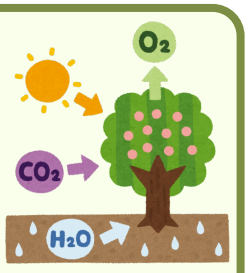
Photosynthetic reaction:

Equation:

Carbon dioxide + Water —(Light)→ Glucose + Oxygen

$$6CO_2 + 6H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6O_2$$

Photosynthesis is an endothermic reaction.



Energy transfers from the environment to the chloroplasts by light.

Glucose produced by photosynthesis can be used in a variety of ways

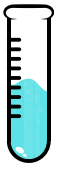
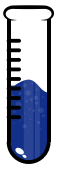
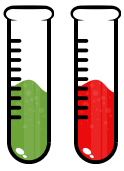
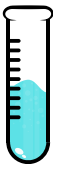
Uses of glucose

- Used in respiration to release energy
- Produce cellulose to strengthen cell walls
- Stored as fat or oil
- Converted into insoluble starch for storage
- Produce amino acids for protein synthesis
  - Nitrate ions from the soil are combined with glucose to produce amino acids

Leaves or foods may be tested for:

- glucose
- starch
- protein

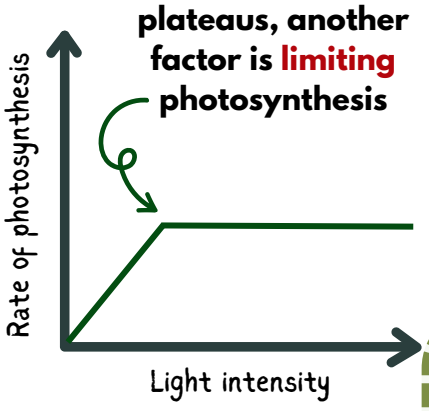
Food tests:

Test	Positive	Negative
Protein Biuret solution	 Purple	 Blue
Starch Iodine reagent	 Blue / Black	 Orange / Brown
Glucose Benedict's reagent	 Green to red	 Blue

B4.1 Photosynthesis

Rate of photosynthesis:

The rate of photosynthesis is affected by a number of factors



1. Light intensity

- Generally, as light intensity increases, the rate of photosynthesis increases

2. Carbon dioxide concentration

- As carbon dioxide concentration increases, the rate of photosynthesis increases, as carbon dioxide is a reactant

3. Temperature

- As temperature increases, the rate of photosynthesis increases, until a point.
- As the reaction is controlled by enzymes, they denature at high temperatures and the rate will decrease.

4. Amount of chlorophyll

- Due to chlorophyll absorbing light energy, a reduction in chlorophyll will decrease the rate of photosynthesis.

Investigating the effect of light intensity on photosynthesis

Aquatic plants like pondweed can be used to investigate the rate of photosynthesis under different conditions.

- Pondweed is placed in a test tube of sodium hydrogen carbonate.
- A lamp is set at a range of distances from the test tube.
- Light intensity is proportional to distance
- Bubbles of oxygen are produced and counted over a set period of time.

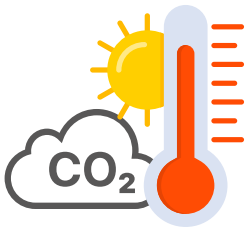
Temperature can be controlled using a water bath or beaker

Rate of photosynthesis continued:

Limiting factors:

Factors do not work separately, they can interact, with any one being the limiting factor.

Temperature and carbon dioxide can interact with the effect of light intensity



- Photosynthesis increases, then factors become limiting
- Increasing carbon dioxide concentration, further increases the rate of photosynthesis, until another factor becomes limiting
- Increasing temperature further increases photosynthesis, until another factor becomes limiting
- At point A, temperature is limiting photosynthesis

B4.1 Photosynthesis continued

Importance of limiting factors

When factors limit photosynthesis, they reduce crop yields.

Farmers can enhance conditions in greenhouses, to achieve maximum photosynthesis.

The cost effectiveness of conditions must be considered to also maintain profits.

How to enhance factors:

Light	• Artificial lighting system • Glass greenhouse maxises light transmission • Position plants for maximum absorption
Carbon dioxide	• Paraffin heaters • Apply liquid carbon dioxide • Grow fungi
Temperature	• Glass greenhouse increases temperature • Shades and ventilation for cooling
Water	• Irrigation systems • Hydroponics - grow plants in liquid

Inverse proportions:

Distance and light intensity are inversely proportional to each other.
This is because as one increases, the other decreases.

Inverse square law:
Light intensity actually decreases in proportion to the square of distance.

$$\text{Light intensity} \propto \frac{1}{\text{distance}^2}$$

Use this formula to calculate light intensity when investigating photosynthesis with pondweed.

This means when a lamp is moved 2 metres from the plant, its light intensity is 1/4 the original intensity.