science

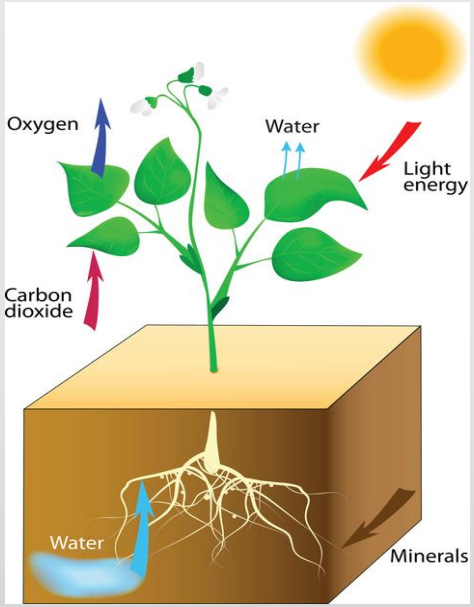
biology

GCSE B4 – Bioenergetics

1) Photosynthesis:

Carbon dioxide	+	Water	→	Glucose	+	Oxygen
$6CO_2$	+	$6H_2O$	→	$C_6H_{12}O_6$	+	$6O_2$

The plant manufactures glucose from carbon dioxide and water using energy transferred from the environment to the chloroplasts by light



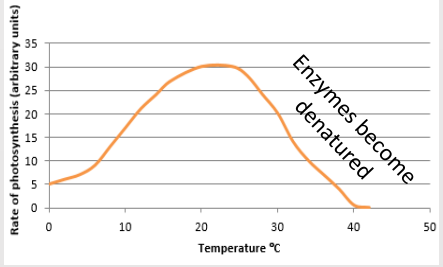
Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)

Plants use the glucose produced in photosynthesis in a variety of ways

Respiration, stored as insoluble starch, fats or oils for storage, cellulose for cell walls, combine with nitrates from the soil to form amino acids for protein synthesis

The rate of photosynthesis is affected by temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll

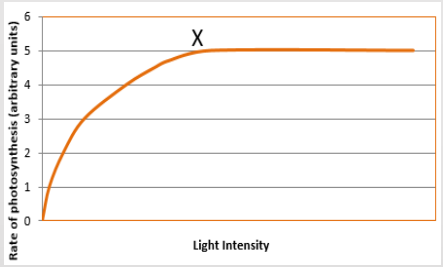
2) Rate of Photosynthesis:



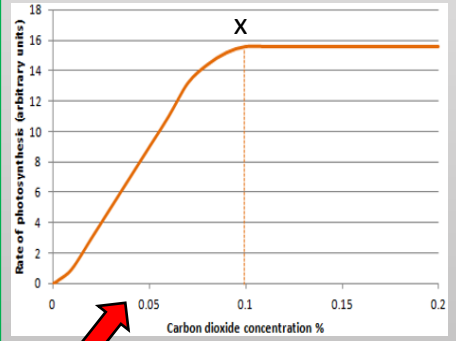
As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.

Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the **enzymes** become **denatured** and the rate of reaction will decrease and stop

As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.



At point **X** another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll



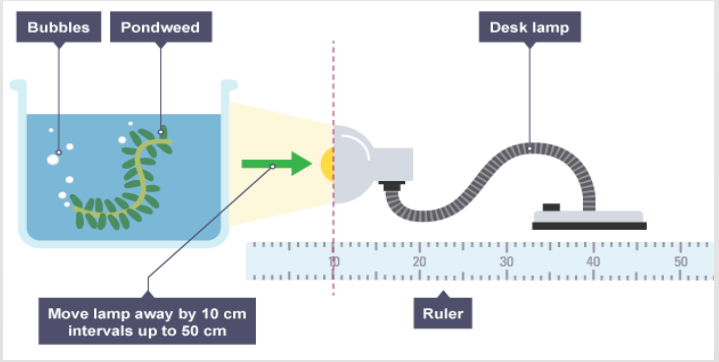
The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).

At point **X** another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll

3) Required Practical – effect of light intensity on the rate of photosynthesis

Sodium carbonate solution (to provide CO_2 for photosynthesis)

- Solution should be kept at a constant temperature – use an LED bulb to minimise heat from the lamp
- Give the pond weed a minute to acclimate to the environment before counting the bubbles of oxygen that are made per minute.
- Move the lamp 10cm further away and repeat
- The closer the light, the more oxygen is made because the rate of photosynthesis increases.



HT ONLY: Light intensity obeys the inverse square law. This means that if you double the distance between the plant and the light source you quarter the light intensity

4) HT Only: Greenhouses and increased crop yield

Heating	Used to provide optimum temperatures for maximum plant growth.
Artificial lighting	Enhances the natural sunlight especially overnight and on cloudy days.
Extra carbon dioxide	Gas can be pumped into the air inside the greenhouse.

Growers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.

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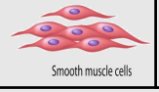
5) Cellular respiration:

Exothermic reaction continuously occurring in living cells. The **energy released** by the **mitochondria** supplies all the energy needed for **living processes**.

Organisms need energy for:

For movement	 Smooth muscle cells	To enable muscles to contract in animals.
For keeping warm		To keep a steady body temperature in a cold environment.
For chemical reactions		To build larger molecules from smaller one.

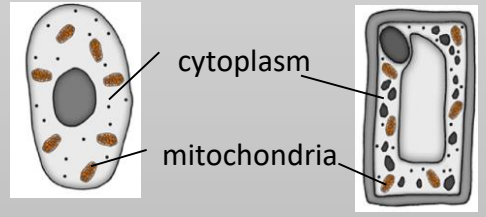
Aerobic:

- Needs oxygen
- Releases a lot of energy

Glucose + Oxygen → Carbon Dioxide + Water

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Respiration with oxygen. Occurs inside the mitochondria continuously. Glucose is oxidised by oxygen to transfer the energy the organism needs to perform it's functions.



animal cell **plant cell**

6) Anaerobic respiration:

- No oxygen
- Leads to oxygen debt
- Very little energy is released

Lactic acid is toxic to cells causing cramp and muscle fatigue. It is broken down by repaying the **O_2 debt** (breathing heavily after exercise)

Glucose → Lactic acid

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$

7) Anaerobic respiration in plant and yeast cells

The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation

glucose ⟶ ethanol + carbon dioxide

This process is economically important in the manufacture of alcoholic drinks and bread.



8) Exercise: During exercise the human body reacts to increased demand for energy

Heart rate increases: Top pump oxygenated blood faster to the muscle tissues and cells.

Breathing rate and breath volume increase: This increases the amount of oxygen entering the blood stream.

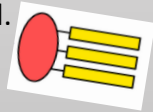
HT ONLY: The extra amount of oxygen required to remove all lactic acids from cells is called the oxygen debt

Lactic acid builds up in the muscles cells during exercise → Blood flows through the muscle cells and transports the lactic acid to the liver → The liver oxidises the lactic acid and converts it back to glucose

9) Metabolism: The sum of all the reactions in a cell or the body

The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.

- **Conversion** of glucose to starch, glycogen and cellulose.
- The **formation** of lipid molecules from a molecule of glycerol and three molecules of fatty acid.



- The use of glucose and nitrate ions to **form** amino acids which in turn are used to **synthesise** proteins.
- Respiration
- **Breakdown** of excess proteins to form urea for excretion.

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