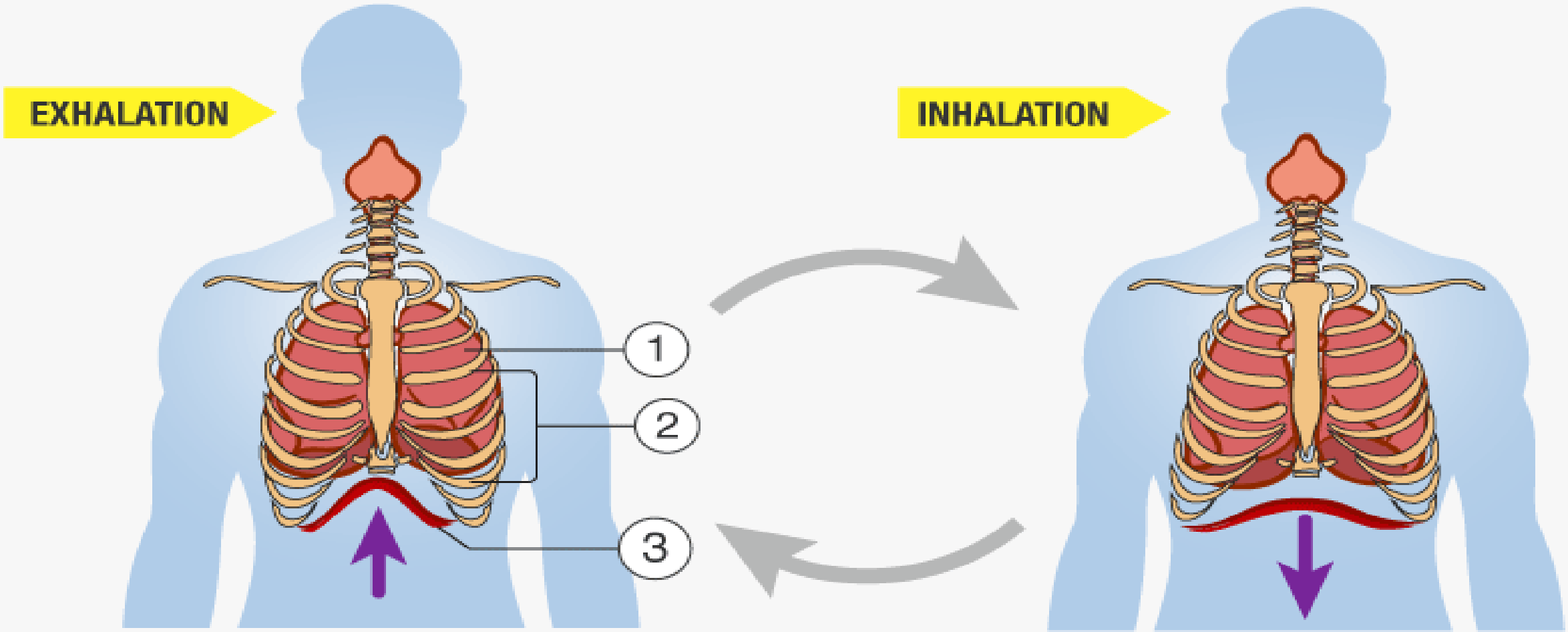
RESPIRATION



1 Lung | 2 Ribs | 3 Diaphram

@PETER L OKION 778001502/ 758795415

Introduction

Cellular Respiration (or ***Tissue Respiration***) is the process by which food substances are broken down to release ***Energy*** in body cells.

Respiration mainly takes place in the **Mitochondria** and is **Enzyme catalyzed** to produce **ATP** (*Adenosine Triphosphate*).

Since the release of energy occurs inside the cell, it is called ***Internal Respiration.***

The energy released from the food is used to attach a ***phosphate group*** to a compound called ***Adenosine Diphosphate*** (**ADP**) found in all cells to form ***Adenosine Triphosphate*** (**ATP**).

ATP formed is an ***energy store*** i.e. **ADP + P → ATP**

NB: All ATP stores energy for a short time and when the cells need energy, ATP is hydrolyzed to release the energy stored.

$$ATP + H_2O \rightarrow ADP + P + Energy$$

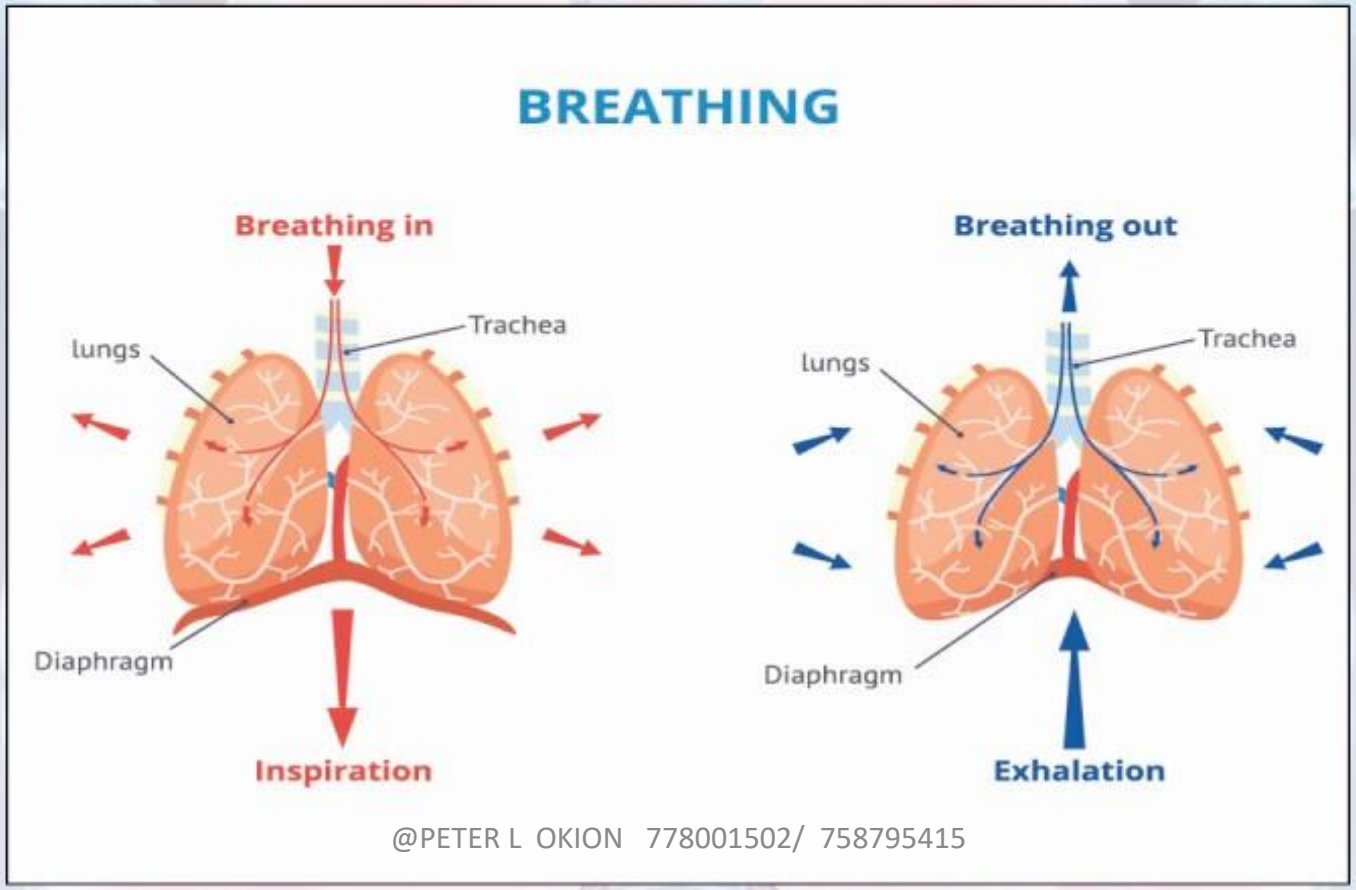
Uses of Energy

- ✓It is used for muscle contraction in animals
- ✓Energy is used for growth i.e. replacement of worn-out cells
- ✓Used by plants for photosynthesis
- ✓Movement of substances in and out of cells by active transport.
- ✓Used for production of heat for maintenance of normal body temperature
- ✓Carrying impulses along nerve cells in animals
- ✓Absorption of water and mineral salts in plants.

Respiration

Learning Objective

I will learn the difference between aerobic and anaerobic respiration.



Types of Tissue Respiration

There are two types of tissue respiration.

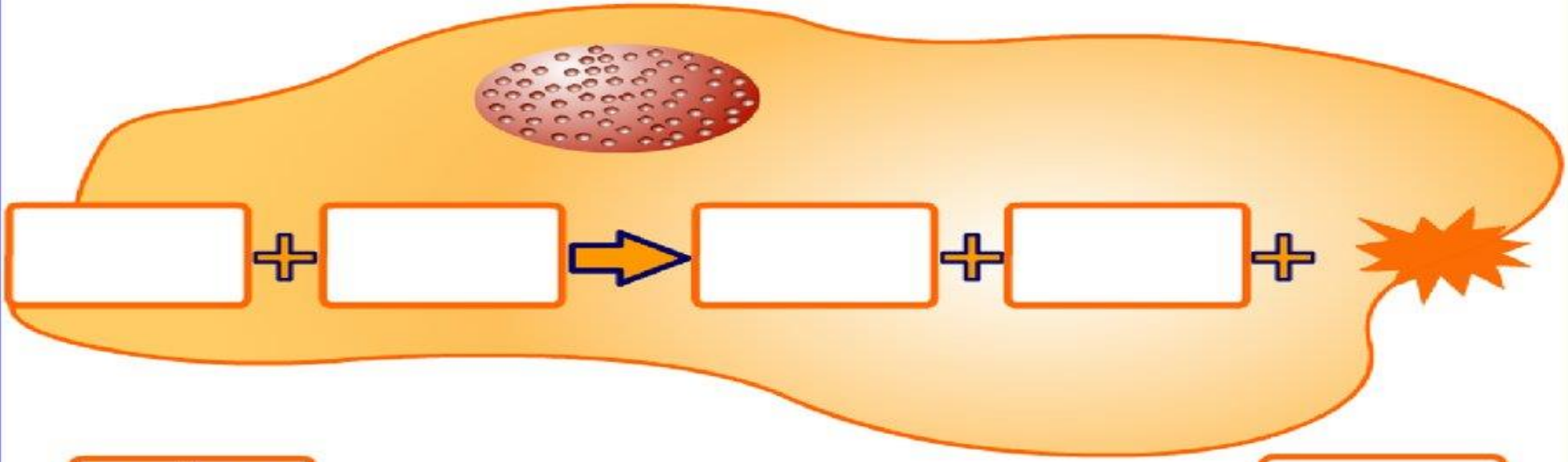
These include:-

a) Aerobic respiration

b) Anaerobic respiration

Aerobic respiration

Complete the word equation for **aerobic respiration**.



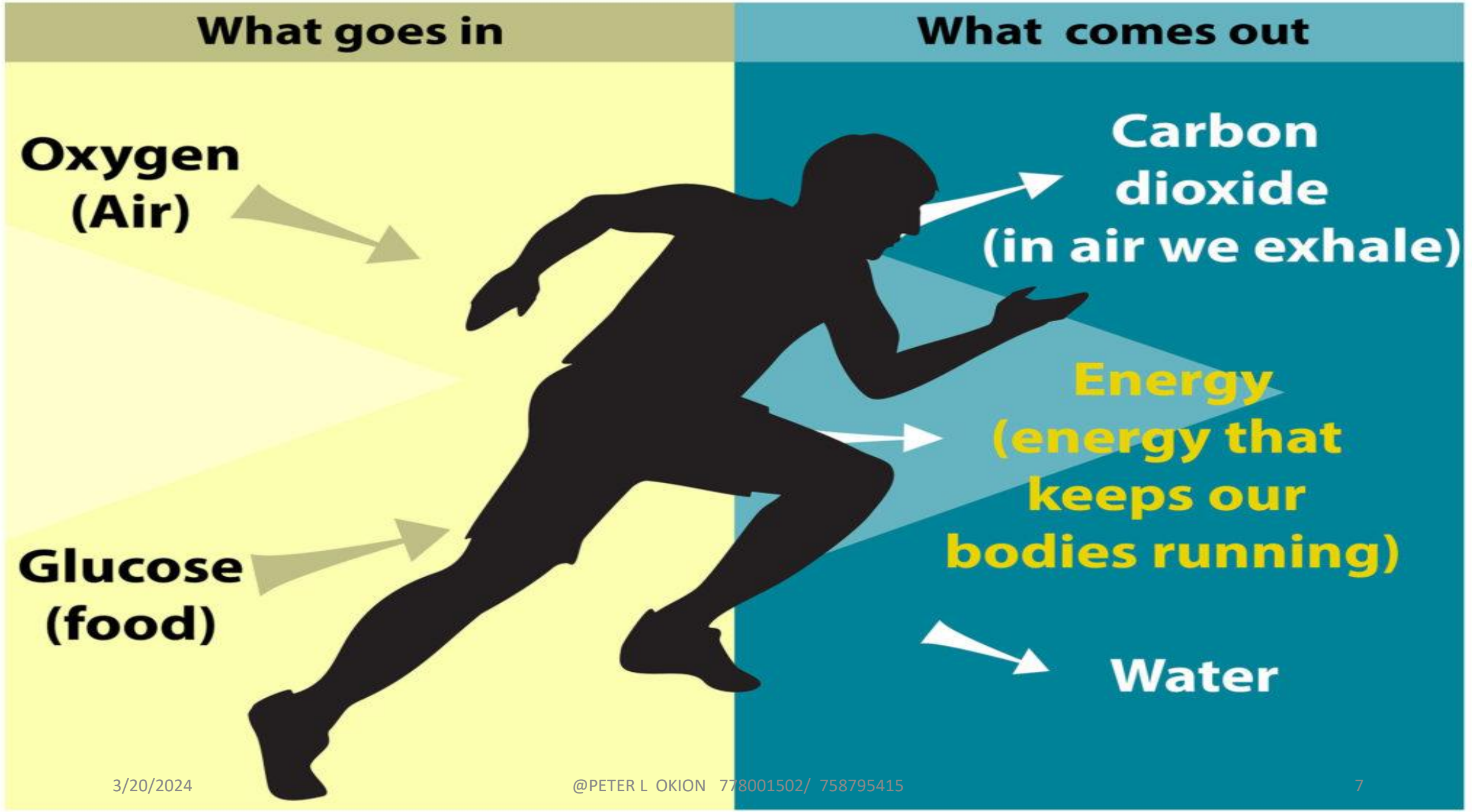
carbon dioxide

energy

glucose

oxygen

water


What goes in
What comes out
Oxygen
(Air)
Glucose
(food)
Carbon
dioxide
(in air we exhale)
Energy
(energy that
keeps our
bodies running)
Water

What is Aerobic Respiration?

- The breaking down of sugar to produce energy where oxygen is present.

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{Enzymes} 6CO_2 + 6H_2O + 36ATP$$

Glucose + Oxygen → Carbon Dioxide + Water+ Energy

Aerobic Respiration

This is the breakdown of food substances in ***presence of oxygen*** in the body cells to release energy.

The respiratory substrates include mainly ***carbohydrates and lipids***.

WRITE THE EQUATION OF RESPIRATION

When an organism respires, it utilizes food to generate ***carbon dioxide, water and energy.***

These are referred to as ***products*** of aerobic respiration.

NB: Experiments can be carried out to demonstrate that respiration is taking place in organisms through detection of products given off or through decrease in the dry weight of an organism

Experiments of Respiration

Experiment 1: To show that germinating/respiring seeds give off carbon dioxide.

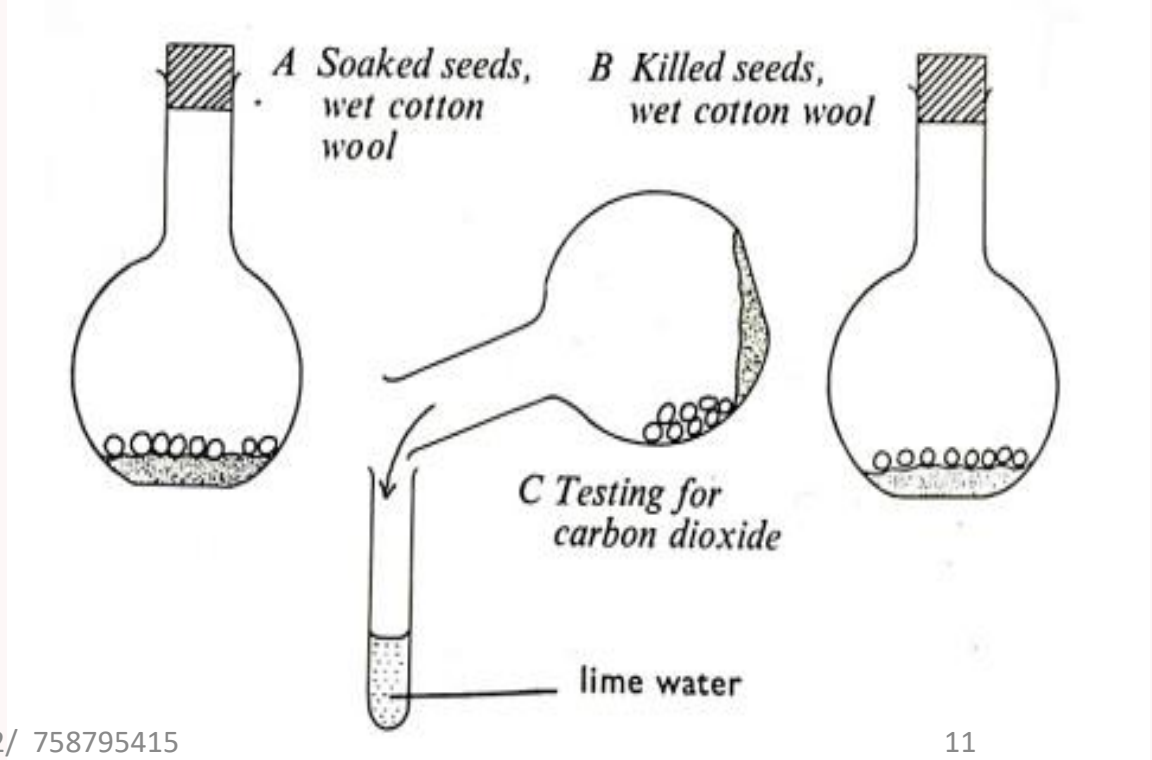
Materials

- ✓Soaked been seeds
- ✓Wet cotton wool
- ✓Conical flasks
- ✓Lime water or bicarbonate indicator
- ✓Sodium hypochlorite or jik
- ✓Heat source
- ✓Boiled seeds

Procedure

- ✓Wet cotton wool is placed in two flasks A and B.
- ✓Soaked seeds are added to flask A and an equal number of boiled seeds to flask B.
- ✓Both groups of seeds are soaked for 15 minutes in sodium hypochlorite solution to prevent fungal and bacterial growth which might produce carbon dioxide.
- ✓The flasks are securely corked and left in the same conditions of light and temperature until germination is clearly observable in flask A. the seeds in flask B should not germinate.
- ✓The gases in each flask are then tested by removing the cork and tilting the flask over a test tube of lime water and shaking up the test tube

SET UP



Results

The air from flask A turns lime water ***milky*** showing that carbon dioxide is present. Air from flask B has no effect on lime water.

Interpretation

The carbon dioxide must have been produced by the germinating seeds.

B acts as a control experiment and proves that it is not the cotton wool or anything other than germinating seeds that give carbon dioxide.

Conclusion

Carbon dioxide is given off during germination as the germinating seeds respire

Experiment 2: To show that carbon dioxide is produced by respiring animals

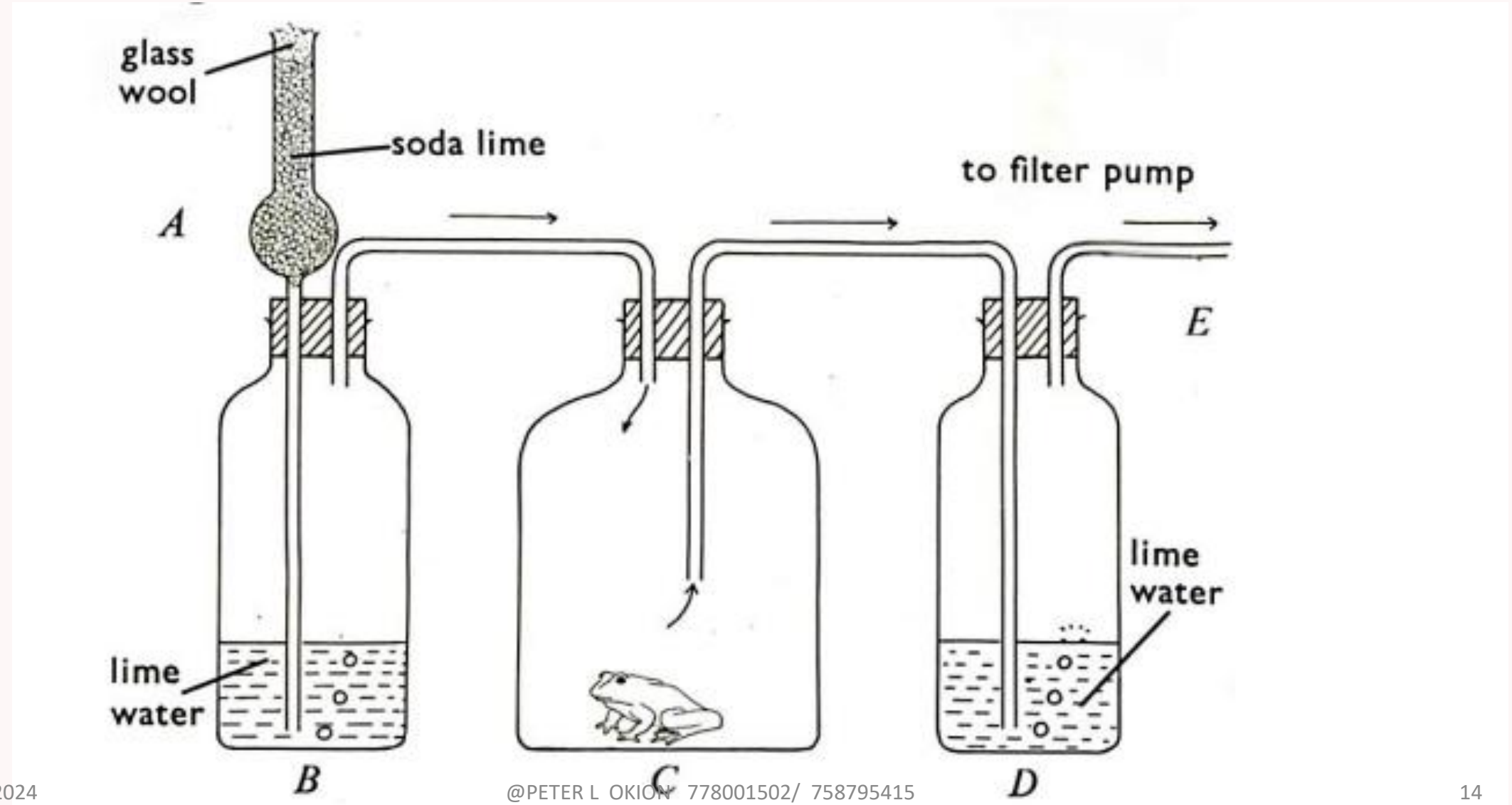
Materials

- ✓Small animal such as frog or insect
- ✓Conical flasks
- ✓Lime water
- ✓Suction pump
- ✓Soda lime
- ✓Delivery tubes
- ✓Glass wool

Procedure

- ❑Flasks are connected using capillary tubes and the setup is as shown below
- ❑The animal is placed in vessel C. A stream of air is drawn slowly through the apparatus by means of the filter pump at E
- ❑The soda lime at A absorbs carbon dioxide from the incoming air. The lime water at B should be clear to prove that carbon dioxide is absent from air going to vessel C.

SET UP


glass
wool
soda lime
A
to filter pump
E
lime
water
lime
water
B
C
D

Observation

The lime water in vessel D turns to white precipitate.

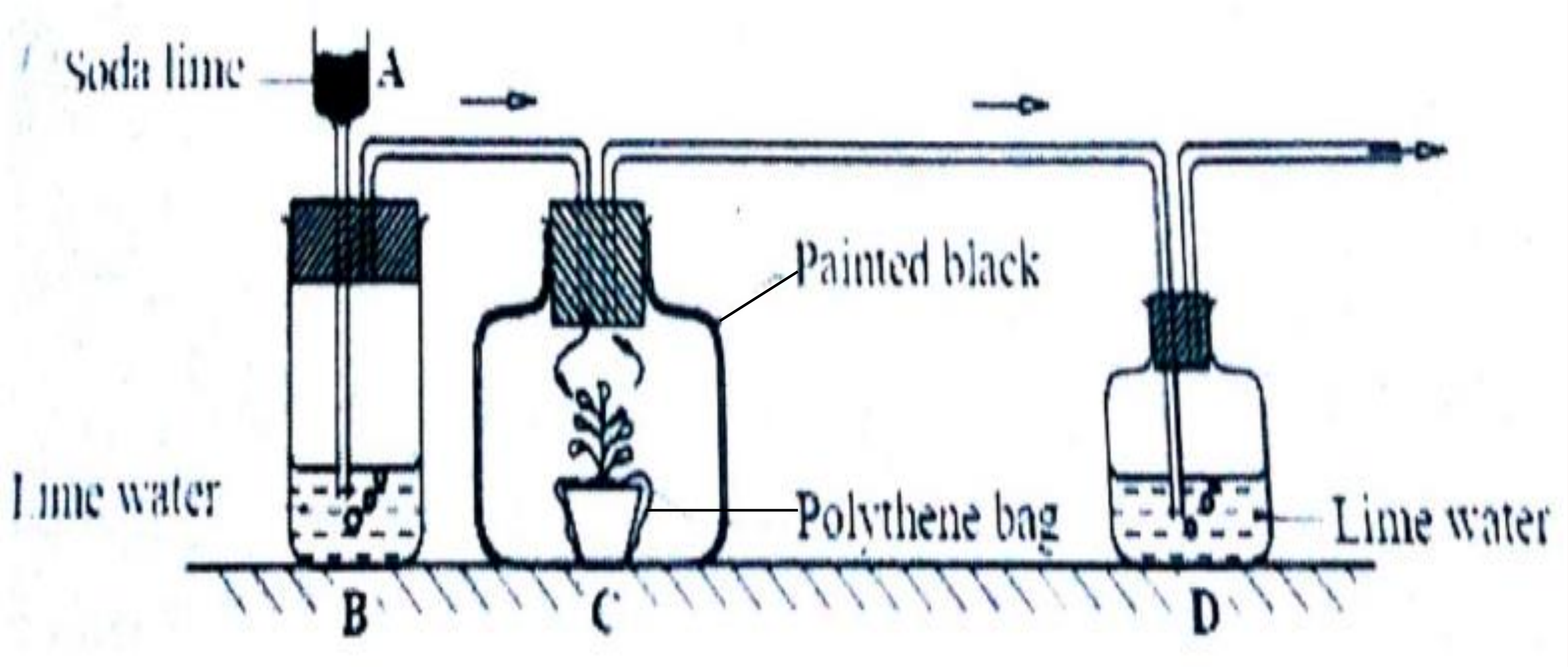
Conclusion

Carbon dioxide is given off by respiring organisms

Note

A potted plant can also be used in vessel C but must be blackened out to prevent photosynthesis from taking place. The pot must be enclosed with an impermeable material so that respiration of the organisms in soil does not affect the results.

SET UP


Soda lime
A
Painted black
Lime water
Polythene bag
Lime water
B
C
D

QNS:

1. Suggest the aim of the experiment. **(01mark)**
2. State the role of each of the following substances used in the experiment
   (i) Soda lime in **A** **(01mark)**
   (ii) Lime water in jar **B** **(01 mark)**
3. Explain what was observed in
   (i) Jar **B** **(02 marks)**
   (ii) Jar **D** **(02 marks)**
4. Explain why;
   (i) Jar **C** was painted black. **(02 marks)**
   (ii) The pot containing the plant was enclosed in a polythene bag. **(02 mark)**

Experiment 4: To show that germinating seeds release heat (energy) during respiration

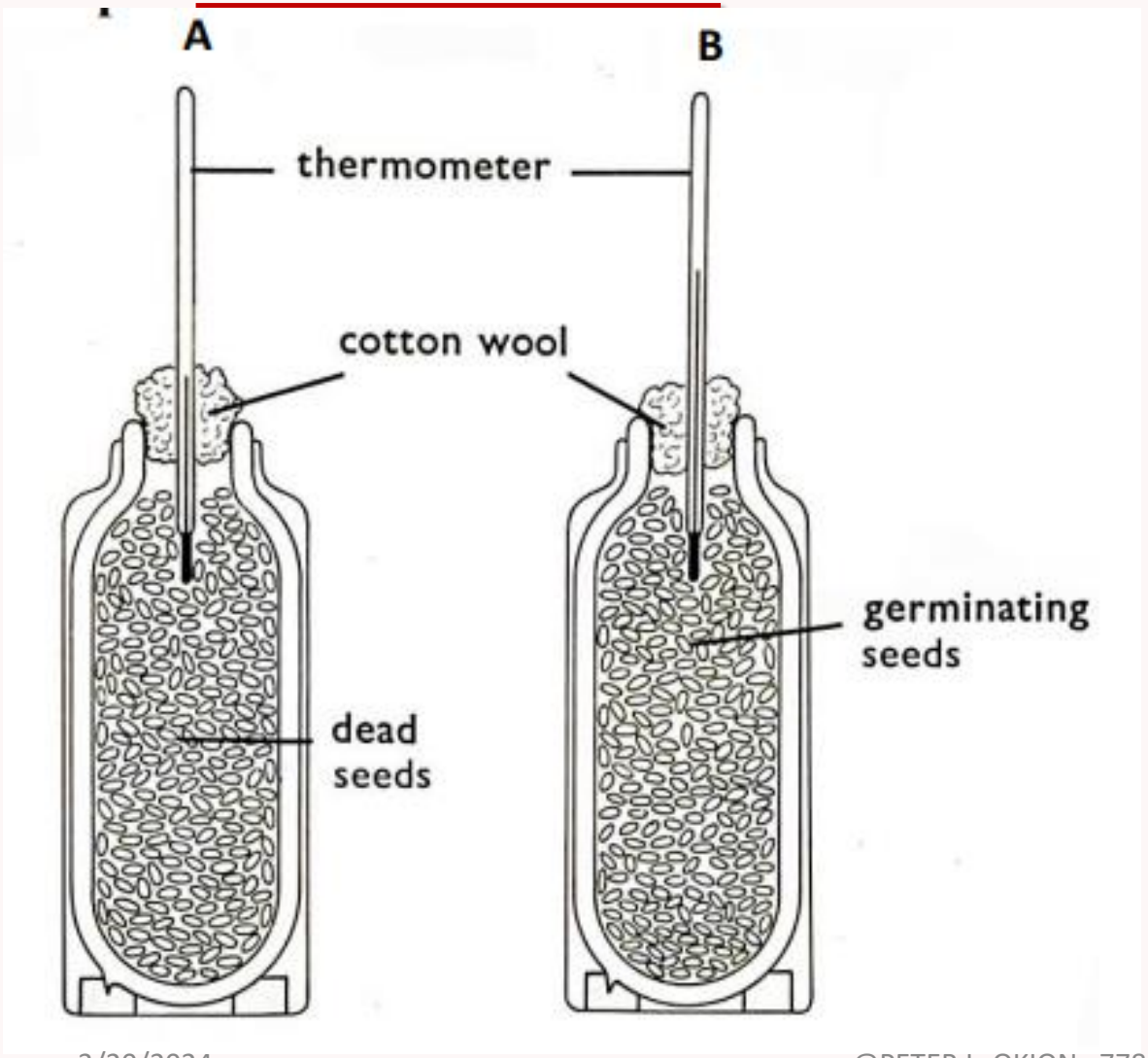
Materials

- ✓Soaked bean seeds
- ✓Vacuum flasks
- ✓Thermometers
- ✓Cotton wool
- ✓Sodium hypochlorite or jik
- ✓Heat source

Procedure

- ❑Sufficient amount of seeds to fill two small vacuum flasks are soaked in water for 24 hours and half of them are killed by boiling for 10 minutes.
- ❑Both lots of seeds are soaked for 15 minutes in a solution of sodium hypochlorite to kill fungal spores on the grains. The seeds are rinsed with tap water.
- ❑The living seeds are placed in flask A and the dead in flask B.
- ❑The thermometers are inserted and the mouths of flasks plugged with cotton wool.

SET UP



Result

After a few days the temperature in the flask with living seeds will be considerably higher than the control.

Conclusion

During germination of seeds, heat energy is released

Experiment 5: To show that oxygen is used up during respiration

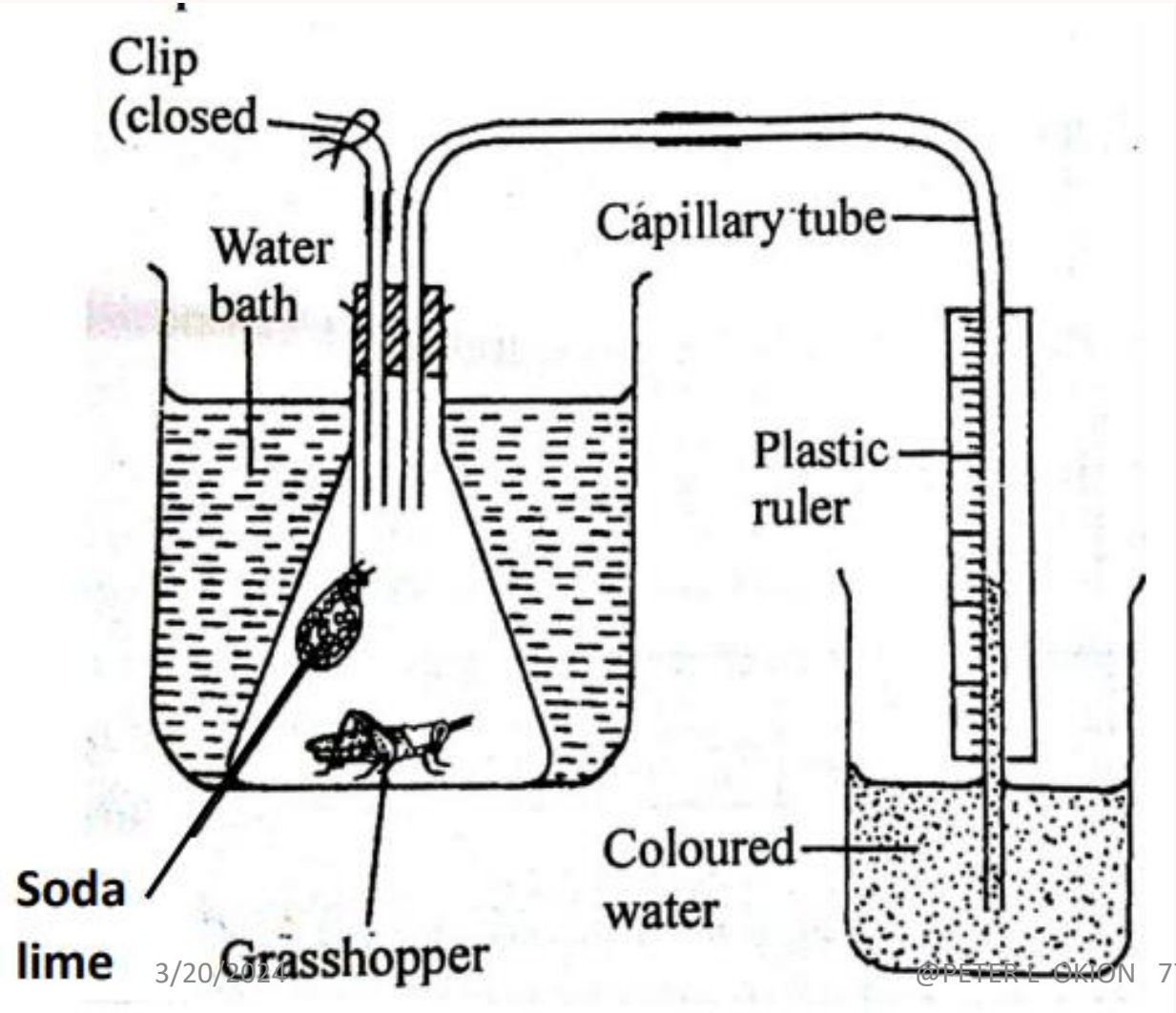
Materials

- ✓Small animal
- ✓Cotton wool
- ✓Soda lime
- ✓Colored water
- ✓Test tubes
- ✓Water bath
- ✓Capillary tubes
- ✓Screw clip
- ✓Rubber bang

Procedure

- ❑Small animal is placed in one test tube and covered with cotton wool
- ❑Soda lime is placed at the top of cotton wool in each test tube to absorb carbon dioxide gas from the test tube.
- ❑A capillary tube is used to connect each test tube to the container containing colored water.
- ❑The setup is placed in a water bath to maintain favorable temperature for metabolism
- ❑The setup is left to stand for 5 days

SET UP



Observation

The colored water rises in capillary tube from the container connected to the test tube with small animal.

Explanation

Small animal uses up oxygen from the test tube and create a vacuum so the colored water rises in the capillary tube.

Anaerobic respiration

Lactic acid

Aerobic respiration

When the body is able to supply the cells with the oxygen and glucose that they need, it carries out aerobic respiration.

Anaerobic respiration

When the body cannot supply the cells with the oxygen needed to break down glucose, then it has to carry out anaerobic respiration. Energy is released without oxygen:

Dfn:

This is the chemical breakdown of food materials in a cell to release energy in **absence of oxygen.**

The food substrate for anaerobic respiration is **glucose and fat**.

The products are; **lactic acid, water and energy in animals** while **in plants, ethanol (alcohol), carbon dioxide and energy** are formed i.e.

In animals: **Glucose → Lactic acid + Water +Energy**

In plants: **Glucose → carbon dioxide + Ethanol + Energy**

Lactic acid in animals and ethanol in plants are formed due to **incomplete break down of glucose.**

The incomplete breakdown of food means that **less energy** is made available during anaerobic respiration than is released during aerobic respiration.

The first stage in the breakdown of glucose is anaerobic i.e.

Glucose → Lactic acid + Water +Energy

The products of anaerobic respiration are then oxidized to carbon dioxide and water. i.e.

Lactic acid → carbon dioxide + Water

Examples of conditions where anaerobic respiration occurs in animas

- ✓ During vigorous or strenuous exercise such as flying in insects and birds and muscular exercise such as running.
- ✓ At high altitudes
- ✓ Reduced blood volume and pressure due to slow heartbeat. Some organs and tissues don’t receive sufficient oxygen thus carry out anaerobic respiration.

Lactic Acid Fermentation in Muscles

This occurs during ***vigorous muscular activity*** when blood is ***unable to supply enough oxygen*** to the ***skeletal muscles***.

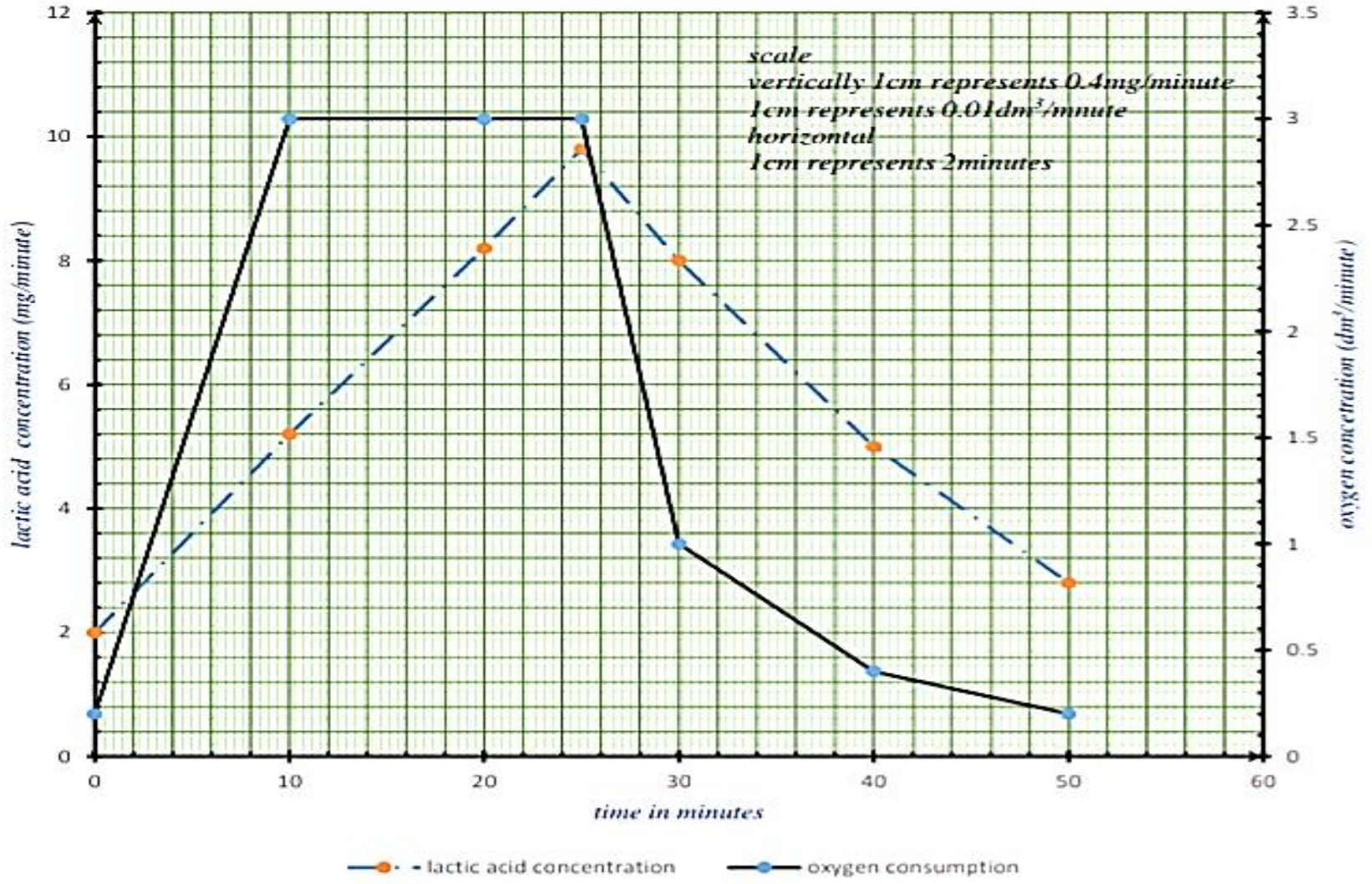
This results in muscle fibres producing **lactic acid** as a result of anaerobic respiration, resulting in ***pain and muscle cramps***.

Lactic acid is **poisonous** so must be removed.

It is taken to the **liver** by blood where it is broken down into **water and carbon dioxide and energy in presence of oxygen.**

The extra oxygen required to breakdown lactic acid to carbon dioxide and water is ***oxygen debt*** and results in rapid rate of breathing that arises after a race or any vigorous activity.

Graphs showing the variation of lactic acid concentration and oxygen concetration in blood of an athlete with time



- For the above information, the exercise lasted for 25 minutes.

✓ During exercise, the oxygen consumption increased rapidly for the first 10 minutes. The oxygen is being used during aerobic respiration to supply energy required for contraction of muscles.

✓ After exercise, oxygen consumption decreases. The extra oxygen is used for breakdown of lactic acid by liver cells into carbon dioxide, water and energy.

✓ During exercise, Lactic acid concentration increased rapidly. Oxygen supply to skeletal muscles by blood is less than demand, therefore the muscle cells resort to anaerobic respiration to supply energy for exercise resulting into formation of lactic acid.

✓ Beyond 25 minutes, lactic acid concentration decreases rapidly. Oxygen debt is supplied/paid which is utilized to breakdown lactic acid into carbon dioxide, water and energy.

Sample question

The concentration of lactic acid in blood during and after a ten minutes race was determined. The results are shown in the table below;

Time (minutes)	0	10	15	30	40	55
Lactic acid concentration ($mg/100cm^3$)	20	80	96	72	54	52

a) Plot a graph of lactic acid concentration against time (6 marks).

b) Describe the shape of the graph (4 marks).

c) Explain the variation of lactic acid as shown by the graph (6 marks).

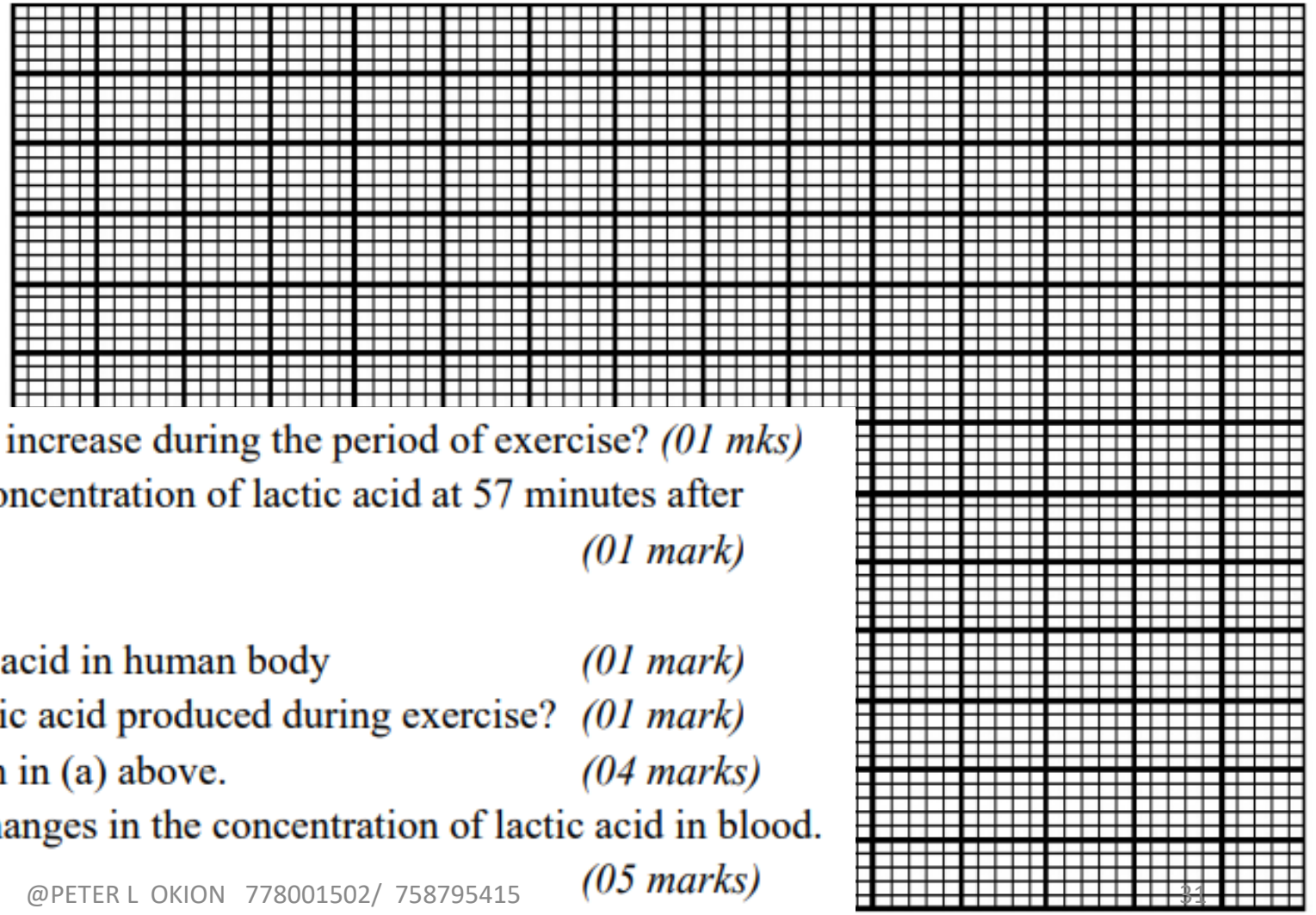
d) Determine the lactic acid concentration at 25 minutes (1 mark).

Sample question

An investigation was carried out into the concentration of lactic acid in the blood of human before, during, and after a vigorous exercise. The results are summarized in the table below.

Time (minutes)	**−10**	***0***	***10***	***15***	***20***	***40***	***60***	***80***
Concentration of lactic acid (mg/100cm^3)	***9***	***14***	***80***	***95***	***70***	***35***	***22***	***18***

a) Represent the above information on a suitable graph (07 marks)



b) (i). By how much did the lactic acid increase during the period of exercise? *(01 mks)*

(ii). From your graph, estimate the concentration of lactic acid at 57 minutes after commencing the exercise? *(01 mark)*

c) State:

i. The process that produces lactic acid in human body *(01 mark)*

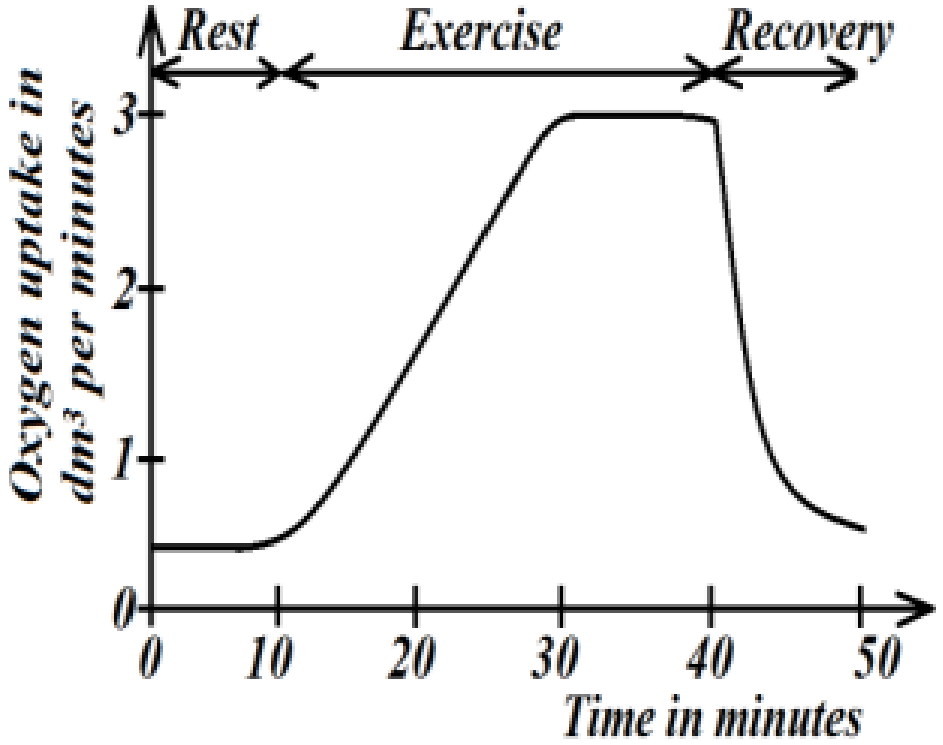
ii. Where in the human body is lactic acid produced during exercise? *(01 mark)*

d) (i) Describe the shape of your graph in (a) above. *(04 marks)*

(ii) Give reasons for the observed changes in the concentration of lactic acid in blood. *(05 marks)*

Sample question

1. The graph below shows the volume of oxygen taken by human before, during and after exercise per minute.



a) State the major type of respiration taking place during:
   i. Resting
   ii. Exercise
   iii. Recovery *(03 marks)*

b) Describe the changes in oxygen uptake during:
   i. Exercise *(02 marks)*
   ii. Recovery *(02 marks)*

c) Explain the changes in the oxygen uptake during:
   i. Exercise *(04 marks)*
   ii. Recovery *(03 marks)*

d) Explain why the ventilation rate increases during exercise. *(03 marks)*

e) Suggest why the person's heart rate also changes during exercise. *(03 marks)*

Anaerobic Respiration in Plants

Some plants can respire anaerobically and produce a different intermediate compound called ethanol i.e.

Glucose → carbon dioxide + Ethanol + Energy.

Certain bacteria and fungi like yeast also derive most of their energy from anaerobic respiration and the end products are frequently alcohol and carbon dioxide.

This process is called ***alcohol fermentation***

Examples of conditions under which anaerobic respiration occurs in plants and yeast.

- ✓Roots of a plant growing in water logged soils.
- ✓Fermentation of alcohol using yeast.
- ✓Impermeable seed coats during seed germination.

Experiment to demonstrate that carbon dioxide is given off during anaerobic respiration

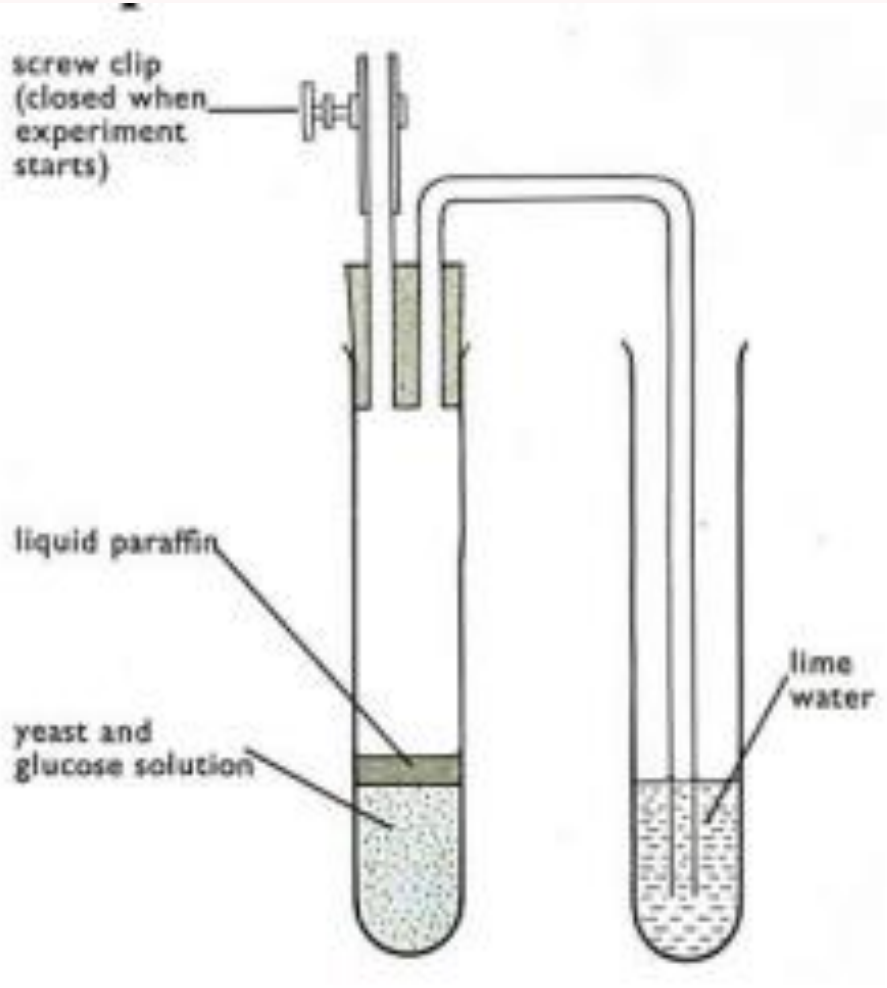
Materials

- ✓Water
- ✓Heat source
- ✓Glucose
- ✓Yeast
- ✓Test tubes or boiling tubes
- ✓Delivery tubes
- ✓Lime water
- ✓Liquid paraffin

Procedure

- ❑A given amount of water is boiled to drive out all the dissolved oxygen
- ❑The water is cooled and used to make up a 5% solution of glucose and a 10% suspension of dried yeast.
- ❑A mixture of 5 cm^3 of the glucose solution and 1cm^3 of the yeast suspension are placed in a test tube
- ❑A thin layer of liquid paraffin is poured into the mixture exclude atmospheric oxygen from entering the mixture.
- ❑A delivery tube is fitted and allowed to dip into clear lime water. The experiment is left to stand for 20 minutes

Set up



Observation

After 20 minutes bubbles of a gas are seen escaping from the mixture into the lime water and turn it **milky**.

The gas is therefore carbon dioxide.

Conclusion

Carbon dioxide is given off during anaerobic respiration.

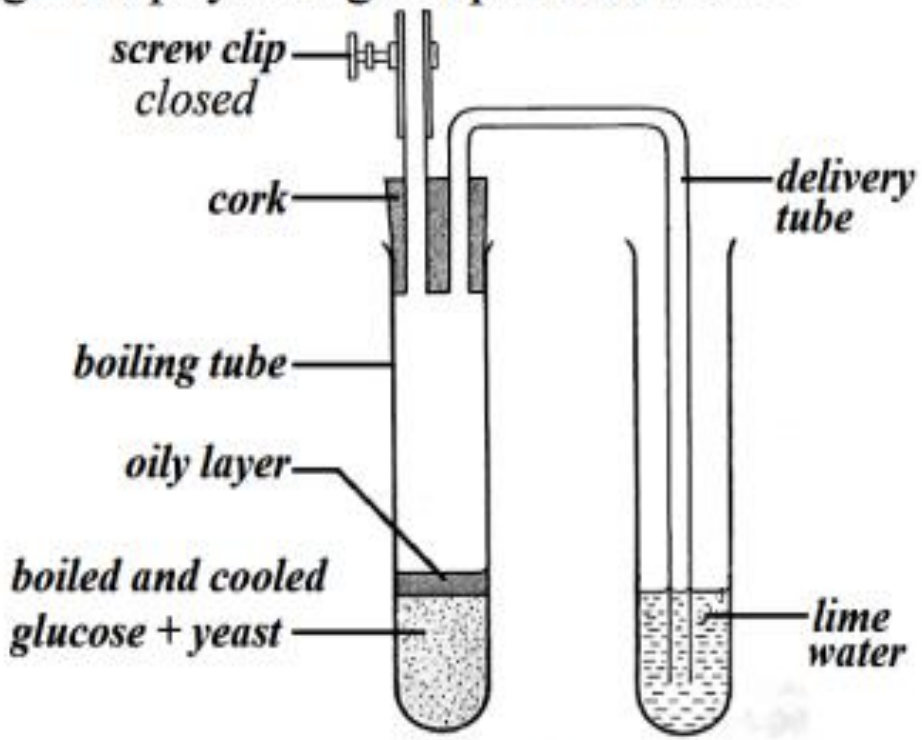
Note

A control experiment can be set up in the same way but this time using ***boiled yeast*** which ***does not ferment.***

The fact that living yeast produces carbon dioxide despite being deprived of oxygen is evidence to support the argument that anaerobic respiration is taking place.

Sample question

1. The figure below shows an experimental setup to investigate a physiological process in the yeast cell.



a) State the:
   i. aim of the experiment *(01 mark)*
   ii. process taking place *(01 mark)*

b) What is the importance of:
   i. boiling glucose solution *(01 mark)*
   ii. adding oily layer *(01 mark)*

c) (i). State what was observed in the test tube containing the limewater *(01 mark)*

   (ii). Explain your stated observation in (c) (ii) above. *(02 mark)*

d) State **3** industrial use of the physiological process stated in (a) (ii) in nature. *(02 marks)*

Commercial Application of Anaerobic Respiration

1. Production of organic acids such as vinegar and citric acid used for food processing.
2. Baking of bread where CO_2 is used to cause the dough to rise.
3. Brewing of alcoholic drinks like beer, wine, spirits and other local drinks
4. Dairy products like cheese and yoghurt
5. Biogas production (methane) using anaerobic bacteria in cow dung and other organic materials

Comparison between Aerobic & Anaerobic Respiration

SIMILARITIES

- ✓Both require glucose as a raw material
- ✓Both release energy
- ✓Both release carbon dioxide
- ✓Both take place in living cells

Differences

AEROBIC	ANAEROBIC
Occurs in most organisms	Occurs mainly in simple organisms e.g. yeast and internal parasites.
Goes on throughout life	Occurs temporarily in very active muscles in higher plants
Liberates large quantities of energy	Liberates less energy
Utilizes oxygen	Does not utilize oxygen
Products are water and carbon dioxide	Products are ethanol and carbon dioxide in plants and lactic acid in animals.
There is complete oxidation of food	There is incomplete oxidation of food.

Differences between Respiration & Photosynthesis

Respiration	Photosynthesis
Oxygen is absorbed in the process	Oxygen is liberated
Carbon dioxide is liberated	Carbon dioxide is absorbed
Takes place during day and night	Mostly occurs in presence of light
Light is not essential for the process	Light is essential for the process
Energy is released in the process	Energy is stored during the process
Chlorophyll is not necessary	Chlorophyll is necessary
There is loss of weight in plants	Gain in weight of plants
Takes place in animals and plants	Takes place in green plants only.

END

BIOLOGY IS LIFE

SLIDES PREPARED BY TR. OKION L PETER