Assessment Schedule – 2023

Biology: Demonstrate understanding of life processes at the cellular level (91156)

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate ***understanding*** involves: • defining, using annotated diagrams or models to describe, and describing characteristics of, or providing an account of, life processes at the cellular level.	*Demonstrate* ***in-depth understanding*** involves: • using biological ideas to give reasons how or why life processes occur at the cellular level.	*Demonstrate* ***comprehensive understanding*** involves: • linking biological ideas about life processes at the cellular level; discussion of ideas may involve justifying, relating, evaluating, comparing and contrasting, analysing.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 5	6 – 12	13 – 18	19 – 24

Evidence

Question One

Expected Coverage	Achievement	Achievement with Merit	Achievement with Excellence
(a): Carbon dioxide + water → glucose + oxygen (in the presence of light and chlorophyll). *Accept symbol equation (balanced or unbalanced).* **(b):** An enzyme is a biological catalyst. The starting substrates / reactants for photosynthesis are carbon dioxide and water. The reactants of photosynthesis are CO_2 and H_2O. The light-dependent reaction splits water into H^+ and O and creates ATP (adenosine 5'-triphosphate) to drive the light-independent reaction. The light-independent reaction captures / fixes the carbon / CO_2 and joins the H^+ with the CO_2 to produce the glucose. An increase in CO_2 / water concentration will allow photosynthesis to increase because an increase in substrate / reactants concentration will increase the rate of enzyme reactions because the water / CO_2 / substrate will join with the enzyme to form the enzyme-substrate complex more often. Increased CO_2 will increase the speed of the light-independent reactions as more carbon can be obtained to make glucose. CO_2 will form a substrate + enzyme complex with the enzymes of the light-independent reaction. Increased H_2O will increase the speed of the light-dependent reactions as the higher concentration will allow H_2O to form an enzyme-substrate complex with the enzymes of the light-dependent reaction at a faster rate. Therefore, the water molecules will be split at a faster rate, releasing O_2 and making the H^+ ions for the next step of photosynthesis / light-independent phase. Decreased CO_2 / water concentration will slow the photosynthesis reaction down (CO_2 decrease slows light-independent reaction, H_2O decrease slows light-dependent reaction). Increasing substrate concentration will speed photosynthesis until some other factor, such as enzyme saturation, becomes the limiting factor. High temperatures will speed up photosynthesis at first, because collisions between water / CO_2 and the photosynthesis enzymes will happen at a faster rate, resulting in more successful collisions.	• Provides correct word equation. **Describes:** • enzyme as a biological catalyst / speeding biological reactions. **Identifies:** • starting reactants as CO_2 and water. **States** that: • more reactants / CO_2 / water will increase photosynthesis OR less reactants / CO_2 / water will decrease photosynthesis • low temperatures will slow / stop photosynthesis / enzyme reactions • high temperatures can denature enzymes • high temperatures will stop / slow photosynthesis reactions. Describes: • the light-dependent / independent reaction.	**Explains** that: • denaturing changes the shape of the enzyme's active site so that photosynthesis stops / reactions can't proceed • high heat breaks the bonds within the enzyme and permanently changes shape of active site • increased substrate concentration will aid / speed up photosynthesis due to the increased formation of the enzyme-substrate complex or decreased substrate concentration will slow / stop photosynthesis due to reduced formation of enzyme-substrate complex • photosynthesis can only occur if all substrates are at a sufficient concentration • how CO_2 / H_2O affect the light-independent / light-dependent reactions • low temperature reduces successful collisions, which limits photosynthesis (and does not permanently denature / damage the enzyme).	**Discusses**, demonstrating comprehensive understanding of: • the effect of **both** very high and very low temperatures on enzymes and the photosynthesis reactions • the effect of the concentration of **both** named substrates / reactants / CO_2 and water, linked to the light-independent / light-dependent reactions of photosynthesis and enzymes • photosynthesis, which can only occur if all substrates / reactants are at a sufficient concentration to form enzyme-substrate complexes and factors (temperature) are at an optimum for enzyme activity.

Expected Coverage	Achievement	Achievement with Merit	Achievement with Excellence
However, if the temperature gets very high, the enzyme will denature and stop the reaction. This will happen because high temperatures will break the H-bonds within the enzyme which will cause the active site to change shape and the substrate /H_2O /CO_2 will no longer fit the active site, therefore stopping photosynthesis. Low temperatures will slow the rate of enzyme reactions because they will cause the enzymes to collide with the substrate /water/ CO_2 less often due to slower molecule movement. Low temperatures do not denature the enzyme so, once the temperature rises again, the enzymes and photosynthesis reactions can resume at a faster pace. Very low temperatures that turn the water to ice would stop photosynthesis because water must be in liquid form for photosynthesis.			

Not Achieved		Achievement		Achievement with Merit		Achievement with Excellence	
N1	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
ONE evidence point at Achievement.	TWO evidence points from Achievement.	THREE evidence points at Achievement.	FOUR evidence points at Achievement.	THREE evidence points at Merit.	FOUR evidence points at Merit.	ONE evidence point at Excellence.	TWO evidence points at Excellence.

N0 = No response; no relevant evidence.

Question Two

Expected Coverage	Achievement	Achievement with Merit	Achievement with Excellence
Active transport uses energy to transport materials across the cell membrane against their concentration gradient / from low to high concentration using a protein pump. Therefore, active transport is used when the cell needs to transport a substance into the cell against its concentration gradient. In contrast, facilitated diffusion is the movement of materials from a high to low concentration through a protein channel, without the use of energy / ATP. Facilitated diffusion is needed to transport ions / polar molecules / large molecules that can't diffuse freely through the phospholipid bilayer. In this case, protein channels create a gap / hole in the membrane for the sulphate ions to move into the cell from high to low concentration. Both processes are similar because both use proteins to transport substances. Active transport of sulphate ions is made possible by protein pumps in the cell membrane. The sulphate ion will bind with the protein on the outside of the membrane and ATP will allow the pump to change shape and deliver the sulphate to the inside of the cell membrane. In facilitated diffusion, the proteins just create a gap / hole and do not need to change shape using ATP. Unlike active transport, facilitated diffusion will stop once equilibrium is reached / concentration of sulphate ions are the same on both sides of the cell. Active transport will continue to take in sulphate ions after equilibrium is reached. The graph of facilitated diffusion shows that, between 150 s and 240 s, the uptake of sulphate ion has started to level off / little uptake of sulphate ion by the cell. This shows that equilibrium is beginning to be reached (ions moving in = ions moving out), and there is no longer a concentration gradient to allow the facilitated diffusion of sulphate. Since active transport can move sulphate against the concentration gradient, sulphate ion is still being pumped into the cell, even after there is less sulphate out of the cell than in. With active transport, equilibrium does not stop the entry of materials into the cell.	**Describes:** • active transport as using energy / ATP **and** move materials through the cell membrane against a concentration gradient / from low to high concentration • facilitated diffusion as using passive transport / doesn't use energy **and** moves things with the concentration gradient / high to low concentration • the difference, as active transport requires energy / ATP and facilitated diffusion does not require energy • the graph, e.g. the graph shows that active transport takes in more sulphate ion than facilitated diffusion (or vice versa) • an example of active transport / facilitated diffusion, e.g. active transport is done by protein pumps / endocytosis • one similarity between active transport and facilitated diffusion clearly worded as a comparison, e.g. both use proteins.	**Explains:** • how active transport occurs, including the use of protein pump / membrane / named structure • why active transport occurs, relating to context / sulphate ions / root cells • the process of facilitated diffusion needing a protein channel • a difference **or** similarity between facilitated diffusion and active transport, e.g. in terms of proteins not changing shape versus changing shape / both can transport ions which otherwise can't pass through the bilayer • facilitated diffusion is needed because the sulphate ion needs a carrier protein as it won't move freely through the phospholipid bilayer / membrane • facilitated diffusion will also allow the diffusion of other large molecules that can't move freely through the phospholipid bilayer / membrane (such as glucose) • using the graph, why the sulphate ion uptake is greater with active transport **or** less with facilitated diffusion, e.g. the graph shows that sulphate ion uptake is greater with active transport because uptake can happen even if the concentration of sulphate outside the cell is lower than inside / uptake stopped with facilitated diffusion because equilibrium was reached.	**Discusses**, demonstrating comprehensive understanding of: • why sulphate ion uptake continues with active transport **and** stops when equilibrium is reached during facilitated diffusion, with reference to the graph • specific structures in the membrane for both types of transport, e.g. carrier protein / protein pore for facilitated diffusion and protein pump changing shape for active transport, phospholipid bilayer prevents free diffusion of charged ions • similarities and differences of both facilitated diffusion and active transport, e.g. both processes need the use of proteins, but only in active transport is ATP needed to change the shape of the protein; both can transport ions but, in facilitated diffusion, transport stops once equilibrium is reached, whereas active transport can continue.

Not Achieved		Achievement		Achievement with Merit		Achievement with Excellence	
N1	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
ONE evidence point at Achievement.	TWO evidence points at Achievement.	THREE evidence points at Achievement.	FOUR evidence points at Achievement.	THREE evidence points at Merit.	FOUR evidence points at Merit.	ONE evidence point at Excellence.	TWO evidence points at Excellence.

N0 = No response; no relevant evidence.

Question Three

Expected Coverage	Achievement	Achievement with Merit	Achievement with Excellence
DNA replication occurs before mitosis / cell division. To replicate the DNA, the double helix is unwound and the two sides are unzipped / separated. This is done by enzymes. Each side / strand of the DNA is used as a template and an enzyme joins DNA nucleotides to each original strand, using the base pairing rule of A to T and C to G. When all the new nucleotides are added along each parent strand, two identical DNA strands are produced. This way of replicating DNA is known as semi-conservative replication because each new DNA double helix contains one of the original parent strands and one completely new strand. Mitosis is cell division that creates two identical new cells. The purpose of mitosis is to produce new cells for growth and to repair / replace damaged tissues. The relationship between DNA replication and mitosis is that DNA replication must happen before mitosis occurs. This ensures that each new cell has the correct amount of DNA and has the genetic information needed to carry out its function. For example, cells in an animal's body have different functions, and each cell must have the information needed to produce materials / enzymes etc. needed to carry out that function, e.g. cells in digestive tract must have instructions for making digestive enzymes. To repair tissues, new cells must be made that are identical to the tissue being repaired, e.g. damaged skin cells of the caterpillar must be replaced with new skin cells. In addition, for the caterpillar to grow after it hatches, its existing cells can't just get bigger, it must make new cells by mitosis. This is because cells must retain a large surface-to-volume ratio (SA:V) for the efficient transport of materials. Once the adult butterfly stops growing, mitosis is still needed to repair tissue. When tissue needs to be repaired, the new cells must be identical to the damaged cells. However, the rate of mitosis will be slower once growth has stopped. If a cell is too large to transport materials or does not have the DNA instructions to carry out its function, the cell will die. Therefore, for cells to remain alive, they must go through mitosis to maintain the	**Describes:** • DNA is replicated before cell division / mitosis • DNA replication involves unzipping of molecules **and** adding complementary nucleotides / bases • DNA replication is semi-conservative / involves enzymes / other possible detail • mitosis makes two identical cells **or** is used for growth / repair **or** maintains small cell size • DNA replication is needed before mitosis so cells have the correct amount of DNA • one life-cycle stage, e.g. mitosis is needed so the animal can grow bigger after it is born / hatched.	**Explains:** • DNA replication includes TWO of the following: i. use of parent strand as template / semi-conservative ii. explicitly states base pairing rule (A–T, C–G) for adding nucleotides iii. use of enzymes at a specific step iv. other possible detail • purpose of mitosis is to make two new identical cells for growth AND to repair tissue • DNA replication is needed before mitosis so new cells have the correct information / instructions to carry out their function • cells must retain a small size for efficient transport of materials / maintain SA:V ratio / so cells can't grow too large • mitosis is needed for repair once growth has stopped / at identified stage of life cycle.	**Discusses**, demonstrating comprehensive understanding of: • the need for each cell to have the DNA instructions to carry out its function AND to retain a small cell size for efficient transport of materials for cell survival • mitosis, giving examples of the need for it in relation to a specific life stage for growing, and explicitly links making more cells as needed for growth and the repair of tissue • the link between cell survival and survival of the entire organism.

Expected Coverage	Achievement	Achievement with Merit	Achievement with Excellence
correct SA:V ratio, as well as the DNA information needed. If the cells die, the caterpillar / butterfly will also die.			

Not Achieved		Achievement		Achievement with Merit		Achievement with Excellence	
N1	N2	A3	A4	M5	M6	E7	E8
ONE evidence point at Achievement.	TWO evidence points at Achievement.	THREE evidence points at Achievement.	Describes any FOUR evidence points at Achievement.	THREE evidence points at Merit.	FOUR evidence points at Merit.	ONE evidence point at Excellence.	TWO evidence points at Excellence.

N0 = No response; no relevant evidence.