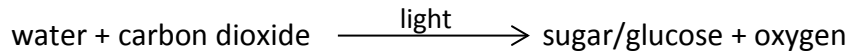


Demonstrate understanding of life processes at the cellular level.

Cell Organelles and Transport

Answers

(2014:2)



Photosynthesis occurs in plants / chloroplasts, and is a chemical reaction that splits water molecules into hydrogen and oxygen. Carbon dioxide is joined to the hydrogen to form glucose. The excess oxygen is released as by-product.

The amount of water or CO₂ available to the plant will affect the rate of photosynthesis. If the plant does not have enough water, the plant will be deprived of H or CO₂(so will be unable to construct a glucose molecule), and thus lower photosynthesis rate.

Increased amount of CO₂ will increase the rate of photosynthesis to a certain limit, after which a further increase in its amount will no longer increase the rate any further. This is when the other factors necessary for photosynthesis, such as light, become “limiting factors”; that is, those other factors also need to increase to bring about a further increase in the rate.

The rate of photosynthesis will always correspond to the factor which is in least supply.

Other factors that affect the rate are light intensity / availability / quality, wave length of light, amount of chlorophyll / chloroplast number, temperature, enzyme concentration, nutrients.

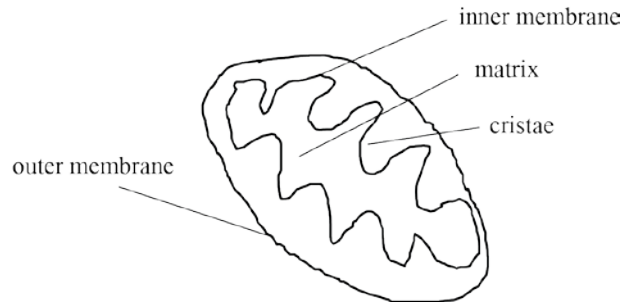
Examples, but could discuss other factors:

- Generally warmer temperatures are better than cooler temperatures for photosynthesis. This means enzymes can collide more with substrates and more chemical reactions can occur. However, if the temperature increases too much, the enzyme may denature, resulting in the active site changing shape (no longer fitting the substrate), in which case the chemical reactions would stop, and photosynthesis rate decrease / stop.
- Different intensities of light provide different amounts of energy / photons.
- Different wavelengths / colours of light provide different amounts of energy / photons. Least energy from Green light as it is reflected.
- Plant nutrient exposure will affect the production of enzymes. As amino acids are required for enzyme construction / protein synthesis, if essential amino acids are not taken up by the plant, the plant may not be able to construct the enzymes necessary for photosynthesis to occur (thus decreasing the plants rate of photosynthesis). As well as this, the amount of nutrients, such as potassium and nitrates, also affects the rate of photosynthesis. These nutrients could be used by enzymes as co-factors. If the co-factors / nutrients are limited, this would limit chemical reactions and the rate of photosynthesis.

● BIOLOGY

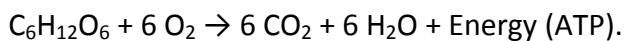
(2014:3)

(a)



(b) Aerobic respiration takes place in mitochondria. Glucose + oxygen → carbon dioxide + water

(Can also state the reactants and products in a non-balanced chemical equation.)



(May mention that fats and proteins can also be consumed as reactants.)

Glucose is consumed by animals or made by plants. Glucose molecule is broken down and reacts with oxygen (inhaled) to form ATP / energy. Water and carbon dioxide are by-products of the reaction.

Stages of respiration include Glycolysis, where Glucose is broken down, the Krebs Cycle where CO₂ is produced / hydrogen is produced and the electron transport chain where Hydrogen is used to make ATP.

The purpose of respiration is to release energy from food. Energy is needed for metabolism, growth, movement, and reproduction.

Examples from table – why different numbers of mitochondria are found in different cells:

Red blood cells do not contain mitochondria because they have **very low (do not require) energy requirements** as they only carry out passive processes / transporting O₂ / diffusion, OR do not carry out active ones, (such as DNA replication, cell division etc). (Red blood cells derive energy via glycolysis, which occurs in the cytoplasm.)

Skin cells have a couple of hundred mitochondria because they need to divide often. They are not involved in movement, so **do not require large amounts of energy**.

Liver cells contain 1000–2000 mitochondria because the liver is the involved in digestion / toxin removal which **requires a lot of energy**, therefore requires large numbers of mitochondria.

The heart muscle contains 5000+ mitochondria because it is constantly moving / contracting throughout a person's life. Movement **requires lots of energy**. The heart muscle pumps blood to every organ around the body, therefore it is very important it never stops.

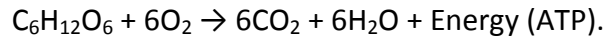
The number of mitochondria in a cell varies widely by organism and tissue type. Red blood cells do not have mitochondria, whereas muscle cells contain up to several thousand mitochondria. Variation in number is related to the energy requirements of the particular cells. The higher the energy demand, the greater the number of mitochondria.

● BIOLOGY

(2013:1)

The purpose of aerobic respiration is to release energy from food. It is needed for metabolism, growth, movement and other cellular processes.

Definition may be given as: 'To convert biochemical energy from nutrients into useable energy (ATP) and then release waste products.'



(May mention that fats and proteins can also be consumed as reactants.)

Aerobic respiration takes place in **mitochondria**.

Mitochondria have an outer membrane, which regulates the passage of materials in and out of the organelle.

The inner mitochondrial membrane is compartmentalised into numerous cristae, which expands its surface area, thereby enhancing its ability to produce ATP. Mitochondria from cells that have a greater demand for ATP, such as muscle cells, contain even more cristae.

The matrix is the fluid-filled space enclosed by the inner membrane, containing many enzymes, which can function on the large surface area created by the cristae.

The number of mitochondria in a cell varies widely by organism and tissue type. There are more in animal cells than plant cells. Many cells have only a single mitochondrion, whereas others can contain many more (muscles, glands, etc), even up to several thousand mitochondria (e.g. liver cells). Variation in number is related to the energy requirements of the particular cells. The higher the energy demand, the greater the number of mitochondria.

(2013:2(b))

The epidermis is usually transparent (epidermal cells lack chloroplasts) and coated on the outer side with a waxy cuticle that prevents water loss which would decrease the rate of photosynthesis.

The location of cells containing most chloroplasts are found near the top of the leaf in (palisade) long cylindrical cells, with the chloroplasts close to the walls of the cell. These factors combine and lead to more light being received where it can be used to maximize the rate of photosynthesis.

The slight separation of the cells provides maximum absorption of carbon dioxide.

Beneath the palisade layer is the spongy mesophyll. The cells of the spongy layer are more rounded and not so tightly packed. There are large intercellular air spaces. This maximizes the rate of diffusion of the gases during photosynthesis. (CO₂ entering the leaf and O₂ leaving it.)

Specialised guard cells, mainly on the lower leaf epidermis, function to control the movement of gases and water loss.

Chloroplast, as the organelle associated with photosynthesis and their structure also maximises the rate at which it can occur: flat stacks of thylakoids have an increased surface area for the absorption of light.

Stroma is a clear fluid, which doesn't block the light.

Chloroplasts have thin membranes/large surface area for absorption of light.

The combination of the cell and organelle structure and location collectively helps to keep photosynthesis at its maximum potential rate.

● BIOLOGY

(2011:1)

Describes the functions of both mitochondria (cellular respiration) and chloroplasts (photosynthesis) appropriately, giving detail of the basic processes for each one.

Explains how the structures of the organelles allow them to carry out their function, referring to at least two named structures in each case.

Compares and contrasts the two organelles to identify the similarities and differences in their structure, location, and number, and gives reasons for these.

Mitochondria

- Double membrane of mitochondria with the 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 materials of the reactants and the products of respiration and therefore allows increased reactions to proceed in contact with the cristae.
- Outer membrane is semi-permeable to allow the passage of smaller molecules from one side to the other. This ensures that reactants and products can be easily transported and used as required

Chloroplasts

- 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 disk-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.

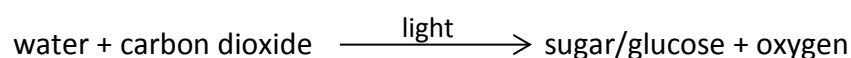
Chloroplasts are only found in plant cells (and some eukaryotic organisms). This is because they are only found in autotrophic organisms, those that can manufacture their own energy source. Chloroplasts are usually found in the upper parts of leaves in the highest density. This maximises the ability 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 the mitochondria, the chloroplast also increases the surface area available for chemical reaction by having increased membrane space. While the mitochondria achieves this by in-foldings of the inner membrane (cristae), the chloroplasts has stacks of thylakoid membranes called grana.

(2010:1)

Photosynthesis is the process used to convert light energy into chemical energy / glucose / food.



Reasons for the 3 organelles presence in the Euglena

- the eye spot detects the (direction) light and the flagellum moves the Euglena towards it.
- the flagellum moves the Euglena towards the light so that the chloroplast can absorb light to carry out photosynthesis.

● BIOLOGY

- the chloroplast contains chlorophyll which absorbs light for the process of photosynthesis to make glucose.
- the flagellum moves Euglena around until eye spot detects light.

Links the roles of the organelles working together and links them to photosynthesis.

E.g. The eye spot detects the (direction of) light and the flagellum moves the Euglena towards it. This means that the chloroplast is fully exposed to the available light. Chlorophyll in the chloroplast is then used in photosynthesis to produce glucose.

(2010:3)

- (a) Reasonable description of the structure (bilayer of phospholipids / phosphate heads and fatty acid tails / phosphates with lipids) - an appropriately annotated diagram is acceptable – must be a bilayer with phospholipids / lipids labelled.
Function of the cell membrane - is a semipermeable barrier, controlling the movement of substances in and out of cells (Also acceptable are: selectively permeable, partially permeable differentially permeable).
- (b) Organelles require different substances to carry out their role. The membrane controls the passage of molecules into and out of the organelle for its specific functioning. The membrane also allows the organelle to remain separate / intact from the rest of the cell so that it can perform its specific function / e.g. carbon dioxide / water enters chloroplast for photosynthesis / oxygen / pyruvic acid enters mitochondrion for respiration.
- (c) Active transport is the movement of molecules against the concentration gradient (low to high concentration) therefore requiring ATP energy. Osmosis is the movement of water across a semi-permeable membrane with a concentration gradient. Energy is required for active transport because the movement is against the concentration gradient / of large molecules. Osmosis is the movement of water across a semipermeable membrane with a concentration gradient so energy is not required.
Osmosis occurs in living organisms such as paramecium living in fresh water environments where water comes inside the cells because of the concentration gradient. To get rid of the excess water, and to avoid bursting of the cell the contractile vacuole collects and expels this water through the radiating channels. This requires energy as it is going against the concentration gradient.