XI
17

BREATHING AND EXCHANGE OF GASES

SYLLABUS

Respiratory organs in animals (recall only); Respiratory system in humans; Mechanism of breathing and its regulation in humans-Exchange of gases, transport of gases and regulation of respiration Respiratory volumes; Disorders related to respiration-Asthma, Emphysema, Occupational respiratory disorders.

KEY CONCEPTS

INTRODUCTION

* Oxygen (O_2) is utilised by the organisms to indirectly break down nutrient molecules like glucose and to derive energy for performing various activities.
* Carbon dioxide (CO_2) which is harmful is also released during catabolic reactions.
* It is, therefore, evident that O_2 has to be continuously provided to the cells and CO_2 produced by the cells have to be released out.
* This process of exchange of O_2 from the atmosphere with CO_2 produced by the cells is called breathing, commonly known as respiration. It takes place in three basic steps -

(i) **Pulmonary ventilation :** The first process, pulmonary (pulmo = lung) ventilation, or breathing, is the inspiration (inflow) and expiration (outflow) of air between the atmosphere and the lungs.

(ii) **External (pulmonary) respiration :** This is the exchange of gases between the air spaces of the lungs and blood in pulmonary capillaries. The blood gains O_2 and loses CO_2.

(iii) **Internal (tissue) respiration** : The exchange of gases between blood in systemic capillaries and tissue cells is known as internal (tissue) respiration. The blood loses O_2 and gains CO_2.

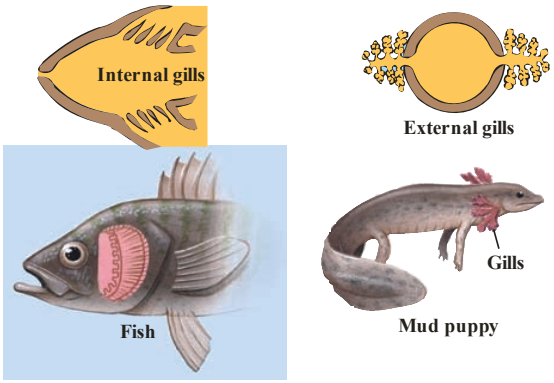
Within cells, the metabolic reactions that consume O_2 and give off CO_2 and give off CO_2 during production of ATP are termed cellular respiration.

RESPIRATORY ORGANS

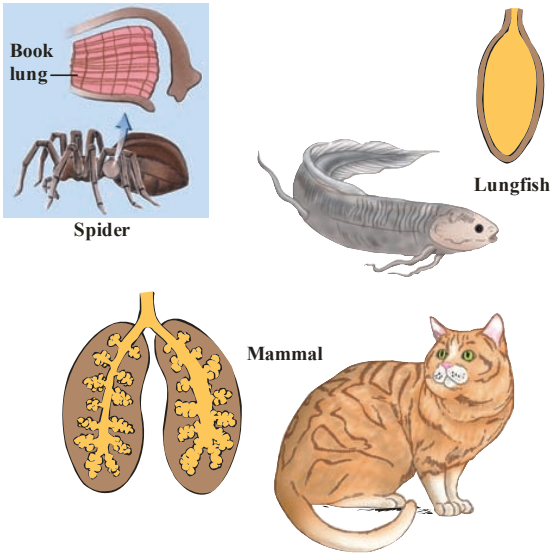
* Lower invertebrates like sponges, coelenterates, flatworms, etc., exchange O_2 with CO_2 by simple diffusion over their entire body surface.
* Earthworms use their moist cuticle and insects have a network of tubes (tracheal tubes) to transport atmospheric air within the body.
* In cockroaches, three pairs of longitudinal tracheal trunks are present all along the length of body which are further connected with each other with the help of transverse branches.
* The main tracheae give off smaller tracheae whose branch repeatedly form a network of trachioles throughout the body.
* Trachea internally lined by chitinous cuticle called intima, which spirally thickened to form taenidae.
* From each tracheal trunk three branches come out. The dorsal branch is supplied to the dorsal muscles where as ventral one to nerve cord and ventral muscles and middle one to the alimentary canal.

(a) Body surface. Some small, multicellular animals exchange gases through the body surface.

(b) Tracheal tubes. Insects and some other arthropods exchange gases through a system of tracheal tubes, or tracheae.



(c) Gills. Most aquatic animals exchange gases through gills, thin structures that extend from the body surface. Gills can be internal or external.



(d) Lungs. Lungs are adaptations for terrestrial gas exchange.

Figure : Adaptations for gas exchange

* Special vascularised structures called gills (branchial respiration) are used by most of the aquatic arthropods and molluscs whereas vascularised bags called lungs (pulmonary respiration) are used by the terrestrial forms for the exchange of gases.
* Among vertebrates, fishes use gills whereas amphibians, reptiles, birds & mammals respire through lungs.Amphibians like frogs can respire through their moist skin (cutaneous respiration) also. Mammals have a well developed respiratory system.

Table : Respiratory organ of animals

Animals	Respiratory organs
Sponges, Coelenterates, Flatworms	General body surface
Earthworm, Frogs	Moist cuticle (skin)
Insects	Tracheal tubes
Aquatic arthropods Molluscs, Fishes	Gills
Reptiles, Birds, Mammals	Lungs

HUMAN RESPIRATORY SYSTEM

* A pair of external nostrils opens out above the upper lips. It leads to a nasal chamber through the nasal passage.
* The nasal chamber opens into pharynx the portion which is common passage for food and air

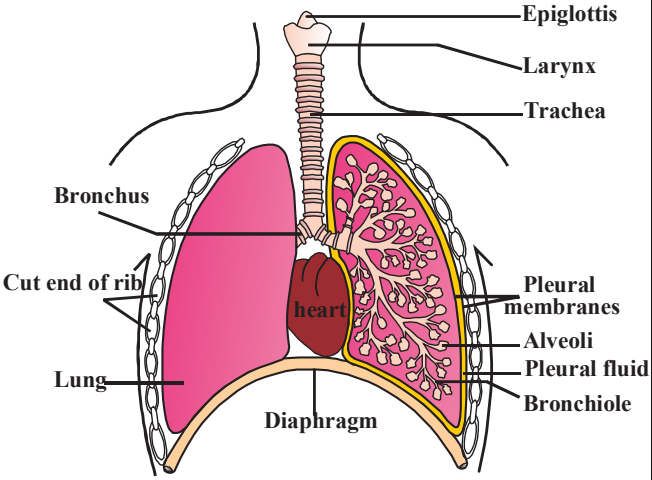


Figure : Diagrammatic view of human respiratory system (Sectional view of the left lung is also shown)

* The pharynx opens through larynx region into the trachea. Larynx is a cartilaginous box which helps in sound production and hence called the sound box.
* During swallowing glottis can be covered by a thin elastic cartilaginous flap called epiglottis to prevent the entry of food into the larynx.

* Trachea is a straight tube extending up to the mid-thoracic cavity, which divides at the level of 5th thoracic vertebra into a right and left primary bronchi.
* Each bronchi undergoes repeated divisions to form the secondary and tertiary bronchi and bronchioles ending up in very thin terminal bronchioles.
* The tracheae, primary, secondary and tertiary bronchi, and initial bronchioles are supported by incomplete cartilaginous rings.
* Each terminal bronchiole gives rise to a number of very thin, irregularwalled and vascularised bag-like structures called alveoli.
* The branching network of bronchi, bronchioles and alveoli comprise the lungs.
* We have two lungs which are covered by a double layered pleura, with pleural fluid between them. It reduces friction on the lungsurface.
* The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface.
* The part starting with the external nostrils up to the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system.
* The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature.
* Exchange part is the site of actual diffusion of O_2 and CO_2 between blood and atmospheric air.
* The lungs are situated in the thoracic chamber which is anatomically an air-tight chamber.
* The thoracic chamber is formed dorsally by the vertebral column, ventrally by the sternum, laterally by the ribs and on the lower side by the dome-shaped diaphragm.
* The anatomical setup of lungs in thorax is such that any change in the volume of the thoracic cavity will be reflected in the lung (pulmonary) cavity. Such an arrangement is essential for breathing, as we cannot directly alter the pulmonary volume.

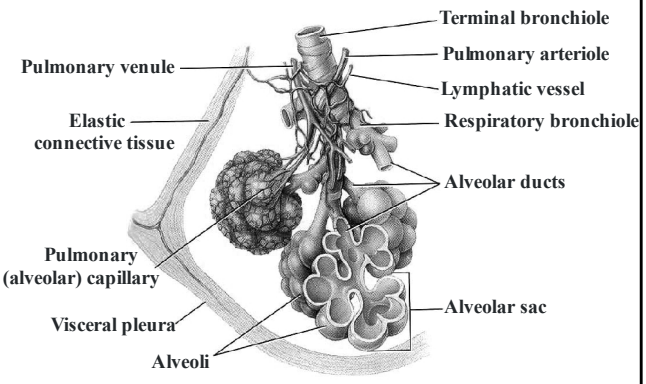


Figure : Diagram of a portion of a lobule of the lung

* Respiration involves the following steps:

(i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.

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

(iii) Transport of gases by the blood.

(iv) Diffusion of O_2 and CO_2 between blood and tissues.

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

MECHANISM OF BREATHING

* Breathing involves two stages : inspiration during which atmospheric air is drawn in and expiration by which the alveolar air is released out.
* The movement of air into and out of the lungs is carried out by creating a pressure gradient between the lungs and the atmosphere.
* Inspiration can occur if the pressure within the lungs (intra-pulmonary pressure) is less than the atmospheric pressure, i.e., there is a negative pressure in the lungs with respect to atmospheric pressure.
* Similarly, expiration takes place when the intra-pulmonary pressure is higher than the atmospheric pressure.
* The diaphragm and a specialised set of muscles – external and internal intercostals between the ribs, help in generation of such gradients.
* Inspiration is initiated by the contraction of diaphragm which increases the volume of thoracic chamber in the antero-posterior axis.

* The contraction of external inter-costal muscles lifts up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis.
* The overall increase in the thoracic volume causes a similar increase in pulmonary volume.
* An increase in pulmonary volume decreases the intra-pulmonary pressure to less than the atmospheric pressure which forces the air from outside to move into the lungs, i.e., inspiration.

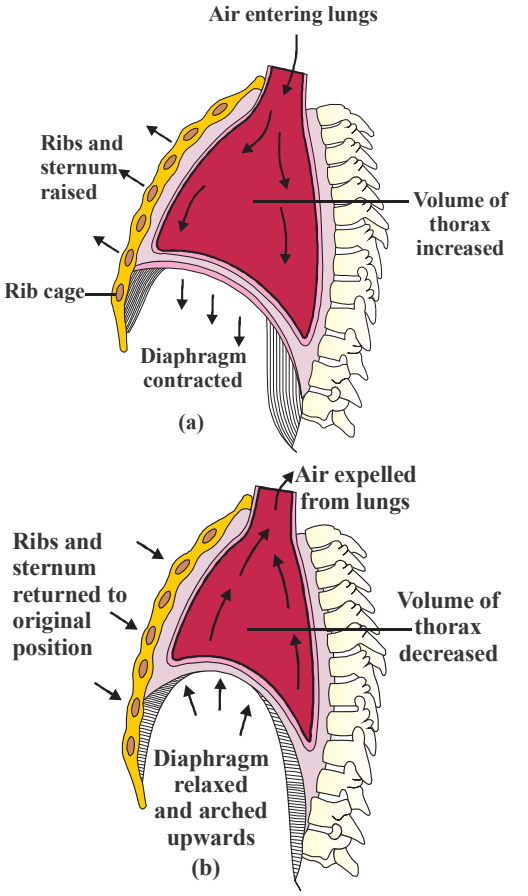


Figure : (a) Inspiration (b) Expiration

* Relaxation of the diaphragm and the inter-costal muscles returns the diaphragm and sternum to their normal positions and reduce the thoracic volume and thereby the pulmonary volume. This leads to an increase in intra-pulmonary pressure to slightly above the atmospheric pressure causing the expulsion of air from the lungs, i.e., expiration.
* On an average, a healthy human breathes 12-16 times/minute.

RESPIRATORY VOLUMES AND CAPACITIES

* **Tidal Volume (TV):** Volume of air inspired or expired during a normal respiration. It is approx. 500 mL., i.e., a healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.
* **Inspiratory Reserve Volume (IRV):** Additional volume of air, a person can inspire by a forcible inspiration. This averages 2500 mL to 3000 mL.
* **Expiratory Reserve Volume (ERV):** Additional volume of air, a person can expire by a forcible expiration. This averages 1000 mL to 1100 mL.
* **Residual Volume (RV):** Volume of air remaining in the lungs even after a forcible expiration. This averages 1100 mL to 1200 mL. By adding up a few respiratory volumes described above, one can derive various pulmonary capacities, which can be used in clinical diagnosis.
* **Inspiratory Capacity (IC):** Total volume of air a person can inspire after a normal expiration. This includes tidal volume and inspiratory reserve volume (TV + IRV).
* **Expiratory Capacity (EC):** Total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume (TV + ERV).
* **Functional Residual Capacity (FRC) :** Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.
* **Vital Capacity (VC) :** The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.
* **Total Lung Capacity :** Total volume of air accommodated in the lungs at the end of a forced inspiration. This includes RV, ERV, TV and IRV or vital capacity + residual volume.

EXCHANGE OF GASES

* Alveoli are the primary sites of exchange of gases. Exchange of gases also occur between blood and tissues. O_2 and CO_2 are exchanged in these sites

by simple diffusion mainly based on pressure/ concentration gradient.

* Solubility of the gases as well as the thickness of the membranes involved in diffusion are also some important factors that can affect the rate of diffusion.
* A concentration gradient is present for oxygen from alveoli to blood and blood to tissues.
* Similarly, direction, i.e., from tissues to blood and blood to alveoli. As the solubility of CO_2 is 20-25 times higher than that of O_2, the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher compared to that of O_2.

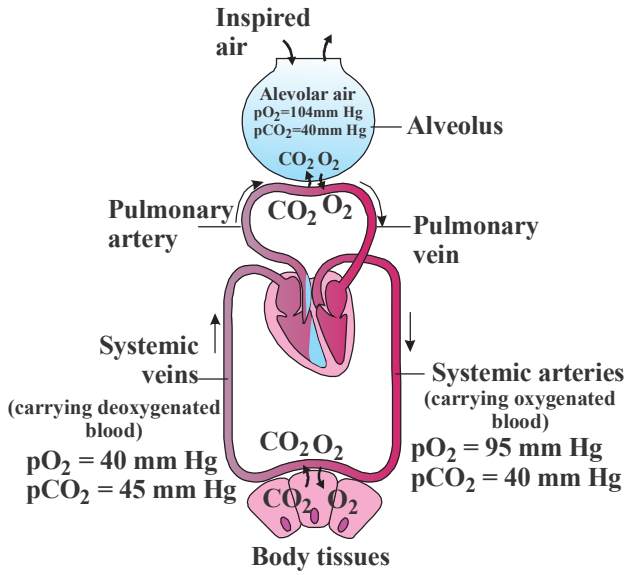


Figure : Diagrammatic representation of exchange of gases at the alveolus and the body tissues with blood and transport of oxygen and carbon dioxide.

* The diffusion membrane is made up of three major layers namely, the thin squamous epithelium of alveoli, the endothelium of alveolar capillaries and the basement substance in between them.

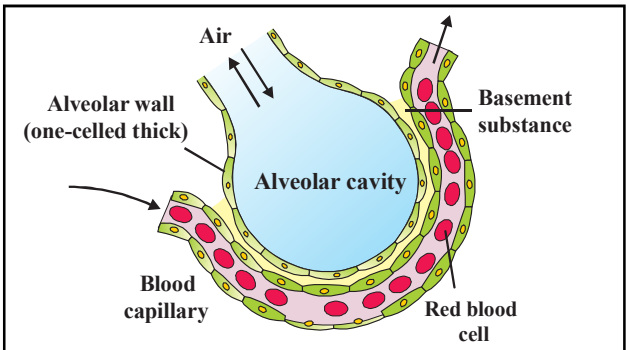


Figure : A diagram of a section of an alveolus with a pulmonary capillary.

* All the factors in our body are favourable for diffusion of O_2 from alveoli to tissues and that of CO_2 from tissues to alveoli.

TRANSPORT OF GASES

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

Transport of Oxygen

* Haemoglobin is a red coloured iron containing pigment present in the RBCs. O_2 can bind with haemoglobin in a reversible manner to form oxyhaemoglobin.
* Each haemoglobin molecule can carry a maximum of four molecules of O_2.
* 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.

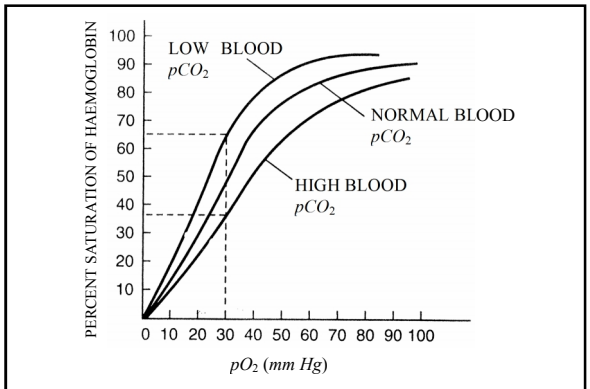


Fig : Effect of p CO_2 on affinity of hemoglobin for oxygen

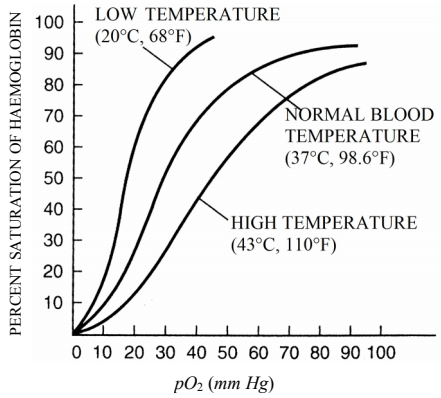


Fig : Oxygen-hemoglobin dissociation curve showing the relationship between temperature and hemoglobin saturation with O_2

* **Bohr's effect :** Hb-O_2 dissociation curve shifts to right when tension in blood is high. Bohr discovered this effect in 1904. Bohr effect is the effect of CO_2 on oxyhaemoglobin. Deoxygenation of oxygaemoglobin is directly proportional to blood pCO_2. Extent of Bohr's effect depends upon the tension of CO_2 in blood only. CO_2 of tissue fluid and alveoli does not exert Bohr's effect. During exercise muscles need more O_2 and want to remove CO_2 which has high production. Because of pressure gradient CO_2 moves from tissues fluid to capillary blood $\rightarrow$ Exert Bohr's effect $\rightarrow$ O_2 release is hastened from Hb-O_2 i.e. Hb-O_2 curve shifts to right.
* 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. This clearly indicates that O_2 gets bound to haemoglobin in the lung surface and gets dissociated at the tissues.
* Every 100 ml of oxygenated blood can deliver around 5 ml of O_2 to the tissues under normal physiological conditions.

Transport of Carbon dioxide

* CO_2 is carried by haemoglobin as carbamino-haemoglobin (about 20-25 per cent).
* This binding is related to the partial pressure of CO_2. pO_2 is a major factor which could affect this binding.
* When pCO_2 is high and pO_2 is low as in the tissues, more binding of carbon dioxide occurs whereas, when the pCO_2 is low and pO_2 is high as in the alveoli, dissociation of CO_2 from carbamino-haemoglobin takes place, i.e., CO_2 which is bound to haemoglobin from the tissues is delivered at the alveoli.
* RBCs contain a very high concentration of the enzyme, carbonic anhydrase and minute quantities of the same is present in the plasma too. This enzyme facilitates the following reaction in both directions.

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

* At the tissue site where partial pressure of pCO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3 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.
* CO_2 trapped as bicarbonate at the tissue level and transported to the alveoli is released out as CO_2.
* Every 100 ml of deoxygenated blood delivers approximately 4 ml of CO_2 to the alveoli.

REGULATION OF RESPIRATION

* A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible for respiratory regulation.
* Another centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre.
* Neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.
* A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO_2 and hydrogen 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.

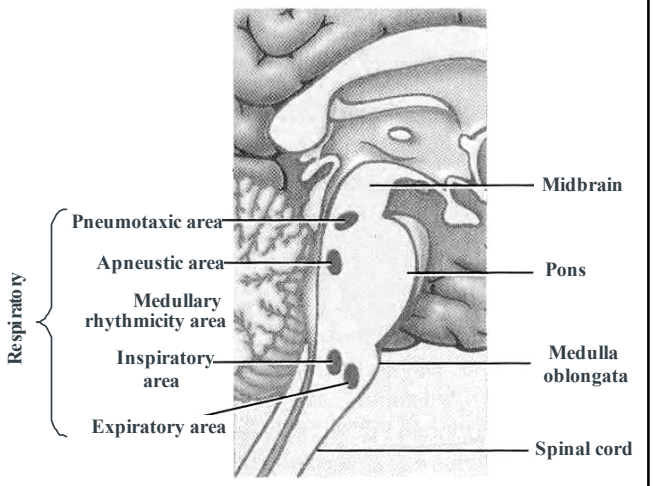


Figure : Sagittal section of brain stem

* Receptors associated with 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.
* The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

DEEP OR FORCED OR VOLUNTARY BREATHING

* Deep or forced voluntary inspiration is caused by excessive contraction of diaphragm and muscles.
  Deep expiration is done by contraction of internal inter-costal muscles and relax of other muscles and diaphragm. Impulse for deep breath starts from cerebrum.
* The deep breathing is referred to as thoracic breathing in contrast to the normal or quiet breathing referred to as abdominal breathing.
* Sudden deep breath : Sudden deep breath is due to increased pCO_2 and decreased pO_2.
* **Breathing at high altitude : A**ir at mountains is thin and of low density. Residents of high altitudes are acclimatized. Visitors first suffer from Hypoxia (at 4000 m). This causes mountain sickness including high blood pressure and high breathing rate (normal rate of breathing is 12 to 18/minute). Visitor becomes normal after some days when his number of RBC, and haemoglobin percentage increase.

BREATHING RATES

Respiratory rate :
Man 12 -18/min., - Inspiration = 2 sec.
Expiration = 3 sec.
In new born baby = 44/min.
Embryo = 0.
At the time of sleeping = 10/min. (Minimum).
Frog = 80/min., Rabbit = 38/min.,
Shrew = 120/min. (Maximum),
Elephant = 6/min.

RESPIRATORY PIGMENTS

* Haemoglobin : Found in vertebrates and in some annelids e.g. Earthworm. In annelids it dissolve in plasma. Colour of oxyhaemoglobin is Red. Colour of deoxyhaemoglobin is Purple.
* Hemocyanin : In this Cu^+ ions is present. It is of blue colour.
  It is found in mollusc, (Octopus) Arthropoda (Prawn).
* Chlorocruonin : (Fe^{++} ion containing green colour pigment) Found in sabella (Annelids)
* Haemoerythrin : (Fe^{++} containing red colour pigment)
  Found in annelid plasma.
* Pinaglobin : Containing brown pigment [Mn] present. Eg. Mollusca (eg. Pinna).
* Vanadium : Present in protochordates , Vanadium compound, green colour e.g. Ascidians.

DISORDERS OF RESPIRATORY SYSTEM

* **Asthma** is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.
* **Emphysema** is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking.
* **Occupational Respiratory Disorders:** 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.
* **Hypoxia :** Hypoxia is a condition of oxygen shortage in the tissues.
* **Asphyxia (Suffocation) :** The content of blood falls and the content rises and paralyses the respiratory centre. Breathing stops and death occurs.
* **Bronchitis :** It is caused by the permanent swelling in bronchi. As a result of bronchitis cough is caused and thick mucus with pus cells is spitted out. Dyspnea fever develops. Dyspnea means hunger of air or deficiency of oxygen in the blood or development of hypercapnia i.e., increase of concentration in blood. This disease is accelerated by fatigue, malnutrition, cold etc. the patient experiences difficulty in breathing.
* **Pneumonia :** Oxygen has difficulty diffusing through the inflammed alveoli and the blood pO_2 may be drastically reduced. Blood pCO_2 usually remain normal because CO_2 diffuses through the alveoli more easily than O_2. In chronic patients of common cold and influenza, the lining epithelium of bronchi and lungs is inflammated. This disease is caused by streptococus pneumoniae, other bacteria, fungi, protozoans, viruses and the patient feels difficulty in breathing. Its prominent symptoms are trembling, pain in chest, fever, cough delirium etc.
* **Lung cancer :** It is believed that by excess smoking, lung cancer (carcinoma of lungs) is caused. The tissue increases limitlessly, which is called malignancy. This disease is fatal. The frequency of occurrence of this disease in smokers is 20% more. Malignancy of tissues (neoplasia) causes pressure on the cells of other tissues and destroys them. The blood capillaries are ruptured, blood starts flowing and death is caused by excessive bleeding.
* **Tuberculosis :** This disease is also called T.B. and was considered fatal, but these days its full cure is possible. Thus, disease is called curable, these days. It is caused by bacteria Mycobacterium tuberculosis. These bacteria settle in lungs at different places and convert normal tissue into fibrous tissue. Since the respiratory surface is decreased, the difficulty in breathing is also experienced. If the patients start taking medical advice and the medicines right from the initial stage regularly, the patients can be fully cured of the disease. Now a days a new therapy DOT (Direct observed treatment) is used for tuberculosis treatment, recently launched by Indian Government. Many other drugs like rifampin and isoniazid are successful for the treatment of tuberculosis.

CONCEPT REVIEW

* The mammalian respiratory system includes the lungs and a system of airways. A breath of air passes in sequence through the **nostrils, nasal cavities, pharynx, larynx, trachea, bronchi, bronchioles**, and **alveoli**. Each lung occupies a pleural cavity and is covered with a **pleural membrane.**
* During breathing, the diaphragm contracts, expanding the chest cavity. The membranous walls of the lungs move outward along with the chest walls, lowering pressure within the lungs. Air from outside the body rushes in through the air passage ways and fills the lungs until the pressure equals atmospheric pressure.
* **Tidal volume** is the amount of air moved into and out of the lungs with each normal breath. **Vital capacity** is the maximum volume that can be exhaled after the lungs fill to the maximum extent. The volume of air that remains in the lungs at the end of a normal expiration is the **residual capacity.**
* **Respiratory centers** in the medulla and pons regulate respiration. These centers are stimulated by **chemoreceptors** sensitive to an increase in carbon dioxide concentration. They also respond to an increase in hydrogen ions and to very low oxygen concentration.
* Oxygen and carbon dioxide are exchanged between alveoli and blood by diffusion. The pressure of a particular gas determines its direction and rate of diffusion.

* **Hemoglobin** is the respiratory pigment in the blood of vertebrates. Almost 99% of the oxygen in human blood is transported as **oxyhemoglobin** (HbO_2).
* The maximum amount of oxygen that can be transported by hemoglobin is the **oxygen-carrying** capacity. The actual amount of oxygen bound to hemoglobin is the **oxygen content**. The **percent O_2 saturation**, the ratio of oxygen content to oxygen carrying capacity, is highest in pulmonary capillaries, where oxygen concentration is greatest.
* The **oxygen-hemoglobin dissociation curve** shows that as oxygen concentration increases, there is a progressive increase in the amount of hemoglobin that combines with oxygen. The curve is affected by pH, temperature, and CO_2 concentration.
* Owing to lowered pH caused by carbonic acid, oxyhemoglobin dissociates more readily as carbon dioxide concentration increases. This is the **Bohr effect**.
* About 60% of the carbon dioxide in the blood is transported as bicarbonate ions. About 30% combines with hemoglobin, and another 10% is dissolved in plasma.
* Carbon dioxide combines with water to form carbonic acid; the reaction is catalyzed by **carbonic anhydrase**. Carbonic acid dissociates, forming bicarbonate ions (HCO_3^-) and hydrogen ions (H^+).
* Hemoglobin combines with H^+, buffering the blood. Many bicarbonate ions diffuse into the plasma and are replaced by Cl^- ions; this exchange is known as the **chloride shift**.
* The ciliated mucous lining of the nose, pharynx, trachea, and bronchi trap inhaled particles.
* Inhaling polluted air results in **bronchial constriction,** increased mucous secretion, damage to ciliated cells, and coughing. Breathing polluted air or inhaling cigarette smoke can cause **chronic bronchitis, pulmonary emphysema**, and **lung cancer**.

IMPORTANT POINTS

* In elephant false vocal cords are absent.
* In hippopotamus, true vocal cords are absent.
* In birds sound is produced by syrinx.
* Sound of rabbit is called as Quacking
* The vocal cords are made up of yellow elastic tissue covered by non keratinized stratified squamous epithelium.
* Rhinitis - Chronic or acute inflammation of the mucous membrane of nose.
* Orthopnea -Inability to breath in horizontal position.
* Hypercapnia - Excess carbon dioxide in the body fluid.
* Haldane effect -The promotion of CO_2 dissociation by oxygenation of haemoglobin is called Haldane effect.
* IC = TV + IRV, while EC = TV + ERV.
* VC = ERV + TV + IRV
  TLC = RV + (ERV + TV + IRV)
* Organs of respiration
  (a) Flatworm - Body surface (b) Birds - Lungs
  (c) Frog- Skin and Lungs
  (d) Cockroach - Trachea
* Lungs have a large number of narrow tubes called bronchioles.
* Trachea and bronchi possess incomplete cartilaginous rings.
* For proper transport of O_2 and CO_2 blood should be slight alkaline.
* Respiratory movements are controlled by medulla oblongata.
* In expiration, diaphragm becomes relaxed.
* Respiratory system is derived from endoderm.
* Presence of large number of aleveoli around alveolar ducts opening into bronchioles in mammalian lungs is an efficient system of ventilation with little residual air.
* Earthworm = Cutaneous ; Human = Pulmonary
  Prawn = Branchial ; Insects = Tracheal.
* Prawn respires through gills.
* Asthma = Allergy, spasm of tracheal muscle.
  Bronchitis = Inflammation of bronchi.
  Rhimitis = Inflammation of nasal tract.
  Emphysema = Fully blown out alveoli
* Tidal volume = 500ml of air.
  Inspiratory reserve volume= 2500-3000ml of air.
  Expiratory reserve volume = 1000ml of air.
  Residual volume = 1200 ml of air
  Vital capacity = 3400-4800 ml of air.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.
For Q.1-Q.4
Match the column I with column II.

Q.1

	Column I	Column II
(a)	Earthworms	(i) Network of tubes
(b)	Aquatic arthropods	(ii) Lungs
(c)	Molluscs	(iii) Gills
(d)	Terrestrial organisms	(iv) Moist cuticle
(e)	Insects	

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

Q.2

	Column I	Column II
(a)	Hypopnoea	(i) Difficult breathing
(b)	Hyperpnoea	(ii) Painful breathing
(c)	Apnoea	(iii) No breathing
(d)	Dyspnoea	(iv) Rapid breathing
(e)	Orthopnoea	(v) Slow breathing

Codes
(A) (a) – (v), (b)–(iii), (c)–(iv), (d)–(ii), (e)–(i)
(B) (a) – (v), (b)–(iii), (c)–(i), (d)–(ii), (e)–(iv)
(C) (a) – (v), (b)–(iv), (c)–(iii), (d)–(ii), (e)–(i)
(D) (a) – (v), (b)–(iv), (c)–(ii), (d)–(iii), (e)–(i)

Q.3

	Column I	Column II
(a)	Tidal Volume (TV)	(i) 1100 to 1200 mL
(b)	Inspiratory Reserve Volume (IRV)	(ii) 1000 to 1100 mL
(c)	Expiratory Reserve Volume (ERV)	(iii) 2500 to 3000 mL
(d)	Residual Volume (RV)	(iv) 500 mL

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

Q.4

	Column I	Column II (Symptoms)
(a)	Asthma	(i) Inflammation of nasal tract
(b)	Bronchitis	(ii) Spasm of tracheal muscle
(c)	Rhinitis	(iii) Fully blown out alveoli
(d)	Emphysema	(iv) Inflammation of bronchi
		(v) Cough with blood stained sputum.

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

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.19 :
Choose one word for the given statement from the list.

Increase, Decrease, Outside, RBC, Alveolar, Bicarbonate, CO_2, CO, Breathing, Respiration, Vertebral column, Sternum, Ribs, Diaphragm, Inspiration, Expiration, 97, RBC, 3, Plasma, Fishes, Lungs, Moist skin, Glottis, Abdomen, Trachea, Rhythm centre, Epiglottis, Mid thoracic, Bronchi

Q.5 Process of exchange of O_2 from the atmosphere with ____ produced by the cells is called ____, which is commonly known as ____.

Q.6 Breathing involves ___ during which atmospheric air is drawn in and ___ by which the alveolar air is released out.

Q.7 Nasopharynx opens through the ____ of the larynx region into the ____.

Q.8 Among vertebrates, _____ use gills whereas reptiles, birds and mammals respire through the _____. Amphibians like frogs can respire through _____ also. Mammals have a well adapted respiratory system.

Q.9 An ____ in the pulmonary volume ____ the intra pulmonary pressure to less than the atmospheric pressure which forces the air from ____ to move into, the lungs, i.e., ____.

Q.10 The thoracic chamber is formed dorsally by the ____, ventrally by the ____, laterally by the ____ and on lower side by the dome-shaped ____.

Q.11 Blood is a medium to transport O_2 and CO_2. About ____ percent of O_2 is transported by ____ in the blood and the remaining ____ per cent of O_2 is carried in a dissolved state through the ____.

Q.12 CO_2 diffuses into ___ and forms HCO_3^- and H^+. At the ___ site where pCO_2 is low, the reaction proceeds in the opposite direction. Thus, CO_2 is trapped as ___ at the tissue level and transported to alveoli is released out as ___.

Q.13 During swallowing, glottis can be covered by a thin elastic cartilaginous flap called ____ to prevent the entry of food into larynx. Trachea is a straight tube extending up to ____ cavity, which divides at the level of 5th thoracic vertebra into right and left primary ____

Q.14 Haemoglobin of the human blood forms a stable complex compound with ___ gas, leading to death.

Q.15 Additional muscles in the ____ impacts the ability of humans to increase the strength of inspiration and expiration.

Q.16 Receptors associated with the aortic arch and carotid artery can recognise the changes in ____ and H^+ concentration and send necessary signals to the ____ for remedial actions.

Q.17 The conducting part of the respiratory system transports the atmospheric air to alveoli.
[True / False]

Q.18 Respiration in humans is an active process.
[True / False]

Q.19 Diaphragm helps in generating the pressure gradient in the lungs. **[True / False]**

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : RESPIRATORY ORGANS

Q.20 Which portion of the human respiratory system is called sound box?
(A) Larynx (B) Trachea
(C) Nasopharynx (D) Glottis

Q.21 Respiratory or exchange part of the respiratory system comprises
(A) lungs and pleural membrane.
(B) alveoli and their ducts.
(C) bronchus and their protecting covering.
(D) diaphragm and alveoli.

Q.22 Carbon dioxide (CO_2) is released during
(A) catabolic reactions (B) anabolic reactions
(C) amphibolic reactions (D) All of the above

Q.23 Which of the following statement is incorrect about nasopharynx?
(A) Internal nostrils opens into nasopharynx.
(B) It is the common passage for air only.
(C) It is a portion of pharynx.
(D) Nasopharynx opens through the glottis of the larynx region into the trachea.

Q.24 Actual site of exchange of gases in the lungs is
(A) alveoli (B) pleura
(C) bronchioles (D) tracheoles

Q.25 Friction on the lungs is surface reduced by
(A) double layered pleura
(B) single layered pleura
(C) ribs covering lungs
(D) mucous membrane surrounding the lungs

Q.26 O_2 exchange with CO_2 by simple diffusion over the entire body surface takes place in
I. sponges II. coelenterates
III. flatworms
Select the correct option to complete the given statement.
(A) I and II (B) II and III
(C) I and III (D) All of the above

Q.27 Respiration in insects is called direct because
(A) The tissues exchange O_2/ CO_2 directly with the air in the tubes.
(B) The tissues exchange O_2/ CO_2 directly with coelomic fluid.
(C) The tissues exchange O_2/CO_2 directly with the air outside through body surface.
(D) Tracheal tubes exchange O_2/CO_2 directly with the haemocoel which then exchange with tissues.

Q.28 At which thoracic vertebra does trachea divide into right and left primary bronchi?
(A) 5 (B) 6
(C) 9 (D) 4

Q.29 Lungs comprises
(A) network of bronchi (B) bronchioles
(C) alveoli (D) All of these

Q.30 Conducting part of the respiratory system comprises
(A) external nostrils upto the terminal bronchioles
(B) internal nostrils upto trachea
(C) epiglottis upto trachea
(D) larynx upto bronchi

PART - 2 : MECHANISM OF BREATHING

Q.31 Movement of the air into and out of the lungs is carried out by
(A) imbibition (B) pressure gradient
(C) osmosis (D) diffusion

Q.32 Approximate volume of air a healthy man can expire or inspire per minute is
(A) 5000 to 6000 mL (B) 6000 to 7000 mL
(C) 6000 to 8000 mL (D) 7000 to 9000 mL

Q.33 Inspiration is initiated by
(A) extension of the diaphragm
(B) contraction of the diaphragm
(C) extension of the lungs
(D) contraction of the lungs

Q.34 During inspiration the diaphragm
(A) expands
(B) shows no change
(C) contracts and flattens
(D) relaxes to become dome-shaped

Q.35 Mark the correct pair of muscles involved in the normal breathing in humans
(A) External and internal intercostal muscles
(B) Diaphragm and abdominal muscles
(C) Diaphragm and external intercostal muscles
(D) Diaphragm and internal intercostal muscles

Q.36 I. Intra pulmonary pressure remains less than the atmospheric pressure.
II. There is a negative pressure in the lungs than the atmospheric pressure.

In which of the above two situations inspiration takes place?
Choose the correct option accordingly.
(A) Only I (B) Only II
(C) Both I and II (D) I or II

Q.37 Air entering the lungs is
(A) warm and filtered
(B) contains only oxygen
(C) cool and filtered
(D) enriched with CO_2 and NO_2

PART - 3 : EXCHANGE OF GASES

Q.38 Partial pressure of the gas is the pressure contributed by
(A) all gases in a mixture
(B) individual gas in a mixture
(C) pressure exerted by atmosphere on gases
(D) atmosphere on O_2 only

Q.39

Respiratory Gas	Atmospheric Air	Alveoli
O_2	159	A
CO_2	0.3	B

Partial pressure (in mm Hg) of oxygen and carbon dioxide at different part involved in diffusion in comparison to those in atmosphere.
Identify A and B and choose the correct option accordingly.
(A) A-50; B-50 (B) A-104; 8-40
(C) A-40; B-104 (D) A-101; 8-104

Q.40 The solubility of CO_2 in the blood is
(A) 10-15 times higher than that of O_2.
(B) 20-25 times higher than that of O_2.
(C) slightly higher than that of O_2.
(D) slightly lower than that of O_2.

Q.41 Primary site of the gaseous exchange in humans is
(A) lungs (B) alveoli
(C) bronchus (D) diaphragm

Q.42 The partial pressure of CO_2 (pCO_2) is the highest in –
(A) trachea (B) alveoli
(C) tissues (D) bronchi

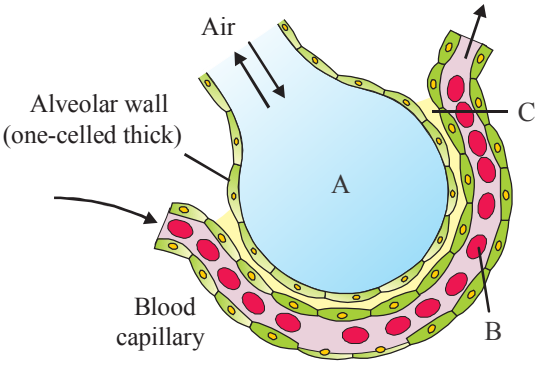
Q.43 Diffusion membrane is made up of
(A) thin squamous epithelium of alveoli.
(B) endothelium of alveolar capillaries,
(C) basement substance in between the two mentioned above
(D) All of the above

Q.44 Factors affecting the rate of diffusion is/are
(A) pressure gradient
(B) solubility of gases
(C) thickness of membranes
(D) All of these

Q.45 How many layers are present in the diffusion membrane of alveolar capillary?
(A) 5 (B) 3
(C) 2 (D) 4

Q.46 Almost same pCO_2 in humans is found in –
(A) oxygenated blood and tissues
(B) deoxygenated blood and oxygenated blood
(C) deoxygenated blood and tissues
(D) All of the above

Q.47 Identify A, B and C in the given diagram and choose the correct option accordingly.



(A) A-Alveolar cavity, B-WBC, C-Capillary wall
(B) A-Alveolar cavity, B-RBC, C-Systemic wall
(C) A-Alveolar cavity, B-RBC, C-Basement substance
(D) A-Alveolar cavity, B-WBC, C-Systemic wall

Q.48 In the diagram given in the previous question, the function performed by A, B and C are as. follows
A-Diffusion of O_2 to blood.
B-Transport of CO_2 .
C-Exchange of gases takes place.
Select among A, B and C which one is correctly matched and choose the correct option accordingly.
(A) Only A (B) Only B
(C) Only C (D) A, B and C

Q.49 Mark the true statement among the following with reference to normal breathing
(A) Inspiration is a passive process where as expiration is active.
(B) Inspiration is a active process where as expiration is passive.
(C) Inspiration and expiration are active processes.
(D) Inspiration and expiration are passive processes.

Q.50 The partial pressure of O_2 is the highest in
(A) alveoli (B) bronchi
(C) trachea (D) tissues

Q.51 Name the artery which carries deoxygenated blood.
(A) Pulmonary artery (B) Pulmonary trunk
(C) Systemic artery (D) Vena cava

Q.52 Partial pressure of O_2 and CO_2 in atmospheric air compared to those in alveolar air is
(A) pO_2-Higher, pCO_2-Lower
(B) pO_2-Higher, pCO_2-Higher
(C) pO_2-Lower, pCO_2-Lower
(D) pO_2-Lower, pCO_2-Higher

Q.53 It is known that exposure to carbon monoxide is harmful to animals because
(A) It reduces CO_2 transport
(B) It reduces O_2 transport
(C) It increases CO_2 transport
(D) It destroys hemoglobin

Q.54 Exchange of O_2 and CO_2 between the blood and tissue is based on
(A) pressure/concentration gradient
(B) inspiratory capacity
(C) osmotic gradient
(D) tidal volume

Q.55 In humans, exchange of gases occurs
(A) by diffusion
(B) between blood and tissue
(C) between alveoli and pulmonary blood capillary
(D) All of the above

PART - 4 : TRANSPORT OF GASES

Q.56 Binding of O_2 with haemoglobin is primarily depended upon
I. partial pressure of O_2.
II. partial pressure of CO_2
III. hydrogen ion concentration.
IV. temperature.
Choose the correct option.
(A) I, II and IV (B) II, III and IV
(C) I, III and IV (D) All of these

Q.57 Carbonic anhydrase is found in
(A) blood (B) plasma
(C) Both (A) and (B) (D) None of these

Q.58 What are the favourable conditions for formation of oxyhaemoglobin?
(A) high pO_2 (B) low pCO_2
(C) low H^+ (D) All of these

Q.59 Haemoglobin is the red coloured iron containing pigment which is present in
(A) WBC (B) RBC
(C) platelets (D) tissue

Q.60 Under which condition, dissociation of oxygen from oxyhaemoglobin in tissues occurs?
(A) low pO_2 (B) high pCO_2
(C) high H^+ (D) All of these

Q.61 pCO_2 is higher in tissues due to
(A) anabolism
(B) catabolism
(C) building up of carbohydrates
(D) building up of proteins

Q.62 Each haemoglobin molecule can carry maximum of –
(A) 2 molecules of O_2 (B) 3 molecules of O_2
(C) 4 molecules of O_2 (D) 1 molecule of O_2

Q.63 CO_2 is carried by haemoglobin as
(A) carboxy haemoglobin
(B) carbamino haemoglobin
(C) carbamido haemoglobin
(D) deoxyhaemoglobin

Q.64 The oxygen - haemoglobin dissociation curve will show a right shift in case of
(A) High pCO_2 (B) High pO_2
(C) Low pCO_2 (D) Less H^+ concentration

Q.65 CO_2 is transported in blood in the form of
(A) haemoglobin (B) oxyhaemoglobin
(C) carbonate (D) bicarbonate

Q.66 Every 100 mL of deoxygenated blood delivers approximately
(A) 3 mL of CO_2 (B) 2 mL of CO_2
(C) 4 mL of CO_2 (D) 1 mL of CO_2

Q.67 Oxygen dissociation curve is a
(A) sigmoid curve
(B) 'J'-shaped curve
(C) exponential growth curve
(D) hyperbolic curve

Q.68 The factor which do not affect the rate of alveolar diffusion is –
(A) solubility of gases
(B) thickness of the membranes
(C) pressure gradient
(D) reactivity of the gases

Q.69 Oxyhaemoglobin in the blood is formed when
(A) O_2 binds with WBC (B) O_2 binds with RBC
(C) O_2 binds with iron (D) O_2 binds with plasma

Q.70 Dissociation of CO_2 from carbamino haemoglobin takes place when
(A) pCO_2 is less in alveoli and pO_2 is high
(B) pCO_2 is low and pO_2 is high in alveoli
(C) pCO_2 is equal to pO_2 in lungs, i.e; low
(D) pCO_2 is equal to pO_2 in tissue, i.e., high

Q.71 Under normal conditions, what amount of O_2 is delivered by 100 mL of the oxygenated blood?
(A) 5 mL (B) 4 mL
(C) 3 mL (D) 2 mL

PART - 5 : REGULATION OF RESPIRATION

Q.72 A chemosensitive area is situated adjacent rhythm centre in the brain. This area is highly sensitive to
(A) CO_2 concentration (B) O_2 concentration
(C) H^+ concentration (D) Both (A) and (C)

Q.73 The breathing centre initiates the ventilation in response to
(A) increase of air pressure.
(B) decrease of air pressure.
(C) increase of CO_2 in arterial blood.
(D) increase of O_2 in arterial blood.

Q.74 Which of the following gas is quite insignificant the regulation of respiration rhythm?
(A) SO_2 (B) N_2
(C) CO (D) O_2

Q.75 Human beings have a significant ability maintain and moderate the respiratory rhythm suit the demands of the body tissues. This acheived by
(A) arterial system (B) systemic vein system
(C) neural system (D) cardiac system

Q.76 When a sea diver goes very deep, he has to breath on compressed air at high pressure. After some times, he looses his strength to work and feel drowsy. This is because of –
(A) compressed air.
(B) more CO_2 diffusing into the blood.
(C) more nitrogen diffusing in the blood and body fats.
(D) nervous system do not work properly.

Q.77 Respiratory centre of the brain is stimulated by
(A) CO_2 content in venous the blood.
(B) CO_2 content in arterial the blood.
(C) O_2 content in arterial the blood.
(D) O_2 content in venous the blood.

Q.78 Pneumotaxic centre of the brain can
(A) moderate the function of respiratory system
(B) decrease the heart rate
(C) increase the heart rate
(D) increase the flow of blood

Q.79 Rate of breathing is controlled by –
(A) amount of freely available oxygen
(B) stress
(C) muscular functions of the body
(D) carbon dioxide

Q.80 Respiratory process is regulated by certain specialized centres in the brain. One of the following listed centres can reduce the inspiratory duration upon stimulation
(A) Medullary inspiratory centre
(B) Pneumotaxic centre
(C) Apneustic centre
(D) Chemosensitive centre

Q.81 Why do human beings face difficulty to breath high elevations?
(A) Lower % of O_2 (B) Temperature lower
(C) High pressure (D) Low pO_2

Q.82 Which part of the brain is called respiratory rhythm centre?
(A) Cerebellum region (B) Brain stem region
(C) Medulla region (D) Temporal region

Q.83 Why breathing is accelerated when the person opens his nose after holding the breathe by closing his nose?
(A) CO_2 build up in the body.
(B) CO build up in the body.
(C) H^+ decreases in the body.
(D) CO_2 decrease in body.

PART - 6 : DISORDERS OF RESPIRATORY SYSTEM

Q.84 Asthama is caused by
(A) infection in the lungs
(B) infection in the trachea
(C) infection in the glottis
(D) spasm in the bronchioles and bronchi

Q.85 Pneumonia is an infection of
(A) trachea (B) larynx
(C) vocal cord (D) lungs

Q.86 Incidence of Emphysema – a respiratory disorder is high in cigarette smokers. In such cases
(A) The bronchioles are found damaged
(B) The alveolar walls are found damaged
(C) The plasma membrane is found damaged
(D) The respiratory muscles are found damaged

Q.87 One of the major cause of emphysema is
(A) pollution (B) smog
(C) cigarette smoking (D) sanitary condition

Q.88 Disease aggravated by pollution is –
(A) haemophilia (B) rheumatism
(C) scurvy (D) bronchitis

Q.89 Which of the following diseases are occupational respiratory disorders?
(A) Silicosis, fibrosis and asbestosis
(B) Emphysema and mountain sickness
(C) Asthma and emphysema
(D) Asthma and AIDS

Q.90 Tobacco smoke contains CO which –
(A) reduces the oxygen-carrying capacity of blood
(B) causes gastric ulcers
(C) raises blood pressure
(D) is carcinogenic

Q.91 Emphysema is a chronic disorder which is caused due to
(A) damaged trachea
(B) damaged nostrils
(C) damaged alveolar walls
(D) damaged lungs

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 If your pet dog lived at atmospheric $pO_2 = 150$ mm Hg and exhibited arterial $pO_2 = 100$ mm Hg and tissues $pO_2 = 10$mm Hg, you would expect the dog to –
(A) die.
(B) accumulate CO_2.
(C) have a serious but nonlethal O_2 deficit.
(D) function normally.

Q.2 A cockroach obtains O_2 for tissues by means of
(A) internal gills
(B) psuedolungs
(C) counter-current exchange
(D) a tracheal system

Q.3 The normal path of air flow through a mammalian respiratory system is –
(A) trachea, larynx, pharynx, bronchus, bronchiole.
(B) larynx, pharynx, trachea, bronchus, bronciole.
(C) pharynx, larynx, trachea, bronchus, bronciole.
(D) pharynx, trachea, larynx, bronchus, bronchiole.

Q.4 Which of the following is a benefit of gas exchange in air compared with water?
(A) higher concentration of molecular oxygen.
(B) oxygen diffuses more slowly in air.
(C) no energy required for ventilation .
(D) moist respiratory surface not needed.

Q.5 Which of the following adaptations for gas exchange is most characteristic of insects?
(A) lungs
(B) tracheal tubes (tracheae)
(C) parabronchi
(D) air sacs

Q.6 Which of the following are accurately matched?
(A) bony fish – operculum
(B) insect – alveoli
(C) bird – spiracles
(D) mammal – gill filaments

Q.7 Tracheal tubes (tracheae)
(A) are typically found in mollusks.
(B) are highly vascular
(C) branch and extend to all the cells
(D) are characteristic of many mammals

Q.8 The most efficient vertebrate respiratory system is that –
(A) amphibians (B) birds
(C) reptiles (D) mammals

Q.9 In a bird, the correct sequence for a breath of air is
(A) anterior air sacs → posterior air sacs → lung
(B) posterior air sacs → lung → anterior air sacs
(C) para bronchi → posterior air sacs → anterior air sacs
(D) posterior air sacs → alveoli → anterior air sacs

Q.10 The amount of air moved in and out of the lungs with each normal resting breath is the –
(A) vital capacity (B) residual capacity
(C) vital volume (D) tidal volume

Q.11 Oxygen in the blood is transported mainly –
(A) in combination with hemoglobin.
(B) as bicarbonate ions.
(C) as carbonic acid.
(D) dissolved in plasma.

Q.12 When a diver ascends too rapidly –
(A) bronchial constriction occurs.
(B) a diving reflex is activated.
(C) nitrogen rapidly bubbles out of solution in the body fluids.
(D) nitrogen hypoxia occurs.

Q.13 Most of the mucus produced by epithelial cells in the nasal cavities is disposed of by means of
(A) a large handkerchief (B) nose picking
(C) evaporation (D) swallowing

Q.14 Which of the following is the equation for aerobic respiration in humans?

(A) Glucose → Alcohol + Energy
(B) Glucose → Lactic acid + Energy
(C) Glucose+Oxygen → Energy + Carbon dioxide + Water
(D) Glucose+Carbon dioxide → Oxygen + Energy + Water

Q.15 During which of the following processes is chemical energy converted to heat energy?

(A) Photosynthesis (B) Respiration
(C) Breathing (D) Excretion

Q.16 What is the approximate oxygen content of expired air?

(A) 0% (B) 4%
(C) 16% (D) 20%

Q.17 Which of the following processes in living organisms involves respiration?

(A) Absorption of mineral salts at the roots
(B) Diffusion of carbon dioxide out of leaves
(C) Movement of oxygen into the leaves
(D) Transpiration

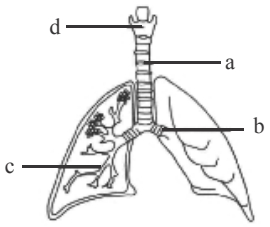
Q.18 What will be the conditions of the following structures during expiration?

	Rib cage	Diaphragm	Lung pressure
(A)	Moves upward and forward	Contracts	High
(B)	Moves downward and backward	Relaxes	High
(C)	Moves upward and forward	Relaxes	Low
(D)	Moves downward and backward	Contracts	Low

Q.19 The following represents the composition of five samples of air. Which of the following could be a sample of air breathed out by a person after vigorous outdoor exercise?

(A) Carbon dioxide-0; Oxygen-24; Nitrogen-75; Inert gases-1; Water vapour-Saturated
(B) Carbon dioxide-21; Oxygen-0; Nitrogen-78; Inert gases-1; Water vapour-Trace
(C) Carbon dioxide-7; Oxygen-14; Nitrogen-78; Inert gases-1; Water vapour- Saturated
(D) Carbon dioxide-Trace; Oxygen-17; Nitrogen-82; Inert gases-1; Water vapour-Saturated

Q.20 The diagram shows organs associated with breathing in humans.



What are the numbered structures?

(A) a-Bronchus, b-Bronchiole, c-Larynx, d-Trachea
(B) a-Bronchiole, b-Bronchus, c-Larynx, d-Trachea
(C) a-Larynx, b-Trachea, c-Bronchus, d-Bronchiole
(D) a-Trachea, b-Bronchus, c-Bronchiole, d-Larynx

Q.21 When bacteria get into the respiratory tract with the air, they are mainly

I. Destroyed by antibodies.
II. Engulfed by white blood cells.
III. Removed with the mucus film by the beating of cilia.

(A) I, II and III (B) I and III only
(C) III only (D) II only

Q.22 Why carbon monoxide (CO) is poisonous for humans?

(A) It affects the nerves of lungs.
(B) It affects the diaphragm and intercostal muscles.
(C) It reacts with oxygen and reduces the percentage of oxygen in air.
(D) Haemoglobin combines with carbon monoxide instead of oxygen and its product cannot be dissociated.

Q.23 Identify the correct and incorrect match about respiratory volume and capacities and mark the correct answer

i. Inspiratory capacity (IC) = Tidal Volume + Residual Volume

ii. Vital Capacity (VC) = Tidal Volume (TV) + Inspiratory Reserve Volume (IRV) + Expiratory Reserve Volume (ERV).

iii. Residual Volume (RV) = Vital Capacity (VC) – Inspiratory Reserve Volume (IRV)

iv. Tidal Volume (TV) = Inspiratory Capacity (IC) – Inspiratory Reserve Volume (IRV)

(A) (i) Incorrect, (ii) Incorrect, (iii) Incorrect, (iv) Correct

(B) (i) Incorrect, (ii) Correct, (iii) Incorrect, (iv) Correct

(C) (i) Correct, (ii) Correct, (iii) Incorrect, (iv) Correct

(D) (i) Correct, (ii) Incorrect, (iii) Correct, (iv) Incorrect

Q.24 Carbon monoxide from car exhausts has been the cause of many deaths. Yet it has no lasting poisonous qualities. Its effects stem from the fact that haemoglobin has a far greater affinity for carbon monoxide than oxygen. Carbon monoxide binds permanently with haemoglobin. What does death from carbon monoxide poisoning result from?

(A) Formation of toxic monoxide ion.

(B) A severe decrease in the oxygen carrying capability of the blood.

(C) A decrease in the carbon dioxide carried by the blood.

(D) Hyperventilation due to increased breathing rate.

Q.25 Which of the following changes will occur when a person is doing vigorous exercise?

	Depth of breathing	**Rate of breathing**	**% O_2 in inhaled air**
(A)	Increases	Increases	Increases
(B)	Decreases	Constant	Increases
(C)	Increases	Increases	Constant
(D)	Decreases	Constant	Constant

Q.26 Which of the following describes what happens during inspiration?

	External intercostal muscles	Internal intercostal muscles	Movement of rib cage	Effect on chest volume
(A)	Contract	Relax	Down and in	Decreases
(B)	Contract	Relax	Up and out	Increases
(C)	Relax	Contract	Down and in	Decreases
(D)	Relax	Contract	Up and out	Increases

Q.27 The table shows the ventilation rates of an adult man while resting and while exercising.

Adult man	**Volume of air inhaled per breath/cm^3**	**Number of breaths per min.**
Resting	400	10
Exercising	1000	40

Compared with resting, the volume of air exchanged per minute was increased during exercise by –

(A) 2.5 times (B) 4 times

(C) 10 times (D) 100 times

Q.28 Which of the following are the end products and effects of anaerobic respiration in muscles?

(A) Carbon dioxide and muscle contraction.

(B) Ethanol and loss of coordination

(C) Lactic acid and oxygen debt

(D) Water and muscle relaxation

Q.29 The respiration of a molecule of glucose can be either aerobic or anaerobic. Which of the following correctly describes anaerobic respiration?

	Amount of energy released	**Carbon dioxide produced**	**Lactic acid produced**
(A)	High	Yes	No
(B)	High	Yes	Yes
(C)	Low	Yes	No
(D)	Low	Yes	Yes

Q.30 During which of the following activities is anaerobic respiration likely to occur?

(A) Driving a car (B) Sleeping

(C) Sprinting on the track (D) Watching television

Q.31 What are the conditions in the muscles when lactic acid is produced?

	Concentration of carbon dioxide	Supply of oxygen
(A)	High	Less than oxygen demand
(B)	High	More than oxygen demand
(C)	Low	Less than oxygen demand
(D)	Low	More than oxygen demand

Q.32 It is sometimes said that "one breathes faster when running because the muscles need more oxygen". Which of the following is the reason why the above statement is wrong?
(A) The muscles do not use more oxygen when one is running.
(B) It is not only when one is running that the muscles need more oxygen.
(C) More oxygen is supplied to the muscles by more rapid circulation of the blood whether one breathes faster or not.
(D) The stimulus for breathing is the concentration of carbon dioxide in the blood rather than a lack of oxygen.

Q.33 Which of the following is the cause of emphysema?
(A) Destruction of alveolar walls.
(B) Clogged alveoli.
(C) Clogged arteries in the lungs.
(D) Infection of the alveoli.

Q.34 Which of the following is the cause of bronchitis?
(A) Blockage of the bronchioles.
(B) Destruction of the alveolar walls.
(C) Inflammation of the walls of the airways.
(D) Overproduction of mucus.

Q.35 When yeast is used in bread making, which type of respiration occurs, which product is useful and which product is waste?

	Respiration	Useful product	Waste product
(A)	Aerobic	Glucose	Ethanol
(B)	Aerobic	Ethanol	Carbon dioxide
(C)	Anaerobic	Carbon dioxide	Ethanol
(D)	Anaerobic	Glucose	Carbon dioxide

Q.36 When 1200 mL air is left in the lungs, it is called
(A) Vital capacity
(B) Tidal volume
(C) Residual Volume
(D) Inspiratory reserve volume

Q.37 Which of the following conditions are found in the alveoli of lungs?
I. high p O_2 II. low p CO_2
III. high p CO_2 IV. low p O_2
V. low H^+ VI. high H^+
Choose the correct option.
(A) I, III and V (B) III, IV and VI
(C) I, IV and VI (D) I, II and V

Q.38 The vital capacity of human lung is equal to –
(A) 3500 ml (B) 4800 ml
(C) 500 ml (D) 1200 ml

Q.39 The type of respiration in mammals is called –
(A) Pulmonary respiration
(B) Gill respiration
(C) Cutaneous respiration
(D) Tracheal respiration

Q.40 The trachea is prevented form collapsing by the presence by rings of –
(A) striated muscles (B) cartilage
(C) adenoids (D) sinuses

Q.41 The process of breathing is controlled by respiratory centre located in the –
(A) spinal cord (B) cerebellum
(C) medulla oblongata (D) hypothalamus

Q.42 When the carbon dioxide concentration in blood increases, the rate of breathing will –
(A) remain unaffected (B) decrease
(C) stop (D) increase

Q.43 During inspiration –
(A) The diaphragm gets raised and ribs get lowered.
(B) Both diaphragm and ribs get raised.
(C) Both diaphragm and ribs get lowered.
(D) The diaphragm get flattered and ribs get raised.

Q.44 Which one of the following can respire in the absence of oxygen
(A) Amoeba (B) Tapeworm
(C) House fly (D) Hydra

Q.45 The breathing rate gets increased by the increase in the content of –
(A) nitrogen (B) oxygen
(C) carbon dioxide (D) carbon monoxide

Q.46 The normal rate of respiration in man per minute is about:
(A) 10 to 15 times (B) 16 to 20 times
(C) 19 to 21 times (D) 23 to 25 times

Q.47 A normal man at rest inspires and expires about 500 millilitres of air, this amount is known as –
(A) complemental volume of air
(B) tidal volume of air
(C) reserve volume of air
(D) residual volume of air

Q.48 One of the following is not respiratory pigment –
(A) Anthocyanin (B) Haemoglobin
(C) Haemoerythrin (D) Haemocfdnin

Q.49 The disease that occurs when the haemoglobin content of the blood goes down is –
(A) plurisy (B) emphysema
(C) anaemia (D) pneumonia

Q.50 The percentage of carbon dioxide, oxygen and nitrogen in exhaled air of man are about –
(A) 0.04 : 16 : 79 (B) 0.4 : 20 : 70
(C) 4.0 : 20 : 79 (D) 4.0 : 16 : 79

Q.51 The transport of oxygen by the blood takes place by –
(A) leucocytes (B) thrombocytes
(C) plasma (D) erythrocytes

Q.52 Lungs are surrounded by
(A) Pleura (B) Pericardium
(C) Epineurium (D) Perineurium

Q.53 The toxic effect of CO is due to its greater affinity for haemoglobin as compared to O_2 approximately by –
(A) 2 times (B) 20 times
(C) 200 times (D) 1000 times

Q.54 A person suffers punctures in his chest cavity in an accident, without any damage to the lungs its effect could be
(A) Reduced breathing rate
(B) Rapid increase in breathing rate
(C) No change in respiration
(D) Cessation of breathing

Q.55 Volume of air breathed in and out during normal breathing is called –
(A) vital capacity (B) IRV
(C) ERV (D) tidal volume

Q.56 Correct sequence of the air passage in humans is
(A) Nose → Larynx → Pharynx → Bronchioles → Alveoli
(B) Nose → Pharynx → Larynx → Bronchioles → Bronchi
(C) Nose → Pharynx → Larynx → Bronchioles → Trachea
(D) External nostril → Nasal passage → Internal nostril → Pharynx → Larynx → Trachea → Bronchi → Bronchiole → Alveoli

Q.57 Identify the type of pulmonary volume/capacity on the basis of quantity of air present in the lungs given below.
I. ~1100 mL - 1200 mL
II. ~ 500 mL
III. ~ 5000 mL - 6000 mL
Choose the correct option.
(A) I- VC, II- FRC, III- RV
(B) I- RV, II- TV, III-TLC
(C) I- EC, II- IC, III- RV
(D) I- TV, II- IRV, III- ERV

Q.58 Arrange the given steps by which the pulmonary volume increases in the sequence of events occuring first.

I. Contraction of intercostal muscles.

II. Lifting up of the ribs.

III. Sternum causing an increase in the volume of the thoracic chamber in dorsoventral axis.

IV. Contraction of the diaphragm which in the volume of the thoracic chamber antero-posterior axis.

Choose the correct option.

(A) I → II → III → IV (B) IV → I → II → III

(C) IV→ I → III → II (D) I → III → IV→ II

Q.59 Almost same pO_2 in humans is found in

(A) alveoli and tissues

(B) oxygenated blood and deoxygenated blood

(C) alveoli and oxygenated blood

(D) tissue and deoxygenated blood

Q.60 In breathing movements, air volume can be estimated by

(A) Stethoscope (B) Hygrometer

(C) Sphignomanometer (D) Spirometer

Q.61 Identify the component of respiratory system which displays the features given below and choose the correct option.

I. Double layered.

II. Fluid contained in it reduces the friction on the lung surface.

III. Its outer layer is in contact with thoracic wall.

IV. Its inner layer is in contact with lungs.

(A) Visceral layer (B) Peritoneum cavity

(C) Visceral organs (D) Pleura

Q.62 Which one of the following is the correct statement regarding the process of respiration in humans?

(A) Cigarette smoking may lead to inflammation of nasopharynx

(B) Neural signals from the pneumotoxic centre in the pons region of the brain can't increase the duration of inspiration.

(C) Workers in grinding and stone breaking industries may suffer from lung fibrosis.

(D) About 90% of CO_2 is carried out by haemoglobin carbominohaemoglobin.

Q.63 I. On an average a healthy human breathes 12-16 times/minute.

II. The volume of air involved in the breathing movements can be estimated by spirometer.

III. Diaphragm is very useful in both inspiration and expiration.

Which of the above statements are incorrect?

Choose the correct option.

(A) I and II (B) II and III

(C) I and III (D) None of these

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 The alternating cycle of contraction and relaxation of the diaphragm and external intercostal muscles underlie _____ .
(i) inspiration and expiration.
(ii) inhalation and exhalation.
(iii) expiration and inspiration.
(iv) exhalation and inhalation.
(v) oxygen intake and CO_2 output.
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii), (v)
(C) (ii), (iii), (v) (D) (i), (ii), (iii)

Q.2 All respiratory surfaces share the following characteristics:
(i) moist (ii) thin
(iii) large surface area (iv) alveoli
(v) spiracles
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii), (v)
(C) (ii), (iii), (v) (D) (i), (ii), (iii)

Q.3 Counter-current exchange –
(i) is used by bony fish.
(ii) maximizes gas exchange by maintaining diffusion gradient.
(iii) respiratory medium moves in same direction as blood flow.
(iv) respiratory medium moves in opposite direction of blood flow.
Choose the correct option –
(A) (i), (ii), (iv) (B) (i), (iii)
(C) (ii), (iii), (iv) (D) (i), (ii), (iii)

Q.4 As RBCs circulate into the region of actively metabolizing tissues (e.g., muscle), you would expect –
(i) increase binding of CO_2 to Hb.
(ii) increase in reduced Hb.
(iii) increase in bicarbonate ion concentration in plasma.
(iv) movement of chloride out of RBC.
Choose the correct option –
(A) (i), (ii), (iv) (B) (i), (iii), (iv)
(C) (ii), (iii), (iv) (D) (i), (ii), (iii)

Q.5 Detect O_2 levels in blood and provide information to the medulla oblongata.
(i) carotid bodies (ii) islets of Langerhans
(iii) aortic bodies (iv) nodes of Ranvier
Choose the correct option –
(A) (i), (ii) (B) (i), (iii)
(C) (ii), (iii) (D) (i), (iv)

Q.6 The ability of oxygen to bind to Hb is affected by –
(i) pO_2 in respiratory medium
(ii) pH
(iii) temperature
(iv) pCO_2 in tissues
Choose the correct option –
(A) (i), (ii), (iv) (B) (i), (iii), (iv)
(C) (i), (ii), (iii), (iv) (D) (i), (ii), (iii)

Q.7 Which of the following is not true of the diving reflex?
(A) breathing stops.
(B) the heart slows.
(C) less blood is distributed to the muscles.
(D) metabolic rate increases by about 20%.

For questions 8 to 10

Refer to the table below which shows the blood flow to the skeletal muscle and an organ, X, at rest and during exercise.

Body part	Blood flow (ml/min)	
	At rest	During exercise
Skeletal muscle	1200	12500
Organ X	500	2000

Q.8 Which of the following are reasons why blood flow to the skeletal muscle increases during exercise?
(a) To remove more urea from the muscle
(b) To carry more heat away from the muscle
(c) To increase the oxygen supply to the muscle
(A) (a) and (b) only (B) (a) and (c) only
(C) (b) and (c) only (D) (a), (b) and (c)

Q.9 Which of the following is NOT a cause for the increase in blood flow to the skeletal muscle during exercise?

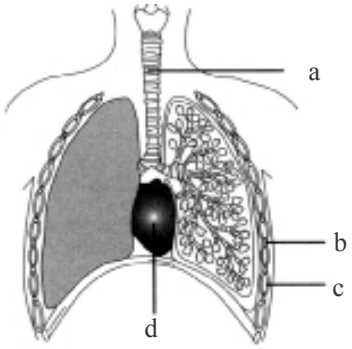
(A) Increase in heart rate
(B) Increase in breathing rate
(C) Increase in blood pressure
(D) Dilation of arterioles in the muscle

Q.10 Which of the following may be the identity of organ X?
(A) The skin (B) The brain
(C) The kidneys (D) The small intestine

Q.11 Arrange the given steps of expiration in the sequence of event occuring first.
I. Relaxation of the diaphragm and sternum.
II. Reduction of the pulmonary volume.
III. Expulsion of air from the lungs.
IV. Increase in intra pulmonary pressure.
Choose the correct option.
(A) I → II → III → IV (B) I → II → IV → III
(C) IV→ III → II → I (D) IV → II → III→ I

Q.12 Arrange the given steps of respiration in sequence of event they occur.
I. Diffusion of gases, O_2 and CO_2 across the alveolar membrane.
II. Transport of gases by the blood.
III. Utilisation of O_2 by the cells for catabolic reactions and the resultant release of CO_2.
IV. Pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.
V. Diffusion of O_2 and CO_2 between the blood and tissue.
Choose the correct option.
(A) I → V → II → I → IV
(B) III → II → V → I → IV
(C) V→ IV → III → II → I
(D) I → II → III→ IV → V

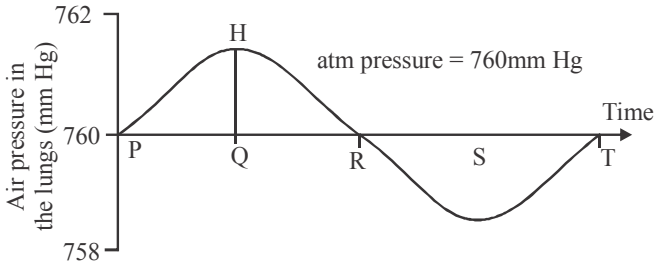
Q.13 In a traffic accident, an accident victim was found to be struggling to breathe. His chest cavity was moving but his lungs were not inflating. Which part of his body in the diagram below could possibly have been injured to cause this?



(A) c (B) b
(C) c (D) d

For questions 14 to 16

Refer to the graph below which shows the change in air pressure in the lungs of a person.



Q.14 Which of the following regions indicates inhalation?
(A) P to Q (B) P to R
(C) R to S (D) R to T

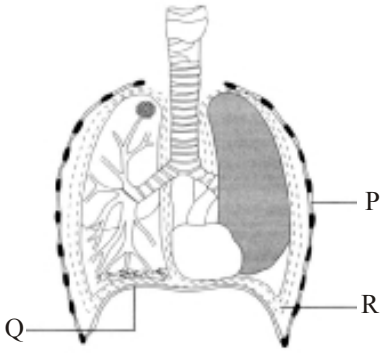
Q.15 Which of the following correctly describes the state of the rib cage and the shape of the diaphragm at Q?

	Rib cage	Diaphragm
(A)	Downward	Flattened
(B)	Downward	Dome-shaped
(C)	Upward	Flattened
(D)	Upward	Dome-shaped

Q.16 The shape of the curve above will change when the person is doing vigorous exercise.
Which of the following correctly describes the changes?

	Distance between P and T	Distance between H and Q
(A)	Increases	Increases
(B)	Increases	Decreases
(C)	Decreases	Increases
(D)	Decreases	Decreases

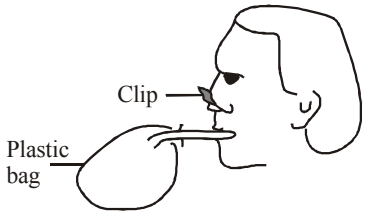
Q.17 The diagram below shows a section through the human thorax. Two sets of muscles are labelled P and Q and the thoracic cavity is labelled R.



Which of the following occur in order for air to enter the lungs?

	Muscles P	Muscles Q	Volume of R
(A)	Relax	Contract	Increased
(B)	Contract	Contract	Increased
(C)	Contract	Relax	Reduced
(D)	Relax	Relax	Increased

Q.18 A person's nose was clipped and was asked to breathe in and out of a plastic bag as shown in the diagram below.



Which of the following changes in the blood of the person is the reason for the change in his breathing rate and depth?

(A) The carbon dioxide concentration had increased.
(B) The lactic acid concentration had increased.
(C) The oxygen concentration had decreased.
(D) The temperature of his blood had increased.

Q.19 Tobacco smoke contains carcinogens. Which effect does this gas have on the body?

(A) It causes cells to divide out of control.
(B) It destroys walls of the alveoli.
(C) It increases the risk of bronchitis.
(D) It lowers the ability of the blood to carry oxygen.

Note (Q.20-Q.25) :

(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(C) Statement - 1 is True, Statement- 2 is False
(D) Statement -1 is False, Statement -2 is False

Q.20 **Statement 1 :** Most fish when out of water, die of suffocation.
Statement 2 : Atmospheric air contains far less oxygen content than the dissolved oxygen in water.

Q.21 **Statement 1 :** During inspiration, pressure of air falls in the thorax.
Statement 2 : There is a rise in volume of thorax during inspiration.

Q.22 **Statement 1 :** Vital capacity is higher in athletes than non-athletes.
Statement 2 : Vital capacity is about 3.5-4.5 litres in a normal adult person.

Q.23 **Statement 1 :** Insects develop a complex system of air tubes called trachea for respiratory purpose.
Statement 2 : Exchange through body surface is not possible in insects.

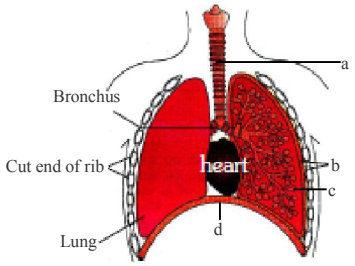
Q.24 **Statement 1 :** Forceful expiration occurs through expiratory muscles.
Statement 2: Expiratory muscles expires quickly.

Q.25 **Statement 1:** Coughing and sneezing are necessary.
Statement 2 : Coughing and sneezing are reflex actions.

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 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 **[NEET 2013]**



(A) d – Lower end of lungs – diaphragm pulls it down during inspiration.
(B) a – trachea - long tube supported by complete cartilaginous rings for conducting inspired air.
(C) b – pleural membrane - surround ribs on both sides to provide cushion against rubbing.
(D) c – Alveoli - thin walled vascular bag like structures for exchange of gases.

Q.2 Approximately seventy percent of carbon-dioxide absorbed by the blood will be transported to the lungs – **[AIPMT 2014]**
(A) As bicarbonate ions
(B) In the form of dissolved gas molecules
(C) By binding to R.B.C.
(D) As carbamino-haemoglobin

Q.3 When you hold your breath,which of the following gas changes in blood would first lead to the urge to breathe? **[AIPMT 2015]**
(A) rising CO_2 concentration.
(B) falling CO_2 concentration.
(C) rising CO_2 and falling O_2 concentration.
(D) falling O_2 concentration.

Q.4 Name the pulmonary disease in which alveolar surface area involved in gas exchange is drastically reduced due to damage in the alveolar walls. **[RE-AIPMT 2015]**
(A) Emphysema (B) Pneumonia
(C) Asthma (D) Pleurisy

Q.5 Name the chronic respiratory disorder caused mainly by cigarette smoking **[NEET 2016 PHASE 1]**
(A) Emphysema (B) Asthma
(C) Respiratory acidosis (DRespiratory alkalosis

Q.6 Asthma may be attributed to – **[NEET 2016 PHASE 1]**
(A) Bacterial infection of the lungs
(B) Allergic reaction of the mast cells in the lungs
(C) Inflammation of the trachea
(D) Accumulation of fluid in the lungs

Q.7 Reduction in pH of blood will **[NEET 2016 PHASE 1]**
(A) Reduce the rate of heart beat.
(B) Reduce the blood supply to the brain.
(C) Decrease the affinity of hemoglobin with oxygen.
(D) Release bicarbonate ions by the liver.

Q.8 Lungs do not collapse between breaths and some air always remains in the lungs which can never be expelled because– **[NEET 2016 PHASE 2]**
(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.

Q.9 The partial pressure of oxygen in the alveoli of the lungs is – **[NEET 2016 PHASE 2]**
(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.

Q.10 Lungs are made up of air-filled sacs the alveoli. They do not collapse even after forceful expiration, because of : **[NEET 2017]**
(A) Residual Volume
(B) Inspiratory Reserve Volume
(C) Tidal Volume
(D) Expiratory Reserve Volume

Q.11 Which of the following options correctly represents the lung conditions in asthma and emphysema, respectively? **[NEET 2018]**

(A) Increased respiratory surface; Inflammation of bronchioles.

(B) Increased number of bronchioles; Increased respiratory surface.

(C) Inflammation of bronchioles; Decreased respiratory surface.

(D) Decreased respiratory surface; Inflammation of bronchioles.

Q.12 Match the column I **[NEET 2018]**

Column I	**Column II**
a. Tidal volume	i. 2500 – 3000 mL
b. Inspiratory Reserve volume	ii. 1100 – 1200 mL
c. Expiratory Reserve volume	iii.500 – 550 mL
d. Residual volume	iv. 1000 – 1100 mL

(A) a-i, b-iv, c-ii, d-iii (B) a-iii, b-i, c-iv, d-ii

(C) a-iii, b-ii, c-i, d-iv (D) a-iv, b-iii, c-ii, d-i

Q.13 Which of the following is an occupational respiratory disorder? **[NEET 2018]**

(A) Botulism (B) Silicosis

(C) Anthracis (D) Emphysema

Q.14 Due to increasing air-borne allergens and pollutants, many people in urban areas are suffering from respiratory disorder causing wheezing due to **[NEET 2019]**

(A) benign growth on mucous lining of nasal cavity.

(B) inflammation of bronchi and bronchioles.

(C) proliferation of fibrous tissues and damage of the alveolar walls.

(D) reduction in the secretion of surfactants by pneumocytes.

Q.15 Tidal Volume and Expiratory Reserve Volume of an athlete is 500 mL and 1000 mL, respectively. What will be his Expiratory Capacity if the Residual Volume is 1200 mL? **[NEET 2019]**

(A) 1500 mL (B) 1700 mL

(C) 2200 mL (D) 2700 mL

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (B) **(2)** (C) **(3)** (D)
(4) (D)
(5) CO_2, breathing, respiration
(6) Inspiration; expiration
(7) Glottis, trachea
(8) Fishes, lungs, moist skin
(9) Increase, decrease, outside, inspiration
(10) Vertebral column, sternum, ribs, diaphragm
(11) 97, RBC, 3, plasma
(12) RBC, alveolar, bicarbonate, CO_2
(13) Epiglottis, mid thoracic, bronchi
(14) CO
(15) Abdomen
(16) CO_2 ; rhythm centre
(17) True
(18) **False.** Respiration is a passive process.
(19) True

EXERCISE - 1 [SECTION-3]																									
Q	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
A	A	B	A	B	A	A	D	D	A	D	A	B	C	B	C	A	C	A	B	B	B	B	C	D	D
Q	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**
A	B	C	C	D	B	A	C	A	B	A	D	D	C	D	B	D	B	C	B	A	D	C	A	D	B
Q	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**			
A	B	A	D	C	D	C	C	B	A	D	B	D	C	A	D	D	B	C	D	A	A	C			

EXERCISE - 2																									
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
A	D	D	C	A	B	A	C	B	B	D	A	C	D	C	B	C	A	B	C	D	C	D	B	B	C
Q	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	B	C	C	D	C	A	D	A	D	C	C	D	B	A	B	C	D	D	B	C	A	B	A	C	D
Q	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**												
A	D	A	C	D	D	D	B	B	D	D	D	C	D												

EXERCISE - 3																									
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
A	A	D	A	D	B	C	D	C	D	D	B	A	A	D	B	C	B	A	A	C	A	B	A	C	B

EXERCISE - 4															
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
A	D	A	A	A	A	B	C	B	B	A	C	B	B	B	A

SOLUTIONS

EXERCISE-1

(1) (B) **(2)** (C) **(3)** (D) **(4)** (D)

(5) CO_2, breathing, respiration

(6) Inspiration; expiration

(7) Glottis, trachea

(8) Fishes, lungs, moist skin

(9) Increase, decrease, outside, inspiration

(10) Vertebral column, sternum, ribs, diaphragm

(11) 97, RBC, 3, plasma

(12) RBC, alveolar, bicarbonate, CO_2

(13) Epiglottis, mid thoracic, bronchi

(14) CO

(15) **Abdomen.** We can voluntarily take deep breath by an effort. In the process of deep inspiration, chest distention is brought about by the external intercostal muscles and the abdominal muscles.

(16) CO_2 ; rhythm centre

(17) True

(18) **False.** Respiration is a passive process.

(19) True

(20) **(A).** Larynx is a cartilaginous box, which helps in sound production and hence called sound box. Until puberty, there is a little difference in the size of larynx (sound box) in males and females. Thereafter, it grows larger and become prominent in males. Therefore, it is called Adam's apple in man. It is the first part of the trachea present in the neck.

(21) (B) **(22)** (A)

(23) **(B).** Nasopharynx is a portion of pharynx. It is the common passage for food and air. Nasopharynx opens through the glottis into the trachea.

(24) **(A).** Exchange part of the respiratory system is the actual site through which the exchange of O_2 between the blood and atmospheric air takes place. Alveoli is the part of lungs at which this exchange takes place.

(25) **(A).** Humans have two lungs, which are covered by a double membrane called pleura, with pleural fluid between them. Pleural fluid reduces the friction on the lung surface. The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in the contact with the lung surface.

(26) **(D).** Mechanism of breathing varies among the different groups of animals depending mainly on their habitats and level of organisation. Lower invertebrates like sponges, coelenterates, flatworms, etc., exchange with by simple diffusion over their entire body surface.

(27) **(D).** Direct respiration is the exchange of gases, without any special respiratory organ and blood. In insects, the tracheal tubes exchange O_2 and CO_2 directly with the haemocoel which then exchange with tissues.

(28) **(A).** Trachea is a straight tube extending upto the mid thoracic cavity, which divides at the level of 5th thoracic vertebra into the right and left bronchi. Each bronchi undergoes repeated division to form secondary and tertiary bronchi ending up to very thin terminal bronchioles.

(29) **(D).** Inside the lungs, each bronchus divides into numerous bronchioles, each of which terminates into an elongated saccule called the alveolar duct, which bears air sacks or alveoli on its surface. Alveoli provides a large surface for gaseous exchange. The number of alveoli in the human lungs has been estimated to be approximately 750million.

(30) **(A). Respiratory System**

Conducting Portion : The conducting portion provides a passage for the air. It conditions the incoming air by warming, moistening and cleaning it. It consists of nasopharynx, larynx, trachea, bronchi, bronchioles and terminal bronchioles.

Respiratory Portion : The respiratory portion consisting bronchioles, alveolar ducts and alveolar sacs, serves to get rid of CO and pick up oxygen. This system is derived from the endoderm.

(31) **(B).** The movement of the air into and out of the lungs is carried out by creating a pressure

gradient between the lungs and the atmosphere. Inspiration can occur if the pressure within the lungs (intra pulmonary pressure) is less than the atmospheric pressure, i.e., there is a negative pressure in the lungs with respect to the atmospheric pressure. Expiration takes place when the intra pulmonary pressure is higher than the atmospheric pressure. i.e., there is positive pressure in the lungs with respect to the atmospheric pressure.

(32) **(C).** A healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.

(33) **(B).** Inspiration is initiated by the contraction of diaphragm, which increases the volume of thoracic chamber in the antero-posterior axis. The contraction of the external intercostal muscles lifts up the ribs and the sternum causing an increase in the volume of thoracic chamber in the dorso-ventral axis. The overall increase in the thoracic volume causes a similar increase in the pulmonary volume.

(34) **(C).** Periodically filling the lungs with atmospheric air and then emptying it is called breathing or ventilation of the lungs. During inhalation or inspiration, the diaphragm contracts, putting backwards by the partial flattening and increasing the thoracic cavity lengthwise.

(35) **(A).** Breathing involves two stages: inspiration during which atmospheric air is drawn in and expiration by which the alveolar air is released out. Inspiration can occur if the pressure within the lungs (intra-pulmonary pressure) is less than the atmospheric pressure, i.e., there is a negative pressure in the lungs with respect to atmospheric pressure. Similarly, expiration takes place when the intra-pulmonary pressure is higher than the atmospheric pressure. The diaphragm and a specialised set of muscles-external and internal intercostals between the ribs, help in generation of such gradients.

(36) **(C).**

(37) **(A).** Air entering the lungs is warm and filtered.

(38) **(B).** Pressure contributed by the individual gas in a mixture of gases is called partial pressure and is represented as for oxygen and for carbon dioxide.

(39) **(B).**

Respiratory Gas	**Atmospheric Air**	**Alveoli**
O_2	159	104
CO_2	0.3	40

(40) **(B).**

(41) **(B).** Alveoli are the primary site of exchange of gases. Exchange of gases also occur between the blood and tissue O_2 and CO_2 are exchanged in these sites by simple diffusion, mainly based on pressure concentration gradient.

(42) (C) **(43)** (D)

(44) **(D).** Pressure/Concentration gradient, solubility of gases as well as the thickness of the membranes involved in diffusion are some important factors that affects the rate of diffusion.

(45) **(B).** The diffusion membrane is made up of three major layers namely, the thin squamous epithelium of alveoli, the endothelium of alveolar capillaries and the basement substance in between them. However, its total thickness is much less than a millimetre. Therefore, all the factors in our body are favourable for the diffusion of O_2 from alveoli to tissues and that of CO_2 from the tissues to alveoli.

(46) **(C).** Deoxygenated blood and tissues both have the same partial pressure of O_2 and CO_2

(47) (C) **(48)** (D)

(49) **(B).** Inspiration 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 Expiration is the process by which foul air is expelled out of the lungs. Expiration is a normal passive process that involves relaxation of inspiratory muscles.

(50) **(A).** Partial pressure of respiratory gases in-mm Hg.

O_2 : Atmospheric air : 158
Alveolar air : 100
Deoxygenated blood : 40

Oxygenated blood : 95
Expired air : 116
Tissue cells : 40
CO_2 : Atmospheric air : 0.3
Alveolar air : 40
Deoxygenated blood : 45
Oxygenated blood : 40
Expired air : 32 ; Tissue cells : 45

(51) (C) **(52)** (A)

(53) **(B).** Carbon monoxide poisioning occurs after enough inhalation of carbon monoxide (CO). Carbon monoxide binds with haemoglobin to form carboxy haemoglobin because of which oxygen is not released to the tissues.

(54) **(A).** Exchange of O_2 and CO_2 between the blood and tissue is based on pressure/ concentration gradient.

(55) **(D).** In humans, exchange of gases occurs
(i) by diffusion
(ii) between blood and tissue
(iii) between alveoli and pulmonary blood capillary.

(56) **(D).**

(57) **(C).** Carbonic anhydrase is found in the blood and the minute quantity of same is in plasma.

(58) **(D).**

(59) **(B).** Haemoglobin is a red coloured iron containing pigment, present in the RBCs. O_2 binds with haemoglobin in reversible manner to from oxyhaemoglobin.

(60) **(D).**

(61) **(B).** In the tissues, where partial pressure of CO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3^- and H^+. At the alveolar site, where is low, the reaction proceeds in the opposite direction, leading to the formation of CO_2 and H_2O. Thus, gets trapped as bicarbonate at the tissue level and transported to the alveoli and released as CO_2.

(62) **(C).** Each chain contains one heme group (colored orange), each of which contains one iron ion . The iron is the site of oxygen binding; each iron can bind one O_2 molecule thus each hemoglobin molecule is capable of binding a total to four O_2 molecules.

(63) **(B).**

(64) **(A).** The oxygen haemoglobin dissociation curve is shifted either to right or left by various factors. The oxygenhaemoglobin curve is shifted to right in the following conditions
(i) Decrease in partial pressure of oxygen.
(ii) Increase in partial pressure of carbon dioxide (Bohr effect).
(iii) Increase in hydrogen ion concentration and decrease in pH (acidity).
(iv) Increased body temperature.
(v) Excess of 2, 3-diphosphoglycerate (DPG).

(65) **(D).** About 7% of the carbon dioxide is transported as dissolved in plasma.
23% as carbamino haemoglobin.
7% as bicarbonate.
Most of the carbon dioxide that is dissolved in blood plasma reacts with water to form carbonic acid. All carbonic acid of RBCs dissociates into hydrogen and bicarbonate ions, that bicarbonate ions diffuses from the RBCs to blood plasma.

(66) (C) **(67)** (A)

(68) **(D).** Alveoli (Thin, irregular-walled and vascularised bag like structure at the end of bronchiole) are the primary site of exchange of gases and are exchanged in these site by
(i) Simple diffusion based on pressure/ concentration.
(ii) Solubility of gases.
(iii) Thickness of the membranes involved in diffusion.
Reactivity of the gases don't affects the alveolar diffusion.

(69) (B) **(70)** (B) **(71)** (A)

(72) **(D).** A chemosensitive area is situated near the respiratory centre, medulla. It is highly sensitive to the change of concentration of CO_2 and hydrogen ions or change in blood pH.

(73) (C) **(74)** (D)

(75) **(C).** Neural system in humans regulates and modulates the respiratory rhythm.
Respiratory centre is located in the medulla oblongata and pons varolii. These centre regulates the rate and the depth of breathing by controlling the contraction of

diaphragm and other respiratory muscles. **Medulla oblongata** contains inspiratory rhythm centre in the dorsal portion of the respiratory centre or in ventral portion of the brain.

(76) **(C).** Sea diver feels fatigued and drowsy because of the diffusion of more nitrogen into the blood and then from blood, nitrogen diffuses into the muscles and body fats.

(77) **(B).**

(78) **(A).** Another centre present in the pons region of the brain called pneumotaxic centre can moderate its functions of the respiratory rhythm centre. Neural signal from this centre can reduce the duration of inspiration and thereby, alter the respiratory rate.

(79) **(D).**

(80) **(B).** Pneumotaxic centre is located in the dorsal part of pons varolii. The function of the pneumotaxic centre is primarily to limit inspiration.

(81) **(D).** Inspiration takes place when there is negative pressure of inside the body than outside. In the mountains, there is less pressure of (negative) than inside, that's why, breathing is difficult in mountain regions.

(82) **(C).**

(83) **(A).** Breathing gets accelerated when the person opens his nose after holding the breath by closing his nose due to increase CO_2 in arterial blood.

(84) **(D).** Asthma is the difficulty in breathing causing wheezing due to the inflammation of bronchi and bronchioles.

(85) **(D).** Pneumonia is an infection of lungs by Diplococcus pneumoniae which leads to the accumulation of mucous and lymph in alveoli, impairing gaseous exchange.

(86) **(B).** Emphysema is a condition of short breath due to breakdown of alveolar wall and reduction of respiratory area due to smoking.

(87) **(C).**

(88) **(D).** Bronchitis is aggravated by pollution. It involves the permanent swelling and inflammation of bronchi, cough with thick mucous and pus cells are spitted out.

(89) **(A).** Occupational Respiratory Disorders In certain industries, especially those involving grinding or stone breaking, so much dust is produced. In that condition, the respiratory diseases like, silicosis, fibrosis and asbestoses occurs. Long exposure can give rise to inflammation leading to fibrosis and thus, causing serious lung damage.

(90) **(A).** Tobacco smoke contains CO (carbon monoxide) which reduces the oxygen-carrying capacity of blood.

(91) **(C).** Emphysema is a chronic disorder in which the alveolar walls are damaged due to which the respiratory surface is decreased. One of the major causes of this condition is smoking.

EXERCISE-2

(1) **(D).** (D) is correct because atmospheric pO_2 is typically 150mmHg near sea level; normal arterial pO_2 is generally 100 mmHg (after extraction from atmospheric air) and tissue pO_2 levels are typically 10 mmHg (where O_2 is being used).

(2) (D) **(3)** (C) **(4)** (A) **(5)** (B)

(6) **(A).** The operculum of a bony fish is the hard bony flap covering and protecting the gills.

(7) (C) **(8)** (B)

(9) **(B).** Birds have lungs, but they also have air sacs. Depending upon the species, the bird has seven or nine air sacs. Birds do not have a diaphragm; instead, air is moved in and out of the respiratory system through pressure changes in the air sacs.

(10) **(D).** Tidal volume is the lung volume representing the normal volume of air displaced between normal inhalation and exhalation when extra effort is not applied. In a healthy, young human adult, tidal volume is approximately 500 mL per inspiration or 7 mL/kg of body mass.

(11) (A) **(12)** (C) **(13)** (D) **(14)** (C)
(15) (B) **(16)** (C) **(17)** (A) **(18)** (B)
(19) (C) **(20)** (D) **(21)** (C)

(22) **(D).** The affinity of haemoglobin to carbon monoxide is about 250 times more than that of oxygen. 0.1% of carbon monoxide

blocks 50% of Hb of the body due to which the oxygen carrying capacity of the blood gets decreased. This is called hypoxia.

(23) (B) **(24)** (B) **(25)** (C) **(26)** (B)
(27) (C) **(28)** (C) **(29)** (D) **(30)** (C)
(31) (A) **(32)** (D)

(33) **(A).** Emphysema gradually damages the air sacs (alveoli) in lungs, making progressively more short of breath.

(34) (D) **(35)** (C) **(36)** (C) **(37)** (D)
(38) (B) **(39)** (A) **(40)** (B) **(41)** (C)
(42) (D) **(43)** (D) **(44)** (B)

(45) **(C).** Breathing exchanges oxygen and carbon dioxide between the body and the environment. Carbon Dioxide (CO_2) is essentially a waste product of the body but is important as a hameostatic feedback mechanism. The level of CO_2 in the blood is the most important influence on the regulation of ventilation. The blood level of CO_2 acts directly on the respiratory centres in the medulla and is a major influence on cerebro-spinal fluid pH. An increase in CO_2 level leads to an increase in ventilation by stimulating phrenic and intercostal nerves that activate the respiratory muscles.

(46) (A) **(47)** (B) **(48)** (A) **(49)** (C)
(50) (D) **(51)** (D) **(52)** (A) **(53)** (C)

(54) **(D).** Punctures in a person's chest may lead to loss of pressure gradient.

(55) (D)

(56) **(D).** Pair of external nostrils opens above the upper lips, which leads to a nasal passage. It opens into the nasopharynx. Nasopharynx opens through the glottis of the larynx region into the trachea. Trachea is a straight tube extending upto mid-thoracic cavity, which divides at the right and left bronchi. Each bronchi undergoes repeated division to form secondary and tertiary bronchi and bronchioles ending up in very thin terminal bronchioles, which gives rise to a number of very thin, irregular walled, vascularised bag like structure called alveoli.

(57) **(B).** I. Residual volume. II. Tidal volume.
III. Total lung capacity.

(58) **(B).**

(59) **(D).** Partial pressure of pO_2 in tissues and deoxygenated blood are almost same. Alveoli has 104mm of Hg, whereas oxygenated blood has 95mm of Hg. Percentage of gases in different parts of body.

Air	Oxygen %	Carbon dioxide %	Nitrogen %	Water vapours
Inhaled Air	20.84	0.03-0.04	79	Variable
Alveolar Air	13.1	5.3	79	Saturated
Exhaled Air	15.7	4.0	79.7	Saturated

(60) **(D).** Spirometry is the process of recording the changes in the volume and movement of air in and out of the lungs and the instrument used for this purpose is called spirometer or respirometer. The graph showing the changes in the pulmonary volumes and capacities under different conditions of breathing is called spirogram.

(61) **(D).** Humans have two lungs, which are covered by a double layered pleura with pleural fluid between them. Pleural fluid reduces the friction on the lung-surface. The outer pleural membrane is in close contact with the thoracic lining whereas, the inner pleural membrane is in the contact with the lung surface.

(62) **(C).**

(63) **(D).** Diaphragm is very useful in both expiration and inspiration. On an average, a healthy human breathes 12-16 times/minute. The volume of the air involved in breathing movements can be estimated by using a spirometer, which helps in the clinical assessment of pulmonary functions.

EXERCISE-3

(1) (A) **(2)** (D)

(3) **(A).** (i) is correct because counter-current exchange is used in bony fish; (iv) is correct because in counter-current circulation, the respiratory medium (in this case, water) flows in the direction opposite to that which the respiratory surface (in this case, lamellae) is perfused with blood. (ii) is correct

because the counter-current circulation results in the pO_2 of water always being higher than the pO_2 of blood, thus favoring the diffusion of O_2 from water to blood across the entire length of the respiratory surface.

(4) (D) **(5)** (B) **(6)** (C) **(7)** (D)
(8) (C) **(9)** (D) **(10)** (D) **(11)** (B)

(12) **(A).** Major steps involving respiration are
Step I : Utilisation of O_2 by cell for catabolic reactions.
Step II : Diffusion of O_2 and CO_2 between blood and tissues.
Step III : Transportation by blood.
Step IV : Diffusion of gases (O_2 and CO_2) through alveolar membrane.
Step V : CO_2 goes out and atmospheric air is drawn in.

(13) (A) **(14)** (D) **(15)** (B) **(16)** (C)
(17) (B) **(18)** (A) **(19)** (A) **(20)** (C)

(21) **(A).** During inspiration (breathing in) the pressure of air falls in the thorax because of increase in its volume which is brought about by the contraction of diaphragm and inspiratory muscles. Since lungs are situated in the thorax, therefore a fall of pressure in thorax also lowers the pressure inside lungs, due to which air from outside rushes into the lungs thorugh nostrils, trachea and bronchi.

(22) **(B).** If a person first inspires with his outermost 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.

(23) **(A).** As the integument of insect is thick and impermeable to minimise lose of body water, they can not carryout gas exchange through their body surface. To overcome this difficulty they have developed a complex system of air tubes called trachea to reach the air directly near the tissue cells. Each trachea communicates with the exterior through openings in the body wall.

(24) **(C).** In forceful expiration requiring effort, a different group of intercostal and some abdominal muscles contract to reduce the volume of thorax more than that in ordinary respiration. So, a larger volume of air is breathed out, such muscles are called expiratory muscles.

(25) **(B).**

EXERCISE-4

(1) **(D).** a – Trachea ; b – Pleural membrane ; c – Alveoli, d – Diaphragm

(2) **(A).** Nearly 20 – 25% of CO_2 is transported by RBCs, whereas, 70 percent of it is carried as bicarbonates. About 7 percent of CO_2 is carried as dissolved state in plasma.

(3) **(A).** Rise in CO_2 concentration is detected by chemosensitive area activates inspiratory centre in Medulla oblongata, which lead to urge of breathing. Role of O_2 concetration is non significant.

(4) **(A).** Emphysema is mainly due to cigarette smoking in which the walls of alveoli are damaged that leads to reduction in surface area for gaseous exchange.

(5) **(A).** Emphysema is characterised by inflation of alveoli which is mainly due to chronic cigarette smoking.

(6) **(B).** Asthma is an allergic reaction characterised by spasm of bronchi muscles because of effect of histamine released by mast cells.

(7) **(C).** Reduction in pH of blood favours the dissociation of oxyhemoglobin.

(8) **(B).** Lungs do not collapse between breaths and some air always remains in the lung which can never be expelled because there is a negative intrapleural pressure pulling at the lung walls.

(9) **(B).** Partial pressure of oxygen in alveoli of lungs is 104mm of Hg that is more than that of blood in pulmonary artery (40 mm of Hg).

(10) **(A).** Volume of air present in lungs after forceful expiration as residual volume which prevents the collapsing of alveoli even after forceful expiration.

(11) **(C).** Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles. Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased.

(12) **(B).** Tidal volume is volume of air inspired or expired during normal respiration. It is approximately 500 mL. Inspiratory reserve volume is additional volume of air a person can inspire by a forceful inspiration. It is around 2500 – 3000 mL. Expiratory reserve volume is additional volume of air a person can be expired by a forceful expiration. This averages 1000 – 1100 mL. Residual volume is volume of air remaining in lungs even after forceful expiration. This averages 1100 – 1200 mL.

(13) **(B).** Silicosis is due to excess inhalation of silica dust in the workers involved grinding or stone breaking industries. Long exposure can give rise to inflammation leading to fibrosis and thus causing serious lung damage. Anthrax is a serious infectious disease caused by *Bacillus anthracis*. It commonly affects domestic and wild animals. Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased.
Botulism is a form of food poisoning caused by *Clostridium botulinum*.

(14) **(B).** Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles. It can be due to increasing air born allergens and pollutants. Asthma is an allergic condition. Many people in urban areas are suffering from this respiratory disorder.

(15) **(A).** Tidal Volume = 500 ml
Expiratory Reserve Volume = 1000 ml
Expiratory Capacity = TV + ERV
= 500 + 1000 = 1500 ml