather than focusing on a way to measure the level of pain.

The best answers demonstrated an understanding that pain levels need to be quantified given their subjective nature and should be compared with baseline data.

(c) Required a good understanding of the use of a placebo as the control group and the ability to relate this to the specific experiment in question. Most candidates scored at least 1 mark. Most could identify the false copper bangles as the placebo and many then went on to give a general explanation of the role of a placebo. The best answers applied their knowledge to this experiment and showed an understanding that the placebo enables experimenters to see the true effects of copper by removing psychological bias.

Question 2

(a) IV: Temperature (of water baths/enzyme/starch and enzyme solution) (1 mark)

(b) DV: Digestion or breakdown of starch/starch digesting enzyme activity/presence of starch/rate of starch breakdown. (1 mark)

(c) 3 marks for answers such as the following:

- An increase in temperature will increase the starch-digesting enzyme activity up to a certain point when optimum is reached after which enzyme activity will decrease.
- An increase in temperature will increase the starch-digesting enzyme activity.
- An increase in temperature will decrease the starch-digesting enzyme activity.
- An increase in temperature increases/decreases enzyme activity.

(1 for the IV, 1 for the DV and 1 for a statement that can be tested by experimentation)

2 marks were gained if a student stated a hypothesis relating only to optimum temperature for enzymes, such as:

- The optimal temperature for starch digesting enzymes is 40 degrees Celsius.

(d) ½ mark given for each correct factor and 1 for a description of how the factor could influence results.
Factors included: volume/concentration of starch, volume/concentration of enzyme, shape or size of container, exact timing of drops, temperatures of water baths, light levels, time in water bath and thermometer used.

(e) At lower temperatures the starch breakdown by the enzyme is slow (½ mark) and then increases at 40°C. This is the optimum temperature for that particular enzyme (1 mark). At temperatures greater than 40°C, the enzymes do not function (as they are denatured) explaining why no starch is digested at higher temperatures (1 mark). An additional ½ mark was given for referring to the data table.

(f) 1 mark for a correct flaw and 1 mark for a correct reduction for that flaw. Flaws included:

- requirement of additional timepoints or temperatures
- only one water bath / test per temp
- needs more at each temp for repetition / to increase sample size and reduce chance of error
- measuring colour changes can be subjective
- need a colour chart or spectrophotometer to compare colours.

Marker Comments

For (a) and (b) markers were looking for specificity about identifying the IV and DV. The best answers clearly stated the temperature of the solutions, for example.

For (b) many candidates stated that the DV was the change in colour of the iodine. This only attracted ½ a mark, as this not the DV; rather it was how the DV was measured.

For (c) markers were looking for students to relate the change in temperature to the rate of activity of the starch digesting enzyme/presence of starch. Those candidates who stated a hypothesis solely around optimal temperature did not gain full marks, as the 20-degree temperature increments in the experimental method could not accurately assess this.

Most students did very well on question 2(d). The most common response referred to either the volume or concentration of the starch and enzyme solutions.

For (e), most students identified either the optimum temperature or the denaturing of the enzyme. The best answers were able to recognise both and refer that information to the table. Many students who did not receive full marks did so because they did not reference the data. Referencing the data was important as it was specifically requested in the question.

For (f) many students were able to identify the small sample size and lack of repeats and this was the most common full mark answer. Many students lost marks for failing to identify a way to reduce or eliminate their flaw.

Question 3

(a) Several students misinterpreted the question in part and instead talked more about experimental design. For example, some students wrote about the cost, how long the experiment should run, sample size and repetition.

Points were given for safety of the drug (1), side effects (1), effectiveness of the drug (1), reaction with other drugs (1), valid methodology of the trial (1), reaction with other foods or drugs (1), tested on animals first for effectiveness and safety (1).

(b) Students addressed different aspects of a trial but not necessarily the ethical considerations repeating aspects covered in question a. Some students listed potential side effects or the possibilities of "harm" by using the drug not necessarily addressing the context ethical considerations.

Not many students achieved full marks when answering this question. Students were awarded a (½) point for a simple statement addressing an ethical consideration and if the student wrote extensively about one of the following, they were awarded one point.

The subjects of the trial need to concede a voluntary (½) fully informed (½) consent (½).

They needed to know procedures for dealing with side effects (½) and that they could quit (½) the trial at any time (½).

They need to be aware (½) that they might be given the placebo (½) and people in the placebo group will need to be given the next best treatment (½).

Needs to be overseen by ethics committee (½).

Needs to be tested on animals first (½) ensuring animals will have minimum harm (½) and won't be exposed more than necessary for the confirmation of the effectiveness (½) of the drug.

Subjects will be informed about the privacy (½) and anonymous (½) character of the information.

All information will be kept secured to maintain data confidentiality (½).

Subjects will be informed of the effectiveness of the drug as soon as the trial finishes (½) and will be the first ones to receive treatment if proven to be successful (½).

Participants will receive health care throughout the study (½).

If a clinical trial is 'blinded' or 'masked', it means that the participants and/or the researchers don't know who is receiving the new intervention and who is not (½).

Marker Comments

(a) Most candidates achieved at least 2 points in this question.
(b) Most students got 2 to 4 points. Very few achieved full marks.

Question 4

a)

Letter	Molecule
A	Enzyme/Active Site
B	Substrate/polysaccharide
C	Product*/disaccharide
D	Product*/monosaccharide
E	Cofactor/coenzyme/substance not involved in the reaction/substrate for another enzyme/spectator molecule/competitive inhibitor/sugar/glucose/inhibitor
F	Non-competitive inhibitor/inhibitor**

* 'broken down substrate' was given ¼ mark if this answer was given for both C and D (½ mark in total).
** 'inhibitor' was accepted as a correct answer for this question but not 'competitive inhibitor'.

(b) F (non-competitive inhibitor) binds to the enzyme (½ mark) which is not the active site (½ mark) - allosteric site. This changes the shape of the enzyme molecule (denatures it) and thus the shape of the active site (1 mark). As a consequence, the enzyme can no longer function to catalyse the reaction (½ mark) because the substrate no longer fits into the active site (½ mark).

Marker Comments

Common mistakes included:

- An assumption that this was a biomolecules question. Students gave answers such as 'protein', 'lipid' and 'carbohydrate'.
- Confusion between the role of the enzyme and the substrate. Students used these terms interchangeably.
- Many candidates claimed that non-competitive inhibitors permanently altered the enzyme molecule whereas for most non-competitive inhibitors the change is reversible. Candidates were not penalised for this.
- If F was incorrectly identified in part a), error carried forward was applied so that marks could be earned in part b) for a correct description of the role of the substance that the student had identified as F in part a).
- Candidates must specifically mention the substrate not fitting into the active site in the presence of the inhibitor for full marks in part b).

PART 2

Question 5

(a) X – phosphate
Y – sugar/deoxyribose/pentose sugar

(b) T, C, G, G, C, T
(½ mark deducted for each wrong answer)

(c) UCGGCU

(d) 430

(e) The function of the coding strand is for DNA replication. DNA unwinds and the non-coding strand is matched with complimentary bases to form a new strand.

1 mark also awarded for good answers describing the protection of the coding strand and prevention of mutations.

Marker Comments

(b) Common mistakes included:

- Reversing the labels for X and Y
- Identifying the sugar as 'glucose'
- Substituting U for T in the base sequence

(c) This question was mostly done well by candidates. -½ mark for any errors. No marks awarded for AGCCGA. ½ mark for TCGGCT.

(d) Mostly answered correctly. 429 also accepted as a correct answer.

Question 6

(a) tRNA (½ mark awarded for anticodon)

(b) leucine (½ mark awarded for GAA or Y)

(c) Structure X is mRNA (½). mRNA codes for a specific protein therefore the length of mRNA depends upon the protein (series of amino acids) it is coding for. mRNA has codons that attract the anticodons of structure Y with their complimentary bases (1).

Structure Y is tRNA (½). tRNA has an anticodon as well as an amino acid attachment site (½). When matched with the mRNA, tRNA brings the amino acid it codes for. The amino acids bond together (peptide bonds) to form a polypeptide chain or protein (1).

Marker Comments

Many candidates failed to discuss the structure of Y and X and relate it to the function. Many students used information dumps from the information sheet. Many discussed the origin of mRNA rather than relating structure to function.

Question 7

- Point A factor: CO_2 concentration (½).

  Reason: As the CO_2 concentration increases the rate of photosynthesis increases on the graph. CO_2 is used up in the reaction. CO_2 is a reactant in photosynthesis (2 marks for 2 points).

- Point B factor: Could be any other factor (light intensity, temperature, enzyme concentration, number of chloroplasts) (½).

  Reason: The graph indicates that at point B increasing CO_2 does not result in an increased rate of photosynthesis. Therefore, some other factor must be limiting the rate of photosynthesis. E.g. Lack of light intensity means that there is not sufficient energy from sunlight for the reaction to proceed. Increase in temperature increases kinetic energy of molecules therefore rate of reaction (2 marks).

Marker Comments

Most candidates were able to identify factors that influenced rate of photosynthesis and why. A common omission was to not relate answers to the graph provided (and point A and B on the graph), or not to say why that factor was needed for photosynthesis. Many students misinterpreted the graph as representing daytime and nighttime, and a significant number of students thought the graph represented something to do with a light compensation point.

Question 8

Aerobic respiration happens in the presence of oxygen (½). It produces 38 ATP (½) and no toxic bi-products (½). Anaerobic respiration occurs when no oxygen is present (½). It only produces 2 ATP (½) and ethanol (½).

When the roots do not have access to oxygen their anaerobically respire and therefore produce less energy in the form of ATP. They need the ATP to power active processes (½). Without sufficient ATP they will not be able to transport minerals across the cell membrane and hence the cell will die (½).

Ethanol is toxic to the plant and will therefore kill the root cells (1).

Marker Comments

Many candidates failed to discuss the issue of decreased ATP as well as ethanol toxicity.

PART 3

Question 9

(a) Prokaryote (1)

- No membrane bound organelles, such as mitochondria, ER (1).
- No distinctive nucleus, DNA is scattered in the cytoplasm (1).
- Many prokaryotes have a capsule surrounding organism, as shown (1).
- Eukaryotic (½) – has a nucleus and other structures which could be membrane bound organelles (1½).

(b)

Feature	Bacteria	Viruses
Capsid	A	P
Cell wall	P	A
Flagellum	P	A
Plasma	P	A

8 correct (2), 6 correct (1½), 4 correct (1), 2 correct (½)

Marker Comments

(a) Generally answered well. Many students incorrectly identified the cell as eukaryotic, saying that it has a nucleus, but they were awarded some marks. Some students wrote about the size of the cell being smaller than a eukaryotic cell, however there was no evidence for size in the diagram. Several students gave reasons for the cell being prokaryotic, writing that it had a cell wall and a flagella, which is also true for some eukaryotic cells.

(b) Answered reasonably well, however, some students left blanks in the table.

Question 10

(a)

Structure	Name
A	Golgi apparatus / body
B	Rough endoplasmic reticulum (C)
C	Ribosomes (B)
D	Mitochondria

(b) (i) Microvilli (½) increased SA:Vol ratio (or SA) of the cell (1) for rapid diffusion (½)
OR,
(Thin moist selectively permeable membranes allow for efficient diffusion).

(ii) Active transport requires energy (½). This energy (ATP) is supplied by cellular respiration (½) which occurs in the mitochondria (1).

(iii) Ribosomes (½), mostly located on the rough ER, synthesise the enzymes (½). Golgi body (½) modifies, packages and stores the enzymes (½).

OR

Mitochondria (½) create energy (ATP) for protein synthesis (½).

Marker Comments

(a) Generally answered well. No marks awarded for just stating Endoplasmic Reticulum (ER). Needed to say Rough Endoplasmic Reticulum (RER). Many candidates tried to use both Golgi apparatus and Golgi body, writing as if they were different organelles.

(b) Answered reasonably well, with many students gaining most marks.

(i) Many candidates wrote about '1 cell thick' and 'short diffusion distances', not realising that the image was only of 1 cell. Candidates were thinking of tissue, not of individual cells. Some candidates wrote about the fact that there was no cell wall which meant that substances could pass rapidly into the cell. Misinterpretation of cell wall function and not realising that insect cells would not have a cell wall.

(ii) Many candidates focused on blood supply/capillaries being very close to the cell. Focus was on 'from cell to blood' rather than the 'active transport' part of the question. Marks were also allocated for stating exocytosis in vesicles (½) and for naming the cell membrane with an explanation that it contains proteins used for active transport (½).

(iii) Many candidates stated that the ER stores enzymes and were not awarded a mark. Students didn't receive full marks if they wrote about Rough ER without mentioning that ribosomes actually synthesised the enzymes (½).

Some marks were allocated for the following:

- lysosomes store enzymes (½)
- vesicles store enzymes (½)
- the nucleus has DNA which codes for proteins (½).

Question 11

Mitosis: 4 (½)

Reason: The chromosome number (2n) doubles to 4n, during DNA replication (½). The cell then divides resulting in the original number of chromosomes (½). (Diploid number.)

Meiosis: 1 (½)

Reason: The cell's chromosomes doubles during DNA replication, then splits twice, resulting in half the original number of chromosomes (n) (1). (This results in the haploid number, producing gametes.)

Marker Comments

The majority of the students answered the question fairly well. Some students used the content on information sheet to answer the second part ('give a reason'). However, many students mentioned the replication of DNA/ chromosome/ genetic material and/or final outcome as haploid/ diploid.

Question 12

Factor 1: The concentration gradient (½). Increased concentration gradient leads to an increased diffusion rate, across the cell membrane (1).

Factor 2: Temperature (½). The higher the temperature the faster the motion of the molecules resulting in a greater rate of diffusion (1).

Factor 3: SA:Vol ratio (½). A large SA:Vol ratio provides more surface area for an increased rate of diffusion (1).

Factor 4: Thin membrane (½) provides less distance for diffusion, thus increasing the rate of diffusion (1).

Factor 5: Number of carrier proteins (½), more carrier proteins allows for faster diffusion (1).

Marker Comments

This question was answered well by most students. There were other factors mentioned by some students including:

- Particle/ Material/ Substance size
- Transport medium
- Distance travelled / diffusion distance / cell (one cell or two cells thick etc)
- Blood supply (Diffusion of gases in lungs)
- Membrane permeability.

Some students got confused with factor 'Temperature' and enzyme activity and related high temperatures with reduced enzyme activity resulting in slow or no diffusion. Some students confused diffusion with osmosis and active transport and mentioned ATP as one of the factors.

Question 13

(a) Distilled water (1).

(b) Distilled water is more hypotonic compared to pond water. Therefore, more water enters the cell by osmosis, from a low to high concentration (1). The contractile vacuole must beat faster to remove the excess water (1).

(c) As the salt concentration of the solution increases, it becomes less hypotonic. Therefore, less water enters the cell by osmosis (1). Less water needs to be expelled out of the cell, so the contractile vacuole beats at a lower rate (from 3.3 to 1.5 bpm) (1).

(d) At 0.25% the solution becomes isotonic to the cell. There is no overall net movement of water (1) into or out of the cell. The volume of the cell remains constant and the contractile vacuole does not need to beat (1).
OR,
The solution has become weakly hypertonic (1) to the cell and some water leaves the cell due to osmosis. The contractile vacuole stops beating, as it is already losing water (1).

(e) The beating of the contractile vacuole requires energy (ATP) from cellular respiration (1). Cyanide acts to stop cellular respiration (by inhibiting the enzyme reactions) and the lack of energy stops the contractile vacuole from beating (1). As the contractile vacuole stops beating, it cannot remove the excess water (1) which continues to move into the organism by osmosis, as it is in a hypotonic solution. This results in the cell swelling and increasing in volume (1).

Marker Comments

Many students found question 13 difficult, with not many gaining high marks, and many scoring only a few marks. Due to the questions being quite similar there was some holistic marking. Some students would write down all the information in (b) then skim it in other questions. Some students repeated themselves as they rewrote information to cover themselves in all questions.

(a) Nearly every student answered this correctly.

(b) To gain full marks, students need to use terminology correctly, such as osmosis, hypotonic and hypertonic. Some common misconceptions included that distilled water is cleaner, so easier for CV to pump water (less impurities, more efficient). Also, that pond water had lots of stuff in it, therefore harder to CV to pump water.

(c) Some common misconceptions included that the CV and osmosis can work together to remove water under hypertonic conditions within the cell.

(d) Some common misconceptions included CV dies in high concentration, no longer works because it is too salty. That the CV can hold water when too concentrated.

(e) Many students thought the freshwater meant distilled water. That as the concentration of sodium chloride increased it was harder for the CV to pump or did not have the strength to pump. A lot of the students wrote about concentration but did not refer to water or solute and they lost marks here unless it was obvious (in many cases they were just dumping information).

PART 4

Question 14

(a) Correct Answer:

Blood concentration	Liver	Small intestine	Active muscle
Carbon dioxide	+	+	+
Glucose	-	+	-
Urea	+	0	0

Marking Scheme: One mark given for each correct column with a half mark deducted for each error in that column.

(b) Blood carbon dioxide levels increased at Y because the liver cells are respiring (using oxygen) and producing CO_2 (1).

Blood glucose levels decreased at Y because the excess glucose (from the digestion of food) is EITHER taken out of the blood and stored as glycogen (1) OR it is used in cellular respiration (1).
Blood urea levels increased at Y because excess amino acids (from the digestion of food) are broken down/deaminated and converted to urea by the liver (1).

Marker Comments

Overall, this question was very poorly done with about 50% of candidates obtaining less than 2 marks (out of 6) for the whole question.

(a) Only a small number of students (less than 5%) were able to obtain full marks. However, most candidates were able to obtain part marks by predicting the significant blood level changes (for CO_2, glucose and urea) that occurred in active muscle. Unfortunately, the blood changes in the liver were the least understood.

(b) The written answers indicated that students had very little knowledge of liver function and a surprising number of students (about 20%) tried to explain their responses based on their knowledge of kidney function. There were also numerous incorrect anatomical statements regarding the liver's blood flow and its actual role in relation to the digestive system. Furthermore, a significant proportion of candidates (about 25%) simply repeated in words what they had indicated in question a) without trying to give any explanation for the blood levels changes that they had predicted.

Many students stated that the liver produces bile, but very few candidates demonstrated any appreciation of the many other functions of the liver. In this respect, it was evident that only a few candidates seemed to know that the liver is a vital organ which is responsible for regulating body chemistry and maintaining body temperature. Wherever possible, part marks were given to answers which indicated some knowledge of liver function (e.g. cellular respiration, ATP / energy / heat production, glycogen formation and urea formation). These part marks were awarded regardless of whether or not the candidate had predicted the correct blood level changes for CO_2, glucose and urea in the liver.

Question 15

(a) Aquatic: I and IV (½). Higher concentration of ammonia (animal 1 -68% and animal IV – 73.3% of nitrogen excreted) (½). Ammonia is toxic and requires a lot of water to remove it / soluble in water and diffuses away (1). Needs to be constantly/rapidly removed due to toxicity / can't be stored (½). Removed from the organism in the most energy efficient form, as the animal makes use of the watery environment so it doesn't have to expend energy on converting ammonia to less toxic waste (1).

(b) Terrestrial: 11 and 111 (½).
111: highest concentration of uric acid in animal III – 80.8% of nitrogen excreted (½). Uric acid is solid, insoluble and nontoxic (½). Uric acid can be stored as insufficient water (water in a desert environment needs to be conserved) to flush waste away (1).

I I: highest concentration of urea in animal II – 85% of nitrogen excreted (½). Urea is soluble and is flushed through kidneys/stored for short periods of time (½). So long as there is some water available in the terrestrial environment, urea is primarily excreted as it saves energy in comparison to uric acid production (1).

Marker Comments:

This question was reasonably well done, although a small number of students scored 0. This was because they completely misunderstood the connection between the environment and the waste products produced.

It was pleasing to see that most students used the data from the table in their answers. Many were able to identify that high percentage of ammonia in part a as being important but then failed to use the data for b).

A number of students didn't know the meaning of 'terrestrial' making b) challenging. Many students identified animal II only in b) and received credit for this. The best answers analysed both animal II and III, and linked the nitrogenous wastes produced to the animal's environment.

Question 16

(a) The table shows an inverse relationship between humidity and transpiration rate – as increasing humidity results in a decrease in transpiration (1). Transpiration is the movement of water through a plant (½) as the concentration gradient becomes less steep with increasing humidity (½), a slower rate of diffusion of water vapor occurs (harder for water to evaporate) (½) this results in a decrease in the transpiration rate (½).

(b) **Feature 1:** Thick waxy cuticle surrounds the leaf (½).
Explanation: The waxy cuticle reduces the amount of evaporation from leaf cells (½). By having a waterproof waxy layer/barrier all around the leaf (½), not just on top which conserves moisture (½). As a result, less water is drawn into the leaves (½) therefore reducing the rate of transpiration (½).

Feature 2: Sunken Stomata (½).
Explanation: This gives the plant a more humid microclimate at the leaf surface / site of water loss in pits (½) which decreases the concentration gradient from the leaf (½), ensuring less water evaporates from the leaf (½) therefore reducing the rate of transpiration (½).

Other acceptable:

Feature: Shape of leaf / fairly round cross-section / thicker mesophyll layer*/position of vascular bundle (½).
Explanation: Reduces SA:Vol ratio of the leaf which reduces water loss for the leaf (½) because there is less exposed surface to lose water compared the volume of the leaf (½). The thicker cross-section of leaf also creates a greater distance between the xylem and the stomata (½) which increases the time taken for water movement, thereby slowing the rate of transpiration (½).

* *Storage of moisture and heat reducing capacity was also considered.*
* *Increase in diffusion distance.*

Feature: Stomata's close during the day. Not a structure, however some marks were awarded for explanation of preventing water loss and slowing transpiration.

Marker Comments

(a) This part of the question was generally well done. Most candidates were awarded at least partial marks for recognising the relationship: as humidity increases, transpiration rate decreased.

Candidates that demonstrated they understood / had described the relationship between the variables of humidity and transpiration were awarded a full (1) mark. Candidates who simply plotted a graph without explanation were awarded a half (½) mark. Candidates that then continued to provide an explanation as to how humidity impacted transpiration were given an additional half (½) marks per reasonable part of explanation to a total of two (2) marks.

Candidates who were less successful simply quoted from the information sheet without reference to the question. A surprising number of candidates confused low transpiration rate with high water loss. Some candidates mentioned that the water loss was important to prevent drowning and excess water in the plant. Some candidates did not recognise that this question referred to plants and provided responses related to animals.

Some candidates used other terms such as respiration, photosynthesis and translocation in place of transpiration. Candidates were only awarded partial marks (½) if they demonstrated relationships between these processes and the rate of transpiration.

Stomata closing was not awarded any marks for this part of the question as high humidity rarely causes closure of stomata (however, it was relevant to part b).

(b) This question was well attempted and most candidates achieved at least partial marks.

The diagram and accompanying text caused some confusion in the way candidates interpreted it. For example, several candidates interpreted the definition of the xerophyte as meaning they should provide ways in which the plant could maximise water loss because the plant didn't need as much water.

Marks were awarded for a specific feature shown in the diagram that would support reduced water loss in xerophytic plants. Marks were not awarded for features that were not specifically identified or particular to the xerophyte, for example. Thick cuticle (½) vs cuticle (0); sunken stomata (½) vs stoma (0); thicker mesophyll vs mesophyll. Marks were awarded if they demonstrated some understanding of water loss, prevention and its impact on transpiration.

Candidates who performed well in this part were able to easily spot structural features that were different between the typical and xerophytic plant. It was assumed that the stomata on the xerophyte were sunken, even though the diagram did not quite show it well.

Candidates who were less successful pulled words from the diagrams and then used the definitions from the information booklet as explanations, for example, xylem and phloem was common. Several used SA:Vol ratio but did not explain as it could apply in this circumstance, and sometimes related it to thermoregulation (possibly because of the questions on the following page about thermoregulation in animals) or cell diffusion. The vascular bundles, in particular, caused these candidates the most confusion as they did not seem to understand that this was a representative diagram only and not a true reflection of the number of vascular bundles present nor the size. A scale or label "not to scale" on the diagram may have helped alleviate this confusion for some candidates.

Some candidates used the diagram as a jumping point only and then shared much greater detailed information that they knew (or imagined) rather than they could see, for example, the presence of hairs in sunken stomata, – generally this was not penalised unless it clearly did not support the context of the question.

Stoma was cited by a considerable number of candidates. Some of them clearly demonstrated an understanding of how these might reduce water loss and be different in a xerophyte – these candidates were awarded marks (up to 2½). Other candidates appeared to simply pull labels from the diagram and cite definitions from the information booklet – these were less likely to have marks attributed unless they could demonstrate how water loss could be reduced, for example, closed during the day which was awarded partial marks.

Question 17

(a) (i) False (½)
'Ecto' means outside (½), therefore ectotherms rely on heat from outside i.e. external sources (½) to provide energy (½). Examples of ectotherms include 'cold-blooded' animals such as lizards or snakes which rely on behavioural responses to change body temperature (½).

(ii) True (½)
Larger bodies generally have a lower SA:Vol ratio (1) which means that the rate of heat loss is slower compared with smaller-bodied animals (½).

(b) Marks provided for either verbal description or annotated negative feedback diagram with correct elements identified & named.

Stimulus: (½ mark given if student identified the word stimulus with the actual stimulus) - Increasing temperature (½).

Receptor: (½) - hypothalamus in the brain/thermoreceptors in skin or muscles (½).

Transmission of message: (½ ditto) - nerve signal sent from thermoreceptors to hypothalamus, secretion of thyroid releasing hormone (TRH) to pituitary gland, thyroid stimulating hormone (TSH) from pituitary to thyroid, secretion of T3 & T4 hormones from thyroid, nerve signal sent to skin (any for ½).

Effector: (½) - blood vessels dilate to radiate heat / sweat glands open to allow evaporative cooling, behaviour response to move into cooler area, reduction of basal metabolic rate to reduce heat production (any two for ½ mark each).

Response: (½) - The skin / body is cooled (½).

Body temperature reduces / restores homeostasis via a negative feedback loop (½) e.g. the response acts in the opposite direction to the stimulus and hence maintains a steady state for the organism (½).

Students do not need to include the five main headings to gain full marks as students may give a full description without them.

Marker Comments:

(a) (i) As the term 'ectothermic' is no longer in the syllabus, students were given up to 1 mark credit if they chose the wrong answer (true rather than false) but provided a reasonable, consistent explanation e.g. defined ectotherm & endotherm but the wrong way round. Similarly, if students chose true but then described the behavioural responses of ectotherms they were also given credit.

(ii) Students were not given credit for suggesting that larger animals had more fur/fat/blubber than smaller animals nor other descriptions of heat conservation mechanisms. Students needed to correctly identify SA:Vol ratio and then describe some indication that the rate of loss of heat was affected. No marks were given for saying larger animals had a smaller surface area or that they lost less heat.

(b) Students were given full marks if they identified all the stages in the negative feedback process and included at least two of the responses which lowered body temperature. A total of 1 mark was given for just copying the material from the homeostasis diagram from the information sheet with at least one part of the feedback loop completed for temperature. Up to 2½ marks were given for correctly identifying the components in the negative feedback loop without any accompanying information and up to 4 marks were given for a correctly described and interpreted negative feedback loop applied to *decreasing* temperature as a stimulus. No additional marks were given if students described both the response to increasing & decreasing temperature.

PART 5

Question 18

(a) Asexual reproduction/ budding (1).

(b) Chance of mutation (1) in the copying during mitosis / cell division that leads to genetic variability (1).

Marker Comments:

(a) The question asks for the TYPE of reproduction, not the PROCESS of reproduction. 'A-sexual'/ 'a sexual' notations were both accepted although unusual. Incorrect answers included: fragmentation, binary fission and self-fertilisation. Students often crossed out 'asexual', leaving 'sexual' because the diagram shows a hydra offspring with four and not five tentacles (so the offspring is not identical to the parent) but there is no second parent pictured.

(b) It is important that mutations are identified as the source of genetic variation. If sexual reproduction was the answer given in a), then follow-through marks were given for two gametes/ crossing over/ independent assortment (1) caused the genetic variation (1). Because there is no second parent pictured (for sexual reproduction) and when part b) is read (about variation being introduced) then the answer to a) may have become clearer. Incorrect answers included: students arguing that genetic variation was not possible (due to the lack of

two gametes/ crossing over/ independent assortment) and that genetic variation was due to evolution/ reproductive isolation/ geographic isolation/ clines/ adaptations/ environmental pressures/ speciation/ gene flow/ self-fertilisation/ photosynthesis.

Question 19

(a) If it was X-linked inheritance, '12' would be X^dX^d and she would have to inherit X^d from '8' and '9'. (1) However, '9' has only one X chromosome, it would have to be X^DY for '12' to be affected. (1) As he is unaffected, he is X^DY, hence this cannot be a X-linked inheritance. (1) Males pass on the traits to their daughters and this does not happen with the parent '3' or '9'. (1) Hence it is not possible for this to be sex-linked.

(½) mark if students stated with evidence that it was a recessive pattern of inheritance.
OR,

Using any other pieces of evidence and referring to individuals in the pedigree.

(b)

Individual 8	Dd	Individual 10	DD or Dd or D-
Individual 9	Dd	Individual 12	dd

Note: Full marks given for Individual 10 having 2 possible genotypes. No points awarded if only one genotype mentioned. ½ mark deducted if students did not use D and d for alleles as stated in the question. 1 mark deducted if students used X and Y notation in answer – as Question 1 clearly states it was NOT sex-linked.

(c)

	D	**d**
D	DD	Dd
d	Dd	dd

Genotypes: DD /Dd/ dd

Phenotypes: ¾ unaffected / ¼ affected

25% chance or 1 in 4 will be dd

½ mark for correct father genotype. ½ mark for correct mother genotype. 1 mark for fully correct punnett square completion. 1 mark for correct interpretation of punnett square. 1½ - 2 marks awarded for correct working/procedure but incorrect parental genotype (1 or 2).

Marker Comments

This question was generally well attempted, with most candidates receiving partial to full marks. Most of these marks were awarded in b) and c).

(a) This was well attempted by most candidates. However, to receive full marks full genotype sex-linked notation was required. Many students simply stated that it was not X-linked because affected daughters need to have affected fathers. More information was required to flesh the full understanding out (e.g. showing a punnett square of potential genotypes or explaining why fathers must express the trait whether it is x-linked recessive or dominant). Many students referred to individual 5 (affected male) as their evidence, however incorrectly stated that he must have an affected mother. With X-linked recessive his mother is likely to be an unaffected carrier of the condition, and this would not be evident on a simple pedigree. Therefore, this was not accepted as evidence, unless students further stated that the mother was a carrier and that all her sons would need to be affected.

(b) Was generally answered well. However, many candidates lost marks for not correctly identifying that Individual 10 was capable of having 2 genotypes from the information in this pedigree. Students were also deducted marks for using incorrect allele notation, when it was specifically stated in the question to use D and d. Many students also used X-linked allele notation which was incorrect considering the condition was an autosomal pattern of inheritance.

(c) Was answered well. Most students were able to correctly identify parental genotypes, construct a punnett square and analyse the information correctly as a typical autosomal recessive pattern. Some students incorrectly used X-linked notation in their answers and included either one or two incorrect parental genotypes. When this occurred, part marks were shown if it was obvious that candidates knew how to complete and analyse a punnett square.

Question 20

(a) Within a *cline* there will be phenotypic/ visual/ structural/ size differences in the rats (½) which is due to ecological/ geographical/ climatic differences in the regions where the populations are found (½). To test for the presence of a cline, rats from two different populations/ from either end of the cline/ from NSW & WA (½) will need to be interbred (½). If the rats from different populations can successfully reproduce (½) to produce fertile offspring (½) then they are part of a cline. This may not be the case with populations of rats from the extreme edges of the cline due to significant structural changes (½) however gene flow must occur between the different populations of rats/ they must share a common gene pool which could be tested for using DNA/ genetic analysis (½).

(b) Genetic variation already exists in the population/variation in the population occurs due to mutations/ crossing over/ random assortment (½); that variation provides a selective advantage with environmental pressures/ change/ disease (½); this results in individuals with that trait/ variation surviving and reproducing (½); traits are then passed on to future generations/ increased frequency of these alleles in the population/ natural selection for this trait occurs in the population (½).

(c) Yes, these two populations of bush rats are separate species (1); a species can interbreed to produce fertile offspring (½) and as these populations cannot, then they are a separate species/ speciation has occurred (½).

Also accepted: in a cline gene flow occurs between nearby populations, but may not occur between populations at either end of the cline (½); as such, it is possible that bush rats from NSW and WA may not be able to interbreed (½), but if these populations can both interbreed with populations from SA (or other location) (½) then they could still be considered a cline rather than a separate species (½).

(d) Black Rat (*Rattus rattus*) is most closely related to the bush rat (1); this is because they are both from the same genus (½) *Rattus* (½).

Marker Comments

(a) A number of students indicated that they did not know what a "cline" was. However, the definition was in the Information Booklet and stronger students used the definition given (which was given ½ a mark for stating the definition) and then applied it to the scenario and question. In this way, students could still get full marks. Many students talked about "them" interbreeding but did not note who "them" were – they needed to specify rats from the two discrete populations. Clarity is needed in written answers.

(b) This question illustrated many misconceptions around natural selection and the role of genetic variability. There was a lot of answers with information dumping of terms without showing understanding of the concepts involved. For example, a large number of students discussed natural selection as if it is an animate object that chooses which animals survive (e.g. natural selection kills off organisms with that trait) or they discussed the alleles/ traits/ variations dying or surviving, rather than the organisms that possessed the traits. There was also misunderstanding around

the role of genetic variation, with many students stating that natural selection causes genetic variation, rather than acknowledging that genetic variation is essential for natural selection to occur.

(c) Question done well with a large number of students gaining full marks by applying the definition of a species to this scenario.

(d) Many students received one and a half for this question as they were able to recognize that the bush rat and the black rat shared a portion of their scientific name but could not remember that the first word of the scientific name is the genus. A large number of students gave the wrong answer (Heath Rat) and justified this by saying that it was most closely related as it lived in a similar environment/ faced similar selective pressures/ was a native species/ was found in the bush rather than in towns. They were awarded no marks for this answer.

Question 21

(a) This question was well answered with the majority of candidates getting all correct or at least 3 ½ points.

Statement	B lymphocytes	T lymphocytes
Matured in bone marrow	✓	X
Form part of immune response	✓	✓
Differentiates into memory cells	✓	✓
Produces chemicals that can kill infected cells	X	✓
Form plasma cell clones	✓	X

(½ mark each)

(b) There were several variations within the answers accepted for this question. Students really needed to show an understanding of key differences between how/what the immune response is once an individual is vaccinated and once an individual gets infected. There are few key aspects that markers were looking for and needed to be shown (see list below) and the marks were allocated cumulatively.

- Why there is a lag time before increase in antibody production for vaccination and immediate production of antibodies after an infection.
- The role of the B-lymphocytes activation after vaccination and then after infection.
- Why there is a difference in the concentration of antibodies after vaccination in comparison to after infection.

Mark Allocation:

- <u>After vaccination</u>: a vaccination containing an attenuated form of the flu virus would contain a small dose of antigens found on the surface and because the individual hasn't encountered the antigen previously there would be a lag time (as seen on the graph) in the primary response (½); Helper-T cells stimulate B-cells; the B-cells (lymphocytes) recognise/bind the antigen (½) and multiply to produce plasma cells and memory cells containing specific antibodies against the flu virus (1). Plasma cells can last for months in the lymph nodes that is why the graph doesn't go back to zero (½).

  Vaccination is the primary artificially acquired immunity. (½)

- <u>After infection</u>: as there is already memory cells of the antigen – due to the previous vaccination, the response (concentration of antibodies) is fast, immediate and higher (1). B-lymphocytes clone and differentiate into plasma cells that release antibodies and memory B-cells hence increase in concentration of antibodies in blood (1).

The infection is a secondary naturally acquired immune response (½).

Points were given if students discussed the role of T-cells as long as they also detailed how the B-cells functioned in this immune response – as the data was identifying the concentration of antibodies – thus link to B-cells.

Marker Comments

Many candidates found this question difficult and focused on a Cell mediated response rather than the Humoral response. If an answer only discussed the role of T-cells, then no credit was given.
Many candidates just described the differences between the graph data without explaining why there are differences in terms of the immune response.

Other Common Errors:

- Incorrectly identifying that antibodies kill the virus rather than binding/clumping and neutralizing the virus ready for destruction.
- Only mentioning 'memory cells' and not specific about what type of memory cell.
- Mixing up B-cell and T-cell 'naming' within the answer.