Chapter 4

Breathing and Exchange of Gases

Solutions (Set-1)

SECTION - A

School/Board Exam. Type Questions

Very Short Answer Type Questions :

1. Where are the respiratory gases exchanged in the body of earthworm?

Sol. Exchange of gases takes place at cuticle which is moist, thin and vascular.

2. Name the membrane that surrounds the human lungs.

Sol. Pleura or pleural membranes

3. Give the name of the partition between thoracic and abdominal cavity.

Sol. Diaphragm

4. Write down the catabolic reaction that takes place during respiration.

Sol. $\underset{\text{Glucose}}{C_6H_{12}O_6} + 6\underset{\text{Oxygen}}{O_2} \longrightarrow 6\underset{\text{Carbon dioxide}}{CO_2} + 6\underset{\text{Water}}{H_2O} + \text{Energy}$

5. In which axis, does the volume of thoracic cavity increase during the contraction of external intercostal muscles?

Sol. In dorso-ventral axis, *i.e.*, backward-forward direction.

6. What is vital capacity?

Sol. It is the maximum volume of air a person can breathe in and out after a forceful expiration and inspiration.

7. Give values of alveolar pO_2 and alveolar pCO_2.

Sol. Alveolar pO_2 is equal to 104 mm Hg.

Alveolar pCO_2 is equal to 40 mm Hg.

8. What are the three forms in which CO_2 is transported in blood?

Sol. As bicarbonate ions, carbonic acid (dissolved form) and carbaminohaemoglobin.

9. How many O_2 molecules can be carried by a single molecule of Hb?

Sol. Four

10. Which respiratory disease is characterised by damaged alveolar walls?

Sol. Emphysema

Short Answer Type Questions :

11. Give three differences between breathing and respiration.

Sol.

Breathing	Respiration
1. It is simply inhalation of fresh air and exhalation of foul air.	It is the oxidation of food (glucose) to form CO_2, water and release energy.
2. It is a physical process.	It is a biochemical process.
3. No energy is released during this mechanism.	Energy is released during this process.

12. Explain how gases are exchanged in sponges.

Sol. In sponges, gaseous exchange takes place, at cell surface as in these animals, cells are in direct contact with environment. Oxygen dissolved in water passes into the cells by diffusion while CO_2 liberated by the cells diffuses out into the surrounding water through the general body surface.

13. Describe the nature of respiratory organ of earthworms.

Sol. Earthworm : Cuticle is the outermost covering of their body and the underlying epidermis which are utilised for the exchange of gases by simple diffusion. They are thin, moist and vascular, so that diffusion of gases takes place easily.

14. Explain the structure which prevents the entry of food into the larynx.

Sol. Epiglottis prevents the entry of food into the larynx during swallowing. It is a leaf-shaped cartilaginous structure made up of elastic cartilage which covers the glottis during swallowing, so that the food cannot enter the larynx.

15. Describe wind pipe, a part of human respiratory tract.

Sol. It is a straight tube called trachea extending upto the mid-thoracic cavity. This tube finally divides into right and left primary bronchi at the level of 5^{th} thoracic vertebra. It is lined by cartilaginous rings that prevents collapsing.

16. Explain the membranes which surround the lungs.

Sol. The membranes that surround the lungs are called pleura or pleural membranes. These are two in number and a narrow space present between the two is known as pleural cavity which is filled with pleural fluid secreted by pleural membranes. Outer pleural membrane is in close contact with the thoracic cavity and inner one is in close contact with lung surface.

17. Write the sequence of structures included in human respiratory system.

Sol. External nostrils → Nasal chamber → Pharynx → Glottis → Larynx → Trachea → Primary bronchi → Secondary bronchi → Tertiary bronchi → Bronchioles → Alveolar ducts → Atria → Alveolar sac → Alveoli

18. Differentiate between inspiration and expiration.

Sol.

Inspiration	Expiration
1. Inspiration is a process by which fresh air enters the lungs.	Expiration is a process by which foul air (containing CO_2) is expelled out of the lungs.
2. It is simply the inflow of fresh air.	It is simply the outflow of air.

19. What is the role of external intercostal muscles in inspiration?

Sol. During inspiration, external intercostal muscles contract and lift up the ribs and sternum causing an increase in the volume of thoracic cavity in dorso-ventral axis that leads to similar

Increase in the volume of pulmonary cavity
↓ Causes
Decrease in pressure within the pulmonary cavity
↓ Causes
Atmospheric air enters into the lungs as air moves from a region of high pressure to that of low pressure *e.g.,* lungs

20. Write down the route adopted by air during inspiration and expiration.

Sol. Movement of air during inspiration :

External nostrils → Nasal cavities → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli

Movement of air during expiration :

Alveoli → Bronchioles → Bronchi → Trachea → Larynx → Pharynx → Nasal cavities → External nostrils

21. How is the movement of air into and out of the lungs carried out? Give an example.

Sol. The movement of air into and out of the lungs is carried out by creating a pressure gradient between lungs and the atmosphere. Pressure gradient is the pressure difference. For example, pressure of O_2 in atmospheric air is higher than the alveoli because of which O_2 diffuses in from atmospheric air.

22. What is meant by vital capacity? List any two categories of people which possess higher vital capacity.

Sol. Vital capacity is the maximum volume of air a person can breathe in after a forceful expiration or the maximum volume of air a person can breathe out after a forceful inspiration.

Athletes and young ones possess higher vital capacity than non athletes and old aged people respectively.

23. Define the terms inspiratory capacity and expiratory capacity.

Sol. Inspiratory capacity : It is defined as the total volume of air a person can inspire after a normal expiration. It includes tidal volume and inspiratory reserve volume.

Expiratory capacity : It is defined as the total volume of air a person can expire after a normal inspiration. It includes tidal volume and expiratory reserve volume.

24. What is partial pressure? How does it help in exchange of O_2 between alveoli and blood?

Sol. Partial pressure is the pressure contributed by a single gas in a mixture of gases. It is represented as pO_2 (for oxygen) and pCO_2 (for carbon dioxide). Gases move from their region of high partial pressure to a region of lower partial pressure.

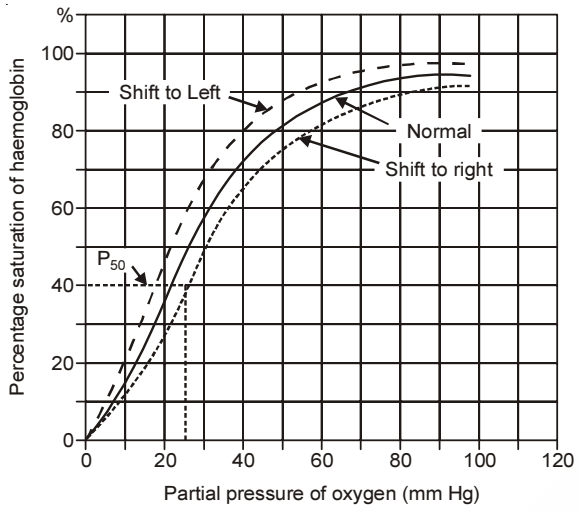
It helps in exchange of O_2 between alveoli and blood. As the pO_2 in alveoli is higher, *i.e.*, 104 mm Hg than that present in the blood, *i.e.*, 40 mm Hg. So, O_2 diffuses into the blood from higher pO_2 to lower pO_2.

25. Why does O_2 move from blood to tissues whereas CO_2 moves from tissues to blood?

Sol. This is due to partial pressure gradient. The pO_2 is higher in systemic arteries carrying oxygenated blood, *i.e.*, 95 mm Hg than that in tissues, *i.e.*, 40 mm Hg. So, O_2 moves from systemic arteries to body tissues, whereas CO_2 moves from tissues to blood because the pCO_2 is higher in tissues, *i.e.*, 45 mm Hg than that in blood capillaries, *i.e.*, 40 mm Hg.

26. Give graphic presentation of O_2-dissociation curve. Which part of graph indicates association of O_2 with Hb?

Sol.



The association of O_2 with Hb is indicated when the graph shifts towards the left-hand side of the normal curve.

27. "About 20–25% CO_2 is transported as carbaminohaemoglobin". Explain.

Sol. CO_2 that enters in the RBC forms a reversible compound, *i.e.*, carbaminohaemoglobin, which binds with amino group of protein part (globin). Reaction involved is

$$Hb + CO_2 \rightleftharpoons \underset{\text{Carbaminohaemoglobin}}{HbCO_2}$$

It is transported to the alveoli, from where it is exhaled out as CO_2 because dissociation of CO_2 and Hb occurs in the alveoli.

28. For which gas O_2 and CO_2, does Hb have higher affinity? Write the equation showing the binding of Hb with O_2 and CO_2.

Sol. Hb has high affinity for O_2 than CO_2.

Binding of O_2 with Hb :

$$\underset{\text{Haemoglobin}}{Hb} + \underset{\text{Oxygen}}{O_2} \rightleftharpoons \underset{\text{Oxyhaemoglobin}}{HbO_2}$$

Binding of CO_2 with Hb :

$$\underset{\text{Haemoglobin}}{Hb} + \underset{\text{Carbon dioxide}}{CO_2} \rightleftharpoons \underset{\text{Carbamino-haemoglobin}}{HbCO_2}$$

29. Explain the role of chemosensitive area in the regulation of respiration.

Sol. This area is highly sensitive to CO_2 and H^+ ions. Whenever there is an increase in these substances, this area gets activated which inturn activates rhythm centre to increase the rate of respiration. Due to which these substances are eliminated out of the body.

30. Explain causes and symptoms of respiratory disease Emphysema.

Sol. Causes : It is caused due to excessive cigarette smoking. Other causes involve inhalation of smoke particles, harmful gases over a period of time.

Symptoms : Alveolar walls are damaged due to which the surface area for exchange of gases is reduced. Alveolar sacs remain filled with air even after expiration.

Long Answer Type Questions :

31. Which features decide the type of respiratory organ in an animal? Explain with examples.

Sol. Two main features of animals which decide the type of respiratory organs are

1. **Habitat :** It is the place where an animal lives. The nature of respiratory organ depends on the habitat of an animal. For example, fishes live in water, so they have gills to respire. Reptiles live on land and they respire through lungs.
2. **Level of organisation :** According to the level of organisation of animals, breathing mechanism varies. For example, Poriferans have cellular level of organisation. In them, no well-developed tissues, organs are present that's why they can exchange O_2 with CO_2 by simple diffusion over their entire body surface. Simple diffusion means the movement of molecules from their higher concentration region to their lower concentration region.

32. Explain the nature of respiratory organs in
    (i) Coelenterates
    (ii) Earthworm

Sol. (i) In coelenterates, gaseous exchange takes place through cell surface. In these animals, cells are in direct contact with environment. Respiratory organs are absent in these lower animals as they do not have blood to transport gases. Oxygen dissolved in water passes into the cells through diffusion while CO_2 liberated by the organisms diffuses out of the cells into the surrounding water through the cell surface.

(ii) In earthworms, cuticle is the outermost covering of their body which is utilised for the simple diffusion of gases.

33. Explain the larynx and trachea in detail.

Sol. Larynx : It is also known as sound/voice box because it helps in the production of sound. It is made up of cartilages and present at the upper part of trachea. Its upper part has a opening, *i.e.*, glottis. During swallowing this, glottis can be covered by epiglottis which is a leaf-shaped cartilaginous structure made up of elastic cartilage. It prevents the entry of food into the larynx during swallowing.

Trachea : It is also known as wind pipe. It is a straight tube extending upto the mid-thoracic cavity, commonly called chest cavity. This tube finally divides into right and left primary bronchi at the level of 5^{th} thoracic vertebra. It is lined by cartilaginous rings that prevent it from collapsing.

34. From where do alveoli arise? Explain the features of alveoli which make them the respiratory surface.

Sol. Alveoli arise from bronchioles. Bronchioles give rise to a number of alveoli. There are about 300 million alveoli in two lungs.

The features of alveoli which make them the respiratory surface are

(i) **Thin membrane :** They have very thin membrane and lined by thin squamous epithelium.
(ii) They have irregular walls which increase the surface area for diffusion of gases.
(iii) **Richly supplied with blood :** These are balloon-like structures having a network of blood capillaries. Due to very close contact of blood capillaries with alveoli, the exchange of gases takes place easily.

Because of these features, they act as respiratory surface where exchange of gases O_2 and CO_2 occurs.

35. Explain the internal structure of lungs. What is the function of outer membranes of lungs that surround them?

Sol. Internally lungs are made up of

(i) **Branching network of bronchi :** It includes the branching of bronchi which are primary, secondary and tertiary bronchi.
(ii) **Bronchioles :** These are the terminal endings of tertiary bronchi which give rise to a large number of balloon-like structures known as alveoli.
(iii) **Alveoli :** These are balloon-like structures having very thin, irregular membrane and highly vascular, well-supplied with blood capillaries. This is the site where exchange of gases takes place.

Function of membranes : Membranes that surround the lungs are pleural membranes.

(i) These provide protection to the lungs.
(ii) Release a fluid known as pleural fluid in the pleural cavity which lubricates the pleural membranes, so that they may slide over each other without friction during breathing.

36. First step of respiration is breathing. Write down the further steps involved in respiration.

Sol. Further steps involved in respiration are

1. **Diffusion of gases between alveoli and blood :** Diffusion of gases O_2 and CO_2 takes place across the alveolar membrane to the blood capillaries surrounding it. The membrane is very thin and richly supplied with blood capillaries.
2. **Transport of gases :** Blood is the medium for transport of gases O_2 and CO_2, which transports O_2 to the body cells from alveoli and CO_2 from the body cells to alveoli.
3. **Diffusion of gases between blood and tissues :** O_2 is diffused from blood to tissues and CO_2 is diffused from tissues to blood.
4. **Utilisation of O_2 :** O_2 is used by the body cells for the release of energy. Breakdown of glucose occurs in presence of O_2 which produces CO_2, water and energy.

37. How diaphragm and abdominal muscles cause inhalation of air?

Sol. Diaphragm : The contraction of muscle fibres of diaphragm causes it to become flat, so the volume of thoracic cavity increases in antero-posterior axis in rabbit and lengthwise in man.

Abdominal muscles : These muscles relax and allow compression of abdominal organs by the diaphragm. Due to which the volume of thoracic cavity increases.

As a result,

Volume of thoracic cavity increases which
↓ Leads to
Similar increase in the volume of pulmonary cavity
↓ Causes
Decrease in the pressure of pulmonary cavity, lesser than the atmospheric air
↓ Causes
Inhalation of air from atmospheric air to the lungs

38. Explain the role of external intercostal muscles in creating low pressure within the pulmonary cavity.

Sol. External intercostal muscles : These muscles are present between the ribs. The contraction of these muscles lifts up the ribs and sternum causing an increase in the volume of the thoracic cavity in the dorso-ventral axis, *i.e.*, backward-forward direction.

Increase in the volume of thoracic cavity —Leads to→ Similar increase in the volume of pulmonary cavity
↓ Causes
Decrease in pressure within the pulmonary cavity which is less than the atmospheric pressure.
↓ Causes
Atmospheric air to enter into the lungs (inhalation)

39. Explain the terms :

(i) FRC

(ii) TLC

Sol. (i) **Functional Residual Capacity (FRC) :** It is defined as the volume of air that will remain in the lungs after a normal expiration. This includes expiratory reserve volume and residual volume. It is about 2500 ml to 3000 ml.

(ii) **Total Lung Capacity :** It is defined as the total volume of air present in the lungs and the respiratory passage after a maximum inspiration. It includes residual volume, expiratory reserve volume, tidal volume and inspiratory reserve volume. In other words, it is the combination of vital capacity and residual volume. It is about 5000 ml to 6000 ml.

40. How are gases exchanged between alveoli and blood?

Sol. Partial pressures of O_2 and CO_2 in mm Hg.

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)
O_2	159	104	40
CO_2	0.3	40	45

The pO_2 in the atmospheric air is higher, *i.e.*, 159 mm Hg than that in the alveoli, *i.e.*, 104 mm Hg and pO_2 in alveoli is higher than that in the deoxygenated blood in the capillaries of the pulmonary arteries (40 mm Hg). As we know, gases diffuse from their higher partial pressure to their lower partial pressure. Therefore, O_2 moves from atmospheric air to alveoli and then finally to blood. In relation to CO_2, movement is in opposite direction. The pCO_2 is higher in deoxygenated blood (45 mm Hg) than that in alveoli (40 mm Hg) and it is further low in atmospheric air, *i.e.*, 0.3 mm Hg. Therefore, CO_2 moves from deoxygenated blood to alveoli and finally to atmospheric air.

41. Define diffusion. Explain with the help of diagram, the structure of alveolar-capillary membrane.

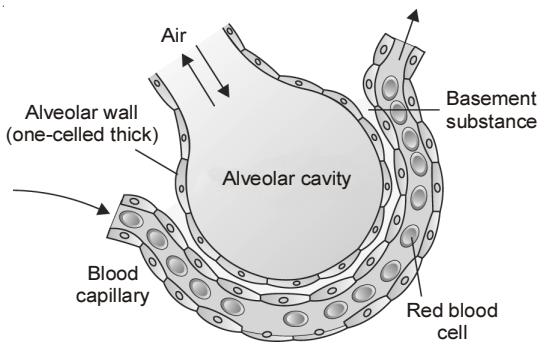
Sol. Diffusion is defined as the movement of molecules (ions, gases) from their higher concentration/pressure to their lower concentration/pressure region.

Alveolar-capillary membrane is made up of three layers which are as follows :

(i) Thin squamous epithelium of alveoli that lines it.

(ii) Endothelial lining of alveolar capillaries that surround it.

(iii) **Basement substance :** In between thin squamous epithelium of alveoli and endothelium of alveolar capillaries, basement substance is present.



42. Why is O_2 associated with Hb in lungs whereas dissociated in tissues?

Sol. Conditions which are favourable for the association of O_2 and Hb in lungs are

(i) High pO_2

(ii) Low pCO_2

(iii) Less H^+ ion concentration and high pH

(iv) Low temperature

All these factors shift the O_2-dissociation curve towards left. This shift indicates the association of O_2 and Hb which occurs in alveoli (lungs).

Conditions which are favourable for the dissociation of O_2 from oxyhaemoglobin are

(i) Low pO_2

(ii) High pCO_2

(iii) High H^+ ion concentration and decrease in pH

(iv) High temperature

All these factors shift the O_2-dissociation curve towards right. This shift indicates the dissociation of O_2 from oxyhaemoglobin which occurs in the body tissues.

43. Explain the role of medulla and pons in the regulation of respiration.

Sol. In medulla and pons, respiratory centres are present which regulate the rate of respiration. These centres are respiratory rhythm centre present in medulla region of brain and pneumotaxic centre is present in pons region of brain.

(i) **Respiratory rhythm centre :** It can either cause expiration or inspiration according to the neurons which are activated and thereby, regulate the respiratory rhythm according to the need of the body.

(ii) **Pneumotaxic centre :** It moderates the function of respiratory rhythm centre. The neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

44. How is rate of respiration regulated by chemosensitive area and receptors present in carotid artery?

Sol. Chemosensitive area : This area gets activated when the level of CO_2 and H^+ ions increases which inturn activates the respiratory rhythm centre for altering the rate of respiration. This area is located adjacent to the respiratory rhythm centre.

Receptors associated with carotid artery also affect the rate of respiration. The receptors present in carotid artery are chemoreceptors sensitive to chemicals or substances such as CO_2 and H^+ ions. These receptors work according to the level of CO_2 and H^+ ions in blood. Increased concentration of CO_2 in blood lowers its pH because of which the rate of respiration increases to eliminate the excess of CO_2 from the body.

45. Give the meaning of 'Emphysema'. What are the causes and symptoms of this respiratory disease?

Sol. The word 'Emphysema' means 'full of air' or 'inflation'.

Causes : The major cause is excessive cigarette smoking. Others may include inhalation of smoke or toxic substances over a period of time.

Symptoms : The walls of alveoli are damaged due to excessive smoking, loss of elasticity of walls of bronchioles and alveoli. Due to this, the surface area for exchange of gases is reduced. Alveolar sacs remain filled with air even after expiration. The lungs remain inflated as exhalation becomes difficult.

SECTION - B

Model Test Paper

Very Short Answer Type Questions :

1. Name two lower invertebrates using gills as respiratory organ.

Sol. Prawn and *Unio*

2. Which part of human respiratory system gives rise to a number of alveoli?

Sol. Bronchioles

3. Why doesn't the trachea collapse during inspiration?

Sol. Trachea is supported by cartilaginous rings which prevent its collapse during inspiration.

4. What is the source of pleural fluid present in pleural cavity?

Sol. Pleural membranes, *i.e.*, visceral pleura.

5. In which axis, does the volume of thoracic cavity increase due to contraction of diaphragm?

Sol. In anterio-posterior axis in rabbit and lengthwise in man.

6. Give the values of pO_2 and pCO_2 in tissues.

Sol. pO_2 and pCO_2 in tissues are 40 mm Hg and 45 mm Hg respectively.

7. What happens to the rate of respiration when pH of blood decreases?

Sol. Rate of respiration increases

8. A person is working in a stone-breaking factory from long time. From which type of respiratory disease can he suffer?

Sol. Occupational respiratory disease, *i.e.*, silicosis.

Short Answer Type Questions :

9. Why is there a difference in the respiratory organs of tadpole larva of frog and an adult frog?

Sol. Frog is an amphibian, it has dual mode of life. During larval form, it lives in water so it uses gills for respiration, whereas the adult form lives on land, thereby using moist skin and lungs as respiratory organs. Habitat plays a key role in deciding the nature of respiratory organ.

10. What happens to the larynx during swallowing of food?

Sol. The upper part of larynx, *i.e.*, glottis is covered by a leaf-shaped cartilaginous structure known as epiglottis. So, during swallowing, epiglottis covers the opening of larynx and prevents entry of food in it.

11. Which conditions affect the binding of CO_2 with Hb in tissues and alveoli?

Sol. Conditions are

Tissues	Alveoli
High pCO_2	Low pCO_2
Low pO_2	High pO_2
These are responsible for binding more CO_2 with Hb.	These are responsible for dissociation of CO_2 from carbaminohaemoglobin.
$Hb + CO_2 \longrightarrow HbCO_2$	$HbCO_2 \longrightarrow Hb + CO_2$

12. What will happen to pleural membranes if pleural fluid is absent between them?

Sol. The membranes will be damaged due to absence of pleural fluid between them as it lubricates the pleural membranes, so that they may slide over each other without friction during breathing.

13. What do you mean by cellular respiration?

Sol. It is the chemical reaction from which an organism derives energy and it takes place within the cells. It is accompanied by the utilisation of O_2 for the chemical reaction, *i.e.*, oxidation of glucose.

Reaction is

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2 \longrightarrow \underset{\substack{\text{Eliminated out}\\ \text{of the body}}}{6CO_2} + 6H_2O + \text{Energy}$$

14. How does the pressure of intrapulmonary cavity decrease due to relaxation of abdominal muscles?

Sol. After relaxation, these muscles cause the compression of abdominal organs by the diaphragm due to which volume of thoracic cavity increases which leads to similar increase in the volume of pulmonary cavity. Due to which pressure of intrapulmonary cavity decreases.

15. To which portion of haemoglobin, do O_2 and CO_2 bind?

Sol. Hb has two portions :

(i) **Haem :** Iron part

(ii) **Globin :** Protein part

O_2 binds with the iron atom of haem portion of haemoglobin.

Each polypeptide chain carries a haem group and each haem group carries an iron atom to which O_2 binds.

CO_2 binds with the amino group of globin which is a protein portion of Hb.

Short Answer Type Questions :

16. What is the internal structure of lungs composed of?

Sol. The internal structure of lungs is made up of

(i) **Branching network of bronchi :** It includes primary, secondary and tertiary bronchi.

(ii) **Bronchioles :** These are the terminal branching of tertiary bronchi, gives rise to a number of alveoli.

(iii) **Alveoli :** These are balloon-like structures for the exchange of gases arise from bronchioles.

17. Define P_{50}. Which factors favour the dissociation of O_2 from Hb in tissues?

Sol. The partial pressure of O_2 at which the haemoglobin saturation is 50% is called P_{50}.

The factors that favour the dissociation of O_2 from Hb in tissues are :

(i) Low pO_2

(ii) High pCO_2

(iii) High H^+ ion concentration, decrease in pH and increase in acidity.

(iv) High temperature

18. We know that about 7% of CO_2 is transported as dissolved form, about 70% is transported as bicarbonate ions. How is the remaining percentage of CO_2 transported?

Sol. Remaining percentage, *i.e.*, about 20–25% of CO_2 is transported as carbaminohaemoglobin. CO_2 that enters the RBC, forms a reversible compound, *i.e.*, carbaminohaemoglobin ($HbCO_2$) by binding with globin part of haemoglobin.

$$Hb + CO_2 \rightleftharpoons \underset{\text{Carbaminohaemoglobin}}{HbCO_2}$$

Finally, it reaches the alveoli from where it is eliminated out.

19. Explain how pCO_2 and concentration of H^+ ions affect the rate of respiration?

Sol. Increase in pCO_2 and H^+ ions activate the chemosensitive area which inturn can signal the respiratory rhythm centre to increase the rate of respiration, so that these substances are eliminated out.

Receptors present in aortic arch and carotid artery also recognise the changes in pCO_2 and H^+ ions concentration and send signals to respiratory rhythm centre to alter the rate of respiration.

20. Explain a chronic disorder which occurs due to excessive cigarette smoking.

Sol. Emphysema is the chronic disorder occurs due to excessive cigarette smoking.

In this disease, the walls of alveoli are damaged due to which surface area for exchange of gases is reduced. Alveolar sacs remain filled with air even after expiration. The lungs remain inflated as exhalation becomes difficult. This disease can be prevented by avoiding cigarette smoking.

21. Define tidal volume and total lung capacity.

Sol. (i) **Tidal volume (TV) :** It is defined as the volume of air inspired or expired during normal respiration. It is approximately 500 ml.

(ii) **Total lung capacity (TLC) :** It is defined as the total volume of air present in the lungs and the respiratory passage after a maximum inspiration. It is about 5000–6000 ml.

Long Answer Type Questions :

22. How is O_2 transported by blood in our body?

Sol. Blood carries oxygen from the lungs to the heart and from there it reaches to various body cells.

Oxygen is transported in the following manner :

(i) **In dissolved form :** About 3% O_2 is carried in dissolved state through plasma.

(ii) **As oxyhaemoglobin :** About 97% O_2 is transported by RBCs in the blood. Haemoglobin (Hb) is made up of two parts – haem and globin. Haem is iron part and globin is protein part.

$$\underset{\text{Haemoglobin}}{Hb} \longrightarrow \underset{\text{(Iron part)}}{Haem} + \underset{\text{(Protein part)}}{Globin}$$

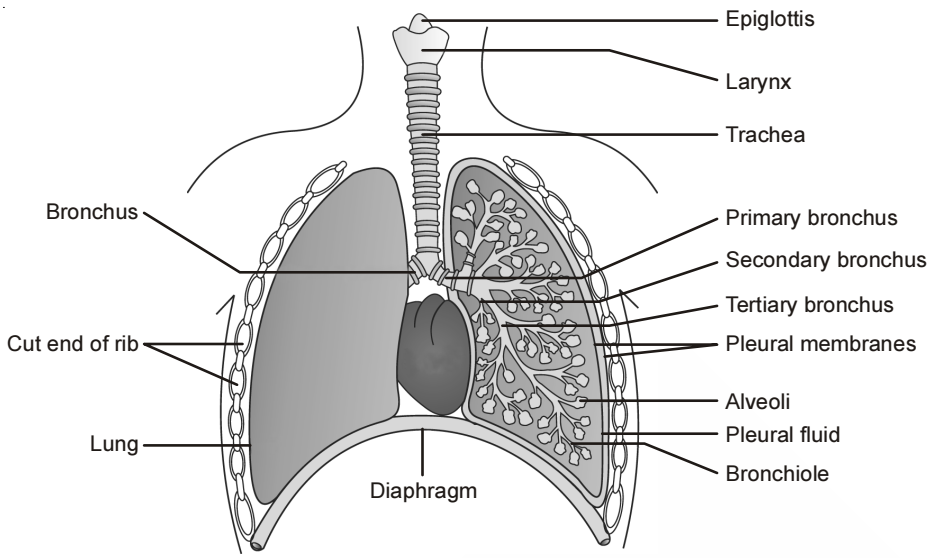
It is red coloured iron containing pigment present in RBCs. It binds with O_2 in a reversible manner to form oxyhaemoglobin (OxyHb) and transports it.

$$\underset{\text{Haemoglobin}}{Hb} + \underset{\text{Oxygen}}{O_2} \underset{\text{Tissues}}{\overset{\text{In lungs}}{\rightleftharpoons}} \underset{\substack{\text{Oxyhaemoglobin}\\\text{(OxyHb)}}}{HbO_2}$$

O_2 binds with Hb at the lungs surface and gets dissociated at the tissues. Under the high partial pressure, *i.e.*, 95 mm Hg oxygen easily binds with Hb in the pulmonary blood capillaries. When this oxygenated blood reaches to different tissues, the pO_2 decreases and the bonds holding oxygen to Hb become unstable. As a result, oxygen is released from blood capillaries to tissues where it is utilised for oxidation of glucose.

23. Draw a well-labelled diagram of respiratory organ of humans and explain the respiratory surface, *i.e.*, alveoli.

Sol.



Bronchioles give rise to a number of alveoli. There are about 300 million alveoli in two lungs. The membrane of alveoli is very thin, irregular and richly supplied with blood vessels. Due to very close contact of blood vessels with alveoli, the exchange of gases takes place easily.

Bronchioles $\xrightarrow{\text{Lead to}}$ Alveolar ducts $\xrightarrow{\text{Lead to}}$ Atria $\xrightarrow{\text{Lead to}}$ Alveolar sacs

❑ ❑ ❑

Solutions (Set-2)

Objective Type Questions

(Respiratory Organs)

1. The process of oxidation of glucose during which CO_2, H_2O and energy are produced is known as

   (1) Breathing (2) Inspiration

   (3) Cellular respiration (4) Expiration

Sol. Answer (3)

Breathing = Inspiration (Inhalation of air) + Expiration (Exhalation of air)

Respiration is the process of oxidation of food in which CO_2, H_2O and energy is/are produced.

2. The respiratory organs vary in different animals due to their

   (1) Nutrition (2) Habitat and level of organisation

   (3) Excretion (4) Reproduction

Sol. Answer (2)

Based on different habitats (place where an animal live) and level of organisation, the breathing mechanism varies, hence the respiratory organs also vary in different animals.

3. Which of the following are the respiratory organs of insects?

   (1) Tracheal tubes (2) Gills

   (3) Cuticle (4) Lungs

Sol. Answer (1)

Insect(*e.g.* Cockroach) $\rightarrow$ Tracheal system

Gills $\rightarrow$ Aquatic animal (fish, tadpole of amphibian)

Cuticle $\rightarrow$ Earthworm

Lungs $\rightarrow$ Amphibians, birds, reptiles, mammals

4. Which animal among the following respires via buccal cavity, moist skin and lungs?

   (1) *Hydra* (2) Frog

   (3) *Sycon* (4) Earthworm

Sol. Answer (2)

Frogs can respire by their moist skin, buccal cavity and lungs as they live on land and its larval form i.e. tadpole which lives in water respires through gills.

***Hydra, Sycon* :** Lack well-developed respiratory system and exchange of gases occurs by simple diffusion.

Earthworm : Moist cuticle.

5. Respiratory organs in aquatic arthropods like cray fish, prawn and molluscs like *Unio* are

(1) Body wall (2) Lungs (3) Trachea (4) Gills

Sol. Answer (4)

Aquatic arthropods (Crustacean) respire through gills.

6. Pulmonary respiration is most well-developed in

(1) Mammals (2) Invertebrates

(3) Amphibians (4) Hemichordates

Sol. Answer (1)

The respiratory system is well developed in the vertebrates as they have more complex body.

In between amphibians and mammals, mammals have more well-developed respiratory organ *i.e.,* lungs.

7. Which structure in human respiratory system is **not** involved in conditioning of air?

(1) Initial bronchioles (2) Nasal chamber

(3) Alveoli (4) Trachea

Sol. Answer (3)

Alveoli are surfaces for exchange of gases.

(1) Mucus from goblet cells and glands make the surface sticky for trapping dust particles present in inspired air.

(2) Moisture from the epithelium also makes the air humid.

(3) It brings the temperature of the incoming air, upto the body temperature.

8. A thin-elastic cartilaginous flap which prevents the entry of food into the larynx is known as

(1) Glottis (2) Wind pipe

(3) Epiglottis (4) Bronchiole

Sol. Answer (3)

Epiglottis covers the glottis during swallowing of food.

9. At which level of thoracic vertebra, does trachea divide?

(1) 2nd thoracic vertebra (2) 5th thoracic vertebra

(3) 3rd thoracic vertebra (4) 4th thoracic vertebra

Sol. Answer (2)

The trachea divides into right and left primary bronchi at the level of 5th thoracic vertebra.

10. Trachea divides into right and left

(1) Secondary bronchi (2) Tertiary bronchi

(3) Bronchioles (4) Primary bronchi

Sol. Answer (4)

The trachea divides into right and left primary bronchi at the level of 5th thoracic vertebra.

11. Which membrane covers the lungs and provides protection?

(1) Pericardium (2) Renal capsule

(3) Pleura (4) Epineurium

Sol. Answer (3)

Pericardium : covers heart

Renal capsule : covers kidney

Pleura : lungs

Epineurium : covers nerve trunk

12. Where are lungs situated in the human body?

(1) Abdominal cavity (2) Thoracic cavity

(3) Coelomic cavity (4) Pleural cavity

Sol. Answer (2)

A pair of lungs are present in humans, lie in an air-tight chamber known as **thoracic cavity** or **chest cavity.**

(Mechanism of Breathing)

13. Which of the following volume is **not** included in vital capacity?

(1) ERV (2) TV

(3) IRV (4) RV

Sol. Answer (4)

Because VC = ERV + TV + IRV

or VC = ERV + IC

Here, **RV** = Residual volume **IRV** = Inspiratory reserve volume

VC = Vital capacity **IC** = Inspiratory capacity

ERV = Expiratory reserve volume **TV** = Tidal volume

14. Select the last step involved in respiration.

(1) Diffusion of gases

(2) Breathing

(3) Utilisation of O_2 by body cells and resultant release of CO_2

(4) Transport of gases

Sol. Answer (3)

Steps involve in respiration :

(1) Breathing (2) Diffusion of gases between alveoli and blood

(3) Transport of gases (4) Diffusion of gases between blood and tissue

(5) Utilisation of O_2 by body cells

15. Inspiration occurs when intra-pulmonary pressure is

(1) Higher than atmospheric pressure (2) Lower than atmospheric pressure

(3) Equal to atmospheric pressure (4) Zero compared to atmospheric pressure

Sol. Answer (2)

Air can flow into lungs, when the pressure within the lungs is less than that in the atmospheric pressure.

16. Which muscles help us to increase the strength of expiration?

(1) Cardiac muscles (2) Abdominal muscles

(3) Internal intercostal muscles (4) Both (2) & (3)

Sol. Answer (4)

Cardiac muscles *i.e.,* muscles of heart, do not have any role in expiration.

Abdominal and internal intercostal muscles undergo contraction and increase the strength of expiration.

17. The breathing rate of a normal healthy man is

(1) 8–18 times/min (2) 6–12 times/min (3) 16–24 times/min (4) 12–16 times/min

Sol. Answer (4)

Breathing rate of a normal healthy man is about 12–16 times/min.

18. What is the value of tidal volume in a normal healthy man?

(1) Approximately 6000–8000 ml/min (2) 1000–1100 ml/min

(3) 2500–3000 ml/min (4) Approximately 8000–12000 ml/min

Sol. Answer (1)

Minute volume = TV × Breathing rate

500 ml × 12–16 /min $\Rightarrow$ ~ 6000 – 8000 ml

Minute volume is also known as pulmonary ventilation.

19. The volume of air remaining in the lungs even after a forceful expiration is

(1) Tidal volume

(2) Residual volume

(3) Inspiratory reserve volume

(4) Expiratory reserve volume

Sol. Answer (2)

(1) Tidal volume (500 ml) : It is the volume of air a person can inspired or expired during normal breathing.

(3) Inspiratory reserve volume (2500 – 3000 ml) : The additional or extra volume of air, a person can expire by forceful expiration.

(4) Expiratory reserve volume (1000 – 1100 ml) : The additional or extra volume of air, a person can expire by forceful expiration.

(Exchange of gases, transport of gases)

20. What is the main site of human respiratory system where exchange of gases occurs?

(1) Alveoli (2) Bronchiole

(3) Primary and secondary bronchi (4) Trachea

Sol. Answer (1)

The membrane of alveoli is very thin, irregular (simple squamous) and richly supplied with blood vessels. Due to very close contact of blood vessels with alveoli, the exchange of gases takes place easily.

21. Partial pressure for oxygen and CO_2 is represented as

(1) pO and pCO (2) p_O and p_{CO_2}

(3) pO_2 and pCO_2 (4) O_2p and CO_2p

Sol. Answer (3)

Gaseous exchange depends on partial pressure of gases.

22. What will be the pCO_2 and pO_2 in atmospheric air as compared to alveoli respectively?

(1) Low and high (2) High and low

(3) High and high (4) Low and low

Sol. Answer (1)

pCO_2 and pO_2 in atmospheric air will be low and high respectively in comparison to alveolar air.

In atmospheric air : pO_2 = 159 mmHg

pCO_2 = 0.3 mmHg

In alveoli : pO_2 = 104 mmHg

pCO_2 = 40 mmHg

23. What is the value of pCO_2 in atmospheric air, alveoli and tissues respectively?

(1) 0.3 mm Hg, 40 mm Hg and 95 mm Hg

(2) 95 mm Hg, 40 mm Hg and 159 mm Hg

(3) 45 mm Hg, 0.3 mm Hg and 40 mm Hg

(4) 0.3 mm Hg, 40 mm Hg and 45 mm Hg

Sol. Answer (4)

Respiratory gas	Atmospheric air	Alveoli	Blood (oxygenated)	Blood (Deoxygenated)	Tissue
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

24. O_2 binds with haemoglobin of RBC to form

(1) Carboxyhaemoglobin (2) Oxyhaemoglobin

(3) Carbaminohaemoglobin (4) Aminohaemoglobin

Sol. Answer (2)

$$\underset{\text{(Haemoglobin)}}{Hb} + \underset{\text{(Oxygen)}}{O_2} \underset{\text{In tissue}}{\overset{\text{In lungs}}{\rightleftharpoons}} \underset{\text{(Oxyhaemoglobin)}}{HbO_2}$$

$$Hb + \underset{\text{(Carbon dioxide)}}{CO_2} \rightleftharpoons \underset{\text{(Carbamino-haemoglobin)}}{HbCO_2}$$

$$Hb + \underset{\text{(Carbon monoxide)}}{CO} \rightleftharpoons \underset{\text{(Carboxy haemoglobin)}}{HbCO}$$

25. With which part of Hb, do O_2 molecules bind?

(1) Haem (2) Globin

(3) Both haem and globin (4) Amino group of globin

Sol. Answer (1)

Haem group contains Fe^{2+}, which has affinity for oxygen.

26. $Hb + O_2 \underset{(2)}{\overset{(1)}{\rightleftharpoons}} HbO_2$

Select (1) and (2) from the given options

(1) (1) is tissues and (2) is lungs (2) (1) is lungs and (2) is blood

(3) (1) is blood and (2) is lungs (4) (1) is lungs and (2) is tissues

Sol. Answer (4)

$$Hb + O_2 \underset{\text{Tissue}}{\overset{\text{Lungs}}{\rightleftharpoons}} HbO_2$$

27. A graph plotted between pO_2 and percentage saturation of Hb with O_2 is known as

(1) O_2 hemoglobin association curve (2) CO_2-O_2 dissociation curve

(3) O_2 hemoglobin dissociation curve (4) CO_2-O_2 association curve

Sol. Answer (3)

A graphical representation of relationship between pO_2 and percentage saturation of haemoglobin with O_2 is known as oxygen dissociation curve or oxygen haemoglobin dissociation curve. It is sigmoid or S-shaped curve.

28. Which factors affect the dissociation of O_2 from Hb?

(1) pH, pO_2, pCO_2 and temperature (2) Only pH

(3) Salinity, temperature and pCO_2 (4) HCO_3^- ion concentration, pH and salinity

Sol. Answer (1)

Factors responsible for the dissociation of oxygen from Hb which occurs in the body tissues :

(a) Low partial pressure of oxygen (c) High partial pressure of carbon dioxide

(c) Low pH (d) High temperature

29. High percentage of CO_2 is transported in dissolved form as compared to O_2. This is because

(1) O_2 has high solubility in plasma

(2) CO_2 has high solubility in plasma

(3) pCO_2 is high in blood than pO_2

(4) CO_2 has low solubility in plasma

Sol. Answer (2)

Ratio of CO_2 and O_2 solubility in plasma is 25 : 1 (CO_2 : O_2).

30. Which factor in tissues favours the formation of HCO_3^- and H^+ ions in the blood?

(1) Low pCO_2

(2) High pO_2

(3) High pCO_2

(4) High alkalinity

Sol. Answer (3)

$$CO_2 + H_2O \underset{Zn^{2+}}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} \underset{\text{(Carbonic acid)}}{H_2CO_3} \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} \underset{\text{(Hydrogen ion)}}{H^+} + \underset{\text{(Bicarbonate ion)}}{HCO_3^-}$$

31. How much CO_2 is delivered to the alveoli by every 100 ml of deoxygenated blood?

(1) 6 ml (2) 4 ml

(3) 5 ml (4) 3 ml

Sol. Answer (2)

About 4 ml CO_2 is delivered to the alveoli by every 100 ml of deoxygenated blood.

32. Which enzyme is present in RBCs and plasma to catalyse the given reaction?

$$CO_2 + H_2O \rightleftharpoons \underset{\text{Carbonic acid}}{H_2CO_3} \rightleftharpoons H^+ + HCO_3^-$$

(1) Carbonic anhydrase (2) Catalase

(3) Aldolase (4) Carboxylase

Sol. Answer (1)

Carbonic anhydrase is present in very high concentration in RBC and in small quantity in plasma.

(Regulation of Respiration, Disorders of Respiratory System)

33. A specialised centre known as respiratory rhythm centre regulates respiration. It is located in

(1) Pons (2) Medulla oblongata

(3) Cerebrum (4) Cerebellum

Sol. Answer (2)

Respiratory rhythm centre present in medulla regulates the normal rhythm of respiration.

34. Which substances when present in high level can activate the chemosensitive area present adjacent to rhythm centre?

(1) CO_2 and O_2 (2) HCO_3^- ions and O_2

(3) pCO_2 and H^+ ions (4) H^+ and HCO_3^- ions

Sol. Answer (3)

Chemosensitive area i.e. sensitive for chemicals and is located adjacent to the rhythm centre which contains chemoreceptors which are sensitive for CO_2 and H^+ ions. The respiratory centre is stimulated by concentration or partial pressure of CO_2 and H^+ ions in blood and body fluids.

35. Which of the following is an occupational respiratory disease?

(1) Diphtheria (2) Pneumonia

(3) Tuberculosis (4) Asbestosis

Sol. Answer (4)

Occupational respiratory disorders occur due to the continuous exposure to harmful substances, gases, fumes and dust in the environment, where a person works.

Asbestosis caused due to continuonus exposure to asbestos dust at place of work.

Pneumonia : caused due to the bacteria like *Streptococcus pneumoniae* and *Haemophilus influenzae.*

Tuberculosis : caused due to *Mycobacterium tuberculosis.*

Diphtheria : caused due to *Corynebacterium diphtheriae*.

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