14 Breathing and Exchange of Gases

Mountain climbers use compressed oxygen tanks at high altitudes to compensate for the decreased oxygen pressure. Oxygen is stored in small, portable cylinders, and this oxygen is used during high altitude climbing. Many used and empty oxygen cylinders can be found as waste on mountains.

Topic Notes

- *Respiration*

RESPIRATION 1

TOPIC 1
RESPIRATORY ORGANS

Depending upon the habitats and level of organisations, different groups of organisms have different breathing mechanisms. Lower invertebrates like sponges, coelenterates, flatworms, etc., exchange O_2 with CO_2 by simple diffusion for the purposes of breathing or respiration.

(1) In insects, a network of tracheal tubes are present for gaseous exchange while earthworm has moist cuticle to transport and exchange gases.

(2) Respiration through skin is seen in amphibians like frogs and such respiration is called cutaneous respiration.

(3) Aquatic arthropods, molluscs and fishes (vertebrates) use gills as vascularised structures for branchial respiration.

(4) Lungs and vascularised bags are the most modified means for pulmonary respiration in amphibians, reptiles, birds and mammals.

Example 1.1: **Case Based:**

All organisms need O_2 to survive. Animals, birds, humans and even plants respire through various methods but the mechanisms of respiration remain the same, i.e. through the exchange of gases. Atmosphere has many gases in different volumes and proportions. Gases are used by living organisms and are used for various purposes and they are replenished within the atmosphere through many ways. Mostly hydrogen and helium gas were found in the earth's early environment and these gases were formed by the process of outgassing. The process of outgassing is responsible for releasing gases when under extreme heat or vacuum, non-metallic material is exposed. Such non-metallic material can be rubber, polymer, any adhesive, etc. Because as Earth cooled, volcanic gases blasted into the atmosphere, forming an atmosphere. It contained hydrogen sulphide, methane, and ten to 200 times the amount of carbon dioxide in the atmosphere today.

Earth's surface cooled and cemented enough for water to accumulate on it after around half a billion years. Earth's atmosphere has changed now due to the course of evolution. There are many factors responsible for this. About 78% of the atmosphere contains nitrogen, 21% is oxygen, 0.9% is argon and other gases remain 0.1%. Other gases that make up the remaining 0.1% include trace amounts of carbon dioxide, methane, water vapour and neon.

(A) Which gas is found most abundant in the atmosphere?
- **(a) Hydrogen** **(b) Nitrogen**
- **(c) Oxygen** **(d) Carbon dioxide**

(B) Which gas is used by plants for respiration?
- **(a) Oxygen** **(b) Nitrogen**
- **(c) Carbon monoxide** **(d) Hydrogen**

(C) What are the structures in plants which help in respiration?

(D) What mechanism of respiration is followed by simpler organisms like *Amoeba*?

(E) Assertion (A): Respiration and photosynthesis involve similar gases.
Reason (R): The process of respiration involves oxygen intake and carbon dioxide release.
- **(a) Both A and R are true and R is the correct explanation of A.**
- **(b) Both A and R are true and R is not the correct explanation of A.**
- **(c) A is true but R is false.**
- **(d) A is false but R is true.**

Ans. **(A)** *(b) Nitrogen*

Explanation: Nitrogen is the most prevalent naturally occurring gas, accounting for around 78% of air. At around 21%, oxygen is the second most prevalent gas. Carbon dioxide has a volume content of about 0.04% (400 ppm) in the Earth's atmosphere and 0.000055% of the atmosphere is made up of hydrogen.

(B) *(a) Oxygen*

Explanation: Plants need oxygen from the atmosphere to respire, but in return, the process also produces carbon dioxide.

(C) Plants respire through stomata (a pore found in leaves) and lenticels (found in stems).

(D) *Amoeba* is a unicellular freshwater organism which utilises dissolved oxygen. The oxygen dissolved in water diffuses into the cell through the cell membrane and thus allowing the *Amoeba* to breathe.

(E) *(b) Both A and R are true and R is not the correct explanation of A.*

Explanation: In the process of photosynthesis, carbon dioxide is used for the formation of sugars in the presence of sunlight and oxygen is released as a by-product whereas oxygen is utilised in respiration and carbon dioxide is released as a by-product. So, the gases involved in the two processes remain the same but their utilization varies.

Important

➥ *Breathing occurs in two stages namely, inspiration and expiration. During inspiration, air enters the lungs from atmosphere and during expiration, air leaves the lungs. During normal breathing, inspiration is the active process and expiration is a passive process.*

Example 1.2: Breathing and Respiration are two different processes. How?

Ans.

S. No.	Breathing	Respiration
(1)	It is simply an intake of fresh air and removal of foul air.	It is the oxidation of food to form carbon dioxide, water and energy.
(2)	It is a physical process.	It is a biochemical process.
(3)	No energy is released, rather use.	Energy is released in the form of ATP.
(4)	It occurs outside the cells, hence it is an extracellular process.	It occurs inside the cells, hence it is an intracellular process.
(5)	No enzyme is involved in the process.	A large no. of enzymes are involved in this process.

Human Respiratory System

The human respiratory system consist of the following parts:

(1) Nostrils (External Nares): Holes of the nose are called nostrils. These are paired openings that open into two nasal cavities.

(2) Nasal cavities/Nasal Chambers: Two nasal cavities are separated from each other by a thin, cartilaginous median vertical partition called a nasal septum.

(3) Internal Nares: These are the posterior openings of the nasal cavities that lead into the nasopharynx.

(4) Pharynx: It is comprised of the nasopharynx, oropharynx and laryngopharynx. The pharynx provides passage to both air and food.

(5) Larynx (Sound Box): Until puberty, there is little difference in the size of the larynx in males and females. Thereafter, it grows larger and becomes more prominent in males. Human larynx consists of the following structures:

(i) Glottis: The pharynx opens into the larynx by a slit-like aperture, called glottis.

(ii) Cartilage of the larynx: The important cartilage of the larynx are as follows:

- **Epiglottis:** It is a leaf-shaped cartilage of the larynx. It is made up of elastic cartilage. During swallowing the epiglottis closes the glottis to check the entry of food into it.
- **Thyroid Cartilage:** It is the largest cartilage of the larynx. It forms a sub-cutaneous projection named laryngeal prominence (also called Adam's apple). Thyroid cartilage is composed of hyaline cartilage.
- **Cricoid Cartilage:** It is like a signet ring and lies below the thyroid cartilage. It is also made up of hyaline cartilage as well.
- **Arytenoid Cartilage:** They are small, two in number and are situated at the back of the larynx. The greater part of the arytenoid cartilage consist of hyaline cartilage but their apical parts are generally consist of elastic cartilage.

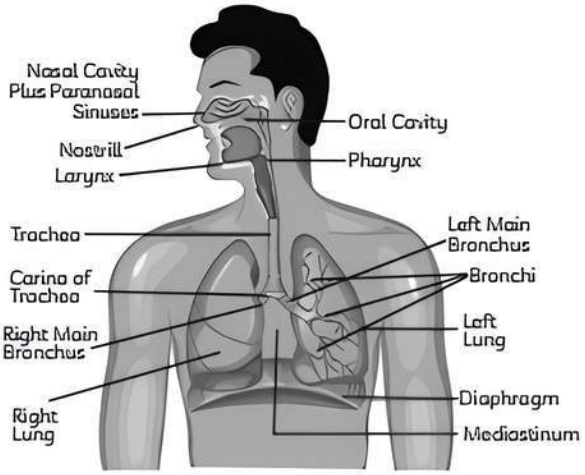
- **Cartilage of Santorini:** They are two small conical nodules of elastic cartilage located at the upper end of the arytenoid cartilage.

(iii) **Hyoid Bone:** It lies just above the larynx. Embryologically it is considered a bone of skull.

(iv) **Thyrohyoid Membrane:** It is a broad, flat membrane attached to the hyoid bone above and to the thyroid cartilage below.

(v) **Laryngeal ligament and Muscle:** The laryngeal ligament connect different cartilages of the larynx. The laryngeal muscles play an essential role in the movement of the larynx.

(vi) **Vocal Cords:** There are two vocal cords present inside the larynx. The upper pair consider as false vocal cords whereas lower pair is considered as true vocal cords. Thicker and longer vocal cords are found in males than females. Therefore, males have a lower range of pitch than females. Sound is generally produced by true vocal cords.



The human respiratory system

(6) **Trachea (Windpipe) and Primary (Principal) Bronchi:** The larynx leads into a long tube, the trachea and windpipe bearing rings of hyaline cartilage which are incomplete posteriorly. These cartilaginous rings support the walls of the trachea and prevent its collapse during inspiration.

The trachea is lined by pseudostratified ciliated columnar epithelium-bearing glandular cells (mucous glands). The secretion of mucous glands keeps the walls of the tube moist and traps dust particles which enter with the air. The vibratile cilia of the epithelium then carry out the mucous containing dust particles upto the throat where they can easily be spit out.

At its lower end, the trachea bifurcates into a pair of primary bronchi which enter the right and left lungs. The walls of the bronchi are likewise supported by cartilaginous rings.

(7) **Lungs (Pulmones):** There is a pair of lungs present which lies in the thoracic cavity, one on either side of the heart. The thoracic cavity is enclosed behind by the thoracic vertebrae, literally by the ribs and in front by the sternum. The thoracic cavity is closed below by the diaphragm.

Each lung is enclosed in a double membrane called pleurae. The outer membrane is called parietal pleura. The inner membrane is known as visceral pleura, which closely invests in the lungs. A narrow space exists between the two pleurae. It is called the pleural cavity that contains a pleural fluid secreted by pleurae. The pleural fluid lubricates the pleurale, so that they may slide over each other without friction during friction.

Important

➥ *Mediastinum is the partition between the two lungs and therefore, includes the pleura of both sides, but it is generally defined as the interval between two pleural sacs. It contains heart, oesophagus, thoracic duct of lymphatic system, remains of thymus, etc.*

Pulmonary Respiration involves the following steps:

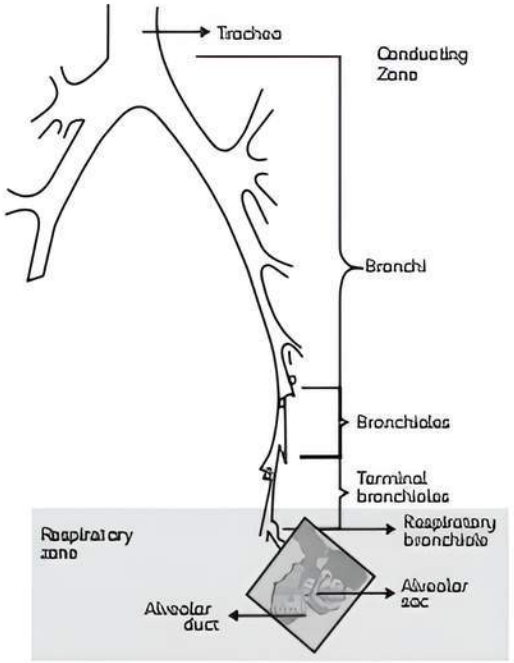
(1) Breathing in the inflow (inspiration) and outflow (expiration) of air between the atmosphere and the alveoli of the lungs.

(2) Diffusion of gases (O_2 and CO_2) across the alveolar membrane.

(3) Transport of gases by the blood.

(4) Diffusion of O_2 and CO_2 between the blood and the tissues.

(5) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2 (cellular respiration).



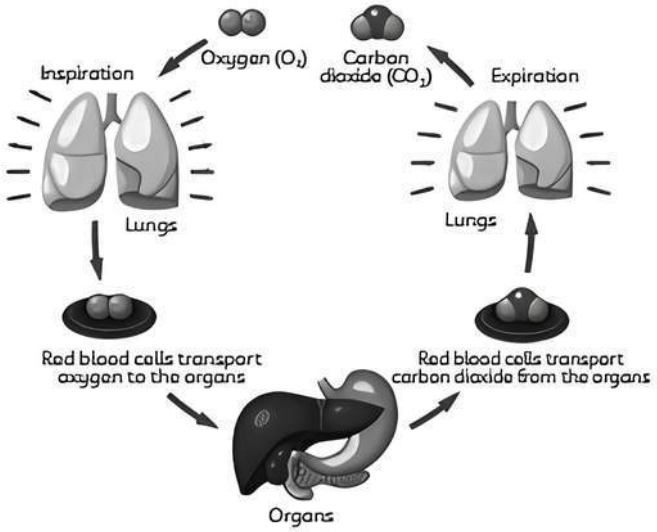
The conducting part of the respiratory system

Important

➥ *In the lungs, air channels branch in 23 different ways, considerably increasing the cross section available for circulation.*

Example 1.3: Diffusion of gases occurs in the alveolar region only and not in the other parts of the respiratory system. Why?

Ans. Because the boundary seen between the alveoli and the capillaries is thin, gases diffuse from a higher partial pressure to a lower partial pressure. As a result, gaseous exchange occurs exclusively in the alveolar region and not elsewhere in the respiratory system.



The exchange part of the respiratory System

Mechanism of Breathing

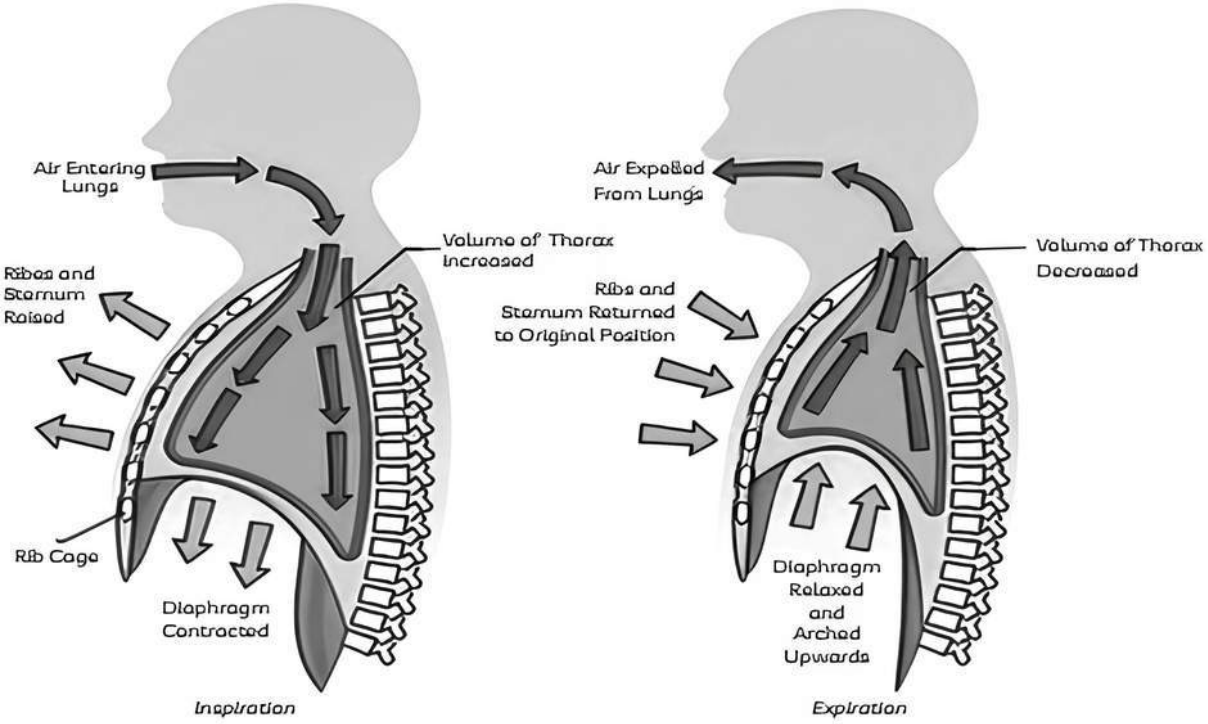
Intake of atmospheric air into the alveoli of the lungs (Inspiration) and release of alveolar air in the atmosphere (expiration) are the two prominent steps of breathing. The movement of air into and out of the lungs depends upon the pressure gradient between the lungs and the atmosphere. Diaphragm and specialised set of muscles (external and internal intercostal muscles) play an important role in creating a pressure gradient between the lungs and the atmosphere.

During inspiration, the diaphragm contracts and increases the volume of thoracic chamber in the antero-posterior axis. When external inter-costal muscle contracts, it lifts up the ribs and sternum resulting in the increase of thoracic volume in the dorso-ventral axis. Due to the overall increase in the volume of thoracic chamber, an increase in pulmonary volume takes place. Due to an increase in pulmonary volume, a decrease in intra-pulmonary pressure takes place, which is less than the atmospheric pressure (positive pressure). This causes the air to enter the lungs.

During expiration, diaphragm and external intercostal muscles relax. Diaphragm and sternum return to their original positions. Due to which volume of thoracic chamber decreases and intrapulmonary pressure increases. The intra-pulmonary pressure increases slightly higher than atmospheric pressure and causes the expulsion of air from the lungs to the atmosphere. The stomach muscles play an important role in the process of breathing (Inspiration and Expiration).

Important

➥ *On an average, a healthy human breathes 12-16 times/minute. The volume of air involved in breathing movements can be estimated by using a spirometer which helps in clinical assessment of pulmonary functions.*



The mechanism of inhalation and exhalation

Example 1.4: **What will be the pO_2 and pCO_2 in the atmospheric air compared to those in the alveolar air?**

(a) pO_2 lesser and pCO_2 higher

(b) pO_2 higher and pCO_2 lesser

(c) pO_2 higher and pCO_2 higher

(d) pO_2 lesser and pCO_2 lesser

Ans. *(b) pO_2 higher and pCO_2 lesser*

Explanation: Partial pressure of oxygen in the atmosphere is higher than partial pressure of oxygen in alveolar air. The pressure of oxygen in ambient air is roughly 159 mm Hg. It's around 104 mm Hg in alveolar air. Carbon dioxide partial pressure in ambient air is lower than carbon dioxide partial pressure in alveolar air. It is around 40 mm Hg in alveolar air and about 0.3 mm Hg in atmospheric air.

Respiratory Volumes and Capacities

Tidal volume (TV)

It is the total volume of air inspired or expired during normal respiration and it is approximately 500 mL. A healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.

Inspiratory Reserve Volume (IRV)

Extra amount of air that can be inspired through a forceful inspiration is called Inspiratory Reserve Volume and it is approximately 2500-3000 mL.

Expiratory Reserve Volume (ERV)

Extra amount of air that can be expired through a forceful expiration is called Expiratory Reserve Volume and it is approximately 1000-1100 mL.

Residual Volume (RV)

The amount of air which remains inside the lung alveoli after the forceful expiration is called residual volume and it is approximately 1100-1200 mL.

Inspiratory Capacity (IC)

It is the total volume of air a person can inspire after a normal expiration. This includes tidal volume and inspiratory reserve volume.

$$TV + IRV = IC$$

Expiratory Capacity (EC)

It is the total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume.

$$TV + ERV = EC$$

Functional Residual Capacity (FRC)

The amount of air which remains inside the lung alveoli after the normal expiration is called functional residual capacity.

$$ERV + RV = FRC$$

Vital Capacity (VC)

It is the maximum amount of air that can be inspired after a forceful expiration or maximum amount of air that can be expired after a forceful inspiration.

$$ERV + TV + IRV = VC$$

Total Lung Capacity (TLC)

It is the total volume of air that present in the lungs and respiratory passage after a maximum inspiration or forceful inspiration.

$$RV + ERV + TV + IRV$$

OR

$$VC + RV = TLC$$

Example 1.5: **Case Based:**

Breathing is the essential activity of all the living organisms. However, the ability to breathe, i.e. to have air enter the lungs during inspiration and air leaves the lungs during expiration is dependent on the air pressure of the atmosphere and the air pressure within the lungs. In general, two muscle groups are used during normal inspiration and expiration: the diaphragm and the external intercostal muscles. Both inspiration and expiration occur due to the expansion and contraction of the thoracic cavity, respectively. The following given diagram clears the role of the muscle groups during the process of inspiration and expiration.

(A) Which of the given statement is true in relation with the mechanism of breathing?

(a) During inspiration, the diaphragm and inter-costal muscle contract and it lift up the ribs and sternum.

(b) During expiration, the diaphragm and inter-costal muscle contract and it lift up the ribs and sternum.

(c) During inspiration, diaphragm and external intercostal muscles relax.

(d) During breathing, diaphragm and sternum return to their original positions.

(B) The components involved in promoting ventilation in pulmonary respiration are:

(a) Thoracic cavity

(b) Diaphragm and intercostal muscles

(c) Dorsoventral axis

(d) All of the above

(C) Why is only oxygen required during the breathing in the process?

(D) Briefly explain the meaning of tissue respiration.

(E) Assertion (A): During the process of breathing, human beings sometimes take deep breaths and are not normal.

Reason (R): Rising levels of carbon dioxide is the reason behind the sudden deep breaths of the people.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Ans. (A) *(a) During inspiration, the diaphragm and inter-costal muscle contract and it lift up the ribs and sternum.*

Explanation: In general, two muscle groups are used during normal inspiration and expiration: the diaphragm and the external intercostal muscles.

During inspiration, the diaphragm contracts and increases the volume of thoracic chamber in the antero-posterior axis. When external inter-costal muscle contracts, it lifts up the ribs and sternum resulting in the increase of thoracic volume in the dorso-ventral axis. Due to the overall increase in the volume of thoracic chamber, an increase in pulmonary volume takes place. Due to increase in pulmonary volume, a decrease in intrapulmonary pressure takes place, which is less than the atmospheric pressure (positive pressure). This causes the air to enter the lungs.

(B) *(b) Diaphragm and intercostal muscles*

Explanation: When the diaphragm contracts, the chest cavity lengthens and widens, allowing the lungs expansion. Also, intercostal muscles help in breathing by helping to shift the rib cage.

(C) Oxygen aids in the growth, reproduction, and conversion of food into energy of organisms. Oxygen fuels our cells and helps provide the basic building blocks that our bodies need to survive. For example: Everyday, about 700 billion cells in our bodies wear out and must be replaced. Without oxygen, our bodies cannot build these new cells.

(D) Tissue respiration is a physico-chemical process in which oxidative breakdown of nutrients takes place. This process comprises of breathing and the oxidation of food in the cells collectively forming tissues.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The brain does not get instructions to speed up and deepen breathing when blood oxygen levels are low. Deeper breathing is induced by rising carbon dioxide concentrations.

One of the finest ways to reduce stress in the body is through deep breathing. This is due to the fact that deep breathing signals the brain to relax and calm down. Our entire body is impacted by how we breathe. Relaxation, tension relief, and stress relief can all be achieved with breathing exercises.

TOPIC 2

EXCHANGE OF GASES

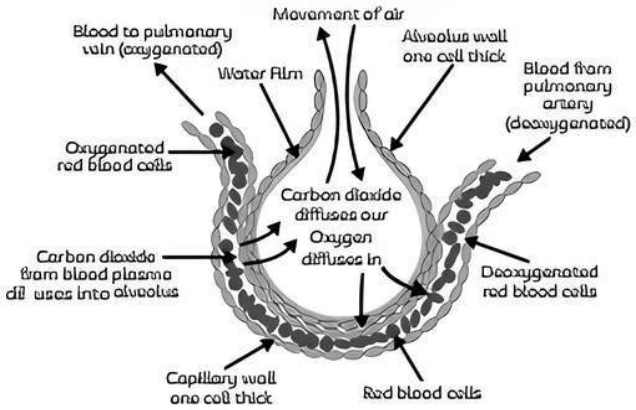
The exchange of gases takes place in alveoli and it occurs by simple diffusion due to differences in concentration and pressure gradient of gases. The partial pressure of gases *i.e.*, the pressure of a particular gas in the mixture of gases. It is responsible for gaseous exchange. The solubility of gases in an aqueous medium is another very important factor. CO_2 is 20-25 times more soluble than O_2 and hence CO_2 can readily diffuse through the diffusion membrane of alveoli. The diffusion membrane is made up of following three layers:

(1) alveolar epithelium

(2) capillary endothelium

(3) basement substance or basement membrane and is present in between the alveolar epithelium and capillary endothelium layer.

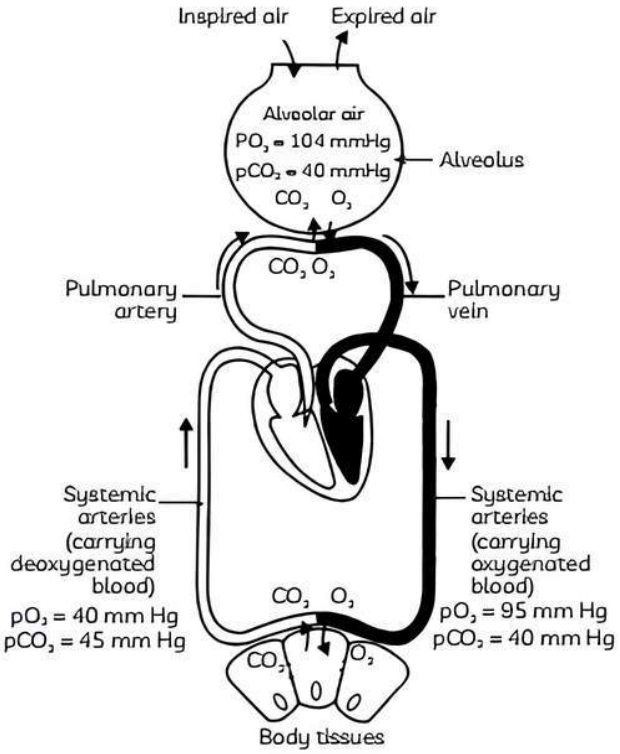
All these three layers contribute to the less than a millimetre thickness of the diffusion membrane.



The structure of alveoli and gaseous exchange

Example 1.6: What is the effect of pCO_2 on oxygen transport?

Ans. The pCO_2 plays an important role in the transportation of oxygen. At the alveolus, the low pCO_2 and high pO_2 favour the formation of haemoglobin. Whereas, the high level of pCO_2 and lower level of pO_2 in the tissues encourages oxygen dissociation from oxyhaemoglobin. As a result, lowering pCO_2 in the blood increases haemoglobin's affinity for oxygen. As a result, oxygen is carried around the body as oxyhaemoglobin, which dissociates from oxygen in the tissues.



The gaseous exchange within the different parts of the body.

Example 1.7: What happens to the respiratory process in a man going up a hill?

Ans. The atmospheric oxygen levels drop as altitude rises. As a result, when a person walks upward, each breath provides less oxygen. As a result, the oxygen volume in the blood decreases. In response to low oxygen in the blood, the respiratory rate increases.

TOPIC 3

TRANSPORT OF GASES

Like goods are manufactured and transported from company storage to shops from where customers can buy those products as much as they need. Oxygen is first converted into dissolved aqueous form and then transported through the blood to various organs and tissues from where cells can utilize them.

Blood carries oxygen and carbon dioxide from lungs to tissues and body parts to lungs, respectively. This transportation is very essential in the process of respiration. RBCs are the actual carrier for gases in the blood and carry 97% of oxygen and the rest of 3% oxygen is carried by plasma in dissolved form. Although CO_2 transportation through RBCs is only contributed for 20-25% and only 7% of CO_2 is transported through plasma. Remaining 70 per cent of carbon dioxide is transported through plasma in dissolved state as bicarbonate.

Example 1.8: What is the site of gaseous exchange in an insect?

Ans. In Insects, respiration takes place through the tracheal system. The tracheal system that reaches to all sites in the body that may become effectively sub-cellular in muscle fibres facilitates gaseous exchange in insects.

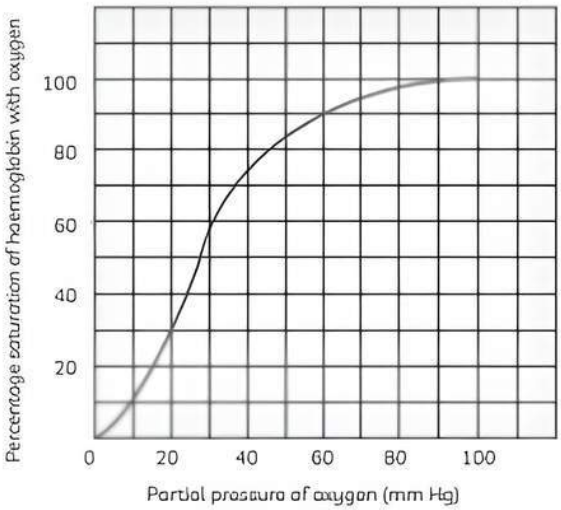
Transport of Oxygen

A red pigment or protein is present in red blood cells (RBCs) which carry oxygen inside the body which is called haemoglobin. Each RBC can at most carry four oxygen molecules and transport occurs through binding of RBCs with oxygen in a reversible manner to form oxyhaemoglobin so that it can be easily diffused to the cells needing oxygen. Partial pressure of oxygen (pO_2) is responsible for such

binding. During inspiration, pO_2 is high; all other factors are low like temperature, H^+ concentration and partial pressure of carbon dioxide (pCO_2). These conditions favour the oxygen intake by the blood from alveoli and oxygen binds with haemoglobin in RBCs. But in the tissues, all these conditions are reversed (low pO_2, high pCO_2, and high H^+ and high temperature) and dissociation of oxygen from haemoglobin is favoured. This change in partial pressure is essential for oxygen binding and dissociation with hemoglobin to transport it from one part of the body (alveoli of the lungs) to another (cells and tissues). In this way, 100 mL of blood can transport 5 ml of oxygen to the tissues at normal physiological conditions.

Example 1.9: Define the oxygen dissociation curve. Can you suggest any reason for its sigmoidal pattern?

Ans. The relationship between the partial pressure of oxygen (PO_2) and percentage saturation of the haemoglobin with oxygen is graphically represented by a curve called oxygen dissociation curve. The oxygen binding to haemoglobin causes the dissociation curve to have a sigmoid shape. While the first oxygen binds with haemoglobin, the tendency for the second oxygen molecule to bind rises. As a result, haemoglobin draws in more oxygen.



Oxygen dissociation curve

Transport of Carbon Dioxide

When food is oxidised, CO_2, H_2O and energy are produced. Carbon dioxide in the gaseous form diffused out of the cell into the blood capillaries. From here, it is transported in three ways:

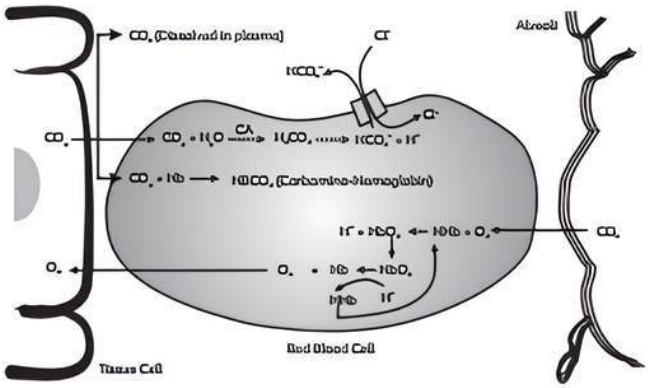
(1) 20-25% of CO_2 is transported through blood through binding with haemoglobin. When CO_2 binds with haemoglobin, carbamino-haemoglobin is formed. Partial pressure plays yet very important role in CO_2 binding and dissociation to the haemoglobin. During expiration at the tissue level, pCO_2 is high (due to catabolic processes within the cells) and pO_2 is low which favours carbon dioxide binding with haemoglobin leading to the formation of carbamino-haemoglobin and at alveoli level, pCO_2 is low and pO_2 is high which marks for carbon dioxide dissociation from carbamino-haemoglobin.

(2) 7% of CO_2 is transported by the blood from tissues to the lungs in dissolved form.

(3) About 70% of carbon dioxide is transported in the form of bicarbonate ions (HCO_3^-). A very important and fastest enzyme called carbonic anhydrase plays an important role in CO_2 binding with H_2O in RBCs and it is present in high quantities inside the RBCs and in very fewer quantities inside the plasma. The enzyme catalyses reversible binding of carbon dioxide with water to form hydrogen bicarbonate (H_2CO_3) which later diffuses into bicarbonate ions (HCO_3^-) and hydrogen ions. In this way, 100 ml of blood can transport 4 ml of CO_2 to the lungs' alveoli.

Example 1.10: Have you heard about Hypoxia? Try to gather information about it, and discuss it with your friends.

Ans. A situation in which the body or a portion of the body lacks sufficient oxygen at the tissue level is referred to as Hypoxia.



CA = Carbonic Anhydrase

The gaseous exchange between the alveoli, blood and tissue

TOPIC 4

REGULATION OF RESPIRATION

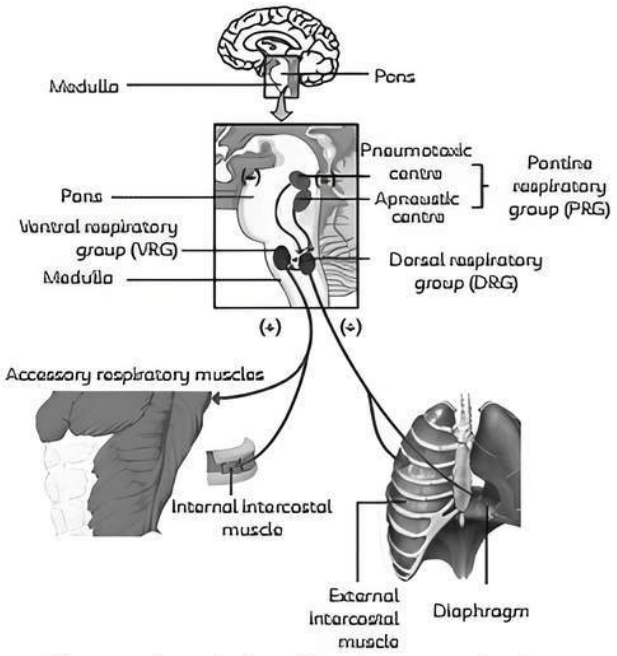
In humans, respiration is regulated by both the neural system and also by a chemical system. A specialised region called respiratory rhythm centre is present in the medulla region of the brain which

is actively responsible for regulating respiration. The pneumotaxic–centre is present in the pons region of the brain. It moderates the functioning of the respiratory rhythm centre. Neural signal from this centre can reduce the duration of inspiration and thus alter respiratory rate.

Chemical control: A chemosensitive area present adjacent to the rhythm centre which is highly sensitive to CO_2 and H^+ ions concentration. If the concentration of CO_2 and H^+ increases then the Rhythm centre is activated and proper measures are taken into account to eradicate the harmful substances.

Important

➥ *Oxygen does not have a significant direct effect on the respiratory centre of the brain in controlling respiration. Oxygen act on peripheral chemoreceptors located in the carotid and aortic bodies that send appropriate nervous signals to the respiratory centre for control of respiration.*



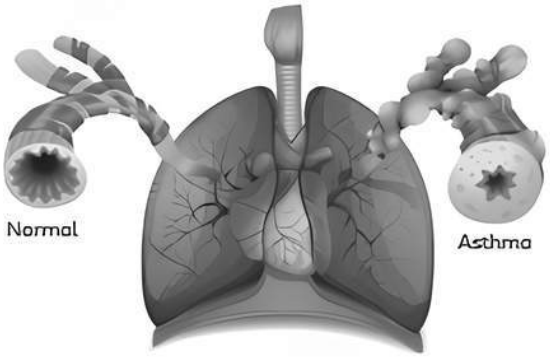
The neural regulation of respiratory mechanisms

TOPIC 5

DISORDERS OF RESPIRATORY SYSTEM

Asthma

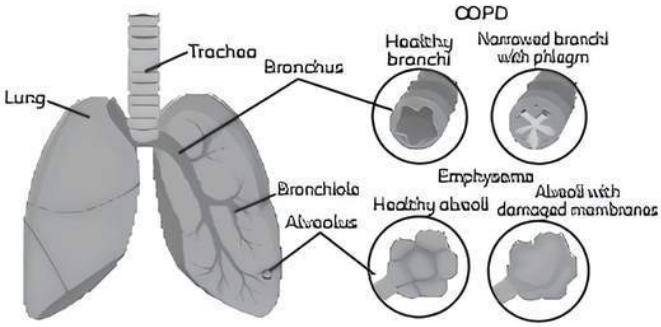
It is a condition caused due to difficulty in breathing problems caused by inflammation of the bronchi and bronchioles.



Inflammation of bronchial tube in asthma.

Emphysema

It is a serious condition of difficulty breathing caused by a decrease in respiratory surface because of damaged alveolar walls. One of the major causes of emphysema is cigarette smoking.



The alveoli in healthy and emphysema affect bronchi alveoli

Occupational Respiratory Disorders

It occurs due to occupation of certain individuals. Certain activities and professions like stone-breaking and grinding can cause certain respiratory problems that may arise due to dust accumulation in lungs causing serious respiratory health problems like inflammation, fibrosis (proliferation of fibrous tissues) or in worst case lung damage. Workers can avoid this disorder by wearing masks in workplace.

OBJECTIVE Type Questions

[**1** mark]

Multiple Choice Questions

1. How many times does a man respire in a minute?

(a) 10-12 (b) 12-14
(c) 12-16 (d) 14-18

Ans. *(c) 12-16*

Explanation: In normal conditions, a man respires nearly 14-18 times but during forceful breathing or in case of a breathing problem, the number may increase or decrease accordingly.

2. Regarding the functions of our respiratory system (conducting part), mark the wrong entry.

(a) Humidifies the air
(b) Warms up the air
(c) Exchange of gases
(d) Cleans up the air **[NCERT Exemplar]**

Ans. *(c) Exchange of gases*

Explanation: When air is inspired then during the passage of the nasal tract, air is brought up to the temperature suiting to the body, and vapours are added to humidify it and clears it from foreign particles.

3. It is known that exposure to carbon monoxide is harmful to animals because:

(a) It reduces CO_2 transport
(b) It reduces O_2 transport
(c) It increases CO_2 transport
(d) It increases O_2 transport
[NCERT Exemplar]

Ans. *(b) It reduces O_2 transport*

Explanation: Binding of CO to haemoglobin is quite strong and not easily removed, in such cases, there is fewer RBCs available for oxygen binding which makes it difficult for humans to breathe.

4. Trachea divides at which level of thoracic vertebrae?

(a) 4^{th} **(b) 5^{th}**
(c) 6^{th} **(d) 7^{th}** **[Diksha]**

Ans. *(b) 5^{th}*

Explanation: The trachea divides into left and right primary bronchi at the level of 5^{th} thoracic vertebra.

5. Statement A: The branching network of bronchi, bronchioles and alveoli comprises the lungs.
Statement B: This repeated branching provides a smaller surface area for exchange of gases.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(c) Only A is correct.*

Explanation: The bronchi within the lungs divide into smaller bronchi and even smaller tubes known as bronchioles. Alveoli, which are tiny air sacs at the ends of bronchioles, are where the actual exchange of oxygen and carbon dioxide occurs. This repeated branching provides a larger surface area for exchange of gases. The lungs of every individual contain hundreds of millions of alveoli.

6. External nostrils → vestibules → nasal chambers → internal nares → naso pharynx → X → larynx → trachea.
What is X?

(a) Glottis **(b) Alveoli**
(c) Atria **(d) Bronchi**

Ans. *(a) Glottis*

Explanation: Glottis is a part of respiratory passage and it opens into the larynx. Near the glottis is a flap-like structure called epiglottis. At the time of swallowing of food, this flap covers the glottis to prevent the entry of food particles into it.

7. Statement A: Lungs are covered by double-layered pleural membranes, with pleural fluid between them.
Statement B: This reduces friction on the lung surface.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(a) Both A and B are correct.*

Explanation: A double-layered pleura with pleural fluid in between covers the two human lungs. It lessens lung surface friction. While the inner pleural membrane (visceral pleura) is in contact with the lung surface, the outer pleural membrane (parietal pleura) is in intimate contact with the thoracic lining.

8. Statement A: Breathing becomes difficult in asthma.
Statement B: Asthma occurs due to inflammation of bronchi and bronchioles.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(a) Both A and B are correct.*

Explanation: The inner walls of your lungs' airways may swell and become irritated if you have asthma. Additionally, the linings of your airways may secrete too much mucus. An asthma attack follows. You may cough and wheeze during an asthma episode because of your constricting airways, which makes breathing more difficult.

The smooth muscles in the bronchioles of the lung contract during an asthma

episode, reducing airflow across the airways. Inflammation or excessive mucus discharge may further reduce airflow.

9. **Statement A: Same mechanisms of breathing are adopted by different organisms.**

Statement B: Mechanisms of breathing do not vary among organisms depending upon their habitats.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(b) Both A and B are incorrect.*

Explanation: Different mechanisms of breathing are adopted by different organisms Mechanisms of breathing vary among organisms depending upon their habitats and levels of organisation. It can be done via simple diffusion through skin, gills, lungs, etc.

10. **Which of the below options does not take part in respiratory regulation by rhythm centre?**

(a) O_2 **(b)** CO_2
(c) H^+ **(d) None of these**

Ans. *(a)* O_2

Explanation: CO_2 and H^+ ions act as activator for respiratory rhythm centre to regulate the respiration mechanism but O_2 plays an insignificant role in it.

11. **From the below-mentioned curves, which is obtained through the oxygen dissociation curve?**

(a) Straight line (b) Simple
(c) Sigmoidal (d) Closed

Ans. *(c) Sigmoidal*

Explanation: Oxygen dissociation curve is simply a manifestation of providing the data of per cent saturation of haemoglobin with oxygen in the blood. Amount of per cent haemoglobin saturation with oxygen can be easily studied by studying the sigmoid curve of oxygen dissociation curve.

12. **Which region of the brain is responsible for regulating the pulmonary respiration inside the human body?**

(a) Hypothalamus (b) Pituitary
(c) Cerebellum (d) Medulla

Ans. *(d) Medulla*

Explanation: Medulla is the long stem-like structure which makes the lowest part of the brain and is responsible for autonomic activities of the body like respiration.

13. **Who respires through cutaneous respiration?**

(a) Humans (b) Molluscs
(c) Frogs (d) Fish

Ans. *(c) Frogs*

Explanation: The respiration through skin is called cutaneous respiration and is commonly found among amphiblans *i.e.*, Frogs.

14. **Match the following and mark the correct option:**

Animal	Respiratory Organ
(A) Insects	(i) Lungs
(B) Fishes	(ii) Gills
(C) Earthworm	(iii) Trachea
(D) Human beings	(iv) Moist cuticle

Codes:
(a) (A) - (iv), (B) - (iii), (C) - (ii), (D) - (i)
(b) (A) - (iii), (B) - (ii), (C) - (iv), (D) - (i)
(c) (A) - (ii), (B) - (i), (C) - (iv), (D) - (iii)
(d) (A) - (i), (B) - (iii), (C) - (ii), (D) - (iv)

Ans. *(b) (A) - (iii), (B) - (ii), (C) - (iv), (D) - (i)*

Explanation: The correct matching are:

Aquatic Arthropods	-	Trachea
Fishes	-	Gills
Earthworm	-	Moist cuticle
Human beings	-	Lungs

15. **Terminal oxidant of aerobic respiration is:**

(a) Carbon dioxide (b) Oxygen
(c) Water (d) ATP

Ans. *(b) Oxygen*

Explanation: The oxidation that takes place at the end of aerobic respiration is known as terminal oxidation. In this process, reduced co-enzymes release their electrons and protons. Eventually, molecular oxygen, the released protons and electrons combine to form water.

16. **Among the following, which one acts as a respiratory substrate during cellular respiration?**

(a) Carbohydrate (b) Protein
(c) Lipids (d) All of these

Ans. *(d) All of these*

Explanation: The most frequent respiratory substrates are carbohydrates, proteins, lipids, and organic acids that produce energy during their oxidation.

17. **Which statement supports that respiration is an amphibolic pathway?**

(a) Respiration involves a catabolic process.
(b) Respiration involves an anabolic process.
(c) Respiration involves both anabolic and catabolic processes.
(d) None of the above

Ans. *(c) Respiration involve both anabolic and catabolic processes.*

Explanation: The respiratory process, which is a catabolic channel for respiratory substrates, is later an anabolic mechanism for the production of many metabolic products and secondary metabolites. Various substances are synthesized during this process in cell. As a result, the respiratory route is both catabolic and anabolic, hence, the respiratory system is an amphibolic system.

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true..

18. Assertion (A): **Emphysema is caused by dust accumulation in lungs.**

Reason (R): **It causes a shortening of breath and decreases respiratory surface.**

Ans. *(d) A is false but R is true.*

Explanation: Emphysema occurs most often in people who smoke, but also in people who regularly breathe in irritants. It resulted in decrease in respiratory surface due to damage of alveolar walls.

19. Assertion (A): **Alveoli act as primary site for respiratory exchange.**

Reason (R): **The respiratory exchange depends upon the concentration and pressure gradient of gases.**

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: In alveoli, gases are exchanged through simple diffusion. The gases move from high concentration and pressure gradient to low concentration and pressure gradient.

20. Assertion (A): **Residual volume is retained air in the lungs.**

Reason (R): **After forceful expiration, some volume of air remains inside the lung.**

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The air volume retained within the lungs after the forceful expiration is residual volume.

21. Assertion (A): **The gaseous transportation is dependent on solubility of gases.**

Reason (R): **CO_2 is more soluble than O_2 in an aqueous solution.**

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: CO_2 is 20-25 times more soluble than O_2. It is more easily transported through plasma and blood than oxygen.

22. Assertion (A): **Symptoms of emphysema develops when a person living on a plane ascends and stay on a mountain.**

Reason (R): **Air pressure and partial pressure of oxygen fall with the rise in altitude.**

[Delhi Gov. QB 2022]

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Emphysema is a lung disorder that causes shortness of breath. Air sacs in the lungs are damaged when a person is suffering from emphysema. The causes of this disease are smoking, air pollutants etc., In higher altitudes, the O_2 level falls due to which a person can suffer from shortness of breathe.

CASE BASED Questions (CBQs)

[**4** & **5** marks]

Read the following passages and answer the questions that follow:

23. *A 60-year-old man presented to the emergency department complaining of persistent right-sided chest pain and cough. The chest pain was pleuritic in nature and had been present for the last month. The associated cough was productive of yellow sputum*

without hemoptysis. He had unintentionally lost approximately 30 pounds over the last 6 months and had nightly sweats. He had denied fevers, chills, myalgias or vomiting. He also denied sick contacts or a recent travel history. He recalled childhood exposures to persons afflicted with tuberculosis.

The patient smoked one pack of cigarettes daily for the past 50 years and denied recreational drug use. He reported ingesting twelve beers daily and had had delirium tremens, remote right-sided rib fractures and a wrist fracture as a result of alcohol consumption. He had worked in the steel mills but had discontinued a few years previously. He collected coins and cleaned them with mercury.

(A) What factors hold true to the below statements?

(a) No respiratory volume could be traced after the death of a patient.

(b) Some respiratory volume could be traced after the death of a patient.

(c) Entire respiratory volume could be traced after the death of a patient.

(d) Respiratory volume does not matter after the death.

(B) Whether a child died after a normal birth or died before birth can be confirmed by measuring:

(a) The weight of the child

(b) The dead space air

(c) The tidal volume of air

(d) Residual volume of air

(C) The volume of ventilated air that does not participate in gas exchange are known as:

(a) The residual volume

(b) The dead space

(c) The inspiratory reserve volume

(d) The tidal volume

(D) Breathing is also known as:

(a) Ventilation

(b) Respiration

(c) Both (a) and (b)

(d) Vernation

(E) After a person's pulse and breathing stop, how much later does all cellular metabolism stop?

(a) 4–10 min **(b) 4–10 sec**

(c) 72 sec **(d) 1 min**

Ans. (A) *(b) Some respiratory volume could be traced after the death of a patient.*

Explanation: The residual respiratory volume (RV) remains inside the body even after forceful expiration. Lungs' alveoli retain this small amount of air within them and hence it can be traced as a residue of one survival.

(B) *(d) Residual volume of air*

Explanation: Measuring a child's residual air volume enables doctors to determine if they are dealing with a stillborn or healthy newborn. The first cry of a newborn opens the respiratory route, which causes a certain amount of air to be stored in his lungs. Residual volume is the name given to this amount of air. To confirm that a child died following a natural birth, the child's lungs are cut and put in water after death. Due to buoyancy, the lungs float in water since they are filled with air. If the lungs sink in water due to the lack of air in then, indicates that the child died before birth.

(C) *(b) The dead space*

Explanation: The amount of air that is inhaled but does not participate in gas exchange is referred to as "dead space" because it either stays in the conducting airways or reaches alveoli that are either poor or not perfused. It indicates that not all of the air in each breath is accessible for the exchange of carbon dioxide and oxygen. Animals inhale and exhale air through their lungs, squandering the portion of the inhalation that remains in the conducting airways, where there can be no gas exchange.

(D) *(a) Ventilation*

Explanation: The act of breathing, also known as ventilation, involves moving air into and out of the lungs in order to facilitate gas exchange with the body's internal environment, primarily to expel carbon dioxide and draw in oxygen.

(E) *(a) 4–10 min*

Explanation: Depending on the surrounding temperature, cell metabolism probably continues for four to ten minutes after a person dies.

During this time, oxygenated blood is not moving around, which prevents the usual exchange of oxygen and carbon dioxide.

As a result, carbon dioxide produced during cell respiration- which consumes oxygen to create cellular energy and produces carbon dioxide as a byproduct- does not leave the cell. This causes the cell's pH to decrease, creating an acidic intracellular environment. The lysosome, which houses enzymes for breaking down anything from proteins to lipids and nucleic acids, is one of the internal membranes that are damaged by this acidic environment. These enzymes are unleashed and start to break down the cell from the inside after the membranes have ruptured. The rate of autolytic spreads throughout the body and eventually destroys all the cells of the body.

24. *Allergic reactions can cause symptoms in your nose, lungs, throat, sinuses, ears, lining of the stomach or on the skin. Allergies can trigger the symptoms of asthma, making it more difficult to breathe. An environmental allergy can affect your airway in two distinct ways, potentially resulting in shortness of breath. Allergic rhinitis, also known as hay fever, affects your nose and sinuses. It can lead to sneezing, congestion, an itchy nose, and itchy eyes. If you are especially congested, you may find it difficult to breathe through the nose. Allergic asthma primarily affects airways in the lungs and can develop among people who have been diagnosed with asthma. It can cause coughing, wheezing, tightness in the chest, and shortness of breath or rapid breathing. In the case of allergic asthma, these symptoms can develop simultaneously.*

A person had difficulty breathing when he/she came across certain factors like changes in weather, pollens, dust, etc.

(A) Do these symptoms necessarily mean that the patient is suffering from a certain respiratory disease or disorder?

(B) Name the factors which might be responsible for difficulty in breathing.

(C) What medications are involved for treating patients suffering from breathlessness due to allergies?

Ans. (A) No, these can also be common symptoms of diseases like cold and cough and these symptoms do not depict that the person necessarily has a certain respiratory disease or disorder.

(B) The factors may include dust allergies, mildew, or pollen allergies, stress and worry, clogged airways due to a stiff nose or throat phlegm, and decreased oxygen consumption due to high altitude heights.

(C) Antihistamine is prescribed for avoiding immunogenic responses due to allergen triggers. Use of bronchodilator drugs and inhalers for relief.

Related Theory

The overconsumption of antihistamines that may cause certain unpleasant symptoms like tiredness (lethargy) and poor concentration, response time, and cognition, as well as dry mouth, hazy eyesight and trouble in urination.

25. *Breathing is a physical phenomenon where oxygen from the atmosphere is exchanged with the carbon dioxide produced by the cells. Various organisms have different mechanisms for breathing depending upon their needs and habitat. For example, lower invertebrates like sponges exchange gases by simple diffusion while earthworms use cuticles and insects have a network of tubes to transport atmospheric air within the body. Special vascularised structures called gills are used by aquatic arthropods and molluscs whereas vascularised bags called lungs are used by terrestrial forms for the exchange of gases. Fishes use gills while birds and mammals have lungs and amphibians use their moist skin to exchange gases.*

(A) Assertion (A): Breathing is different from respiration.

Reason (R): Breathing is physical and respiration is biochemical.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

(B) Why is the mechanism of breathing different for different organisms?

(a) To meet their needs.

(b) To help them adapt to their environment.

(c) To suit their mode of life.

(d) All of the above

(C) What special name is given to the vascularised bags of terrestrial animals

and vascularised structures of aquatic arthropods and molluscs?

(a) Gills and lungs respectively
(b) Lungs and trachea respectively
(c) Lungs and gills respectively
(d) Gills and trachea respectively

(D) How do lower invertebrates like sponges exchange gases?

(a) Diffusion (b) Osmosis
(c) Breathing (d) Cuticle exchange

(E) Assertion (A): The larynx is called the sound box.

Reason (R): The larynx is a cartilaginous box that helps in sound production.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

[Delhi Gov. QB 2022]

Ans. (A) *(a) Both A and R are true and R is the correct explanation of A*

Explanation: Breathing is a physical process. It occurs through nose, lungs, etc. While respiration is a biochemical process that takes place in cells and cell organelles.

(B) *(d) All of the above*

Explanation: Mechanism of breathing varies among different groups of animals depending mainly on their habitats and level of organisation.

(C) *(c) Lungs and gills respectively*

Explanation: Special vascularised structures called gills (branchial respiration) are used by most of the aquatic arthropods and molluscs whereas vascularised bags called lungs (pulmonary respiration) are used by the terrestrial forms for the exchange of gases.

(D) *(a) Diffusion*

Explanation: Lower invertebrates like sponges, coelenterates, flatworms, etc., exchange O_2 with CO_2 by simple diffusion over their entire body surface.

Related Theory

Earthworms use their moist cuticle and insects have a network of tubes (tracheal tubes) to transport atmospheric air within the body.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The vocal cords are responsible for sound production. As the larynx houses the vocal cords it is called a voice box.

Related Theory

In males, the larynx enlarges at the time of puberty and is termed as Adam's apple. It can be seen as a pointed structure in front of the neck of males. The pitch and volume are manipulated by the larynx. In puberty, the male voice becomes hoarse-like and becomes deep. It is due to hormonal functions exerted over vocal cords.

Caution

Larynx is not only involved in voice production but also in protecting the lungs from the invasion of foreign substances.

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

26. Where do the lungs are situated in the human body?

Ans. The lungs are situated in the thoracic chamber.

Related Theory

The thoracic chamber is situated near the sternum from the ventral region, formed by a vertebral column from the dorsal region and ribs support it from the lateral area. A flexible dome-shaped diaphragm is situated at the lower side of the thoracic chamber which helps the lungs to expand during inhalation.

27. Name the primary site of exchange of gases in our body. [NCERT Exemplar]

Ans. The principal sites of gaseous exchange are alveoli. Gases are exchanged among blood and tissues as well.

28. What is meant by Inspiratory Reserve Volume and give their approximate values in human adults? [Diksha]

Ans. Additional amount of air that can be inspired through a forceful inspiration is called Inspiratory Reserve Volume and its approximate volume is 2500 ml to 3000 mL.

29. Which equipment is used to study and assess the pulmonary function and breathing movements?

Ans. The spirometer is a medical diagnosis tool that monitors how much air you breathe in and out, as well as how long it takes to totally exhale after taking a deep breath.

30. Where does energy produced within the cell during cellular respiration?

Ans. The process of cellular respiration is the breakdown of dietary components inside the cell to generate energy for ATP production. Energy is produced in cytoplasm of cell and mitochondria. Mitochondria is main site of energy production.

31. What do you understand by the term Hypoxia?

Ans. Hypoxia is a medical state in which the organism, over the whole or in part, does not receive enough oxygen.

32. About 97% of O_2 is transported by RBCs in the blood. How does the remaining 3% of O_2 transported? [Delhi Gov. QB 2022]

Ans. Remaining 3% is transported in a dissolved state in water of plasma and cells.

33. How can you define the respiratory quotient?

Ans. The respiratory quotient is the ratio of carbon dioxide evolved to oxygen consumed in respiration during a given length of time.

34. Describe Total lung capacity (TLC).

Ans. Total lung capacity (TLC) is the total volume of air that is present in the lungs and respiratory passage after a maximum inspiration or forceful inspiration. It includes:

RV + ERV + TV + IRV or VC + RV = TLC.

35. What is the importance of respiratory substrates?

Ans. Respiratory substrates are organic substrates which are oxidized through the process of respiration to release energy within living cells.

36. Differentiate between histotoxic and hypoxic hypoxia.

Ans. Hypoxic is characterised by inadequate supply of oxygen from the atmosphere; however, cyanide poisoning causes histotoxic hypoxia.

37. Give the name and function of a fluid-filled double membranous layer which surrounds the lungs. [Delhi Gov. QB 2022]

Ans. Pleura is a double-layered membrane which covers the lungs from outside and provides protection from mechanical injury. A narrow space present between the two pleural membranes is called pleural cavity. Pleural cavity is filled with pleural fluid secreted by pleural membrane. This fluid decreases friction on the pulmonary surface.

38. How is presence of cartilage in the trachea relevant?

Ans. The C-shaped cartilaginous rings can protect the trachea's wall from collapsing if there is less oxygen within trachea.

SHORT ANSWER Type-I Questions (SA-I)

[**2** marks]

39. State the different modes of CO_2 transport in blood. [NCERT Exemplar]

Ans. CO_2 transport in blood can occur by these different modes as follows:

(1) 70% of CO_2 is transported as bicarbonate.

(2) Remaining amount of carbon dioxide (20-25%) is transported as carbamino-hemoglobin.

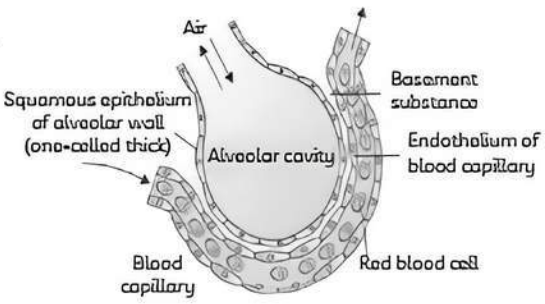
(3) 7% of CO_2 is transported through plasma in a dissolved state.

40. Explain the importance of partial pressure in gaseous transport during pulmonary respiration.

Ans. The partial pressure of gases creates a gradient between the regions from where gases are needed to be exchanged. This gradient creates the difference of gases availability within different regions of the body in terms of pressure and concentration and hence causes gases to transport.

41. Draw a labelled diagram of a section of an alveolus with a pulmonary capillary. [Delhi Gov. QB 2022]

Ans.



42. Define the partial pressure of oxygen and carbon dioxide.

Ans. The partial pressure of oxygen is the pressure of oxygen exerted in the pressure exerted

by a mixed volume of gases and the partial pressure of carbon dioxide is the pressure of carbon dioxide gas in the pressure exerted by a mixed volume of gases present.

43. What is the difference between asthma and emphysema?

Ans. Asthma is a condition caused due to the inflammation in bronchi and bronchioles whereas emphysema occurs due to damaged alveoli. Although in both the cases the patient suffers from difficulty in breathing. Asthma could be mild or severe but emphysema if not treated could damage lungs seriously.

44. How can you categorise respiration into different types?

Ans. Respiration can be categorised majorly into three types:

(1) The breathing process is known as external respiration. It comprises of gas inhalation and exhalation.

(2) Internal respiration is the process of exchanging gases among the blood and the cells of the body.

(3) Food is converted to energy during cellular respiration. It is of two types—aerobic respiration that does require oxygen, whereas anaerobic respiration does not.

45. Following is the table showing partial pressure (in mmHg) of oxygen and carbon dioxide) at different parts involved in diffusion in comparison to those in the atmosphere. Fill in the blank –A, B, C and D.

Respiratory gases	Atmospheric air	Alveoli	Blood (Deoxygenate)	Blood (Oxygenate)	Tissue
O_2	(A)	104	40	(D)	40
CO_2	0.3	(B)	(C)	40	45

[Delhi Gov. QB 2022]

Ans.

Respiratory gas	Atmospheric air	Alveoli	Blood (Deoxygenate)	Blood (Oxygenate)	Tissue
O_2	**159**	104	40	**95**	40
CO_2	0.3	**40**	**45**	40	45

SHORT ANSWER Type-II Questions (SA-II)

[**3** marks]

46. Compared to O_2, diffusion rate of CO_2 through the diffusion membrane per unit difference in partial pressure is much higher. Explain. [NCERT Exemplar]

Ans. CO_2 is 20-25 times more soluble than O_2. Due to the high solubility of CO_2, the diffusion rate of carbon dioxide is much higher than oxygen. The relative solubility difference causes the difference in oxygen and carbon dioxide transportation rates.

47. What is the function of carbonic anhydrase?

Ans. Carbonic anhydrase plays an important role in carbon dioxide transport in the blood (RBCs) and plasma.

The enzyme catalyzes the reversible reaction between carbon dioxide and water to form hydrogen bicarbonate (H_2CO_3)

Bicarbonate later dissociates into bicarbonate ions (HCO_3^-) and hydrogen ions (H^+) Carbonic anhydrase is the fastest enzyme.

48. What are the explicit features of human lungs?

Ans. (1) Human lungs are highly vascularised, air-filled sac-like structures covered with a double wall layer called pleura.

(2) In between the pleural membranes, pleural fluid is present which helps in preventing shock and reducing friction.

(3) Small balloon-like structures called alveoli are present which are the primary site for gaseous exchange.

49. List any three causes for Hypoxia.

Ans. (1) Low oxygen in the surroundings or environments.

(2) Respiratory disease like asthma, emphysema, *etc.*, and heart disease like tachycardia.

(3) Low RBCs count (anaemia).

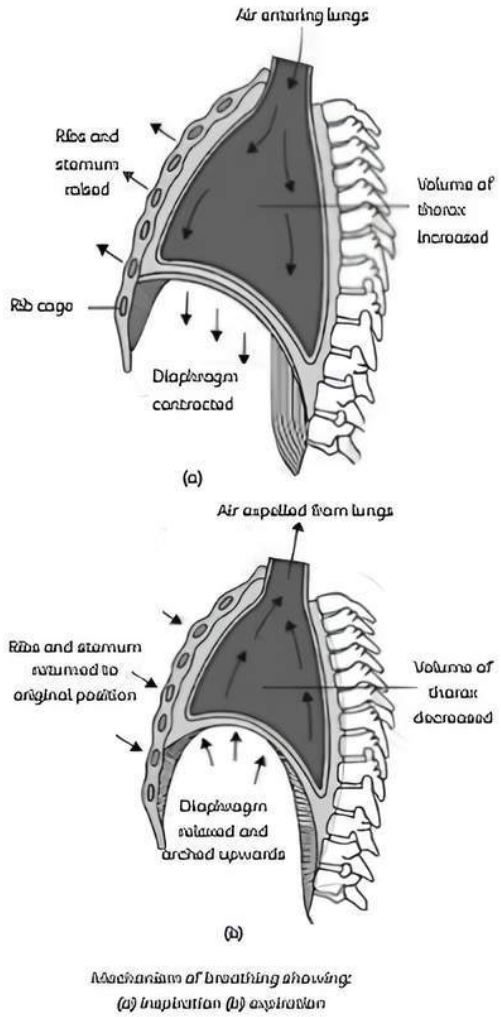
LONG ANSWER Type Questions (LA)

[4 & 5 marks]

50. Explain the mechanism of breathing with the help of a labelled diagram involving both stages—inspiration and expiration.

[Delhi Gov. QB 2022]

Ans.



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

51. How is oxygen transported in the human tissues?

Ans. (1) In alveoli; pO_2 is high, whereas H^+ ions, pCO_2 and temperature are lower causing oxygen to be transported inside.

(2) Haemoglobin is majorly responsible for oxygen transportation in the human body.

(3) Haemoglobin is the protein present in RBCs and each haemoglobin carries four molecules of oxygen.

(4) Oxygen binds with haemoglobin in reversible manner and is transport to the tissues through blood transportation. When oxygen binds with haemoglobin, it forms oxyhaemoglobin.

(5) In tissues; PO_2 is low, whereas H^+ ions, PCO_2 and the temperature is higher.

(6) So, oxygen is transported down the gradient and carbon dioxide is received by blood for transporting back to the lungs.

52. How does the human body respire?

Ans. The subsequent steps are taken followed in the process of respiration:

(1) The atmospheric air is breathed in and passed through the conducting part to the alveoli.

(2) The CO_2 from the blood is diffused out in the alveoli region and the rich O_2 is diffused into the blood.

(3) Blood transports the diffused oxygen to various parts of the body.

(4) The O_2 is taken by the cells and tissues and CO_2 from the cells and various body parts is diffused back into the blood.

(5) The blood carries CO_2 from all body parts to the lung for the repetition of above-mentioned steps.

53. Explain the role of the neural system in regulation of respiration. [NCERT Exemplar]

Ans. (1) The neural system takes an active part in regulating the respiratory system.

(2) In the lower part of the brain, Medulla region, a specialized region called respiratory rhythm centre is present.

(3) Respiratory rhythm centre takes an active part in regulating respiration when it is activated.

(4) The concentration of CO_2 and H^+ ions act as activators for activating the rhythm centre and taking necessary steps.

(5) The pneumotaxic centre present in the pons region of the brain accounts for proper functioning of respiratory rhythm centre