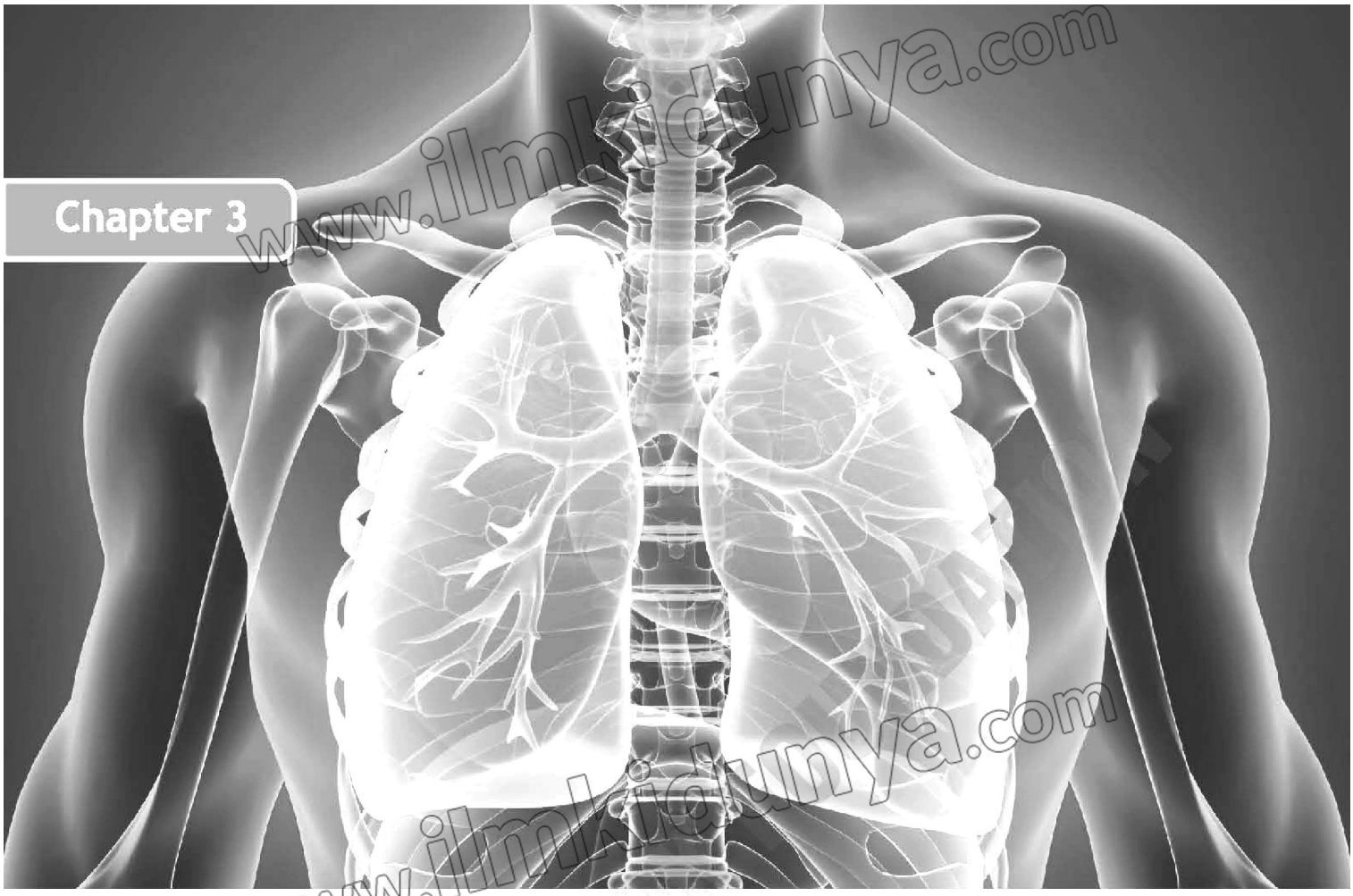


Chapter 3

RESPIRATORY SYSTEM OF MAN

Students' learning outcomes
After studying this chapter, students will be able to:

1. [B-12-R-01] Define the respiratory surface and list its properties.
2. [B-12-R-02] Describe the main structural features and functions of human respiratory system.
3. [B-12-R-03] Explain the ventilation mechanism in humans.
4. [B-12-R-04] Discuss the transport of oxygen and carbon dioxide through blood.
5. [B-12-R-05] Outline the role of respiratory pigments.
6. [B-12-R-06] State the causes, symptoms and treatment of upper respiratory tract infections (sinusitis, otitis media) and lower respiratory infections (pneumonia, pulmonary tuberculosis).
7. [B-12-R-07] Describe the disorders of lungs (emphysema and COPD)
8. [B-12-R-08] List the effects of smoking on respiratory system.

Like other life processes, the respiration process also occurs at cellular level and organismic level. The process of respiration that occurs at cellular level is also called **internal respiration** which is a catabolic process. It involves the breakdown of complex organic compounds into simpler molecules with the release of energy. On the other hand, the process of respiration that occurs at organismic level is also called **external respiration**. It involves the inhaling of oxygen and exhaling of carbon dioxide. Both the processes are interlinked as the oxygen, required for cellular respiration, is inhaled from environment while the carbon dioxide which is produced in cellular respiration, is exhaled into the environment. This chapter deals with various aspects of respiration.

3.1 PROPERTIES OF RESPIRATORY SURFACE

The area where gaseous exchange with the environment actually takes place is called the **respiratory surface**. The respiratory surface must have the following properties so that diffusion can occur effectively:

- It must be moist and permeable so that gases can pass through.
- It must be thin, because diffusion is only efficient over distance of 1 mm or less.
- It should possess a large surface area so that sufficient amount of gases can be exchanged according to the organism's need.
- It should possess a good blood supply.
- There should be a good ventilation mechanism to maintain a steep diffusion gradient across the respiratory surface.

3.2 RESPIRATORY SYSTEM OF MAN

The body system which is responsible for the exchange of gases between body fluid and outer environment is called **respiratory system**.
The human respiratory system can be divided into two regions, upper respiratory tract and lower respiratory tract.

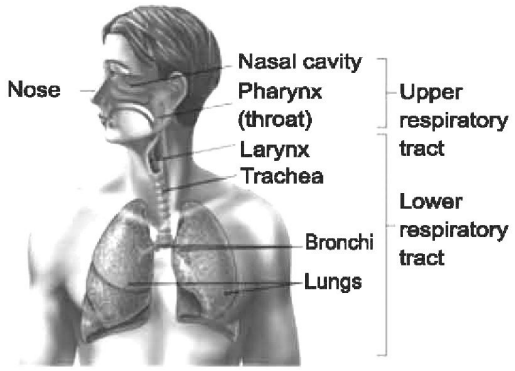


Fig. 3.1: Human respiratory tract

3.2.1 Upper Respiratory Tract

The upper respiratory tract includes nostrils, nasal cavity and pharynx.

Nose

The nose is only externally visible part of the respiratory system. Human nose is composed of bones, cartilage and fatty tissues. The external openings of nose are called **nostrils** and the inner hollow spaces are called **nasal cavities**. There are two nasal cavities which are partitioned by means of nasal septum (the part of nasal bone). The anterior parts of nasal cavities near the nostrils are called **vestibules** which contain hair. Both the nostrils and nasal cavities are lined by ciliated mucous membranes.

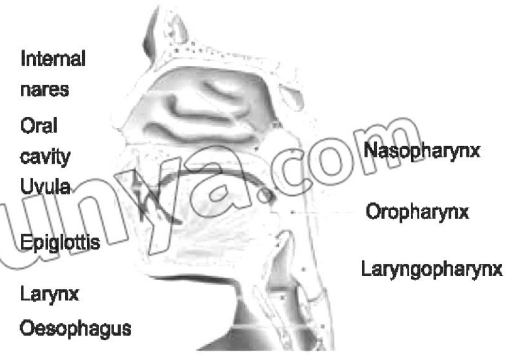


Fig. 3.2: Human respiratory tract

Nose hair, mucus and cilia serve as a defence mechanism against the harmful pathogens and particulate matter present in the air. The mucus and cilia filter the air and prevent the entry of foreign particles such as microorganisms, dust and particulate matter inside the respiratory system. The mucus also helps in moistening the air. Cilia move the trapped substances to the pharynx for their removal. Underneath the mucous membrane, there are blood capillaries that help to warm the air to about 30°C, depending upon the external temperature.

Pharynx

Pharynx is cone-shaped passageway leading from the oral and nasal cavities to the esophagus and larynx. The pharynx is part of the digestive system and also the respiratory system. The human pharynx is conventionally divided into three sections: the nasopharynx, the oropharynx, and the laryngopharynx

3.2.2 Lower Respiratory Tract

The lower respiratory tract includes the larynx, trachea, bronchi and lungs.

Larynx

The larynx is an enlargement in the airway at the top of the trachea and below the pharynx. The larynx is composed primarily of muscles and cartilages. One of the cartilages is the **epiglottis.** This structure usually stands upright and allows air to enter the larynx. During swallowing, however larynx is raised and the epiglottis is pressed downward. As a result, the epiglottis partially covers the opening into the larynx and helps to prevent foods and liquids from entering the air passages. The opening of the larynx is called **glottis.** It is also lined with mucus membrane. Inside the larynx, there are two vocal cords which are responsible for vocalization.

Trachea

The trachea or windpipe is a membranous tube. It consists of dense regular tissue and smooth muscle reinforced with 15-20 C-shaped pieces of cartilage.

SCIENCE TITBITS

The alveoli of human lungs are lined with a **surfactant**, a film of lipoprotein that lowers the surface tension and prevents them from closing. Surfactant also speeds up the transport of oxygen and carbon dioxide between the air and liquid lining the alveolus and helps to kill any bacteria, which reach the alveoli. Surfactant is constantly being secreted and reabsorbed in a healthy lung.

Bronchi and bronchioles

The trachea divides to form two smaller tubes called **primary bronchi.**

The primary bronchi divide into **secondary bronchi** within each lung. There are two secondary bronchi in the left lung and three in the right lung. The secondary bronchi, in turn, give rise to **tertiary bronchi.** The bronchi continue to branch, finally giving rise to **bronchioles** which are less than 1mm in diameter. The bronchioles also subdivide several times to become even smaller **terminal bronchioles.** In the secondary bronchi, the C-shaped cartilages are replaced with cartilage plates but the bronchioles and their terminal branches have no cartilage structures.

Alveolar ducts and alveoli

The terminal bronchioles divide to form **alveolar ducts.** These alveolar ducts end at tiny air filled chambers called **alveoli** which are the sites of gas exchange between the air and the blood. There are over 700 million alveoli present in the lungs.

The wall of each alveolus is only 0.1 µm thick. On its outsides is a dense network of blood capillaries. Lining each alveolus is moist squamous epithelium. This consists of very thin, flattened cells, reducing the distance over which diffusion must occur. Collagen and elastin proteins are also present in their walls which allow the alveoli to expand and recoil easily during breathing.

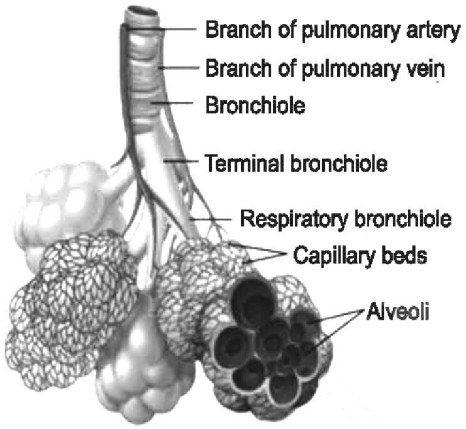


Fig. 3.3: Alveoli

External structure of lungs

The lungs are the principal organs of respiration. Each lung is conical in shape, with its base resting on the diaphragm and its apex extends to a point just above the clavicle. The right and left lungs are separated medially by the heart and **mediastinum**, which is the area between the lungs.

The left lung has two lobes, **superior lobe** and **inferior lobe**. The left lung shares space with the heart. The right lung has three lobes. The **hilum** is a triangular shaped depression of both the lungs where the blood vessels and airways pass into the lungs. The lungs are spongy due to presence of alveoli.

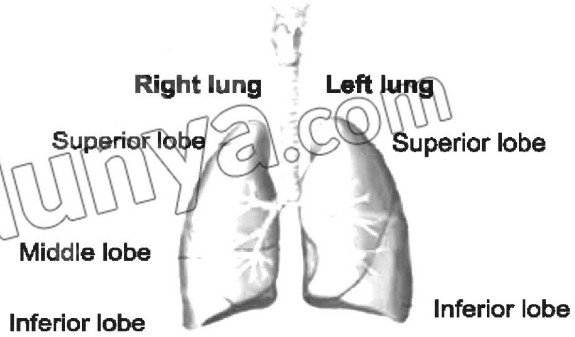


Fig. 3.4: Human lungs

3.3 MECHANISM OF VENTILATION (BREATHING)

The lungs themselves neither draw in air nor push it out. The diaphragm and the intercostal muscles accomplish the expansion and contraction of the lungs. The **diaphragm** is a large dome of skeletal muscle that separates the thoracic cavity from abdominal cavity. There are two sets of **intercostal muscles** between each pair of ribs: the external intercostal and the internal intercostal. The muscle fibres run diagonally but in opposite direction in the two sets of muscles. Breathing takes place in two phases i.e., inspiration and expiration.

Inspiration: It is taking in of air; it is the active phase of breathing. During inspiration contraction of the diaphragm causes its dome shape to flatten or less dome shape whereas contraction of the external intercostal and relaxation of the internal intercostal causes the rib cage to move upward and forward. Both these events result in increase of inner space of thoracic cavity. Consequently, the pressure in the thorax and hence in the lungs, is reduced to less than atmospheric pressure. Air therefore enters the lungs and alveoli become inflated.

Expiration: It is the removal of air out of the lungs; it is the passive phase of breathing. During expiration relaxation of the diaphragm causes it to become more dome shape whereas relaxation of the external intercostal and contraction of the internal intercostal cause the rib cage to move downward and backward. Both these events result in decrease of inner space of thoracic cavity. Consequently, the pressure in the thorax and hence in the lungs, is increased to more than atmospheric pressure, therefore, air is forced to expelled from the lungs.

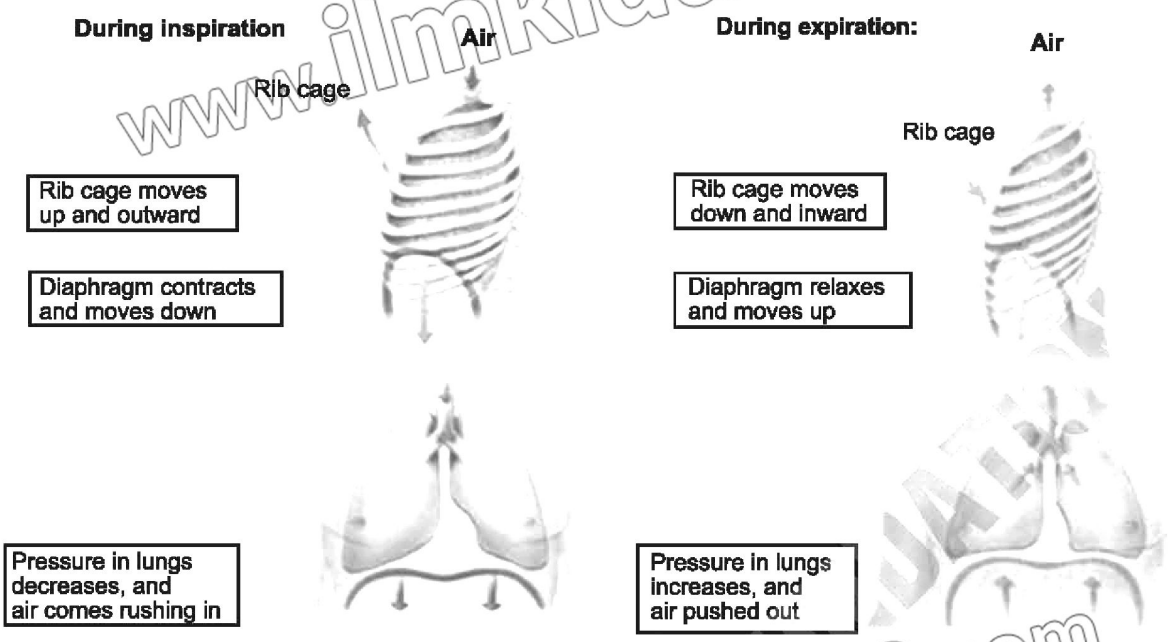


Fig. 3.5: Mechanism of breathing in human

3.3.1 Control of Breathing (Ventilation)

Normally we are not conscious of our breathing because it is controlled involuntarily. A **breathing centre** located in the **medulla** of the brain carries out involuntary control of breathing. The ventral portion of the breathing centre acts to increase the rate and depth of inspiration and is called **inspiratory centre**. The dorsal and lateral portions inhibit inspiration and stimulate expiration. These regions form the **expiratory centre**.

Through the **cerebral cortex** it is possible to consciously or unconsciously increase or decrease the rate and depth of the respiratory movement. A person may also stop breathing voluntarily. Occasionally people are able to hold their breath until the blood partial pressure of oxygen declines to a level low enough that they lose consciousness. After consciousness is lost, the respiratory centre resumes its normal function in automatically controlling respiration. Emotions acting through the **limbic system** of the brain can also affect the respiratory centre.

3.4 TRANSPORT OF GASES

Like other materials, respiratory gases are also transported in various regions of the body by means of blood. The blood transports oxygen from the lungs to different tissues and carbon dioxide from tissues to the lungs.

3.4.1 Transport of Oxygen in Blood

Approximately 97% of oxygen is carried by the red blood cells as **oxyhaemoglobin**, while 3% is transported as dissolved oxygen in the **plasma**. At its high partial pressure oxygen binds with haemoglobin.

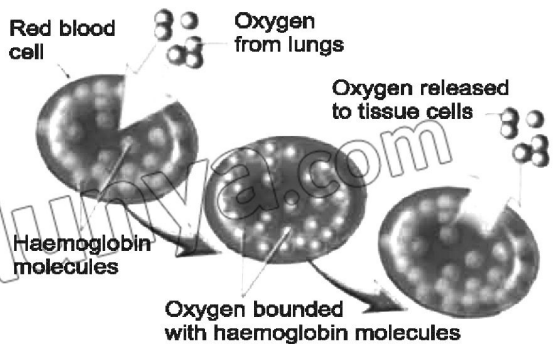


Fig. 3.6: Human lungs

This binding is reversible that occurs in the lungs in the presence of enzyme carbonic anhydrase. Each molecule of haemoglobin can bind with four molecules of oxygen to form oxyhaemoglobin.

$$Hb + 4O_2 \xrightarrow{\text{Carbonic anhydrase}} Hb4O_2$$

The ability of haemoglobin to bind with oxygen is called **oxygen carrying capacity** of blood.

SCIENCE TITBITS

The oxygen carrying capacity of blood is directly proportional to the partial pressure of oxygen (PO_2). Maximum oxygen carrying capacity of arterial blood is 20 ml/100 ml of blood (100% saturated) which is achieved at 100 mmHg Po_2. The 5 ml of O_2 is released to the tissues by each 100 ml blood. Oxygen carrying capacity is sensitive to a variety of environmental conditions like rise in body temperature, drop in pH of blood and partial pressures of carbon dioxide and oxygen.

SCIENCE TITBITS

The amount of haemoglobin is 15 gms/100 ml of blood. Since 1gm Hb can combine with 1.34 ml of O_2, therefore 100 ml blood combines with 20 ml O_2 (100% saturated). Normally each 100 ml of arterial blood contains 19.4 ml O_2 (i.e., it is 97% saturated; PO_2 is 95 mmHg), while 100 ml of venous blood contains 14.4 ml O_2 (i.e., it is 75% saturated; Po_2 is 40 mmHg).

3.4.2 Transport of Carbon dioxide in Blood

Carbon dioxide is transported in the blood in three main ways: (i) In the form of bicarbonate ions. (ii) In the form of carboxyhaemoglobin. (iii) Dissolved in plasma.

(I) As bicarbonate ions

Approximately 70% of carbon dioxide is carried in the blood as bicarbonate ions. Carbon dioxide diffuses into the blood, enters the red blood cells and combines with water to form carbonic acid in the presence of enzyme carbonic anhydrase. The chemical reaction can be depicted as follows:

$$CO_2 + H_2O \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} H_2CO_3$$

Carbonic acid, H_2CO_3 is an unstable compound and dissociates to form hydrogen ions and bicarbonate ions.

$$H_2CO_3 \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} H^+ + HCO_3^-$$

Accumulation of H^+ ions increases acidity in the blood, i.e., it leads to the decrease in pH. This does not occur since haemoglobin buffers the hydrogen formed. The hydrogen ion readily associates with oxyhaemoglobin ($Hb4O_2$) to form haemoglobinic acid (HHb) and oxygen is released to the tissue.

$$Hb4O_2 + H^+ \longrightarrow HHb + 4O_2$$

From inside of the erythrocytes negatively charged HCO_3^- ions diffuse to the plasma. This is balanced by the diffusion of chloride ions, (Cl^-), in the opposite direction. This is achieved by special bicarbonate-chloride carrier proteins that exist in the RBC membrane. This protein moves the two ions in opposite directions, maintaining the balance of ions on either side. This is called the **chloride shift or Hamburger' phenomenon**.

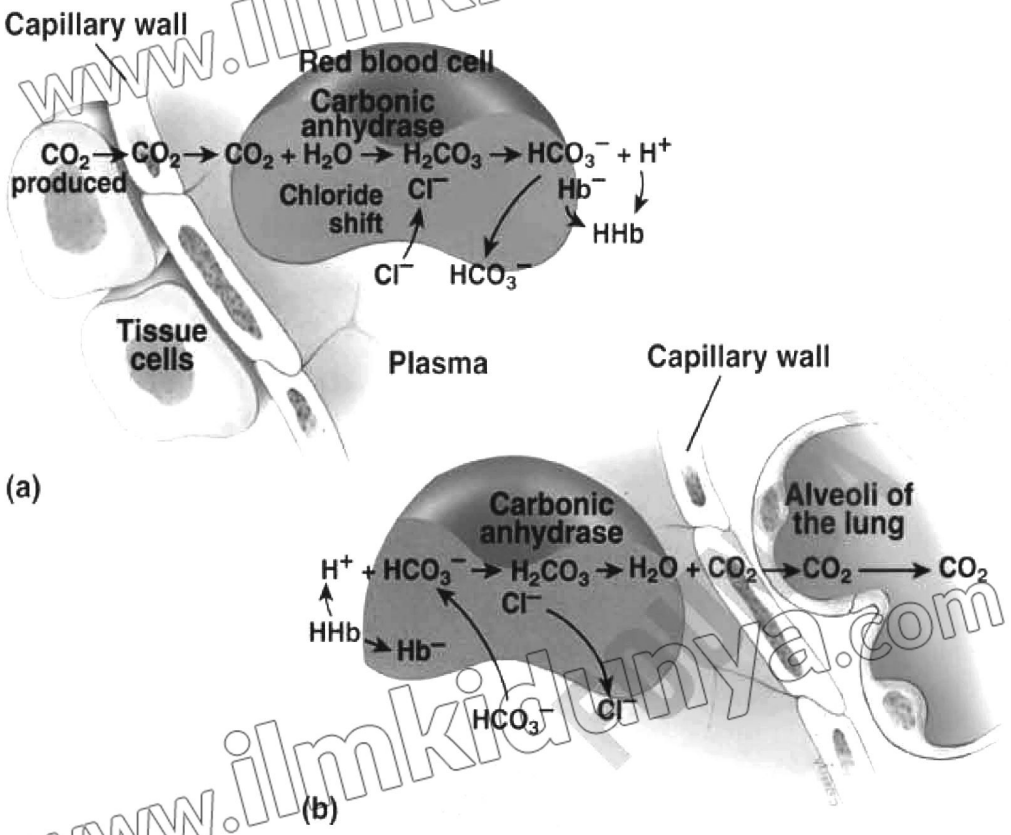


Fig. 3.7: Transport of CO_2 as bicarbonate ions (a) Transfer of CO_2 from tissues to blood (b) Transfer of CO_2 from blood to lungs.

The chloride ions that enter the RBC combine with potassium (K+) to form potassium chloride, whereas bicarbonate ions in the blood plasma combine with Na+ to form sodium bicarbonates. The blood pH is thus maintained at approximately 7.4 by the buffer mechanism that exists in blood.

Transport of CO_2 depends on the partial pressure of CO_2. The partial pressure of Co_2 is higher in tissues than blood so it diffuses into blood here it react with water and transported to the lungs as bicarbonate ion. In lungs process reverses and bicarbonate ions combine with hydrogen ion to release carbon dioxide and water.

(II) As carboxyhaemoglobin

About 23% of carbon dioxide is carried as carboxyhaemoglobin. CO_2 combines with the globin part of haemoglobin. The reaction depends upon the partial pressure of CO_2. When the PCO_2 is higher in the tissues than blood, formation of carboxyhaemoglobin occurs. When the PCO_2 is higher in the blood than tissues as in case of lungs, carboxyhaemoglobin releases its CO_2.

(iii) As dissolved CO_2 in plasma

Only 7% of carbon dioxide is carried this way. This is rather inefficient way to carry carbon dioxide, but it does occur.

3.5 ROLL OF RESPIRATORY PIGMENTS

Respiratory pigments are coloured molecules, which act as oxygen carriers by binding reversibly to oxygen. All known respiratory pigments contain a coloured non-protein portion e.g., **haem** in the haemoglobin. The two well-known respiratory pigments are haemoglobin and myoglobin.

Haemoglobin

It contains four globin protein chains, each associated with haem, an iron-containing group. Iron combines loosely with oxygen and in this way oxygen is carried in the blood. At high oxygen concentrations, the pigment combines with oxygen, whereas at low oxygen concentrations the oxygen is quickly released.

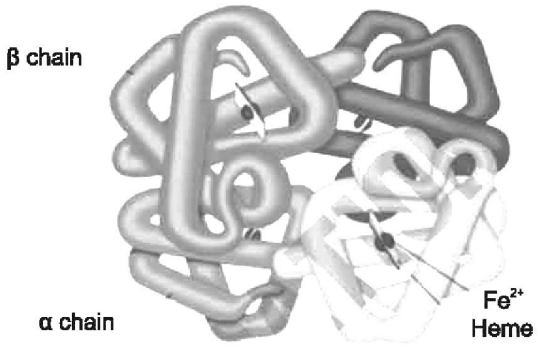


Fig. 3.8: Haemoglobin

Myoglobin

It consists of one polypeptide chain. This chain is associated with an iron containing ring structure. This iron can bind with one molecule of oxygen. It is found in skeletal muscles and is the main reason why meat appears red. It serves as an intermediate compound for the transfer of oxygen from haemoglobin to aerobic metabolic processes of the muscle cells. Myoglobin releases oxygen when the partial pressure of oxygen is below 20 mmHg. In this way it stores oxygen in resting muscle, only releasing it when supplies of oxyhaemoglobin have been exhausted.

Fig. 3.9: Myoglobin

Table 3.1 Differences between haemoglobin and myoglobin

Haemoglobin	Myoglobin
It consists of four polypeptide chains.	It consists of one polypeptide chain.
Each molecule possesses four iron containing haem groups.	Each molecule possesses one iron containing haem group.
Four oxygen molecules can bind to each haemoglobin molecule.	Only one oxygen molecule can bind to each myoglobin molecule.
It is found in RBCs.	It is found in muscles.
It transports oxygen.	It stores oxygen.
It has less affinity with oxygen.	It has more affinity with oxygen.
It loses oxygen at PO_2 60 mmHg.	It loses oxygen at PO_2 20 mmHg.

Science, Technology and Society Connections

Describe the carbon monoxide poisoning (caused by gas heaters left on overnight in closed environments).

Gases that have undergone incomplete combustion produce CO and toxic fumes (hydrogen cyanide). In carbon monoxide poisoning caused by gas heaters, left on overnight in closed environments, CO binds to haemoglobin preventing the uptake of oxygen by haemoglobin. The symptoms of CO poisoning are nausea, vomiting, headache, mental status changes, and cherry-red lips. CO binds to haemoglobin with affinity 249 times greater than that of oxygen. CO poisoning also decreases ability of haemoglobin to release oxygen to tissue.

3.6 RESPIRATORY DISORDERS

Respiratory tract infections are infections of parts of the body involved in breathing such as sinuses, throat, airways and lungs. The causes of respiratory tract infections can be bacterial, viral and fungal infections. Factors that increase susceptibility included weakened immune systems, smoking, air pollution and close contact with the infected individuals. Infections can affect the upper respiratory tract or the lower respiratory tract.

3.6.1 Upper Respiratory Tract Infection

The infections of the upper respiratory tract include sinusitis, etc.

Sinusitis

Sinusitis is an inflammation of the nasal sinuses that may be acute (symptoms last 2 - 8 weeks) or chronic (symptoms last much longer). The sinuses are holes in the skull between the facial bones.

Cause: Sinusitis is generally caused by cold and wet climate. Atmospheric pollution, smoke, dust, overcrowding, dental infections, viral infections etc., also cause sinusitis.

Symptoms: Fever, nasal obstruction, raspy voice, pus-like nasal discharge, loss of sense of smell, facial pain or headache that is sometimes aggravated by bending over.

Treatment: If a bacterial infection is present, antibiotics or sulpha drugs are usually prescribed. Beside it the physician may also prescribe nebulization which can be useful in reducing inflammation in the sinuses and nose and to accelerate recovery.

Otitis media

Otitis media is inflammation or infection located in the middle ear.

Causes: Middle ear infections are usually a result of a malfunction of the eustachian tube. When this tube is not working properly, it prevents normal drainage of fluid from the middle ear, causing a buildup of fluid behind the eardrum. When this fluid cannot drain, it allows for the growth of bacteria and viruses in the ear that can lead to acute otitis media. The following are some of the reasons: (i) A cold or allergy which can lead to swelling and congestion of the lining of the nose, throat, and eustachian tube (this swelling prevents the normal drainage of fluids from the ear) (ii) A malformation of the eustachian tube.

Symptoms: The following are the most common symptoms of otitis media. However, each child may experience symptoms differently. Symptoms may include: (a) unusual irritability

(b) Difficulty sleeping or staying asleep (c) Tugging or pulling at one or both ears. (d) Fever, especially in infants and younger children (e) Fluid draining from ear(s) (f) Loss of balance (g) Hearing difficulties (h) Ear pain.

Treatment: It may include: (a) Antibiotic medication by mouth or ear drops (b) Medication (for pain and fever) (d) A combination of the above.

3.6.2 Lower Respiratory Tract Infection

The infections of lower respiratory tract include, pulmonary tuberculosis etc.

Pneumonia

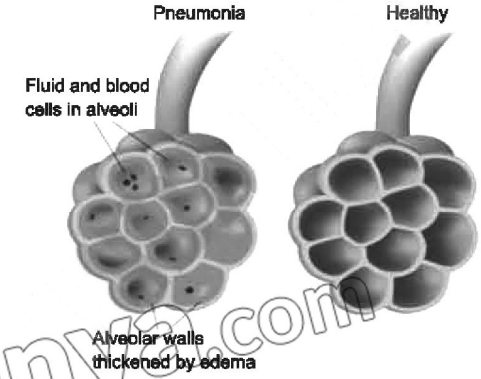


Fig. 3.10: Pneumonia

Pneumonia is an infection that inflames the air sacs in one or both lungs. The air sacs may fill with fluid or pus, causing cough with phlegm or pus, fever, chills, and difficulty breathing.

Causes: A variety of organisms, including bacteria, viruses and fungi, can cause pneumonia.

Symptoms: These may include: (a) Chest pain when you breathe or cough (b) Confusion or changes in mental awareness (in adults age 65 and older (c) Cough, which may produce phlegm (d) Fatigue (e) Fever, sweating and shaking chills. (f) Lower than normal body temperature (in adults older than age 65 and people with weak immune systems) (g) Nausea, vomiting or diarrhea (h) Shortness of breath.

Treatment: Some treatments may include:

1. **Antibiotics:** Pneumonia caused by bacteria is treated with an antibiotic.
2. **Antifungal medications:** Antifungal can treat pneumonia caused by a fungal infection.
3. **Antiviral medications:** Viral pneumonia usually isn't treated with medication and can go away on its own.
4. **Draining of fluids:** If you have a lot of fluid between your lungs and chest wall (pleural effusion), a physician may drain it. This is done with a catheter or surgery.

Pulmonary Tuberculosis

Pulmonary Tuberculosis (TB) is a highly contagious chronic bacterial infection of lungs. When people have pulmonary tuberculosis, the alveoli burst and are replaced by inelastic connective tissue. The cells of the lung tissue build a protective capsule around the bacilli and isolate them from rest of the body. This tiny capsule is called **tubercle**. The tubercles can rupture, releasing bacteria that infect other parts of the lung.

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

Symptoms: There is a low-grade intermittent fever usually in the evening, night sweats, weight loss, anorexia, depression, weakness and dry cough with sputum, dull ache in the chest due to Inflammation of the pleura of the lungs.

Treatment: Taking medicines for 9 months regularly can cure T.B disease. This is called **Daily Observed Treatment Short Course (DOTS)**. This treatment is given to patients under supervision to ensure that the "medicines intake" completely cures the patient.

SCIENCE TITBITS

The spread of pulmonary TB can be controlled by some preventive measures like:

1. Living room should be well ventilated and bright.
2. Always cover the mouth with cloth during coughing and sneezing.
3. Avoid spitting openly.
4. Always burry or burn the sputum of patient.
5. The patients should spit in a utensil with lime powder to prevent the spread of disease.
6. The use of masks and other respiratory isolation procedures to prevent spread to medical personal is also important.

3.6.3 Disorders of lungs

There are many disorders that affect lungs. Emphysema and COPD are two common examples of disorders of lungs.

Emphysema

Emphysema is a lung disease that results from damage to the walls of the alveoli in the lungs. A blockage (obstruction) may develop, which traps air inside the lungs. With fewer alveoli, less oxygen moves into your bloodstream.

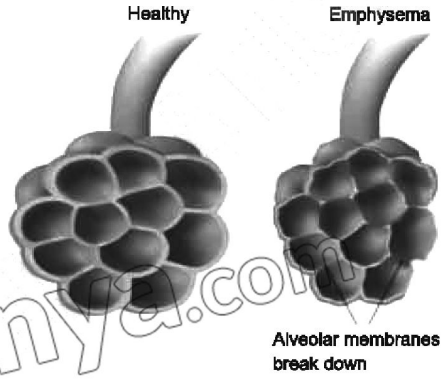


Fig. 3.11: Emphysema

Causes: Smoking is the main cause of emphysema. There are other causes. These include: (a) Marijuana (b) Vaping and e-cigarettes (c) Cigar smoke. (d) Air pollution. (e) Dust.
Symptoms: These include: (a) Long-term coughing (smoker's cough). (b) Wheezing. (c) Shortness of breath, especially during light exercise like climbing steps. (d) Constant feeling of not being able to get enough air. (e) Tightness in the chest. (f) Increased mucus production. (g) Abnormal mucus color (yellow or green). (h) Ongoing fatigue. (i) Heart problems.
Treatment: Treatment options may include: (a) Quitting smoking. (b) Bronchodilators (c) Inhaled and oral corticosteroids (d) Antibiotics (e) Anti-inflammatory medications.

Chronic obstructive pulmonary disease (COPD)

Chronic obstructive pulmonary disease (COPD) is the name for a group of lung conditions that cause breathing difficulties. It includes: (a) emphysema - damage to the air sacs in the lungs (b) chronic bronchitis - long-term inflammation of the airways
Causes: COPD happens when the lungs become inflamed, damaged and narrowed. The main cause is smoking. Some cases of COPD are caused by long-term exposure to harmful fumes or dust. Others are the result of a rare genetic problem that makes the lungs more vulnerable to damage.

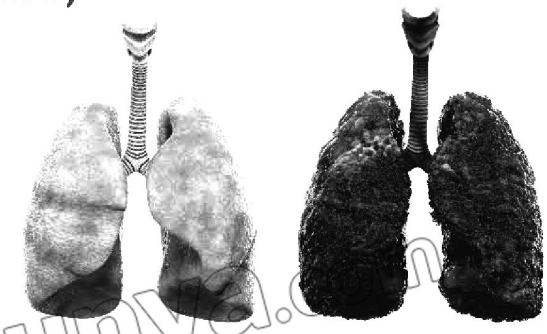


Fig. 3.12: Effects of smoking on lungs

Symptoms: The main symptoms of COPD are: (a) shortness of breath, (b) a persistent chesty cough, with phlegm (c) frequent chest infections (d) persistent wheezing

Treatment: Treatments include: (a) stopping smoking (b) inhalers and medicines - to help make breathing easier (c) pulmonary rehabilitation -a specialized programmed of exercise and education (d) surgery or a lung transplant- although this is only an option for a very small number of people.

3.6.4 Effects of smoking

The effects of smoking on respiratory system are:

1. Cigarette smoking causes about 87% of lung cancer.
2. Besides lung cancer, cigarette smoking is also a major cause of cancer of the mouth, larynx and esophagus.
3. Cigarette smoking causes other lung diseases e.g., chronic bronchitis, emphysema.
4. Cigarette smokes contain chemicals which irritate the air passages and lungs, causing early morning cough.
5. Smokers are likely to get pneumonia because damaged or destroyed cilia cannot protect lungs from bacteria and viruses that float in the air.
6. Almost immediately, smoking can make it hard to breathe. Within a short time, it can also worsen asthma and allergies.

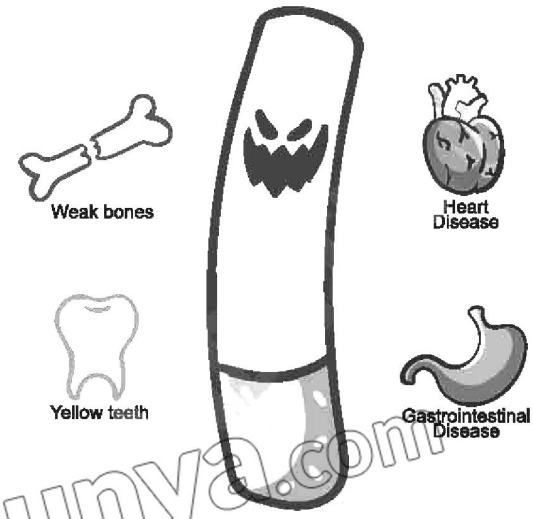
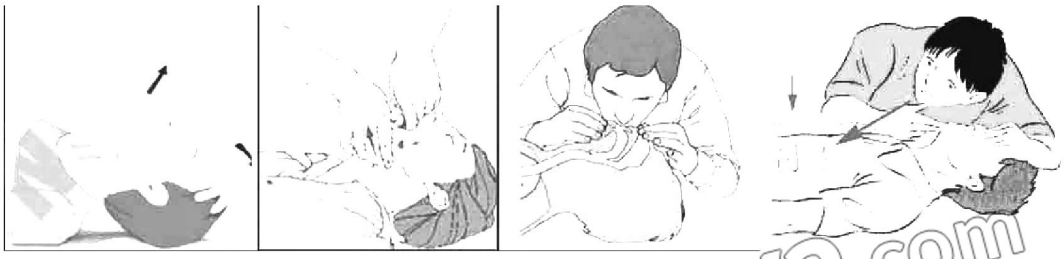


Fig. 3.13: Effects of smoking

Science, Technology and Society Connections

Mouth to mouth artificial respiration. (Cardiopulmonary Resuscitation (CPR)

Mouth to mouth artificial respiration is called resuscitation. It is a technique used to recover a person who has stopped breathing. In this technique, the rescuer presses his or her mouth against the mouth of the victim and allowing for passive inhalation, forces air into the lungs at intervals of several seconds.



What to do:

1. Stretch out victim on his back and kneel close to his side. Loosen any tight clothing around his neck or chest.
2. Remove foreign objects if present from victim's mouth and throat by finger sweeping.
3. Lift up chin and tilt head back as far as possible. If the head is not tilted, the tongue may block the throat.

4. Begin the resuscitation immediately. Pinch the nostrils together with the thumb and index finger of the hand that is pressing on the victim's forehead. This prevents the loss of air through the nose during resuscitation.
5. Inhale deeply.
6. Place your mouth tightly around the victim's mouth (over mouth and nose of small children) and blow into the air passage with brief intervals. Continue this activity so long as there is any pulse or heartbeat.
7. Watch the victim's chest. When you see it rise, stop blowing, raise your mouth, turn your head to the side and listen for exhalation.
8. If patient is revived, keep him warm and do not move him until the doctor arrives, or at least for half or one hour.

STEAM ACTIVITY 3.1

a. How to measure your respiratory rate

Your respiratory rate is also known as your breathing rate. This is the number of breaths you take per minute.

You can measure your breathing rate by counting the number of breaths you take over the course of one minute while you are at rest.

To get an accurate measurement:

1. Sit down and try to relax.
2. It's best to take your respiratory rate while sitting up in a chair or in bed.
3. Measure your breathing rate by counting the number of times your chest or abdomen rises over the course of one minute.
4. Record this number.

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

1. When blood leaves the capillary bed most of the carbon dioxide is in the form of
   A. carbonate ions B. bicarbonate ions
   C. hydrogen ions D. hydroxyl ions
2. When you inhale, the diaphragm
   A. relaxes and moves upward B. relaxes and moves downward
   C. contracts and moves upward D. contracts and moves downward
3. With which other system do specialised respiratory systems most closely interface in exchanging gases between the cells and the environment?
   A. the skin B. the excretory system
   C. the circulatory system D. the muscular system
4. Which of the following is the respiratory surface in human respiratory system:
   A. larynx B. trachea
   C. bronchi D. alveoli

5. How is most of the oxygen transported in the blood?

A. dissolved in plasma
B. bound to haemogloibin
C. as bicarbonate
D. dissolved in water

6. The lateral walls of the chest cavity of man are composed of the:

A. ribs
B. intercostal muscles
C. ribs and intercostal muscles
D. ribs, intercostal muscles and diaphragm

7. Which of the following factors is the most effective in accelerating the rate of breathing in man?

A. a lack of oxygen in the blood
B. a lack of oxygen in the tissues
C. an excess of carbon dioxide in the lungs
D. an excess of carbon dioxide in the blood

8. Which of the following changes will increase the body's rate of carbon dioxide excretion into the alveoli?

A. holding the breath
B. the breakdown of alveolar tissue as a result of disease
C. a decrease in the partial pressure of carbon dioxide in the alveolar air
D. a decrease in the pulmonary circulation

9. Breathing is an example of

A. counter current exchange
B. cellular respiration
C. ventilation
D. diffusion

10. Which sequence most accurately describes the sequence of airflow in the human respiratory system?

1. pharynx 2. bronchus 3.trachea 4.larynx 5.alveolus 6.bronchiole

A. 4, 1, 3, 2, 5, 6
B. 1, 4, 3, 2, 5, 6
C. 4, 1, 3, 2, 6, 5
D. 1, 4, 3, 2, 6, 5

11. Which one of the following changes takes place during inspiration?

A. Decrease in thoracic cavity
B. Relaxation in diaphragm
C. Relaxation in external intercostal muscles
D. Sternum moves towards ventral and anterior direction

12. The volume of air that can be exhaled after normal exhalation is the

A. tidal volume
B. residual volume
C. inspiratory reserve volume
D. expiratory reserve volume

13. Hemoglobin

A. combine reversely with only oxygen
C. attach to the alveolar wall
B. all have four heme group
D. none of them

14. The maximum volume of air contained in the lung by a full forced inhalation is called _____.

A. Tidal volume
B. Vital capacity
C. Ventilation rate
D. Total lung capacity

15. Dissociation of O_2 from oxyhaemoglobin is facilutated by:

A. decreased temperature
B. decreases H^+
C. decreased PO_2
D. exercise

16. Which of these correctly orders the structures through which air passes during inhalation?

A. pharynx → trachea → larynx → bronchi
B. pharynx → larynx → trachea → bronchi
C. larynx → pharynx → bronchi → trachea
D. larynx → pharynx → trachea → bronchi

17. The pharynx is also known as the:

A. windpipe
B. trachea
C. voice box
D. throat

18. What is the correct path air takes when it enters the trachea on its way to the lungs?

A. bronchi /bronchioles /pulmonary capillaries/ alveoli
B. bronchioles/ bronchi/ alveoli/ pulmonary capillaries
C. bronchi / pulmonary capillaries/alveoli/ bronchioles
D. bronchi /bronchioles/alveoli / pulmonary capillaries

19. Which of the following is correct for the partial pressure of oxygen in alveoli?

A. less than carbon dioxide
B. less than the blood
C. more than the blood
D. equal to that of the blood

20. Which of the following is the respiratory surface in human respiratory system:

A. larynx
B. trachea
C. bronchi
D. alveoli

Section II: Short Answer Questions

1. What is respiratory surface? Write the properties of respiratory surface.
2. What organs constitute the respiratory system?
3. How nose and nasal cavity function in filtering the incoming air?
4. What is the role of 'pharynx' in human respiration?
5. Describe function of human larynx.
6. Describe the structure and function of alveoli.
7. How the contraction and relaxation of human lungs take place?
8. What is chloride shift?
9. What are the advantages of having millions of alveoli rather than a pair of simple balloon like lungs?
10. Write the differences between:
    (a) Internal and external respiration
    (b) Upper and lower respiratory tract
    (c) Bronchi and bronchioles

(d) Oxyhaemoglobin and carboxyhaemoglobin
(e) Haemoglobin and myoglobin

11. List the effects of smoking.

Section III: Extensive Answer Questions

1. Describe the human upper respiratory tract.
2. Describe the human lower respiratory tract.
3. Describe the mechanism of breathing in man.
4. How the control of breathing takes place?
5. Explain the transport of oxygen in blood.
6. Explain the transport of carbon dioxide in blood.
7. What is the role of respiratory pigments in man?
8. Describe the cause, symptoms and treatments of:
   (a) Sinusitis
   (b) Otitis media
   (c) Pneumonia
   (d) Pulmonary tuberculosis
   (e) Emphysema
   (f) Chronic obstructive pulmonary disease (COPD)

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