Chapter 17. Breathing and Exchange Of Gases

1. Lungs are made up of air-filled sacs, the alveoli. They do not collapse even after forceful expiration, because of
(a) inspiratory reserve volume
(b) tidal volume
(c) expiratory reserve volume
(d) residual volume. *(NEET 2017)*

2. The partial pressure of oxygen in the alveoli of the lungs is
(a) equal to that in the blood
(b) more than that in the blood
(c) less than that in the blood
(d) less than that of carbon dioxide.
(NEET-II 2016)

3. Lungs do not collapse between breaths and some air always remains in the lungs which can never be expelled because
(a) there is a negative pressure in the lungs
(b) there is a negative intrapleural pressure pulling at the lung walls
(c) there is a positive intrapleural pressure
(d) pressure in the lungs is higher than the atmospheric pressure.
(NEET-II 2016)

4. Reduction in pH of blood will
(a) decrease the affinity of haemoglobin with oxygen
(b) release bicarbonate ions by the liver
(c) reduce the rate of heart beat
(d) reduce the blood supply to the brain.
(NEET-I 2016)

5. Name the chronic respiratory disorder caused mainly by cigarette smoking.
(a) Respiratory acidosis
(b) Respiratory alkalosis
(c) Emphysema
(d) Asthma *(NEET-I 2016)*

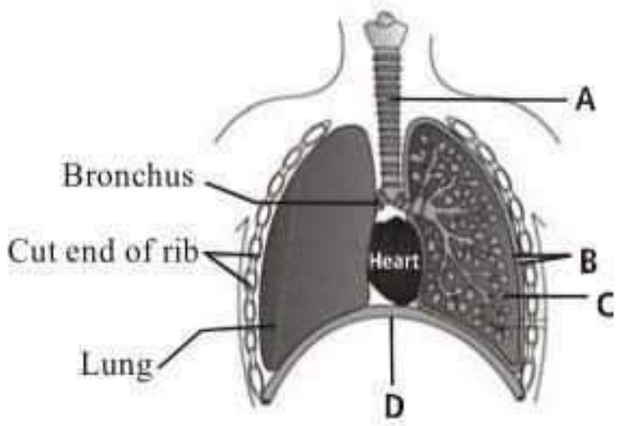
6. Asthma may be attributed to
(a) inflammation of the trachea
(b) accumulation of fluid in the lungs
(c) bacterial infection of the lungs
(d) allergic reaction of the mast cells in the lungs. *(NEET-I 2016)*

7. Name the pulmonary disease in which alveolar surface area involved in gas exchange is drastically reduced due to damage in the alveolar walls.
(a) Pneumonia (b) Asthma
(c) Pleurisy (d) Emphysema
(2015)

8. When you hold your breath, which of the following gas changes in blood would first lead to the urge to breathe?
(a) Falling CO_2 concentration
(b) Rising CO_2 and falling O_2 concentration
(c) Falling O_2 concentration
(d) Rising CO_2 concentration
(2015 Cancelled)

9. Approximately seventy percent of carbon-dioxide absorbed by the blood will be transported to the lungs
(a) as bicarbonate ions
(b) in the form of dissolved gas molecules
(c) by binding to R.B.C
(d) as carbamino - haemoglobin. *(2014)*

10. 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.



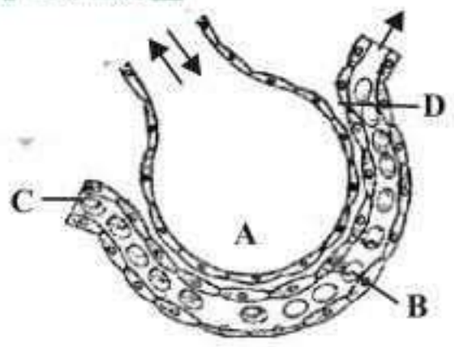
(a) C - Alveoli - Thin walled vascular bag like structures for exchange of gases.

(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 - Surround ribs on both sides to provide cushion against rubbing. *(NEET 2013)*

11. Which one of the following is the correct statement for respiration in humans?
(a) Cigarette smoking may lead to inflammation of bronchi.
(b) Neural signals from pneumotoxic centre in pons region of brain can increase the duration of inspiration.
(c) Workers in grinding and stone-breaking industries may suffer, from lung fibrosis.
(d) About 90% of carbon dioxide (CO_2) is carried by haemoglobin as carbamino-haemoglobin. *(2012)*

12. People who have migrated from the planes to an area adjoining Rohtang Pass about six months back
(a) have more RBCs and their haemoglobin has a lower binding affinity to O_2
(b) are not physically fit to play games like football
(c) suffer from altitude sickness with symptoms like nausea, fatigue, etc.
(d) have the usual RBC count but their haemoglobin has very high binding affinity to O_2. *(2012)*

13. 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. *(2011)*

14. A large proportion of oxygen remains unused in the human blood even after its uptake by the body tissues. This O_2
(a) acts as a reserve during muscular exercise
(b) raises the pCO_2 of blood to 75 mm of Hg.
(c) is enough to keep oxyhaemoglobin saturation at 96%
(d) helps in releasing more O_2 to the epithelial tissues. *(2011)*

15. Which one of the following is a possibility for most of us in regard to breathing, by making a conscious effort?
(a) One can breathe out air totally without oxygen.
(b) One can breathe out air through Eustachian tube by closing both nose and mouth.
(c) One can consciously breathe in and breathe out by moving the diaphragm alone, without moving the ribs at all.
(d) The lungs can be made fully empty by forcefully breathing out all air from them. *(Mains 2011)*

16. Bulk of carbon dioxide (CO_2) released from body tissues into the blood is present as
(a) bicarbonate in blood plasma and RBCs
(b) free CO_2 in blood plasma
(c) 70% carbamino-haemoglobin and 30% as bicarbonate
(d) carbamino-haemoglobin in RBCs. *(Mains 2011)*

17. Listed below are four respiratory capacities (i–iv) and four jumbled respiratory volumes of a normal human adult.

Respiratory capacities	**Respiratory volumes**
(i) Residual volume	2500 mL
(ii) Vital capacity	3500 mL
(iii) Inspiratory reserve volume	1200 mL
(iv) Inspiratoy capacity	4500 mL

Which one of the following is the correct matching of two capacities and volumes?
(a) (ii) 2500 mL, (iii) 4500 mL
(b) (iii) 1200 mL, (iv) 2500 mL
(c) (iv) 3500 mL, (i) 1200 mL
(d) (i) 4500 mL, (ii) 3500 mL *(2010)*

18. What is true about RBCs in humans?
(a) They carry about 20-25 percent of CO_2.
(b) They transport 99.5 percent of O_2.

(c) They transport about 80 percent oxygen only and the rest 20 percent of it is transported in dissolved state in blood plasma.
(d) They do not carry CO_2 at all. *(2010)*

19. What is vital capacity of our lungs?
(a) Inspiratory reserve volume *plus* expiratory reserve volume
(b) Total lung capacity *minus* residual volume
(c) Inspiratory reserve volume *plus* tidal volume
(d) Total lung capacity *minus* expiratory reserve volume *(2009)*

20. The haemoglobin of a human foetus
(a) has only 2 protein subunits instead of 4
(b) has a higher affinity for oxygen that that of an adult
(c) has a lower affinity for oxygen than that of the adult
(d) its affinity for oxygen is the same as that of an adult. *(2009)*

21. The majority of carbon dioxide produced by our body cells is transported to the lungs as
(a) attached to haemoglobin
(b) dissolved in the blood
(c) as bicarbonates
(d) as carbonates. *(2006)*

22. Which one of the following statements is incorrect?
(a) The principle of countercurrent flow facilitates efficient respiration in gills of fishes.
(b) The residual air in lungs slightly decreases the efficiency of respiration in mammals.
(c) The presence of non-respiratory air sacs, increases the efficiency of respiration in birds.
(d) In insects, circulating body fluids serve to distribute oxygen to tissues. *(2006)*

23. People living at sea level have around 5 million RBC per cubic millimeter of their blood whereas those living at an altitude to 5400 metres have around 8 million. This is because at high altitude
(a) people eat more nutritive food, therefore more RBCs are formed
(b) people get pollution-free air to breath and more oxygen is available
(c) atmospheric O_2 level is less and hence more RBCs are needed to absorb the required amount of O_2 to survive
(d) there is more UV radiation which enhances RBC production. *(2006)*

24. Blood analysis of a patient reveals an unusually high quantity of carboxyhaemoglobin content. Which of the following conclusions is most likely to be correct?
The patient has been inhaling polluted air containing unusually high content of
(a) carbon disulphide (b) chloroform
(c) carbon dioxide (d) carbon monoxide. *(2004)*

25. When CO_2 concentration in blood increases breathing becomes
(a) shallower and slow
(b) there is no effect on breathing
(c) slow and deep
(d) faster and deeper. *(2004)*

26. An average person not doing hard work requires energy per day about
(a) 2000 kcal (b) 1000 kcal
(c) 750 kcal (d) 2800 kcal. *(1999)*

27. Haemoglobin is a type of
(a) carbohydrate
(b) respiratory pigment
(c) vitamin
(d) skin pigment. *(1999)*

28. The respiratory centres, which control inspiration and expiration, are located in
(a) diencephalon (b) medulla oblongata
(c) cerebellum (d) spinal cord. *(1999)*

29. The exchange of gases in the alveoli of the lungs takes place by
(a) passive transport (b) active transport
(c) osmosis (d) simple diffusion. *(1998)*

30. The CO_2 content by volume, in the atmospheric air is about
(a) 3.34% (b) 4%
(c) 0.0314% (d) 0.34%. *(1997)*

31. In lungs, the air is separated from the venous blood through
(a) transitional epithelium + tunica externa of blood vessel
(b) squamous epithelium + endothelium of blood vessel
(c) squamous epithelium + tunica media of blood vessel
(d) none of the above. *(1997)*

32. Which vertebrate organ receives only oxygenated blood?
(a) Spleen (b) Liver
(c) Gill (d) Lung *(1996)*

33. How the transport of O_2 and CO_2 by blood happens?
(a) With the help of WBCs and blood serum
(b) With the help of platelets and corpuscles
(c) With the help of RBCs and blood plasma
(d) With the help of RBCs and WBCs *(1996)*

34. When 1500 ml air is in the lungs, it is called
(a) residual volume
(b) inspiratory reserve volume
(c) vital capacity
(d) tidal volume. *(1996)*

35. Lungs are enclosed in
(a) periosteum (b) perichondrium
(c) pericardium (d) pleural membrane. *(1996)*

36. At high altitude, the RBCs in the human blood will
(a) increase in number
(b) decrease in number
(c) increase in size
(d) decrease in size. *(1995)*

37. Although much CO_2 is carried in blood, yet blood does not become acidic, because
(a) CO_2 is continuously diffused through the tissues and is not allowed to accumulate
(b) in CO_2 transport, blood buffers play an important role
(c) CO_2 is absorbed by the leucocytes
(d) CO_2 combines with water to form H_2CO_3 which is neutralized by $NaCO_3$. *(1995)*

38. The carbon dioxide is transported *via* blood to lungs mostly
(a) in combination with haemoglobin only
(b) dissolved in blood plasma
(c) in the form of bicarbonate ions
(d) as carbaminohaemoglobin and as carbonic acid. *(1995)*

39. The ventilation movements of the lungs in mammals are governed by
(a) muscular walls of lung
(b) diaphragm
(c) costal muscles
(d) both (b) and (c). *(1995)*

40. The respiratory centre which regulates respiration is located in
(a) cerebellum
(b) medulla oblongata
(c) cerebral peduncle
(d) the vagus nerve. *(1994)*

41. Carbon dioxide is transported from tissues to respiratory surface by only
(a) plasma and erythrocytes
(b) plasma
(c) erythrocytes
(d) erythrocytes and leucocytes. *(1993)*

42. The alveolar epithelium in the lung is
(a) nonciliated columnar
(b) nonciliated squamous
(c) ciliated columnar
(d) ciliated squamous. *(1990)*

43. Skin is an accessory organ of respiration in
(a) humans (b) frog
(c) rabbit (d) lizard. *(1990)*

Answer Key

1.	(d)	**2.**	(b)	**3.**	(b)	**4.**	(a)	**5.**	(c)	**6.**	(d)	**7.**	(d)	**8.**	(d)	**9.**	(a)	**10.**	(a)
11.	(c)	**12.**	(a)	**13.**	(b)	**14.**	(a)	**15.**	(c)	**16.**	(a)	**17.**	(c)	**18.**	(a)	**19.**	(b)	**20.**	(b)
21.	(c)	**22.**	(d)	**23.**	(c)	**24.**	(d)	**25.**	(d)	**26.**	(d)	**27.**	(b)	**28.**	(b)	**29.**	(d)	**30.**	(c)
31.	(b)	**32.**	(a)	**33.**	(c)	**34.**	(a)	**35.**	(d)	**36**	(a)	**37.**	(b)	**38.**	(c)	**39.**	(d)	**40.**	(b)
41.	(a)	**42.**	(b)	**43.**	(b)														

EXPLANATIONS

1. (d) : Residual volume is the volume of air which remains in the lungs after the most forceful expiration. This residual air enables the lungs to continue exchange of gases even after maximum exhalation. Due to this, lungs do not collapse even after forceful expiration.

2. (b) : The partial pressure of oxygen in alveolar air is 104mmHg whereas it is 40mmHg in deoxygenated blood and 95mmHg in oxygenated blood.

3. (b) : Intrapleural pressure is the pressure of air within the pleural cavity. Intrapleural pressure is always negative, which acts like a suction to keep the lungs inflated and prevent them from collapsing. The negative intrapleural pressure is due to three main factors: surface tension of the alveolar fluid; elasticity of lungs; elasticity of thoracic wall. Normally, there is a difference between intrapleural and intrapulmonary pressure, which is called transpulmonary pressure. This transpulmonary pressure creates the suction to keep the lungs inflated. If there is no pressure difference, there is no suction and lungs will collapse.

4. (a) : Reduction in pH of blood causes oxygen-haemoglobin dissociation curve to shift to right which indicates dissociation of oxygen from haemoglobin. This decreases affinity of haemoglobin for oxygen.

5. (c) : Emphysema is a chronic obstructive pulmonary disease (COPD) caused due to cigarette smoking. It is an inflation or abnormal distention of the bronchioles or alveolar sacs of the lungs which causes irreversible distension and loss of elasticity of alveoli of the lungs.

6. (d) : Asthma is an allergic condition in which the tissue surrounding the bronchioles of the lungs swell up and compress the bronchioles thus causing difficulty in breathing. This allergy mainly involves IgE antibodies and chemicals like histamine and serotonin from the mast cells.

7. (d) : Emphysema is an inflation or abnormal distension of the bronchioles or alveolar sacs of the lungs. Many of the septa between the alveoli are destroyed and much of the elastic tissue of the lungs is replaced by connective tissue. As the alveolar septa collapse, the surface area for gas exchange is greatly reduced. There is loss of elasticity in the walls of bronchioles or alveolar sacs. As a result the alveolar sacs remain filled with air even after expiration. The exhalation becomes more difficult. The lungs remain inflated. Major causes of emphysema are cigarette smoking and the inhalation of smoke or other toxic substances over a period of time.

8. (d) : Excess CO_2 mainly stimulates the respiratory centre of the brain and increases the inspiratory and expiratory signals to the respiratory muscles. O_2 does not have a significant direct effect on the respiratory centre of the brain in controlling respiration.

9. (a) : About 70% of CO_2 (about 2.5ml per 100 ml. of blood), received by blood from the tissues, enters the RBCs where it reacts with water to form carbonic acid (H_2CO_3).
Carbonic anhydrase, exclusively found in RBCs, speeds up the formation of H_2CO_3 and rapidly converts it back to carbon dioxide and water when blood reaches th lungs. Almost as rapidly as formed, all carbonic acid of RBCs dissociates into hydrogen (H^+) and bicarbonate ions (HCO^-_3).

10. (a) : In the given figure A is trachea. It is supported by incomplete cartilaginous rings which prevent its collapse during inspiration. B is pleural membrane. It encloses lungs. C are alveoli. They are thin walled sacs having extensive network of capillaries for gaseous exchange. D is diaphragm.

11. (c) : In certain industries, especially those involving grinding or stone breaking so much dust is produced that the defense mechanism of the body cannot fully cope with the situation. Long exposure can give rise to inflammation leading to fibrosis (proliferation of fibrous tissues) and thus causing serious lung damage. Workers in such industries should wear protective masks.

12. (a) : Tourists visiting high altitude areas such as Rohtang Pass or Mansarovar, experience altitude sickness. Its symptoms include nausea, fatigue and heart palpitations. This is because in the low atmospheric pressure of high altitudes, the body does not get enough oxygen. But, gradually we get acclimatized and stop experiencing altitude sickness. The body compensates low oxygen availability by increasing red blood cell production, decreasing the binding affinity of haemoglobin and by increasing breathing rate.

13. (b) **14. (a)** **15. (c)**

16. (a) : At the tissue site where partial pressure of CO_2 is high due to catabolism, CO_2 diffuses into blood

(RBCs and plasma) and forms HCO_2^- and H^+. At the alveolar site where pCO_2 is low, the reaction proceeds in the opposite direction leading to the formation of CO_2 and H_2O. Thus, CO_2 trapped as bicarbonate at the tissue level and transported to the alveoli is released out as CO_2.

17. (c) :

Respiratory capacities	Respiratory volumes
Residual volume	1200 mL
Vital capacity	4500 mL
Inspiratory reserve volume	2500 mL
Inspiratory capacity	3500 mL

18. (a) : Blood is the medium of transport for O_2 and CO_2. About 97 percent of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a dissolved state through the plasma. Nearly 20-25 percent of CO_2 is transported by RBCs whereas 70 percent of it is carried as bicarbonate. About 7 percent of CO_2 is carried in a dissolved state through plasma.

19. (b) : Vital capacity is the amount of air which one can inhale or exhale with maximum effort. It is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume, while total lung capacity is the total amount of air present in the lungs and the respiratory passage after a maximum inspiration. It is the sum of the vital capacity and the residual volume. TLC = VC + RV. So, vital capacity is also total lung capacity (TLC) – residual volume (RV).

20. (b) : Oxygen is needed for aerobic respiration and diffuses from a region of high to low concentration from the mother's blood to the blood of the foetus. The haemoglobin of the foetus has a higher affinity for oxygen than that of adult haemoglobin and so the efficiency of exchange is increased. Carbon dioxide, a waste product of aerobic respiration diffuses in the opposite direction.

21. (c) : When systemic arterial blood flows through capillaries, carbon dioxide diffuses from the tissues into the blood. Some carbon dioxide is dissolved in the blood. Some carbon dioxide reacts with haemoglobin to form carbaminohaemoglobin. The remaining carbon dioxide is converted to bicarbonate and hydrogen ions. Most carbon dioxide is transported through the blood in the form of bicarbonate ions.

22. (d) : The circulatory system of insects is open, whereby blood (haemolymph), flows freely through the body cavity (haemocoel). There is a dorsal vessel which is closed at the posterior end of the abdomen, and runs forward along the dorsal midline and opens in the head at the anterior portion (aorta). There are several chambers and openings (ostia), along the dorsal vessel where blood enters it through valves. The blood is then pumped forward to the aorta and into the body cavity.Blood contains: water - about 90%; inorganic ions - dissolved salts of Na, K, Ca, Mg; organic molecules - amino acids, sugars for muscle use; blood cells. Haemolymph does not contain an oxygen carrying pigment like Hb, hence, does not assist in respiration.

23. (c) : At high altitudes composition of air remains almost same as at sea level, but density (barometric pressure) of air gradually decreases due to which arterial pO_2 is also decreased (hypoxemia). High altitudes presents with complex conditions to which human body has to acclimatize. Number of red blood cells per unit volume of blood is likely to be higher in a person living at high altitudes. This is in response to the air being less dense at high altitude. More number of red blood cells are needed to trap O_2 from rarefied air having low pO_2 (partial pressure of oxygen).

24. (d) : Carboxyhaemoglobin, a stable compound, is formed when haemoglobin readily combines with carbon monoxide. Carbon monoxide converts iron (II) to iron (III) in its reaction with haemoglobin. In this form haemoglobin does not carry oxygen resulting in its (oxygen) starvation and leads to asphyxiation and in extreme cases to death. The affinity of haemoglobin for CO is 250 times its affinity for O_2 and COHb liberates CO very slowly and also due to that compound the dissociation curve of the remaining HbO_2 shifts to the left, decreasing the amount of O_2 released.

25. (d) : The effect of rising CO_2 tension is to decrease the affinity of Hb for O_2. Thus, when CO_2 concentration in blood increases, breathing becomes faster and deeper.

26. (d) : An average person, not doing hard labour *i.e.*, leading a rather sedentary life, needs about 2800 kcal of energy per day. This is called routine metabolic rate (RMR).

27. (b) : Haemoglobin (Hb) is a conjugated protein. It consists of a basic protein globin joined to a nonprotein group heme. Heme is an iron-porphyrin ring. A mammalian Hb molecule is a complex of 4 heme molecules joined with 4 globin molecules. It is present in RBC, and carries O_2 from the lungs to the tissues and transports CO_2 from the tissues to the lungs.

28. (b) : The respiratory centre is the medulla oblongata, that regulates the rate and depth of breathing. The dorsal group of neurons located in the

dorsal portion of medulla oblongata regulates inspiration and ventral group of neurons located in the ventrolateral part of medulla oblongata regulates both inspiration and expiration.

29. (d) : Diffusion is the net flow of a substance from a region of higher concentration to a region of lower concentration. The exchange of gases between the alveoli and blood in the lung is the result of difference in partial pressure of respiratory gases. The partial pressure of oxygen (pO_2) of the alveolar air is higher than the pO_2 of blood in alveolar capillaries, thus O_2 diffuses rapidly from the alveolar air into the blood of alveolar capillaries. The pCO_2 of blood reaching the alveolar capillaries is higher than the pCO_2 of alveolar air. Therefore, CO_2 into the alveolar air.

30. (c) : The atmosphere (air) is a mixture of several gases. Near the earth's surface it consists of 78% nitrogen, 21% oxygen, 0.93% argon, 0.03% carbon dioxide and small quantities of hydrogen, helium, neon, krypton and traces of many other gases.

31. (b) : In lungs, the air is separated from the venous blood through squamous epithelium and endothelium of blood vessel. As a result, the barriers between the air in an alveolus and the blood in its capillaries is only about 0.5 mm.

32. (a) : Spleen receives only oxygenated blood from the heart through splenic artery. The liver receives a blood supply from two sources. The first is the hepatic artery which delivers oxygenated blood from the general circulation. The second is the hepatic portal vein delivering deoxygenated blood from the small intestine containing nutrients. The blood flows through the liver tissue to the hepatic cells where many metabolic functions take place. The blood drains out of the liver via the hepatic vein. Gill and Lung receive deoxygenated blood as these are the organs where oxygenation of blood takes place.

33. (c) : The transport of O_2 and CO_2 occurs with the help of RBCs and blood plasma. 97% of O_2 is transported by RBCs and 3% of O_2 is carried by plasma. About 7% of CO_2 is transported in plasma and rest by RBCs (23%) by binding with Hb and 70% reacts with water to form carbonic acid in RBCs.

34. (a) : Residual volume is the amount of air that remains in the lungs after forcible expiration. It is about 1500 ml. It enables the lungs to continue exchange of gases even after maximum exhalation or holding the breath. Inspiratory reserve volume is the extra amount of air which can be inhaled forcibly after a normal inspiration. It is about 2000 to 2500 ml. Vital capacity is the amount of air which one can inhale and also exhale with maximum effort. It is about 3.5 - 4.5 litres. Tidal volume (500 ml) is the volume of air normally inspired or expired in one breath without any effort.

35. (d) : Each lung is enclosed in two membranes, the pleura. The inner membrane is called the visceral pleuron and the outer membrane is called parietal pleuron. A very narrow space exists between the two pleura. It is called the pleural cavity and contains a watery fluid called the pleural fluid that lubricates the pleura. Periosteum is the outer membrane of the bone.

Perichondrium is a layer that surrounds the cartilage and pericardium is the membrane that encloses the pericardial cavity, containing the vertebrate heart.

36 (a) : At high altitudes, arterial pO_2 decreases as density of air decreases. Number of RBCs per unit volume of blood is likely to be higher in a person living at high altitudes. More number of RBCs are needed to trap O_2 from air having less O_2.

37. (b) : Buffer is a solution that resists change in pH when an acid or alkali is added or when the solution is diluted. Acidic buffers consists of a weak acid with a salt of the acid. The salt provides the negative ion A, which is the conjugate base of the acid HA. An example is carbonic acid and sodium hydrogen carbonate in which molecules H_2CO_3 and ions HCO_3^- are present. About 70% of CO_2 released combines with water in the RBCs to form carbonic acid. Carbonic acid dissociates into bicarbonate and hydrogen ions. Addition of H^+ ions would make the blood acidic. However, most of the hydrogen ions are neutralized by combination with Hb, forming acid haemoglobin. This reduces the acidity of the blood and also releases additional O_2.

$$HbO_2^- + H^+ \rightleftharpoons HHb + O_2$$

38. (c) : About 70% of CO_2 released diffuses into the plasma and then into the RBCs. Here, it combines with water to form carbonic acid. Carbonic acid dissociates into bicarbonate and hydrogen ions. Hydrogen ions are picked up by proteins and a small amount of bicarbonate ions is transported in the RBCs, whereas most of them diffuse into the plasma to be carried by it. About 7% of CO_2 is transported as dissolved in plasma and 23% of CO_2 combines with Hb to form carbaminohaemoglobin.

$$CO_2 + H_2O \underset{\text{anhydrase}}{\overset{\text{carbonic}}{\rightleftharpoons}} \underset{\text{carbonic acid}}{H_2CO_3}$$

$$H_2CO_3 \rightleftharpoons H^+ + \underset{\text{bicarbonate ion}}{HCO_3^-}$$

39. (d) : The ventilation movements of the lungs in mammals are governed by diaphragm and intercostal muscles (between the ribs). The method is as follows:

During inspiration

Flattening of diaphragm and contraction of intercostal muscles

↓

Volume of thorax increases

↓

Fall of pressure in the thoracic cavity

↓

Air from outside rushes into the lungs *via* nostrils, trachea and bronchi

During expiration

Diaphragm becomes convex and relaxation of external intercostal muscles

↓

Volume of thorax decreases

↓

Rise of pressure in the thoracic cavity

↓

Air from inside rushes through bronchi and trachea and then into lungs and out through nostrils

40. (b) : *Refer to answer 28.*

41. (a) : Carbon dioxide is carried by the blood in three forms : physical solution, bicarbonate ions and carbamino-haemoglobin. A very small amount of carbon dioxide dissolves in the plasma and is carried as a physical solution. About 70% of carbon dioxide released by respiring tissue cells diffuses into the plasma and then into the red blood corpuscles. Here, CO_2 combines with water to form carbonic acid. Carbonic acid dissociates into bicarbonate and hydrogen ions.

42. (b) : In the lung, each alveolar duct opens into a blind chamber, the alveolar sac, or infundibulum. The latter consists of a central passage giving off several small pouches, the alveoli, or air sacs on all sides.The air sacs give the infundibulum the appearance of a small bunch of grapes. The alveoli have a very thin (0.0001 mm thick) wall composed of simple moist, nonciliated, squamous epithelium. The number of alveoli is countless and their surface area enormous. This further accelerates the gaseous exchange in the alveoli.

43. (b) : In addition to lungs, skin is also an organ of respiration in frog. It is practically the only mode of respiration when the frog is under water or hibernating. Skin is richly supplied with blood and is permeable to gases. That is why frogs always stay near water to keep their skin moist. It is further kept moist by secretion of mucus from its glands, and does not become dry out of water.