

## Bioenergetics

Below is a checklist of everything you need to know for this topic:

- |  |   |
|--|---|
|  | State the word and symbol equations for photosynthesis  |
|  | Explain why photosynthesis is an endothermic reaction   |
|  | Explain the effect of temperature, light intensity, carbon dioxide and chlorophyll levels on rate of photosynthesis |
|  | Explain the inverse square law  |
|  | Investigate the effect of light intensity on the rate of photosynthesis   |
|  | Explain why limiting factors are important in the economics of greenhouses  |
|  | State the uses of the glucose produced in photosynthesis  |
|  | State the word and symbol equations for aerobic respiration   |
|  | State the word equation for anaerobic respiration   |
|  | State why organisms need energy   |
|  | Describe the process of fermentation in yeast and how the products are useful                                       |
|  | Explain why heart and breathing rates increase with exercise  |
|  | Explain what is meant by oxygen debt  |
|  | Describe what happens to the lactic acid produced during anaerobic exercise   |
|  | Define metabolism   |
|  | Give examples of processes included in metabolism   |

### Inverse Square Law

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

As the **distance doubles**, **light intensity falls by four**

Distance	Distance <sup>2</sup> (d <sup>2</sup> )	1÷d <sup>2</sup>
5	25	0.025
10	100	0.001
20	400	0.00025

x2      ←      →      ÷4

**Improve the experiment by measuring the volume of gas** instead of counting bubbles. This is because the **bubbles appear very fast** and are all **different sizes**.

The **bubbles contain oxygen gas** which is formed during photosynthesis

### Photosynthesis

Photosynthesis takes place in the **chlorophyll**

**Word Equation:** carbon dioxide + water → glucose + oxygen + energy

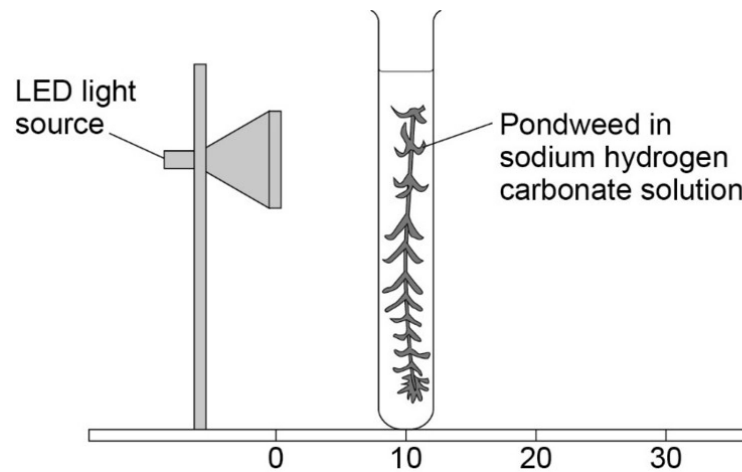
**Symbol Equation:**  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + \text{energy}$

**Uses of glucose** from photosynthesis:

- **Energy source** in respiration
- Converted in to **insoluble starch** for storage
- Produce **fats or oils** for storage
- Produce **cellulose** to **strengthen cell walls**
- Produce **amino acids** for **protein** synthesis

To produce proteins plants also use **nitrate ions** absorbed from the soil

Investigate the **effect of light intensity** on the rate of photosynthesis



**Independent Variable** (the thing you change) – The **distance** of the **lamp** from the pondweed

**Dependent variable** (the thing you measure) – The number of bubbles

**Control Variables:** Time, temperature, species of pondweed, concentration and volume of sodium hydrogen carbonate solution,

The **sodium hydrogen carbonate** acts as a **source of carbon dioxide** for the plant in order for it to be able to carry out photosynthesis

We control temperature as photosynthesis is an **enzyme controlled** reaction – at **high temperatures, enzymes denature**

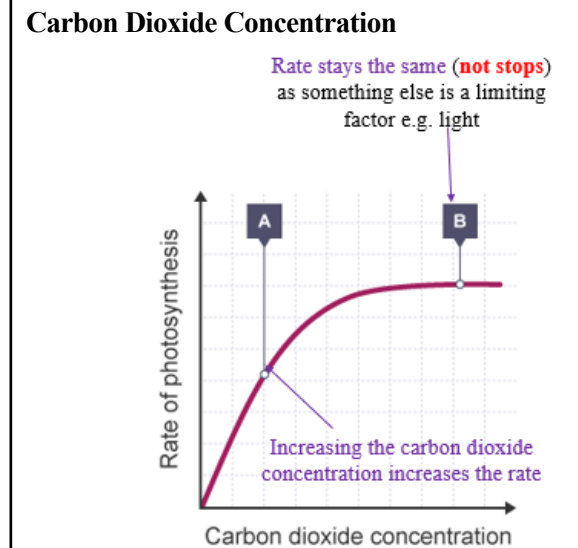
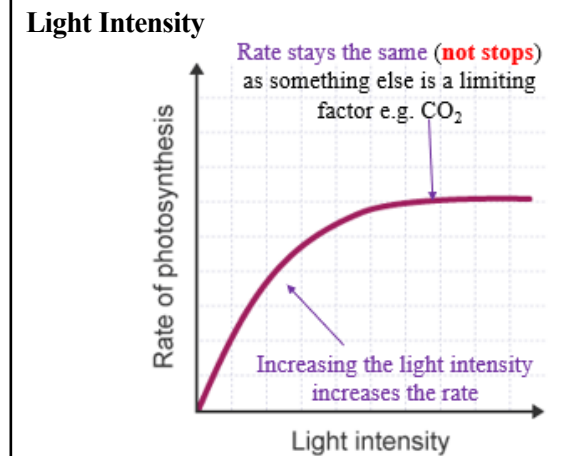
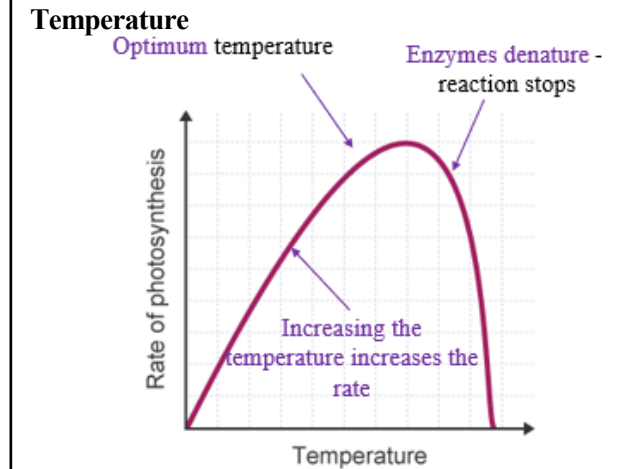
As light intensity falls, so does the rate of photosynthesis

Counting the **number of bubbles** tell us the **rate of photosynthesis**.

We **change light intensity** by **moving the lamp**

Photosynthesis is an **endothermic** reaction – **energy is transferred to the chloroplasts** from the environment by light

### Limiting Factors



Greenhouses use limiting factors to **enhance the rate of photosynthesis** but this can be **expensive**.

## Bioenergetics

### Respiration

Respiration takes place in the **mitochondria**

**Word Equation:** glucose + oxygen → carbon dioxide + water + energy

**Symbol Equation:**  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

Organisms **need energy** for:

- Chemical reactions to **build larger molecules** (e.g. proteins from amino acids)
- **Movement**
- Keeping **warm**
- Growth

### Anaerobic Respiration in Humans

glucose → lactic acid

Takes place when there is a **lack of oxygen** (e.g. during intense exercise)

**Less energy** is released compared to anaerobic respiration

### Anaerobic Respiration in Yeast and Plant Cells

glucose → ethanol + carbon dioxide

This process is known as **fermentation**

**Carbon dioxide** is useful in **baking** (to make bread rise)

**Ethanol** is used to make **wine, beers and spirits**

### Effect of Exercise

- Breathing rate **increases** to take in **more oxygen**.
- **Heart rate increases** to pump more blood to muscles. This blood contains **glucose**.
- Both of these are needed to release **more energy** for respiration

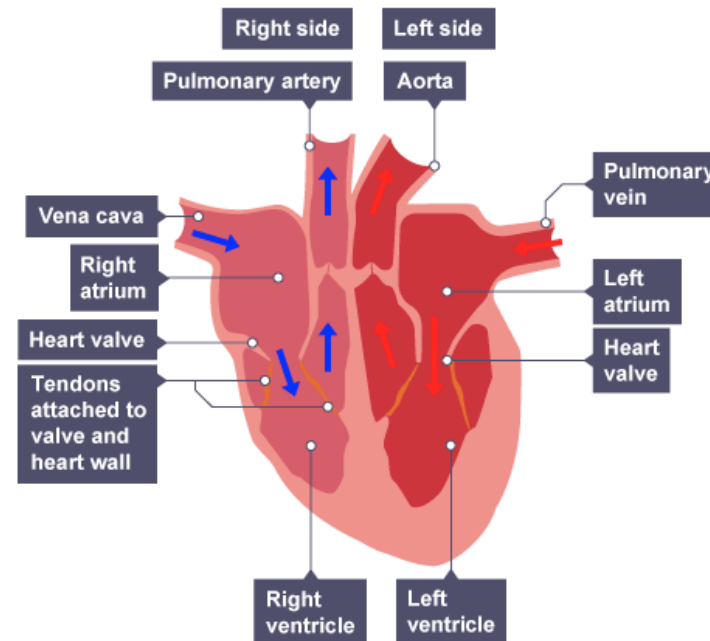
During **long periods of exercise** the muscles become **fatigued** and **stop contracting as efficiently**

Doctors **prescribe exercise** after a heart attack as it helps to **strengthen the heart muscle**

### Oxygen debt

The amount of extra oxygen needed to break down lactic acid that has built up during anaerobic exercise

Lactic acid is transported in the blood to the liver where it reacts with oxygen and is converted back in to glucose



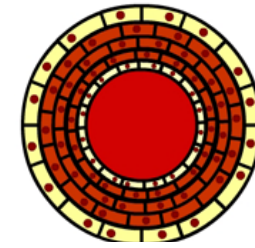
Humans have a **double circulatory system:**

- The left hand side of the heart sends blood to the body
- The right hand side of the heart sends blood to the lungs

The left hand side of the heart is thicker as:

1. It sends blood further
2. It carries oxygenated blood which flows at a higher pressure.

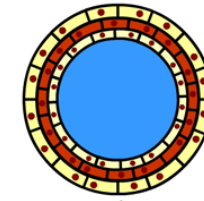
### Blood Vessels



**Artery**

Carry blood away from the heart.

- Blood is oxygenated – flows at a higher pressure
- Walls have muscle and elastic to withstand high pressure



**Vein**

Carry blood back to the heart

- Blood is oxygenated – flows at a lower pressure
- Walls have valves to prevent backflow and make sure blood flows in one direction



**Capillaries**

Important for exchange of materials

- Walls are one cell thick to provide a short diffusion pathway