4.4 Bioenergetics

Photosynthesis

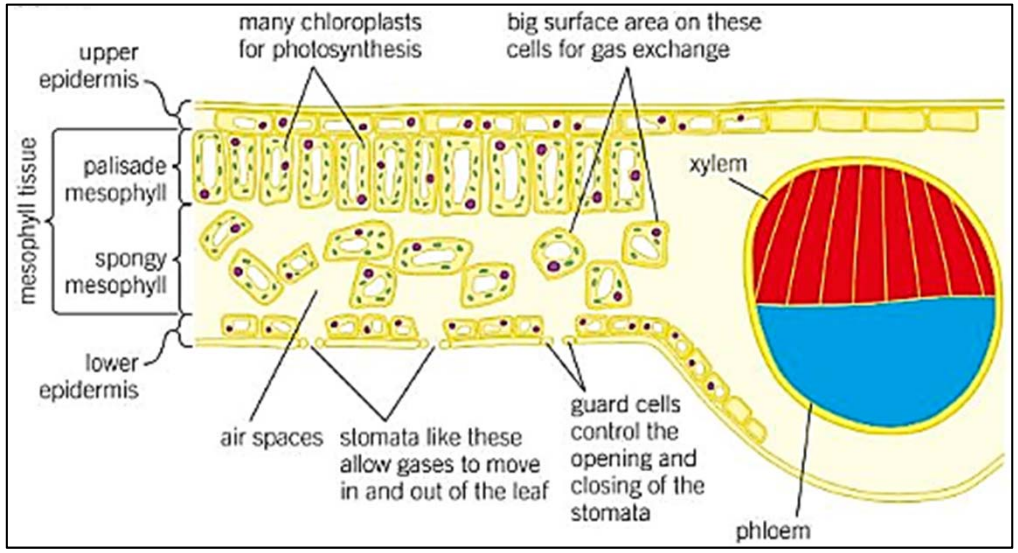
Carbon Dioxide + Water → Glucose + Oxygen

$6CO_{2\ (g)} + 6H_2O_{\ (l)} \rightarrow C_6H_{12}O_{6\ (s)} + 6O_{2\ (g)}$

Testing for Starch

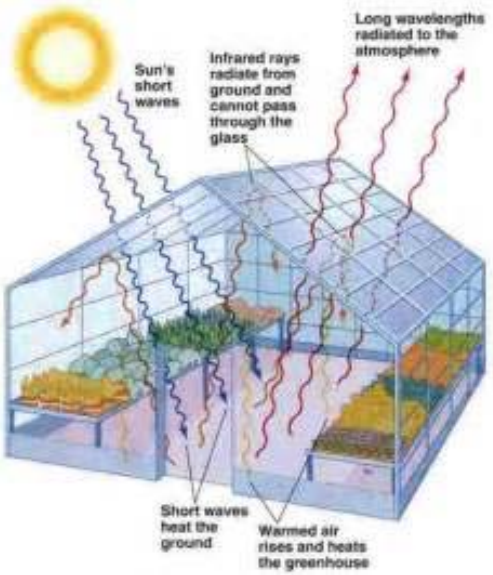
Iodine solution will turn from brown to blue/black in colour.

Leaf Adaptations	
Structure	**Function**
Broad leaf	Large surface area for absorbing light.
Thin leaves	Gases have less distance to travel into the leaf (short **diffusion** distance).
Chloroplasts (containing chlorophyll)	**Chlorophyll** absorbs light for use in **photosynthesis**. **Photosynthesis** takes place in the **chloroplast**.
Veins	Water bought to the leaf in **xyle**m. Products of photosynthesis taken away in **phloem**.
Air spaces	To allow **diffusion** of gases in an out of **palisade** cells.
Guard cells	Open and close **stomata**.



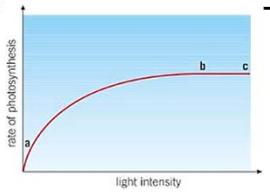
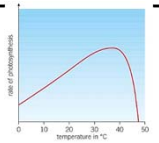
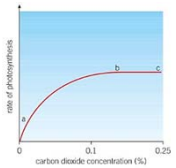
Glucose is….
…used for respiration.
…converted into insoluble starch for storage.
…used to produce fat or oil for storage.
…used to produce cellulose, to strengthen the cell wall.
…used to produce amino acids for protein synthesis.

Maximising Photosynthesis: Greenhouses ensure nothing is a limiting factor to photosynthesis. A **limiting factor** is something which slows down the rate of photosynthesis, such as temperature, light intensity, carbon dioxide concentration and water. **Additional** lighting heat and CO_2 are often provided to enhance growth.



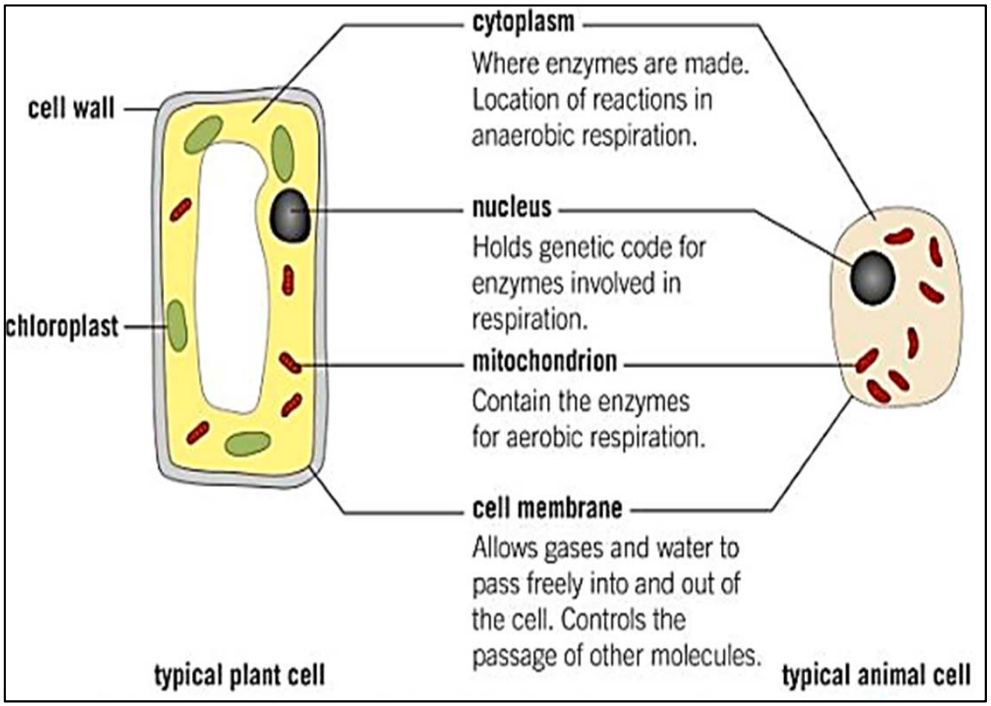
Inverse Square Law

Doubling the distance between light and the plant makes light intensity decrease by a quarter.

Photosynthesis Limitting Factor	**Effect on Rate**
Light 	Increasing light intensity increases the rate of photosynthesis (a) until it reaches its optimum rate (b). Beyond this (c) any further increase in light intensity does not increase the rate further. Another factor, e.g. temperature is limiting the rate.
Temperature 	Increasing the temperature increases the rate of photosynthesis until it reaches its optimum rate. Beyond this enzymes become denatured and the rate decreases.
Carbon Dioxide Concentration 	Increasing the rate of carbon dioxide concentration increases the rate of photosynthesis (a) until it reaches its optimum rate (b). Beyond this (c) any further increase in carbon dioxide concentration does not increase the rate.
Chlorophyll Level	The less chlorophyll there is in a leaf the lower the rate of photosynthesis. Levels of chlorophyll are often limited by the amount of minerals

Aerobic Respiration (With Oxygen)
Glucose + Oxygen → Carbon Dioxide + Water
$C_6H_{12}O_{6\ (s)} + 6O_{2\ (g)} \rightarrow 6CO_{2\ (g)} + 6H_2O_{(l)}$

Anaerobic Respiration (Without Oxygen)
(In animals) is: Glucose → Lactic Acid
(In plant and yeast cells) is: Glucose → Ethanol + Carbon Dioxide

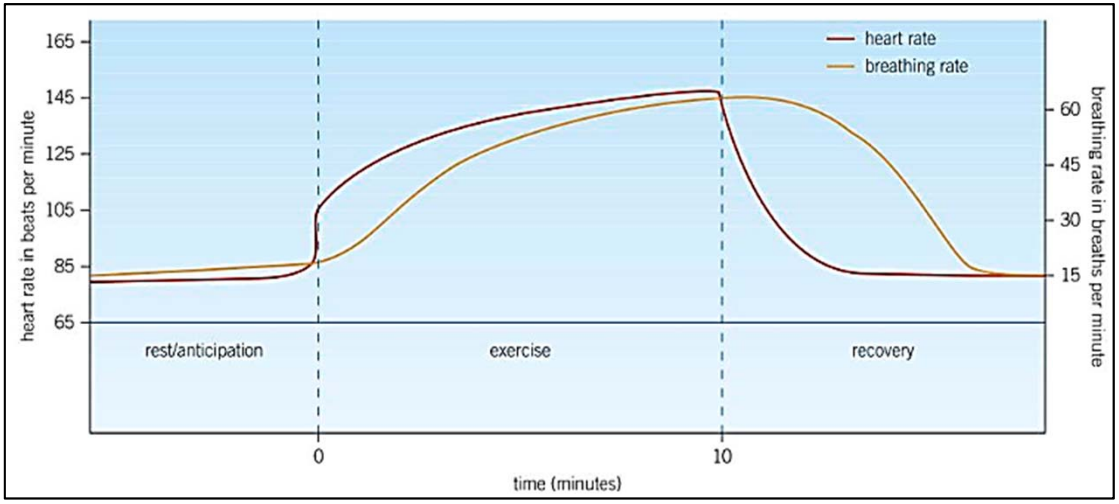


Oxygen Debt
When we respire anaerobically we build up lactic acid. This causes muscle fatigue (tiredness). When you stop exercising your breathing rate remains high for a while as you need extra oxygen to break down the lactic acid.

Fitness
The fitter a person is the quicker they can supply more oxygen to cells to break down the lactic acid. Fitter people have a lower resting heart rate and can get their breathing rate and heart rate down to their resting rate quicker than an unfit person.

Metabolism is the sum of all the reactions in a cell or the body. It includes….
…conversion of glucose to starch, glycogen and cellulose.
…formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids.
….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.

We need respiration to…
…build large molecules from small ones.
…keep warm.
…move muscles.
….carry out active transport of substances into cells across a cell membrane against a concentration gradient.



When we exercise…	
…our heart rate increases…	…which pumps more oxygenated blood around the body increasing the supply of oxygen to muscle cells. It also speeds up the removal of carbon dioxide.
….our breathing rate increases…	….which increases the rate at which oxygen is absorbed into the blood and carbon dioxide removed.
….glycogen stored in muscles is converted to glucose…	….which supplies cells with more glucose to carry out respiration.