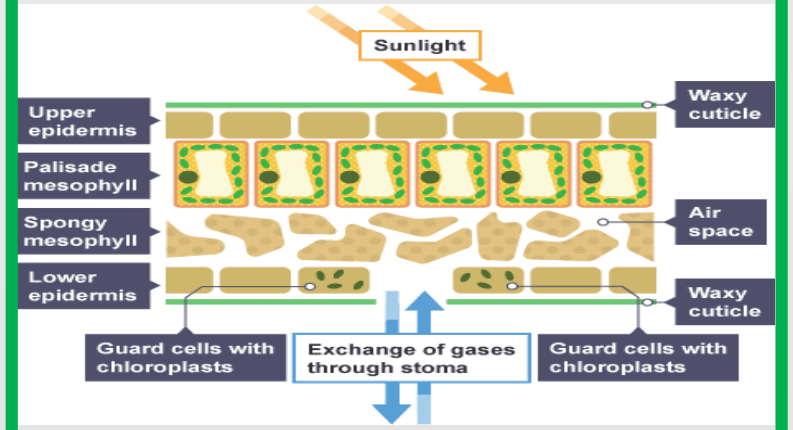
science biology

GCSE B4 – Bioenergetics

Photosynthesis:

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

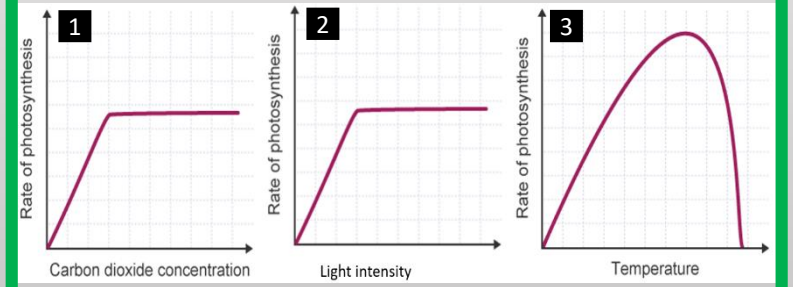
Light and **chlorophyll** are needed to power the reaction.



Uses of glucose:
*Respiration – energy for growth
*Starch – storage
*Making amino acids (for proteins)
*Making fats (stored in seeds)
*Making cellulose (cell walls)

Leaves are adapted to maximize photosynthesis:
Many chloroplasts
Large surface area
Wax cuticle minimizes water loss
Gases diffuse through stomata

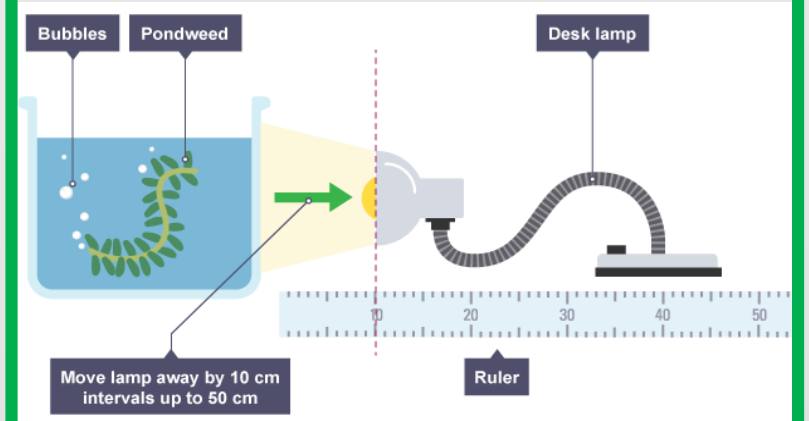
Limiting Factors: carbon dioxide, light & temperature



1. As CO_2 increases, so does the rate until the optimum point when the rate levels off – why? light or temperature are limiting the rate.
2. As light increases, so does the rate until the optimum point when the rate levels off – why? CO_2 or temperature are limiting the rate.
3. As temperature increases, so does the rate until the optimum point when the rate decreases to zero - why? temperature increases the number of collisions until it gets too hot and enzymes denature.

PRACTICAL – EFFECT OF LIGHT ON 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.



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:
• chemical reactions to build larger molecules
• movement
• keeping warm

Aerobic:
- Needs oxygen
- Releases a lot of energy

Glucose + Oxygen → Carbon Dioxide + Water + E

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

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

Glucose → Lactic acid + e

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$

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)

Exercise:

- Heart rate increases: increased blood flow = more oxygen and glucose to muscles = more respiration = more energy for muscle contraction. Also more CO_2 and water removed to the lungs.
- Breathing rate increases = more gas exchange (oxygen into blood and CO_2 and water out of the blood)
- Stored glycogen in muscle broken down into glucose for respiration

Metabolic Rate: The speed of chemical reactions in the body.
A faster metabolic rate = energy released and used more quickly
Metabolism is faster if you are male, young have more muscle mass and may have a genetic link.

Metabolic reactions:

Catabolic reactions (big → smaller molecules)	Anabolic reactions (small → bigger molecules)
*Respiration *Enzymes breaking down food *Break down of proteins to urea in **liver**	*Photosynthesis *Conversion of glucose to starch, cellulose or glycogen *Combining glucose and nitrates to make amino acids and then protein *Fat formation

Anabolic reactions require **energy** from cellular respiration.

Anaerobic respiration in plant and yeast cells:

Glucose → ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called **fermentation** and has economic importance in the manufacture of **bread** and **alcoholic** drinks.
CO_2 bubbles make bread rise
Ethanol makes grape juice alcoholic (wine)

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