BIOLOGY

Chapter 14: Breathing and Exchange Of Gases

BREATHING AND EXCHANGE OF GASES

Breathing

The process of exchange of O_2 from the atmosphere with CO_2 produced by the cell is called breathing. It occurs in two stages of inspiration and expiration. During inspiration air enters the lungs from atmosphere and during expiration air leaves the lungs.

Difference between Breathing and Respiration

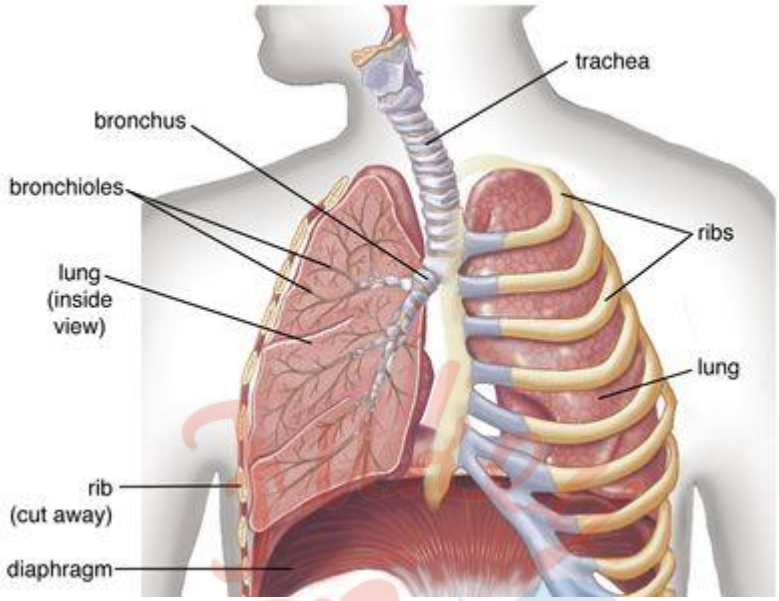
Breathing	Respiration
It is simply an intake of fresh air and removal of foul air.	It is the oxidation of food to form carbon dioxide, water and energy.
It is a physical process.	It is a biochemical process.
No energy is released.	Energy is released in form of ATP.
It is an extracellular process.	It is an intracellular process.

Respiratory Organs

Mechanism of breathing varies in different organism according to their body structure and habitat.

Respiratory Organs	Organisms
Entire Body surface	Sponges, coelenterate, flatworms.
Skin	Earthworm.
Tracheal system	Insects
Gills	Pisces, aquatic arthropods.
Lungs	Amphibians, mammals.

Human Respiratory System



Each bronchiole terminates into an irregular walled, vascularized bag like structure called alveoli. Human respiratory system consists of a pair of nostrils, pharynx, larynx, bronchi and bronchioles that finally terminates into alveoli.

Nasal chamber open into pharynx that leads to larynx. Larynx contains voice box (sound box) that help in sound production.

The trachea, primary, secondary, and tertiary bronchi and initial bronchioles are supported by incomplete cartilaginous rings to prevent collapsing in absence of air. The branching network of bronchi, bronchioles and alveoli collectively form the lungs.

Two lungs are covered with double layered pleura having pleural fluid between them to reduce the friction on lung surface.

Respiratory System: (i) Conducting Parts (ii) Exchange Parts

Conducting parts: include nostrils, pharynx, larynx and trachea. Main functions include-

- Transport of atmospheric air to alveoli.
- Removing foreign particles from air, humidifying it and bringing it to body temperature.

The exchange: parts are alveoli. It is the site of actual diffusion of O_2 and CO_2 between blood and atmospheric air.

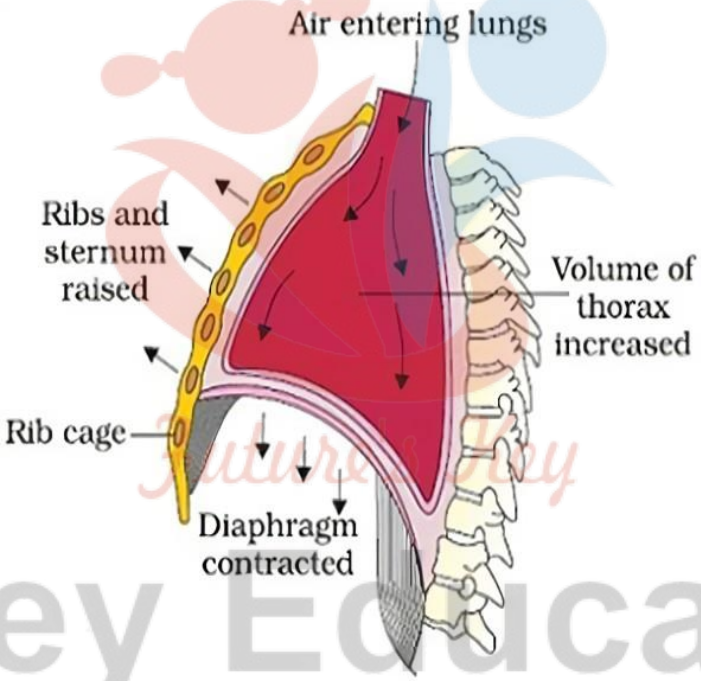
Steps of Respiration

- Breathing in which Oxygen rich atmospheric air is diffused in and CO_2 rich alveolar air is diffused out.
- Diffusion of gases across alveolar membrane.

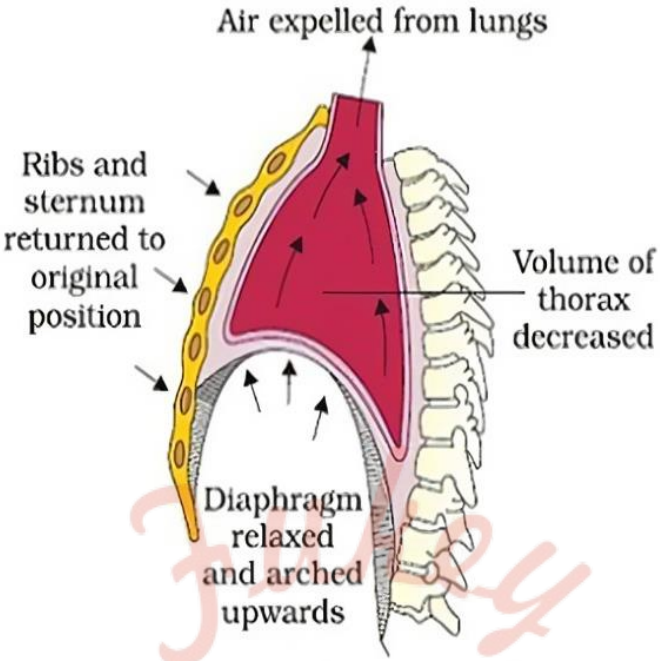
- Transport of gases by blood.
- Diffusion of CO_2 and CO_2 between blood and tissues.
- Utilization of CO_2 by cells to obtain energy and release of CO_2 (cellular respiration).

Mechanism of Breathing

1. Breathing involves inspiration and expiration. During inspiration atmospheric air is drawn in and during expiration, alveolar air is released out.
2. Movement of air in and out takes place due to difference in pressure gradient.
3. Inspiration occurs when pressure inside the lung is less, and expiration occurs when pressure is more in lungs than outside.
4. The diaphragm and external and internal intercostal muscles between the ribs help in developing pressure gradient due to change in volume.



5. The contraction of intercostal muscles lifts the ribs and sternum causing an increase in volume of thoracic cavity that results in decrease in pressure than the atmospheric pressure. This causes inspiration.
6. Relaxation of the diaphragm and intercostal muscles reduce the thoracic volume and increase the pressure causing expiration.
7. The volume of air involved in breathing movements is estimated by using spirometer for clinical assessment of pulmonary functions.



Respiratory Volume and Capacities

Tidal volume (TV): Volume of air inspired or expired during a normal respiration. It is about 500mL in healthy man.

Inspiratory Reserve Volume (IRV): Additional volume of air a person can inspire by forceful inspiration. It is about 2500 mL to 3000 mL.

Expiatory Reserve Volume (ERV): Additional volume of air a person can expire by forceful expiration. It is about 1000 mL to 1100mL.

Residual Volume (RV): Volume of air remaining in lungs even after a forcible expiration. It is about 1100mL to 1200mL.

Inspiratory Capacity (IC): TV + IRV

Expiratory Capacity (EC): TV + ERV

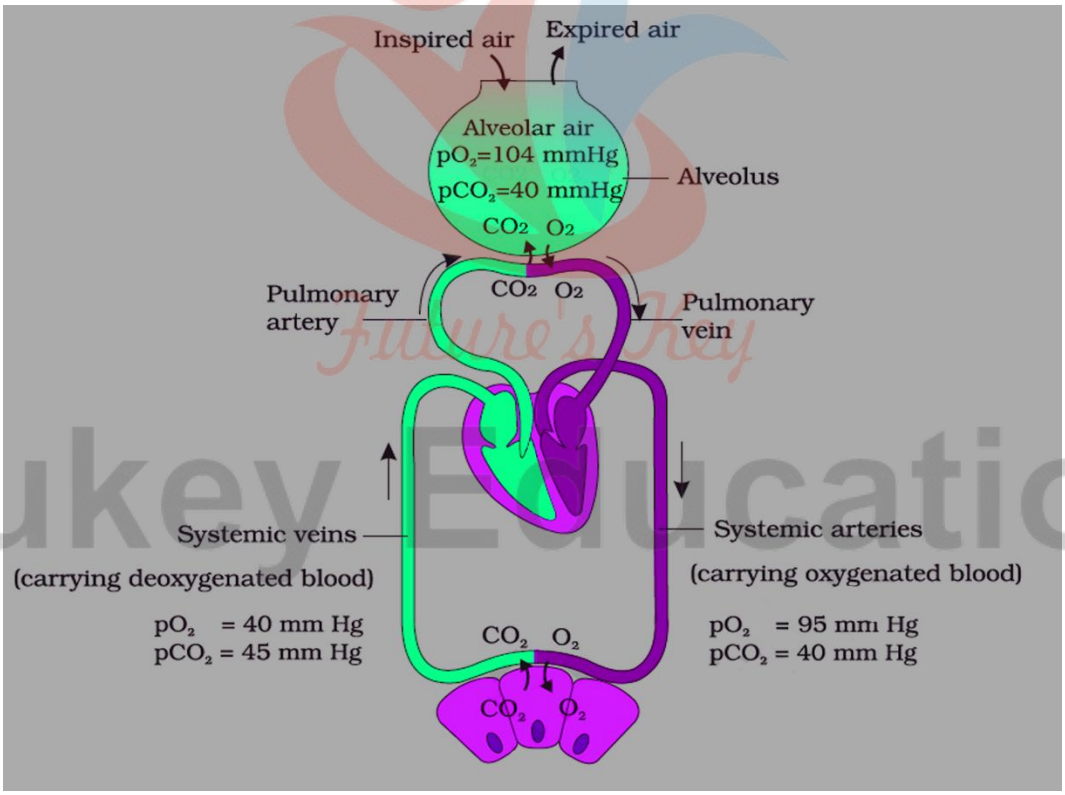
Functional Residual Capacity (FRC): ERV + RV

Vital Capacity (VC): Maximum volume of air a person can breathe in after a forceful expiration. ERV + TV + IRV

Total Lung Capacity (TLC): Total volume of air accommodated in lung at the end of forced inspiration. RV + ERV + TV + IRV or Vital capacity + Residual Volume.

Exchange of Gases

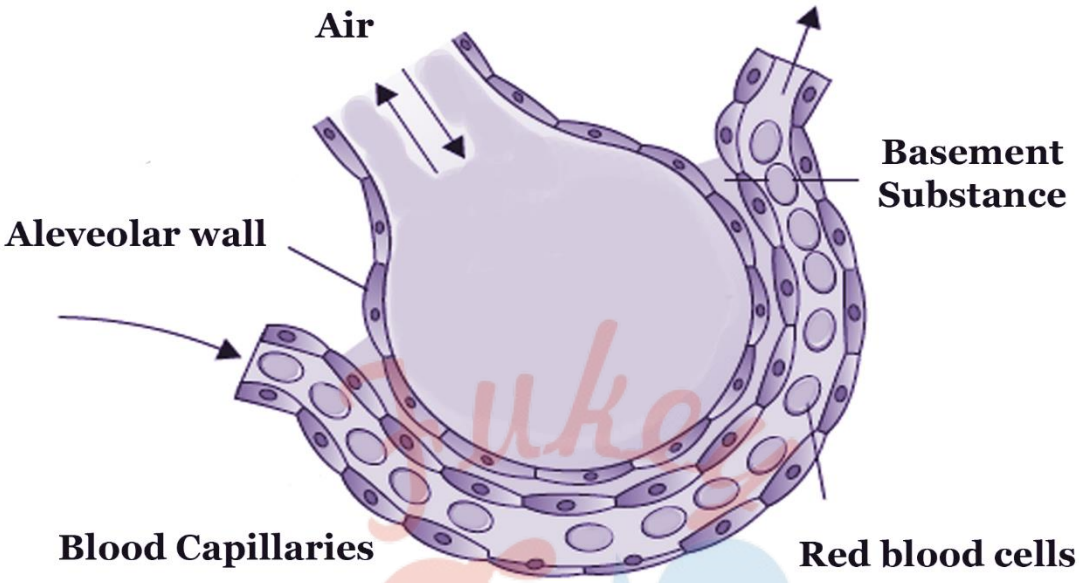
1. Exchange of gases takes place at two sites
   - Alveoli to blood
   - Between blood and tissues.
2. Exchanges of gases occur by simple diffusion due to pressure/ concentration gradient, solubility of the gases and thickness of membrane.
3. Pressure contributed by individual gas in a mixture of gas is called partial pressure represented by pCO_2 and pO_2.
4. Partial pressure of Oxygen and carbon dioxide at different part involved in diffusion varies from one part to another and moves from higher partial pressure to lower partial pressure.
5. Solubility of CO_2 is 20-25 times more than solubility of O_2, so CO_2 diffuse much faster through membrane.
6. Diffusion membrane is three layered thick, that is alveolar squamous epithelium, endothelium of alveolar capillaries and basement substance between them.



Transport of Gases

- Blood is the medium of transport for CO_2 and O_2. Most of oxygen (97%) is transported through RBC and remaining 3% by blood plasma.

- 20-25% of CO_2 is transported by RBC, 70% as bicarbonate and rest 7% in dissolved state by blood plasma.



Transport of Oxygen

- Haemoglobin in RBC combines with O_2 to form Oxyhaemoglobin. Each haemoglobin combine with four oxygen molecules.
- Binding of O_2 is related with partial pressure of O_2 and CO_2, hydrogen ion concentration and temperature.
- Percentage saturation of haemoglobin and partial pressure of oxygen forms sigmoid curve (oxygen dissociation curve).
- In the alveoli, pO_2 is more and pCO_2 is less, less H+ ions concentration and lower temperature favour the binding of O_2 with hemoglobin. Where opposite condition in tissues favour the dissociation of Oxyhaemoglobin.

Transport of Carbon dioxide

- Carbon dioxide is transported by haemoglobin as carbamino-haemoglobin. In tissues pCO_2 is high and pO_2 is less that favour the binding of carbon dioxide with haemoglobin. Opposite condition help in dissociation of carbamino- haemoglobin in alveoli.
- Enzyme carbonic anhydrase help in formation of carbonate ions to transport carbon dioxide.

Regulation of Respiration

- Human beings have ability to maintain and moderate the rate of respiration to

fulfill the demand of body tissues by neural system.

- Respiratory rhythm center is located in medulla region of hind brain. Pneumotaxic center in pons moderate the function of respiratory rhythm center.
- Chemo-sensitive area near rhythm center is highly sensitive to C and H+ ions that ultimately control the respiratory rate. Oxygen do not play major role in controlling rate of respiration.

Functions of Respiration

- Energy production.
- Maintenance of acid-base balance.
- Maintenance of temperature
- Return of blood and lymph.

Mountain Sickness

Mountain Sickness is the condition characterized by the ill effect of hypoxia (shortage of oxygen) in the tissues at high altitude commonly to person going to high altitude for the first time.

Symptoms:

- Loss of appetite, nausea, and vomiting occurs due to expansion of gases in digestive system.
- Breathlessness occurs because of pulmonary oedema.
- Headache, depression, disorientation, lack of sleep, weakness and fatigue.

Disorder of Respiratory System

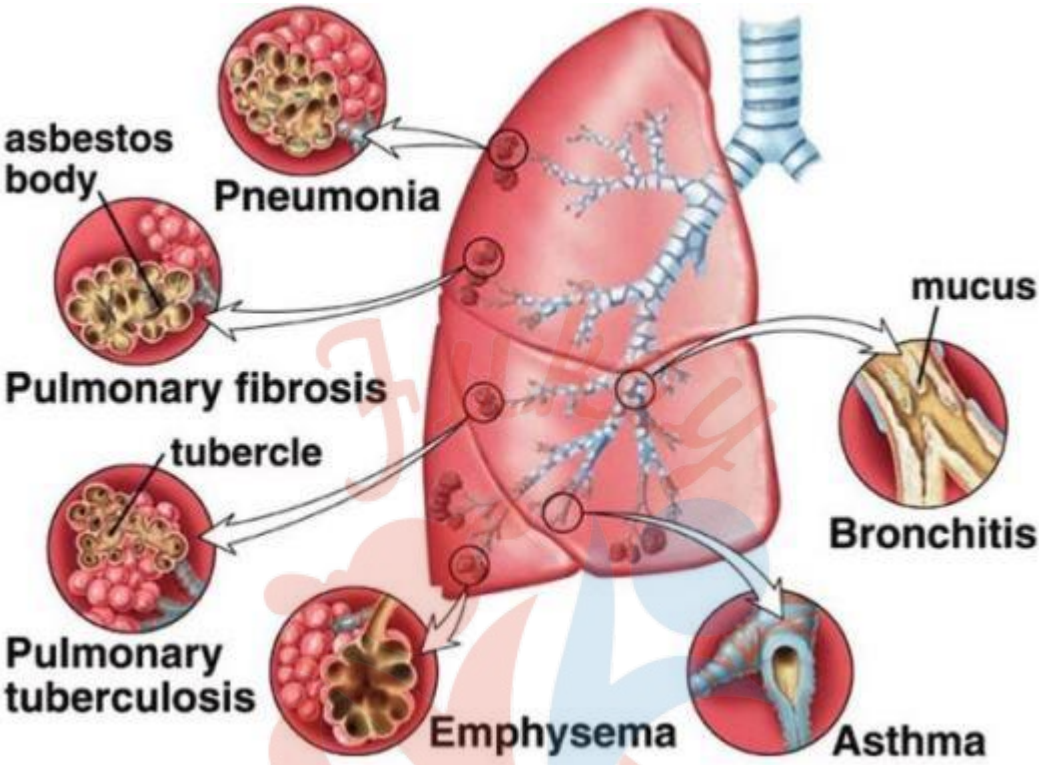
Asthma: It is due to allergic reaction to foreign particles that affect the respiratory tract. The symptoms include coughing, wheezing and difficulty in breathing. This is due to excess of mucus in wall of respiratory tract.

Emphysema: Is the inflation or abnormal distension of the bronchioles or alveolar sacs of lungs. This occurs due to destroying of septa between alveoli because of smoking and inhalation of other smokes. The exhalation becomes difficult, and lung remains inflated.

Occupational Respiratory Disorders: Occurs due to occupation of individual. This is caused by inhalation of gas, fumes or dust present in surrounding of workplace. This includes Silicosis, Asbestoses due to exposer of silica and asbestos. The symptom includes proliferation of fibrous connective tissue of upper part of lung causing inflammation.

Pneumonia: It is acute infection or inflammation of the alveoli of the lungs due to

bacterium streptococcus pneumoniae. Alveoli become acutely inflamed and most of air space of the alveoli is filled with fluid and dead white blood corpuscles limiting gaseous exchange.



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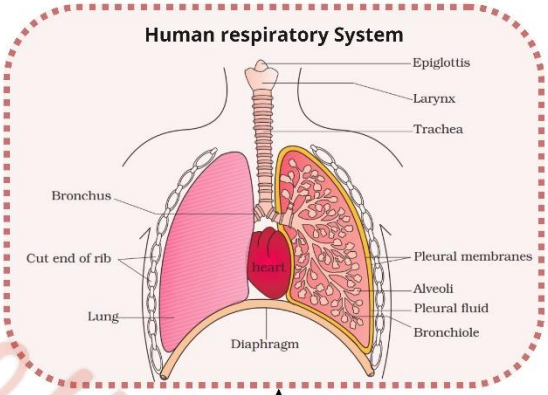
Breathing and Exchange of Gases

Respiratory organs in animals

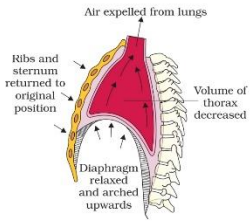
- **Body surface** – Examples - sponges, coelenterate, flatworm
- **Tracheal tube** – Examples - Insects, centipede, millipede etc.
- **Gills** – Example - Fishes, tadpoles, prawn etc.
- **Lungs** – Example - Terrestrial animals like human being

Human respiratory System



Respiratory disorders

- Occupational Respiratory Disorders
- Emphysema
- Asthma
- Bronchitis
- Pneumonia
- Lung cancer

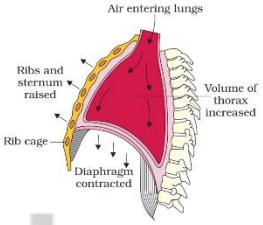


Regulation of Respiration

- Neural regulation- Involves respiratory centers, afferent and efferent nerves.
- Chemical regulation- Through chemoreceptors.

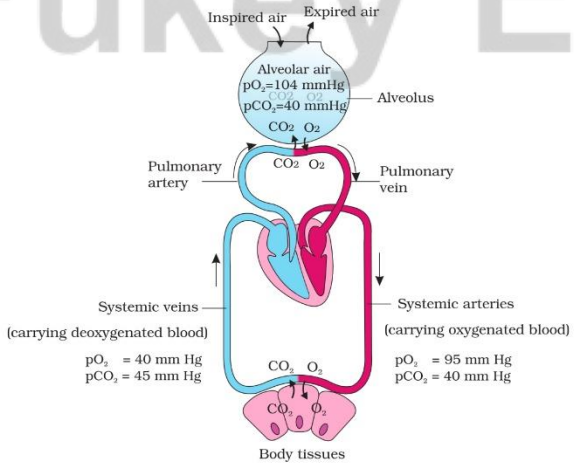
Mechanism of Breathing

- Expiration (Breathing out)
- Inspiration (Breathing in)



Exchange of Gases

- Between blood and tissues
- Between Alveoli and blood



Respiratory volumes and capacities

- Tidal volume → 500 ml
- IRV → 2500 ml to 3000 ml
- ERV → 1000 ml to 1100 ml
- RV → 1100 ml to 1200 ml
- IC → TV + IRV
- EC → TV + ERV
- FRC → ERV + RV
- VC → ERV + TV + IRV
- Total lung capacity
  → RV + ERV + TV + IRV or V.C + TRV

Transport of Gases

Transport of O_2
- As blood plasma (About 3 %)
- As oxyhaemoglobin (About 97%)

Transport of CO_2
- As Carbonic acid (About 7 %)
- As carbamino- haemoglobin (About 20-25 %)
- As bicarbonates (About 70%)

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

Important Questions

➢ Multiple Choice Questions:

Question 1. Which of the following is not a step in the process of respiration?

(a) Breathing
(b) Diffusion of oxygen from blood to tissues
(c) Production of energy
(d) Diffusion of oxygen from tissues to blood

Question 2. The atmosphere contains CO_2 by volume

(a) 0.1%
(b) 0.5%
(c) 0.03%
(d) 0.3%

Question 3. Sudden deep inspiration is due to

(a) Increase in concentration of O_2
(b) Increase in concentration of CO_2
(c) Decrease in concentration of CO_2
(d) Decrease in concentration of CO_2

Question 4. A man respires about

(a) 40 times per minute
(b) 72 times per minute
(c) 12-16 times per minute
(d) 100 times per minute

Question 5. In which form CO_2 is carried in blood

(a) Sodium bicarbonate
(b) Sodium carbonate
(c) Potassium bicarbonate
(d) Potassium carbonate

Question 6. In man, gas exchange between the environment and the body takes place in

(a) Bronchi
(b) Larynx
(c) Alveoli
(d) Trachea

Question 7. Inspiration would not occur if the

(a) Diaphragm is elevated
(b) Diaphragm is lowered

(c) Ribs are elevated
(d) Ribs are elevated and diaphragm is lowered

Question 8. Which one of the following does not contribute to the breathing movement in mammals?

(a) Abdominal muscles
(b) Larynx
(c) Ribs
(d) Diaphragm

Question 9. Breathing centre that controls normal breathing in mammals lies in

(a) Mid brain
(b) Cerebellum
(c) Cerebrum
(d) Medulla oblongata

Question 10. If a person stays on hill for some days:

(a) His body will step up production of RBCs
(b) His body will step down production of RBCs
(c) His RBCs will turn into very large cells
(d) No change in the contents of RBCs in the body

Question 11. The largest quantity of air that can be expired after a maximal inspiratory effort is

(a) Tidal volume
(b) Vital capacity of lungs
(c) Lung volume
(d) Residual volume

Question 12. Which of the following facts suggests that O_2 is transported from lungs to the tissues combined with haemoglobin rather than dissolved in blood plasma:

(a) Oxyhaemoglobin can dissociate into haemoglobin and O_2
(b) An increase in CO_2 concentration decreases the O_2 affinity of haemoglobin
(c) Haehaemoglobin can combine with O_2
(d) O_2 carrying capacity of whole blood is higher than that of plasmsa and O_2 content of blood leaving the lungs is greater than that of blood entering the lungs.

Question 13. If a man from sea coast of Mumbai goes to Mount Everest:

(a) His breathing rate and heart beat will increase
(b) His breathing rate and heart beat will decrease
(c) His breathing rate will increase, but heart beat will decrease
(d) His breathing rate will decrease, but heart beat will increase.

Question 14. Body tissues obtain oxygen from oxyhaemoglobin because of its dissociation caused by

(a) Low CO_2 concentration
(b) Low O_2 and high CO_3 concentration
(c) High CO_2 concentration
(d) Low oxygen concentration

Question 15. Lungs are covered by

(a) Perichondrium
(b) Pleura
(c) Periosteum
(d) Pericardium

➢ Fill In the Blanks:

1. This process of exchange exchange of O_2 from the atmosphere with CO_2 produced by the cells is called …… commonly known as …….
2. …… use their moist cuticle for respiration.
3. Among vertebrates, fishes respire through gills wheres …….. and …….. and ……. use …….
4. …… like …… can respire through their moist skin also.
5. The nasal chamber opens into …… which is a portion of pharyax, the common passage for …….. and ……..
6. Nasopharynx opens through glottis of the larynx region into the ……..

➢ True or False:

1. Each haemoglobin molecule can carry a maximum of four molecules of O_2.
2. O_2 is carried by haemoglobin as carbamino-haemoglobin (about 25-20 percent).
3. Every 10 mL of oxygenated blood can deliver around 10 ml of O_2 to the tissues under normal physiological conditions.
4. In the alveoli, where there is low pO_2, high pCO_2, higher H+ concentration and lesser temperature.
5. Every 100mL of deoxygenated blood delivers approximately 4 ml of CO_2 to the alveoli.
6. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

➢ Very Short Question:

1. How does pepsinogen become active in the stomach?
2. What is pancreatic amylase?

3. Name any animal starch.
4. Name the milk-coagulating enzyme.
5. Which enzyme is necessary for the digestion of fat?
6. Which part of the ruminant stomach secretes gastric juice?
7. Name the water-soluble vitamins.
8. State the function of ascorbic acid.
9. Which is the largest gland in our body?
10. Name the cobalt-containing vitamin.

➢ Short Questions:

1. Define partial pressure of a gas.
2. How would you differentiate between tidal volume and residual volume?
3. What is the need for a circulatory system in a bigger animal?
4. Why does one experience difficulty at a high altitude?
5. What are the conditions essential for effective respiration?
6. What is a specialized respiratory surface and what are its advantages?
7. What is respiration?
8. What is Bronchial Asthma? How it is caused? What are the symptoms of this disease?

➢ Long Questions:

1. Explain gas transport in the blood.
2. Name and explain the respiratory organs of the following,
   (i) Insect
   (ii) Neries
   (iii) Prawn
   (iv) Birds
   (v) Fishes
   (vi) Earthworm.
3. Define the following terms:
   (a) Anaerobic respiration,
   (b) Breathing,
   (c) Vital capacity,

(d) Tidal volume,

(e) Respiratory centre.

4. Write the role of the diaphragm and its Costals muscles in the breathing process.

Assertion Reason Question-

1. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

   (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
   (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
   (c) If Assertion is true but Reason is false.
   (d) If both Assertion and Reason are false.

   Assertion: Most fish when out of water, die of suffocation.

   Reason: Atmospheric air contains far less oxygen content than the dissolved oxygen in water.

2. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

   (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
   (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
   (c) If Assertion is true but Reason is false.
   (d) If both Assertion and Reason are false.

   Assertion: Gill-lamellae in aquatic animals help in exchange of gases.

   Reason: Each gill lamella carries many blood capillaries.

✓ Answer Key-

➢ Multiple Choice Answers:

1. (a) Breathing
2. (c) 0.03%
3. (b) Increase in concentration of CO_2
4. (c) 12-16 times per minute
5. (d) Potassium carbonate
6. (c) Alveoli

7. (a) Diaphragm is elevated
8. (c) Ribs
9. (a) Mid brain
10. (a) His body will step up production of RBCs
11. (c) Lung volume
12. (d) O_2 carrying capacity of whole blood is higher than that of plasma and O_2 content of blood leaving the lungs is greater than that of blood entering the lungs.
13. (a) His breathing rate and heart beat will increase
14. (b) Low O_2 and high CO_2 concentration
15. (d) Pericardium

➢ Fill In the Blanks:

1. breathing, respiration
2. Earthworms
3. reptiles, birds, mammals, lungs
4. Nasopharynsx, frogs
5. nasopharynx, food, air
6. trachea

➢ True or False:

1. True
2. False
3. False
4. False
5. True
6. True

➢ Very Short Answers:

1. Answer: Alveoli in the lungs.
2. Answer: Tracheae and spiracles.
3. Answer: Haemoglobin.
4. Answer: Thin-walled blood capillaries.
5. Answer: They lack mitochondria.

6. Answer: Carbohydrates lipids and proteins.
7. Answer: Because it drives the life processes.
8. Answer: By diffusion and circulatory system.
9. Answer: Molecules of food hold energy in their chemical bonds.
10. Answer: It is the intake of oxygen by the blood from air or water to the respiratory organs and the elimination of CO_2.

➢ Short Answer:

1. Answer: It is the pressure exerted in a mixture of gases and is equal to the total pressure of the mixture of gases divided by the percentage of that gas in a mixture. The atmospheric air pressure at sea level is 760mm of Hg. Oxygen forms 35% of the air. The partial pressure of oxygen is 760 × 35/ 100 = 266 mmHg.
2. Answer:

   i. Tidal volume is the amount of air inhaled or exhaled in one complete breathing. It is about 500 ml.

   ii. Residual volume is the volume of air that remained in the lungs after the maximum effort of exhalation. It is about 1500ml.
3. Answer: In larger animals the deeper cells cannot obtain oxygen directly from the atmosphere simply through the process of diffusion or eliminate CO_2. In such a case, the respiratory system transports the respiratory gases from the respiratory' surface to the deep-lying tissues.
4. Answer: At high altitude, the pressure of air falls and the person cannot get enough oxygen in the lungs for diffusion in the blood. Due to insufficient O_2, the person has difficulty breathing at high altitude. The person feels difficulty such as breathlessness, headache, dizziness, irritability, nausea, vomiting, mental fatigue and a blush (///) on the skin, nails and lips.
5. Answer: Conditions essential for effective respiration:

   i. The respiratory surface should be thin and permeable to O_2 and CO_2

   ii. The rich supply of blood to the respiratory surface.

   iii. Passage for bringing oxygen to the respiratory surface and removing CO_2 through the same passage.

   iv. The respiratory surface should be moist.

   v. Presence of a circulatory system.

   vi. Presence of a respiratory pigment to carry out the respiratory gases (CO_2 and O_2)
6. Answer: A specialized respiratory surface is thin, moist and highly vascular. It remains in

contact with the environment outside the body and tissues inside the body. Diffusion of gases takes place from the respiratory surface between the body and outside the environment. The epidermal capillaries release carbon dioxide and take up oxygen dissolved in the film of surface moisture.

7. Answer: A process of physiochemical change by which environmental oxygen is taken in to oxidise the stored food to release CO_2 water and energy; the energy released is used for doing various life activities whereas CO_2 being foul gas is thrown out from the body. The main source of energy are carbohydrates, lipids and proteins. Respiratory mediums are air and water.

8. Answer: It is characterised by the spasm of the smooth muscles present in the walls of the bronchiole. It is generally caused due to the hypersensitivity of the bronchiole to the foreign substances present in the air passing through it.

   The symptoms of this disease are coughing, difficulty in breathing mainly due to expiration, the mucous membrane starts secreting an excess amount of mucous.

➢ Long Answer:

1. Answer: It may be explained in two steps.

   (a) Transport of O_2 from lungs to tissues.

   (b) Transport of CO_2 from tissues to lungs.

   A. Oxygen Transport

   i. O_2 is transported in the blood via haemoglobin.

   ii. O_2 diffuses into RBC and combines with haemoglobin to form oxyhaemoglobin.

   iii. Oxyhaemoglobin breaks into haemoglobin and oxygen at the tissues, where there are high PCO_2 and PO_2.

   iv. In the lungs, oxyhaemoglobin is formed due to high PO_2 and low PCO_2.

   B. CO_2 Transport: CO_2 is transported in 3 ways with blood.

   i. 70% of CO_2 in RBC reacts with H_2O to form H_2CO_3

$$CO_2 + H_2O \xrightarrow[\text{Anhydrase}]{\text{Carbonic}} H_2CO_3$$

   ii. The rest 30% CO_2 combining with Hb to form carbon haemoglobin. (HCO_3^- carried by RBC and plasma)

   iii. Some CO_2 dissolves in plasma on reaching the lungs.

   $HCO_3^- + H + H_2CO_3$

   H_2CO_3 $CO_2 + 2H_2O$

And this CO_2 is expelled out through the lungs.

2. Answer: Insect: The integument of insects is thick and highly impermeable to minimise the loss of water through the environment. The exchange of gases cannot take place through the skin covering of these insects. These insects have a highly developed complex system called the tracheal. This mode of respiration is called tracheal respiration.

   (ii) Answer: Neries: Parapodia is the respiratory oxygen in neries. In this organism respiratory occurs through the skin covering the parapodia (Locomotory organs), which is again very thin, moist, permeable and highly vascular.

   (iii) Answer: Prawn: Gills, in the animals like prawns, certain molluscs, fishes, tadpoles, the process of gaseous exchange occur by special respiratory organs called gills. These are richly supplied with blood and readily absorb oxygen found dissolved in water and release CO_2 back into the water.

   (iv) Answer: Birds: (lungs). In birds and mammals, the skin is impermeable. These have a high metabolic rate and their oxygen requirement is very high. Birds have spongy lungs to have a more extensive respiratory surface. These lungs always remain in the body to keep the respiratory surface moist, which is necessary for the exchange of respiratory gases.

   (v) Answer: Oxygen and carbon dioxide dissolves in water, and most fishes exchange dissolved oxygen and carbon dioxide in water by means of the gills.

   (vi) Answer: Earthworms do not have lungs. They breathe through their skin. Oxygen and carbon dioxide pass through the earthworm's skin by diffusion

3. Answer: Anaerobic respiration: It is a process that does not involve the use of molecular oxygen. Food is not completely oxidised to CO_2 and water. Less energy is present in anaerobic respiration.

   (b) Answer: Breathing: It is a physical process, which brings in fresh air to the respiratory surface and removes foul impure airs from the outside. It occurs outside the cells and is thus an extracellular process.

   (c) Answer: Vital capacity: It is defined as an important measure of pulmonary capacity. It is the maximum amount of air a person can expel from the lungs after first filling the lungs to their maximum extent.

   Vital capacity is the sum total of inspiration reserve volume, tidal volume and expiratory reserve volume.

   (1 + 1 + VC = IRV = TV/ERV)

   (d) Answer: Tidal volume: It is defined as the volume of air normally inspired or expired in one breath without doing any effort. It is about 500 ml in an adult person. It

represents the volume of air, which is renewed in the respiratory system during every breathing.

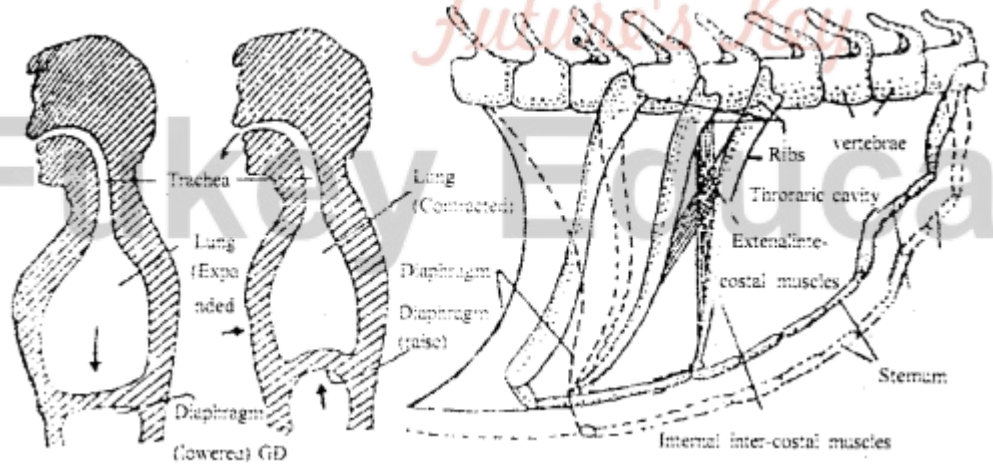
(e) Answer: Respiratory centre: A number of groups of neurons located bilaterally in the medulla oblongata control the respiratory. These are called respiratory centres. These centres are named the dorsal respiratory group. Ventral respiratory group and pneumatic centre.

4. Answer: During breathing, when the lungs contract their volumes decrease resulting in the increase of air pressure in the lungs. Hence, the air is exhaled from the lungs. These two processes are called inspiration and expiration. During normal breathing, the downward and upward movement of the diaphragm takes place. When the diaphragm, contracts, the lower surface of the lung is pulled downward consequently the volume of the lungs increases.

   This causes the inhalation of air or inspiration. When the diaphragm relaxes, lungs are compressed and air exhaled, expiration takes place. The demand for extra oxygen is fulfilled by the expansion of the rib cage, during exercise when the rate of breathing increases.

   During expiration, high pressure is generated in the lungs and air moves out. The upward movement of the rib cage is caused mainly by the external intercostals muscles present between the ribs along with the assistance of few other adjacent muscles.

   Similarly, the downward movement of the rib cage is facilitated by the internal intercostals, external oblique and internal oblique muscles, position of the diaphragm, ribs and sternum during breathing as shown in the diagram



Position of diaphragm, ribs and sternum during breathing

Assertion Reason Answer-

1. (c) If Assertion is true but Reason is false.

Explanation: Although atmospheric air contains far more oxygen content than the water (air contains 21% oxygen and water contains 0.5-0.9% oxygen by volume depending on the temperature), still most fish when out of water die of suffocation due to lack of oxygen. When fish is taken out of water the gills stick together thereby reducing the surface area. Reduced surface area lowers gas exchange and so death occurs.

2. (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Explanation: Gills are the main respiratory organs of aquatic animals. Each gill bears rows of comb-like, soft, thin gill-filament, each gill filament bears many flat, parallel membranelike gill-lamellae. Each gill lamella carries many blood capillaries. Water taken through the mouth, is made to flow from the pharynx in a single direction between the gill lamella. This greatly helps in the gaseous exchange across the lamellar membrane between the capillary blood and the flowing water.