RESPIRATION IN PLANTS

Do Plants respire ?

Yes, like all other organisms, plants too require energy for carrying out body activities. This energy is provided by respiration.

WHAT IS RESPIRATION?

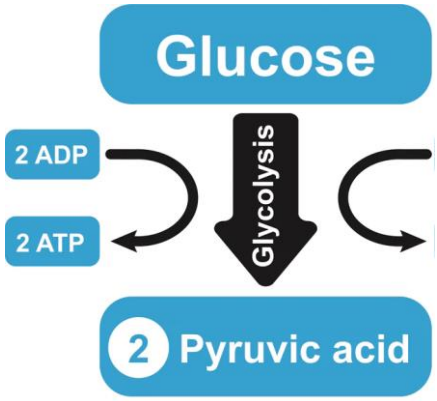
Respiration is defined as a metabolic process wherein, the living cells of an organism obtains energy (in the form of ATP) by taking in oxygen and liberating carbon dioxide from the oxidation of complex organic substances."

The energy is made available by the breakdown of glucose, a simple carbohydrate.

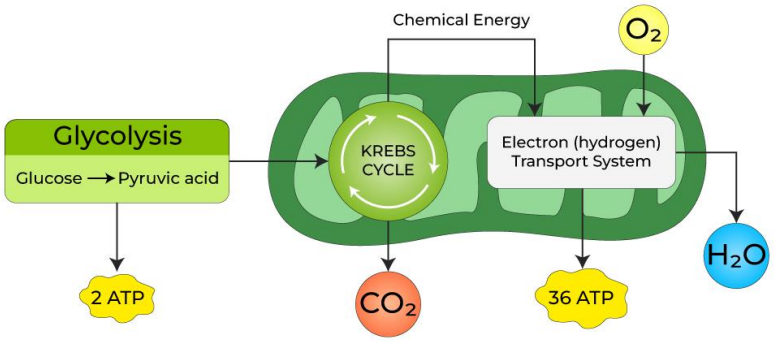
$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzyme}} 6CO_2 + 6H_2O + \text{energy}$$

3 important characteristics of respiration :

1). The breakdown of glucose to carbon dioxide and water. It occur in two major phases : -



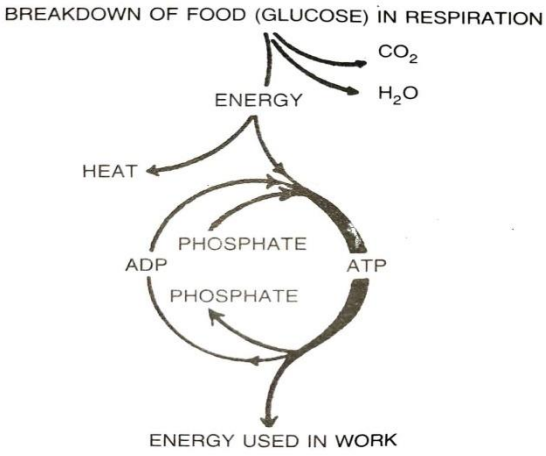
(i) Glycolysis (glucose → pyruvate) occurring in cytoplasm and



(ii) Krebs Cycle (pyruvate→ CO_2+ $6H_2O$ + ATP) occurring in mitochondria.

2. Each breakdown step is due to a particular enzyme.

3. The energy is liberated in the form of heat & ATP a chemical substance called *adenosine triphosphate.*



One mole of glucose on complete oxidation yields 38 molecules of ATP.

Two types of metabolic activities:

(i) Anabolic (constructive or biosynthetic processes), it consumes energy (ii) Catabolic (destructive or breaking down processes), it gives out energy for use by the organism.

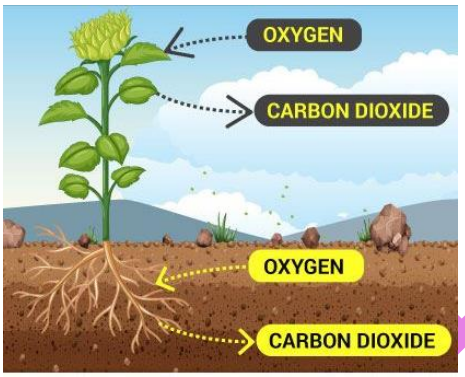
Respiration is a breaking down process by which a living cell oxidises organic substances (glucose) and releases carbon dioxide, water and energy.

RESPIRATION vs. BURNING (Combustion)

Both liberate energy, and both give the end products CO, and water. But this comparison is only superficial.

Respiration	Burning/Combustion
1. Occurs in a **series of chemical steps**	Occurs in a **single step**
2. Carried out by **enzymes**	Carried out by **heat**
3. **Biochemical** process	**Physico-chemical** process
4. Energy liberated as **ATP and some heat**	All the energy liberated as **heat** and light.
5. No light energy is produced	Light energy is produced
6. **Cellular** process	Non-cellular process
7. Occurs **at body temperature**	Occurs **at high temperature** (at ignition point)

THE ENTIRE PLANT RESPIRES



Every part of a plant respires. Three main inlets are:

- **stomata in leaves**
- **lenticels in stem**
- **general surface of the roots**

- **Ploughing or tilling of the soil creates tiny air spaces around soil particles and provides the source of oxygen for the roots.**
- **During daytime, due to photosynthesis, the leaves produce oxygen, some of which is *used in respiration* and the rest is diffused out. The carbon dioxide produced during respiration act as a raw material for photosynthesis.**

Why Sleeping under a tree during hot mid-day is definitely good ?
We gets both oxygen due to photosynthesis and coolness due to transpiration.

TWO KINDS OF RESPIRATION - AEROBIC AND ANAEROBIC

A. Aerobic Respiration

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 38\ ATP$$
(energy/heat)

Respiration proceeds only when oxygen is available and is therefore called aerobic (or oxybiotic) respiration.

B. Anaerobic Respiration

Certain parts of the plants respire even in the absence of oxygen called anaerobic respiration (or anoxybiotic).
In this type of respiration, the glucose molecule is incompletely broken down into ethanol and carbon dioxide with the release of a small quantity of energy.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \rightarrow \underset{\text{Ethanol}}{2C_2H_5OH} + 2CO_2 + 2\ ATP$$

Certain bacteria and fungi which normally respire only anaerobically.

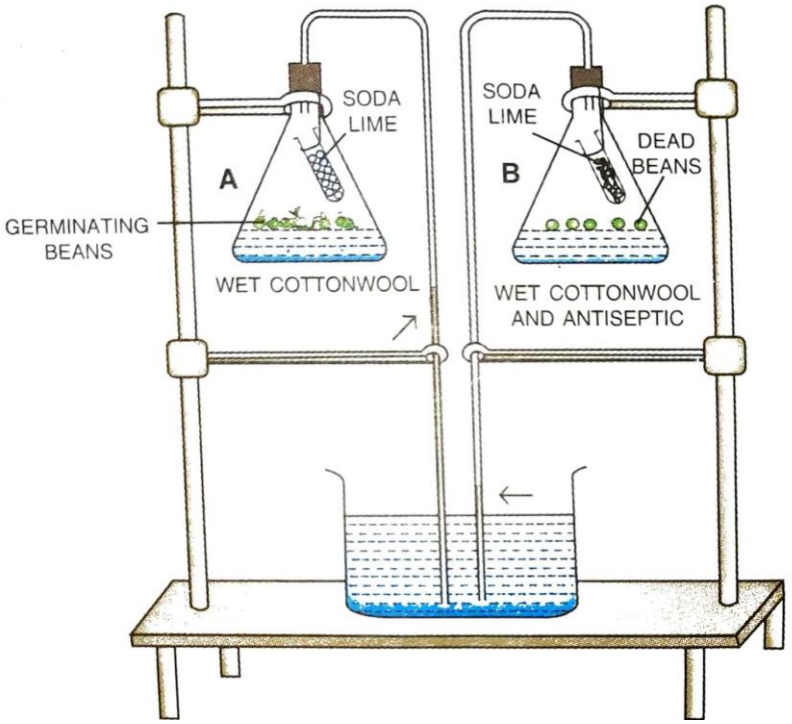
Difference Between Aerobic and Anaerobic Respiration:

Aerobic respiration	*Anaerobic respiration*
1. Proceeds in the presence of oxygen.	Proceeds without using oxygen.
2. Complete break-down of glucose.	Incomplete breakdown of glucose.
3. End-products are carbon dioxide and water.	End-products are ethyl alcohol and carbon dioxide.
4. Energy liberated in large quantity (38 ATP) from one mole of glucose.	Energy liberated in small quantity (2 ATP) from one mole of glucose.
5. Occurs normally throughout life.	Occurs temporarily for short periods.

EXPERIMENTS ON RESPIRATION IN PLANTS

1. Experiment to prove that oxygen is used up in respiration.

Flask (A) contains germinating bean seeds and Flask (B) has dead (boiled) seeds together with some antiseptic to avoid bacterial decay. Wet cotton provides water to both samples. Suspend a small tube containing soda limein each flask for absorbing any carbon dioxide. Flask (A) will show a greater rise in water level. The burning flame is immediately put off in flask (A), but it continues for a short while in flask (B). This proves that oxygen was absent in flask (A) showing thereby that it was used up by the germinating seeds .



2. Experiment to prove that carbon dioxide is produced during respiration in germinating seeds.

Take two flasks A and B. Place some wet cotton- wool at the bottom of each flask. Soaked seeds are placed in flask (A) and an equal number of boiled (dead) seeds are placed in flask (B) A little antiseptic (such as carbolic acid) is added to flask (B) to prevent bacterial growth on dead seeds. A few days later, the seeds in flask (A) will be found to have clearly germinated and those in flask (B) showing no signs of any germination. The gas from flask (A) would turn the lime- water milky, showing the presence of carbon dioxide in it, while the gas in flask (B) will show no effect. Therefore, the conclusion is that the germinating (respiring) seeds give out carbon dioxide.

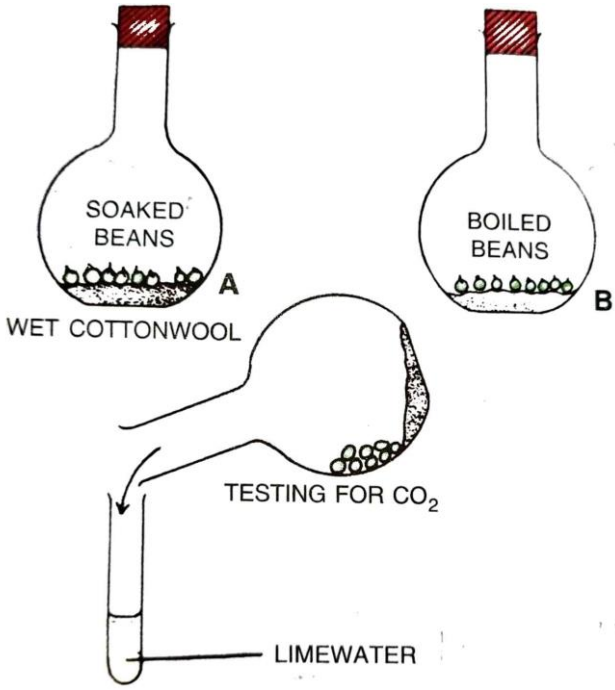
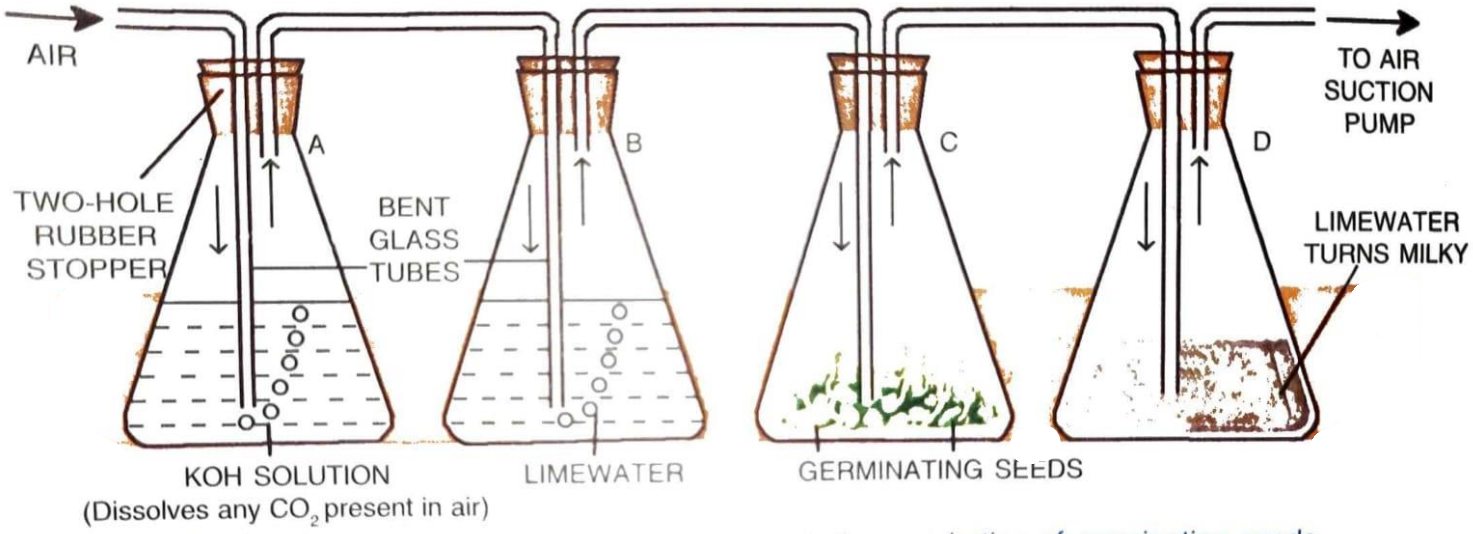


Fig. 7.3 Experiment to show the production of ›on dioxide in germinating seeds.

An alternative method for the same experiment



To show that carbon dioxide is given out during respiration of germinating seeds.

A similar more directly observable experiment to show that carbon dioxide is produced during respiration in germinating seeds. The air drawn in conical flask A is cleared of any CO, present in it. The clear limewater in flask B confirms that the air entering flask C is CO, free.

The limewater in flask D turning milky doubtless proves that the source of CO, was only the germinating seeds.

3. Experiment to prove that carbon dioxide is produced by green plants during respiration.

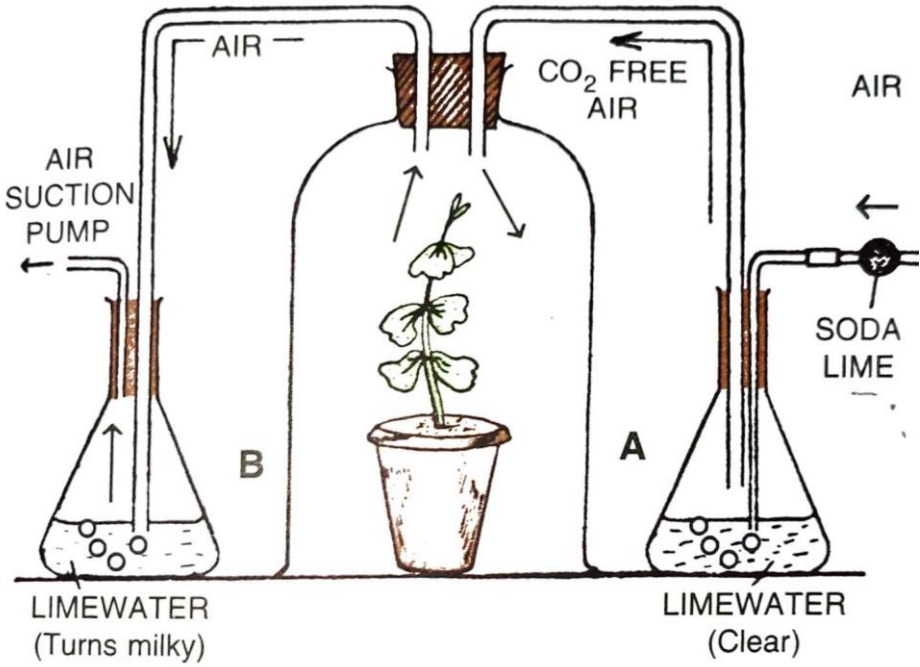


Fig. 7.5 Experiment to show that carbon dioxide is given out by a green plant during respiration.

The bell-jar over a potted plant should be placed on a glass sheet and its rim as well as all other connections should be vaselined to make them air-tight. The outside air is drawn into the apparatus with the help of an air pump. This air passes through the soda-lime which absorbs any carbon dioxide present in the incoming air, and the limewater (Flask A) through which it passes will not turn milky. As the air leaves the bell-jar, and passes through another sample of limewater (Flask B), the carbon dioxide present in it would turn the limewater milky. It is necessary that this experiment is carried out in the dark, or the bell-jar is completely covered by a piece of black cloth to prevent photosynthesis .

4. Experiment to show that heat is evolved during respiration.

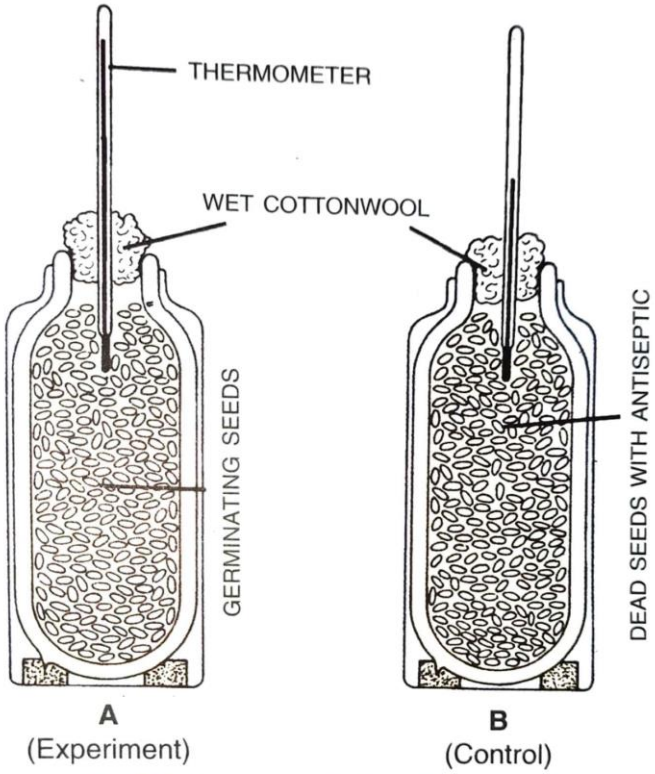


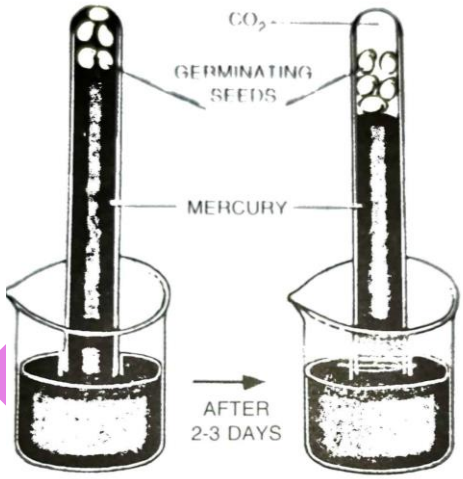
Fig. 7.6 Experiment to show liberation of heat during germination.

Take two thermos-flasks and mark them (A) and (B). Take about 200 seeds and soak them in water for more than 24 hours.
Divide the seeds into two equal groups. Kill <u>one group of seeds by boiling</u> them, and then wash them with dilute formalin or carbolic acid to prevent bacterial decay. Put the live germinating seeds in flask (A) and the killed ones in flask (B). Insert a thermometer in each flask and plug their mouths with cotton wool. After a

few hours, the thermometer in flask-A will show a higher reading, thus indicating that the germinating (live and respiring) seeds give out heat. The thermometer in flask (B) will not show any rise in temperature.

5. Experiment to demonstrate anaerobic respiration.

Take eight to ten soaked and peeled off peas and push them into the mouth of a test-tube filled with mercury and inverted in a beaker of mercury. The seeds will float to the top and will be completely surrounded by mercury. After about two days, the level of mercury in the test-tube will fall and the liberated gas will be found to be carbon dioxide. A similar control experiment could be set up in which the seeds may be kept after killing them by heating and sterilizing them with some antiseptic.
No gas will be liberated in the control.



Experiment to demonstrate anaerobic respiration

RESPIRATION CONTRASTED WITH PHOTOSYNTHESIS

	PHOTOSYNTHESIS	RESPIRATION
1.	Occurs only in the presence of chlorophyll.	Occurs in all living cells.
2.	Occurs only in the presence of light.	Occurs at all times.
3.	Uses carbon dioxide and water.	Uses oxygen and glucose.
4.	Oxygen is released as an end product.	Carbon dioxide is released as end product.
5.	Light energy is converted into chemical energy and stored.	Chemical energy is partly converted into heat and partly into useful energy for various activities.
6.	Results in gain in weight.	Results in weight loss.
7.	Food (glucose) manufactured. (Constructive process, anabolic)	Food (glucose) broken down (oxidised, destructive or katabolic)

RESPIRATION IN PLANTS COMPARED WITH RESPIRATION IN ANIMALS

The basic aspects of respiration are same in all organisms.

(i) there is *no gaseous transport*, the respiratory gases simply diffuse in and out by cell to cell diffusion. (In animals, the blood transports respiratory gases).

(ii) one of the end products of anaerobic respiration in *plants is ethanol/ethyl alcohol* while in animals it is lactic acid.

(iii) in plants the process produces *little heat* as compared to animals.