UNIT I- HUMAN ANATOMY AND PHYSIOLOGY

IB BREATHING AND EXCHANGE OF GASES

Very Short Answer Questions

1. Define vital capacity. What is its significance?

A. **Vital capacity:** The maximum volume of air a person can breathe in after forced expiration. It includes ERV (Expiratory Reserve Volume), TV (Tidal Volume) and IRV (Inspiratory Reserve Volume) (or) the maximum volume of air a person can breathe out after forced inspiration (VC = TV + IRV + ERV). It is about 4,000 to 4600 ml.

2. What is the volume of air remaining in lungs after a normal expiration?

A. The volume of air that remains in the lungs after normal expiration is called 'Functional Residual Capacity (FRC)'.

FRC = ERV + RV

ERV = 1000 to 1100 ml

RV = 1100 to 1200 ml

So, FRC = 2100 to 2300 ml

3. Diffusion of oxygen occurs in the alveolar region only and not in other parts of respiratory system. How do you justify the statement?

A. Alveoli are primary sites of exchange of gas by simple diffusion.

Alveolar region has enough pressure or concentration gradients to facilitate diffusion of gases compared to other regions.

High pO_2, low pCO_2, lesser H^+ concentration, low temperature conditions in alveoli favourable for diffusion of O_2 and formation of oxyhaemoglobin.

Solubility of gases and thinness of the membrane are the other important factors that can influence the rate of diffusion.

4. What is the effect of pCO_2 on oxygen transport?

A. The role of pCO_2 in the transport of oxygen is significant. In the alveolus, the low pCO_2 and high favours the formation of oxyhaemoglobin. Near the tissues, high pCO_2 and low pO_2 favor the dissociation of oxygen from oxyhaemoglobin. Hence, the affinity of haemoglobin for oxygen is enhanced by the decrease of pCO_2 in blood.

5. What happens to the respiratory process in man going up a hill?

A. When a man is going up a hill, there is more consumption of oxygen and resulting in more demand of oxygen. It causes increase in breathing rate on hill.

6. What is tidal volume? Find out the tidal volume in a healthy human, in an hour?

A. **Tidal Volume (TV):** Volume of air inspired (or) expired during normal inspiration (or) expiration. It is approximately 500 ml i.e., A healthy man can inhale (or) exhale approximately 6000 to 8000 ml of air per minute (or) 3,60,000 to 4,80,000 ml per hour.

7. Define oxyhaemoglobin dissociation curve. Can you suggest the percentage of sigmoidal pattern?

A. The oxyhaemoglobin dissociation curve is a graph showing the percentage of oxyhaemoglobin at various partial pressures of oxygen.

Reasons for sigmoidal pattern:

In alveoli, where there is a high pO_2, low pCO_2, lesser H^+ and low temperature, the factors are all favorable for formation of oxyhaemoglobin.

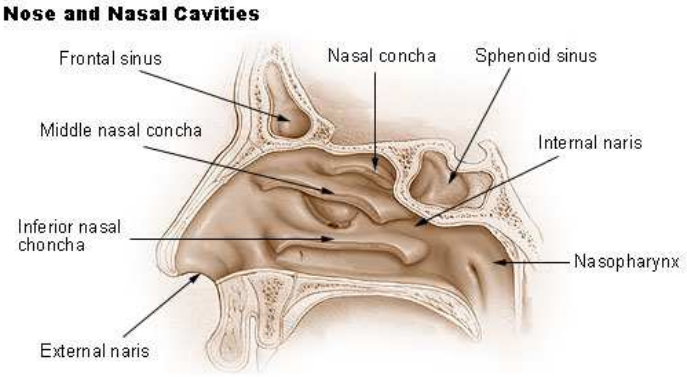
While in the tissues where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist, the conditions are favorable for dissociation of oxygen from oxyhaemoglobin under these conditions.

Oxygen dissociation curve shifts away from the Y – axis and form sigmoid curve.

8. What are conchae?

A. Conchae or turbinates are thin, twisted bony plates which are present in respiratory part of nasal chamber.

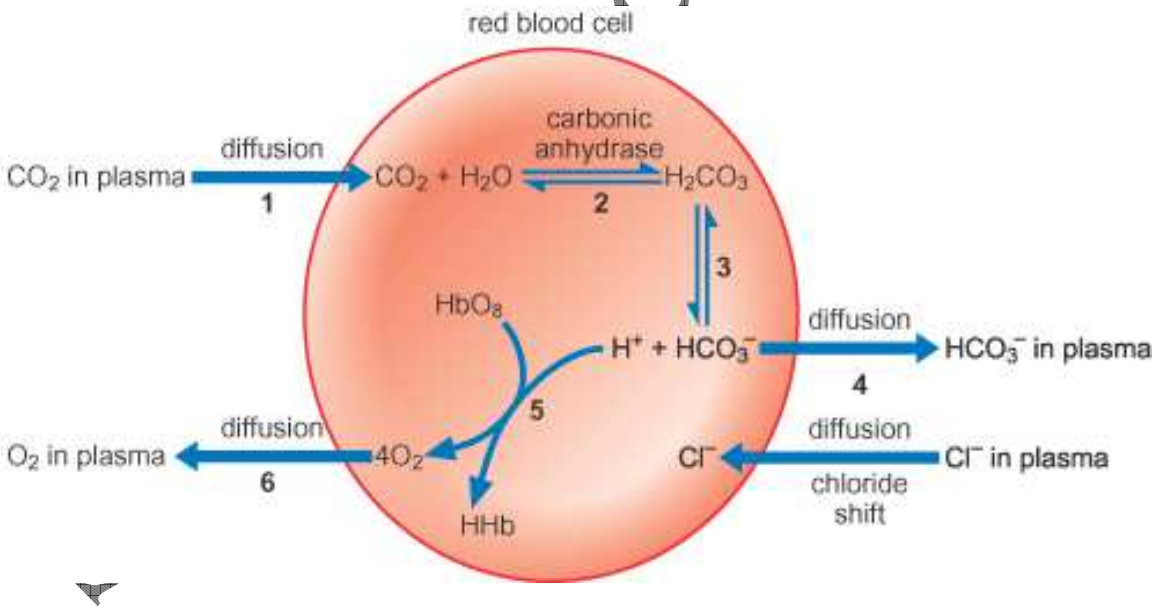
They are three in number. Such as interior concha, middle concha and superior concha.



9. What is meant by chloride shift?

A. Chloride shift: It refers to the exchange of chloride and bicarbonate ions between erythrocytes and plasma.

It is also considered as Hamburger's phenomenon/Hamburger's shift.



10. Mention any two occupational respiratory disorders and their causes in human beings?

A. Occupational respiratory disorders are caused by exposure of the body to the harmful substances from certain industries. Such as:

1) Asbestosis: It occurs due to chronic exposure to asbestos dust in the people working in asbestos industry.

2) Silicosis: It occurs because of long tem exposure to 'silica dust' in the people working in mining industries, quarries, etc.

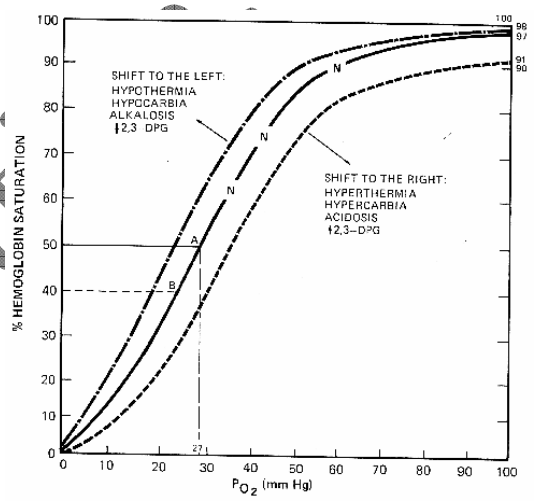
3)**Siderosis**: It occurs due to deposition of iron particles in tissues.

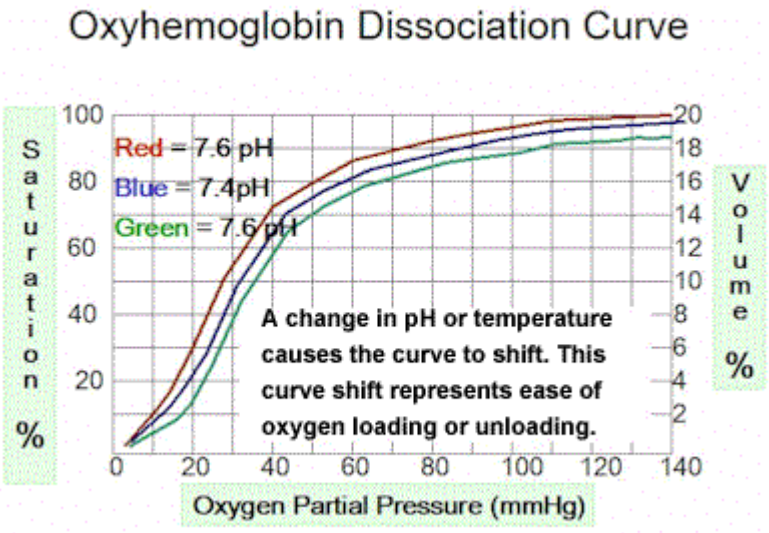
11. Name the muscles that help in normal breathing movements?

A. Muscles of diaphragm and external inter – costal muscles help in the process of normal breathing movements.

12. Draw the diagram of oxyhaemoglobin dissociation curve?

A.





Short Answer Questions

1. Explain the process of inspiration and expiration under normal conditions?

A. Breathing includes inspiration and expiration….

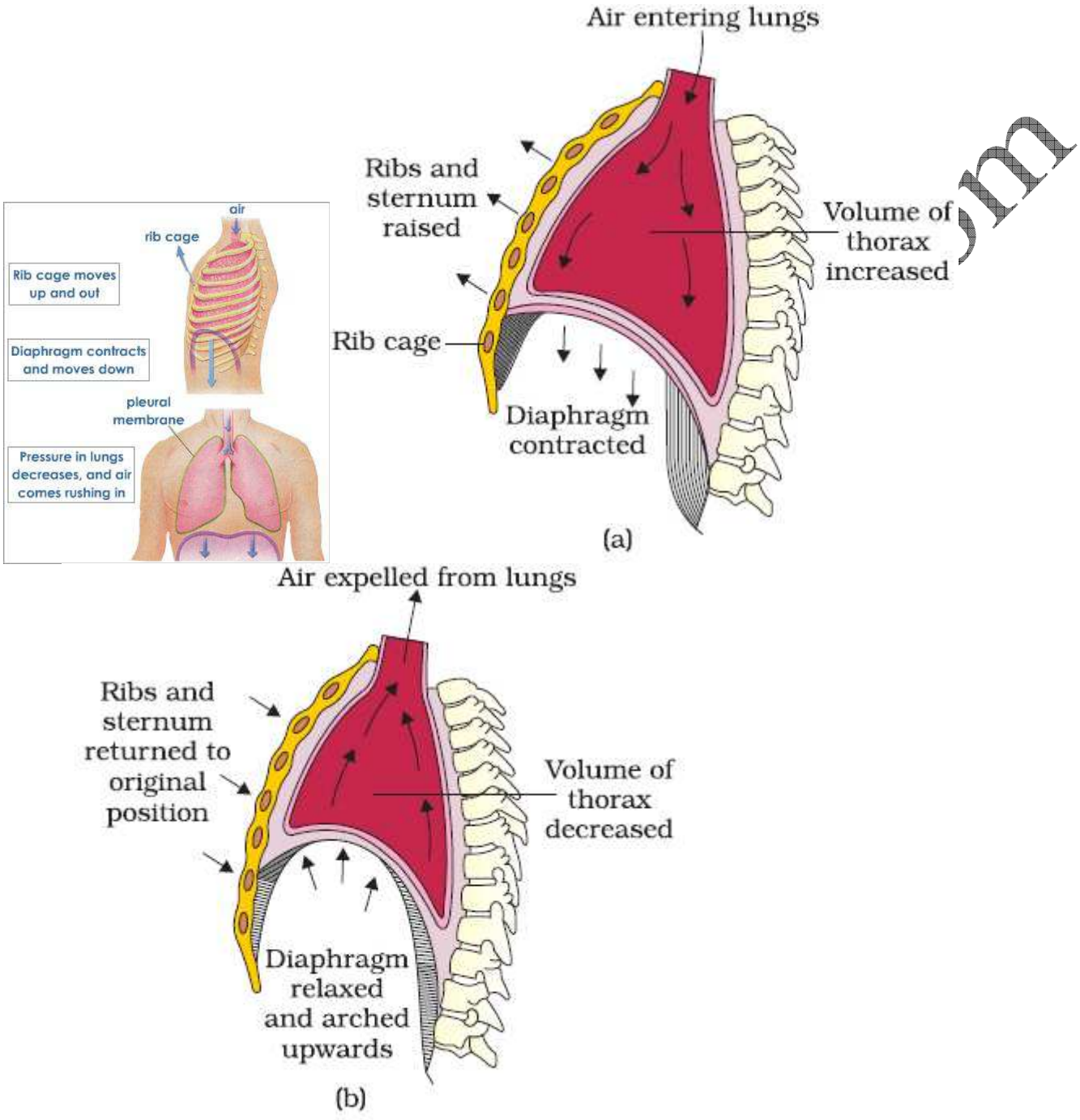


Figure 17.2 Mechanism of breathing showing : (a) inspiration (b) expiration

a) **Inspiration:** Intake of atmospheric air into the lungs is called inspiration.

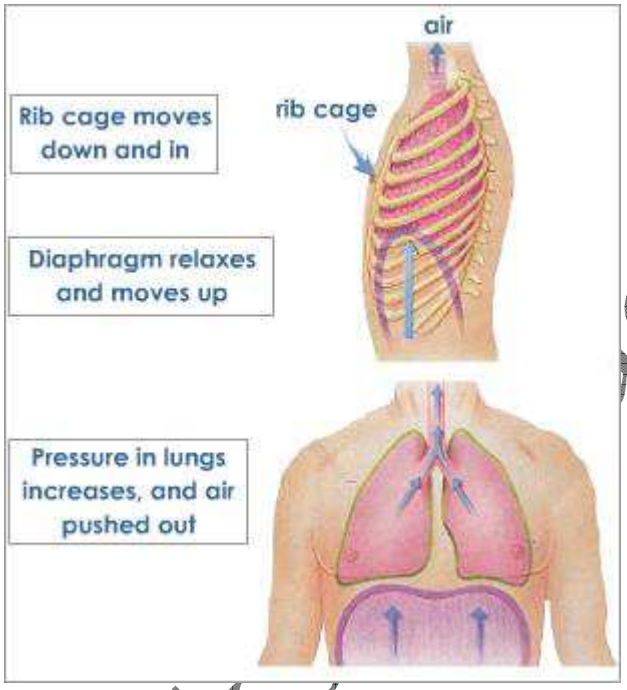
It is an active process, as it takes place by the contraction of the muscles of the diaphragm and the external inter – costal muscles which extend in between the ribs.

The contraction of diaphragm increases the volume of thoracic chamber in the anteroposterior axis.

The contraction of external intercostal muscles lifts up the ribs and sternum causing an increase in the volume of thoracic cavity in the dorsoventral axis.

The overall increase in the thoracic volume causes increase in the pulmonary volume. An increase in the pulmonary volume decreases the intra – pulmonary pressure to less than that of the atmosphere (negative), which forces the air from the outside to move into the lungs.

Expiration:



Release of alveolar air to the exterior is called expiration.

It is a passive process. Relaxation of diaphragm and external inter – costal muscles returns the diaphragm and sternum to their normal positions, and reduces the thoracic volume and thereby the pulmonary volume.

It leads to an increase in the intra – pulmonary pressure to slightly above that of the atmospheric pressure, causing the expulsion of air from the lungs.

2. What are the major transport mechanisms for CO_2 ? Explain?

A. Carbondioxide is transported in three ways.

1. In Dissolved State: 7% of CO_2 is transported in dissolved state through plasma.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

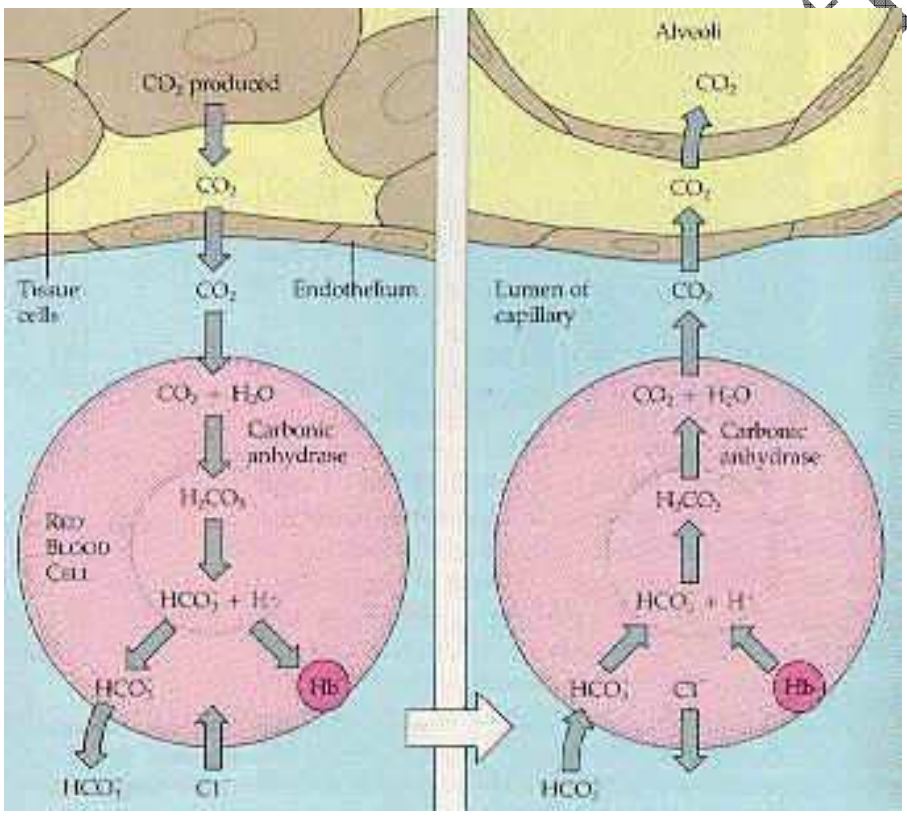
2. As Carbamino Compounds: About 20 – 25% of CO_2 combine directly with free amino group of haemoglobin and forms Carbamino haemoglobin in a reversible manner.

$$Hb - NH_2 + CO_2 \longrightarrow Hb - NHCOO^- + H^+$$

pCO_2 and pO_2 could affect the binding of CO_2 to haemoglobin.

- When pCO_2 is high and pO_2 is low as in the tissues, binding of more CO_2 occurs.

- When pCO_2 is low and pO_2 is high as in the alveoli, dissociation of CO_2 from Carbamino – haemoglobin takes place (i.e., CO_2 which is bound to haemoglobin from the tissues is delivered at the alveoli).



3. As Bicarbonates: About 70% of CO_2 is transported as bicarbonate. RBCs contain a very high concentration of the enzyme, carbonic anhydrase and a minute quantity of the same is present in plasma too. This enzyme facilitates the following reaction in both the directions.

$$CO_2 + H_2O \xrightarrow{\text{Carbonic anhydrase}} H_2CO_3 \xrightarrow{\text{Carbonic anhydrase}} HCO_3^- + H^+$$

At the tissues where partial pressure of CO_2 is high due to catabolism. CO_2 Diffuses into the blood and forms carbonic acid which dissociates into $HCO_3^- + H^+$

At the alveolar site where pCO_2 is low, the reaction proceeds in the opposite direction leading to the formation of CO_2 and water. Thus CO_2 is mostly trapped as bicarbonate at the tissues and transported to the alveoli where it is dissociated out as CO_2.

Every 100 ml of deoxygenated blood delivers approximately 4 ml of CO_2 to the alveolar air.

3. How is respiratory movements regulated in man?

A. In human beings the respiratory movements are regulated by neural system.

1. A special centre present in the medulla region of brain, called 'respiratory rhythm centre' is primarily responsible for the regulation of respiratory movements.

2. Another centre present in the pons of the brainstem called 'pneumotaxic centre' can moderate the functions of the respiratory rhythm centre. Neural signal from and this centre can reduce the duration of inspiration and thereby alter the respiration rate.

3. A chemo – sensitive area is situated adjacent to the respiratory rhythm centre which is highly sensitive to CO_2 and H^+. Increase in these substances can activate this centre, which in turn can send signals to the respiratory rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated.

4. Receptors associated with aortic arch and carotid artery as peripheral chemo receptors also recognize changes in CO_2 and H^+ concentration and send necessary signals to the respiratory rhythm centre for necessary actions.

The role of oxygen in the regulation of the respiratory rhythm is quite insignificant.

4. Distinguish between (a) IRV and ERV, (b) Inspiratory capacity and expiratory capacity, (c) Vital capacity and Total lung capacity.

A. **(a) IRV and ERV:**

IRV (Inspiratory Reserve Volume): The maximum volume of air that can be inhaled during forced breathing, in addition to the tidal volume. This is about 2500 ml to 3000 ml.

ERV (Expiratory Reserve Volume): The maximum volume of air that can be exhaled during forced breathing in addition to the 'tidal volume'. This is about 1000 ml to 1100 ml.

(b) Inspiratory capacity and expiratory capacity:

i) **Inspiratory capacity (IC):** The total volume of air, a person can inhale after 'normal expiration'. This includes tidal volume and inspiratory reserve volume.

IV = TV + IRV

It is about 3000 ml to 3500 ml

ii) **Expiratory capacity (EC):** The total volume of air, a person can expire after a 'normal inspiration'. This includes tidal volume and expiratory reserve volume.

EC = TV + ERV

(c) Vital capacity and Total lung capacity:

Vital capacity (VC): The maximum volume of air a person can breathe in after 'forced expiration'. This includes ERV, TV and IRV (or) the maximum volume of air; a person can breathe out after forced inspiration.

VC = TV + IRV + ERV

Total lung capacity (TL): The total volume of air accommodated in the lungs at the end of forced inspiration.

This includes RV, ERV, TV and IRV

TLC = ERV + IRV + TV + RV (or)

TLC = Vital capacity + residual volume.

5. Describe disorders of respiratory system?

A. **Disorders of respiratory system:**

1) Asthma: Asthma is a difficulty in breathing caused due to inflammation of bronchi and bronchioles. Symptoms include coughing, difficulty in breathing and wheezing.

Releasing of histamine due to allergen causes constriction of bronchi.

2) Emphysema: It is a chronic disorder in which alveolar walls are damaged and their walls coalesce due to which respiratory surface area of exchange of gases is decreased. One of the major reasons is smoking of tobacco.

3) Bronchitis: Bronchitis is the inflammation of the bronchi, resulting in the swelling of mucus lining of bronchi, increased mucus production and decrease in the diameter of bronchi.

Symptoms are chronic cough with thick mucus / sputum / phlegm.

4) Pneumonia: The infection of lungs caused by ***Streptococcus pneumonia*** and also by certain Virus, Fungi, Protozoan's and *Mycoplasmas.*

Symptoms are inflammation of lungs, accumulation of mucus in alveoli and impaired exchange of gases, leading to death if untreated.

Occupational disorders: These are caused by exposure of the body to the harmful substances.

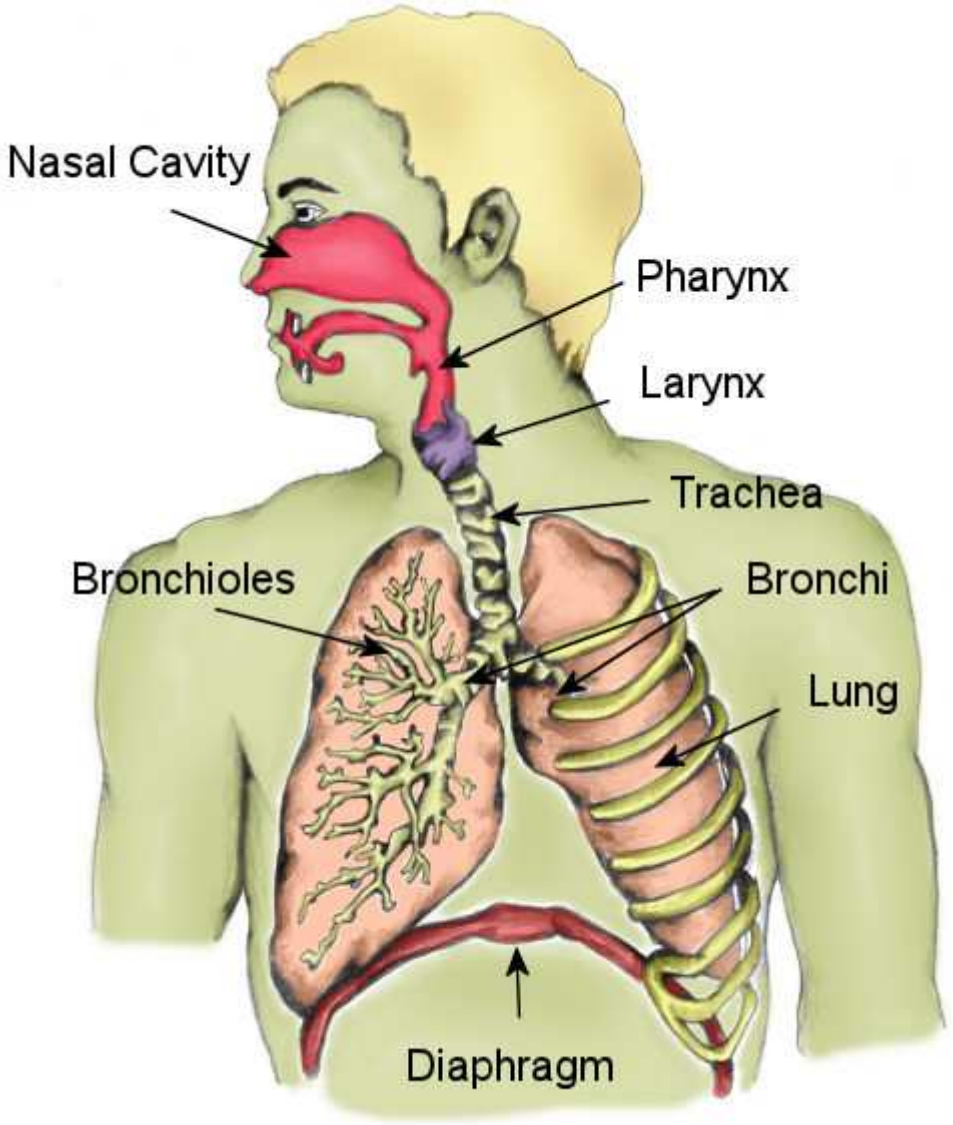
E.g.:

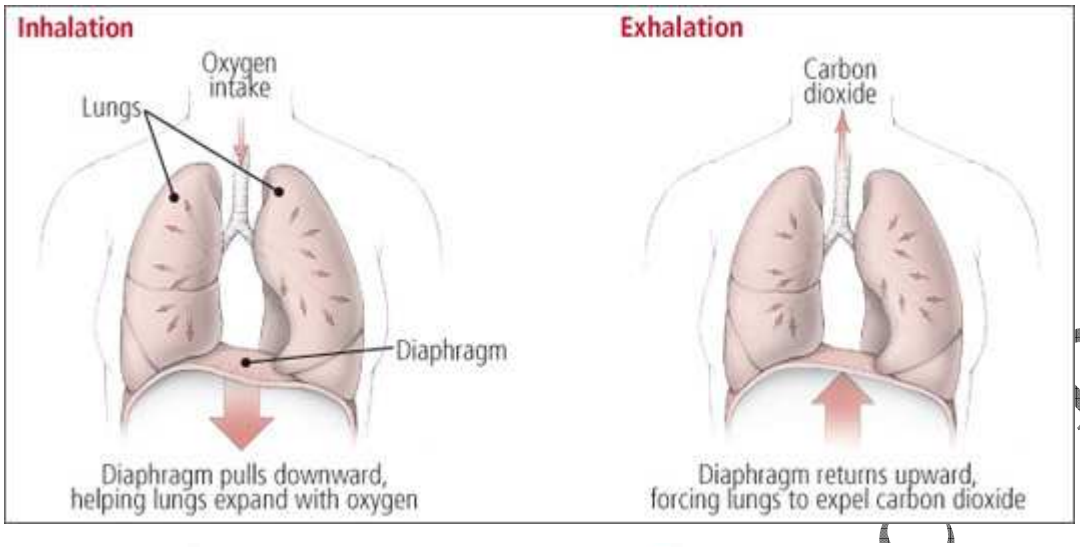
i) Asbestosis: It occurs due to chronic exposure to asbestos dust in the people working in asbestos industry.

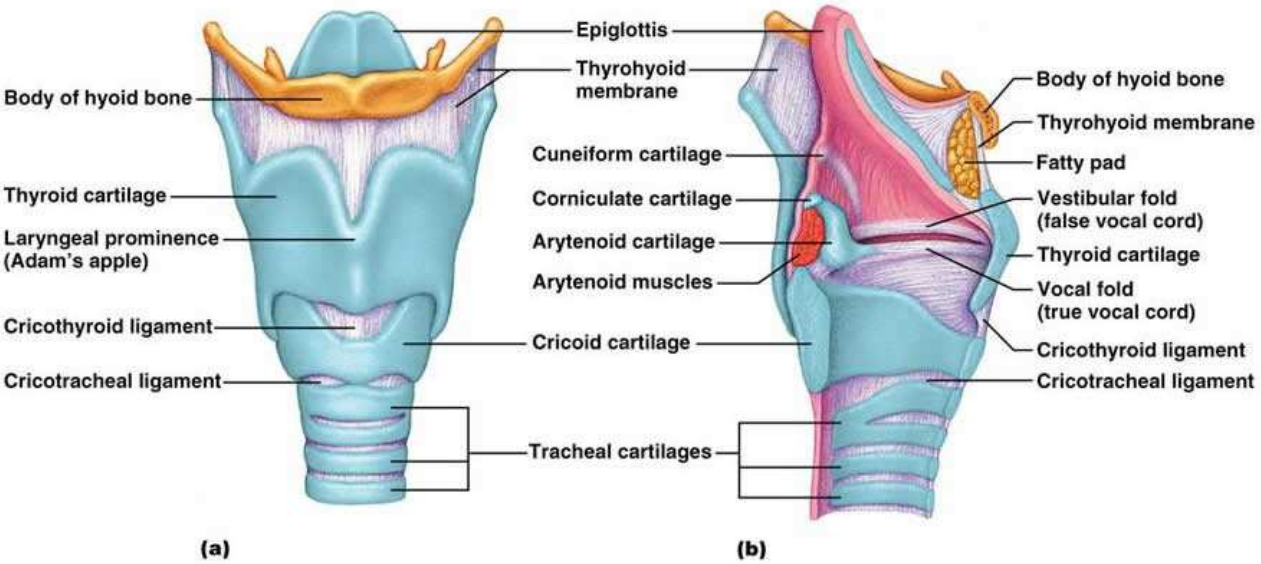
ii) Silicosis: It occurs because of long term exposure to silica dust.

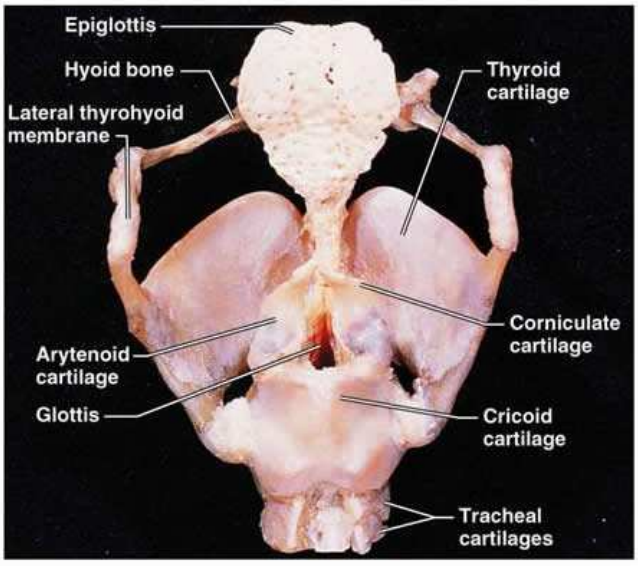
iii) Siderosis: It occurs due to deposition of iron particles in tissues.

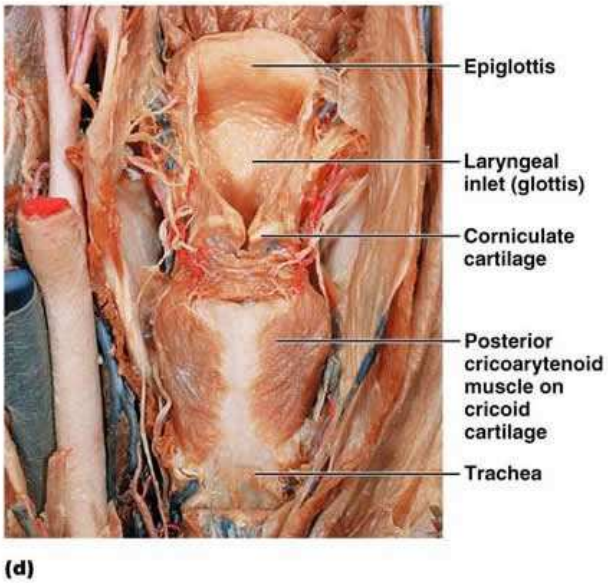
iv) Black lung disease: It develops from inhalation of coal dust.




Inhalation
Oxygen intake
Lungs
Diaphragm
Diaphragm pulls downward, helping lungs expand with oxygen
Exhalation
Carbon dioxide
Diaphragm returns upward, forcing lungs to expel carbon dioxide


Body of hyoid bone
Thyroid cartilage
Laryngeal prominence (Adam's apple)
Cricothyroid ligament
Cricotracheal ligament
Epiglottis
Thyrohyoid membrane
Cricoid cartilage
Tracheal cartilages
(a)
Cuneiform cartilage
Corniculate cartilage
Arytenoid cartilage
Arytenoid muscles
Body of hyoid bone
Thyrohyoid membrane
Fatty pad
Vestibular fold (false vocal cord)
Thyroid cartilage
Vocal fold (true vocal cord)
Cricothyroid ligament
Cricotracheal ligament
(b)


Epiglottis
Hyoid bone
Lateral thyrohyoid membrane
Thyroid cartilage
Corniculate cartilage
Arytenoid cartilage
Glottis
Cricoid cartilage
Tracheal cartilages
(c)


Epiglottis
Laryngeal inlet (glottis)
Corniculate cartilage
Posterior cricoarytenoid muscle on cricoid cartilage
Trachea
(d)