chemical breakdown of food in cells to produce energy.

RESPIRATION.

Respiration is the chemical breakdown of food in cells to produce energy.

Types of respiration.

Aerobic
anaerobic

i. Aerobic respiration
ii. Anaerobic respiration.

Aerobic respiration.

oxidation of food substances in

This refers to the oxidation of food substances inside cells to release energy using oxygen.

aerobes respire aerobically

Organisms which ~~exp~~ respire aerobically are called aerobes.

The energy produced during respiration is converted into a chemical substance known as ATP (Adenosine Triphosphate) by combining a phosphate group onto ADP (Adenosine Di-phosphate)

Adenosine Triphosphate

$$ADP + P_i \underset{\text{energy}}{\rightleftharpoons} ATP$$

Uses of energy produced.

- Locomotion
- Sensation
- movt of materials by active transport.
- make macromolecules
- Excretion
- repair of worn out cells

i. To effect locomotion that is to make muscels contract and relax.
ii. For example ~~exc~~ enzymes, hormones, mucus.
iii. To make macromolecules in the body. for example proteins lipids, DNA
iv. For movement of ~~biolo~~ materials by active transport for example mineral salts in ~~kid~~ kidney ~~reform~~ nephrons
v. For excretion ie removal of metabolic wastes from the body.
vi. For sensation ie detecting stimuli.
v. For repair of worn out body cells and tissues

Explain why energy is stored in form of ATP.
It can easily be stored
It is

- easily stored
- easily be hydrolised
- available any

Explain why energy is stored in form of ATP.
- It can easily be stored.
- It can easily be hydrolised to get back the energy.
- It is readily available whenever needed.
- It can easily be transpored easily to other body parts.

Substances required to release energy.
- Carbohydrates (Glucose)
- Lipids
- Proteins.

1. Carbohydrates

They are mainly respiratory substrates and in some cells e.g brain cells only use carbohydrates because they are easily oxidised.

Carbohydrates require less oxygen for their oxidation. This is because they have less hydrogen in their molecules.

1g of carbohydrates produces 4kcal of energy when broken down.

2 Lipids.

These are rarely used to produce energy because their oxidation requires alot of oxygen implying that they are very hard to oxidise.
However lipids release the largest amount of energy upon oxidation.

* 1g of lipids produces 9kcal of energy when broken down.

3 Proteins

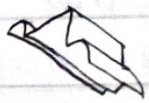
They are hardly used for energy production because they have many other important roles in the body for example formation of body structures.

1g of protoins releases 4Kcal of energy when ~~broke oxidiside~~ oxidised.

4. Alcohol / Ethanol

This is next to lipids in producing energy.
1g of ethanol produces 7Kcal of energy and it is easily oxidised.

However alcohol destroys the body cells and disorients the individual.



Anaerobic respiration.

breakdown of food without O_2 use

This is the breakdown of food without using oxygen to release energy.

It results in the formation of intermediate compounds like lactic acid in animals and ethanol in plants and microbes.

Anaerobic respiration produces less energy because alot of energy remains locked up in the intermediate compounds and the food substances are partially oxidised.

Equations to summarise aerobic and anaerobic respiration.

1. Aerobic respiration

$C_6H_{12}O_6 + All\ O_2 \longrightarrow ATP + CO_2 + H_2O$.

2. Anaerobic respiration.

In animals

$C_6H_{12}O_6 \longrightarrow C_3H_6O_3 + ATP$

(Lactic acid) (energy)

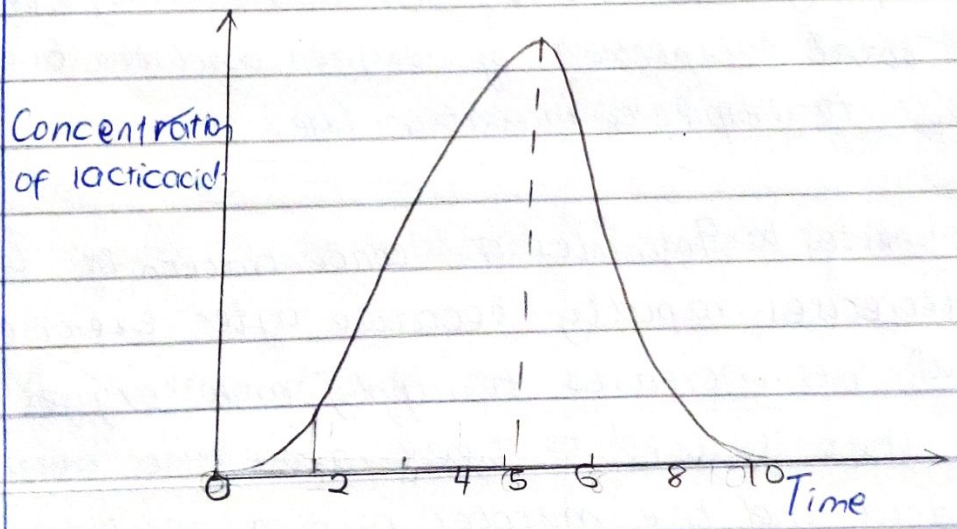
* Some organisms respire anaerobically throughout their lives and are called obligate anaerobes.
* Some bacteria are actually killed by normal atmospheric levels of oxygen and live where there is no oxygen clostridium tetani which causes tetanus. Therefore ~~tetanus~~ obligate anaerobes are organisms which live in environments that completely lack oxygen. Other organisms such as yeast and the parasites such as tape worms can exist when the oxygen is available or not. These can survive on anaerobic respiration when ~~the~~ possible and are called facultative anaerobes
* Also, some cells that are temporarily short of oxygen such as muscles cells. are able to respire anaerobically
* During vigourous activity for example running the oxygen supply to the muscles may not be enough to meet the requirements
* This causes some of the muscles to respire anaerobically using lactic acid whose accumulation causes pain / muscle cramps.

After the exercise, the rate of breathing continues to be high inorder to supply adequate oxygen to break down the lactic acid.

Additional amount of oxygen taken in to break down the accumulated lactic acid. is referred to as the "oxygen debt"

It can also be the amount of oxygen required to prevent accumulation of lactic acid.

A graph showing variation of lactic acid in muscle cells in time of exercise.



Describe how the concentration of lactic acid

Initially at 0 minutes;

From 0minutes to 2minutes, the concentration of lactic acid increases slowly.

From 2 minutes to 5minutes, the concentration of lactic acid increases rapidly to a peak

From 5minutes to 9minutes the concentration decreases rapidly to 0.

Explain the reason.

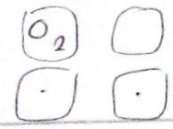
Initially, there is no lactic acid in the body before the exercise since the individual is not very active implying the stored and supplied oxygen at this moment is enough to prevent anaerobic respiration

From 0 to 2 minutes the ~~contrcur~~ concentration increases slowly because of the gradual increase of body activity which causes a gradual pressure on oxygen supply which later becomes less making some muscle respire anaerobically.

From 2 mins - 5 mins, the concentration of lactic acid increases ~~decreases~~ rapidly due to the increased activity that causes total depletion of oxygen and the body still needs to respire to maintain life.

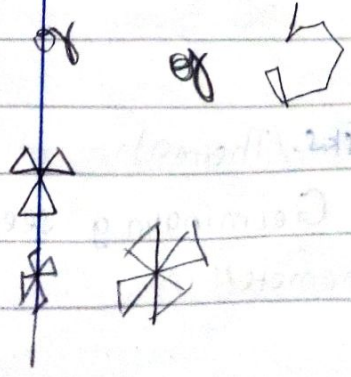
From 5 minutes to 9 minutes the concentration of lactic acid decreases rapidly because after exercise the ventilation rate increases to supply more oxygen to the muscles that is used to break down the accumulated lactic acid and the muscles respire aerobically.

Differences between aerobic and anaerobic respiration



Differences between aerobic & anaerobic respiration.

	Aerobic respiration	Anaerobic respiration.
raw material	Oxygen is used to ~~make~~ break down of glucose	Glucose is broken down in abscence of oxygen.
	Glucose is completely broken down	Glucose is not completely broken down.
Product in amount	Large amount of energy is produced (ie 38 ATP molecules)	Less amount of energy is produced.
	The end products are H_2O, CO_2 & energy in both animals & plants	~~Less amount~~ The end products in plants are carbon dioxide, ethanol & energy while in animals they are lactic acid & energy.
	It occurs in the mitochondria	It occurs in the cytoplasm.
	More carbon dioxide is ~~used~~ produced.	Less carbondioxide is produced.
	Energy production involves a series of electron carrier system	Energy production does not involve electron carrier system.



- Similarities

Both produce energy
Both occur in living cells.
Both require substrates ie glucose or raw materials
Both produce carbon dioxide.

Commercial importance of anaerobic respiration.

1. In brewing industry yeast is used to break down sugars to produce carbon dioxide and ethanol
2. Used baking industry to produce CO_2 which raises the dough of the bread.
3. It is used in the dairy manufacture of some products like yoghurt and ghee. Microbes like bacteria respire anaerobically to produce acids which denature proteins in the milk to produce yoghurt and ghee.

Fermentation refers to the anaerobic breakdown of sugars/starch/carbohydrates to alcohol and ~~starch~~ carbon dioxide by microbes.

Experiments on respiration.

1. ~~To show that energy is given off duri~~

Exp. 1.

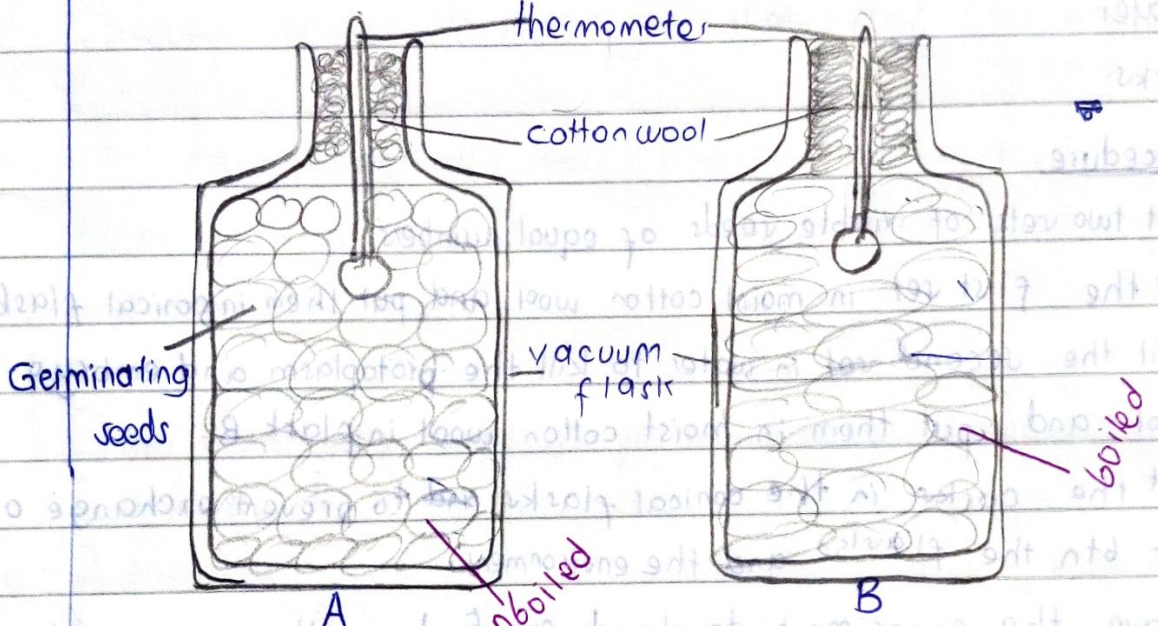
To show that energy is given off during respiration.

Requirements

Boiling water
Formalin
Cotton wool
Vacuum flasks./Thermal.
~~Germometer~~ Germinating seeds
~~Therm~~ Thermometer.

Procedure

- Germinating seeds are obtained ~~and~~ and divided into 2 groups.
- One group is boiled to kill the seeds and then washed with formalin to prevent the seed from decaying.
- The boiled seeds are then placed in vacuum flask and the unboiled seeds in another.
- The mouth of each flask is plugged with cotton wool through which the thermometer is inserted.
- The initial temperature of seeds in each flask is noted.
- The temperature is then noted every after an hour.



The temperatures in arrangement A increase and those in B remain the same.

As the germinating seed respire, energy is released and some of it in form of heat leads to its increase in temperature.

NB: formalin is used to kill microbes ie bacteria and fungi to prevent decomposition that would be produce heat.

Vacuum flasks are used to prevent temp. changes and also to prevent heat loss.

The flask with the dead seeds is the control experiment

Experiment 2:

To show that carbon dioxide is produced during respiration.

Requirements:

1. Cotton wool
2. Germinating seeds
3. Conical flasks
4. Boiled seeds
5. Formalin
6. Test tube
7. Lime water
8. Water
9. Corks

Procedure:

→ Get two sets of viable seeds of equal numbers.

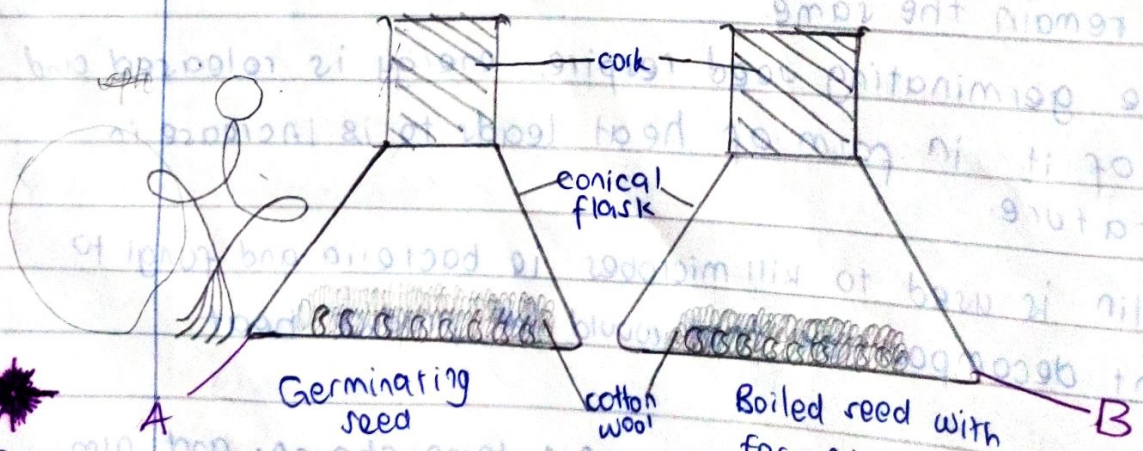
→ Put the first set in moist cotton wool and put them in conical flask A.

→ Boil the second set in water to kill the protoplasm and embryo.

→ Cool and put them in moist cotton wool in flask B.

→ Fit the corks in the conical flasks ~~and~~ to prevent exchange of air btn the flasks and the environment.

→ Leave the experiment to stand for 5 days then remove the germinating seeds and put them in lime water.



Observation.
In arrangement A, the gas turned lime water milky had no effect on the the lime water while the gas has no effect on lime water.

Concl.
Carbon dioxide is produced during respiration.

Interpretation.
In arrangement A, germinating seeds are respiring hence produce carbon dioxide gas that turns lime water milky.

In arrangement B, boiling killed the seeds hence no germination or respiration and no production of carbone dioxide gas.

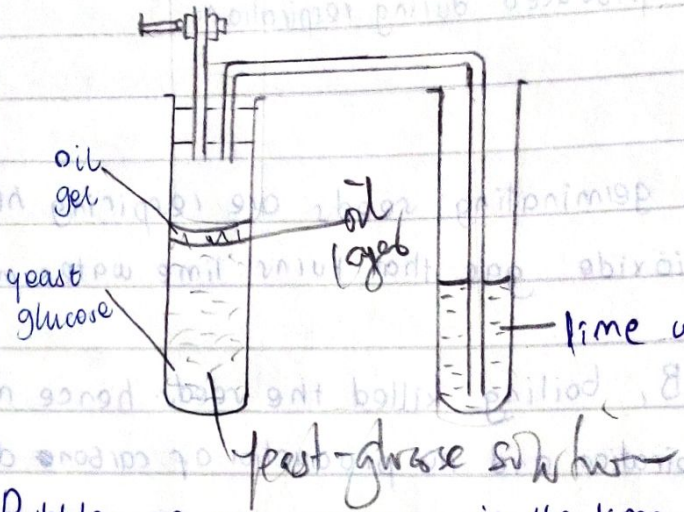
Experiment to show that ~~ye~~ carbon dioxide is produced in anerobic respiratio
~~Two~~ Requirements. [in yeast.
- 2 test tubes
- Delivery tubes.
- Source of heat
- Water
- lime water or bicarbonate indicator.
- oil or liquid paraffin.
- 10% yeast suspension

Procedure.
- Some water is boiled up to expel all the dissolved oxygen. and when cooled it is used to make a 5% soln of glucose.
- 5% of the glucose soln and 1cm^3 of the yeast suspension are placed in a test tube covered with a thin layer of liquid paraffin. to exclude oxygen from the mixture.

AB OO

AB

- A delivery tube is fitted as shown in the diagram below and allowed clear lime water.
- After 15 minutes with gentle ~~wate~~ warming if necessary, there should be signs of fermenting in the yeast-glucose mixture.



Bubbles of gas are seen in the lime water and by the end of the experiment, the lime water turns milky.

The fact that lime water turns milky proves that carbon dioxide is formed.

A control experiment can be set in the same way but using a boiled yeast suspension which will not ferment.

The fact that living yeast ~~produc~~ ~~provide~~ produces CO_2 despite ~~being despite~~ being deprived of oxygen is evidence to support the view that anaerobic respiration is taking place.

Revision question.

1. Why is the experiment kept warm?
To provide the suitable temperature for enzyme activity.

2. Why does lime water turn milky?
Due to the production of carbon dioxide.

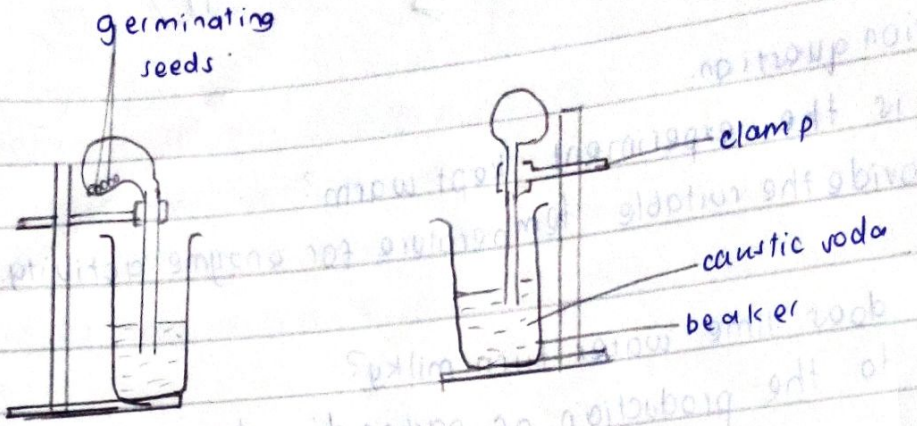
3. What is the importance of glucose, yeast & paraffin.
glucose → the substrate
yeast ⟶ contains the enzyme.
paraffin → prevents entry of oxygen into the beaker.

4. What is the application of this experiment in everyday life?
Brewing of alcohol.

Experiment to show that germinating seeds use up oxygen during respiration.

Requirements:
- 2 retort ~~stands~~ flasks
- Germinating seeds.
- Beakers.
- Caustic soda (NaOH)

Procedure.
Two retort ~~stands~~ flasks, one empty and another containing ~~gem~~ germinating seeds are ~~de~~ dipped in a beaker of caustic soda.
The retort flask that is empty acts as a control.
The caustic soda serves to absorb carbon dioxide ~~from~~ from the air so that any further volume changes are a result of absorption of oxygen.



Observation

After some time, it is observed that the caustic soda in the retort flask containing germinating ~~seeds~~ seeds is risen to cover 1/5 of its volume and there is no rise in the caustic soda in the empty flask.

Conclusion-

This shows that 1/5 of air in the flask is used up during respiration in germination since oxygen occupies approx. 20% of the atmosphere air.

This shows that the gas used up is oxygen since (1/5 x 100% = 20%)

The caustic soda rises to occupy the volume of the flask originally occupied by oxygen.

In the empty flask there is no process absorbing the oxygen and therefore the caustic soda doesn't rise.

Experiment to show that respiring animals use up oxygen from the air

Requirements

- U tube
- Piece of rubber tubing
- thread
- Ignition tube
- Potassium hydroxide pellets
- Rubber band
- Coloured water
- Retort
- Glass with T piece.

Procedure

- 2 sets of apparatus are assembled as shown below.
- A small animal e.g grasshopper or mouse is place in one conical flask and another left empty as a control.
- Ensure that the temperature remains the same till the end of the experiment
- The liquid levels in the arms of the U-Tube are then observed.

Observation.

It is observed that the liquid in the left arm of the U-Tube connected to the flask rises while that in the right arm lower indicating that the air pressure in the flask has reduced

No change occurs in the level of the liquid in the control experiment.

Conclusion.

- Since potassium hydroxide absorbs the carbon dioxide from the air in the flask, any other change in the volume of air in it is attributed to that part of air taken up by the living organisms that is oxygen.

Experiment to show that living organisms give out carbon dioxide.

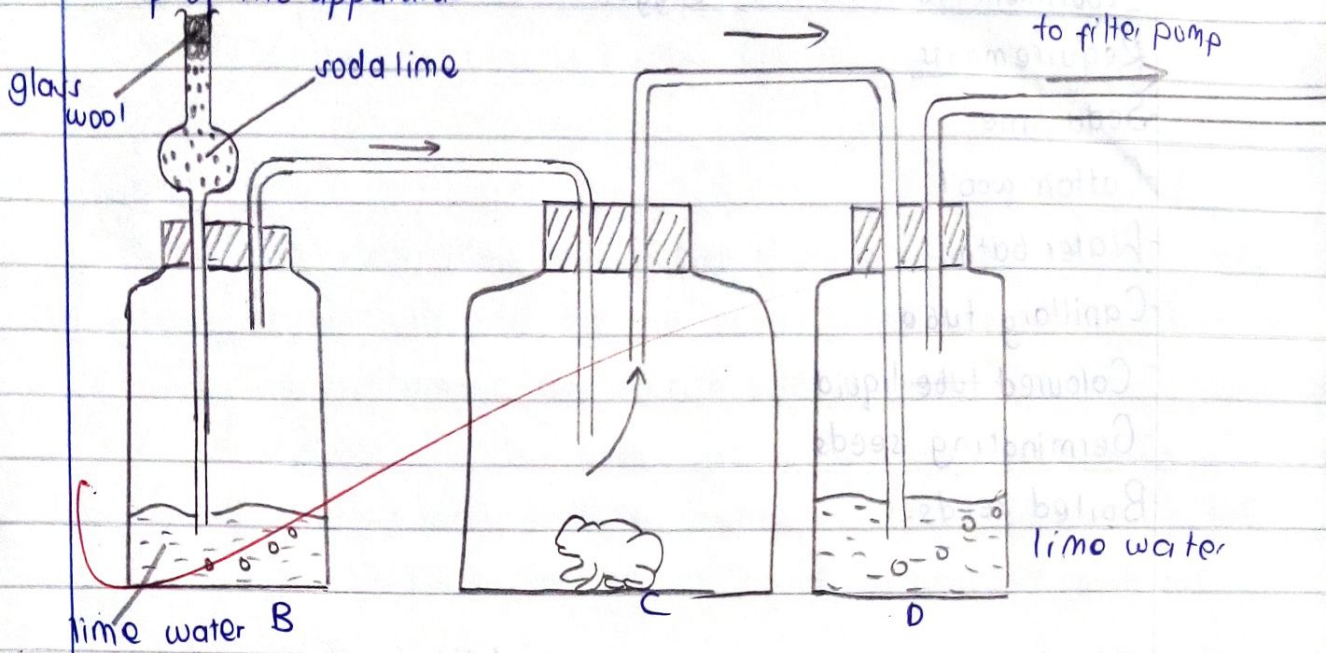
Requirements

i) Living organisms e.g toad
ii) Filter pump
iii) Delivery tube
iv) Lime water
v) Bell jar

Procedure

→ A living material, for example a small mammal is put in a bell jar and the apparatus is set up as shown below
→ Care is taken to make sure that the three jars are air tight.
→ The filter pump is then turned on to draw in air slowly.

Set up of the apparatus



Results

The lime water in the jar on the right, turns milky, while that in the jar on the left remains clear.

Conclusion

Living material gives out carbon dioxide

Interpretation

The lime water in the jar on the left remains clear because the soda lime absorbs the carbon dioxide.

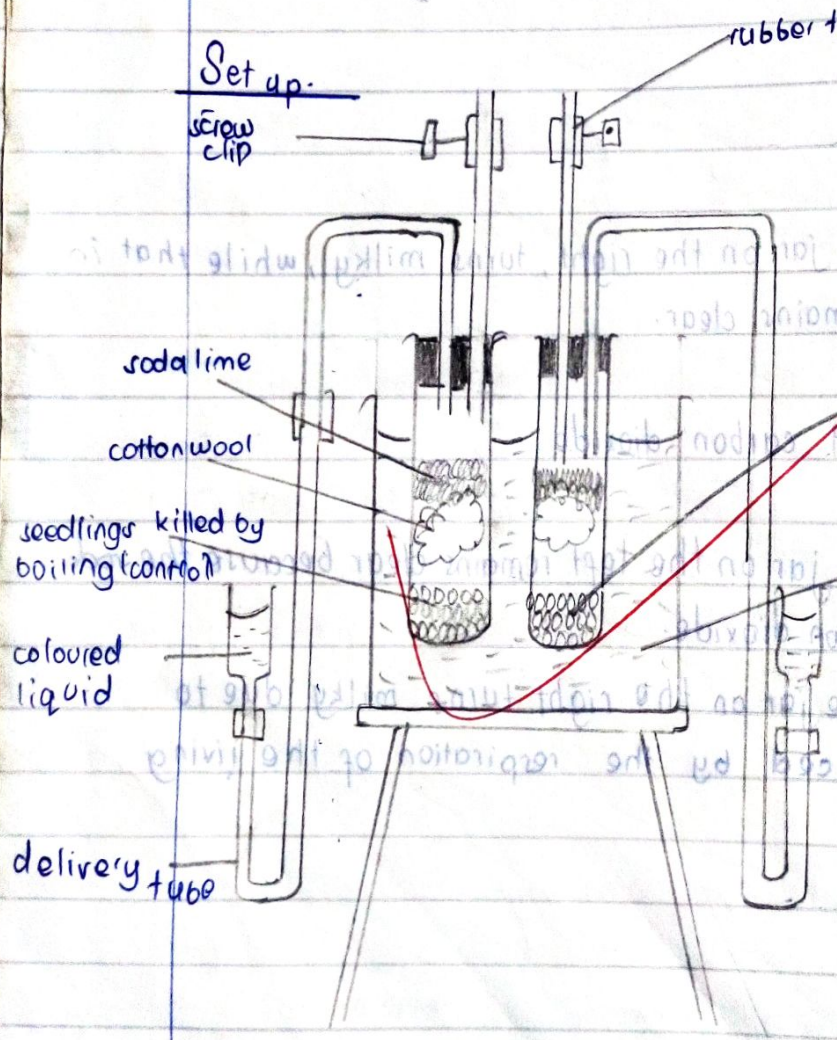
The lime water in the jar on the right turns milky due to carbon dioxide produced by the respiration of the living material.

Experiment to show that oxygen is taken up in respiration.

Requirements

- Soda lime
- Cotton wool
- Water bath
- Capillary tube
- Coloured ~~tube~~ liquid
- Germinating seeds
- Boiled seeds.

Set up.



Procedure

The apparatus is arranged as shown above.

After 15 mins, the tube will have acquired the temperature of the water in the beaker and the screw clips are closed.

- If the seeds are respiring, they will give out CO_2 and take in O_2 so there will be no effective change of the vol. of gas in the tube.
- However, soda lime, will absorb all the carbon dioxide used, so that any volume change, may be attributed to the uptake of O_2.
- If oxygen is absorbed by the seeds, the level of liquid in the capillary tube, should be seen to rise with in 20 minutes. Any change in the temperature of the tubes will cause the air ~~to~~ in them to expand or contract and produce corresponding movements of the liquid in the capillary tube, which could be confused with the movements due to oxygen uptake.
- The water in the beaker however should minimise temperature fluctuations and since these will affect both tubes to the same extent, the change in volume due to oxygen uptake alone can be determined by comparing the levels of the liquid in the experiment and the control.
- The control thus allows for changes due to temperature variation and also serves to show that oxygen uptake results from a living process in germinating seeds and is not merely due to the physical absorption by the seeds.

Concl. - Oxygen is taken up during respiration.

Comparison btn respiration & photosynthesis.

- Both take place in living cells.
- Both involve enzymes.
- Both involve energy in form of ATP.
- Both involve similar compounds for example carbon dioxide, water and glucose.

Respiration	Photosynthesis
Oxygen is used up in the process.	Oxygen is liberated in the process
Carbon dioxide is liberated from oxidation of carbon containing compounds.	Carbon dioxide is absorbed to make carbon containing compounds.
Takes place during day & night	Takes place during day in prescence of light.
In both plants and animals	In only plants.
Light is not essential for the process.	Light is essential for the process.
Energy is not released during the process.	Energy is stored during the process.
Prescence of chlorophyll is not necessary.	Prescence of chlorophyll is needed.
There is loss of weight in plants.	There is gain of weight in plants.