AQA B4 Bioenergetics – photosynthesis COMBINED HIGHER (page 1 of 2)

Photosynthesis

Photosynthesis is a chemical reaction that occurs in chloroplasts in plants and algae to produce glucose. It is represented by this equation:

carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen

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

Photosynthesis is an endothermic reaction as light energy is transferred from the environment to the chloroplasts by light.

The glucose produced in photosynthesis may be:

- Used for respiration
- Converted into insoluble starch for storage
- Used to produce fats or oils for storage
- Used to build cellulose, which strengthens plant cell walls
- Make amino acids by combining with nitrates. The amino acids are then used to build proteins.

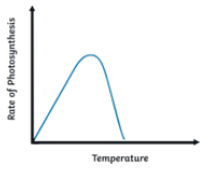
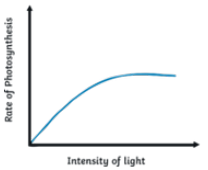
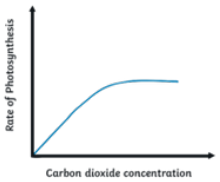
Calculating light intensity

Light intensity is related to the distance of the light from plant. This is an inverse relationship – as one increases, the other decreases.
Light intensity can be calculated using the following equation:

$$\text{INTENSITY} \propto \frac{1}{\text{DISTANCE}^2}$$

As the distance between the light and plant doubles, the light intensity quarters.

Factors affecting the rate of photosynthesis (required practical 6)

Factor	Effect on the rate of photosynthesis	Graph
temperature	Photosynthesis is controlled by an enzyme. As the temperature increases so does the rate of photosynthesis, up until a certain point. If the temperature gets too high then the enzyme will be denatured and the rate of reaction with decrease.	
light intensity	As light intensity increases so does the rate of photosynthesis, until something else becomes the limiting factor (when the graph curve flattens)	
carbon dioxide concentration	As carbon dioxide concentration increases so does the rate of photosynthesis, until something else becomes the limiting factor (when the graph curve flattens)	
amount of chlorophyll	Chlorophyll is the green pigment inside chloroplasts that absorbs light energy. The more chlorophyll a plant has, the quicker photosynthesis can occur.	

Greenhouse economics

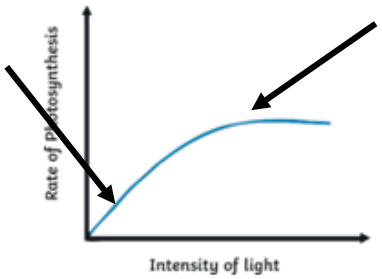
Farmers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.

Condition	How it can be controlled
temperature	Greenhouses can have heating systems installed to provide the optimum temperature for plant growth.
light	Greenhouses can have artificial lighting to ensure that plants can photosynthesise even during cloudy days or during the night.
carbon dioxide concentration	Gas can be pumped into the air inside the greenhouse to increase the carbon dioxide available for plants.

Identifying limiting factors on graphs

A limiting factor is something that is limiting the rate of photosynthesis e.g. if there isn't enough light for the reaction to occur, light is the limiting factor.

As the intensity of light increases, so does the rate of photosynthesis. This means light is the limiting factor



The graph levels out when increasing the light intensity no longer increases the rate of photosynthesis.
This means light is no longer the limiting factor. Something else is limiting the reaction such as temperature of carbon dioxide concentration.

AQA B4 Bioenergetics – respiration COMBINED HIGHER (page 2 of 2)

Respiration

Respiration is a chemical reaction that occurs in all living cells. Respiration transfers the energy needed for the processes of living things. As it releases energy to the surroundings, it is an exothermic reaction.

Organisms need energy for:
1. Chemical reactions to build large molecules
2. Movement (muscle contraction)
3. Keeping warm (respiration releases thermal energy)

Types of respiration

Type of respiration	Equation	Description
aerobic respiration	glucose + oxygen → carbon dioxide + water $C_6H_{12}O_6$ + O_2 → CO_2 + H_2O	Respiration that uses oxygen and occurs in mitochondria of cells. Releases a lot of energy
anaerobic respiration (muscles)	glucose → lactic acid	Respiration when oxygen is in short supply during intensive exercise. Releases less energy than aerobic respiration because the oxidation of glucose is incomplete in anaerobic respiration
fermentation	glucose → ethanol + carbon dioxide	Anaerobic respiration that occurs in microorganisms, e.g. yeast. It has economic importance - carbon dioxide is used to make bread rise and ethanol is used to make alcoholic drinks

Response to exercise

During exercise your body requires more energy and therefore needs to respire more. In order for more respiration to occur your cells must be supplied with more oxygen or glucose. Your body does this by responding in the following ways:

Response	Benefit
Heart rate increase	This increases the blood flow to muscles and supplies them with more oxygen and glucose. This also increases the rate that carbon dioxide is removed from muscles.
Breathing rate increases	Increases the amount of oxygen getting into your bloodstream
Breathe more deeply (breath volume increase)	Increases the amount of oxygen getting into your bloodstream
Arteries to muscles dilate	This means that arteries get wider to increases the blood flow to muscles and supply them with more oxygen and glucose.
Glycogen is converted to glucose	Supplies muscle cells with more glucose

Anaerobic respiration causes muscle fatigue

If insufficient oxygen in supplied during exercise then anaerobic respiration takes place in muscles. Anaerobic respiration causes a build up of lactic acid that causes muscles to become fatigued and causes cramp, as the muscles stop contracting efficiently. This creates an **oxygen debt**.

Oxygen debt is the amount of extra oxygen the body needs to recover after exercise to remove the lactic acid. The lactic acid is transported to the liver via the bloodstream where it reacts with oxygen and is converted back to glucose.

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

Metabolism

Metabolism is the sum of all the reactions in a cell or the body. Metabolic rate is how quickly these reactions occur.
The energy transferred by respiration in cells is used by the organism for many enzyme controlled metabolic reactions that synthesise new molecules.
Some examples of metabolic reactions include:
- Respiration
- Converting glucose to starch, cellulose or glycogen
- Forming lipids from glycerol and fatty acids
- Forming amino acids from glucose and nitrates
- Breakdown of excess proteins to form urea