B4

Photosynthesis

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

Photosynthesis is represented by the equation:
carbon dioxide + water → glucose + oxygen
$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

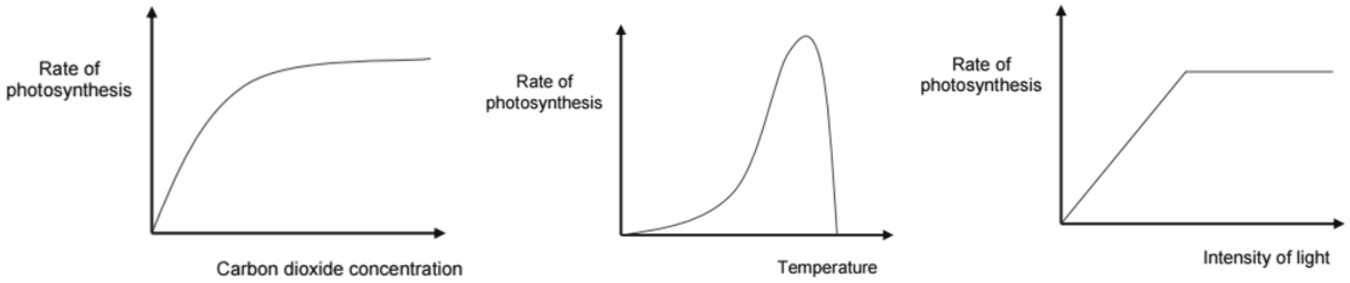
The glucose produced in photosynthesis may be:

- used for respiration
- converted into insoluble starch for storage
- used to produce fat or oil for storage
- used to produce cellulose, which strengthens the cell wall
- used to produce amino acids for protein synthesis.

(To produce proteins, plants also use nitrate ions that are absorbed from the soil.)

Rate of Photosynthesis

Temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll can all effect the rate of photosynthesis.



These factors interact and any one of them may be the factor that limits photosynthesis.

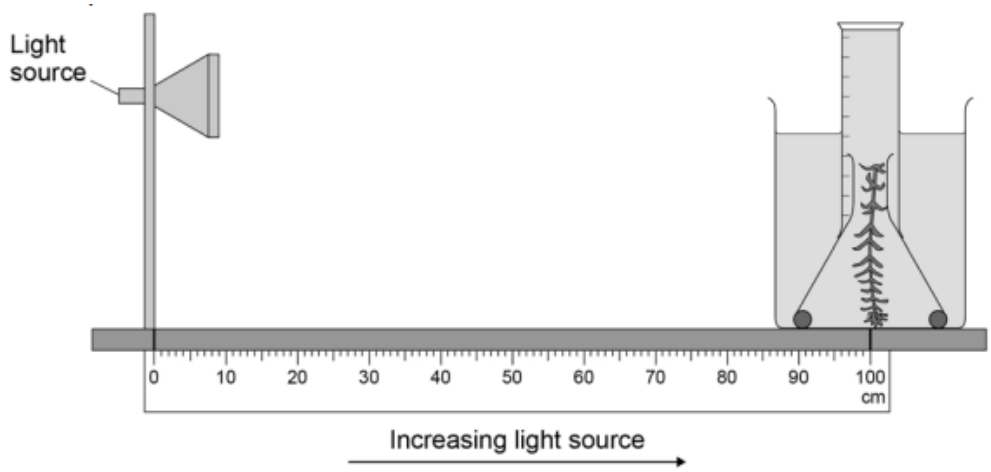
Inverse proportion: as one value goes up the other goes down, specifically as one value doubles the other value halves.

Limiting factors are important in the economics of enhancing the conditions in greenhouses to gain the maximum rate of photosynthesis while still maintaining profit.

B4 Required Practical: Rate of Photosynthesis

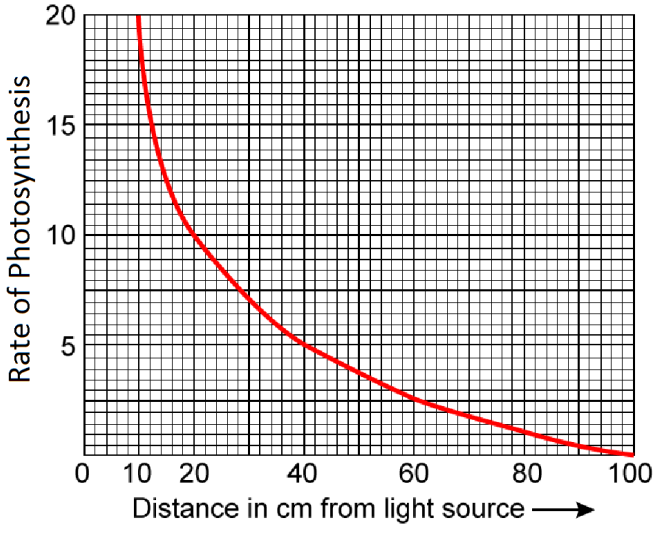
Method

1. Put your 10cm piece of pond weed (cut edge at top) into a beaker of water.
2. Cover the pondweed with an inverted filter funnel – raised off the bottom of the beaker with plasticine.
3. Fill the measuring cylinder with water and gently position as in the diagram.
4. Use the ruler to position the beaker of pondweed 1 metre away from the light source. Your experiment should look like this:



5. Start the stop watch and: a record the volume of gas produced and collected in the measuring cylinder in three minutes.
6. Move the light source so that the pondweed beaker is 80 cm away.
7. Refill the measuring cylinder with water and gently position as in the diagram. Then repeat step 5
8. Repeat for distances of 60, 40 and 20 cm.

Results: Your results will show an **inverse square law** the rate of photosynthesis will decrease by 4 every time the distance is doubled.



B4 Aerobic and Anaerobic Respiration

Cellular respiration is an exothermic reaction which is continuously occurring in living cells. The energy transferred supplies all the energy needed for living processes. Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy.

Aerobic respiration needs oxygen whereas anaerobic respiration does not. Only lactic acid is produced in anaerobic respiration whereas carbon dioxide and water are produced in aerobic respiration. More energy is transferred in aerobic respiration than anaerobic respiration as the glucose is fully broken down.

Organisms need energy for:

- chemical reactions to build larger molecules
- movement
- keeping warm.

Aerobic respiration is represented by the equation:

glucose + oxygen → carbon dioxide + water

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

Anaerobic respiration in muscles is represented by the equation:

glucose → lactic acid

As the oxidation of glucose is incomplete in anaerobic respiration much less energy is transferred than in aerobic respiration.

Anaerobic respiration in plant and yeast cells is represented by the equation:

glucose → ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks.

B4

Response to exercise

During exercise the human body reacts to the increased demand for energy. The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood.

If insufficient oxygen is supplied anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build up of lactic acid (which can cause cramp) and creates an oxygen debt.

During long periods of vigorous activity muscles become fatigued and stop contracting efficiently.

Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose.

Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.

Metabolism

Sugars, amino acids, fatty acids and glycerol are important in the synthesis (building) and breakdown of carbohydrates, proteins and lipids.

Metabolism is 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 that synthesise (build) new molecules.

Metabolism includes:

- conversion of glucose to starch, glycogen and cellulose
- the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids
- 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.