Ratna Sagar

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Education, Our Mission

As per the latest ICSE syllabus

Rama Sagar
Education, Our Mission!

Revised and Updated

LIVING SCIENCE BIOLOGY

D K Rao • J J Kaur

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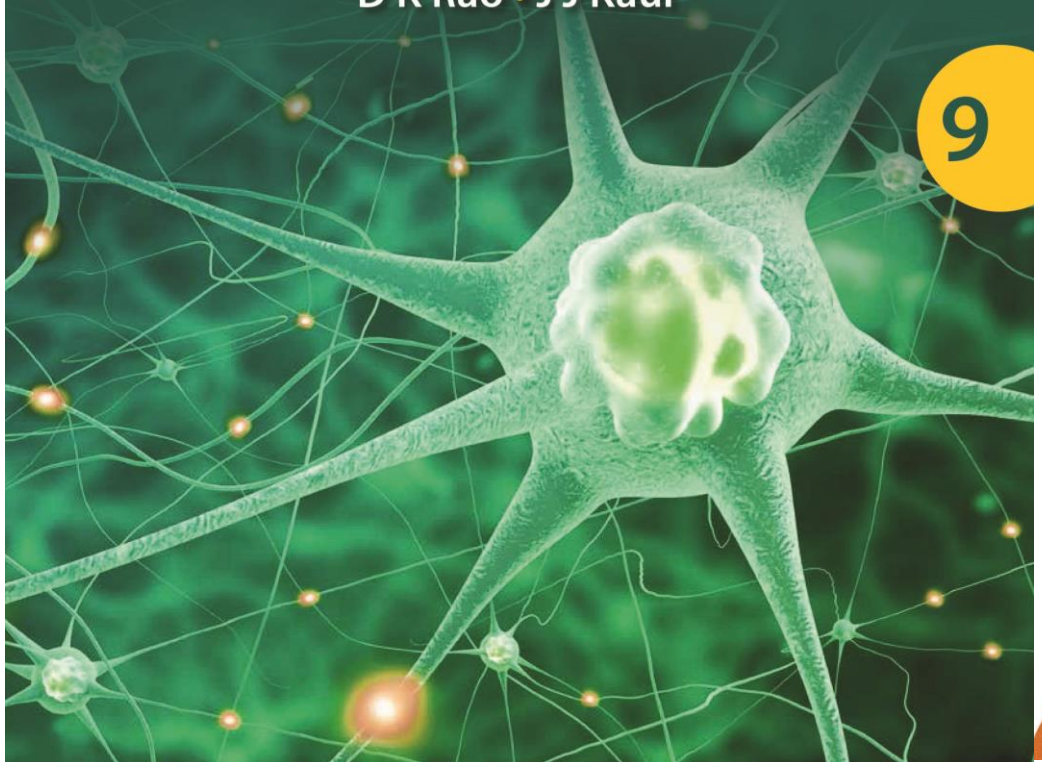

ICSE
Living Science
Biology

Class 9

Chapter 14 The Respiratory System

LEARNING OBJECTIVES

Breathing and Respiration

What is respiration?

- The respiration occurs in two phases in cells

Types of respiration

- Aerobic respiration in animals
- Anaerobic respiration in animals

Respiratory system in human beings

- Nostrils and nasal cavity
- Pharynx, Larynx , Trachea
- Bronchi and bronchioles, Lungs

The breathing mechanism

- Inhalation (Breathing in or inspiration)
- Exhalation (Breathing out or expiration)

Gaseous exchange in lungs and tissues

- Gaseous exchange in lungs
- Gaseous exchange in tissues
- When does a person's breathing rate increase?

Lung capacities

What is respiration?

The process of releasing energy by breaking down (oxidation) glucose for carrying life processes is termed as respiration.

Breathing and Respiration

Respiration is a **catabolic process**. It may be divided into two steps:

❖ **Breathing** or **external respiration** involves **breathing in** (inhalation) **of air containing oxygen** and **breathing out** (exhalation) **of carbon dioxide** produced during oxidation of food.

❖ **Internal** or **cellular respiration** involves **release of energy by oxidation of food** (glucose), and conversion of the energy released into a biologically usable form, such as ATP (adenosine triphosphate) inside the cell.

What is respiration?

Respiration is a chemical process of releasing energy by the break down of glucose molecules for carrying out life processes. The energy released is in the form of ATP.

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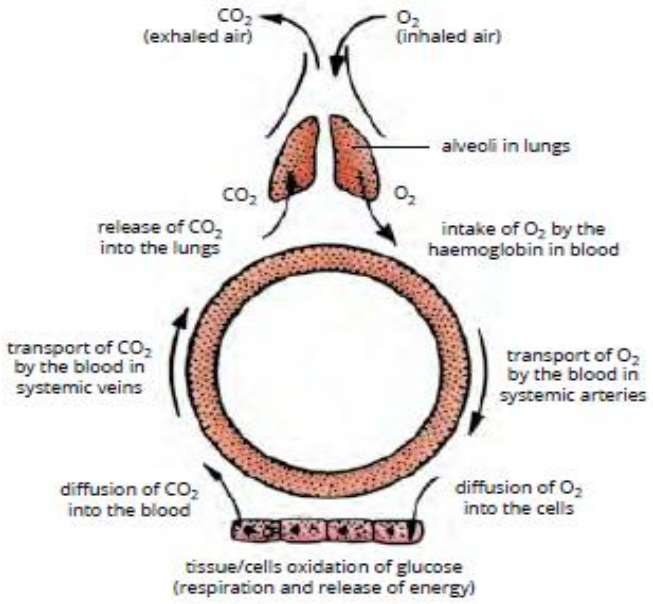
The compounds which are oxidized during the process of respiration are known as **respiratory substrates** (for example, glucose).

❖ **Cellular respiration:** In this, carbohydrates and other metabolites are broken down with the simultaneous build-up of ATP. The process of **oxidation** of food **occurs in** the **mitochondria** of the cell.

❖ Glucose is broken down in the presence of oxygen to CO_2 and H_2O and in turn ATP is released.



The respiration occurs in two phases in cells

1. Glycolysis, which involves breakdown of glucose into pyruvate, occurs in **cytoplasm** of cell. It **does not require oxygen** (anaerobic part of respiration).

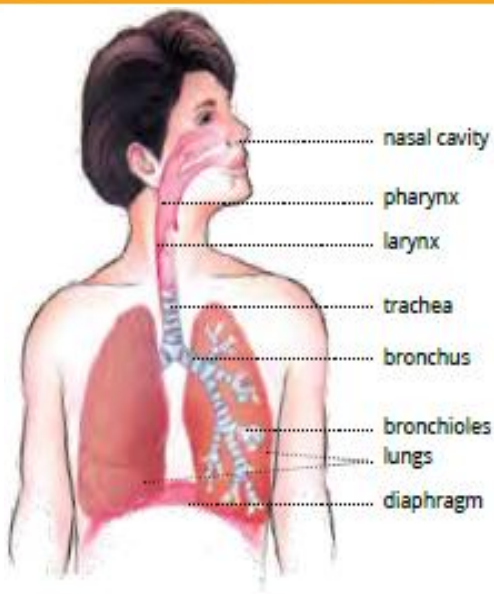
2. Krebs cycle, which involves further breakdown of pyruvate to produce ATP, CO2, occurs in **mitochondria**. It **requires oxygen** (aerobic part of respiration).

Types of Respiration

Depending upon the availability of oxygen, there are two types of respiration – **aerobic respiration** and **anaerobic respiration**.

Respiratory system in human beings

The respiratory system in human beings comprises of **nostrils, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveolar sacs or alveoli and Lungs.**



Nostrils and nasal cavity

The nasal passages opens outside through two nostrils separated by a **cartilaginous septum**. The inner surface of the nasal passage is lined by **hairy**, **ciliated epithelium** and **mucous-secreting cells**.

Pharynx

The nasal cavity opens into **pharynx** located at the back of the mouth. From the nasal cavities, the air moves into the pharynx which is a **common area to both the digestive and respiratory tracts**. The pharynx opens into the **larynx** or **voice box** which leads to the trachea.

It is also connected to the **oesophagus** or **food pipe**. A cartilaginous flap called **epiglottis guards the entrance to trachea**. **When we swallow some food or drink water, the epiglottis covers the trachea to prevent food or water from entering the respiratory tract.**

Larynx

The **larynx** or **voice box** (also known as **‘Adam’s apple’**) is a cartilaginous box-like structure, located at the tracheal opening. It is hollow from inside. **When we swallow some food material, the larynx moves up or down allowing safe passage of air or food.**

Trachea

The **trachea** or **windpipe** is a tube that extends from larynx into the thoracic cavity. It lies on the ventral side of the oesophagus. **Its wall is provided with incomplete C-shaped cartilaginous rings**. These **keep the trachea in dilated position** and **prevent it from collapsing**.

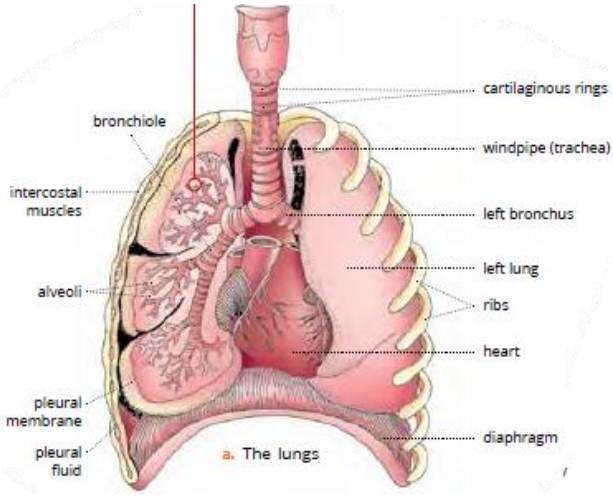
The ciliated epithelial lining and the mucous-secreting cells extend from the nasal cavities up to the trachea. They help in preventing any dust particle or microbe from entering the lungs.

Bronchi and bronchioles

At its lower end, the trachea divides into two tubes called **bronchi**. **The right bronchus is divided into three bronchi** which extend separately into three lobes of the right lung. Similarly, **the left bronchus is divided into two bronchi** penetrating into the two lobes of the left lung.Within the lung, **each bronchus is divided many times into bronchioles**.

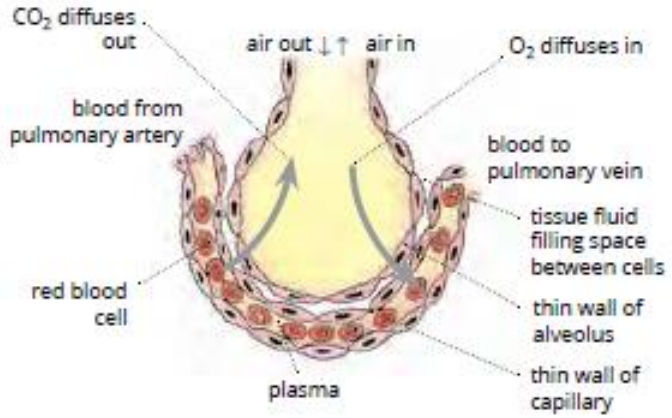
Lungs

The lungs are a pair of highly elastic, hollow, membranous bag-like structures situated in the thoracic cavity along with the heart. The broad lower surface of the lungs rests on a sheet of muscle called the **diaphragm** which forms the floor of the thoracic cavity. **The right lung is larger than the left one**. The right lung is divided into three lobes whereas the left lung has two lobes.



Blood supply to lungs

The right auricle receives the deoxygenated blood and sends it to the lungs through the pulmonary artery. The pulmonary artery divides into two branches, each branch entering the respective lung. These branches further subdivide several times to form capillaries.



These capillaries are arranged around the air sacs. The veins arising from these capillaries join several times and form two pulmonary veins. Two pulmonary veins arise from each lung. These pulmonary veins pour the oxygenated blood into the left auricle of the heart

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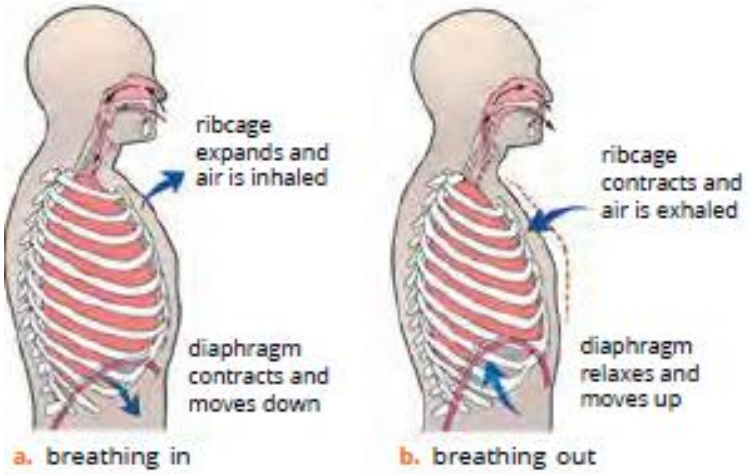
The breathing mechanism

Breathing has a cyclic pattern. **Air is passed into and out of the lungs by alternate expansion and contraction of the thoracic cavity.** This is brought about **by movements of the intercostal and diaphragm muscles** which alter the volume of the thoracic cavity.



Breathing has two steps:
1. Inhalation or inspiration **2.** Exhalation or expiration

Inhalation (Breathing in or inspiration)

Inhalation or breathing in involves contractions mainly of the diaphragm and external intercostal muscles. As the lungs expand, the air pressure in them reduces and air rushes into them from the atmosphere through the air passages.

Exhalation (Breathing out or expiration)

Exhalation or breathing out, is brought about by relaxation of the intercostal and diaphragm muscles. The air rushes out of the lungs because the pressure inside the lungs becomes greater than atmospheric pressure.

Gaseous exchange in lungs and tissues

Gaseous exchange is the main objective of the respiratory system. The process involves exchange of oxygen and carbon dioxide between the lungs and blood and between blood and body cells.

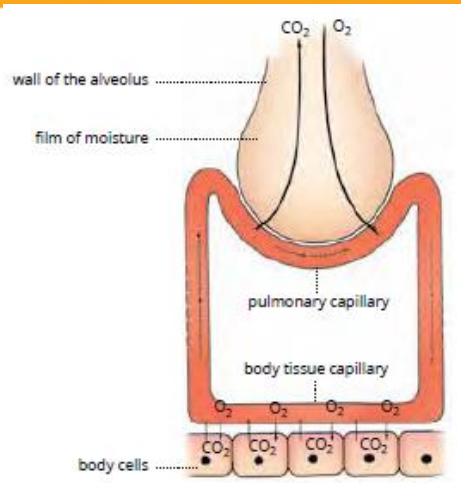
Gaseous exchange in lungs

The concentration of oxygen in lung alveoli is higher than that in the deoxygenated blood in capillaries. This difference causes oxygen to diffuse from the alveoli into the lung capillaries since diffusion continues as long as the molecules concerned are unequally distributed. The blood contained in the capillaries has a high concentration of carbon dioxide which it has absorbed from body tissues. Therefore, carbon dioxide diffuses out from blood capillaries into the alveoli.

Gaseous exchange in tissues

In tissues, oxygen is used up in various metabolic activities and carbon dioxide is produced.

Hence, in tissues the concentration of oxygen is less than that in the capillaries, whereas, carbon dioxide is present in a greater concentration in tissues than in capillaries. Therefore, oxygen diffuses from blood in capillaries to the tissues (body cells) and carbon dioxide diffuses from body cells to the capillaries



When does a person's breathing rate increase?

We normally breathe about 15 to 18 times per minute. The depth and (or) **frequency of breathing increases in the following circumstances**:

- During and immediately after exercise, when a lot of oxygen is used by the muscles (about 20–25 times per minute).
- **At high altitudes**, where the concentration of oxygen in the atmosphere is relatively low. The air we breathe in decreases in pressure. Thus, the person may feel air sickness, unsteady vision, loss of hearing, lack of muscular coordination at **high altitudes**.
- When the circulation is not delivering oxygen to the tissues efficiently, for example, in coronary heart disease.

Lung capacities

❖ **Tidal volume:** This is **the total amount of air breathed in and breathed out in normal unforced breathing.** The tidal volume in a healthy person is about **500 mL**.

❖ **Residual volume:** The air left in the lungs even after a forceful breathing out is the residual volume. The residual volume of air in our lungs is about **1500 mL**.

❖ **Inspiratory reserve volume:** The **maximum air that can be breathed in forcibly over and above the tidal volume** is called the **complemented air** or inspiratory reserve volume. It amounts to about **3000 mL**.

❖ **Expiratory reserve volume:** The **maximum air that can be breathed out forcibly even after an ordinary or normal expiration** is called **supplemented air** or expiratory reserve volume. It is about **1000 mL**.

❖ **Dead air space:** The air remaining in the respiratory passage is called dead air space. It is about **150 mL**.

❖ **Alveolar air:** It is the tidal air in alveoli (air sacs) It is about **350 mL**.

❖ **Vital capacity:** The **vital capacity is the maximum volume of air that can be taken in and taken out by maximum inspiration and expiration**. The vital capacity average is about **4500 mL**.

The vital capacity is generally greater in the following cases:

1. Males when compared to females

2. Adults when compared to children

3. Fit people when compared to unfit people

❖ **Total lung capacity:** The **maximum air that can be contained in both the lungs of a normal person at any time** is the total lung capacity. It is about **6000 mL**, i.e. vital capacity (4500 mL) + residual air (1500 mL).

Inspired air vs expired air

The lungs contain both oxygenated as well as deoxygenated air at any given point of time. At the time of inspiration or breathing in the amount of oxygen is more while during expiration the amount of carbon dioxide is more.

Refer to

ACTIVITY 1

To show movement of diaphragm during breathing.

ACTIVITY 2

To calculate the volume of expired air.

ACTIVITY 3

To show that oxygen is taken in by animals during respiration.

SUMMARY...

❖ Respiration which occurs in the presence of oxygen, is called aerobic respiration. If it occurs in the absence of oxygen, then it is called anaerobic respiration.

❖ Breathing is simply an exchange of respiratory gases, whereas respiration includes inhalation and exhalation (exchange of gases) along with the release of energy (oxidation).

❖ Mitochondria are the sub-cellular compartments that contain the enzymes required to control biochemical processes involved in cellular respiration.

❖ The respiratory system in human beings includes – nostrils, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveolar sacs or alveoli, and lungs.

❖ Gaseous exchange in human beings is brought about by movements of the intercostal and diaphragm muscles which alter the volume of thoracic cavity.

❖ Inspiration or inhalation is brought about by simultaneous contraction of intercostal and diaphragm muscles, whereas relaxation of these muscles brings about expiration or exhalation.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