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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Biology 2024

91156 Demonstrate understanding of life processes at the cellular level

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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

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

Excellence

TOTAL 22

QUESTION ONE: Cellular respiration

(a) Write the word equation **or** the chemical equation for aerobic respiration.

Glucose + Oxygen → 36 ATP + Carbon dioxide + water

(b) *Phoneutria* is a genus of spiders mainly found in South America, commonly referred to as Brazilian wandering spiders.

The sensitive hairs on their bodies help detect vibrations of passing prey, and they can feed on insects, lizards, and frogs. During the day, they will hide for many hours under logs, rocks, or inside termite mounds and banana plants.

These spiders are known for their remarkable speed and agility, and are considered to be one of the fastest spiders in the world. When capturing prey or escaping from predators, they can move at speeds of up to 50 cm per second.

Brazilian wandering spider searching leaf litter for prey.

Discuss the processes of anaerobic and aerobic respiration, linking them to the activities of the Brazilian wandering spider.

In your answer, include discussion of:

- the processes of anaerobic respiration and aerobic respiration in the Brazilian wandering spider, including where in the cell each form of respiration takes place
- why the Brazilian wandering spider can only carry out anaerobic respiration for short periods of time when attacking or escaping
- the advantages and disadvantages associated with the Brazilian wandering spider using both anaerobic and aerobic respiration.

Anaerobic respiration occurs when glucose is broken down to release energy in the form of 2 ATP (adenosine triphosphate) while producing carbon dioxide and lactic acid as waste products, this process occurs in the absence of oxygen.

Glucose → Lactic Acid + Carbon dioxide + 2 ATP. Anaerobic respiration takes place in the cytoplasm of the Brazilian Wandering Spiders, this process is known as glycolysis which is where glucose, a six-carbon is split in two 3-carbon compounds known as pyruvates. Aerobic respiration breaks down glucose to produce energy for the cell in the form of ATP (adenosine triphosphate) in the presence of oxygen during this process UP to 38 ATP is produced per glucose molecule and carbon dioxide and

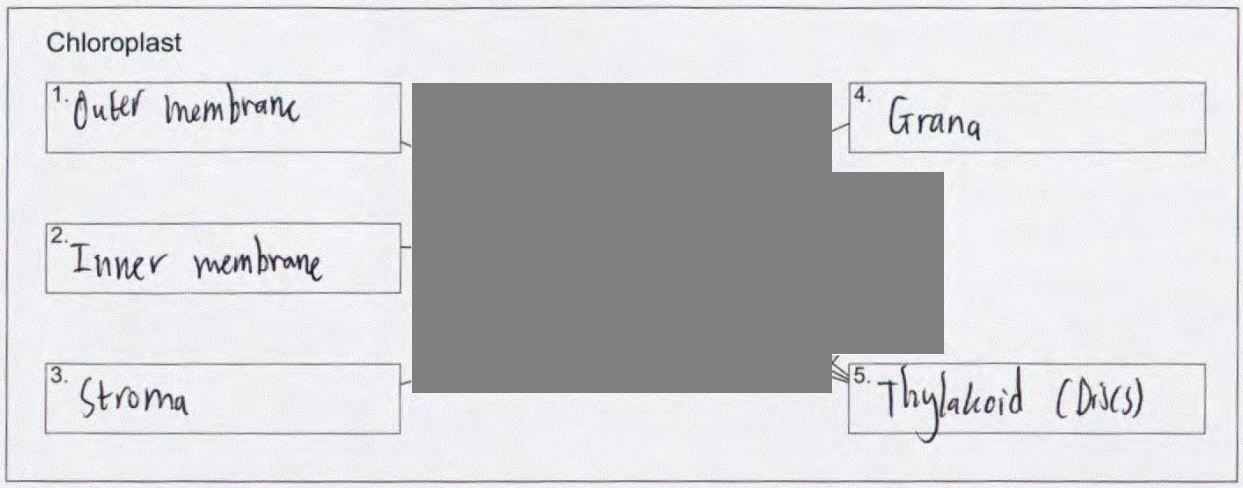
water are produced as waste products of the reaction. Aerobic respiration takes place within the Brazilian Wandering Spider's mitochondria. It is important to note that the waste products of aerobic respiration (carbon dioxide and water) are non-toxic and easily removed from the cell whereas the waste products of anaerobic respiration (lactic acid and carbon dioxide) are toxic and must be removed from the cell, if lactic acid builds up in large quantities it can cause damage to the muscle.

Aerobic respiration word equation: Glucose + Oxygen → 36 ATP + Water + Carbon dioxide.

It is favourable for the Brazilian Wandering Spider to respire anaerobically during fast, quick explosive movements such as during attacking or escaping this is because during these fast movements the cells within the Brazilian Wandering Spider's muscles will not have high enough levels of oxygen to carry out aerobic respiration, fully breaking down the glucose molecule, the low amount of energy (only 2 ATP) produced will allow the muscle to continue working during these fast movements, therefore it is an advantage for the Brazilian Wandering Spider to carry out anaerobic respiration (only partially breaking down the glucose molecule) to sustain its energy needs even in the absence of oxygen. The advantages of aerobic respiration is that the glucose molecule is fully broken down therefore releasing the maximum amount of ATP possible (36 ATP) and the waste products produced are non-toxic and easily removed, however aerobic respiration takes much longer than anaerobic respiration to fully break down the glucose molecule and the oxygen levels within the cell must be high enough to allow this process to occur. The advantages of the Brazilian Wandering Spider using anaerobic respiration is that ATP is produced quickly (glucose only partially broken down) and does not need oxygen to occur however the waste products are toxic and can cause damage to the muscles if they build up in a high quantity without resting the muscles, allowing oxygen levels to be replenished. It would be advantageous for the Brazilian Wandering spider to respire aerobically when hiding for many hours under logs, rocks or inside termite mounds / banana plants as the oxygen levels are high, and the glucose molecule is able to be fully broken down. However while the Brazilian Wandering Spider is moving fast (50cm per second) chasing prey or avoiding an attack it would be advantageous to respire anaerobically as the cells demand for energy is high (large quantities of energy (ATP) in short time) and the oxygen levels are low, however the spider will not be able to anaerobically respire for long periods of time as lactic acid is toxic, can harm muscles and muscle must rest to allow oxygen levels to be replenished.

QUESTION TWO: Photosynthesis

(a) Label the key parts of the chloroplast in the diagram below.



Leaves of some plants that grow in the shade are known as 'shade leaves'. These leaves can be up to five times more efficient in capturing and using the same amount of sunlight as plants whose leaves grow in direct sunlight, which are known as 'sun leaves'.

Shade leaves lose water more quickly than sun leaves when all environmental conditions are the same. Shade leaves are generally larger in area but thinner than sun leaves. Shade leaves also tend to have larger chloroplasts, as well as more chloroplasts within each cell, compared to leaves that grow in full sunlight.

(b) With reference to the information above, evaluate how leaf structure, and the size and number of chloroplasts within plant cells, can be influenced by the availability of light.

In your answer, include discussion of:

- the process of photosynthesis, describing its key stages ✓
- the correlation between the size and number of chloroplasts in shade leaves and sun leaves, and how this size and number difference is linked to photosynthesis ✓
- why shade leaves would lose water more quickly than sun leaves under the same environmental conditions. ✓

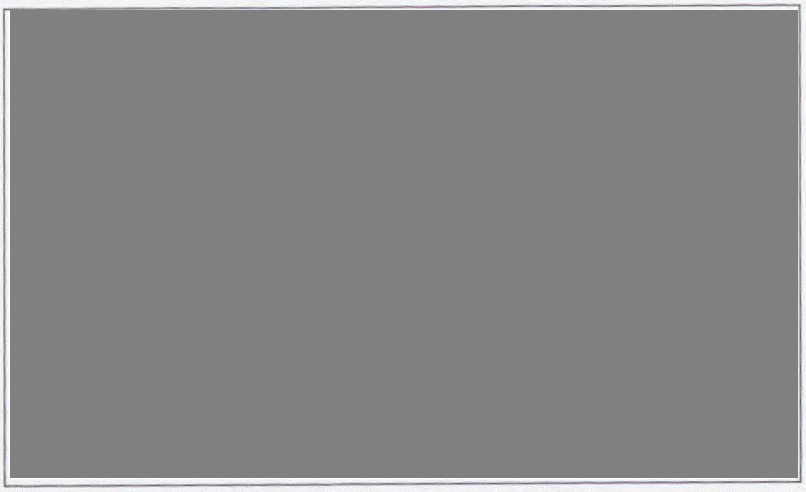
Photosynthesis is the process by which plants are able to produce glucose (energy) by using water, carbon dioxide and sunlight. Photosynthesis consists of two stages, the light dependent stage and the light independent stage. The light dependent stage takes place within the thylakoid discs and is where sunlight is used by the chlorophyll to split the [illegible] into H^+ and Oxygen, some ATP is also produced, this ATP is used to drive the light independent reaction. Oxygen then diffuses out of the chloroplast and is excreted as a waste product. During the light independent stage CO_2 (carbon dioxide) diffuses into the chloroplast where it binds with the hydrogen (H^+) (carried as NADPH) from

the light independent stage to form the glucose molecule as well as oxygen. The ATP produced from the light dependent stage is used to 'drive' this reaction. As the carbon and oxygen needed to produce a glucose molecule ($C_6H_{12}O_6$) are derived from a carbon dioxide molecule. This process occurs in the Stroma of the chloroplast and is catalysed by the RuBisCO enzyme. Shade leaves and sun leaves have different adaptations to ensure that they are best suited to there different environments as shade leaves are often found on plants that grow in shady environments and sun leaves are found on plants that mainly live in areas of high exposure to the sun, (shady areas - (Low exposure to sun). Shade leaves can be up to five times more efficient at capturing and using the same amount of sunlight sun leaves are exposed to because of certain adaptations for example having more number of chloroplasts, this means that the shade leaf is able to maximise photosynthesis, hence glucose production as chloroplasts are the site of photosynthesis. The reason why shade leaves have more chloroplasts than sun leaves is to maximise sunlight absorption as shady leaves will be exposed to lower levels of sunlight therefore by having more chloroplasts, therefore more thylakoids to maximise sunlight absorption, hence photosynthesis as sunlight is essential during the light dependent stage as it is used by chlorophyll to split the glucose into hydrogen (H^+) and oxygen to then be used in the light independent (H^+ only) to join with carbon dioxide to form a glucose molecule. Shade leaves are generally larger than sun leaves, this is to allow more space for all the extra chloroplasts but mainly to maximise sunlight absorption as by increasing the surface area on the leaves, more parts of the leaf are in contact with the sunlight therefore allowing the plant to capture more sunlight for the light independent stage to split more water molecules producing more H^+ and releasing more ATP to drive the light independent reaction therefore producing more glucose (increases photosynthetic rate) because sunlight absorption has more thylakoids (from increased number of chloroplasts) are in contact with the sunlight (larger leaf surface area) maximises photosynthesis. While the leaves are definitely larger they are also thinner, this thin structure is to allow the leaves to maximise surface area by decreasing volume (high SA:V ratio) and thus

structure also supports very 'spread out' leaves. Shade leaves would lose more water than sun leaves if they are placed under the same environmental conditions. This is due to the larger surface area and high number of chloroplasts because the shade leaves have adapted to carry out photosynthesis / absorb light as optimally as possible if they are placed in the same conditions as sun leaves (which are better suited to high light intensity, therefore don't need to have very high surface area and number of chloroplasts. The reason the shade plants will lose water if in same conditions as sun leaves (more sunlight) is because the light dependent will happen too quickly and therefore water will be lost due to evaporation. Therefore leaf structure and size, number of chloroplasts within the plant's leave cells can be influenced by the environmental conditions the plant is placed under. (Light availability)

QUESTION THREE: Cell division

In both plants and animals, cells undergo a cycle of growth, followed by division.



Cell surface area to volume ratio.

Evaluate the impact of changes in the surface area to volume ratio on the diffusion process, and why changes in this ratio may trigger cell division.

In your answer, include discussion of:

- the process of diffusion and its role in cellular activities ✓
- how and why the surface area to volume ratio undergoes changes during the growth of a cell ✓
- how the surface area to volume ratio influences the movement of substances into and out of the cell ✓
- the relationship between the surface area to volume ratio, diffusion, and the initiation of cell division, giving examples of when cell division rates are high in both plants and animals. ✓

Diffusion is a type of passive transport in which cells are moved across the cell membrane (phospholipid bilayer) down the concentration gradient (from an area of high concentration of that specific substance/molecule to an area of low concentration. Only small, non-polar molecules can diffuse freely across the phospholipid bilayer as polar molecules, the charges will be repelled by the hydrophobic tails of the lipids on the interior of the phospholipid bilayer, these larger polar molecules need the help of a protein pump/ channel protein to diffuse. Diffusion is very important for cellular activities as the molecules are moved across the membrane to be used in reactions/processes or move out the cell as they are excreted. Therefore have a very important role in cellular activities. During the growth of the cell

We know that the surface Area to volume (SA:V) ratio undergoes changes such as during mitosis the cell will increase its size therefore decreasing the (SA:V) ratio of the cell prepares to be split creating two identical new cells, the cell must grow in order to ensure that the two cells being produced are large enough to survive. The surface Area to volume ratio (SA:V) plays a very important role in the movement of substances in to and out of the cell (diffusion) as cells with a high SA:V ratio will be able to diffuse substances easily as higher surface area and paired with the lower volume, the transport of materials to the centre of the cell is a lot easier than a cell with a very low SA:V ratio as cells with a high SA:V ratio, the substances have to travel a much smaller distance to the centre of the cell whereas cells with a low SA:V ratio there is lower surface area to diffuse across and the distance to the centre of the cell is much greater therefore cells with a low surface area and high volume are inefficient at transporting substances into and out of the cell, whereas cells with a high surface area and a low volume will be far more efficient at transporting substances. Looking at diagram 1 µm cell has much higher SA:V ratio than 4 µm cell and will therefore be more efficient at transporting materials in or out of the cell. Surface area to volume ratio, diffusion and the initiation of cell division are all interconnected as when the surface area to volume ratio of the cell is high the diffusion rates will be higher (higher surface area) and therefore the rate of cell division in both plant and animal cells will be low as this process would have just occured. Whereas when the surface area to volume ratios of the cell are low, the rate of diffusion will be low as due to decreased surface area paired with high volume the cell is very inefficient at diffusion however the rate of cell division will be high in both plant and animal cells as this signals to the plant/animal that cell division (mitosis) must occur as the cell is both ready and must maintain a high surface area to volume ratio by mitosis as cells simply cannot just get bigger for growth during mitosis. By maintaing a high surface area to volume ratio the rates of diffusion within the cell will be higher. Mitosis is a type of cell division which produces two identical new cells for the purpose of growth and repair/replace damaged tissues within a cell.

Excellence

Subject: Biology

Standard: 91156

Total score: 22

Q	Grade score	Marker commentary
One	E7	The advantages and disadvantages of aerobic and anaerobic respiration are explained thoroughly, with contrasts and comparisons made between the two types of respiration.
Two	E8	Both light-dependent and light-independent phases of photosynthesis are explained thoroughly, including locations, connections between the two phases, and steps involved, making links to the availability of light, the process of photosynthesis, and the context of the question. Comparisons are made between sun leaves and shade leaves, linking to the phases of photosynthesis, chloroplast size and number, and the context of the question.
Three	E7	The process of diffusion is described, and the purpose of diffusion is explained. It connects the decrease of surface area to volume ratio to cell growth and rate of diffusion, and the transport of material is linked to cell function, without using specific examples of increased rates of cell division.