Breathing and Exchange of Gases

OBJECTIVE TYPE QUESTIONS

Multiple Choice Questions (MCQs)

1. The cells of respiratory tract that secrete mucus are
(a) goblet cells (b) Kupffer cells
(c) oxyntic cells (d) all of these.

2. Wall of alveoli is composed of
(a) simple squamous epithelium
(b) simple cuboidal epithelium
(c) pseudostratified epithelium
(d) simple columnar epithelium.

3. During inspiration, muscles of diaphragm
(a) contracts
(b) expands
(c) becomes convex shaped
(d) rises.

4. Which one of the following statements is correct?
(a) Chest expands because air enters into the lungs.
(b) Air enters into the lungs because chest expands.
(c) The muscles of the diaphragm contracts because air enters into the lungs.
(d) All of these

5. Residual volume is
(a) lesser than tidal volume
(b) greater than inspiratory volume
(c) greater than vital capacity
(d) greater than tidal volume.

6. Tidal volume is
(a) 5000 mL (b) 1000 mL
(c) 500 mL (d) 800 mL.

7. Oxygen and carbon dioxide is transported in the blood with the help of
(a) RBCs and blood plasma
(b) RBCs and WBCs
(c) WBCs only
(d) platelets only.

8. The enzyme that increases the reaction rate between CO_2 and H_2O in red blood cells is
(a) carbonic anhydrase (b) adenylate cyclase
(c) carbonic synthetase
(d) alkaline phosphatase.

9. During strenuous exercise, which of the following change occurs?
(a) Glucose is converted into glycogen.
(b) Glucose is converted into pyruvic acid.
(c) Starch is converted into glucose.
(d) Pyruvic acid is converted into lactic acid.

10. What percentage of CO_2 is carried in a dissolved state through plasma?
(a) 3 (b) 7
(c) 20 (d) 97

11. Breathing is controlled by
(a) hypothalamus (b) lungs
(c) medulla oblongata (d) trachea.

12. Which respiratory disorder causes inflammation of lungs due to proliferation of fibrous connective tissue?
(a) Pulmonary tuberculosis
(b) Emphysema
(c) Silicosis
(d) Bronchitis

13. Respiratory centre of brain is sensitive to
(a) more O_2 concentration in blood
(b) more CO_2 concentration in blood
(c) accumulation of blood in brain
(d) all of these.

14. Breathing rate above normal (high) is called
(a) bradypnoea (b) orthopnoea
(c) eupnoea (d) tachypnoea.

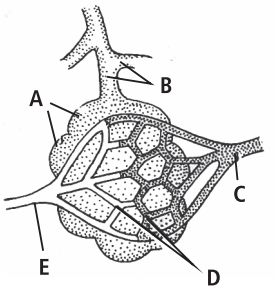
15. The oxidative breakdown of respiratory substrates with the help of oxygen is termed as
(a) fermentation
(b) aerobic respiration
(c) anaerobic respiration
(d) respiratory quotient.

16. The serous membrane in contact with the lung is the
(a) parietal pleura
(b) pulmonary mesentery
(c) pulmonary peritoneum
(d) visceral pleura.

17. For the occurrence of expiration, intrapulmonary pressure should be
(a) equal to atmospheric pressure
(b) more than atmospheric pressure
(c) less than atmospheric pressure
(d) either (a) or (c).

18. Hering-Breuer reflex is related to
(a) effect of pH on respiratory centre
(b) effect of CO_2 on respiratory centre
(c) effect of nerves on respiratory centre
(d) effect of temperature on respiratory centre.

19. Refer to the given figure and select option which correctly identifies the labels.



(a) A-Alveolar ducts, B-Alveoli, C-Venule, D-Arteriole, E-Blood capillaries
(b) A-Alveoli, B-Alveolar ducts, C-Arteriole, D-Blood capillaries, E-Venule
(c) A-Arteriole, B-Alveoli, C-Alveolar ducts, D-Venule, E-Blood capillaries
(d) A-Alveoli, B-Arteriole, C-Venule, D-Blood capillaries, E-Alveolar ducts

20. After forceful inspiration, the amount of air that can be breathed out by maximum forced expiration is equal to
(a) Inspiratory Reserve Volume (IRV) + Expiratory Reserve Volume (ERV) + Tidal Volume (TV) + Residual Volume (RV)
(b) IRV + RV + ERV
(c) IRV + TV + ERV
(d) TV + RV + ERV.

21. Extra amount of air inspired forcibly after normal inspiration is approximately
(a) 4.5 L (b) 3.5 L
(c) 1.5 L (d) 2.7 L.

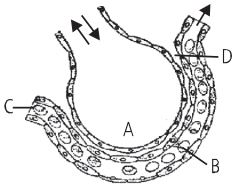
22. Read the given statements and select the correct option.
Statement 1 : CO_2 passes from the blood to the alveoli.
Statement 2 : pCO_2 is higher in deoxygenated blood than in alveoli.
(a) Both statements 1 and 2 are correct and 2 is the correct explanation of 1.
(b) Both statements 1 and 2 are correct but 2 is not the correct explanation of 1.
(c) Statement 1 is correct but statement 2 is incorrect.
(d) Both statements 1 and 2 are incorrect.

23. Identify the correct statement with reference to transport of respiratory gases by blood.
(a) Haemoglobin is necessary for transport of carbon dioxide and carbonic anhydrase for transport of oxygen.
(b) Haemoglobin is necessary for transport of oxygen and carbonic anhydrase for transport of carbon dioxide.
(c) Only oxygen is transported by blood.
(d) Only carbon dioxide is transported by blood.

24. Neither the trachea nor the bronchi contain
(a) hyaline cartilage
(b) ciliated columnar epithelium
(c) goblet cells
(d) simple squamous epithelium.

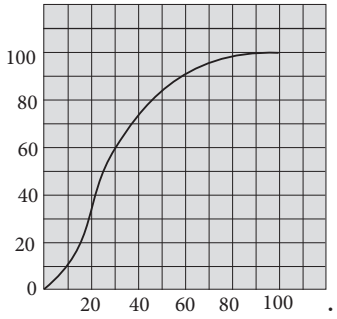
25. Select the correct statement.
(a) H^+ ions released from carbonic acid combine with haemoglobin to form haemoglobin acid.
(b) Oxyhaemoglobin of erythrocytes is alkaline.
(c) More than 70% of carbon dioxide is transferred from tissue to lungs as carbamino compounds.
(d) In healthy person, haemoglobin content is more than 25 g / 100 mL .

26. The figure given below shows a small part of human lung where exchange of gases takes place. Select the option which represents labelled part (A, B, C or D) correctly identified along with its function.



(a) C : arterial capillary - passes oxygen to tissues
(b) A : alveolar cavity - main site of exchange of respiratory gases
(c) D : capillary wall - exchange of O_2 and CO_2 takes place here
(d) B : red blood cells - transport of CO_2 mainly

27. In oxygen dissociation curve x-axis and y-axis represents



(a) x-axis—partial pressure of oxygen
y-axis—percentage saturation of Hb with oxygen
(b) x-axis—percentage saturation of haemoglobin
y-axis—partial pressure of oxygen
(c) x-axis—partial pressure of CO_2
y-axis—percentage saturation of oxyhaemoglobin with oxygen
(d) x-axis—partial pressure of CO_2
y-axis—partial pressure of oxygen.

28. Which of the following events does not occur during internal respiration?
(a) Blood becomes deoxygenated and is carried to the heart.
(b) Carbon dioxide diffuses from the body cells to capillary blood *via* tissue fluid.
(c) Oxygen diffuses from the capillary blood to the body cells through tissue fluid.
(d) Oxygen binds with haemoglobin under low partial pressure of oxygen to form oxyhaemoglobin.

29. Which of the following factors will increase the Bohr's effect?
(i) Increase in partial pressure of oxygen
(ii) Decrease in partial pressure of carbon dioxide
(iii) Increase in H^+ ion concentration
(iv) Increase in body temperature
(v) High pH
(a) (i), (ii), (iii) and (iv) (b) (i), (ii), (iv) and (v)
(c) (iii), (iv) and (v) (d) (iii) and (iv)

30. When about 1200 mL air is in the lungs after forceful expiration, it is called
(a) residual volume
(b) inspiratory reserve volume
(c) vital capacity
(d) tidal volume.

31. Among mammals, the efficiency of ventilation of lungs as compared to reptiles and birds is better developed by the presence of
(a) ribs and costal muscles
(b) only ribs
(c) only costal muscles
(d) diaphragm.

32. Pneumotaxic centre is present in
(a) pons (b) medulla
(c) cerebrum (d) lungs.

33. Factor helps in formation of oxyhaemoglobin in alveoli is
(a) high pCO_2
(b) high pO_2
(c) higher H^+ concentration
(d) all of these.

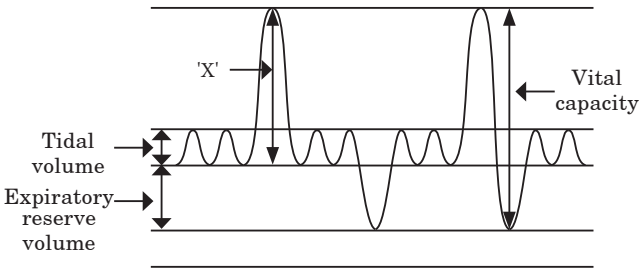
34. Cartilaginous rings in trachea are incomplete at which surface?
(a) Dorsal (b) Ventral
(c) Lateral (d) Ventrolateral

35. Which of the following is correct for bronchioles?
(a) They are filled with pleural fluid.
(b) They are closed at the tip.
(c) They are branches of tertiary bronchi.
(d) They penetrate the body cells.

36. Between breaths the intrapleural pressure is approximately ___ mmHg less than atmospheric pressure.
(a) 1 (b) 4
(c) 8 (d) 10

37. When the blood contains a high percentage of CO_2 and a very low percentage of O_2, the breathing stops and the person becomes unconscious. This condition is known as
(a) suffocation (b) asphyxia
(c) emphysema (d) eupnea.

38. In the graphical representation of pulmonary volumes and capacities, 'X' denotes

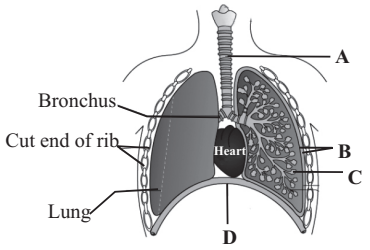


(a) Inspiratory reserve volume
(b) Total lung capacity

(c) Expiratory capacity
(d) Inspiratory capacity.

39. Oxyhaemoglobin is converted into haemoglobin during the internal respiration because
(a) an enzyme splits oxyhaemoglobin
(b) oxygen tension in tissue is less than capillary blood reaching tissue
(c) CO_2 tension is low in blood that reaches tissue
(d) oxyhaemoglobin is unstable.

40. The figure shows a diagrammatic view of human respiratory system with labels A, B, C and D. Select the option which gives correct identification and main function and / or characteristic.



(a) C - Alveoli - Thin walled vascular bag-like structures for exchange of gases.
(b) D - Lower end of lungs - Diaphragm pulls it down during inspiration.
(c) A - Trachea - Long tube supported by complete cartilaginous rings for conducting inspired air.
(d) B - Pleural membrane - Surrounds ribs on both sides to provide cushion against rubbing.

Case Based MCQs

Case I : Read the following passage and answer questions from 41 to 45 given below:

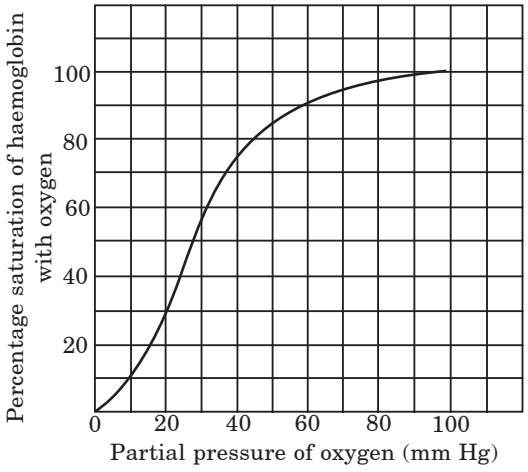


Fig : Oxygen dissociation curve

Binding of oxygen with haemoglobin is primarily related to partial pressure of O_2. Partial pressure of CO_2, hydrogen ion concentration and temperature are the other factors which can interfere with this binding. A sigmoid curve is obtained when percentage saturation of haemoglobin with O_2 is plotted against the pO_2. This curve is called the oxygen dissociation curve and is highly useful in studying the effect of factors like pCO_2, H^+ concentration, etc., on binding of O_2 with haemoglobin. In the alveoli, where there is high pO_2, low pCO_2, lesser H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist, the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin.

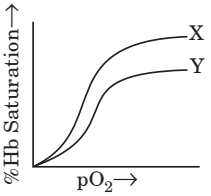
41. Select the correct statement regarding oxygen dissociation curve.
(a) The partial pressure at which the haemoglobin saturation is 50% is called P_{50}.
(b) Decrease in O_2 concentration resulting in increased dissociation of oxyhaemoglobin is known as Bohr effect.
(c) At 40 mmHg of $_pO_2$, the saturation is 95%.
(d) The lower part of the curve represents the binding or acceptance of oxygen by haemoglobin.

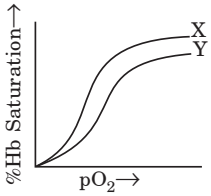
42. Fetal haemoglobin has a sigmoid dissociation curve which is shifted to left relative to adult Hb because
(a) Fetal Hb has higher P_{50}
(b) Fetal Hb has more affinity for carbon dioxide
(c) Fetal Hb has less affinity for oxygen than the adult Hb
(d) Fetal Hb has lower P_{50} (18-20 mm Hg) than adult Hb.

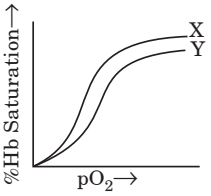
43. Select the correct set of factors that will shift the oxygen-dissociation curve to left.

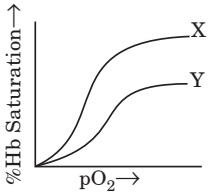
	pCO_2	pO_2	Temp	pH
(a)	↑	↓	↑	↓
(b)	↓	↑	↓	↑
(c)	↑	↑	↓	↓
(d)	↓	↑	↑	↓

44. Which of the following oxygen haemoglobin - dissociation curve corresponds to blood during resting, *i.e.*, normal condition (curve X) and blood during exercise (curve Y)?

(a) 

(b) 

(c) 

(d) 

45. Read the following statements and select the correct option.

Statement A : The oxygen dissociation curve is 'S' shaped or sigmoid shaped.

Statement B : The first oxygen molecule binding to haemoglobin increases the affinity of the Hb to subsequent oxygen molecules.

(a) Both statements A and B are true.
(b) Statement A is false but B is true.
(c) Statement A is true but B is false.
(d) Both statements A and B are false.

Case II : Read the following passage and answer questions from 46 to 50 given below:

A human lung can hold a maximum of six litres of air. The volume of air involved in the process of breathing can be evaluated with the help of an equipment, used to examine the total volume of air inhaled and exhaled by the lungs. It is also used in testing the pulmonary functions. The air in the lungs is measured in terms of lung volume of air breathed by an individual and are of four types : Tidal volume, Inspiratory reserve volume, Expiratory reserve volume and Residual volume.

46. What instrument is used for measuring the volume of air inspired and expired by the lungs?

(a) Drinker's respirator (b) Spirometer
(c) Barometer (d) Calorimeter

47. Which lung capacity involves about 3500-4700 mL of air?

(a) Inspiratory capacity
(b) Functional residual capacity
(c) Vital capacity
(d) Total lung capacity

48. Which of the following statements is correct regarding inspiratory reserve volume?

(a) Volume of air inspired or expired during normal breathing
(b) Extra amount of air inspired forcibly after normal inspiration.
(c) Volume of air that remains in the lungs even after a forcible expiration.
(d) Extra amount of air exhaled forcibly after normal expiration.

49. What volume of air can be expired forcibly after normal expiration?

(a) 500 mL (b) 2600 mL
(c) 1100 mL (d) 1300 mL

50. Which respiratory volume has highest value?

(a) Tidal volume (b) ERV
(c) RV (d) IRV

Assertion & Reasoning Based MCQs

For question numbers 51-60, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

51. Assertion : The dorsal respiratory group (DRG) present in the dorsal portion of medulla oblongata mainly causes expiration.

Reason : The ventral respiratory group (VRG) on the ventrolateral part of medulla oblongata cause either inspiration or expiration.

52. Assertion : Respiratory gas goes from higher partial pressure region to the region of lower partial pressure.

Reason : Respiratory gas exchange occurs through osmosis.

53. Assertion : During inspiration, the volume of thorax increases.

Reason : This happens due to the relaxation of diaphragm and inspiratory muscles.

54. Assertion : Vital capacity is higher in athletes than non - athletes.

Reason : Vital capacity is about 3.5 - 4.5 litres in a normal adult person.

55. Assertion : During expiration, volume of thorax decreases and air is expelled out.

Reason : This happens due to the contraction of expiratory muscles.

56. Assertion : Aerobic animals are not truely aerobic.

Reason : They produce lactic acid anaerobically.

57. Assertion : Oxygenation of blood promotes the release of carbon dioxide from the blood in the lungs.

Reason : Carbon dioxide is carried as bicarbonates in erythrocytes of blood.

58. Assertion : Emphysema is a chronic disorder in which alveolar walls are damaged.

Reason : Emphysema is closely related to cigarette smoking.

59. Assertion : Extra oxygen consumption in human body is known as oxygen debt.

Reason : The extra oxygen is required by the body to oxidise the accumulated lactic acid produced during strenuous exercise.

60. Assertion : Bronchitis is characterised by regular cough with greenish yellow sputum.

Reason : Bronchitis is due to overgrowth of goblet cells lining of bronchi.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (VSA)

1. How cutaneous respiration is different from pulmonary respiration?

2. Name the term used for the volume of air that remains in the lungs, even after the most forceful expiration.

3. What is diffusing capacity of respiratory membrane?

4. What percentage of CO_2 is transported in the form of carbaminohaemoglobin?

5. Where is the respiratory rhythm centre located?

6. Name the respiratory disorders that are referred to as chronic obstructive pulmonary disease.

7. Name the phenomenon that encourages CO_2 exchange in both the tissues and lungs.

8. A fluid filled double membranous layer surrounds the lungs. Name it and mention its important function.

9. Name the aperture by which pharynx opens into the larynx.

10. Cigarette smoking causes emphysema. Give reason.

Short Answer Type Questions (SA-I)

11. Define breathing. How is it different from respiration?

12. Name parts of human respiratory system that constitute conducting portion of respiratory system. What are its functions?

13. Describe the process of inspiration under normal conditions.

14. Describe the role of intercostal muscles in respiration.

15. What is carbonic anhydrase? List the major forms in which the carbon dioxide is transported in the blood.

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

17. What are occupational respiratory disorders? Give two examples of such disorders.

18. Complete the missing terms.

(a) Inspiratory Capacity (IC) = _____ +IRV

(b) _____ = TV + ERV
(c) Functional Residual Capacity (FRC) = ERV + _____ .

19. How right lung can be differentiated from left lung?

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

Short Answer Type Questions (SA-II)

21. Distinguish between
(a) Pharynx and larynx
(b) Tracheoles and bronchioles

22. Describe the following terms:
(a) Inspiratory capacity
(b) Residual volume and
(c) Functional residual capacity.

23. How does the exchange of gases occur between the alveoli and blood? Diagrammatically show the section of alveolus and pulmonary blood capillary.

24. How is O_2 transported in the blood and released in the tissues?

25. What do you understand by Bohr effect? Mention the factors that influence Bohr effect.

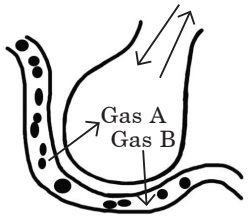
26. Why is haemoglobin called conjugated protein? What happens to the molecule at high and low partial pressure of oxygen?

27. How is vital capacity different from total lung capacity?

28. What do you mean by respiratory centre? Briefly explain the types of respiratory centre.

29. Explain the mechanism of expiration with the help of diagram.

30. The following figure shows an alveolus with a capillary in close contact.
(a) Identify the gases A and B.
(b) Name the process by which these gases move between blood and the alveolus.



31. Give the differences between emphysema and occupational respiratory disorder.

Long Answer Type Questions (LA)

32. Explain the mechanism of breathing in humans with suitable diagrams.

33. (a) Describe the exchange of oxygen and carbon dioxide between blood and tissue cells.
(b) Diagrammatically explain the external and internal respiration.

34. Explain the role of neural system in regulation of respiration.

35. Explain the various factors affecting the oxygen dissociation curve.

36. (a) Distinguish between breathing and respiration.
(b) Describe the olfactory region of the nasal chamber with its function.

ANSWERS

OBJECTIVE TYPE QUESTIONS

1. (a) : Goblet cells of respiratory tract secrete mucus, it keeps the walls of the tube moist and traps dust particles which enter with air.

2. (a) : Wall of alveoli is composed of simple squamous epithelium which helps in gaseous exchange.

3. (a) : During inspiration, muscles of diaphragm and external intercostal muscles contract which increases the volume of thoracic cavity.

4. (b) : Volume of thoracic/chest cavity increases by contraction of diaphragm and external intercostal muscles, it decreases the air pressure in the lungs. The greater pressure outside the body causes air to flow rapidly into the lungs.

5. (d) : Tidal volume is volume of air inspired or expired during a normal respiration. It is approx. 500 mL and residual volume is volume of air remaining in the lungs even after a forcible expiration. This averages 1100 mL to 1200 mL.

6. (c) : It is the volume of air inspired or expired during a normal respiration. It is approximately 500 mL.

7. (a) : Oxygen and carbon dioxide are carried physically dissolved in the blood plasma and chemically combined to the haemoglobin in the erythrocytes.

8. (a) : The zinc containing enzyme, the carbonic anhydrase increases the rate of reaction between CO_2 and H_2O in red blood cells.

$$\underset{\text{(Carbon dioxide)}}{CO_2} + \underset{\text{Water}}{H_2O} \xrightleftharpoons{\text{Carbonic anhydrase}} \underset{\text{Carbonic acid}}{H_2CO_3}$$

$$\underset{\text{Carbonic acid}}{H_2CO_3} \xrightleftharpoons{\text{Carbonic anhydrase}} \underset{\text{(Hydrogen ion)}}{H^+} + \underset{\text{(Bicarbonate ion)}}{HCO_3^-}$$

H_2CO_3 formed is unstable and quickly dissociates into hydrogen ions and bicarbonate ions.

9. (d) : During strenuous exercise pyruvic acid is converted into lactic acid because the person do not immediately get as much oxygen as it is necessary for their work.

10. (b) : Due to high solubility of CO_2 about 7% of it gets dissolved in the plasma and is carried to the lungs.

11. (c) : The respiratory centres are present in medulla oblongata and pons varolii.

12. (c) : Silicosis occurs due to chronic exposure to silica dust in mining industry, leading to proliferation of fibrous connective tissue of upper part of lungs, causing inflammation.

13. (b) : Chemosensitive area and receptors associated with aortic arch and carotid artery is highly sensitive to CO_2 and H^+ ions. Increase in these substances activates this centre which in turn send signal to respiratory centre to make necessary adjustments.

14. (d) : Breathing rate above normal is termed as hyperpnea or tachypnoea.

15. (b) : Aerobic respiration is an enzymatically controlled release of energy in a stepwise catabolic process of complete oxidation of organic food into carbon dioxide and water with oxygen acting as terminal oxidant: the common aerobic respiration consists of three steps-glycolysis, Krebs cycle and terminal oxidation.

16. (d) : Lung is enclosed in two membranes called pleurae, the outer membrane is parietal pleura and inner membrane is visceral pleura, which is in close contact with the lung surface.

17. (b) : Pressure gradient between lungs and atmosphere is required for the movement of air into and out of lungs. Expiration occurs when intrapulmonary pressure is more than the atmospheric pressure , as the air moves from region of higher to region of lower pressure and thus air is expelled out.

18. (c) : Action potential in the afferent nerve fibre from the stretch receptors in lungs travel to the brain and inhibit the activity of the medullary inspiratory neurons. This is called Hering-Breuer reflex.

19. (b)

20. (c) : Vital capacity is the maximum volume of air a person can breathe out after forced inspiration. It includes tidal volume, expiratory and inspiratory reserve volume.

21. (d) : Amount of air inspired forcibly after normal inspiration is inspiratory reserve volume. It is about 2500-300 mL.

22. (a) : pCO_2 in deoxygenated blood is 45 mm Hg, while in alveolar air is 40 mm Hg.

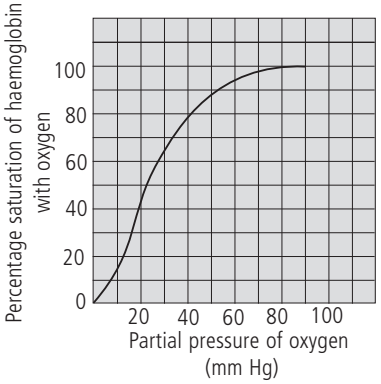
23. (b) : For transport of respiratory gases by blood, haemoglobin is necessary for oxygen transport and carbonic anhydrase for transport of carbon dioxide. About 97% of oxygen is transported as oxyhaemoglobin. Transport of CO_2 as bicarbonate ions is thousand times faster in RBCs due to presence of carbonic anhydrase.

24. (d) : Trachea and bronchi are lined by pseudostratified ciliated columnar epithelium.

25. (a) : Oxyhaemoglobin is stronger acid than deoxyhaemoglobin. About 23% of CO_2 is transferred as carbaminohaemoglobin. In a normal person, haemoglobin content is about 15 gm/100 mL of blood.

26. (b)

27. (a) :



28. (d) : The exchange of oxygen and carbon dioxide between tissue blood capillaries and tissue cell is called internal respiration. Oxyhaemoglobin is formed in the pulmonary blood capillaries at high partial pressure of oxygen and not in the tissues.

29. (d) : Bohr's effect is increased by increase in partial pressure of carbon dioxide, increase in hydrogen ion concentration and decrease in pH and increase in body temperature.

30. (a) : Residual volume is the amount of air that remains in the lungs after forcible expiration. It is about 1200 mL. It enables the lungs to continue exchange of gases even after maximum exhalation or holding the breath.

31. (d) : Diaphragm is dome-shaped muscular and membranous structure which separates thoracic and abdominal cavity in mammals. It is the principle muscle of respiration.

32. (a) : Pneumotaxic centre is located in the upper part of pons varolii.

33. (b) : High pO_2, low pCO_2, less H^+ concentration and low temperature are favourable conditions for formation of oxyhaemoglobin in alveoli.

34. (a) : C-shaped cartilaginous rings present in trachea are incomplete on dorsal surface.

35. (c) : Bronchioles are not filled with any fluid, they open into alveolar duct and do not penetrate the body cells.

36. (b) : The intrapleural pressure is always below atmospheric pressure. Because of the connection between the two pleurae which is similar to two wet pieces of paper adhered to each other, the negative intrapleural pressure helps to expand the lungs during ventilation. If intrapleural pressure is equal to atmospheric pressure, the lungs would collapse. Between breaths the intrapleural pressure is approximately 4 mm Hg less than the atmospheric pressure.

37. (b) : Asphyxia is a condition caused by increase in CO_2 concentration and shortage of O_2 in tissues that paralyses the respiratory centre. As a result, breathing stops and death may occur.

38. (d) : Vital capacity = Tidal volume + Expiratory reserve volume + Inspiratory reserve volume.

Inspiratory capacity = Inspiratory Reserve volume + Tidal volume

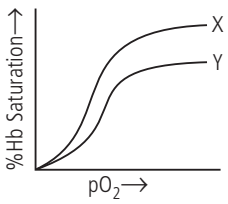
39. (d) : Under high partial pressure, oxygen easily binds with haemoglobin in the pulmonary (lung) blood capillaries. When deoxygenated blood reaches different tissues, the partial pressure of oxygen declines and bonds holding oxygen to haemoglobin becomes unstable.

40. (a) : Diaphragm is a muscular structure that forms lower end of thoracic cavity. Trachea is supported by C-shaped incomplete rings of cartilage. Lungs are enclosed in pleural cavity filled with pleural fluid, which reduces friction while breathing.

41. (a) : Bohr effect is the phenomenon of increase in CO_2 concentration resulting in increased dissociation of oxyhaemoglobin. At 40 mmHg of pO_2, the saturation is 75%. The lower part of curve represents dissociation of oxygen from haemoglobin.

42 (d) **43. (b)**

44. (a) : During exercise, more respiration occurs and hence more oxygen, oxygen dissociation curve shifts to right. At given oxygen partial pressure, haemoglobin is less saturated with oxygen. Haemoglobin has less affinity for oxygen. The standard curve is shifted to the right by an increase in temperature, pCO_2 or a decrease in pH. The curve is shifted to the left by the opposite to these conditions. A rightward shift, by definition, causes a decreases in the affinity of haemoglobin for oxygen.



45. (a) : Haemoglobin molecule can bind to four oxygen molecules reversibly. The dissociation curve is the curve that results from the interaction of oxygen molecules with haemoglobin molecule. It indicates the oxygen saturation and partial pressure of oxygen in the blood. The binding of the first molecule is difficult. As the first oxygen molecule binds to haemoglobin, it increases the affinity of the haemoglobin molecules for the second molecule of oxygen to bind. Subsequently, haemoglobin attracts more oxygen and hence, the curve is sigmoid shape or S-shape.

46. (b) : A spirometer is an apparatus used for measuring the volume of air inspired and expired by the lungs. It measures ventilation, the movement of air into and out of the lungs.

47. (c) **48. (b)**

49. (c) : Expiratory reserve volume (ERV) is the extra amount of air that can be expired forcibly after a normal expiration. It is about 1000-1100 mL.

50. (d) : TV = 500 mL

ERV = 1000 - 1100 mL

RV = 1100 - 1200 mL

IRV = 2500 - 3000 mL

51. (d) : Dorsal respiratory group is a type of group of neurons located in dorsal portion of the medulla oblongata which mainly causes inspiration. Ventral respiratory group of neurons is located in the ventrolateral part of the medulla oblongata which can cause either inspiration or expiration depending upon the neurons stimulated.

52. (c) : Respiratory gas exchange is never done by osmosis. Whether between cells and the extracellular fluid or between the animal and the surrounding medium, gases are exchanged by the process of diffusion. A gas diffuses across a membrane from the side where its partial pressure is higher, to the side where its partial pressure is lower. Partial pressure of oxygen (PO_2) is higher in the air inside the lungs, than in the venous blood, so oxygen diffuses from the air to the venous blood in lung. Same mechanism happens between the cell and extracellular fluid.

53. (c) : During inspiration (breathing in), the volume of thorax increases because of the contraction of diaphragm and inspiratory muscles. Contraction of diaphragm and inspiratory muscles causes downward movement of diaphragm towards the abdomen while the inspiratory muscles move the lateral thoracic walls outward and upward which thus increases the volume of the thorax.

54. (b) : If a person first inspires with his utmost effort and then expires also with maximum effort the volume of air breathed out is called the vital capacity. An athlete requires

more oxygen during exercise on a regular basis. Due to this, amount of oxygen taken in and gases taken out by him is greater than others. This gradual effort of an athlete to meet his oxygen demand ultimately increases the vital capacity.

55. (a) : During expiration, the muscles of the diaphragm relax making it convex, decreasing volume of the thoracic cavity. Internal intercostal muscles and abdominal muscles (muscles of expiration) contract that further decreases the volume of thoracic cavity. Due to this, the pressure inside the thorax and lungs increases which causes air to expel out.

56. (a) : In most animals, tissue oxidation is carried out by aerobic respiration. But sometimes in aerobically respiring animals, anaerobic metabolism takes place in certain tissues like skeletal muscles which do not immediately get as much oxygen as is necessary for their work. This is why the muscles produce lactic acid anaerobically from glucose during vigorous movements.

57. (b) : Carbon-dioxide is carried in the form of bicarbonates and carbaminohaemoglobin in erythrocytes in blood. On reaching the lungs blood is oxygenated. Oxygenation of blood promotes the release of carbon-dioxide from the blood in the lungs in two ways. Firstly, since oxyhaemoglobin is stronger than deoxyhaemoglobin, therefore it donates H^+ which joins bicarbonates (HCO_3^-) to form carbonic acid (H_2CO_3). The latter is cleaved into water and carbon-dioxide by carbonic anhydrase. Thus carbon-dioxide is released from bicarbonate. Secondly, oxyhaemoglobin cannot hold as much carbon-dioxide as deoxyhaemoglobin, therefore, oxygenation of haemoglobin simultaneously releases carbon-dioxide from carbaminohaemoglobin.

58. (b) : Emphysema means air in the tissues. In pulmonary emphysema the air sacs (alveoli) of the lungs are enlarged and damaged, which reduces the surface area for the exchange of oxygen and carbon dioxide. Severe emphysema causes breathlessness, which is made worse by infections. Major causes are cigarette smoking and the inhalation of other smoke or toxic substances over a period of time.

59. (a) : During strenuous exercise, the muscle does not get sufficient oxygen to meet its energy needs immediately. So, it contracts anaerobically and accumulates lactic acid. During recovery, the oxygen consumption of the muscle far exceeds than that in the resting state. The extra oxygen consumed during recovery is called oxygen debt of the muscle.

60. (b)

SUBJECTIVE TYPE QUESTIONS

1. Cutaneous respiration is exchange of gases through skin, *e.g.*, in earthworm. Pulmonary respiration occurs through lungs as in humans.

2. Residual volume (RV) is the volume of air that remains in the lungs even after a forcible expiration. It is about 1100 to 1200 mL.

3. Diffusing capacity is the volume of gas that diffuses through membrane per minute for a pressure difference of 1 mmHg. It depends on solubility of the diffusing gases.

4. About 20-25% of CO_2 is transported by haemoglobin in the form of carbaminohaemoglobin.

5. Respiratory rhythm centre is located in the medulla region of the brain.

6. Bronchitis, emphysema and bronchial asthma.

7. Haldane effect

8. The fluid (pleural fluid) filled double membranous layer surrounding the lungs is called pleura. The pleural fluid lubricates the pleurae so that they may slide over each other without friction during breathing.

9. The pharynx opens into the larynx by the slit-like aperture called glottis.

10. Cigarette smoke contains various harmful chemicals like tar, nicotine, hydrogen cyanide and different metals. They damage alveolar walls due to which respiratory surface is decreased and it causes emphysema. Cigarette smoking is one of the major causes of emphysema. It is a chronic disorder.

11. Breathing is the exchange of oxygen from the atmosphere with CO_2 produced by cells. Breathing is a physical process, it occurs outside the cells, hence an extracellular process. No energy is released or used during breathing. However, respiration is a biochemical process as it involves oxidation of food into carbon dioxide, water and energy. It occurs inside the cells and is an intracellular process.

12. The parts starting with external nostrils upto the terminal bronchioles constitute the conducting parts of human respiratory system. It includes nose, pharynx, larynx, trachea, bronchi, bronchioles and terminal bronchioles.

The main functions of the conducting parts of the respiratory tract are:

(i) Transport atmospheric air to alveoli.

(ii) They filter the air from dust and foreign particles.

(iii) Humidify and bring air to body temperature.

13. Inspiration is the process of intake of fresh air into lungs. It is caused by contraction of diaphragm and intercostal muscles. Inspiration is initiated by contraction of diaphragm, as it becomes flat and gets lowered, thereby increasing the volume of thoracic cavity. Ribs and sternum move upward and outward due to contraction of external intercostal muscles. The increase in thoracic volume increases pulmonary volume, that decreases intra-pulmonary pressure to less than the atmospheric pressure. This forces air from outside to move into the lungs, *i.e.*, inspiration.

14. Inspiration and expiration both are affected by contraction and relaxation of muscles of diaphragm and intercostal muscles. Inspiration is caused by contraction of

external intercostal muscles, it pulls ribs and sternum upward and outward, increasing the volume of thoracic cavity and forcing the air to move into lungs.

Expiration is caused by contraction of internal intercostal muscles, as it pulls ribs downward and inward decreasing the size of thoracic cavity and thus forcing the air out of lungs.

15. Carbonic anhydrase is an enzyme present in erythrocytes that reversibly catalyses the conversion of carbon dioxide and water to carbonic acid. Nearly 20–25 percent of CO_2 is transported by haemoglobin of RBCs, as carbaminohaemoglobin. This binding is related to the partial pressure of CO_2. About 70 percent of it is carried as bicarbonate ion in plasma and about 7 percent of CO_2 is carried in a dissolved state through plasma, by haemoglobin.

16. Oxygen dissociation curve is the graphic illustration of the relationship between the partial pressure of oxygen (pO_2) and percentage saturation of the haemoglobin with oxygen (O_2).

The sigmoidal pattern of oxygen haemoglobin dissociation curve is the result of two properties that play significant role in the transport of oxygen. These two properties are:

(i) Minimal loss of oxygen from haemoglobin occurs above pO_2 of 70–80 mmHg despite significant changes in tension of oxygen beyond this. This is depicted by relatively flat portion of the curve.

(ii) Any further decline in pO_2 from 40 mmHg causes a disproportionately greater release of oxygen from the haemoglobin. It results in the steeper portion of the curve and causes the curve to be sigmoid.

17. Occupational respiratory disorders are due to the occupation of the individual. These are caused by the harmful substances, such as fumes or dusts, present in the environment where an individual works.

Two examples of such disorders are : silicosis and asbestosis which occur due to chronic exposure of silica and asbestos dust in the mining industry respectively. These are characterised by proliferation of fibrous connective tissue of upper part of lung, causing inflammation.

18. (a) Inspiratory Capacity (IC) = Tidal volume (TV) + IRV

(b) Expiratory Capacity (EC) = TV + ERV

(c) Functional Residual Capacity (FRC) = ERV + Residual volume (RV).

19. Differences between right lung and left lung are:

	Right lung	Left lung
(i)	It consists of three lobes and two fissures.	It consists of two lobes and one fissures.
(ii)	Cardiac notch is absent.	Cardiac notch is present along with the inner border of lung.
(iii)	It is broader, larger and heavier.	It is narrower and lighter than the right lung.

20. An increase in carbon dioxide in the blood causes oxygen to be displaced from haemoglobin. Rise in pCO_2 shifts oxygen haemoglobin dissociation curve to the right as it decreases the affinity of haemoglobin for oxygen and increases release of oxygen to the tissues.

21. (a) Differences between pharynx and larynx are as follows :

	Pharynx (Throat)	Larynx (Voice Box)
(i)	It is lined by stratified squamous epithelium.	It is lined mainly by ciliated columnar epithelium.
(ii)	It lacks cartilage.	It is made up of a hyoid bone and some cartilage.
(iii)	Oral cavity and nasal chamber open into it.	Pharynx opens into it through glottis.
(iv)	It is a passage for both food and air.	It is a sound producing organ.

(b) Differences between tracheoles and bronchioles are as follows:

	Tracheoles	Bronchioles
(i)	These are the branches of trachea.	They are the branches of tertiary bronchi.
(ii)	They are present within the tracheole cell, and are found in insects, centipedes, millipedes and ticks.	No such cells are found. They are found in mammals.
(iii)	They are closed at the tip.	They open into alveolar duct.
(iv)	They are filled with a tissue fluid.	They do not have any tissue fluid.
(v)	These penetrate the body cells.	They do not penetrate body cells.

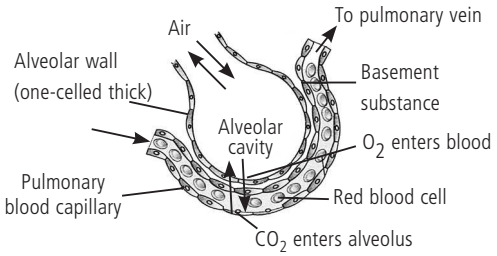
22. (a) Inspiratory capacity (IC) is the total volume of air that can be inhaled after a normal expiration. It includes tidal volume and inspiratory reserve volume (IC = TV + IRV). It is about 2500 – 3000 mL.

(b) Residual volume (RV) is the volume of air that always remains in the lungs after forcible expiration. It enables the lungs to continue the exchange of gases even after maximum exhalation or on holding the breath. It is nearly 1500 mL.

(c) Functional residual capacity (FRC) is the volume of air that will remain in the lungs after a normal expiration. It is the sum total of residual volume and expiratory reserve volume (FRC = RV + ERV). It is about 2500 to 3000 mL.

23. The exchange of gases, *i.e.*, oxygen and carbon dioxide between lung alveoli and pulmonary capillaries is known as external respiration. The respiratory membrane is a thin wall of alveoli that is richly supplied with network of blood capillaries. This membrane has a limit of gaseous exchange between alveoli and pulmonary blood, called diffusing capacity. Diffusing capacity is the volume of gas which diffuses through the membrane per minute for a pressure difference of 1 mmHg. The partial pressure of oxygen pO_2 in the alveoli is higher (104 mmHg) than that in deoxygenated blood in the capillaries of the pulmonary arteries (95 mmHg). As the gases diffuse from a region of higher to a lower concentration, the movement of oxygen is from the alveoli to the blood. The partial pressure of carbon dioxide (pCO_2) is higher in deoxygenated blood (45 mmHg) than in alveoli (40 mmHg), therefore carbon dioxide passes from the blood to the alveoli.

A diagram of a section of an alveolus with a pulmonary capillary is given below :



24. Blood carries O_2 from lungs to the heart and from the heart to the various parts of the body. About 3% of O_2 in the blood is dissolved in plasma which carries O_2 to the body cells and 97% of O_2 is carried in combination with haemoglobin of the erythrocytes. Haemoglobin (Hb) consists of a protein portion called globin and a pigment portion called heme. The heme portion contains four atoms of iron, each capable of combining with a molecule of oxygen. Four molecules of oxygen bind one molecule of haemoglobin. Oxygen and haemoglobin combine in an easily reversible reaction to form oxyhaemoglobin.

$$\underset{\text{Haemoglobin}}{Hb} + O_2 \underset{\text{In tissues}}{\overset{\text{In lungs}}{\rightleftharpoons}} \underset{\text{Oxyhaemoglobin}}{HbO_2}$$

Under high partial pressure, oxygen easily binds with haemoglobin in the pulmonary blood capillaries. When this oxygenated blood reaches the different tissues, the partial pressure of O_2 declines and the bonds holding oxygen to haemoglobin become unstable and O_2 is released from the blood capillaries.

25. Shifting of the oxygen haemoglobin dissociation curve to the right by increasing carbon dioxide concentration in blood is known as Bohr effect. The presence of carbon dioxide decreases the affinity of haemoglobin for oxygen and increases release of oxygen to the tissues. The pH of the blood falls as its CO_2 content increases so that when the pCO_2 rises the curve shifts to the right and the p50 rises.

The following factors influence the Bohr effect:

(i) Decrease in partial pressure of oxygen
(ii) Increase in partial pressure of carbon dioxide
(iii) Decrease in pH
(iv) Increase in H^+ concentration
(v) Increased body temperature
(vi) Excess of 2, 3 - DPG in RBCs

26. Haemoglobin is called a conjugated protein as it contains a protein globulin and non-protein heme. Haemoglobin has four polypeptide chains and four heme groups attached to it. It has 4 atoms of iron in ferrous form (Fe^{2+}). So, haemoglobin can react with 4 molecules of oxygen forming oxyhaemoglobin.

At high partial pressure of oxygen, haemoglobin combines with oxygen to form oxyhaemoglobin and at low partial pressure of oxygen, the oxyhaemoglobin dissociates into oxygen and haemoglobin.

27. Differences between vital capacity and total lung capacity are given below:

	Vital capacity	Total lung capacity
(i)	It is the maximum volume of air a person can breathe in after a forced expiration or breathe out after a forced inspiration.	It is the total volume of air present in the lungs and respiratory passage after maximum inspiration.
(ii)	It is sum of tidal volume, inspiratory reserve volume and expiratory reserve volume.	It is sum of vital capacity and residual volume.
(iii)	It varies from 3400 - 4800 mL.	It varies from 5000 - 6000 mL.

28. Respiratory centre is composed of groups of neurons located in the medulla oblongata and pons varolli and regulates respiration.

It is of two types : medullary and pons respiratory centres.

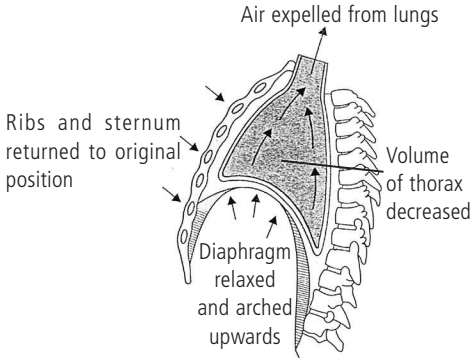
(i) Medullary respiratory centres are further divided into dorsal and ventral respiratory group. Dorsal respiratory group causes inspiration and ventral respiratory group can either inspiration or expiration.

(ii) Pons respiratory centre is divided into pneumotaxic and apneustic centre. Pneumotaxic centre primarily limits the inspiration.

29. Expiration is the exhalation of foul air out of the lungs. During expiration, the muscles of diaphragm relax, making it a dome-shaped and decreasing the volume of thoracic cavity. The internal intercostal muscles contract, pulling the ribs downward and inward and decreasing the size of thoracic

cavity. Contraction of the abdominal muscles compresses the abdominal viscera against the diaphragm, thus resulting in the decrease of the volume of the thoracic cavity. Due to decrease in volume, the intrapulmonary pressure increases. Thus, the air from the cavities of alveoli goes out through the nasal cavities *via* the alveolar ducts, respiratory bronchioles, bronchioles, bronchi, trachea, larynx, glottis, pharynx, internal nares and external nares.

The mechanism of breathing showing expiration can be explained with the help of diagram given below :



30. (a) Gas A is carbon dioxide and Gas B is oxygen.

(b) The process by which gases move between blood and alveolus is diffusion. Gases always diffuse from region of higher to a lower concentration.

31. Differences between emphysema and occupational respiratory disorder are as follows:

	Emphysema	Occupational respiratory disorder
(i)	It is a chronic disorder in which alveolar walls are damaged and respiratory surface is reduced.	It is caused by proliferation of fibrous connective tissue of upper part of lung.
(ii)	One of the major causes of this is cigarette smoking.	It is due to exposure to harmful substances, gas fumes, dust, etc.

32. Breathing refers to inflow (inspiration) and outflow (expiration) of air between atmosphere and alveoli of lungs. There are mainly two processes by which lungs are expanded or contracted.

(i) Inspiration : It is the process by which fresh atmospheric air enters into the alveoli of the lungs. It is an active process and is brought about by activity of inspiratory muscles. The main muscles of inspiration in normal quiet breathing are the external intercostal muscles and muscles of diaphragm.

Diaphragm becomes flat and gets lowered by the contraction of its muscle fibres thereby increasing the volume of the thoracic cavity in length.

External intercostal muscles occur between the ribs. These muscles contract and pull the ribs and sternum upward and outward thus increasing the volume of the thoracic cavity.

Abdominal muscles relax and allow compression of abdominal organs by the diaphragm. The abdominal muscles play a passive role in inspiration. Thus, overall volume of the thoracic cavity increases and as a result there is a decrease of the air pressure in the lungs. The greater pressure outside the body now causes air to flow rapidly into external nares (nostrils) and through nasal cavities into internal nares. Thereafter, the sequence of air flow is like this:-

External nares ⟶ Nasal cavities ⟶ Internal nares ⟶ Pharynx ⟶ Glottis ⟶ Larynx ⟶ trachea ⟶ Bronchi ⟶ bronchioles ⟶ alveolar ducts alveoli.

From the alveoli oxygen passes into the blood of the capillaries and carbon dioxide diffuses out from the blood to the lumen of the alveoli.

(ii) Expiration : It is the process by which foul air is expelled out of the lungs. Expiration is normally a passive process and involves the relaxation of diaphragm.

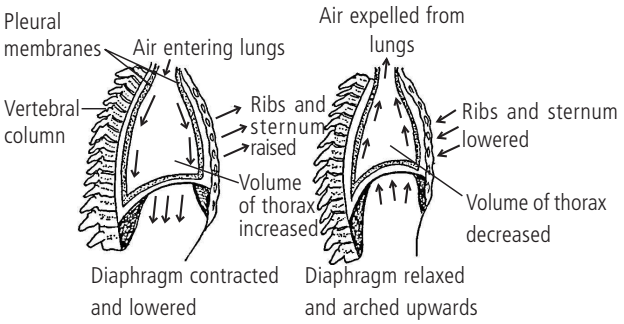
Diaphragm : When muscles of diaphragm relax, it becomes dome-shaped and, decreases the size of thoracic cavity.

Internal intercostal muscles: Contraction of these muscles moves the ribs downward and inward and reduces the size thoracic cavity laterally and dorsoventrally. The abdominal and internal intercostal muscles are called expiratory muscles.

Due to the action of these muscles the overall volume of thoracic cavity decreases and the intrapleural pressure increases. Due to this increased pressure in lungs, foul air is expelled out.

Abdominal muscles : Contraction of abdominal muscles presses the abdominal viscera against the diaphragm, bulging it further upward and thus decreasing the thoracic cavity more vertically.

The diagrammatic representation explaining the mechanism of breathing showing expiration and inspiration is given below :

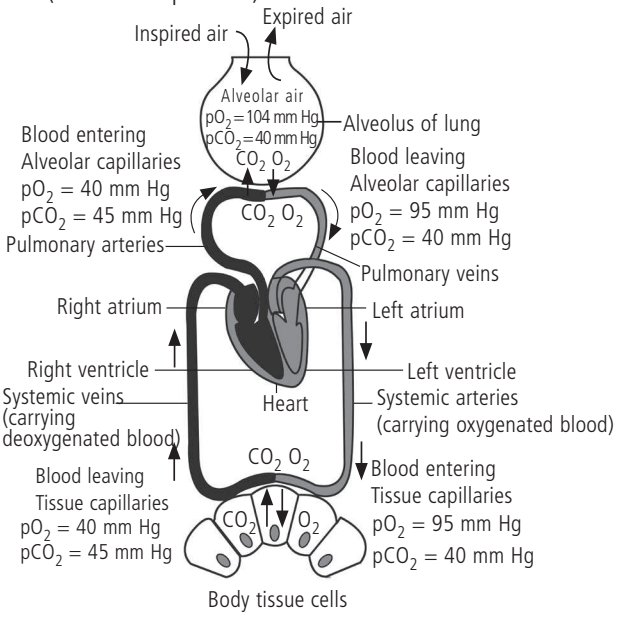


33. (a) The exchange of gases between tissue, blood capillaries and tissue cells is called internal respiration.

In the tissues, exchange of gases occur between the blood

and the tissue cells through tissue fluids that surround the tissue cells. Blood that reaches the tissues has more partial pressure of O_2 (pO_2 = 100 mm of Hg), than that in the body tissue cells (pO_2 = 40 mm of Hg). Similarly, partial pressure of CO_2 is more in tissues (pCO_2 = 45 mm of Hg) than in the blood (pCO_2 = 40 mm of Hg). Due to these differences in partial pressure of gases, O_2 from blood diffuses in the tissues and CO_2 from tissues diffuses into the blood. Gases diffuse from region of higher to lower partial pressure. This exchange of gases occur simultaneously. The venous blood goes to the right side of the heart that sends it to lungs *via* pulmonary artery for reoxygenation.

(b) Diagrammatic representation of gaseous exchange, (i) between alveolus and pulmonary blood capillary (external respiration) and (ii) between blood capillary and body tissues cells (internal respiration).



34. Neural system plays a significant role in maintaining and moderating the respiratory rhythm. Medulla oblongata has a specialised centre called respiratory rhythm centre, that regulates the respiration. The functions of the respiratory rhythm centre are controlled by another centre present in the pons varolii, called pneumotaxic centre. Neural signals from this centre can reduce the duration of inspiration and thereby alter the respiratory rate. Adjacent to the rhythm centre is situated a chemosensitive area which is highly sensitive to CO_2 and H^+ ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated. Receptors present on aortic arch and carotid artery also can recognise changes in CO_2 and H^+ concentration and send necessary signals to the rhythm centre for remedial actions.

35. The oxygen haemoglobin dissociation curve is shifted either to right or left by various factors, like pCO_2, H^+ concentration, temperature.

(i) Shift to right : The shift to the right indicates dissociation of oxygen from haemoglobin in the following conditions :

(a) Decrease in pO_2

(b) Increase in pCO_2

(c) Increase in hydrogen (H^+) ion concentration and decrease in pH (acidity)

(d) Increase in body temperature

(e) Excess of 2,3 DPG (2, 3 – Diphosphoglycerate, a by product of glycolysis)

(ii) Shift to left : The shift to left indicates association of oxygen with haemoglobin in the following conditions :

(a) In the fetal blood, because fetal haemoglobin has more affinity for oxygen than the adult haemoglobin.

(b) Decrease in hydrogen ion concentration and increase in pH (alkalinity).

(c) Decrease in partial pressure of CO_2.

36. (a) : Differences between breathing and respiration are:

S. No.	Breathing	Respiration
(i)	It is a physical process that involves inspiration of fresh air and expiration of foul air.	It is a biochemical process involving exchange of gases and oxidation of food.
(ii)	No energy is released rather used.	Releases energy that is stored in the form of ATP.
(iii)	It involves gaseous exchange between the animal and its external environment.	It involves enzymatic breakdown of glucose and release of energy.
(iv)	It takes place outside the cells.	It takes place inside the cells.
(v)	It is confined to certain organs only and mechanism varies in different animals.	It occurs in all cells of the body and mechanism is similar in all animals.

(b) Olfactory region is the upper region of the nasal chamber that looks yellowish brown. It is lined with a specialised type of pseudostratified columnar epithelium known as olfactory epithelium. The epithelium is confined to the upper part of the nasal chamber and the superior nasal concha.

Function : It acts as an organ of smell, as the olfactory epithelium contains sense receptors. It detects the odour of the inspired (inhaled) air. If the odour is pungent, the air is not allowed to pass in.