

CELLULAR **Gr:11** RESPIRATION

For Study videos

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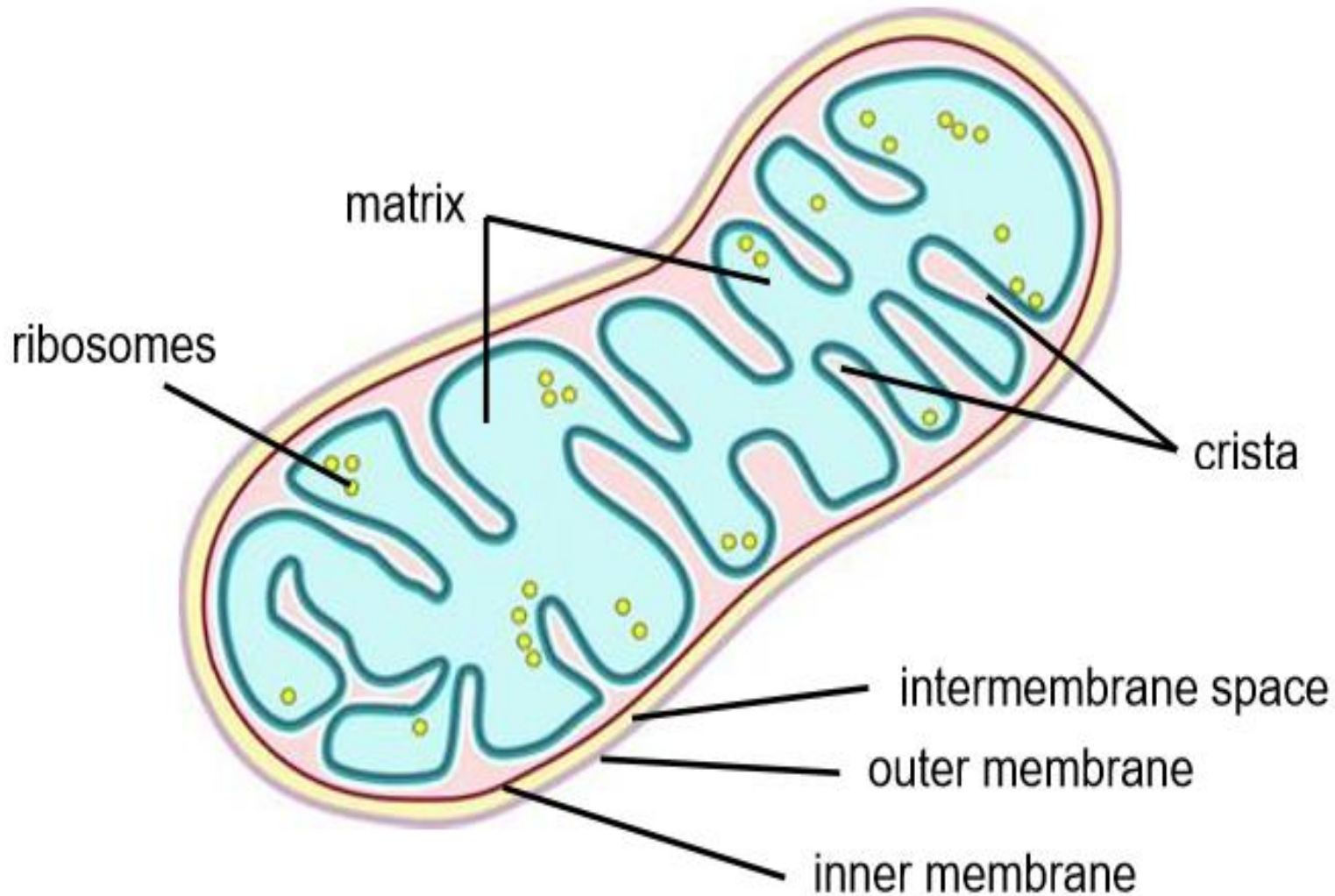
Cellular respiration

- is the chemical process where glucose is broken down gradually, in the presence of oxygen or in the absence of oxygen to release energy.
- **TYPES OF RESPIRATION**
- **aerobic respiration** occurs in the presence of oxygen to release energy
- **anaerobic respiration** occurs in the absence of oxygen to release energy

Importance of energy

- Energy is used by organisms in various ways. Some of the **main ways** in which energy **is used** include:
 - growth
 - cell division
 - movement
 - transport of substances
 - active transport

The internal structure of a mitochondrion



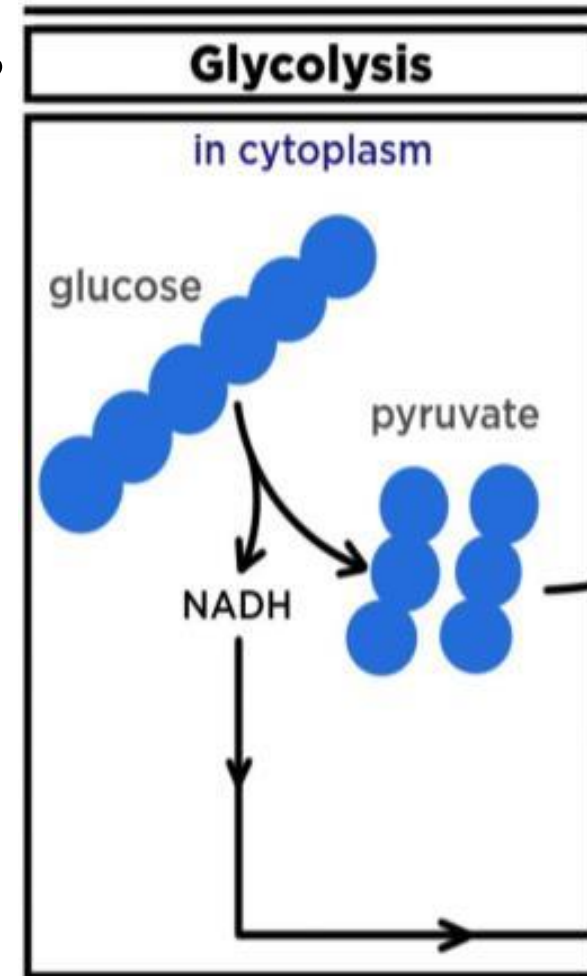
PROCESS OF CELLULAR RESPIRATION

- **1. Aerobic respiration (needs oxygen)**
- Aerobic respiration takes place:
- in the **presence of oxygen**;
- inside the **cytoplasm** and **mitochondria** of cells.

- The **requirements** for the process are **oxygen** and **glucose** and the **by-products** released are **carbon dioxide** and **water** as well as **ATP energy**.
- word equation
- Glucose + Oxygen \longrightarrow Carbon Dioxide + Water + ATP
- **2. The stages of aerobic respiration**
- 1. **Glycolysis** – takes place in the cytoplasm
- 2. **Krebs Cycle** – takes place inside the mitochondrion
- 3. **Oxidative Phosphorylation** – takes place inside the mitochondrion

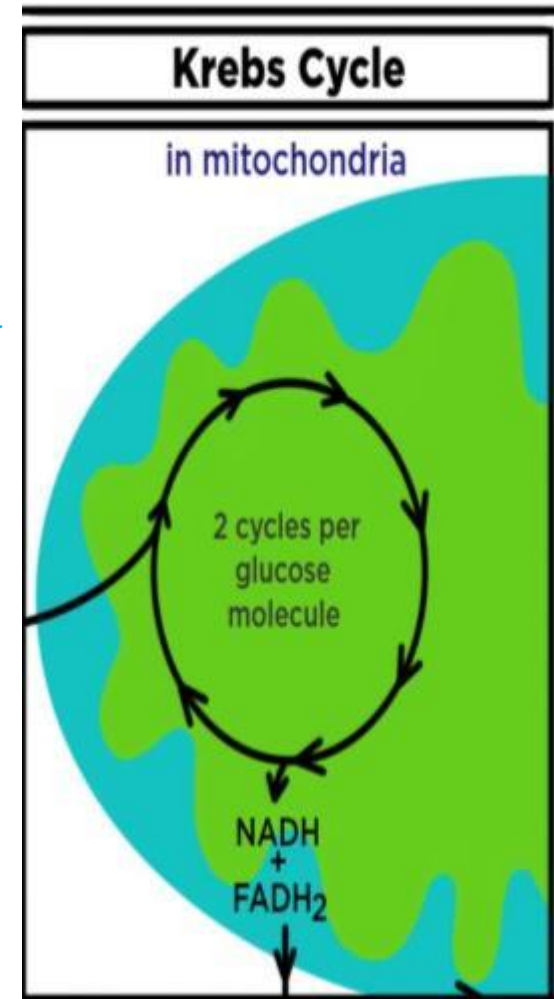
1. Glycolysis

- **takes place** outside the mitochondrion, in the **cytoplasm** of the cell
- **no oxygen** is required during this stage
- **glucose** is **broken** down into smaller molecules, releasing a small amount of energy that is stored in **energy-rich ATP** molecules
- releases **high energy hydrogen** ions (H^+)

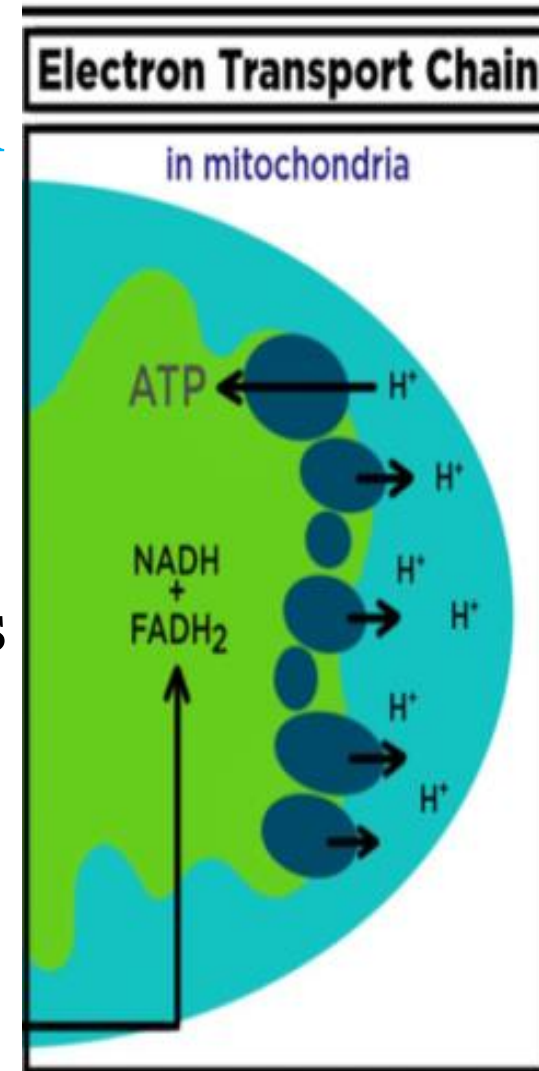


• 2.Krebs Cycle

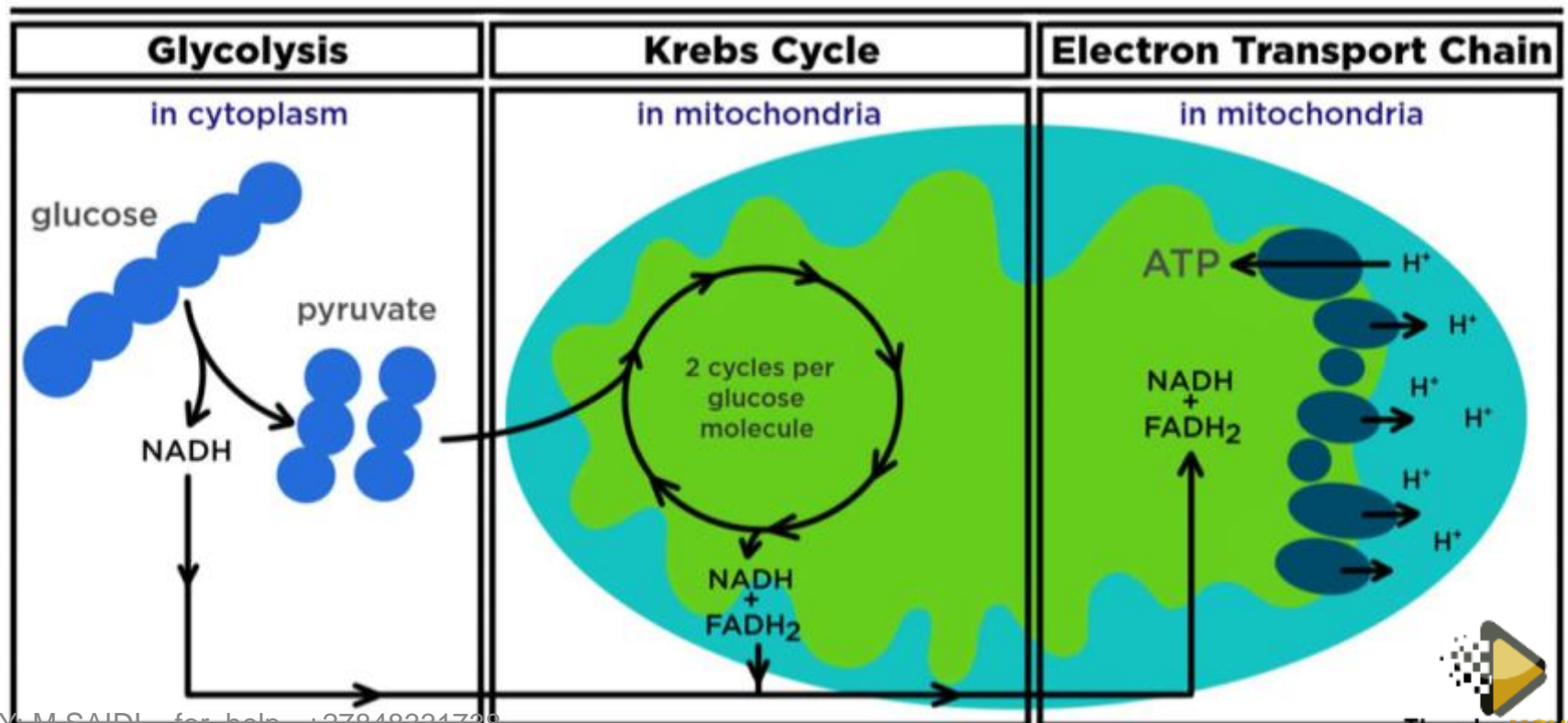
- can only take place if **oxygen is present**
- **occurs** inside of the **mitochondrion**
- releases **carbon dioxide** and **high energy hydrogen ions (H⁺)**
- transports hydrogen atoms to the third stage via hydrogen carrier enzymes



- **3. Oxidative Phosphorylation**
- takes place inside of the **mitochondrion** and **requires oxygen**
- passes high energy hydrogen atoms from one hydrogen carrier enzyme to the next, releasing **energy** in the process
- uses released energy to combine a phosphate molecule to an ADP (Adenosine Di-phosphate) molecule to **form ATP** – called **phosphorylation**



- is represented in the formula: $ADP + P \longrightarrow ATP$
- oxygen acts as a final hydrogen acceptor binding with the hydrogen forming water which is released as a waste product of cellular respiration



Anaerobic respiration (without oxygen)

- it occurs for **short periods** of time,
- mainly during **physical exercise**
- occurs differently in **plants** and **animals**
- produces **less ATP** than aerobic respiration.

Anaerobic respiration in animals

- is known as **lactic acid fermentation**
- occurs in muscles during **intense exercise**
- enables **glycolysis** in the **cytoplasm** of animal cells
- results in the accumulation of **lactic acid** causing the muscles to become **tired** and **painful**
- produces only a **small amount of ATP**
- The **lactic acid** can be converted **back to pyruvic acid** when the muscles **receive oxygen**

Anaerobic respiration in plants

- is known as **alcoholic fermentation**
- enables **glycolysis** in the **cytoplasm** of plant cells
- results in the accumulation of **pyruvic acid**
- forming **ethanol** (alcohol) and releasing **carbon dioxide**
- can be summarized as:
- **glucose** → **ATP** + **pyruvic acid** → **ethanol** + **carbon dioxide**

Uses of anaerobic respiration in industry

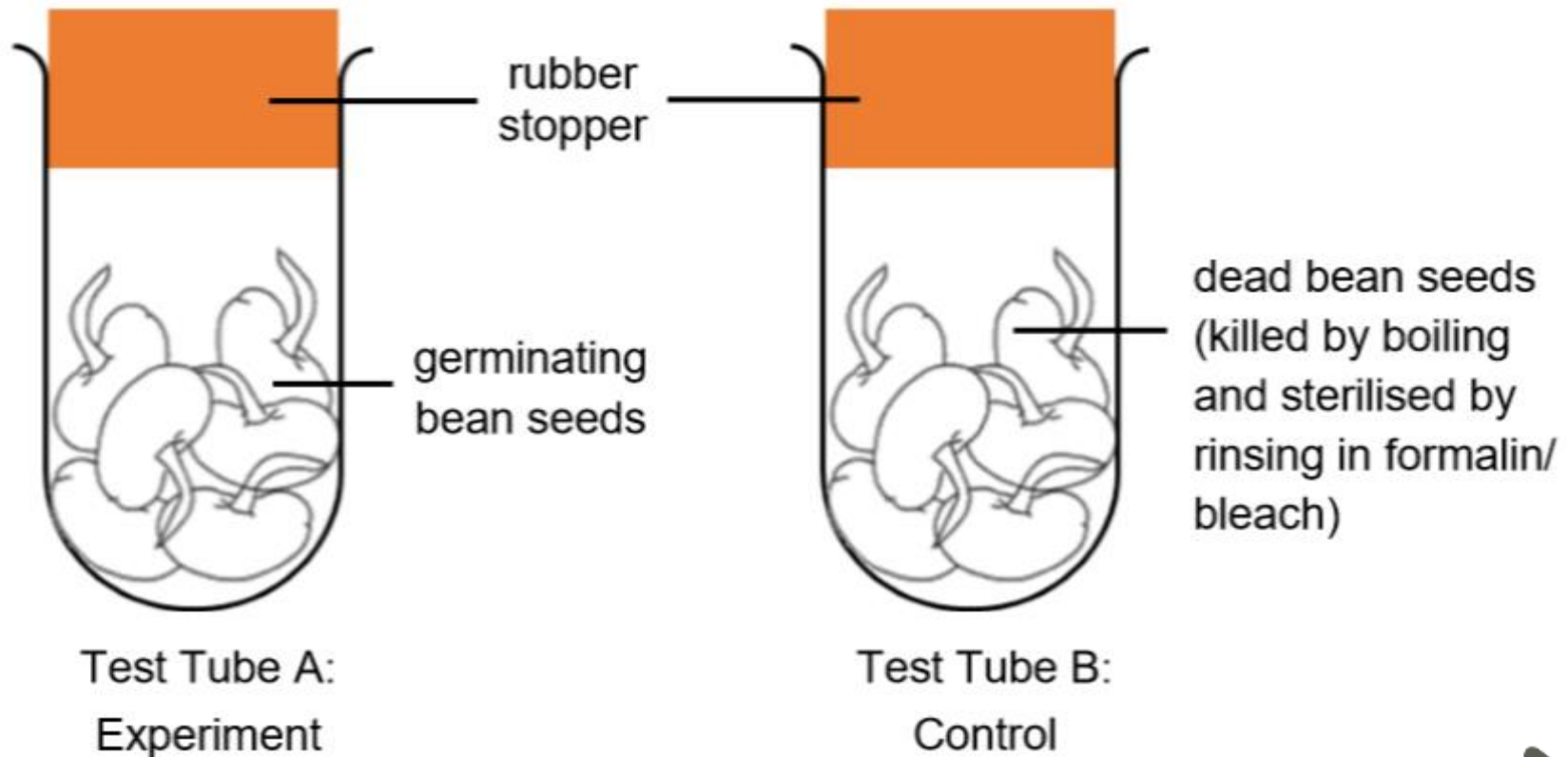
- **Yeast** and other **fungi** respire anaerobically and are used to produce **alcoholic** beverages such as **beer** and **wine**.
- Yeast cells are also used to cause **bread to rise** during the baking process.

Comparison between aerobic and Anaerobic (fermentation) respiration

Aerobic respiration		Fermentation	
1.	Oxygen is used for deriving energy	1.	Occurs in the absence of oxygen
2.	Occurs in the cytoplasm and mitochondria	2.	Occurs in the cytoplasm
3.	End products are carbon dioxide and water	3.	End products are ethyl alcohol and carbon dioxide
4.	Complete oxidation of the respiratory substrate takes place	4.	Incomplete oxidation of the respiratory substrate takes place
5.	About 36 ATP molecules are produced	5.	Only 2 ATP molecules are produced

Investigations on cellular respiration

- **Aim:** to show that oxygen is used during cellular respiration



Method:

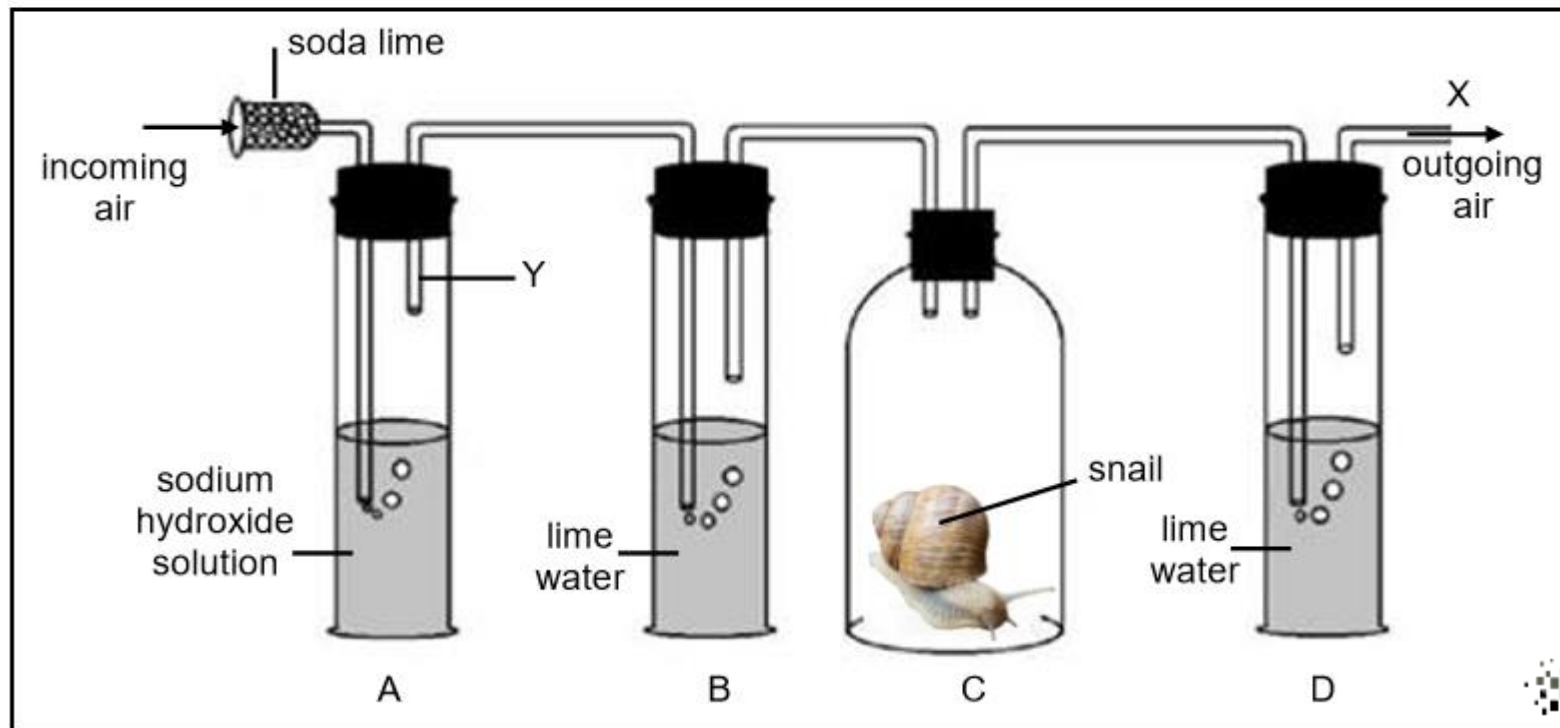
- Use **germinating** beans.
- Ensure the equipment and beans are **sterilised** so that no micro-organisms can influence the results
- Place some of the beans into **boiling water** to **kill** them, so that cellular respiration cannot take place in these beans.
- The test **tubes** must be tightly **sealed**.
- **Leave** the test tubes set-up **overnight**.
- Take the stoppers off of the test tubes the next morning and **insert a glowing** splint into each one.

Results

- **Test tube A** (the experiment): the glowing **splint** **dies** out - **no oxygen** is present,
- it has been used up by the germinating beans during cellular respiration.
- **Test tube B** (the control): the glowing **splint ignites** or burns brighter - **oxygen is present**
- **Conclusion**
- **Oxygen** is **used** by living organisms during cellular **respiration**

Carbon dioxide is produced during aerobic cellular respiration

- **Aim:** To prove that carbon dioxide is produced during aerobic respiration



Method:

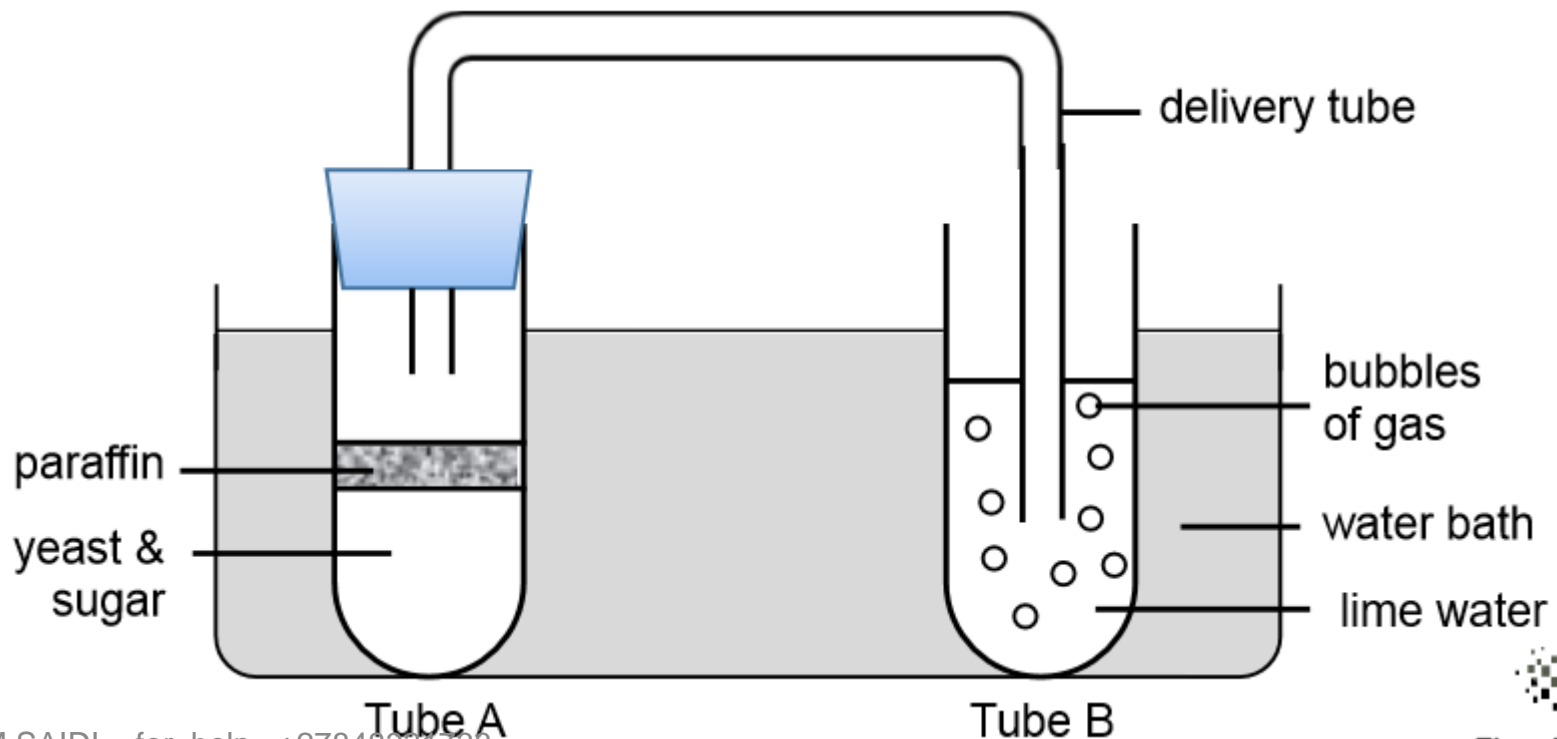
- Use a **small organism** (e.g. snail, rat etc).
- **Sterilise** the equipment so that no micro-organisms can influence the result.
- Place the snail into a large jar.
- Set- up the apparatus , making sure that the test tubes are **tightly sealed**.
- Examine the test tubes the following day and record the results.

Results:

- **Test tube B:** the **lime water** remains **clear**,
- carbon dioxide is removed by the soda lime and sodium hydroxide.
- **Test tube D:** the **lime water** turns **milky** due to carbon dioxide produced by the snail.
- **Conclusion:**
- Carbon dioxide is produced during aerobic respiration by living organisms (the snail).

Carbon dioxide is produced during anaerobic cellular respiration

- **Aim:** To prove carbon dioxide is produced during anaerobic cellular respiration



Method:

- **Sterilise** the equipment so that no micro-organisms can influence the result.
- **Boil the sugar** solution ahead of time to ensure that all of the **oxygen is removed** from the solution.
- Set-up the apparatus
- The yeast and sugar solution should be in Test Tube A
- clear lime water should be in Test Tube B.

- Cover the sugar solution with a thin layer of paraffin so that no oxygen from the air can dissolve into the solution. Make sure that the test tube is tightly sealed.
- The apparatus must be placed in a warm water bath because yeast grows quickly in warm conditions.
- Record the results after a few hours.

- **Results:** The **clear lime** water becomes **milky** in colour.
- **Conclusion:** **Carbon dioxide** is **produced** during **anaerobic** cellular respiration in living cells (yeast)

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