NZPQA

New Zealand Pretend Qualifications Authority

Level 2 Biology

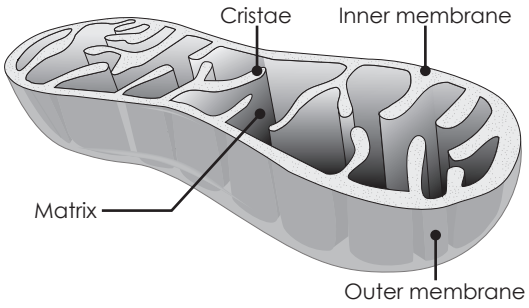
91156 (2.4): Demonstrate understanding of life processes at the cellular level.

For Assessor's use only	**Achievement Criteria**	
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. ☐
Overall Level of Performance ☐		

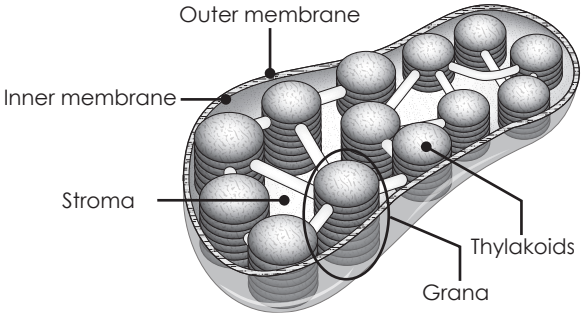
QUESTION ONE: ORGANELLES

Organelles are organised and specialised structures found within cells. Compare and contrast the two organelles shown below.

Mitochondrion (plural = mitochondria)



Chloroplast



In your answer you should:

- Describe the processes carried out by the two organelles.
- Explain how the structures of the organelles allow them to carry out their functions.
- Discuss reasons for similarities and differences in the structure, location, and number of these organelles.

QUESTION TWO: DIFFUSION

Living cells exist in a liquid environment that needs to be regulated so that they function correctly. *Facilitated diffusion* and *diffusion* are two examples of transport processes that occur in cells. Compare and contrast these two transport processes.

In your answer you should:

- Describe each transport process.
- Identify examples of substances that are transported by these processes.
- Discuss the factors that affect the rate of both *facilitated diffusion* and *diffusion*.

QUESTION THREE: DNA REPLICATION

The cell cycle is the series of events that take place in a cell leading to its division and duplication (replication). Before cell division can occur, a DNA molecule must replicate.

Discuss the purpose of DNA replication.

In your answer you should explain how DNA is replicated AND why the process is known as *semi-conservative replication*.

You may draw labelled diagrams as part of your answer.

QUESTION FOUR: ENZYMES

Enzymes are essential molecules that regulate many life processes. Discuss the structure and function of enzymes. In your answer you should include:

- The reason(s) why enzymes are important.
- An explanation of TWO models of enzyme activity.
- TWO factors that affect enzyme activity and how each factor is linked to the functioning of enzymes.

You may include diagrams to help you answer the question.

Suggested Answers - Biology 2.4 Exam

QUESTION ONE

Chloroplasts carry out photosynthesis which uses light energy to assemble H_2O and CO_2 molecules into glucose. Their outer membrane is almost transparent to allow the maximum amount of light to pass through. This maximises the penetration of sunlight energy and therefore enables the rate of the reaction to proceed more quickly. Thylakoids are the sites of light absorption and ATP synthesis, and contain many proteins. Their flat, thin shape allows for maximum uptake of materials due to short diffusion distances. The flattened disc-shape of the grana provides an increased S.A. so that so that the number of reactions that can occur is increased. The stroma is clear, so it doesn't block light, thus maximising the penetration of light into the chloroplast providing the energy for the reaction to proceed.

Mitochondria carry out cellular respiration, which involves the breakdown of glucose to release usable energy (ATP). The double membrane of mitochondria has an inner membrane folded into cristae to make large S.A so that the number of reactions can be increased, especially with respect to ATP production. The matrix contains a highly-concentrated mixture of hundreds of enzymes which allows for easy transport of the reactants and the products of respiration and therefore allows increased reactions to proceed in contact with the cristae. The outer membrane is semi-permeable to allow the passage of small molecules from one side to the other. This ensures that reactants and products can be easily transported and used as required.

Chloroplasts are only found in plant cells (and some eukaryotic organisms). This is because they are only found in autotrophic organisms - those that can manufacture their own energy source. Chloroplasts are usually found in the highest densities in the upper parts of leaves. This maximises the ability to absorb energy from the sun.

Mitochondria are in most eukaryotic cells and are found in the highest density where cellular activity is high due to increased energy requirements such as muscles and glands.

Like mitochondria, chloroplasts also increases the surface area available for chemical reaction by having a large amount of membrane. While the mitochondria achieves this by in-foldings of the inner membrane (cristae), chloroplasts have stacks of thylakoid membranes called grana.

QUESTION TWO

Diffusion is the movement of particles from an area of high concentration to an area of low concentration down a concentration gradient. Diffusion only occurs in liquids and gases and does not require energy or the presence of a membrane. Cells require useful particles like oxygen, water, ions and food molecules to enter them and waste substances like carbon dioxide and ammonia to leave them. These molecules enter and leave the cell by diffusion. Oxygen is required for the process of aerobic respiration and once in the cell it further diffuses into mitochondria which are the site of respiration. Carbon dioxide is produced during respiration and diffuses from the mitochondria and leaves the cell by diffusion.

Large molecules like glucose and starch are too big to pass through the membrane and so other process are required to move them in and out of the cell.

Facilitated diffusion is a special type of diffusion that uses specific transport proteins to carry molecules faster than their normal diffusion rate. Facilitated diffusion only occurs in liquid medium and requires a plasma membrane. It is a passive process requiring no energy as it moves molecules down their concentration gradient.

Glucose is produced by the process of photosynthesis in the chloroplast. It moves by facilitated diffusion through the double membrane of the chloroplast to the cytoplasm. It then leaves the cell through facilitated diffusion to be transported to other parts of the plant via the phloem. Glucose is required by cells for the process of aerobic respiration in the mitochondria. Glucose enters the cell by facilitated diffusion using a specific carrier protein. It then moves through the cytoplasm to the mitochondria where it is transported through the double membrane of the mitochondria by a transport protein.

Amino acids are required for protein synthesis. They also enter the cell by facilitated diffusion. Once in the cytoplasm they are carried by tRNA to the ribosomes.

Several factors affect the rate of diffusion in cells. Gases diffuse faster than liquids as they have more energy to move. Small particles diffuse faster than large ones. Particles diffuse faster at higher temperatures as heat excites the particles, giving them more energy to move.

Facilitated diffusion is carried out by protein molecules and as proteins are affected by temperature, the process of facilitated diffusion is affected by temperature. At low temperature the activity of the transport proteins is low. As temperature increases, the activity of the transport proteins increases to an optimum. At high temperatures the transport proteins are denatured and can no longer transport molecules.

QUESTION THREE

DNA replication is where the DNA in the cell makes an exact copy of itself prior to cell division so that there is a full set of genetic information available in each cell after division has occurred (i.e. for growth and repair of cells).

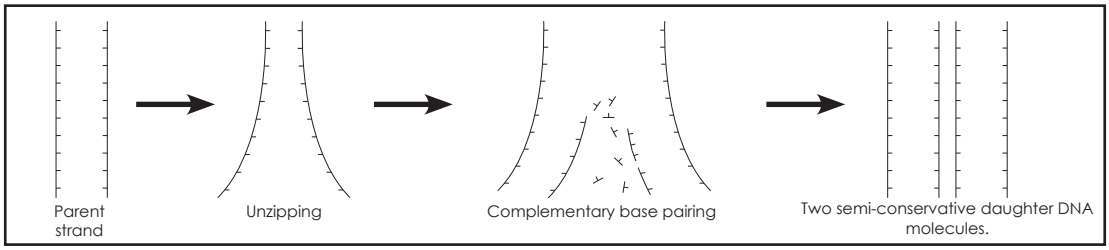
DNA replication is a series of enzyme controlled reactions in which a DNA molecule is copied to produce two identical double-stranded DNA molecules. It occurs in a number of stages.

In stage 1, an enzyme (helicase) unwinds and unzips the DNA molecule, breaking apart the hydrogen bonds that hold the bases together. This creates a replication fork.

In stage 2 the leading strand of the DNA is synthesised continuously by the enzyme DNA polymerase which joins free nucleotides one at a time in the 5'-3' direction. Nucleotides join up following the base pairing rule A-T and C-G. The lagging strand is synthesised discontinuously by the enzyme DNA polymerase creating Okazaki fragments and joins them in the 5'-3' direction.

Finally in stage 3, the enzyme DNA ligase joins the Okazaki fragments on the lagging strand together by re-establishing the bonds between the sugar and phosphate molecules (phosphodiester bonds).

This creates two identical molecules of DNA. The two new molecules of DNA each have one original strand and one new strand i.e. one old strand is 'conserved' in the new molecule.



QUESTION FOUR

Enzymes are biological catalysts that control the rate of reactions in organisms. They have an active site that can work in two ways. The lock and key model where the substrate attaches to the enzyme at the active site. The reaction happens and the product(s) are released. However, in the induced fit model, the active site changes slightly when combined with substrate. The enzyme returns to its 'normal' shape once the substrate / product is released.

(Two factors needed)

- Substrate concentration– As there are more substrate molecules, more can combine with the enzyme and this will increase the rate of reaction. Until the available enzyme molecules become 'saturated' and the rate of reaction levels off. (May use a diagram to show this).
- Co-enzyme – these organic molecules alter the shape of the active site in such a way that it can effectively combine with the substrate(s). Without them the enzymes will not work, or do so at a very low rate of activity.
- Enzyme concentration – more availability of enzymes allows a greater number of reactions to take place so the overall rate of reaction increases. The actual enzyme activity does not increase (i.e. no change in product per unit time per unit mass of enzyme).
- Inhibitors are usually considered poisons because they alter or block the active site to prevent the substrate from binding to the active site.
- pH – if it falls outside of the specific range / optimum pH of an enzyme it can cause the enzyme to denature and change the shape of the active site.
- Temperature – as temperature increases the enzyme activity also increases as more substrate binds to enzymes. Temperatures above the optimum temperature cause the enzyme to denature and change the shape of the active site.