

## Unit 10: Human Respiratory System

### Long Questions

#### DESCRIPTIVE QUESTIONS

#### RESPIRATORY SYSTEM OF MAN

**Q1. What are main organs of respiratory system of man? Also write properties of respiratory surface.**

**Ans.** Respiratory system of man consists of organs that carry out external respiration (uptake of oxygen and disposal of  $\text{CO}_2$ ) at body system level. The main organs of this system are the lungs which provide suitable respiratory surface for gaseous exchange.

**Respiratory Surface:** Respiratory surface means the area where actual gas exchange occurs between the environment and the blood. This gaseous exchange occurs through diffusion. During the oxygen from air diffuses into the blood and ( $\text{CO}_2$  diffuse from blood to air).

**Properties of Respiratory Surface:** Following are the properties of respiratory surface.

- It is moist and permeable. So that gas may pass through it.
- It has thin walls. So that gases have to travel minimum distance.
- It has a blood supply. So that gases can diffuse in and out of blood.
- It has structural support to remain open and does not collapse.
- It is located internally to keep surface moist and not lose water to the atmosphere.
- Air ventilates over it i.e. moves towards and away from it.
- Air reaches to it after passing a branched tubular way, so that air becomes saturated with water vapour before reaching it.

**Q2. Name two major divisions of human respiratory system. Give detail of upper respiratory tract.**

**Ans. Respiratory Tract:** The respiratory system has a continuous system of passages called respiratory track, through which air flows into and out of body.

**Divisions:** The respiratory track has two major divisions.

A. Upper respiratory track

B. Lower respiratory track

**A. Upper respiratory track:** It consists of

(i) Nasal cavity

(ii) Pharynx

(iii) Larynx.

★ **Note:** All questions and paragraphs marked with a star ★ are explanations of the Box Information provided in the textbook.

No gases exchange occurs in these organs.

**1. Nasal Cavity:** The external openings of nose, called **nostrils**, lead to a nasal cavity. It is a large, air-filled space behind the nose and partitioned by a nasal septum (a part of the nasal bone).

**Function:** As inhaled air flows through the nasal cavity, it is warmed and humidified by blood vessels present very close to its surface. Hairs in the nose and mucous produced by mucous membranes trap larger foreign particles in the air before they enter into the respiratory tract.

The nasal cavity also has chemoreceptors needed for sense of smell, and contribution to the sense of taste.

**2. Pharynx:** It is a tube-like structure that connects the nasal cavity and oral cavity to larynx and oesophagus. It is part of both the respiratory and digestive systems.

**Function**

- Air passes from the nasal cavity through the pharynx to larynx (as well as in the opposite direction).
- Food passes from the mouth through the pharynx to the oesophagus.

**3. Larynx:** Larynx connects the pharynx and trachea. It is composed of muscles and cartilages. It is also called as **voice box**, because it contains two bands of smooth muscles called **vocal cords**.

**Function:** The vocal cords vibrate when air flows over them and so produce sound.

**Glottis and Epiglottis:** Opening of larynx is called glottis. Epiglottis is a cartilaginous flap that extends in front and above the glottis.

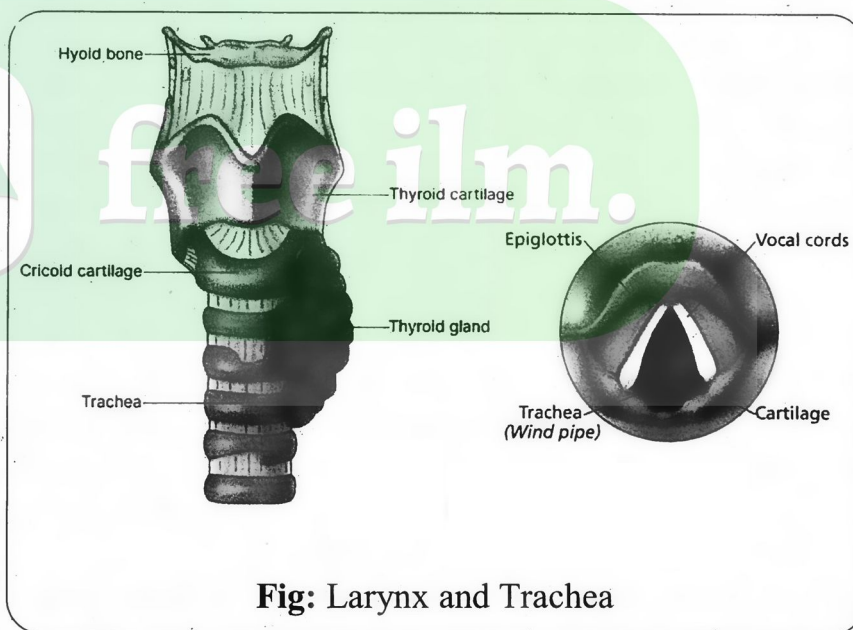
**Function:** When air enters the larynx, the epiglottis keeps standing upwards to give way to air. When we swallow something, the backward motion of the tongue raises the larynx.

Due to this the epiglottis moves downward, to close the glottis. In this way it prevents swallowed material from entering the larynx.

**Q3. Explain lower respiratory tract of human respiratory system.**

**Ans.** Trachea, air passages and lungs are parts of lower respiratory tract. In lungs the air passages make a tree like shape, with repeated branching. The length of these air passages equals to 2,414 Kilometers.

**Trachea:** Trachea, or windpipe, connects the larynx to the lungs. It is the widest passageway in the respiratory tract. It is about 1-inch wide and 4 – 6 inches long. Its walls are made of smooth muscles and C-shaped rings of cartilage. Trachea is lined with mucus and cilia.



**Fig: Larynx and Trachea**

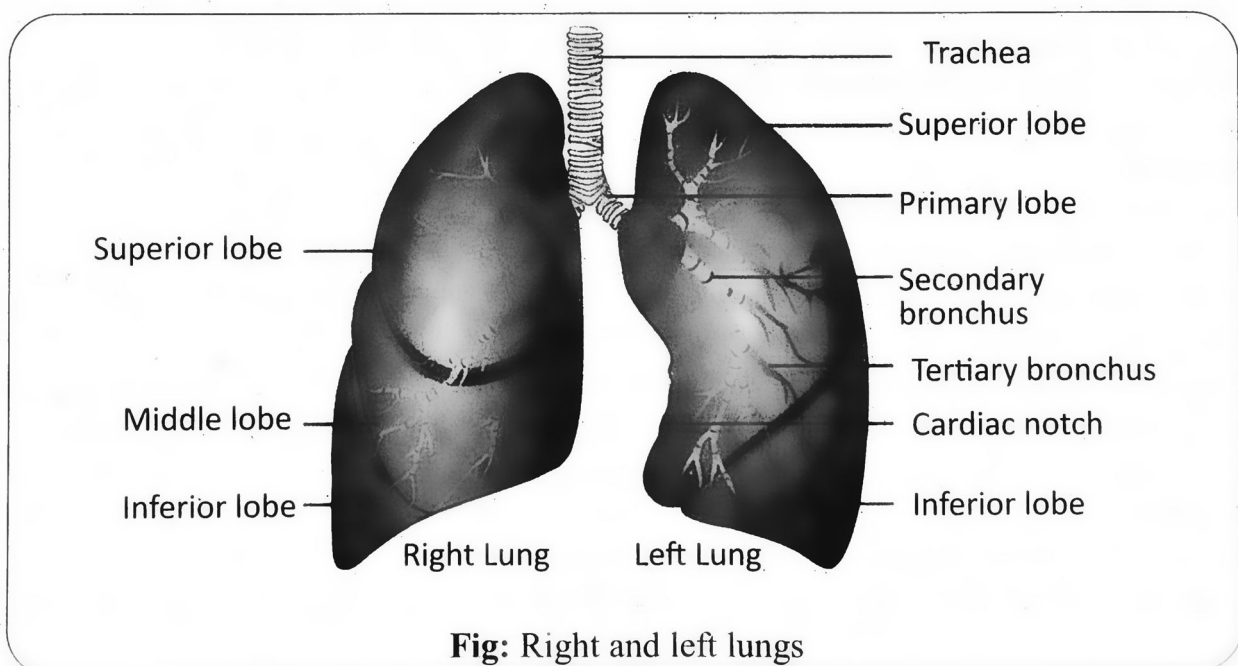
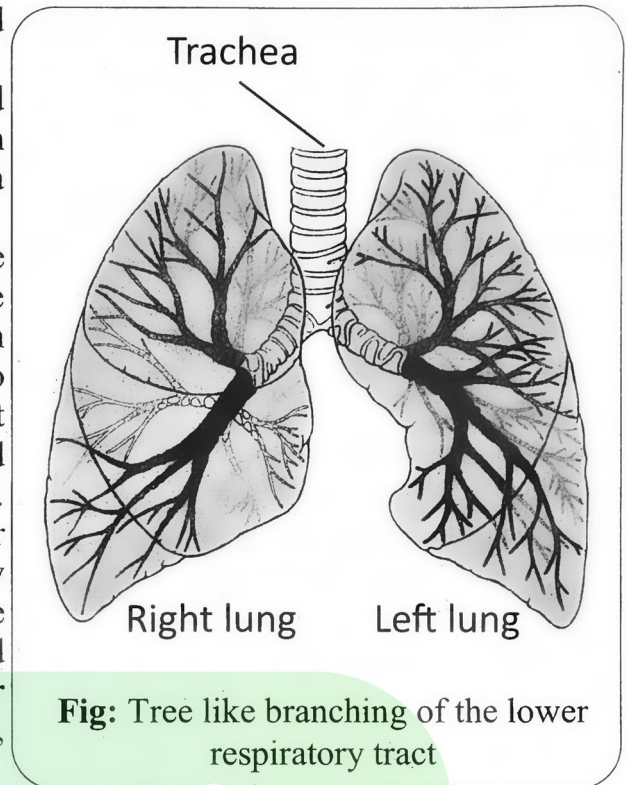
**Function:** Cilia propel foreign particles trapped in the mucus toward the pharynx.

The C-shaped cartilage provides strength and support to the trachea to keep the passage open and prevents collapse during expiration. Trachea branches at the bottom to form two bronchi.

**2. Bronchi, Bronchioles, and Alveoli:** There are two primary bronchi (singular, bronchus). The right and left bronchi enter the lungs and branch into smaller, **secondary branch**. There are two secondary bronchi in left lung while three in right lung. In secondary bronchi, the C-shaped cartilages are replaced with cartilage plates. Secondary bronchi branch into still smaller **tertiary bronchi**, which branch further into very **small bronchioles**. The bronchioles do not have cartilage plates. They divide many times and make **terminal bronchioles** end in **alveolar ducts** which terminate in clusters of tiny air sacs, called alveoli (singular, alveolus), in the lungs.

### Lungs

- The lungs are the largest organs of the respiratory tract
- Outside of each lung is covered by two membranes. First membrane, **visceral pleura**, lines the lungs while the second membrane, **parietal pleura**, lines the inner wall of thoracic cavity.
- Space between these two membranes, is called **pleural cavity**. It is filled with fluid. This allows smooth expansion and contraction of lungs during breathing
- Each lung is divided into lobes. The right lung is larger and contains three lobes. The left lung is smaller and contains two lobes. The smaller left lung allows space for the heart present slightly left of the centre of the chest.



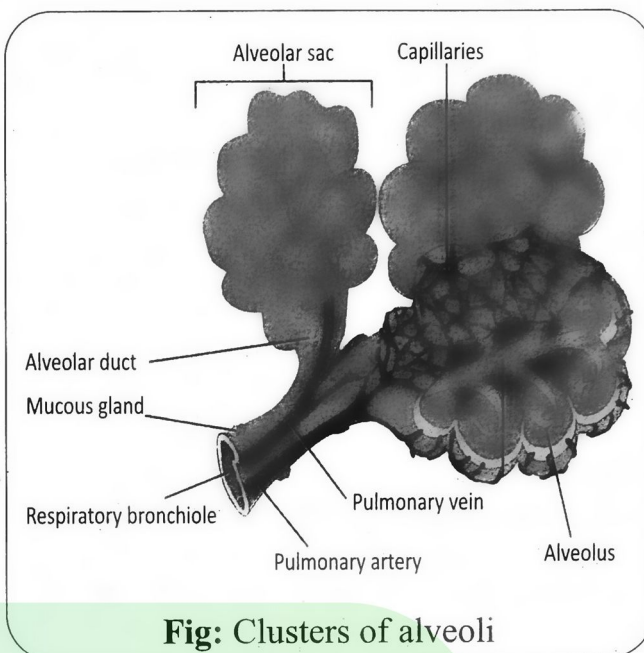
**Q4. What are Alveoli? Write their structure and function.**

**Ans. Alveoli:** The terminal bronchi end in alveolar ducts. Each alveolar duct opens in a cluster of alveoli. These clusters make the bulk of the lung and are surrounded by blood capillaries. Each cluster contains 20-30 alveoli.

**Structure of alveolus:** An alveolus is made of moist epithelial tissue (only 0.1 micrometer thick). They provide the respiratory surface where gas exchange takes place between air and blood.

**Function of alveolus**

- Alveoli are functional units of lungs where gaseous exchange takes place.
- The two lungs may contain approximately 480 million alveoli (range: 274-790 million) per lung pair in adult human.
- They provide huge surface area for gaseous exchange.
- When we breathe in, the alveoli fill with air, causing lungs to expand.
- Oxygen in the air inside the alveoli is absorbed by the blood via diffusion in the capillaries network that surround them. Blood in these capillaries releases  $\text{CO}_2$  into the air inside the capillaries.
- When we breathe out, air leaves the alveoli and rushes into the outside atmosphere, carrying carbon dioxide with it.

**Fig: Clusters of alveoli****Q5. Explain the mechanism of breathing or ventilation and its control.**

**Ans. Breathing:** The movement of the air in and out of the body is called breathing or **ventilation**. Our lungs do not draw in air or push it out. Rather, it is done by creating negative and positive pressures in the lungs. Two sets of muscles play important role in breathing i.e. **diaphragm** (dome-like large skeletal muscle that separates thoracic cavity and abdomen) and the **intercostal muscles** (present between each pair of ribs). Breathing occurs in two steps.

**Inspiration**

Taking in of air is called inspiration or inhalation.

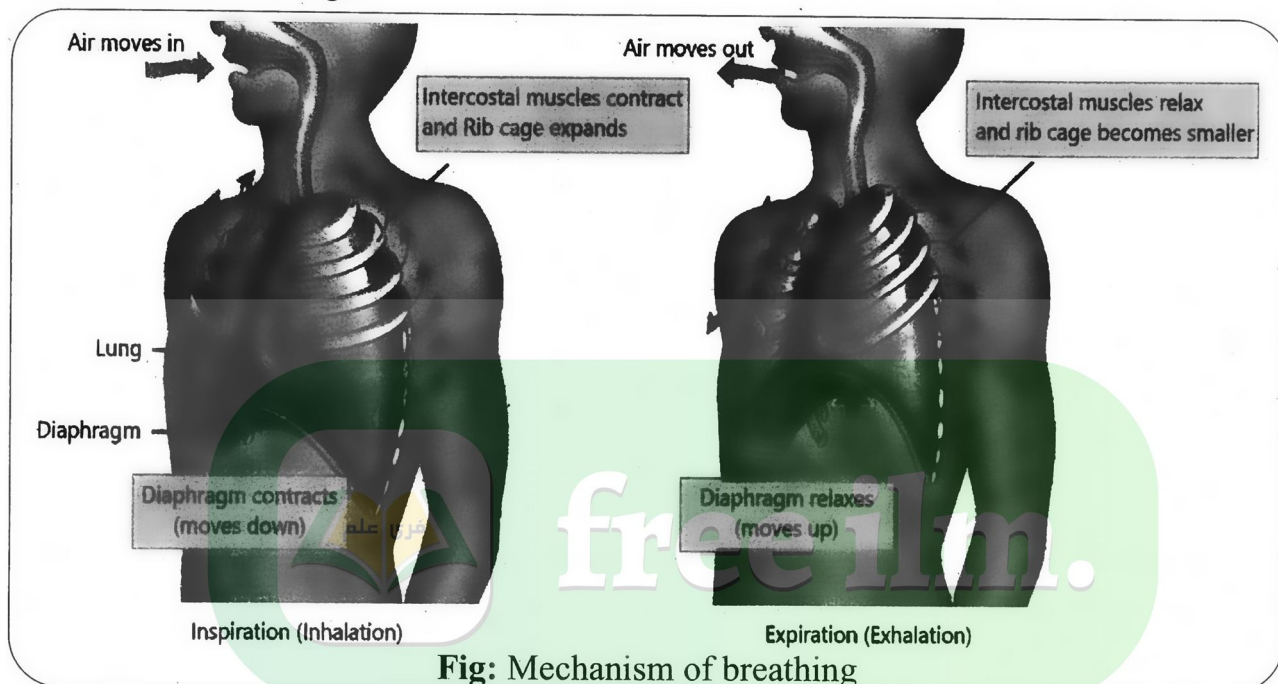
- Firstly, diaphragm contracts and gets lower and take a more flattened shape.
- At the same time, the intercostal muscles contract. They raise the ribs and expand the rib cage. This results in increase in the space in the thorax.
- As a result, lungs expand because of the adherence of visceral and parietal pleural membranes.
- Expansion of lungs lowers the air pressure inside them, then the atmosphere pressure.
- Air diffuse into the lungs due to pressure gradient.

**Expiration**

“Moving the air out of lungs is called expiration or exhalation”.

- Expansion of the thorax and lungs during inspiration, puts them under elastic tension.

- This elastic tension is relieved by the relaxation of the intercostal muscles and diaphragm.
- When diaphragm relaxes, it takes dome-like shape.
- Similarly, when intercostal muscles relax, the ribs are lowered and ribcage moves inward.
- These movements decrease the space in thorax and allow the lungs to recoil (shrink).
- The pressure inside lungs becomes more than the atmospheric pressure and the air moves out of the lungs.



**Fig: Mechanism of breathing**

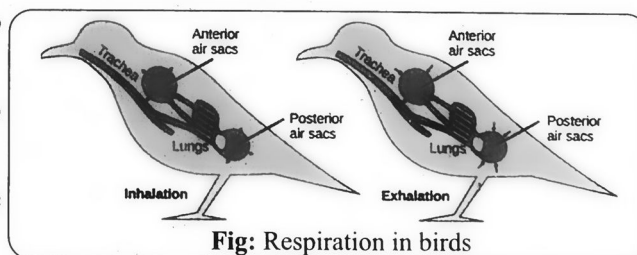
### Control of breathing

Each breath is initiated by neurons in a respiratory centre located in the medulla oblongata i.e., part of the brain stem. These neurons send impulses to the diaphragm and intercostal muscles, stimulating them to contract., causing inspiration. When these neurons stop producing impulses, the diaphragm and intercostal muscles relax and expiration occurs.

### Q6. How respiration occurs in birds?

**Ans. Respiration in birds**

- Birds have lungs as well as air sacs in their body.
- Air flows in one direction. It flows from outside to posterior air sacs.
- For here, the air goes to the lungs, then to anterior air sacs, and then outside.
- The flow of air is in the opposite direction to the blood flow.
- So, gas exchange takes place much more efficiently.
- This type of breathing makes birds to obtain the required oxygen even at high altitudes where oxygen concentration is low.



**Fig: Respiration in birds**

## TRANSPORT OF GASES

**Q7. How oxygen is transported in human body?**

**Ans. Transport of oxygen**

- Partial pressure of oxygen in alveoli allows to diffuse through alveoli into pulmonary capillaries.
- Oxygen can dissolve in blood plasma, but a maximum of 3ml of O<sub>2</sub> per litre.
- But whole blood carries almost 200 mL O<sub>2</sub> per litre. This is because most of the oxygen is bound to molecules of haemoglobin inside the RBCs.
- Partial pressure of O<sub>2</sub> in alveoli (at sea level) is approximately 105 mm Hg, which is less than the partial pressure of oxygen in the atmosphere.
- So 97% of the haemoglobin within RBCs combines with O<sub>2</sub> and becomes **oxyhaemoglobin** which is **bright red**, tomato juice colour.
- As the blood travels through the blood capillaries, some of the oxyhaemoglobin releases oxygen and become a dark red coloured **deoxyhaemoglobin**.
- Consequently, when blood leaves the tissue in the veins, it has low partial pressure of oxygen (40 mm Hg).
- Here, 75% of haemoglobin is saturated in the form of oxyhaemoglobin.
- It means that 22% (97% minus 75%) of the oxyhaemoglobin has released its oxygen to the tissues, leaving 78% oxyhaemoglobin in the blood as a reserve.
- This large reserve of oxygen is used by body during exercise as well as at rest.

**Q8. Explain factors affecting oxygen transport.**

**Ans. 1. Partial pressure of oxygen during exercise:** During exercise, the muscles use more oxygen from the capillary blood. It decreases the venous blood's partial pressure of oxygen to 20 mm Hg. So the percent saturation of haemoglobin becomes less from 75% to 35%. The arterial blood still contains 97% oxyhaemoglobin, the amount of oxygen unloaded is now 62% (97% minus 35%), instead of the 22% at rest.

**2. CO<sub>2</sub> concentration and pH:** The CO<sub>2</sub> produced by tissues lowers the pH of blood. This lowered pH reduces haemoglobin's affinity for oxygen and thus causes it to release more oxygen. Effect of pH on haemoglobin's affinity for oxygen is known as the Bohr's effect.

**3. Temperature:** Increasing temperature during exercise reduces the haemoglobin's affinity for oxygen. Skeletal muscles produce more heat, haemoglobin unloads a higher percentage of oxygen in high temperature.

**Q9. Explain transport of Carbon dioxide in man.**

**Ans.** Blood capillaries deliver oxygen to the tissues and remove carbon dioxide from them. The partial pressure of CO<sub>2</sub> is higher in tissues than in blood which results in diffusion of carbon dioxide into the blood. While the process is reverse in lungs where the partial pressure of CO<sub>2</sub> is lower in alveoli than in blood.

Blood transport CO<sub>2</sub> in three ways.

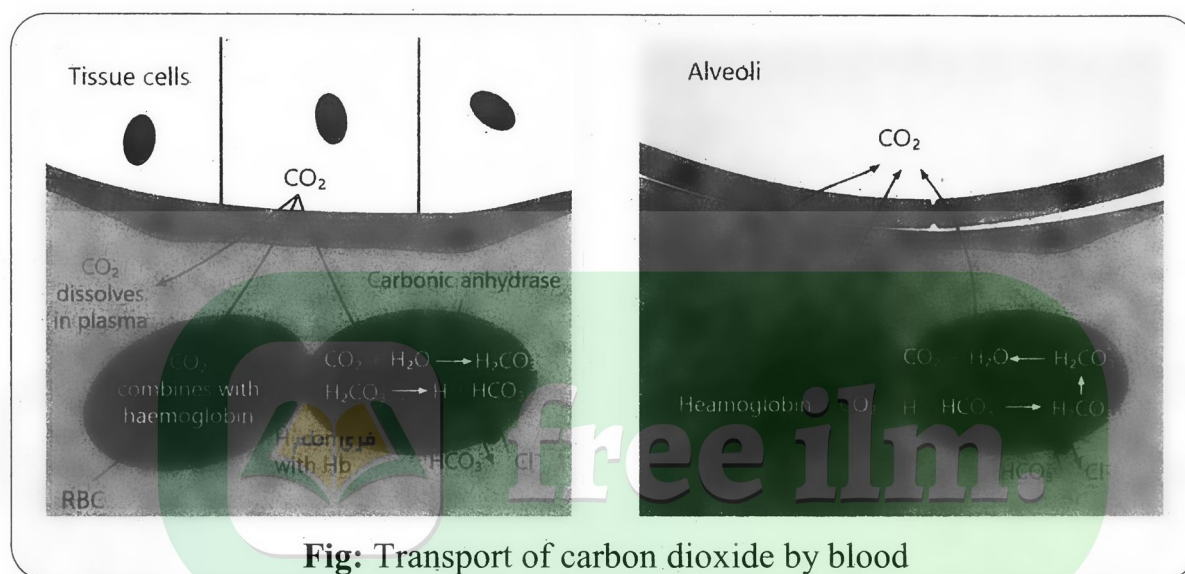
**1. As bicarbonate ions:** About 72% of carbon dioxide is carried in the blood as bicarbonate ions. CO<sub>2</sub> enters the RBCs and combines with water to form carbonic acid (H<sub>2</sub>CO<sub>3</sub>) in the presence of enzyme carbonic anhydrase. Carbonic acid disassociates to form hydrogen (H<sup>+</sup>) and bicarbonate (HCO<sub>3</sub><sup>-</sup>) ions. The hydrogen ion is readily associated to oxyhaemoglobin is released to the tissue. Whole HCO<sub>3</sub><sup>-</sup> moves out of RBCs into plasma. The movement of

bicarbonate ( $\text{HCO}_3^-$ ) ion is facilitated by a transporter that exchanges one chloride ion ( $\text{Cl}^-$ ) for a bicarbonate ion (this is called the “chloride shift” or “Hamburger phenomenon”).

**2. As Carboxyhaemoglobin:** About 20% of  $\text{CO}_2$  is carried as carboxyhaemoglobin. When carbon dioxide diffuses into the blood, its partial pressure raises than the tissues.  $\text{CO}_2$  combines with the globin chains of haemoglobin and forms carboxyhaemoglobin.

**3. As dissolved  $\text{CO}_2$  in plasma:** When  $\text{CO}_2$  enters blood, a little amount dissolves in the water of blood plasma. About 8% of  $\text{CO}_2$  is carried this way. The blood carries  $\text{CO}_2$  in these three forms to the lungs. The lower  $\text{PCO}_2$  of the air inside the alveoli causes the conversion of  $\text{H}_2\text{CO}_3$  into  $\text{H}_2\text{O}$  and  $\text{CO}_2$ .

The  $\text{CO}_2$  diffuses out of blood into the alveoli so that it can leave the body in next exhalation.



**Fig:** Transport of carbon dioxide by blood

## RESPIRATORY PIGMENTS

**Q10. What are respiratory pigments? Give their types and role.**

**Ans. Definition:** Respiratory pigments are special proteins in blood or tissues and are involved in transporting oxygen throughout body. They also do other functions like  $\text{O}_2$  storage,  $\text{CO}_2$  transport, and transport of substances other than respiratory gases.

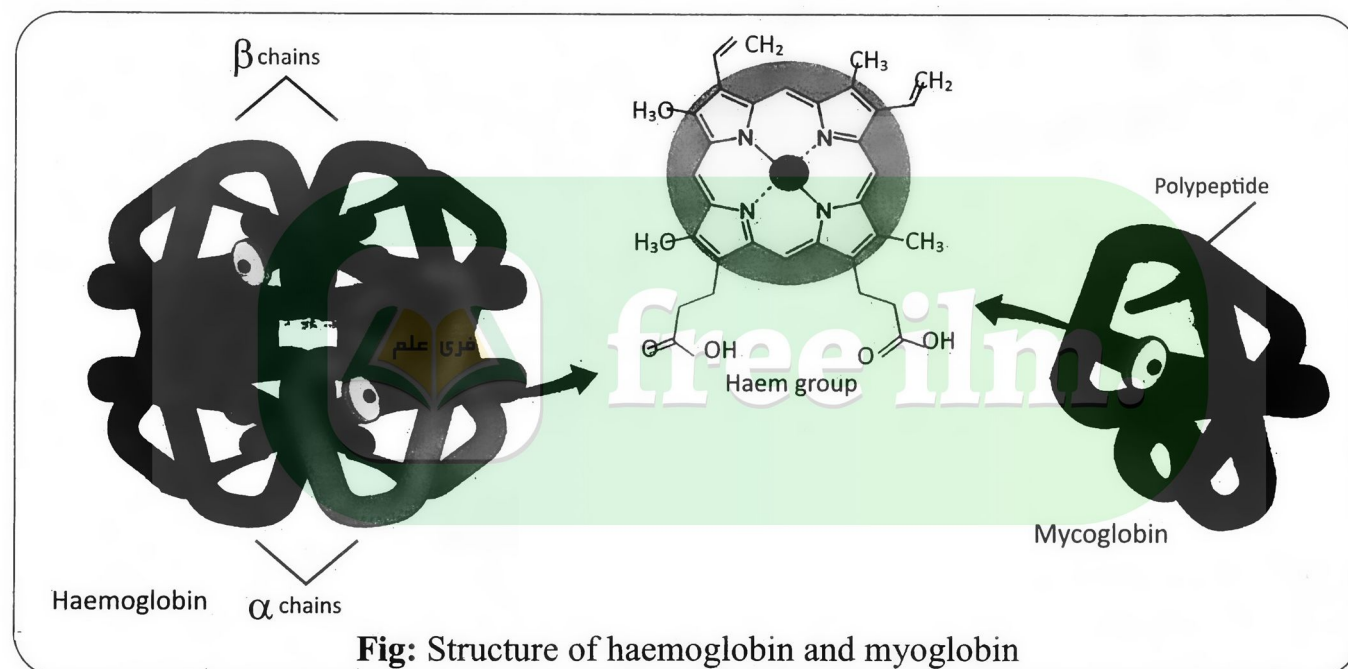
**Types:** Respiratory pigments are of two types i.e. haemoglobin and myoglobin.

### Haemoglobin

- The protein present in RBCs.
- It is composed of 4 globin (globular) polypeptide chains (two  $\alpha$  chains and two  $\beta$ ) and four haem groups.
- There are 141 and 146 amino acids in the  $\alpha$  and  $\beta$  chains, respectively
- Each polypeptide chain is folded in such a way that it contains a pocket where heme group binds.
- So each chain is associated with a haeme group.
- A haem group consist of iron held in porphyrin ring.
- The iron ion is attached with four nitrogen atoms of the polypeptide chain.
- Under higher partial pressure of oxygen, iron ion attaches a molecule of  $\text{O}_2$ . In this way one haemoglobin molecule can carry up to four  $\text{O}_2$  molecules.

## Myoglobin

- Myoglobin is the oxygen binding protein in skeletal and cardiac muscle cells of vertebrates.
- It gives a distinct red or dark gray colour to muscles.
- It is a monomer, composing of a single polynucleotide chain (made of 153 amino acids) and contains single haem group.
- It is capable of binding with a single  $O_2$  molecule.
- The binding affinity of myoglobin is high as compared to that of haemoglobin.
- Myoglobin serves as the oxygen-storing protein in muscles.
- It releases oxygen when the partial pressure of oxygen is below 20 mm Hg.
- So myoglobin provides oxygen to the muscles when they need.



**Q11. Give difference between hemoglobin and Myoglobin.**

**Ans.**

| Differences between Haemoglobin and Myoglobin |                                          |
|-----------------------------------------------|------------------------------------------|
| Haemoglobin                                   | Myoglobin                                |
| • Consists of four polypeptide chains.        | • Consists of one polypeptide chain.     |
| • Possesses four haem groups.                 | • Possesses one haem group.              |
| • Found in blood (RBCs).                      | • Found in skeletal and cardiac muscles. |
| • Can attach four $O_2$ molecules.            | • Can attach one $O_2$ molecule.         |
| • Transports oxygen.                          | • Stores oxygen.                         |
| • Has less affinity with oxygen.              | • Has more affinity with oxygen.         |
| • Loses oxygen at $PO_2$ 60mm Hg.             | • Loses oxygen at $PO_2$ 20mm Hg.        |

## RESPIRATORY DISORDERS

### Q12. Write a note on Sinusitis.

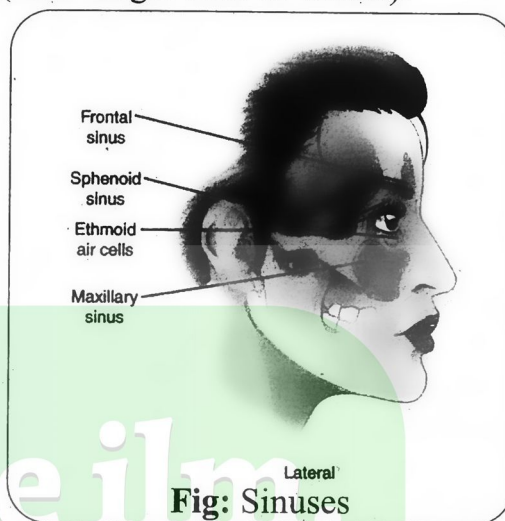
#### Ans. Features

- It is upper respiratory tract disorder.
- It is the inflammation of the lining of the sinuses (four paired air-filled spaces that surround the nasal cavity) i.e. under the eyes, above the eyes and behind the eyes, between eyes and nose.
- It may be acute (lasts for 7 to 10 days) or chronic (lasts longer than 12 weeks).

**Cause:** Most cases of sinusitis are due to viral infections, some may be due to bacterial infections and rare cases due to fungal infections.

#### Symptoms

- Fever
- Blocked nose
- Pus like nasal discharge
- Loss of sense of smell
- Facial pain
- A feeling that phlegm is falling from the back of nose into throat
- Headache



**Fig: Sinuses**

**Treatment:** As most cases are caused by viruses and resolve without antibiotics. If it is due to a bacterial infection, antibiotics or sulpha drugs are used. Beside this the nebulization is prescribed which can reduce inflammation in sinuses and nose. For chronic or recurring (happen again) sinusitis surgery may be done to remove pathogens and mucus.

### Q13. Write a note on Otitis media.

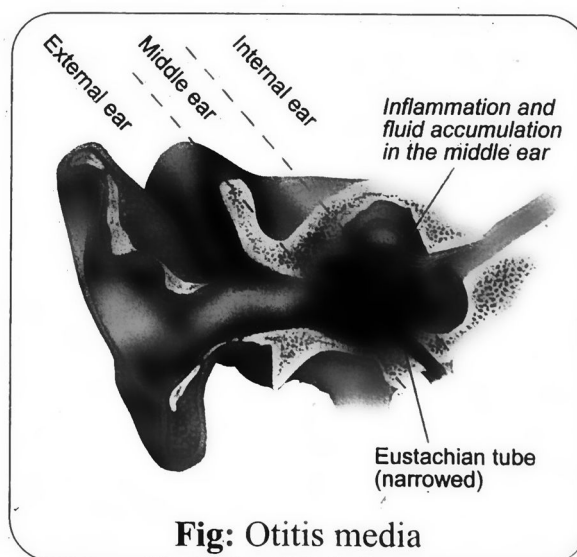
#### Ans. Features

- It is the inflammation of the middle ear
- Otitis may be acute (last for few days) or chronic (lasts more than six weeks)

**Cause:** Cause of otitis media accumulation of fluid in Eustachian tube, which can't be drained from the middle ear. So the growth of bacteria and viruses in the middle ear that leading to the otitis media.

#### Symptoms

- Severe ear pain in one or both ears.
- Fever
- Fluid coming out from ears.
- Loss of balance, and hearing difficulties



**Fig: Otitis media**

**Treatment:** Include oral and topical directly pain killers and antibiotics (if caused by bacterial infection).

**Q14. Write a note Pneumonia.****Ans. Features**

- It is lower respiratory tract infection.
- Pneumonia is a form of acute respiratory infection.
- It can cause mild to life threatening illness.
- In pneumonia, the alveoli of one or both lungs are inflamed and are filled with pus and fluid.
- It makes breathing painful and reduce oxygen intake.
- It is commonly caused by viruses or bacteria.
- It is single largest infection and cause of death in children worldwide.

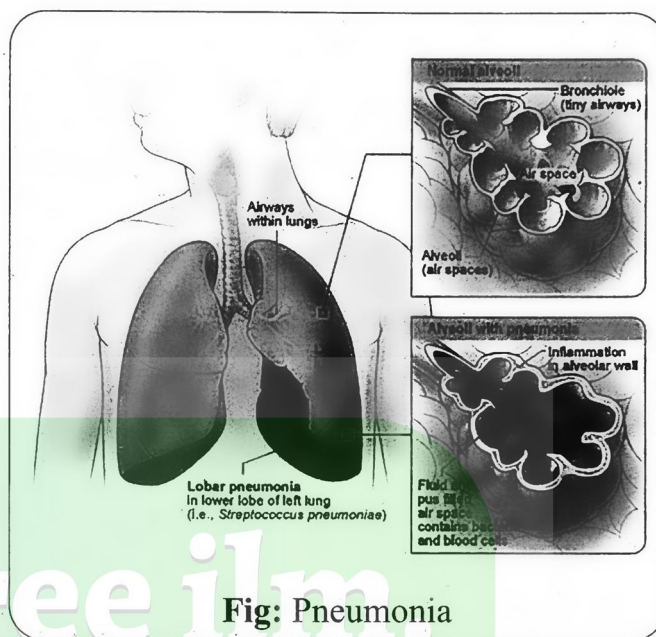
**Cause:** It can be caused primarily by bacteria (*Streptococcus pneumoniae*) or viruses (e.g., human rhinovirus) and less commonly fungi.

**Symptoms:** Its symptoms include

- Cough with phlegm
- Shortness of breath
- Chest pain
- Fever
- Blueness of skin
- Loss of appetite
- High heart rate and fatigue



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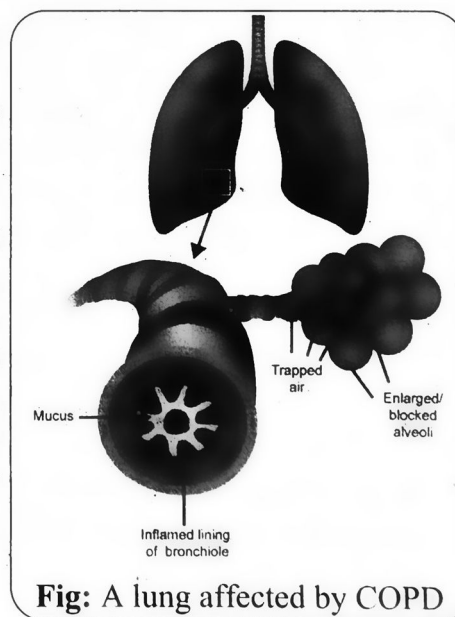


**Fig: Pneumonia**

**Treatments:** Specific antibiotics are used to treat bacterial pneumonia. Analgesics (pain killer) also used to reduce fever and pain. Vaccination prevents pneumonias both in children and adults.

**Q15. Write a note Pulmonary Tuberculosis.****Ans. Features**

- Tuberculosis (TB) is a chronic infection.
- It can affect many parts of the body but generally affects the lungs.
- The tuberculosis of lungs is called pulmonary tuberculosis.
- It is highly contagious and spreads through sneezes.
- The bacteria enter the lungs, multiply and cause inflammation and damage to the lung tissue including the alveoli. The damage to the alveoli can lead to the formation of small cavities or holes in the lung tissue which make it difficult for the lungs to function properly. In advanced stages the alveoli are so damaged that the lungs may become unable to supply the body with enough oxygen. This results condition called **respiratory failure** which is a medical emergency.



**Fig: A lung affected by COPD**

**Cause:** TB is caused by *Mycobacterium tuberculosis*.

**Symptoms:** Major symptoms of pulmonary tuberculosis are cough-with blood, intermittent fever usually in the evening, night sweats, weight loss, anorexia, depression, weakness and dry cough, chest pain due to inflammation of the pleura of the lungs.

**Treatment:** It includes the use of multiple antibiotics over a long period of time (for 9 months) regularly.

**Q16. Write a note on Chronic obstructive pulmonary disease (COPD).**

**Ans. Features:** It is an important disorder of the lungs.

**Cause**

- Common causes of COPD are tobacco smoking, long terms exposure to harmful pollutants and chemical fumes.
- A small percentage may develop COPD due to genetic disorder i.e protein alpha-1 antitrypsin deficiency.

**Symptoms:** The symptoms of COPD include:

- Persistent cough with mucus (sputum)
- Shortness of breath
- Wheezing chest
- Fatigue
- Frequent respiratory tract infection

**Treatment:**

- COPD is incurable but by its progression (increase) can be slowed down by minimizing exposure to smoke, pollutants and chemicals.
- Others therapies (treatment) include bronchodilators, inhaled corticosteroids, pulmonary rehabilitation and oxygen therapy.
- In some severe cases lung transplantation may be done.

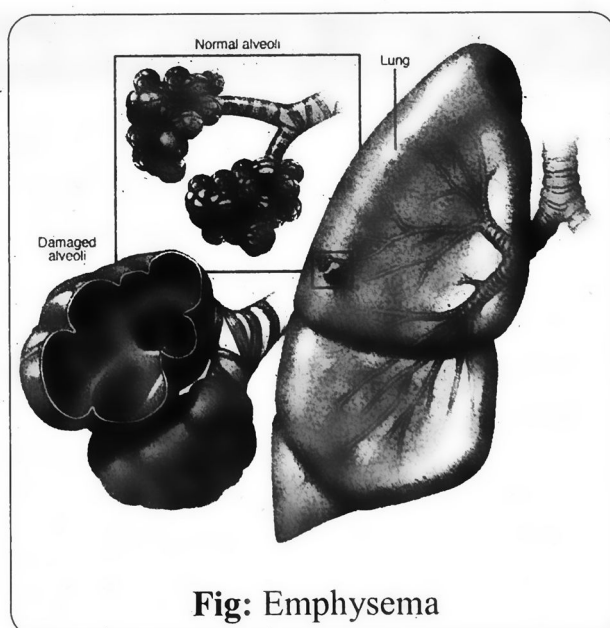
**Q17. Write a note on Chronic bronchitis.**

**Ans. Features**

- It is a type of COPD.
- It involves inflammation and narrowing of the bronchial tubes in the lungs.
- It leads to increased mucus production which can further block the airways and make breathing difficult.
- This disease lasts for 3 months to year.
- It is caused by long-term exposure to irritants such as cigarette smoke, air pollution, or industrial dusts.

**Symptoms**

- Wheezing of chest
- Shortness of breath
- Chest tightness
- Frequent respiratory infections



**Treatment**

- It can be managed by quitting smoking
- Bronchodilators
- Pulmonary rehabilitation
- Oxygen therapy.

**Q18. Write a note on Emphysema.****Ans. Features**

- It is a type of COPD.
- In emphysema, the inner walls of alveoli are ruptured.
- This creates one large air space instead of many small ones.
- This reduces the surface area for gas exchange.

**Cause**

- The primary cause of emphysema is smoking.
- It can also be caused by long-term exposure to air pollution, dust or chemical fumes.
- Genetic deficiency of protein called alpha-1 antitrypsin may be cause emphysema.

**Symptoms**

- Shortness of breath
- Coughing
- Wheezing
- Fatigue
- Chest tightness

**Treatment**

- Quitting Smoking
- Bronchodilators
- Inhaled steroids
- Oxygen therapy
- Pulmonary rehabilitation



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