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91156



NEW ZEALAND QUALIFICATIONS AUTHORITY
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Level 2 Biology, 2016

91156 Demonstrate understanding of life processes at the cellular level

9.30 a.m. Friday 18 November 2016

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of life processes at the cellular level.	Demonstrate in-depth understanding of life processes at the cellular level.	Demonstrate comprehensive understanding of life processes at the cellular level.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL

22

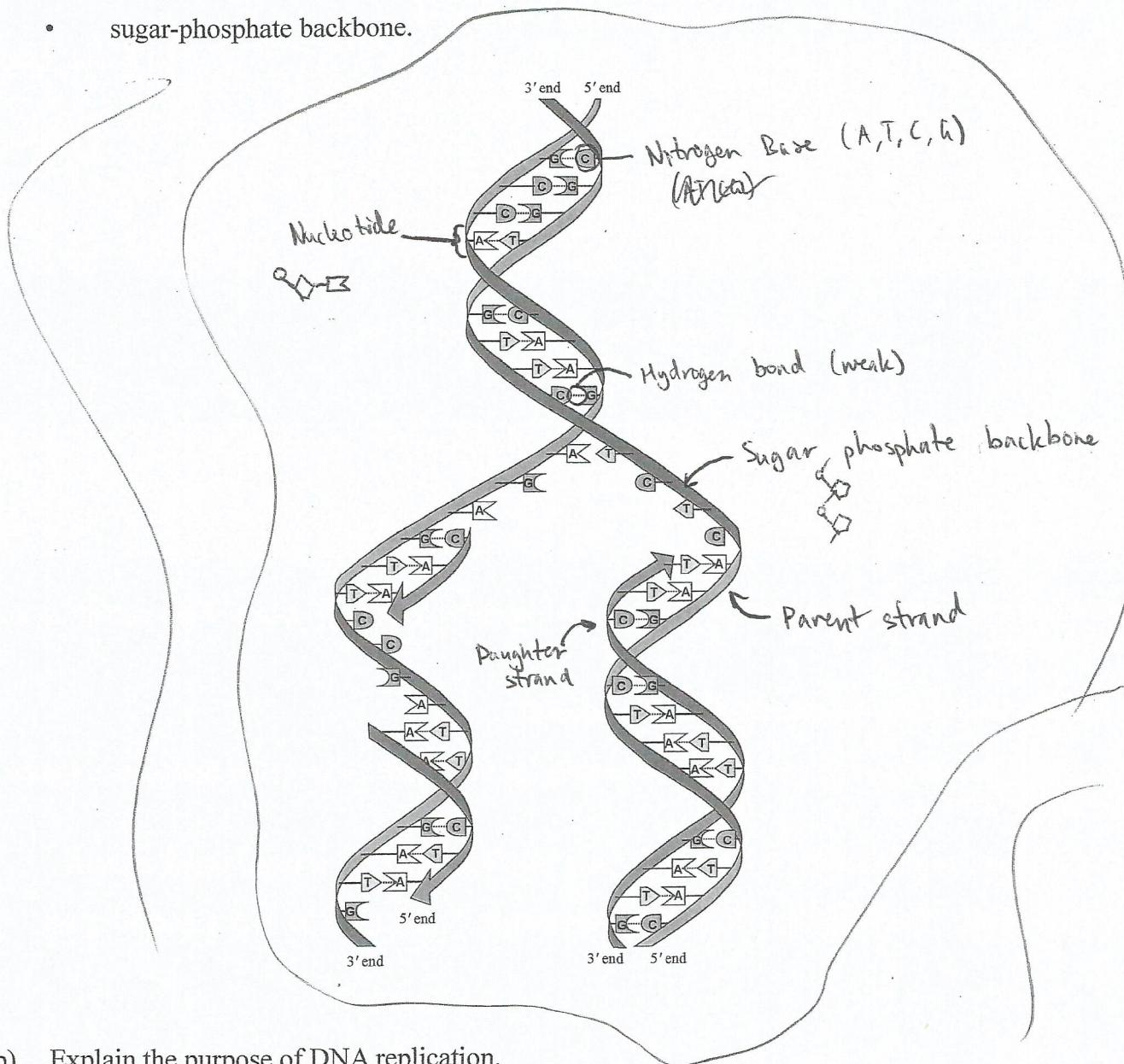
ASSESSOR'S USE ONLY

QUESTION ONE: DNA REPLICATION

- (a) The model below shows DNA replication.

Label the following on the diagram:

- nucleotide
- nitrogen base
- hydrogen bond
- parent strand
- daughter strand
- sugar-phosphate backbone.



- (b) Explain the purpose of DNA replication.

The purpose of DNA replication is to create copies of DNA (and ∵ genetic code) before cell division so the each daughter cell contains the same DNA and ∵ the same genetic code. Without DNA replication, the daughter cells would have no DNA ∵ it would be useless.

- (c) Enzymes are needed for DNA replication.

Discuss the function of enzymes in DNA replication and the factors that affect them.

In your answer include:

- a description of the structure of an enzyme
- an explanation of how enzymes function in DNA replication
- a discussion of at least three factors that affect enzymes during DNA replication.

You may use diagrams in your answer.

An enzyme is a globular protein which is a biological catalyst. It contains an active site. It can either break molecules (catabolic) or build molecules. An enzyme contains an active site to which substrate(s) - one for breaking or two for building - bind to. Then act. Each enzyme's active site ~~is specific~~ only fits with its specific substrate. The substrate are then released and have either been built into one molecule from two substrates or have been broken into two molecules from one substrate.

Enzymes play a key role in DNA replication. Firstly, an enzyme (helicase) unzips the DNA strand. Then, another enzyme (DNA polymerase III) adds complementary base pairs to the newly separated bases. However, the enzyme can only work in the 3'-5' direction. This means it works continuously on the strand which suits its preferred direction (called the leading strand), but can not work on the continuously on the other strand ~~as~~ as it runs in the opposite direction because the two DNA strands are anti parallel. Another enzyme, DNA primer, places primers on the lagging strand to help the DNA polymerase III. The DNA polymerase III work attaches to the primers and works backwards in its preferred direction. It produces fragments of bases called Okazaki fragments. Next, another

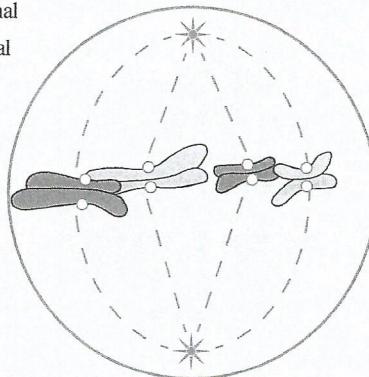
There is more space for your answer to this question on the following page.

ASSESSOR
USE ONLY

enzyme (DNA Polymerase I) replaces the primers on the lagging strand with the correct complementary base pairs. Finally, another enzyme (DNA ligase) goes through the lagging strand and attaches all the fragments together. Four factors that affect enzymes during DNA replication is temperature, pH, substrate concentration and enzyme concentration. Increasing temperature increases the rate of reaction of enzymes (more collisions = higher frequency of successful collisions). The enzymes function best at their optimum temperature. However, if the temperature continues to rise, the hydrogen and disulfide bonds which hold the 3D tertiary structure of the enzyme together can break, resulting in the protein uncoiling. This change in shape means the enzyme is denatured (the active site changed shape so it no longer functions). Changing levels of pH interfere with the charged amino acids and can slow down the functioning of a protein. The enzyme works best at its optimum pH and slows down as it gets higher or lower. Increasing substrate concentration increases the rate of reactions of enzymes (more reactants = more collisions = higher frequency of successful collisions). However, after a point it levels off as the enzymes become saturated. Similarly, increasing substrate enzyme concentration also increases the rate of reactions of enzymes (more reactants = more collisions = higher frequency of successful collisions). However, after a point it also levels off as there are more enzymes than the substrate available meaning no use of extra enzymes.

QUESTION TWO: MITOSIS AND MOVEMENT OF MATERIALS

Maternal
 Paternal



adapted from: <https://www.bio.purdue.edu/BCBLab/?p=1093>

- (a) Describe what is happening in the diagram above during mitosis.

The diagram above is showing the metaphase of mitosis. This is when the chromosomes line up in the middle of the cell and spindles of micro tubule fibres reach out to the chromosomes, ready for anaphase in which the chromosomes get pulled apart to opposite sides of the cell.

- (b) Explain the purpose of mitosis, and how this type of cell division occurs.

The purpose of mitosis is to create duplicate cells which carry the same DNA (and its genetic code) which is used for growing, healing or repairing. Without mitosis we would not be able to grow into a foetus from the embryo. The first stage of mitosis is prophase. The chromosomes condense, ready for cell division. Next, in metaphase, they line up in the middle of the cell and spindles of micro tubule fibres reach out, ready for the next stage. In anaphase, the fibres pull apart the chromosomes to opposite sides of the cell. Finally, in telophase the cell divides into two daughter cells.

- (c) Most cells in the human body grow to a limited size then divide. The new cells grow, but also divide when they have reached a certain size.

Discuss how the surface area to volume ratio affects the process of diffusion, and why the changes in surface area to volume ratio may cause the cell to divide.

In your answer include:

- a description of how the surface area to volume ratio changes as the cell grows
- an explanation of how the surface area to volume ratio affects the movement of materials into and out of a cell
- an explanation of diffusion
- a discussion of how the surface area to volume ratio can affect diffusion and cell division.

The surface area to volume ratio ($SA:V$) changes as the cell grows. When the cell is small, the $SA:V$ is relatively high. As the cell increases in size, the $SA:V$ reduces. This is because the volume of the cell increases at a faster rate than the surface area of the cell. When the $SA:V$ is relatively high, it increases the efficiency of the movement of materials into and out of a cell. As the $SA:V$ decreases, so does the efficiency of the movement of materials into and out of a cell. This is because increasing the volume of a cell means it is more difficult for material to reach the centre of the cell. The ratio of surface area is also decreased, meaning there isn't as much surface area the material needs to diffuse through as there could be for the cell's volume. A small cell has a small volume, meaning the material can easily reach the centre of the cell. The increased ratio of the surface area also means there is more surface area for the materials to diffuse through - more efficient. Diffusion is a method of passive transport (it doesn't require expenditure of cellular energy in the form of ATP), which is the movement of molecules from an area of

high concentration down the concentration gradient to an area of low concentration, until equilibrium is reached. Increasing the SA:V ratio (ie making the cell smaller) makes the diffusion more efficient. A smaller cell means smaller volume. This means the molecules can easily reach the organelles in the centre of the cell. An increased SA ratio means there surface area for molecules to diffuse through is closer to its maximum potential. This, combined with a lower volume, increase diffusion efficiency. Decreasing the SA:V ratio (ie making the cell larger) makes diffusion less efficient. A larger cell means a larger volume. This means the molecules find it harder to reach the organelles at the centre of the cell. A decreased SA ratio means the surface area for molecules to diffuse through is lower than what is could be (maximum potential). Combined with the larger volume, the lower surface area ratio reduce diffusion efficiency. When the efficiency of diffusion is reduced, the cell begins to function slower as not as many required molecules can reach the organelles at the centre ∴ slowing down the essential cell processes. Therefore, the cell undergoes cell division when it gets too large so once the daughter cells are small again, the SA:V ratio is increased and ∴ the efficiency of diffusion is increased - allowing essential cell processes to be faster again.

QUESTION THREE: CELL PROCESSES

Photosynthesis and cell respiration are cell processes carried out within a plant.

Discuss the similarities and differences between photosynthesis and aerobic cell respiration in a plant.

In your answer include:

- a word equation of photosynthesis and aerobic cell respiration
- an explanation of how both aerobic cell respiration and photosynthesis are required to support the overall survival of the plant
- a discussion of the similarities and differences of the two processes.

http://www.ecoagra.com/eA_BPP-HowItWorks.html

Specific details of stages for each process are NOT required.

Photosynthesis is the process of using light energy to turn $\text{CO}_2 + \text{H}_2\text{O}$ into glucose and O_2 to get energy in the form of ATP. The word equation for photosynthesis is carbon dioxide + water $\xrightarrow{\text{light energy}}$ glucose + oxygen. The symbol equation for photosynthesis is $6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. Photosynthesis is required to support the overall survival of the plant as it produces the glucose which the plant requires for aerobic respiration to get the energy needed for most biological processes and is needed for its survival. Respiration is the process of getting energy in the form of ATP from glucose. The word equation for respiration is glucose + oxygen \rightarrow carbon dioxide + water. The symbol equation for respiration is $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$. One molecule of glucose produces 36 ATP. Respiration is required to support the overall survival of the plant as the energy produced by it in the form of ATP is required by most biological processes (such as active transport) and is necessary for the survival of the plant. The differences of the two processes share many differences and similarities. A difference of the two processes is that photosynthesis requires

light energy (to break down the H_2O molecules in the light dependant phase) to react, whereas respiration does not require any condition. This means plants can only photosynthesise ^{aerobic} in daylight or under sufficient light, whereas respiration occurs all the time. Another difference is that photosynthesis only occurs in plants, not animals. This is because animals can eat to get the glucose but plants are autotrophic i.e. they require photosynthesis to get glucose (which is necessary for respiration). Another difference of the two processes is where they occur. Photosynthesis occurs in the chloroplasts of a plant cell (light dependant in thylakoids & light independent in stroma). Whereas respiration occurs firstly in the cytoplasm (glycolysis) then in the mitochondria (Krebs cycle in liquid matrix and E.T.C. on cristae). A similarity of the two processes is they both have the same molecules. In photosynthesis carbon dioxide and water are reactants, whereas in respiration they are products. Similarly, in photosynthesis glucose and oxygen are products, whereas in aerobic respiration they are the reactants. Another similarity in the two processes is that they are both a series of enzyme controlled steps and share the same factors on rate of reaction as enzymes. Finally, a similarity between the two processes is that they both are essential for the overall survival of the plant and both occur in plant cells.

Annotated Exemplar Template

Excellence exemplar 2016

Subject:		Biology	Standard:	AS91156	Total score:	22
Q	Grade score	Annotation				
1	M6	<p>1a All six labels are correctly positioned on the diagram.</p> <p>NB: Nucleotide label impossible to position as there is insufficient detail in the diagram so any reasonable attempt was marked correct and only 5 labels were required to be correct for N2. Also the diagram was virtually the same as the one in the Biozone Workbook but the labels were contradictory. Markers accepted either contradictory option. Either top part of diagram – Parent Strand and bottom “forks” – daughter strand Or complete strand – Parent strand and broken strand – daughter strand.</p> <p>!b Idea of Identical DNA produced (the word ‘copy’ was assumed to mean identical. – A point</p> <p>1b Idea that the resulting new cell was able to perform the same function as its DNA was the same as that of the parent cell - M point</p> <p>1c Discussion of enzyme function in the role of DNA replication and three factors impacting on that function. Factors could be any three of Temperature, pH, Inhibitors, Concentration of Enzyme or Concentration of Substrate.</p> <p>In this example three factors were discussed with reference to Collision Theory and enzyme function but to gain an E grade the student needed to link their discussion to the context and recognise that the overall performance of an enzyme is the combined effect of all factors.</p>				
2	E8	<p>2a Student mentions spindle and that chromosomes line up on it – N2</p> <p>2b Purpose of Mitosis correctly identified as Growth and repair of damaged cells. To gain the ‘M’ grade here the student needed to include the idea that cell division increased the SA:V ratio so improving the efficiency of diffusion. Very few students included this point.</p> <p>2c This student very adequately discusses the movement of materials in a cell, the efficiency of this movement and how it links to the process of diffusion.</p>				
3	E8	<p>This student correctly writes a word equation for both Aerobic Respiration and Photosynthesis. (the absence of ATP in the respiration word equation is compensated for in the symbol equation that was not required.)</p> <p>The student went on to discuss both processes and at least two similarities and differences between them.</p>				