SpeedLabs

Science

CBSE 11th

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Q.1 What will be the pO_2 and pCO_2 in the atmospheric air compared to those in the alveolar air?

(a) pO_2 lesser, pCO_2 higher (b) pO_2 higher, pCO_2 lesser

(c) pO_2 higher, pCO_2 higher (d) pO_2 lesser, pCO_2 lesser

Ans (b) pO_2 higher, pCO_2 lesser

The partial pressure of oxygen in atmospheric air is higher than that of oxygen in alveolar air. In atmospheric air, pO_2 is about 159 mm Hg. In alveolar air, it is about 104 mm Hg.

The partial pressure of carbon dioxide in atmospheric air is lesser than that of carbon dioxide in alveolar air. In atmospheric air, pCO_2 is about 0.3 mmHg. In alveolar air, it is about 40 mm Hg.

Q.2 Define vital capacity. What is its significance?

Ans Vital capacity is the maximum volume of air that can be exhaled after a maximum inspiration. It is about 3.5 – 4.5 liters in the human body. It promotes the act of supplying fresh air and getting rid of foul air, thereby increasing the gaseous exchange between the tissues and the environment.

Q.3 State the volume of air remaining in the lungs after a normal breathing.

Ans The volume of air remaining in the lungs after a normal expiration is known as functional residual capacity (FRC). It includes expiratory reserve volume (ERV) and residual volume (RV). ERV is the maximum volume of air that can be exhaled after a normal expiration. It is about 1000 mL to 1500 mL. RV is the volume of air remaining in the lungs after maximum expiration. It is about 1100 mL to 1500 mL.

$\therefore FRC = ERV + RV$

$\cong 1500 + 1500$

$\cong 3000$ mL

Functional residual capacity of the human lungs is about 2500 – 3000 mL.

Q.4 What happens to the respiratory process in a man going up a hill?

Ans As altitude increases, the oxygen level in the atmosphere decreases. Therefore, as a man goes uphill, he gets less oxygen with each breath. This causes the amount of oxygen in the blood to decline. The respiratory rate increases in response to the decrease in the oxygen content of blood. Simultaneously, the rate of heart beat increases to increase the supply of oxygen to blood.

Q.5 Diffusion of gases occurs in the alveolar region only and not in the other parts of respiratory system. Why?

Ans Each alveolus is made up of highly-permeable and thin layers of squamous epithelial cells. Similarly, the blood capillaries have layers of squamous epithelial cells. Oxygen-rich air enters the body through the nose and reaches the alveoli. The deoxygenated (carbon dioxide-rich) blood from the body is brought to the heart by the veins. The heart pumps it to the lungs for oxygenation. The exchange of O_2 and CO_2 takes place between the blood capillaries surrounding the alveoli and the gases present in the alveoli.

Thus, the alveoli are the sites for gaseous exchange. The exchange of gases takes place by simple diffusion because of pressure or concentration differences. The barrier between the alveoli and the capillaries is thin and the diffusion of gases takes place from higher partial pressure to lower partial pressure. The venous blood that reaches the alveoli has lower partial pressure of O_2 and higher partial pressure of CO_2 as compared to alveolar air. Hence, oxygen diffuses into blood. Simultaneously, carbon dioxide diffuses out of blood and into the alveoli.

Q.6 What are the major transport mechanisms for CO_2? Explain.

Ans Plasma and red blood cells transport carbon dioxide. This is because they are readily soluble in water.

(1) Through plasma: About 7% of CO_2 is carried in a dissolved state through plasma. Carbon dioxide combines with water and forms carbonic acid.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

(Carbonic acid)

Since the process of forming carbonic acid is slow, only a small amount of carbon dioxide is carried this way.

(2) Through RBCs: About 20 – 25% of CO_2 is transported by the red blood cells as carbaminohaemoglobin. Carbon dioxide binds to the amino groups on the polypeptide chains of haemoglobin and forms a compound known as carbaminohaemoglobin.

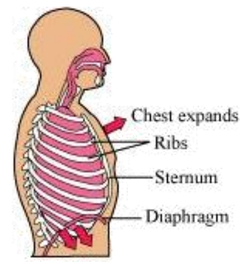
(3) Through sodium bicarbonate: About 70% of carbon dioxide is transported as sodium bicarbonate. As CO_2 diffuses into the blood plasma, a large part of it combines with water to form carbonic acid in the presence of the enzyme carbonic anhydrase. Carbonic anhydrase is a zinc enzyme that speeds up the formation of carbonic acid. This carbonic acid dissociates into bicarbonate (HCO_3^-) and hydrogen ions (H^+).

$$CO_2 + H_2O \xrightarrow{\text{Carbonic anhydrase}} H_2CO_3$$

$$H_2CO_3 \xrightarrow[\text{anhydrase}]{\text{Carbonic}} HCO_3^- + H^+$$

Q.7 Explain the process of inspiration under normal conditions.

Ans Inspiration or inhalation is the process of bringing air from outside the body into the lungs. It is carried out by creating a pressure gradient between the lungs and the atmosphere.



Diaphragm contracts

When air enters the lungs, the diaphragm contracts toward the abdominal cavity, thereby increasing the space in the thoracic cavity for accommodating the inhaled air.

The volume of the thoracic chamber in the anteroposterior axis increases with the simultaneous contraction of the external intercostal muscles. This causes the ribs and the sternum to move out, thereby increasing the volume of the thoracic chamber in the dorsoventral axis.

The overall increase in the thoracic volume leads to a similar increase in the pulmonary volume. Now, as a result of this increase, the intra-pulmonary pressure becomes lesser than the atmospheric pressure. This causes the air from outside the body to move into the lungs.

Q.8 How is respiration regulated?

Ans The respiratory rhythm center present in the medulla region of the brain is primarily responsible for the regulation of respiration. The pneumotaxic center can alter the function performed by the respiratory rhythm center by signalling to reduce the inspiration rate.

The chemosensitive region present near the respiratory center is sensitive to carbon dioxide and hydrogen ions. This region then signals to change the rate of expiration for eliminating the compounds.

The receptors present in the carotid artery and aorta detect the levels of carbon dioxide and hydrogen ions in blood. As the level of carbon dioxide increases, the respiratory centre sends nerve impulses for the necessary changes.

Q.9 What is the effect of pCO_2 on oxygen transport?

Ans pCO_2 plays an important role in the transportation of oxygen. At the alveolus, the low pCO_2 and high pO_2 favours the formation of hemoglobin. At the tissues, the high pCO_2 and low pO_2 favours the dissociation of oxygen from oxyhemoglobin. Hence, the affinity of hemoglobin for oxygen is enhanced by the decrease of pCO_2 in blood. Therefore, oxygen is transported in blood as oxyhemoglobin and oxygen dissociates from it at the tissues.

Q.10 What is the site of gaseous exchange in an insect?

Ans In insects, gaseous exchange occurs through a network of tubes collectively known as the tracheal system. The small openings on the sides of an insect's body are known as spiracles. Oxygen-rich air enters through the spiracles. The spiracles are connected to the network of tubes. From the spiracles, oxygen enters the tracheae. From here, oxygen diffuses into the cells of the body.

The movement of carbon dioxide follows the reverse path. The CO2 from the cells of the body first enters the tracheae and then leaves the body through the spiracles.

Q.11 Define oxygen dissociation curve. Can you suggest any reason for its sigmoidal pattern?

Ans The oxygen dissociation curve is a graph showing the percentage saturation of oxyhemoglobin at various partial pressures of oxygen.

The curve shows the equilibrium of oxyhemoglobin and hemoglobin at various partial pressures.

In the lungs, the partial pressure of oxygen is high. Hence, hemoglobin binds to oxygen and forms oxyhemoglobin.

Tissues have a low oxygen concentration. Therefore, at the tissues, oxyhemoglobin releases oxygen to form hemoglobin.

The sigmoid shape of the dissociation curve is because of the binding of oxygen to hemoglobin. As the first oxygen molecule binds to hemoglobin, it increases the affinity for the second molecule of oxygen to bind. Subsequently, hemoglobin attracts more oxygen.

Q.12 Have you heard about hypoxia? Try to gather information about it, and discuss with your friends.

Ans Hypoxia is a condition characterised by an inadequate or decreased supply of oxygen to the lungs. It is caused by several extrinsic factors such as reduction in pO2, inadequate oxygen, etc. The different types of hypoxia are discussed below.

Hypoxemic hypoxia - In this condition, there is a reduction in the oxygen content of blood as a result of the low partial pressure of oxygen in the arterial blood.

Anaemic hypoxia - In this condition, there is a reduction in the concentration of haemoglobin.

Stagnant or ischemic hypoxia - In this condition, there is a deficiency in the oxygen content of blood because of poor blood circulation. It occurs when a person is exposed to cold temperature for a prolonged period of time.

Histotoxic hypoxia - In this condition, tissues are unable to use oxygen. This occurs during carbon monoxide or cyanide poisoning.

Q.13 Distinguish between

(a) IRV and ERV

(b) Inspiratory capacity and Expiratory capacity

(c) Vital capacity and Total lung capacity

Ans (a) IRV and ERV

Inspiratory reserve volume (IRV)	Expiratory reserve volume (ERV)
(i) It is the maximum volume of air that can be inhaled after a normal inspiration.	(i) It is the maximum volume of air that can be exhaled after a normal expiration.
(ii) It is about 2500 – 3500 mL in the human lungs.	(ii) It is about 1000 – 1100 mL in the human lungs.

(b) Inspiratory capacity and Expiratory capacity

Inspiratory capacity (IC)	Expiratory capacity (EC)
(i) It is the volume of air that can be inhaled after a normal expiration.	(i) It is the volume of air that can be exhaled after a normal inspiration.
(ii) It includes tidal volume and inspiratory reserve volume.	(ii) It includes tidal volume and expiratory reserve volume.
(iii) IC = TV + IRV	(iii) EC = TV + ERV

(c) Vital capacity and Total lung capacity

Vital capacity (VC)	Total lung capacity (TLC)
(i) It is the maximum volume of air that can be exhaled after a maximum inspiration. It includes IC and ERV.	(i) It is the volume of air in the lungs after maximum inspiration. It includes IC, ERV, and residual volume.
(ii) It is about 4000 mL in the human lungs.	(ii) It is about 5000 – 6000 mL in the human lungs.

Q.14 What is Tidal volume? Find out the Tidal volume (approximate value) for a healthy human in an hour.

Ans Tidal volume is the volume of air inspired or expired during normal respiration.

It is about 6000 to 8000 mL of air per minute.

The hourly tidal volume for a healthy human can be calculated as:

Tidal volume = 6000 to 8000 mL/minute

Tidal volume in an hour = 6000 to 8000 mL × (60 min)

= 3.6 × 105 mL to 4.8 × 105 mL

Therefore, the hourly tidal volume for a healthy human is approximately 3.6×10^5 mL to 4.8×10^5 mL.