CHAPTER - 8

RESPIRATORY SYSTEM

Points to be covered in this topic

- 8.1 Introduction
- 8.2 Respiration
- 8.3 Respiratory system
- 8.4 The lungs
- 8.5 Mechanism of respiration
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RESPIRATORY SYSTEM

8.1 INTRODUCTION

- Respiration is defined as the **exchange of gases between body tissues and the external environment.** Supply of oxygen to the tissues and excretion of carbon dioxide occur only through respiration.
- The branch of medicine that deals with the **diagnosis and treatment of diseases of ears, nose and throat** is called as **Otorhinolaryngology.**

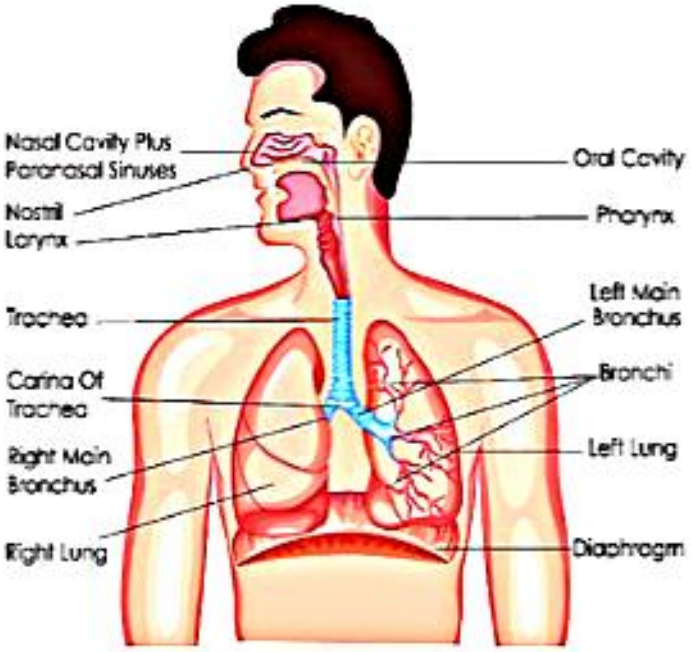

Fig.8.1: Respiratory system

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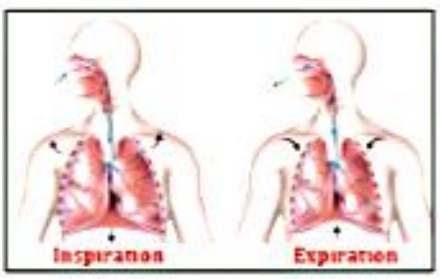
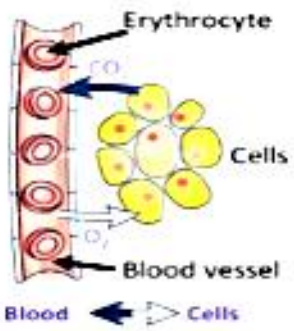
8.2 RESPIRATION

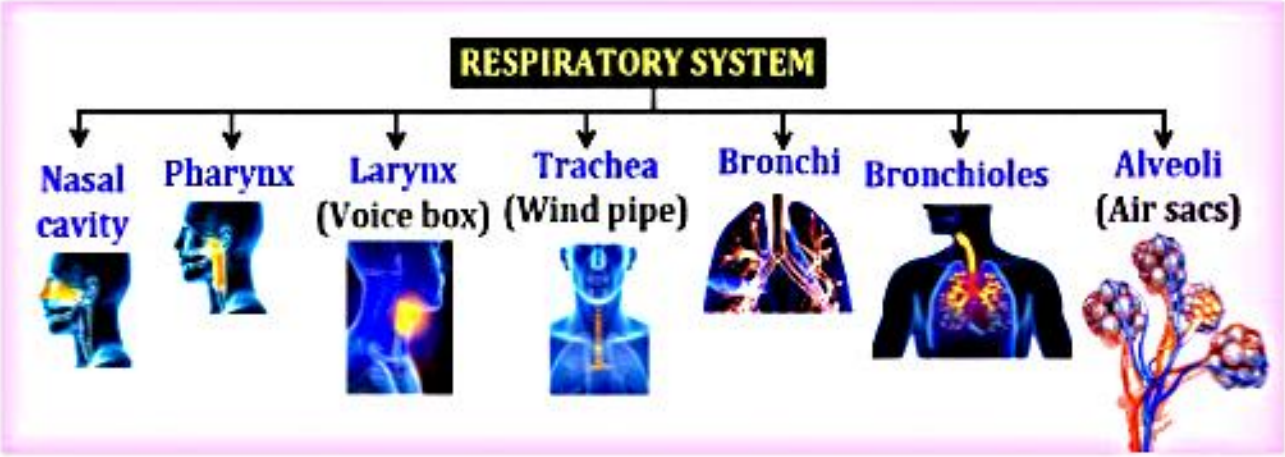
- The oxidative process occurring within living cells by which the chemical energy of organic molecules is released in a series of metabolic steps involving the consumption of oxygen and the liberation of carbon dioxide and water is called as respiration.

Table 1.1: The process of Respiration is divided into 3 different processes

PULMONARY VENTILATION	EXTERNAL RESPIRATION	INTERNAL RESPIRATION
It is the inspiration (inflow) and expiration (outflow) of air between the atmosphere and the lungs 	It is the exchange of gases between the lungs and the blood 	It is the exchange of gases between the blood and cells 

8.3 RESPIRATORY SYSTEM

- The respiratory system consists of the following structures



➢ NOSE

- The nose is a structure of the face made of cartilage, bone, muscle, and skin supports and protects the anterior portion of the nasal cavity.
- It is the external portion of respiratory system and open through the nostrils.
- The nasal cavity is divided by a septum into left and right portion.
- The nasal cavity is a hollow space within the nose and skull that is lined with hair and mucus membrane.
- The nose is lined by vascular ciliated columnar epithelium containing mucus secreting goblet cells.

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✓ Function

- The function of the nasal cavity is to warm, moisturise, and filter air entering the body before it reaches the lungs.
- Hair and mucus lining the nasal cavity helps to trap dust, mold, pollen and other environmental contaminants before they can reach the inner portions of the body.

➢ PHARYNX

- The mouth and nose open into pharynx.
- It lies just posterior to the nasal cavity, oral cavity and larynx and just interior to the cervical vertebrae.
- It is divided into three parts

i. **Nasopharynx:** - Which lies behind the nasal cavities. It contains openings for Eustachian tubes on the lateral wall.

ii. **Oropharynx:** - Which is continuous in front with mouth and below with laryngeal part of pharynx. Its lateral wall contains the tonsils.

iii. **Laryngopharynx:** - Which is the lowest part. It lies behind the larynx.

Fig.8.2: Pharynx

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✓ Function

- Passage of air and food
- Warming and humidifying the air
- Taste - the olfactory nerve endings of the sense of taste are located in the epithelium of the oral and pharyngeal parts.
- Speech - The pharynx functions in speech by acting as a resonating chamber for sound. It helps to give the voice its individual characteristics.

➢ LARYNX (VOICE BOX)

- It lies between pharynx above and trachea below. It is formed by the following cartilages
  - Thyroid cartilage which is the largest.
  - Cricoid cartilage which lies below the thyroid cartilage.
  - Two arytenoid cartilages at the back of cricoid.
  - Epiglottis attached to the top of thyroid cartilage.

✓ Functions

- Production of sound
- Acts as passageway for air.

- Protection of the lower respiratory tract by ensuring that food passes into the oesophagus and not into the lower respiratory tract.
- Larynx produces humidification, filtration and warming of air as it travels through the larynx.

➢ TRACHEA (WIND PIPE)

- It is a cylindrical tube which is about 11 cm. in length.
- It begins at the lower end of pharynx. At the level of 5th thoracic vertebra, it divides into two bronchi.
- Trachea is made of sixteen to twenty C-shaped incomplete cartilages.
- These cartilages are connected by fibrous tissue at the back. The trachea is lined by mucous membrane made of ciliated epithelium.

✓ Functions

- **Mucociliary escalator** - Mucus secreted by the goblet cells of mucosa moistens the air and traps the dust particles.
- **Cough reflex** - A nerve ending in the larynx, trachea and bronchi are sensitive to the irritation which generates nerve impulses conducted by the vagus nerve to the respiratory centre in the brain stem.
- **Warming, humidifying and filtering** - Trachea produces humidification, filtration and warming of air as it travels through the trachea.

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➢ BRONCHI

- The trachea ends by dividing into two bronchi namely right and left bronchi.
- They pass to the corresponding lung.
- The right bronchus is shorter and wider than the left. Bronchi are made of complete rings of cartilage.

✓ Functions

- The primary function is the control of air entering lungs.
- The diameter of respiratory system is altered by contraction or relaxation, thus regulating the volume of air entering the lungs.

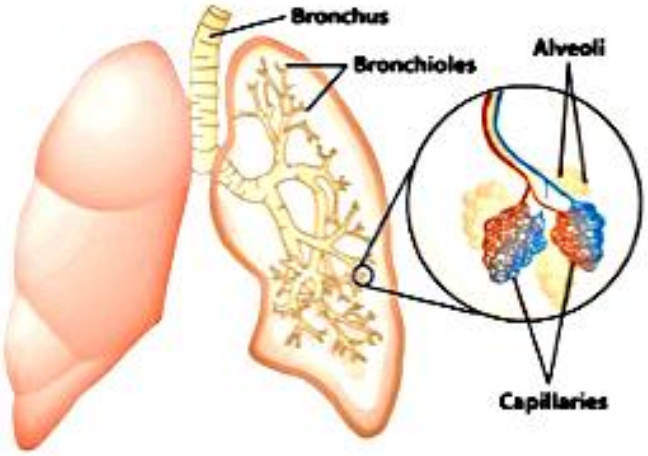

Fig.8.3: Bronchi, Bronchioles and Alveoli

➢ BRONCHIOLES

- They are formed by the division of bronchi.
- Bronchioles are the finest branches of bronchi.
- Bronchioles do not have cartilage. They are lined by cuboidal epithelium.

✓ Functions

- The bronchioles is to deliver air to a diffuse network of around 300 million alveoli in the lungs.

➢ ALVEOLI (AIR SACS)

- They are the final terminations of each bronchi.
- They contain a thin layer of epithelial cells surrounded by numerous capillaries.

✓ Functions

- Exchange of gases takes place through the walls of these capillaries

8.4 THE LUNGS

- Lungs are the principal organs of respiration. They are two in number lying one on each side of the chest cavity. The two lungs are separated in the middle by Heart and other structures of Mediastinum.

➢ Shape

- Lungs are conical in shape.
- The apex of the lung is above, rising slightly over the clavicle.
- The base of the lung is near the diaphragm.

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Lobes

- Each lung is divided into lobes by means of fissures.
- The right Jung, which is bigger, has three lobes.
- The left lung has two lobes.
- Each lobe is composed of a number of lobules.
- Each lobe contains a small bronchial tube.
- This tube divides and subdivides and ends finally in air sacs.

Pleura

- It is a serous membrane which covers the lungs.
- It is made of two layers.
- The inner layer is called as "Visceral layer".
- It is very close to the lungs. The outer layer is called as the "Parietal layer".
- The space between these two layers is filled with " Pleural fluid".

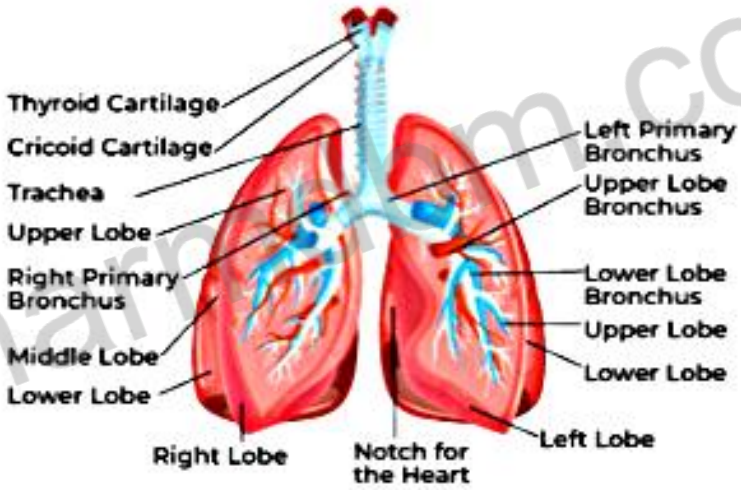

Fig.8.4: Lungs

ROOT OF THE LUNGS

- The medial surface of each lung has a vertical slit called the "Hilum". Structures like blood vessels, nerves and lymphatics pass through the hilum. These structures together constitute the root of the lung. The root of the lung is formed by:
- **Pulmonary arteries** :- Which carry impure (deoxygenated) blood to the lung from heart.
- **Pulmonary veins** :- Which carry oxygenated blood from lungs to the heart.

- **Bronchial arteries** :- Which are branches of thoracic aorta. They carry arterial blood to lungs.
- **Bronchial veins** :- Which return venous blood of lungs to superior vena cava.
- **Bronchi** :- Which divide into bronchioles.
- **Lymphatic vessels (Lymph glands)** :- The superficial, subpleural lymphatic network collects the lymph from the peripheral mantle of lung tissue and drains it partly along the veins toward the hilum.
- **Nerves** :- Sympathetic and vagus nerves which supply the lungs.

8.5 MECHANISM OF RESPIRATION

- Respiration involves two stages

1. Inspiration

2. Expiration

1. Inspiration (or breathing IN)

- It is an active process. It is produced by the contraction of the following muscles:
- Diaphragm, the contraction of which enlarges the chest cavity vertically (i.e., from above downwards).
- Intercostal muscles when contract produce elevation or ribs and sternum. This enlarges the chest cavity in all the other four sides.
- The lungs expand at this stage and fill this in- creased space. Now, the pressure in the lungs is less than atmospheric pressure. So, air flows into the lungs.

2. Expiration (or breathing OUT)

- It is a passive process. It is produced by the relaxation of diaphragm and intercostal muscles. This produces reduction in the size of chest cavity. So, the pressure in the lungs increases which forces the air out.
- The rate of respiration is 16 to 18 per minute in adults. The rate is higher in children

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8.6 RATE OF RESPIRATION

8.7 REGULATION OF RESPIRATION

- Respiration is regulated by two controls

i. Nervous control

- It is exerted by respiratory center present in the medulla oblangata of brain. From this centre afferent impulses pass to:
  - ✓ **Diaphragm through phrenic nerve.**
  - ✓ **Intercostal muscles through intercostal nerves.**
- These impulses cause rhythmic contraction of diaphragm and intercostal muscles.
- Afferent impulses arise due to the distention of air sacs. They are carried by vagus to the respiratory centre.

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ii. Chemical control

- This is affected through carbon dioxide content of blood. An increase in the level of carbon dioxide produces stimulation of the respiratory centre. A decrease in carbon dioxide level produces the opposite effect.

8.7.1 Reflex mechanisms which regulate respiration

i. Carotid body and aortic body chemoreceptors

- Some chemo receptors also regulate respiration reflexly. These receptors are present in the
  - Carotid body which lies in the bifurcation of the common carotid artery
  - Aortic body which is at the foot of the subclavian artery
- These two bodies contain the ending of sensory nerves which run in vagus nerves. Increase in carbon dioxide level of blood stimulates these bodies.

- The impulses are then carried to the respiratory centre which is also stimulated.

ii. Hering - breuer reflex

- The lungs contain some stretch receptors. Expansion of the lungs stimulates these receptors. These impulses now inhibit the respiratory centre. So, inspiration stops. Now the lungs collapse and there is no stretch. So, inhibition of the respiratory centre through vagus also stops. Inspiration starts again. This reflex is called the **"Hering-Breuer reflex."**

8.8 RESPIRATORY VOLUMES

- The contraction of diaphragm and intercostal muscles produces expansion of the chest cavity. So, air enters into the lungs during inspiration. A forced inspiration can produce additional expansion. So, more air can enter the lungs. Similarly, a forced expiration can expel an extra volume of air. Even after a forced expiration, some air still remains in the lungs.

➢ **The various respiratory volumes are defined follows**

✓ **Vital capacity :-** It is defined as the volume of air that can be expelled by a **forced expiration after a forced inspiration** (Normal value is 4 litres).

✓ **Tidal air :-** It is the volume of air passing in and out of the lungs **with ordinary quiet breathing** (Normal value is 0.5 litres).

✓ **Inspiratory reserve :-** It is the additional volume of air that can be taken in by **forced inspiration** (Normal value 25 litres).

✓ **Expiratory reserve :-** It is the volume of air that can be expelled by **forced expiration** after normal inspiration (Normal value is 1 litre).

✓ **Residual volume :-** It is the volume of air which remains in the lungs on **forced expiration after normal inspiration** (Normal value is 1 litre).

✓ **Total lung capacity :-** It is the sum of vital capacity and residual volume

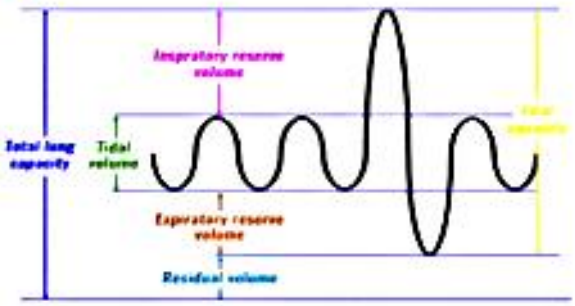

Fig.8.5:- Respiratory Volumes

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8.9 DISORDERS OF THE RESPIRATORY SYSTEM

i. Pneumonia

- Pneumonia is an acute infection or inflammation of the alveoli

ii. Tuberculosis

- The bacterium mycobacterium tuberculosis is the causative agent of an infection communicable disease called as tuberculosis that most often affect the lungs and the pleura but may involve other parts of the body.

iii. Coryza and influenza

- Many viruses can cause coryza (common cold) but a group of viruses called as rhinoviruses are responsible for about 40% of all colds.

iv. Asthma

- It is characterized by chronic airway inflammation, airway hypersensitivity to a variety of stimuli and airway obstruction.
- The trigger for asthma is an allergen such as pollen, house dust mites or particular food.

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v. Chronic obstructive pulmonary disease (COPD)

- It is a type of respiratory disease characterized by chronic and recurrent obstruction of airflow which increases airway resistance.
- **COPD are of 2 types**
  - **Emphysema**
  - **Chronic bronchitis**

vi. Pulmonary edema

- It's an abnormal accumulation of fluid in the interstitial spaces and alveoli of lungs.
- Edema may arise from increased permeability of pulmonary capillaries.
- Most common symptoms are dyspnoea.