RESPIRATORY SYSTEM

INTRODUCTION

Cells continually use oxygen (O_2) for the metabolic reactions that release energy from nutrient molecules and produce ATP. At the same time, these reactions release carbon dioxide. Since an excessive amount of CO_2 produces acidity that is toxic to cells, the excess CO_2 must be eliminated quickly and efficiently. The two systems that cooperate to supply O_2 and eliminate CO_2 are the cardiovascular system and the respiratory system. The respiratory system provides for gas exchange, intake of O_2 and elimination of CO_2, whereas the cardiovascular system transports the gases in the blood between the lungs and body cells. Failure of either system has the same effect on the body: disruption of homeostasis and rapid death of cells from oxygen starvation and buildup of waste products. In addition to functioning in gas exchange, the respiratory system also contains receptors for the sense of smell, filters inspired air, produces sounds, and helps eliminate wastes.

Respiration : Respiration is the exchange of gases between the atmosphere, blood and cells. It takes place in three basic steps :

(1) 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.

(2) 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.

(3) 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.

4.1 RESPIRATION

Respiration is a process which involves intake of oxygen from environment and to deliver it to the cells. It include stepwise oxidation of food in cells with incoming oxygen, elimination of CO_2 produced in oxidation, *release of energy during* oxidation and storing it in the form of ATP.

(i) **Respiratory surface :** The surface at which extend of gases (CO_2 and O_2) takes place is called respiratory surface. Respiratory surface must be vascular and have enough area for gas exchange. For example – plasma membrane in protozoa, body wall (skin) in annelids, alveocapillary membrane in men.

(ii) **Respiratory medium :** Oxygen is dissolved in air and water. Thus water and air are source of oxygen for animals and called respiratory medium. Water and air are external respiratory medium.

Respiratory medium comes in contact with respiratory surface and gaseous exchange takes place between respiratory medium and blood or any other transport medium through respiratory surface by simple diffusion. Inside the body an internal respiratory medium is also found. This internal respiratory medium is tissue fluid. Cells exchange their gases with tissue fluid through plasma membrane.

(iii) **Types of respiration :** It is of two types

(a) **Aerobic respiration :** It occurs in the presence of molecular oxygen. The oxygen completely oxidises the food to carbon dioxide and water, releasing large amount of energy. The organisms showing aerobic respiration, are called aerobes. It is found in most of animals and plants. Aerobic respiration is of two main types direct and indirect.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2} \rightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \underset{\text{Energy}}{2830\ kJ}$$

(1) **Direct respiration :** It is the exchange of environmental oxygen with the carbon dioxide of the body cells without special respiratory organs and without the aid of blood. It is found in aerobic bacteria, protists, plants, sponges, coelenterates, flatworms, roundworms and most arthropods.

Protists : *Amoeba proteus* is about 0.25 *mm*. Wide and has a large surface area to volume ratio. Diffusion of gases occurs over the entire surface *via* cell membrane, and is enough to fulfill its metabolic requirements.

Coelenterates : In *Hydra* and *Obelia,* practically all cells are in contact with the surrounding water. Each cell can exchange gases sufficient for its own needs through the cell membrane adjacent to water.

Flatworms : *Planaria* can also exchange gases sufficient for its needs by diffusion over its body surface. This is facilitated by its very thin body which increases the surface area to volume ratio.

(2) **Indirect respiration :** It involves special respiratory organs, such as skin, buccopharyngeal lining, gills and lungs, and needs the help of blood. The respiration in the skin, buccopharyngeal lining, gills and lungs is respectively called cutaneous buccopharyngeal, bronchial and pulmonary respiration. Cutaneous respiration takes place in annelids, some crustaceans, eel fish, amphibians and marine snakes. It occurs both in water and in air. Buccopharyngeal respiration is found in certain amphibians such as frog and toad. It occurs in the air. Branchial respiration is found in many annelids, most crustaceans and mollusks, some insect larvae, echinoderms, all fishes and some amphibians. It occurs in water only. Pulmonary respiration is found in snails, pila, some amphibians and in all reptiles, birds and mammals. It takes place in air only.

(b) **Anaerobic respiration :** It occurs in the absence of molecular oxygen and *is also called fermentation*. In this, the food is only partially oxidised so only a part of energy (5%) is released and of energy remains trapped in the intermediate compounds. It is found in lower organisms like bacteria and yeast. It is also found in certain parasitic worms (*Ascaris, Taenia*) which live in deficient medium. The organism showing anaerobic respiration, are called anaerobes. These involve one of following reactions.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow[\text{(Fermentat ion of sugars)}]{\text{In yeasts}} \underset{\text{Ethanol}}{2C_2H_5OH} + 2CO_2 + 118\ kJ$$

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{In intestinal worms}} \underset{\text{Lactic acid}}{2CH_3CHOHCOOH} + \text{Energy}$$

Certain body tissues of even aerobes also show anaerobic metabolism *e.g.*, during the vigorous contraction of skeletal muscle fibres. In this, the glucose is metabolised into the lactic acid in anaerobic conditions. The rapid formation and accumulation of lactic acid are responsible for muscle-fatigue. *The mammalian RBCs shows* anaerobic respiration as these lack the mitochondria. In lens of eye and cornea of eye respiration is anaerobic because these structures are a non vascular. *Anaerobic respiration appeared first in primitive organisms because there was absence of O_2 in primitive atmosphere*.

Difference between aerobic and anaerobic respiration

Aerobic respiration / Metabolism	Anaerobic respiration / Metabolism
It uses molecular oxygen.	It does not use molecular oxygen.
Always release CO_2.	May or may not release CO_2.
It produces water.	It does not produce water.
It produce much more energy (whole energy present in glucose).	It produce less energy (only 5% of that available in glucose).
It yields inorganic end products only.	It yields organic end products with or without inorganic product.
It is found in majority of animals.	It found in some parasitic worms. (Ascaris, Taenia).

4.2 Respiratory organs

(i) **Skin :** Respiration by skin is called cutaneous respiration. Skin is the only respiratory organ in most annelids (*earthworm and leeches*) *and an additional respiratory organ in amphibians (Toads and frogs)*. Skin should be thin, moist, naked, permeable and well vascular for respiration. For cutaneous respiration animal should have large surface area then its volume and should have relatively inactive life to minimize the use of oxygen. In earthworms, epidermis has rich network of blood capillaries and their body surface has a moist film containing secretions of epidermal mucous glands, excretory wastes and coelomic fluids. The epidermal capillaries that in turn release the CO_2, take up oxygen dissolved in film of surface moisture. Some marine annelids *such as sandworms (nereis) have parapodia (locomotory* appendages) for respiration. In frog 100% cutaneous respiration during hibernatin. In all marine snakes 20% respiration by skin.

(ii) **Tracheae :** In insects, peripatus centipedes and millipedes tracheae are found for respiration. Tracheae are complex system of whitish, shining, intercommunicating air tubules. Tracheae are ectodermal air tubes. 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.* Trachioles internally lined by chitinous cuticle called intima, which spirally thickened to form taenidae. Tracheae without taenidae, tracheae lined by trachein protein. 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.

Tracheae open out on body wall through ten paired lateral apertures called stigmata or spiracles or stigmatum. Stigmata are two pairs thoracic and eight pairs abdominal. Each spiracle is surrounded by an annular sclerite (peritreme) which opens into air filled cavity called atrium or tracheal chamber. Expansion of abdominal cavity allows the space inside the tracheal trunk to expand. As a result air enters through the spiracles and distributed in body cavity through tracheal system. When abdominal cavity contracts the tracheal system also contracts the pressure of air inside the tracheal systems increases causing the release of air to the outside. Most of CO_2 diffuse out by chitin. At rest, the tracheoles are filled with watery fluid, oxygen is dissolved in this fluid and diffuses to cells. During activity the fluid in the tracheoles is drawn osmotically into the tissues. Consequently more air rushes into the tracheoles. Similarity between the trachea of cockroach and rabbit is that, wall of both are non collapsible.

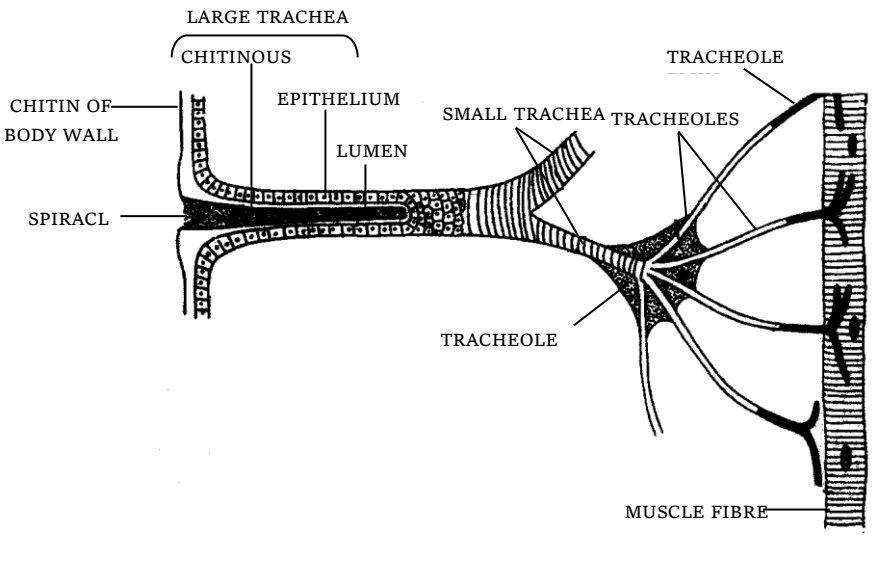


Fig. – Trachea of

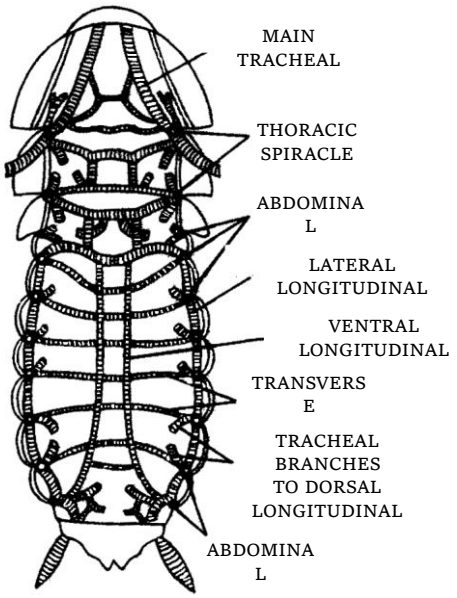


Fig. – Show respiratory system of

(iii) **Book lungs and book gills :** *Spiders ticks, mites and scorpion (belongs to class arachnida) have book lungs for respiration.* In scorpion 4 pairs of book lungs are present. A book lung is a

chamber containing a series of thin vascular, parallel lamellae arranged like the pages of book. Book gills are found in marine king crab or horse shoe crab.

(iv) **Gills :** Aquatic animals such as *prawn, unio,* fishes, sea stars and *tadpoles* respire by gills. Respiration by gills called bronchial respiration. Gills are of two types :

(a) **External gills :** External gills are found in arenicola (lug worm), larvae of certain insects *e.g.* damsel fly and some amphibians *e.g.* necturus, siren, proteus, *frog tadpole first develop external gills which* are replaced by internal gills later.

(b) **Internal gills :** The internal gills may be phyllobranch (prawn), monopectionata (pila) eulamellibrach (unio), lameellibranch, fillibranch (pisces). In all fishes, gills are hemibranch or demibranch and holobranch. In gills, gill lamellae are found which have capillary network. Water is drawn into gills $\rightarrow$ blood flowing in the capillaries of gill lamellae absorb oxygen from water and release CO_2 $\rightarrow$ water containing CO_2 is thrown out from gills. The 80% of O_2 of incoming water is absorbed. Water breathing causes some problems such as

(1) For indrawing the water inside the gills, animals have to make great muscular effort because water is about 800 time more denser than air.

(2) Water has less uncombined O_2 than air. Therefore large quantity of water is required to be passed over the gills to fulfill the oxygen need.

(3) As the temperature rises the O_2 content of water falls and animals face problem.

Oxygen content of respiratory media	
Respiratory media	**Oxygen content**
Air	209.5 *ml./l.*
Fresh water at 25°*C*	5.8 *ml./l.*
Fresh water at 5°*C*	9.0 *ml./l.*
Sea water at 5°*C*	6.4 *ml./l.*

(v) **Buccopharyngeal lining :** Frog breathes by buccopharyngeal lining of buccopharyngeal cavity. This is called buccopharyngeal respiration.

Animals	Respiratory organs
Protists, Bacteria	Direct respiration through plasma membrane
Porifera and Coelenterates	Direct respiration by each cells through plasma membrane also by canal system in porifera.
Platyhelminthes (*Fasciola hepatica*, tapeworm)	Anaerobic
Nematodes (*Ascaris*)	Anaerobic
Annelids (Earthworm and Leeches)	Skin
Nereis	Parapodia
Insects	Trachea
Centipedes	Trachea
Millipedes	Trachea
Spider and Scorpion, ticks, mites	Book lungs
Marine king crab	Book gills
Prawns, Unio and Pila	Gills
Echinodermata	Bronchiole, Tube feet, Respiratory tree, Bursae and water lungs.
Fishes, Sea star, Tadpoles	Gills
Frogs, Toads	Buccopharyngeal, Lungs, Skin
Reptiles, Birds, Mammals	Lungs
Aves, chemeleon, house fly, locust	Air sacs.
Bony fish	Air bladder.
Urochordata	Test
Marine turtle	Clocal respiration
Mollusca, Herdmania	Mental

4.3 Respiratory system of human

Human respiratory *system is derived* from endoderm. Human respiratory system may be divided into two components.

(i) **Respiratory tract or conducting portion** (ii) **Respiratory organs**

(i) **Respiratory tract or conducting portion :** It is the passage for the air. In this part gaseous exchange does not takes place. It is also called dead air space. It is divided in following parts :

(a) **Nose :** (Latin-Nasa) (Greek-Rhine) cavity of nose is called nasal cavity. Nasal cavity is divided into two parts by nasal septum called mesenthmoid. Each part is called nasal chamber. Each nasal chamber opens out side by external nares. Nasal septum has two part. First part is small and is made of cartilage (hyaline). Second part is major and it is bony. Vomer is the main bone. Each nasal chamber has three region.

(1) **Vestibular region :** Vestibular region also known as vestibule, lined by non keratinized squamous epithelium, it is ectodermal in origin and have sebaceous gland, sweat gland and hair. Vestibule is also found in inner air larynx, mouth and vagina. It acts like a seive to check the entry of large dust particles and other things.

(2) **Respiratory region :** Middle region lined by respiratory epithelium which is *ciliated pseudostratified columnar epithelium*. It contains mucus and serous cells. Mucus cells produce mucus and serous cells produce watery fluid. Respiratory epithelium is highly vascular and appears pink or reddish. *Respiratory region acts as a air conditioner and makes the temperature of in going air nearly equal* to body. It also acts as a filter not give entry to dust particles, flies or mosquitoes.

(3) **Olfactory region :** It is upper region. It is lined by olfactory epithelium. This is also called Schneiderian epithelium. Olfactory region is the organ of smell and detect the odour of inspired air. Inspiration is stopped if odour of air is foul or offensive. According to new researches pheromone receptors are found in nasal cavities.

(b) **Nasal conchae :** Lateral wall of nasal cavity have three shelves like structures called conchae or turbinate. 3 pairs of nasal conchae are found. Nasal conchae are covered with mucus membrane. They increase the surface of nasal chamber. Both the chambers of nasal cavity open into nasopharynx by their apertures called internal nostrils or conchae. Adjacent to internal nostril there are opening of eustachian tube. Names of these three conchae and names of the bones that form them are given below.

(1) Superior conchae : The dorsal most chochae is supported mainly by nasal bone called nasoturbinate. It is the smallest conchae.

(2) Middle conchae : Ethmoid bone called ethmoturbinate.

(3) Inferior conchae : The ventral most conchae supported by maxilla bone called maxilloturbinate. It is a separate bone itself.

(c) **Pharynx :** It is the short vertical about 12 *cm* long tube. *The food and air passages cross here*. It can be divided in 3 parts –

(1) **Nasopharynx :** Nasopharynx is only respiratory upper part in which internal nares open. There are 5 opening in its wall; two internal nares, two eustachian tube opening and opening into oropharynx.

(2) **Oropharynx :** Middle part is called oropharynx. In this part oral cavity open known as fauces. Two pair tonsils the palatine and lingual tonsils are found in the oropharynx.

(3) **Laryngopharynx or hypopharynx :** Lowest part is called laryngopharynx. It leads into two tubes. One at the front is wind pipe or trachea and one at the back is food pipe or oesophagus. Both oro and laryngo pharynx is both a respiratory and a digestive pathway.

Nasopharynx lined by ciliated pseudostratified epithelia, oropharynx and laryngopharynx lined by non keratinized epithelium. Mouth serves as an alternate route for air when nasal chambers are blocked. Foramen by which *pharynx opens into larynx called glottis*. In general it remains open. During swallowing it is closed. It provides passage for air. Pharyns leads into the oesophagus through an aperture called gullet. In general condition it remains closed and opens at the time of swallowing. During swallowing epiglottis closes the glottis.

(d) **Larynx or Voice box :** *It is found both in frogs and rabbits*. Larynx does not help in respiration. It is present on tip of trachea and is made up of 9 cartilages such as *thyroid (single) has a prominence called pomum admi or adam's apple*, cricoid (single), arytenoid (paired) are piece of hyaline cartilage. While epiglottis (single), carniculate (paired) cuniform (paired), santorini are piece of elastic cartilage. Clinically, the cricoid cartilage is the landmark for making an emergency air way.

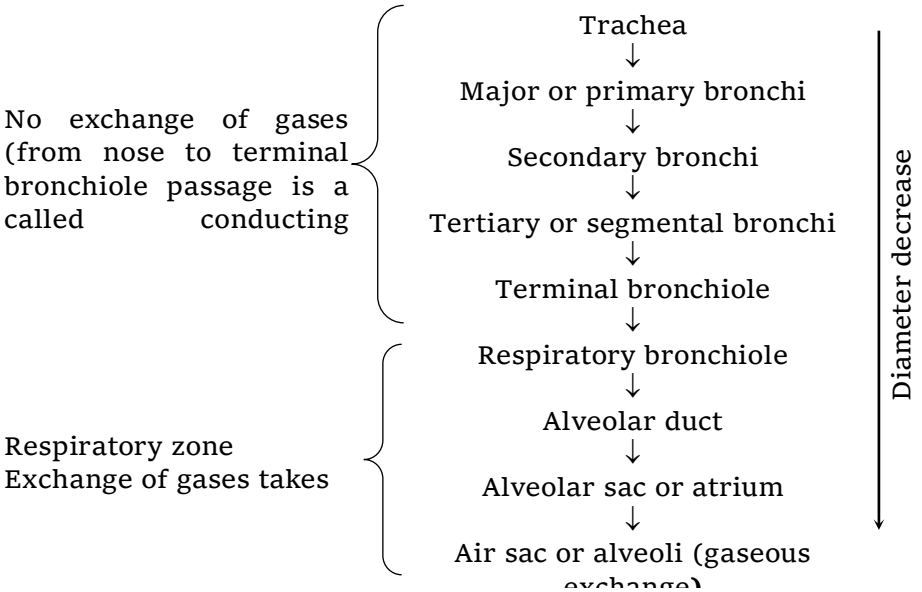
Larynx is a short tubular chamber and opens into the laryngopharynx by *a slit like aperture called* glottis. Glottis always remains open except during swallowing. Larynx is more prominent in men than women due to male harmone. Before puberty, the larynx is inconspicuous and similar in both sexes. *Larynx is a voice producing instrument*. For this purpose larynx have two types of vocal cord. *In birds voice producing organ is syrinx*, found at lower end of tracheae.

(1) **False vocal cord or vibrating fold or anterior vocal cord :** These are folds of mucus membrane. Gap between them is called rema vestibuli. These are not responsible for sound production. In elephants only true vocal cords are present and are responsible for this trumpet sound.

(2) **True vocal cord or posterior vocal cords :** They are made up of yellow elastic fibres. Gap between them is called rema glottides or peep hole. In males the length *of true vocal cord is 2.25 cm and in female is 1.75 cm.* The free inner rim of each vocal cord is set into vibrations as air is expelled from the lungs and the sound is produced when the cords vibrate. Pitch of the sound can be altered by contracting or relaxing the vocal cords to varying the degrees. Sound produced by rabbit is called quaking. Hippopotamus lacks true vocal cords. Vocal cords or folds in lined by non keratinized stratified squamous epithelium. Pitch is controlled by the tension of vocal folds. Lower sound produced due to decreasing muscle tension on vocal cords. Due to influence of androgens, vocal cords are usually thicker and longer in males than in females, therefore they vibrate more slowly. Thus men generally have a lower range of pitch then women. The pharynx, mouth nasal cavity act as resonating chamber. Muscle are face, tongue and lips help us enunciates words.

(e) **Trachea :** It is a tubular structure of about 12 *cm.* in length and 2.5 *cm* in diameter. The wall of trachea is made of fibres, cartilage muscles and the mucus membrane. In middle of thorax at the level of 4^{th} and 5^{th} thoracic vertebra *it divides into two branches called right and left primary bronchi*. Right primary bronchus is short and broad and divides into three branches called lobes or secondary bronchi which extend separately into the three lobes of right lung. Left primary bronchus divides into two lobes

or secondary bronchi that pass into two lobes of left lung. At the point of bifurcation trachea has projection of cartilage called carina. Further division of secondary bronchi is given in form of arrow diagram.



Bronchioles are narrowest and most numerous tubes of lungs. Alveoli are not tube they are sacs like structures. Into alveolar sac 3 to 6 air sacs or alveoli open. *There are 300 millions of alveoli in the two* lungs. Air capillaries replace alveoli in birds. O_2 *carried in inhalation ultimately* reaches in alveoli. *Area of internal surface of both lungs (alveoli) is about* $70 m^2 (750\ ft^2)$, *about the size of a handball court. Thus provide large surface for gaseous exchange. Area of inner surface of bronchiole is* $10\ m^2$. Trachea and its branches up to alveoli are called bronchial tree.

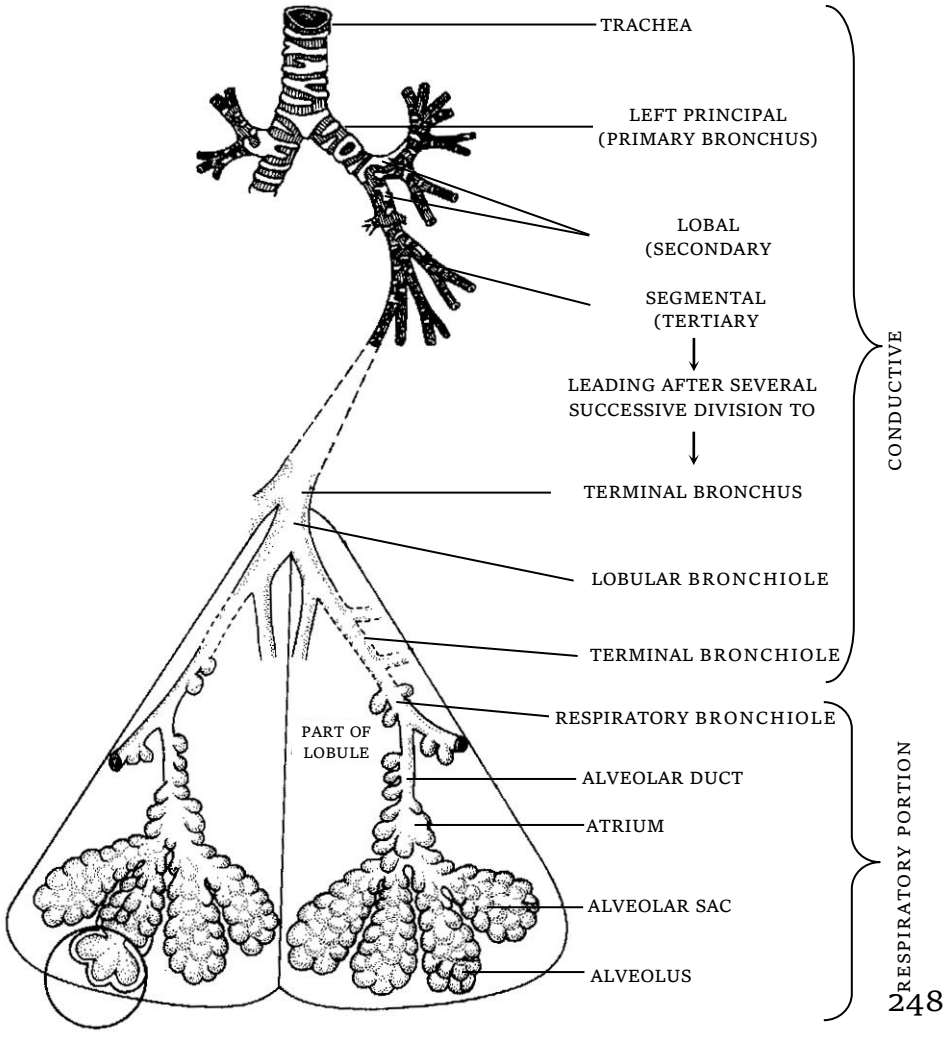


Fig. – Bronchial

The alveolar walls consists of two types of alveolar epithelial cells or pneumocytes. Type I alveolar (squamous pulmonary epithelial) cells are simple squamous epithelial cells that forms a continuous lining of the alveolar wall, interrupted by occasional, type II alveolar (septal) cells. Type I alveolar cells are the main site where gas exchange, takes place. Type II cuboidal alveolar cells secrete alveolar fluid. Associated with the alveolar wall are alveolar macrophages (dust cell). The thickness of alveolar-capillary membrane is 0.5μm (about $^{1}/_{16}$ the diameter of RBC). Pulmonary blood circulation differes from systemic circulation in two ways –

(i) Pulmonary blood vessels provide less resistance to blood flow.

(ii) Less pressure is required to remove blood through pulmonary circulation.

In trachea about 16 – 20 c-shaped cartilagenous (hyaline) rings are found. These rings are incomplete posteriorely or incomplete dorsally. Cartilagenous rings are also found in the bronchi. In bronchioles these rings are absent. *In insects trachea also find supporting rings cartilagenous rings keep trachea and bronchi open permanently even during negative pressure created by expiration. Larger bronchioles are supported by connective tissue alone which extend from the intertubular septa*. Muscles of human tracheo bronchial tree are smooth and are supplied by sympathetic and parasympathetic nerves. Contraction of these muscles leads to narrowing of the bronchus. It is called bronchiospasm. Effect of bronchiospasm is remarkable on fine bronchioles where muscles are present but cartilagenous rings for support are absent. Bronchiospasm below tertiary bronchi clinically called bronchial asthma. Sympathetic nerves stimulation causes relaxation of bronchial muscles and hence drugs which causes stimulation of sympathetic nerves called sympathomimetic drugs, are given in treatment of bronchial asthma.

Wall of trachea,upper bronchi is lined by pseudostratified ciliated columnar epithelium rich in mucus secreting cells. Mucus holds the dust and bacteria which are *swept by cilia toward the pharynx from where they are swallowed or thrown out*. Tobacco smoke contains ciliotoxius which damages the cilia. Terminal *bronchioles and beginning of respiratory bronchiole are lined by simple ciliated columnar epithelium without mucus cells*. The mucus if present may block the these narrow tubules. Rest of respiratory bronchiole and alveolar duct have non ciliated cuboidal epithelium. There are 10 bronchioles in right lung and 8 bronchioles in left lung. The bronchioles contain 3 special types of cells along with normal epithelium.

Different epithelium living in respiratory tract	
Vestibular region of nose	Skin having hair
Respiratory region of nose	Ciliated pseudostratified
Olfactory region of nose	Olfactory (Schneiderian) epithelium
Pharynx (Oropharynx, Laryngopharynx)	Non-keratinised stratified squamous
Trachea and bronchi (Upper)	Pseudostratified ciliated columnar epithelium with mucus cells
Lower bronchi (Secondary / Tertiary)	Lined by simple ciliated columnar epithelia
Terminal bronchioles and beginning of	Simple ciliated columnar epithelium without

respiratory bronchiole	mucus cells
Rest of respiratory bronchioles, alveolar duct	Non ciliated cuboidal epithelium
Alveoli	Non ciliated squamous
Alveoli of frog's lungs	Columnar ciliated epithelium

(1) **Kultchitsky cells or argentaffin cells :** They secrete serotonin and histamine. Serotonin dilate while histamine constrict the bronchioles.

(2) **Clara cells :** They secrete a phospholipid named diapalmityl lecithin which acts as a surfactant. *This surfactant prevents the collapse of bronchioles lacking cartilagenous rings. Collapsing of lungs is called atelectesis*. Pottle in 1956 proved the existence of surfactant. Surfactant is formed by clara cells only at later stage of foetal life. Some times at birth some infants are devoid of surfactant so there is great respiratory difficulty because lungs refuse to expand. In this condition death may occur. This is called respiratory distress syndrome (RDS) or hyaline membrane disease (HMD) or glassy lung disease.

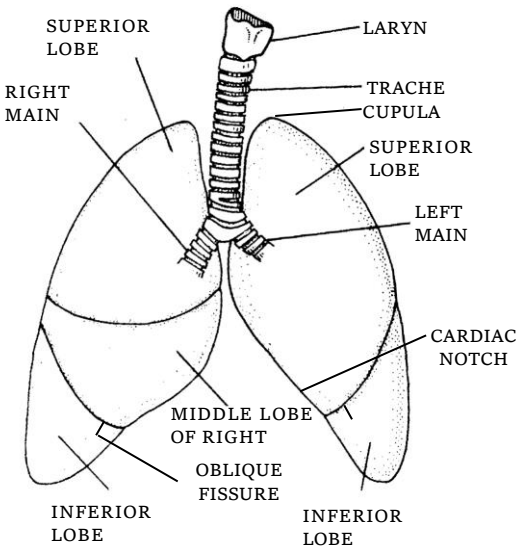


Fig. – Lungs

(3) **Dust cells :** They are phagocytes which eat foreign particles (dust).

(ii) **Respiratory organs :** In men the respiratory organ are a pair of lung. *Some snakes have unpaired* lungs. Respiration by lungs is called pulmonary respiration. Lungs are found in all vertebrates except fishes. In Lung fishes such as protopterus, neoceratodus and lepidosiren air bladder is found, which is modified lung. *Respiration in men and rabbit is pulmonary*.

(a) **Lungs :** *Lungs lie in thoracic cavity* on both side of heart in mediasternum space. Base of lung is attached to diaphragm. *Right lung is divided into 3 lobes viz.* Superior, Middle, Inferior and left lung is divided into two lobes Superior and Inferior. *In rabbit, the left lung is divided into two lobes left anterior and left posterior where as the right lung has four lobes anterior azygous, right anterior, right posterior and posterior azygous*. Lungs of reptiles are more complex than those of amphibians. *In birds lungs are supplemented by elastic air sacs which* increase respiratory efficiency. The narrow superior partion of lung is termed the apex or cupula.

Each lung is enclosed in two membrane called pleura. Pleura are layers of peritonium of thorax. Inner membrane is called the visceral pleuron. It is firmly bound to surface of lungs. The outer membrane is called parietal pleuron. It is attacked to chest wall or wall of thoracic cavity. *A narrow space exists between the two pleura. It is called pleural cavity*. In pleural cavity a watery fluid is found called pleural fluid. Pleural fluid is glycoprotein in nature and secreted by pleura. Pleural fluid lubricate the pleura so that they may slide over each other without friction. This fluids reduces friction bewteen

the membrane. When the lungs expand and contract in respiration. Pressure inside pleural cavity is negative – 5 *mm Hg*. *Plurisy is inflamation of pleura and cause collection of fluid in pleural cavity. It results painful* breathing (dyspnea). The surface of lung lying against the ribs, known as coastal surface. The mediastinal (medial) surface of each lung contains a region – the hilus, through which bronchi, pulmonary blood vessels, lymphatic vessels and nerve enter and exit.

4.4 Pulmonary volumes and capacities

In clinical practice, the word respiration (ventillation) means on inspiration plus one expiration. The healthy adult averages 12 respiration's a minute and moves above 6 litres of air into and out of the lungs while at rest. A lower-than-normal volume of air exchange is usually a sign of pulmonary mal-function. The apparatus commonly used to measure the volume of air exchanged during breathing and the rate of ventilation is a spirometer (*spiro*=breathe) or respirometer. The record is called a spirogram. Inspiration is recorded as an upward deflection and expiration is recorded as a downward deflection, and the recording pen usually moves from right to left.

There are 4 respiratory volumes and capacity.

Respiratory volumes :

(i) **Tidal volume (TV) :** It is volume of air normally inspired or expired in one breath (i.e. inspiration and expiration) without any extra effort. It is about 500 ml. in normal healthy adult. In infants it is 15 ml and in fetus it is 0 ml. Tidal volume varies considerably from one person to another and in same person at different times. In an average adult, about 70% (350 ml) of tidal volumes reaches respiratory bronchioles, alveolar duct, sacs and alveoli (respiratory portion). The other 30% (150ml) remains in air spaces of nose, pharynx, larynx, trachea, bronchi, bronchioles and terminal bronchioles (conducting portion). These areas are known as anatomic dead space.

The total volume of air taken in during 1 minute is called the minute volume of respiration (MVR) or minute ventilation, It is calculated by multiplying the tidal volume by the normal breathing rate per minute. An average MVR would be 500 ml times 12 respirations per minute of 6000 ml/min. Not all of the MVR can be used in gas exchange, however, because some of it remains in the anatomic dead space. The alveolar ventilation rate (AVR) is the volume of air per minute that reaches the alveoli. In the example just given, AVR would be 350 ml times 12 respirations per minute or 4200 ml/min. Remains 3 air volumes result when one engages in strenous breathing.

(ii) **Inspiratory reserve volume (IRV) :** By taking a very deep breath, you can inspire a good deal more than 500 ml. This additional inhaled air, called IRV is about 3000 ml.

(iii) **Expiratory reserve volume (ERV) :** If you inhale normally & then exhale as forcibly as possible, you should be able to push out 1200 ml. of air in addition to 500ml. of T.V. The extra 1200 ml. is called ERV.

(iv) **Residual volume (RV) :** Even after expiratory reserve volume is expelled, considerable air remains in the lung, this volume, which can not be measured by spirometry, it is called residual volume is about 1200 ml.

(v) **Dead space** : *Portion of tracheobronchial tree where gaseous exchange does not occur* called dead space. *It is also called conductive zone. Dead space is 150 ml.*

(vi) **Functional residual capacity (FRC) :** It is the amount of air that remains in the lungs after a normal expiration. It is about 2300 ml.

FRC = ERV + RV

= 1100 + 1200 = 2300 ml.

(vii) **Vital capacity (VC) :** This is the maximum amount of air that can be expired forcefully from his lungs after first filling these with a maximum deep inspiration. It is about 4600 ml.

VC = IRV + TV + ERV

= 3000+500+1100 = 4600 ml.

(viii) **Total lung capacity (TLC) :** TLC is the sum of vital capacity (VC) and residual volume (RV). It is about 5800ml.

TLC = VC + RV

= 4600 + 1200 = 5800 ml.

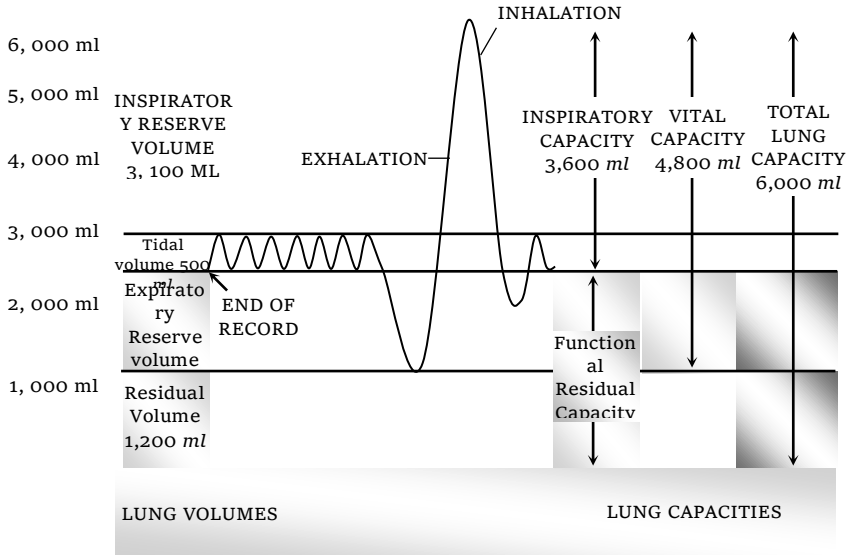


FIG. – SPIROGRAM OF LUNG VOLUMES AND CAPACITIES (AVERAGE VALUES FOR A HEALTHY ADULT)

(ix) **Inspiratory capacity (IC) :** It is the total amount of air a person can inspire by maximum distension of his lungs.

I.C. = TV + IRV

= 500 + 3000 = 3500 ml.

4.5 PROCESS OF RESPIRATION

The process of respiration is completed in 4 steps :

(i) **Breathing or ventilation** (ii) **Exchange of gases or External respiration**

(iii) **Transport of gases** (iv) **Cellular respiration**

(i) **Ventilation or breathing :** Movement of thorax, expansion (inflation) and deflation of lungs and flow of air into the lungs and from the lungs. *It is extracellular, energy consuming and physical*

process. Sum of inspiration and expiration is called respiratory movement. There are two steps of breathing :

Difference between breathing and respiration

Breathing (Ventilation)	Respiration
It is a physical process.	It is a biochemical process.
It is simply an intake of fresh air and removal of foul air.	It involves exchange of gases and oxidation of food.
No energy is released rather used.	Energy is released that is stored in ATP.
It occurs outside the cells, hence it is an extra-cellular process.	It occurs inside the cells, hence it is an intra-cellular process.
No enzymes are involved in the process.	A large number of enzymes are involved in the process.
Breathing mechanism varies in different animals.	Respiratory mechanism is similar in all animals.
It is confined to certain organs only.	It occurs in all living cells of the body.

(a) ***Inspiration*** **:** Intake of fresh air in lungs from outside. It is an active process. Blood pressure increases during later part of respiration. Following muscles are involve in inspiration.

(1) ***Diaphragm*** **:** Principle muscles of inspiration. Its skeletal muscles attached to sternum, vertebral column and ribs. It is formed by radial muscles fibres. The last end of radial muscles fibres form flat sheet called aponeurosis which encircle the aperture present at the centre of diaphragm through which oesophagus passed. *Muscular diaphragm is present only in mammals and its primary function is to divide body cavity in two parts upper thoracic* and *lower abdominal*.

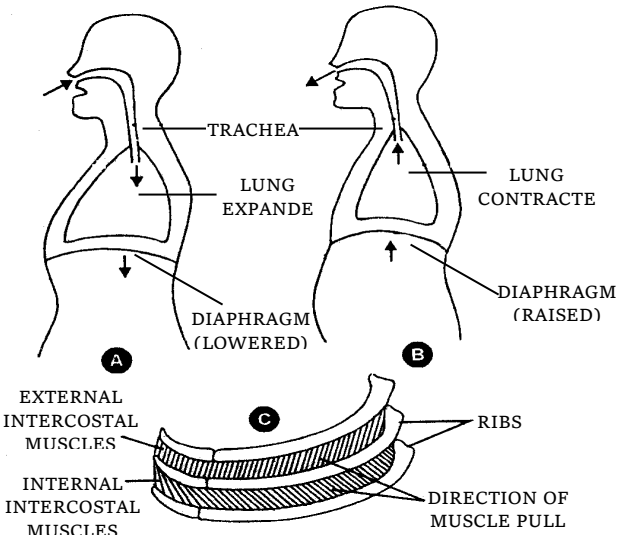


Fig. – Mechanism of breathing. **A – Inspiration (Chest cavity enlarged) B – Expiration (Chest cavity reduced) C – Intercostal muscles**

In relaxed condition it is dome shaped. Convex towards thoracic cavity and concave towards abdominal cavity. During inspiration it contract and become straight and descends down. This cause an increase in vertical diameter of thoracic cavity. In quiet (*i.e.* tidal air volume breathing) breathing it descends about 1.5 *cms.* In very deep inspiration it may descends for about 10 *cms*. Descent of diaphragm can explain about 75% of tidal air volume. 70% muscles fibres of diaphragm have some resistance to fatigue. *Nerve which supply to diaphragm is phrenic nerve*. Contribution of diaphragm in

breathing of full term pregnant lady is 0%. *Most important function of diaphragm of mammals is to aid in inspiration*. If diaphragm is punctured, respiration will stop and patient will die.

(2) ***External intercostal muscles*** **:** Gaps between the ribs are called intercostal spaces. They are filled by intercostal muscles. Intercostal muscles are of two types external intercostal muscles and internal intercostal muscles.

External *intercostal muscles are related to inspiration and internal intercostal muscles are related to expiration*. Here we are concerned with external intercostal muscles. External intercostal muscles start from lower border of upper rib and comes to end outer lip of upper border of lower rib. Thus direction of external intercostal muscles fibres is downward forward. *Contraction of external intercostal muscles causes increase in anteroposterior diameter of thoracic cavity and transverse diameter of thoracic cavity.*

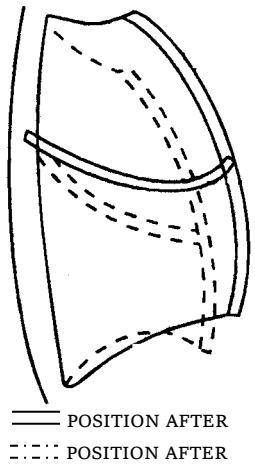


Fig. – Thoracic rib cage in side view, showing movements of ribs and

This two dimensional increase in diameter (*i.e.* anteroposterior and transverse) of thoracic cavity is due to special arrangement of ribs. This increase of thoracic cavity assist by diaphragm the most important muscle of inspiration, it is dome-shaped skeletal muscle. Contraction of diaphargm causes it to flatten lowering its dome. For simplification we can assume that each rib attach anteriorly to sternum by its anterior end and posteriorly to vertebral column by its posterior end. Note these two points carefully –

(a) Anterior end of rib is lower than the posterior end.

(b) Middle portion of rib which is called shaft lies at lower level than the two end of rib (*i.e.* anterior and posterior)

Contraction of external intercostal muscles cause elevation of ribs. Anterior end of ribs which lies lower than the posterior end. Elevates and moves forward and causes an increase in anteroposterior diameter of thoracic cavity. This movement of ribs is called pump handle movement. *This movement mostly occur in vertebrosternal rib i.e. 2nd to 6th ribs.* Elevation of shaft of rib due to contraction of external intercostal muscles causes outward movement of rib. This causes an increase in transverse diameter (side by side) of thoracic cavity. This movement of ribs called bucket handle movement. This movement occurs in vertebrochondral ribs *i.e.* 8^{th}, 9^{th} and 10^{th} ribs. In infants the ribs are approximately horizontal (*i.e.* shaft does not lie at lower level than the two ends of rib and anterior end of ribs is not lower than posterior end) thus respiration is mainly diaphragmatic.

(3) ***Accessory muscles of inspiration :*** *These muscles normally are not called into action but in forced inspiration they come into action. Accessory muscles are scaleni, sternomastoid and alae nasi.*

(b) ***Expiration*** **:** Out flow of the air from the lungs is called expiration. When the inspiratory muscles relax. As the external intercostal relax, ribs move inferiorly and as the diaphragm relaxes, its dome moves superiorly owing to its elasticity. These movements decrese vertical and anterior-posterior dimentions of thoracic cavity. *Normally it is a passive process* and occurs when the muscles of inspiration stop to contract. Lungs are made of elastic fibres. These elastic fibres behave as rubber band. These elongate when stretched but recoil back to its original length when stretch is withdrawn. Thus lungs shrink due to elastic recoil of elastic fibres and air is expelled out from the lungs. Thus expiration takes place. In forced expiration (*i.e.* asthma, coughing) the muscles of expiration contract and help to reduce the volume of thoracic cavity. In this conditions expiration is active process. Following muscles are involve in expiration.

(1) ***Inte*** Direction of fibres ction is just opposite to s. These muscles b osterior and transverse di

(2) **Abd** of anterior abdomir diaphragm up.

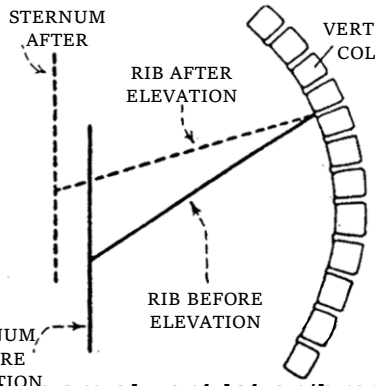


Fig. – Show how 'pump handle' movements of the sternum bring about an increase in the anteroposterior diameter of

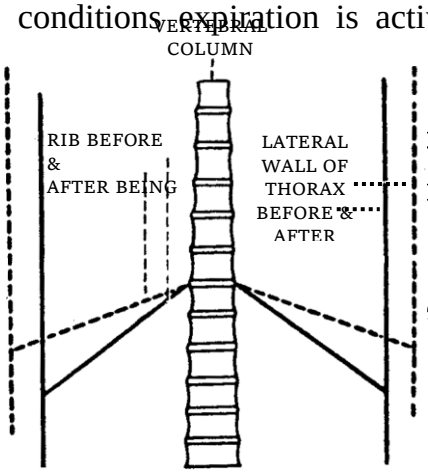


Fig. – Scheme to show how 'bucket handle' movements of the vertebrochondral ribs bring about an increase in the transverse diameter of the thorax.

to action of muscles of inspiration.

Inspirat

↓

Lungs follow the enlargement of thoracic cavity and expand.

↓

Expansion of lungs leads to reduction of air pressure within the lungs than the atmospheric pressure.

↓

Air from the outside, where pressure of air is high, comes inside the lungs.

↓

At the top point of inspiration contraction of inspiratory muscles suddenly stops.

Impulses from

↓

Expiratio

Inspiratory muscles relax and also due to elastic recoil, lungs shrink.

↓

Air pressure within lungs exceeds atmospheric air pressure.

↓

Pressure *within pleural cavity is called intrapleural pressure. It is normally negative (–5 cm.).* if atmospheric pressure (760 *mm Hg*) is considered to be zero (or base) than the 755 *mm Hg* intrapleural pressure is said to be negative *i.e.* – 5 *mm. Hg. During inspiration, negativety increases and during expiration it decreases*. In quiet respiration intrapleural pressure varies between – 3.5 *mm Hg* (at the end point of inspiration) to +0.7 *mm Hg* (at then end of expiration) In very deep inspiration intrapleural pressure may be – 30 *mm Hg*. In violent expiration, especially with glottis closed the intrapleural pressure may be +20 *mm Hg*. In clinical practice, the intrapleural pressure is measured in *cm* H_2O. (1

cm H_2O = .7 *mm Hg*). Pressure within lungs is assumed to be equal intrapleural pressure. In diseases in which breathing is difficult (*i.e.* asthma, emphysema) patients are most comfortable on sitting up, leaving forwards and fixing the arms.

During inspiration fresh air follows following path external nares → nasal chambers → internal nares → pharynx → *glottis* → *larynx* → *trachea* → *bronchi* → *bronchioles* → *alveolar ducts* → *alveoli*.

Advantage of negative pressure breathing : Mammals have negative pressure breathing, *i.e.* the lungs draw air due to reduction in pressure within them. This allows them to eat and breathe at the same time. If air were to be forced into the lungs, it might carry food particles into the trachea and block it. Negative pressure breathing gently moves air which is less likely to carry food particles into the wind pipe.

Positive pressure breathing : Frog closes the mouth, opens the nares and lowers the throat. This enlarges the buccopharyngeal cavity, where reduced pressure draws fresh air *via* nares. This part of breathing occurs on the negative pressure principle. The frog then closes the nares and raises the throat, forcing the air into the lungs. This is positive pressure breathing. After exchange of gases in the lungs, frog opens the nares and expels foul air by contracting abdominal muscles.

(ii) **Exchange of gases :**

(a) **Exchange of gases in lungs :** It is also called external respiration. In this gaseous exchange oxygen passes from alveoli to pulmonary capillary blood and CO_2. Comes to alveoli from pulmonary capillary. In order to be exchange the gases have to pass through alveolocapillary membrane or respiratory membrane. *Composition of alveolocapillary membrane is* epithelium lining of alveolar wall, epithelial basement membrane, a thin interstitial space, capillary basement membrane and capillary endothelial membrane.

Thickness of respiratory membrane is 0.5 μm. Respiratory membrane has a limit of gaseous exchange between alveoli and pulmonary blood. It is called diffusion capacity. Diffusion capacity is defined as volume of gas that diffuse through membrane per minute for a pressure difference of 1 *mm Hg*. Exchange of gases through alveolocapillary membrane is a *purely physical diffusion phenomenon*. No chemical reaction is involved. Diffusion of a gas depends upon pressure gradient across the membrane and solubility of gas.

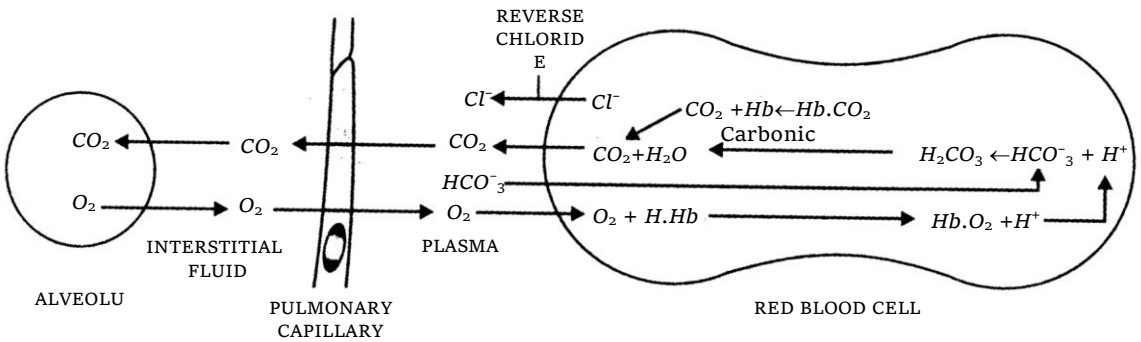


Fig. – Exchange of O_2 and CO_2 in the lungs

More pressure gradient → quickly diffusion. Diffusion of CO_2 is 20 times faster than oxygen. Diffusion is also directly proportional to thickness of membrane, surface area of membrane, permeability of membrane. As already mentioned, we inhale 500 *ml.* of air (tidal volume) in each breath, *i.e.*, 6000 *ml.* each minute (at a normal rate of 12 breaths per minute). About 150 *ml.* of inspired or expired air in each breath is retained in the respiratory passageways. Since this air is not involved in gaseous exchange, the space enclosed by respiratory passageways is called "dead space". Obviously, only 350 *ml* of inhaled air in each breath (4200 *ml* per minute) reaches into the lung alveoli, mixes with the functional residual air of alveoli and, thus, takes part in gaseous exchange. It brings with it about 69 *ml* of O_2. When it is expired, it takes back only about 48 *ml* of O_2. With each breath, thus, about 21 *ml* of O_2 becomes available to pulmonary blood for absorption from alveolar air. Thus, our normal intake of O_2 amounts to about 250 *ml* per minute. Similarly, the inspired air in each breath brings only about 0.14 *ml* of CO_2 into alveolar air, but when expired, it contains about 18.55 *ml* of CO_2. Thus, with each breath, our blood gets rid of about 18.4 *ml* of CO_2 (about 220 *ml* each minute).

Since gaseous exchange occurs continuously between the 2300 *ml* of alveolar air and pulmonary blood, the 350 *ml* of atmospheric air, reaching into and leaving lung alveoli in each breath, in effect, merely serves to slowly renew the alveolar air. This slow renewal of alveolar air prevents sharp and sudden changes in P_{O_2}, P_{CO_2} and *pH*-concentrations in blood.

Partial pressure : Partial pressure of a gas is the pressure it exerts in a mixture of gases, and is equal to the total pressure of the mixture divided by percentage of that gas in the mixture. For instance, if the pressure of atmospheric air at sea level is 760 *mm*. Of mercury (*Hg*) and oxygen forms 21% of the air, the partial pressure of oxygen will be 21% of 760, or 159 *mm. Hg*. In other words, the partial pressure of a gas is proportional to its concentration in the mixture. Only about 0.3 *ml.* of O_2 can dissolve in 100 *ml.* of plasma, about 20 *ml.* of O_2 is carried by haemoglobin in 100 *ml.* of blood. *In atmospheric air except these gases some traces of helium, argon and neon are also found.*

Partial pressures of respiratory gases in *mm. Hg*

Gas	Inspired air	Alveolar air	Venous blood	Arterial blood	Expired air	Tissue cells
Oxygen	158	100 – 105	40	95 – 100	116	20 – 40
Carbon dioxide	0.3	40	46	40	32	45 – 52
Nitrogen	596	573	573	573	565	–

Composition of three samples of air

Gases	Inspired air	Expired air	Alveolar air	Gain / loss %
Oxygen	20.84%	15.70%	13.6%	Gain 5.14%
Carbon dioxide	0.04%	4.00%	5.3%	Loss 3.96%
Nitrogen	78.62%	74.50%	74.9%	Gain 4.12%
Water	0.5%	6.2%	6.2%	Loss 5.7%

A part of the inspired air is left in the respiratory tract, the so called "dead space", where no gaseous exchange occurs. This "dead space" air is expelled at the next expiration. The expired air, thus, contains fresh air from the "dead space" and foul air from the lungs. Therefore, the alveolar air has less oxygen and more carbon dioxide than the expired air. A part of the expired air is also left in the dead space. This air enters the lungs at the next inspiration. Some air is also left in the lungs after expiration as residual air. The fresh inspired air is mixed up in the lungs with the foul air from the "dead space" and the stale residual air. Therefore, the alveolar air has less O_2 and more CO_2 than the inspired air also. The inspired air has the composition of the atmospheric air. Exchange of gases in lungs can be divided into two steps :

(1) **Uptake of O_2 by blood in lung :** The P_{O_2} (partial pressure of oxygen) of the alveolar air is higher than the P_{O_2} of blood in alveolar capillaries. Due to a P_{O_2} difference between air and blood, oxygen diffuses rapidly from the alveolar air into the blood of alveolar capillaries. It may be remembered that gases always diffuse from a region of higher partial pressure (concentration) to a region of lower partial pressure or concentration. At rest RBC stay for only one second in a pulmonary capillary. *Hb* becomes saturated within about 0.3 *sec*. During exercise, circulation speed is high RBC stays for 0.3 *sec* in a capillary, again it sufficient duration for oxygenation.

(2) **Release of CO_2 by the blood :** The P_{CO_2} (partial pressure of carbon dioxide) of blood reaching the alveolar capillaries is higher than the P_{CO_2} of alveolar air. Therefore, carbon dioxide diffuses from the blood of alveolar capillaries into the alveolar air. The exchange of gases in the alveoli that raises the P_{O_2} of blood and lowers its P_{CO_2} is the external respiration. The blood oxygenated by this respiration is returned from the lungs by pulmonary veins to the left side of the heart. The heart supplies the oxygenated blood to the body tissues. *In alveolar air partial pressure of O_2 is 100 mm Hg and in pulmonary capillary blood is 40 mm Hg. Thus O_2 from alveolar air transfer to blood. P_{CO_2} in alveolar air is 40mm Hg and is pulmonary capillary blood CO_2 is 46mm Hg. Thus CO_2 flows from blood to alveolar air.*

(b) **Exchange of gases in tissues :** In the tissues, exchange of gases occurs between the blood and the tissue cells. This exchange occurs *via* tissue fluid that bathes the tissue cells. The blood reaching the tissue capillaries has P_{O_2} higher than that in the tissue cells and P_{CO_2} lower than that in the tissue cells. The tissue cells constantly use oxygen in oxidation that produces carbon dioxide. Therefore, they always have lower P_{O_2} and higher P_{CO_2} than the blood coming to them. Because of P_{O_2} and

P_{CO_2} differences between blood and tissue cells, oxygen separates from oxyhaemoglobin and diffuses from the blood into the tissue fluid and thence in to the tissue cells; and carbon dioxide diffuses from the tissue cells in to the tissue fluid and thence in to the blood in the tissue capillaries. Gases mostly diffuse through the tissue fluid as such, only small amounts dissolve in it.

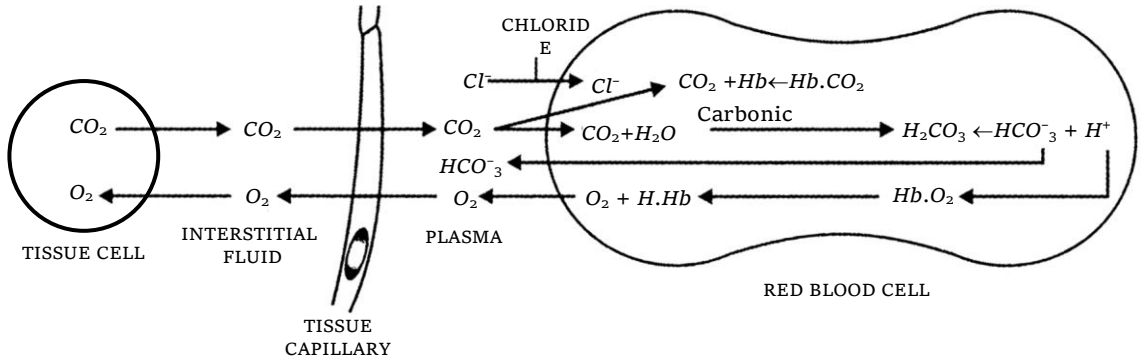


Fig. – Exchange of O_2 and CO_2 in the tissue

Exchange of gases in the tissues that lowers the P_{O_2} of the blood and raises its P_{CO_2} is called internal respiration. The blood deoxygenated by this respiration returns to the right side of the heart that sends it to the lungs for reoxygenation.

(iii) **Transport of gases :** Blood carries O_2 from respiratory organs to the tissue cells for oxidation and CO_2 from tissue cells to respiratory organs for elimination. *Blood should be slightly alkaline to help the transport of O_2 and CO_2 properly.*

(i) **Transport of oxygen :** Lung contains atmospheric air. From the lung O_2 diffuses into the blood. The blood transport O_2 from the lung to the cells. This is called oxygen transport. O_2 is carried in the blood in three forms –

(1) **In physical solution :** *100 ml. oxygenated blood contains 20 ml(0.3 ml dissolved in plasma and 19.7 ml bound to Hb) of oxygen*. 2-3% oxygen is transported in form of physical solution. Thus 0.3 *ml* to 0.6 *ml.* O_2 is in physical solution form in 100 *ml* of blood. Pressure of a gas in blood is produced by only that portion of O_2 which is in physical solution. HbO_2 (oxyhaemoglobin) is not directly responsible for pressure produced by gas. O_2 first dissolves in plasma and forms physical solution. As soon as the conc. of O_2 in physical solution in plasma exceeds to 0.3 *ml* to 0.6 *ml*/100 *ml* of blood, O_2 goes to combine with *Hb* as HbO_2 thus *Hb* acts as a sink.

(2) **As oxyhaemoglobin (HbO_2) :** Most of O_2 is transported in form of oxyhaemoglobin. 98.5% in the form of HbO_2, 1.5% is carried in the dissolved state in watery blood plasma. O_2 is transported in form of oxyhaemoglobin. Following events are happened in this connection.

O_2 flows from alveolus to capillary blood

↓

O_2 form physical solution in plasma

↓

Tension of O_2 in plasma increase

↓

Hb exposed to higher O_2 tension

↓

Hb form oxyhaemoglobin with

One gram haemoglobin binds about 1.34 ml of oxygen. 100 ml. of blood contain 15 gm. haemoglobin. Thus 100 ml. blood can carry 20 ml. (19.4 ml exactly) O_2 *as* HbO_2. *The iron of haemoglobin normally remains in reduced (ferrous* $-Fe^{++}$*) state. If made to react with ozone or some other oxidizing agent, it loses an electron and becomes oxidized (ferric* $-Fe^{+++}$*).* Haemoglobin, thus oxidized, is called methaemoglobin. The latter cannot deliver oxygen. Pure oxygen does not oxidize the iron of haemoglobin; a molecule of O_2 binds reversibly with each iron atom one after the other in such a way that the iron does not lose an electron and, hence, remains in ferrous condition. That is why, this reaction is called the process of oxygenation, rather than oxidation of haemoglobin. Oxygenated haemoglobin is called oxyhaemoglobin : *It is bright red, while haemoglobin has a slight tinge of violet.* That is why, oxygenated or purified blood appears bright red and deoxygenated or impure blood bluish.

(3) **By cell membrane of RBCs :** Traces of O_2 is presumably transported as bound with the cell membrane of RBCs.

Oxygen content : Total volume of O_2 in 100 *ml.* of whole blood *i.e.* volume of O_2 in physical solution form and oxyhaemoglobin form. It is equal to 19.7 + 0.3 = 20 *ml* of oxygen.

Oxygen capacity : Maximal amount of O_2 that can be held by the blood at 760 *mm Hg* pressure and 37^oC. Oxygen capacity is about 20 *ml*/100 *ml.*

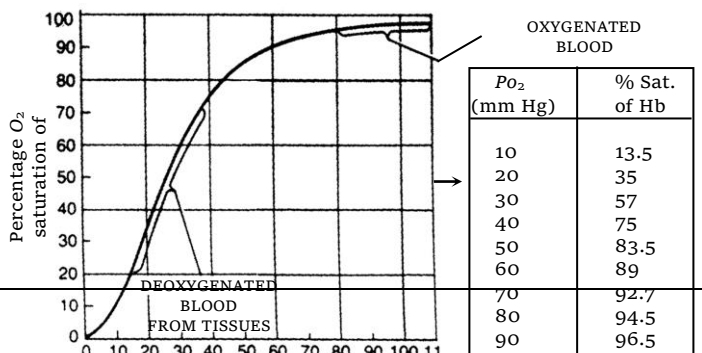
Percentage of saturation of haemoglobin : $\frac{o\text{xygen content}}{\text{oxygen capacity}} \times 100$. In healthy men 5% saturation of *Hb* in arterial blood is $\frac{19}{20} \times 100 = 95\%$. In mixed venous blood at rest it is about 75%.

Oxygen-haemoglobin dissociation curve : When a graph is plotted between % saturation of haemoglobin and oxygen tension, a curve is obtained termed as O_2 - *Hb* dissociation curve. Oxygen-*Hb* dissociation curve is sigmoid shaped-or *S* shaped. This *sigmoid shaped* curve is characteristic for *Hb*.

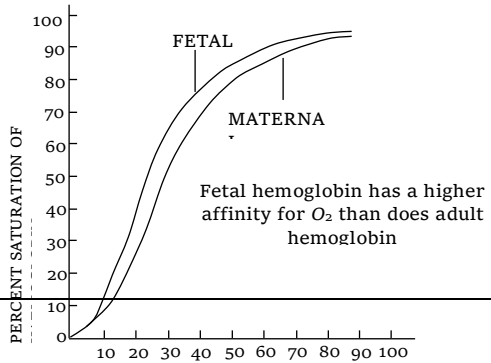
Biological advantage of the sigmoid shape (curve)

(i) Due to sigmoid shape P_{50} value of *Hb* is high. It is 25 *mm Hg*. So in the tissues O_2 unloading is satisfactory.

(ii) Even if there is moderate low atmospheric pressure sufficient amount of *Hb* becomes saturate.



Po_2 (mm Hg)	% Sat. of Hb
10	13.5
20	35
30	57
40	75
50	83.5
60	89
70	92.7
80	94.5
90	96.5



Dissociation of oxygen from oxyhaemoglobin

Arterial blood reaches to the tissue level
↓
It is exposed to low tension of O_2 in tissue
↓
O_2 flows from plasma to the tissue
↓
Concentration of O_2 in physical solution decrease
↓
HbO_2 dissociated to make up the loss of O_2 from physical solution in plasma

If O_2 concentration in tissues is equal to the respiratory surface, dissociation of Hb-O_2 cannot be possible into Hb and O_2. The percentage of haemoglobin that is bound with O_2 is called percent saturation of haemoglobin. It depends upon the partial pressure of oxygen (P_{O_2}) in blood. As already noted, the partial pressure of oxygen (P_{O_2}) in the oxygenated blood leaving the lungs is about 95 to 97 *mm Hg* and, at this P_{O_2}, haemoglobin is about 97% saturated with O_2. Conversely, the P_{O_2} in deoxygenated blood returning from body tissues is only 40 *mm Hg* and, at this P_{O_2}, haemoglobin is only about 70% to 75% saturated with O_2. *Thus about 25% Hb gives up its O_2 during one circulation of blood. Ratio of oxyhaemoglobin and haemoglobin in the blood is based upon CO_2 tension in blood. (See Bohr's effect)*

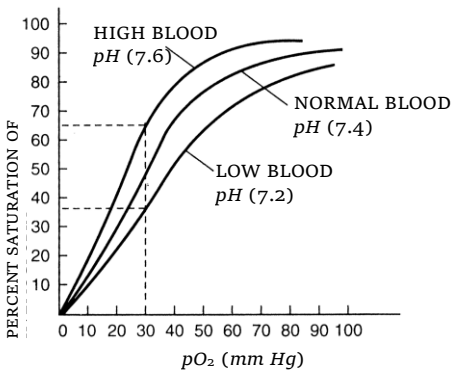


Fig. – Effect if pH on affinity of hemoglobin for oxygen

Shift of *Hb-O_2* curve

(a) ***Right shift means :*** *Low affinity of Hb for O_2 as a result release of O_2 from HbO_2*

Thus it is clear that right shift is required when supply of O_2 is needed. At tissue level blood loses its O_2 and curve shifts to right. During active exercise muscles require more O_2 than normal condition. This supply of extra O_2 comes from shifting of curve to right.

Factors which shift curve to right

(i) *High CO_2 tension in blood*. This is called Bohr's effect (*PCO_2* 60 mm *Hg*).

(ii) *Low pH of blood* or increase concentration of H^+ ions (*pH* 7.2).

(iii) *High body temperature* (43ºC or 110ºF).

(iv) *Increase level of 2.3 DPG* (Diphosphorylglycerate) now called BPG (Biphospho glycerate) in RBC's. BPG – previously called diphosphoglycerate (DPG), decreases the affinity of *Hb* for O_2 and thus helps to release O_2 from *Hb*. BPG formed in RBC certain hormones such as thyroxine, human growth hormone, epinephrine, norepinephrine and in people increases the formation of BPG. The level of BPG also higher in people living at high attitude. It forms during glycolysis in RBCs. At tissue level right shift of curve is favourable.

Bohr's effect : *Hb-O_2 dissociation curve shifts to right when CO_2 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.

(b) **Left shift means :** *Increase affinity of Hb for O_2. Hb-O_2 formation is hastened.*

$\downarrow$

In lungs CO_2 is released from capillary blood.

$\downarrow$

Affinity of *Hb* for O_2 increases *i.e.* curve shift to left.

$\downarrow$

Hb-O_2 formation is hastened. Which is strongly required for proper oxygenation of blood. At lung level left shift is favourable.

PCO_2 20 mm *Hg*

Increase pH of blood – 7.6

Low body temperature 20ºC or 68°F

Concept of P_{50} : Partial pressure of O_2 at which 50% haemoglobin of blood becomes saturated called P_{50}. *P_{50} value of Hb is 25 mm Hg. P_{50} indicates the affinity for Hb toward oxygen*. High value of P_{50} indicates low affinity for *Hb* toward O_2 thus O_2 release hastened. *Low value of P_{50} indicates high affinity for Hb toward O_2. Thus formation of HbO_2 hastened. High P_{50} value is same as shift to right and low P_{50} value is same as shift to left*. Foetal haemoglobin and myoglobin have low P_{50} value. Presence of CO_2 acidity (low *pH*), temperature rise, 2, 3 DPG cause rise of P_{50} value. If P_{50} value of *Hb* rises to 100 *mm Hg* person will die of O_2 deficiency because loading and unloading of *Hb* will not occur.

Haemoglobin : *Oxygen carrier or respiratory pigment in vertebrates blood is haemoglobin. Hb* molecule is made of two components haem and globin. Globin part is globulin protein which is made of four polypeptide chain, two α chains (141 amino acid) and two β chains (146 amino acid). Thus

total no. of amino acid in *Hb* 574. Haem is iron containing compound and belongs to the class of compound called protoporphyrins. The plasma membrane of RBC encloses 280 millions *Hb* molecules i.e. 33% of cell weight. *Hb* in RBC synthesized before loss of nucleus. *Hb* also transport about 23% of total CO_2. *Hb* is conjugate or chromo protein. *Iron of Hb is in ferrous state* (Fe^{++}) and even after the combination with O_2 it remains ferrous. Iron of *Hb* remains in Fe^{++} state due to presence of methaemoglobin reductase enzyme. One *Hb* molecule has 4 haem molecules. Each haem is associated without polypeptide chain. Each *Hb* molecule can combine with one molecule (2 atoms) of oxygen. *Thus each molecule of Hb combines 4 molecules of* O_2. Haem molecule is made up by 4 pyrrole structures. Iron is found in centre of 4 pyrrole rings. *Hb* is synthesized by cells of erythroid series in the red bone marrow. Affinity of *Hb* for oxygen is ideal neither excessive nor little. *Affinity of Hb for* O_2 *is more than the* CO_2. Haemoglobin act as a buffer. Addition of hydrogen ions would make the blood very acidic. However, most of the hydrogen ions are neutralized by combination with haemoglobin, which is negatively charged, forming acid haemoglobin. This reduces the acidity of the blood, and also releases additional oxygen. $HbO_2^- + H^+ \rightleftharpoons HHb + O_2$

If the blood becomes too basic, acid haemoglobin dissociates, releasing hydrogen ions. $HHb \rightarrow H^+ + Hb$. Thus, the haemoglobin also acts as a buffer, a substance that keeps the *pH* from fluctuating.

Myoglobin : It is chemically and functionally similar to *Hb*. It is made up of one polypeptide chain (153 amino acids) attached with on haem group. P_{50} value for myoglobin is 5 *mm Hg*. This indicates that myoglobin release oxygen less readily than *Hb*. It is found in muscles. It acts as a store house for O_2. An average man can store about 1.5 *litre* oxygen in myoglobin. *Hb-*O_2 *dissociation curve for myoglobin is hyperbola*.

(ii) **Transport of CO_2 :** Transportation of CO_2 by blood is mush easier due to its high (20 times that of O_2) solubility in water. Blood can carry upto 50% or 60% of CO_2 by volume, but normally about 4 ml of CO_2 on an average is transported from tissue to the lungs in each 100 ml of blood in man. With 5 litres of cardiac output per minute, the blood thus transports about 200 to 220 ml of CO_2 each minute. Obviously, this is the rate at which CO_2 is produced and released into tissue fluids by cells, and at which it diffuses out into alveolar air from pulmonary arterial blood. The blood transports this CO_2 in three ways.

(a) **In dissolved state :** Deoxygenated (PCO_2 is 45 to 46 mm Hg) and oxygenated (PCO_2 is 40 mm Hg) bloods respectively carry about 2.7 and 2.4 ml of CO_2 per 100 ml of blood in dissolved state in plasma (= in solution with plasma). Thus, about 0.3 (2.7 minus 2.4) ml of CO_2 is transported by each 100 ml. of blood in

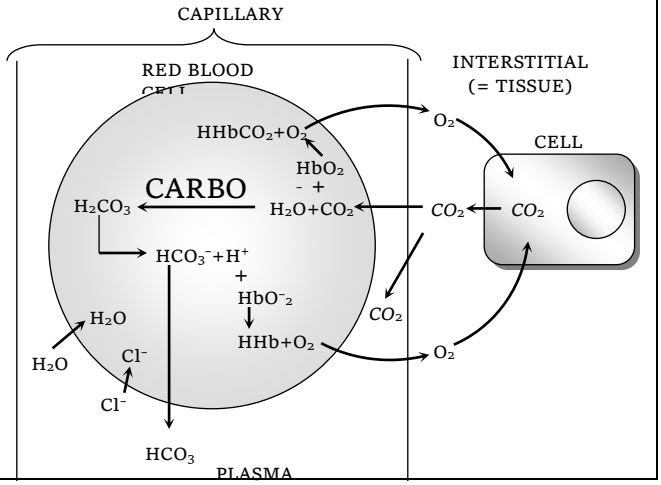


Fig. – Transportation of CO_2 by blood

dissolved state in plasma. This is about 7% of all the CO_2 transported by blood from tissues to the lungs.

(b) **In the form of bicarbonate ions :** Most of the CO_2 that dissolved in blood plasma reacts with water, forming carbonic acid – $CO_2 + H_2O \rightleftharpoons H_2CO_3$ (carbonic acid)

This reaction is very slow in plasma, but occurs very rapidly inside RBCs, because an enzyme, carbonic anhydrase, present in RBCs, accelerates its rate about 5000 times. That is why, about 70% of the CO_2 (about 2.5 ml per 100 ml of blood), received by blood from the tissues, immediately enters into RBCs and hydrated to carbonic acid. Almost as rapidly as formed, all carbonic acid of RBCs dissociates into hydrogen and bicarbonate ions (H^+ and HCO^-_3). The hydrogen ions mostly combine with heamoglobin for keeping the pH of blood. (7.4) in steady state, because haemoglobin is a powerful acid base buffer. Being quite diffusible, the bicarbonate ions, on the other hand, diffuse from RBCs into the plasma. To maintain electrostatic neutrality of plasma, many chloride ions, in turn, diffuse from plasma into the RBCs. Obviously, the chloride contents of RBCs increase when oxygenated blood becomes deoxygenated. This is termed "chloride or Hamburger shift".

Sequence of events : From tissues CO_2 enters in plasma $\rightarrow$ a small fraction of CO_2 is dissolved in plasma $\rightarrow$ rest of CO_2 enters into the RBC $\rightarrow$ within RBC CO_2 combines with H_2O in presence of enzyme carbonic anhydrase and forms $H_2CO_3 \rightarrow H_2CO_3$ splits into H^+ and $HCO_3^- \rightarrow$ most of the HCO_3^- comes out of RBC and enters in plasma and form $NaHCO_3$, small fraction stays back within the RBC to form $KHCO_3$ and H^+ combine with *Hb* to form reduced haemoglobin *H.Hb*.

Transformation forms of CO_2	**Transported quantity**
CO_2	7 % (0.3 ml/100ml of blood)
$HHbCO_2$	23% (2.5 ml/100 ml of blood)
HCO_2^-	70% (1ml/100 ml of blood)

(c) **In the form of carbamino compounds :** In addition to reacting with water, CO_2 also directly and reversibly reacts with haemoglobin, loosely binding with it and forming an unstable compound, called carbaminohaemoglobin (CO_2HHb). It also similarly forms loose bonds with some plasma proteins. It is estimated that about 23% of the CO_2 (1 ml per 100 ml of blood), collected from cells through tissue fluids, is transported by blood in this form.

Haldane effect and CO_2 diffusion into the alveoli : Whereas the Bohr effect promotes O_2 transport, the Haldane effect is important in promoting CO_2 transport. The Haldane effect results from the simple fact that oxyhaemoglobin behaves as a strong acid. This in turn, displaces CO_2 from the blood in two ways.

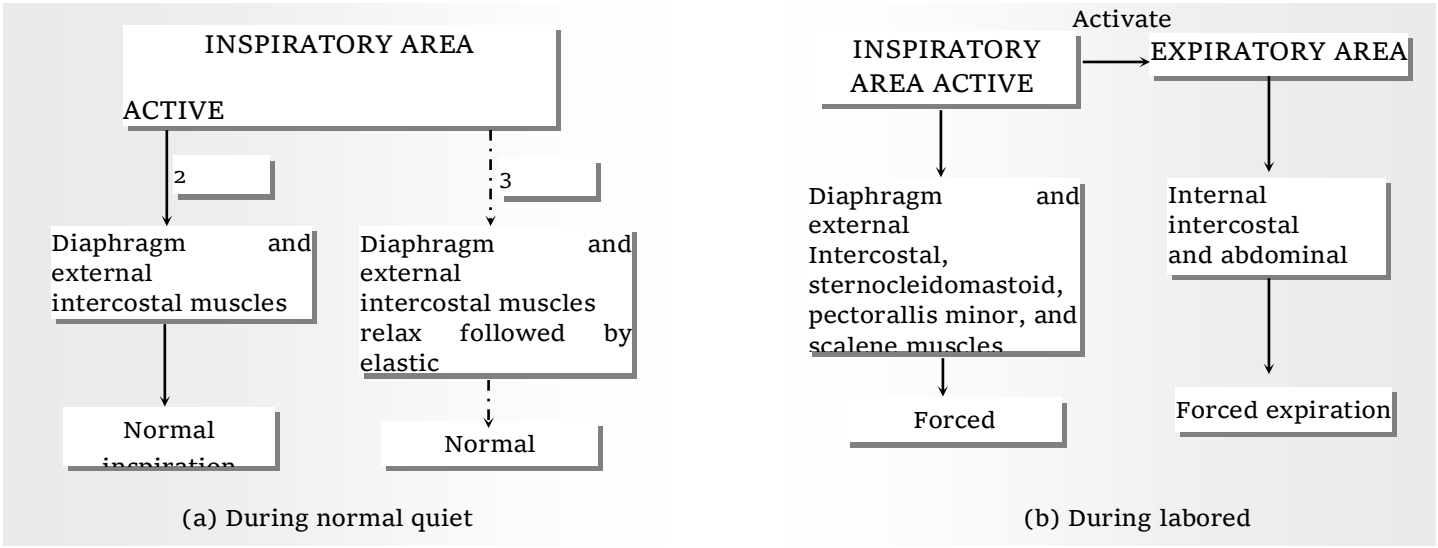
(i) Due to its increased acidity, the haemoglobin loses its capacity to combine with CO_2. Hence all carbamino haemoglobin dissociates to release its CO_2.

(ii) Secondly, the highly acidic oxyhaemoglobin releases an excess of H^+ which bind with bicarbonate ions (HCO_3^-), forming carbonic acid. The latter soon dissociates into H_2O and CO_2. This CO_2 diffuses into the alveoli.

Thus, in the lung, the haldane effect, increases release of CO_2 because of O_2 uptake by haemoglobin. In the tissues a reverse process occurs. The Haldane effect increases CO_2 uptake because of removal of O_2 from haemoglobin.

4.6 CONTROL OF BREATHING

Respiratory rhythm is controlled by nervous system. Inspiratory and expiratory centres are jointly called rhythmicity centres. Inspiratory centre is dominant over expiratory centre. When pneumotaxic is stimulated respiration rate increases inspiration as well as expiration is shortened. Respiratory movements are under control of medulla oblongata.



For the control of respiration following respiratory centres are found in hind brain

Type of centre	Location	Function
Inspiratory centre	Medulla oblongata	Inspiration (2 second active condition).

Respiratory centre	Medulla oblongata	Expiration (3 second inactive condition)
Apneustic centre	Pons	Slow and deep inspiration
Pneumotaxic centre	Pons	Control other centres and produce normal quite breathing
Gasping centre	Pons	Sudden and shallow respiration

(i) **Chemical control :** This includes CO_2, O_2 and H^+ conc. of blood for detection of concentration of O_2, CO_2 and H^+ ions in blood two types of receptors are found. These receptors are called chemoreceptor.

(a) **Peripheral chemoreceptor :** These include two sets – Carotid body is present in the wall of the left and the right common carotid arteries and aortic bodies is present in the arch of aorta. They are placed in the vascular endothelium and come in contact with the blood. When PO_2 decreases or increases in arterial blood, these receptors are stimulated and send impulses to respiratory centre to respectively increases or decreases the rate intensity of inspiratory signals.

Low partial pressure (concentration) of O_2 in blood increases respiratory rate. High partial pressure (concentration) of CO_2 in blood increases respiratory rate. High concentration of H^+ ion (low *pH*) increases respiration rate. Carotid body cells are affected only by dissolved O_2. For correction of CO_2 concentration central chemoreceptors play the dominant role. Role of peripheral centre is minor. For correction of O_2 concentration, there are no central chemoreceptors. Only peripheral receptors are found.

(b) **Central chemoreceptors :** These are present on ventral surface of medulla. Cells of these centres are bathed in brain tissue fluid. They are in close vicinity of CSF. In brain tissue fluid as well as in CSF the CO_2 is converted into $\overset{CA}{\rightleftharpoons} H_2CO_3 \rightarrow H_2CO_3 \quad H^+ + HCO_3^- \rightarrow H^+$ ions are liberated $\rightarrow H^+$ ions stimulate the central chemoreceptor (C.C) cell $\rightarrow$ stimulation from C.C goes to respiratory centre $\rightarrow$ Respiration stimulate.

(ii) **Effect of different gases**

(a) **Effect of CO_2 :** *Rise in tension of arterial CO_2 or alveolar CO_2 causes stimulation of respiration. Both the rate and depth of respiration increased*. This leads to washing out of CO_2 from body.

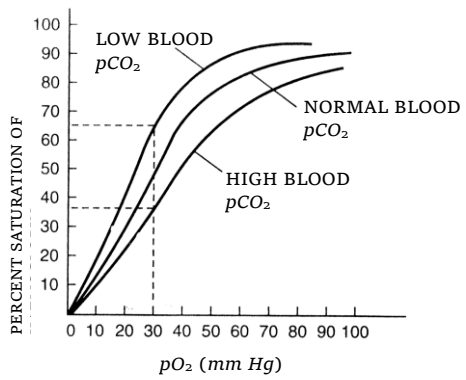


Fig. – Effect of pCO2 on affinity of hemoglobin for oxygen

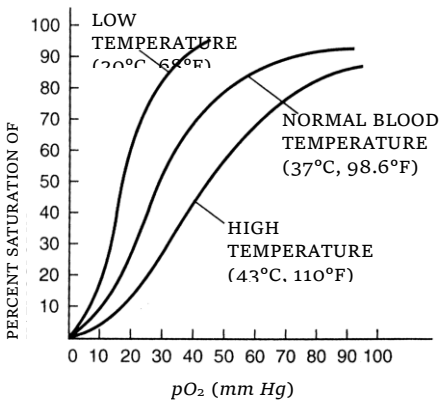


Fig. – Oxygen-hemoglobin dissociation curve showing the relationship between temperature and hemoblobin saturation with O_2

(b) **Effect of O_2 :** Fall of O_2 concentration in inspired air causes stimulation of peripheral chemoreceptors neural impulse arise from peripheral chemoreceptors. These impulse gots respiratory centre and cause respiratory stimulation. Some factor which increase the respiratory rate.

(iii) **Factors increases respiratory rate**

(a) Sympathetic stimulation causes reduction of blood supply to carotid body by vasoconstriction $\rightarrow$ stimulation.

(b) Excitement (c) Muscular exercise (d)Rise in body temperature

(e) Rise in H^+ ion conc. or low *pH.* (f) Renal failure (g) Diabetes acidosis

(h) Pain (i) Blood pressure (j) Lymphatic system

(iv) **Adaptations of diving mammals :** Marine mammals (seals, whales) can make long underwater dives as they have more blood per kilogram of body weight, can store more oxygen in blood and muscles, have a large spleen with a considerable stockpile of blood, and can reduce O_2 consumption rate when under water.

4.7 Respiration in frog

Frog is an amphibious animal *i.e.* they are live in water as well as on land hence according to their adaptations they process different modes of respiration, which are as follows –

(i) ***Cutaneous respiration :*** *By the skin. Under water, during hibernation frog respires by only skin. On land cutaneous respiration continues as usual. Thus cutaneous respiration take place always*. By cutaneous respiration frog fulfill its 30% need of oxygen.

(ii) **Buccopharyngeal respiration :** Like the skin, the mucosa of buccopharyngeal cavity in frog is also ideally adapted for gaseous exchange. Hence, while quietly floating upon water surface, and even when resting upon land, frogs respire by their buccopharyngeal cavity also. During this process, the mouth, gullet and glottis remain closed, but nares remain open. The floor of the cavity is alternately lowered and raised (oscillatory movements). Atmospheric air is sucked into the cavity through nares when the floor lowers, and it is forced out when the floor rises. Lowering of the floor is brought about by contraction of a pair of sternohyal muscles whose one end is inserted upon ventral surface of hyoid and the other upon dorsal surfaces of clavicle and coracoid bones of pectoral girdle. Similarly, raising of the floor is brought about by contraction of a pair of petrohyal muscles whose one end is inserted upon the sides of hyoid and the other upon the auditory capsules of respective sides near squamosals.

Intake of O_2 by buccopharyngeal respiration approximately accounts for only about 5% of total O_2-intake. It stops when mouth is opened.

(iii) **Pulmonary respiration :** In frog, pulmonary respiration accounts for about 65% of the total O_2-intake. It particularly occurs when frogs lead an active life during rains and spring; either hopping upon land in search of food, or actively breeding in water.

(a) **Inspiration :** The floor of buccopharyngeal cavity is lowered by contraction of sternohyal muscles, so that air fills in the cavity. Next the submental muscles of lower jaw contract, raising the mentomeckelian bones located at the front end of lower jaw rami. These bones, in turn, raise the premaxillae which close the external nares. Now, the petrohyal muscles contract and raise the floor of the cavity. Due to the resultant pressure, the air of the cavity forces its way into the lungs through glottis, because the external nares are closed. This is, thus, inspiration.

(b) **Expiration :** The floor of the cavity is first raised, and external nares are closed. Next, the floor of the cavity is lowered, so that air fills in the cavity from the lungs, because external nares are closed. This expulsion of air from lungs into buccopharyngeal cavity is helped by contraction of abdominal and lung muscles. Soon, the submental muscles relax to open the external nares and the floor of the cavity is raised, so that the air is forced out of the cavity.

4.8 Important Concept of Respiration

(i) **Respiratory quotient (R.Q.) :** Respiratory quotient is the ratio of carbon dioxide output to oxygen usage during respiration. It is measured by Ganong's respirometer.

$$\text{R.Q.} = \frac{\text{Volume of } CO_2 \text{ formed}}{\text{Volume of } O_2 \text{ utilized}}$$

High RQ	Low RQ
Due to fat deposition	*When CO_2 is fixed*
Due to fever	*When CO_2 retain in tissue*
Due to muscle exercise	*In hibernating mammals*
During glycolysis	*Due to acidosis*
In low O_2 environment	*Due to alkalosis*
Due to oxidation of pyruvic acid.	*Due to diabetes*
	In starvation
	During gluconeogenesis

	During glyconeogenesis

The volume of RQ depends upon the type of fuel substance being utilized for energy production.

Respiratory substrate	Respiratory quotient
Carbohydrate	*1.00*
Proteins	*0.5 – 0.9* Slightly less than 1 (0.9)
Fats	*0.7*
Organic acid	*1.33*

In an organism utilizing carbohydrates as source of energy anaerobically, the RQ is likely to be infinity. When carbohydrates are substrates for respiration, it is called 'floating respiration'. Diabetic patient shows low R.Q. due to increased dissimilation of fats and the decreased dissimilation of carbohydrate.

(ii) **Effect of *CO* :** Carbon monoxide is a poisnous gas. *Hb* has maximum affinity for *CO*. *Carbon monoxide binds with haemoglobin at the same place where* O_2 *binds, but about 250 times more readily than* O_2. *Hence, it readily displaces* O_2 *from haemoglobin and even a 0.4 mm Hg partial pressure of CO in alveolar air is enough to occupy about half of the haemoglobin of pulmonary blood rendering it useless for* O_2^- *transport*. A *CO* pressure of about 0.7 *mm Hg* (concentration of about 1%) in alveolar air can be lethal. That is why, the atmosphere of industrial areas, being loaded with chimney smoke, is regarded harmful to health. It forms carboxyhaemoglobin with *Hb* which is most stable. Sudden deep inspiration is due to either increase in concentration of CO_2 or decrease in concentration of O_2. Forced deep breathing for a few minutes by a person sitting at rest may be followed by a temporary cessation of breathing. This is influenced by too much O_2 and least CO_2 in blood. Sudden deep inspiration is due to either increase in concentration of CO_2 or decrease in concentration of O_2.

(iii) **Regulation at high altitudes :** At high altitudes, the composition of air remains almost the same as at sea-level, but the density (barometric pressure) of air gradually decreases. While ascending up a mountain, one inspires thin air, getting less oxygen. Less O_2 level in the blood results in hypoxia. The chemoreceptor simulatory mechanism progressively increases the rate of ventilation. Ventilation ordinarily does not increase significantly until one has ascended to about 2500 *metres*, because the P_{CO_2} and *pH* remain almost normal. At an altitude of about 3500 to 4000 *metres*, increasing hypoxia causes drowsiness, lasstitude mental fatigue, headache and nausea. By the time one ascends upto about 5000 to 6000 *metres*, the rate of ventilation reaches about 65% above normal, because a large amount of CO_2 is breathed out, reducing P_{CO_2} and increasing *pH*. A continuous exposure of a few days to this height, however, increases ventilation to about 3 to 7 times normal, because P_{CO_2} becomes normal and

pH decreases. Thereafter, a person gradually starts becoming acclimatized to high altitude conditions due to a significant increase in RBC-count and haemoglobin content in blood, in diffusion capacity of lungs, in vascularity of tissues and in ability of cells to utilize oxygen despite low P_{O_2}. When acclimatized, the breathing in concerned person becomes normal. Above on altitude of 6000 metres person becomes unconscious. At an altitude of 11000 metres, the air is so thin that a person can not remain alive even with the help of oxygen cylinder.

(iv) **Disorders of Respiratory system**

(a) **Hypoxia :** Hypoxia is a condition of oxygen shortage in the tissues. It is of two types :

(1) **Artificial Hypoxia :** It results from shortage of oxygen in the air as at high (over 2400 *m*.) altitudes. It causes mountain sickness characterised by breathlessness, headache, dizziness, nausea, vomiting, mental fatigue and bluish tinge on the skin and mucous membranes.

(2) **Anaemic Hypoxia :** It results from the reduced oxygen-carrying capacity of the blood due to anaemia (decreased haemoglobin content in blood) or carbon monoxide poisoning (some haemoglobin occupied by *CO*). in both cases, less haemoglobin is available for carrying O_2.

(b) **Asphyxia (Suffocation) :** The O_2 content of blood falls and the CO_2 content rises and paralyses the respiratory centre. Breathing stops and death occurs.

(c) **Bad cold :** Disease-causing microbes present in the air attack respiratory tract, producing inflammation of the mucous membrane and caused increased secretion :

(1) **Rhinitis** in the nasal chambers.

(2) **Sinusitis** in the sinuses.

(3) **Pharyngitis** in the pharynx, often called sore throat, and is usually accompanied by tonsillitis (enlargement of tonsils).

(4) **Laryngitis** in the larynx, causing hoarse voice and difficulty in speaking.

(5) **Bronchitis** in the bronchioles.

(d) **Emphysema :** The air-pollutants that cause chronic bronchitis, may breakdown the alveoli of the lungs, reducing the surface area for gas exchange. The victim becomes permanently short of breath.

(e) **Bronchial asthma :** It is an allergic attack of breathlessness associated with bronchial obstruction or spasm of smooth muscle (contraction), characterized by coughing difficult breathing and wheezing patient has trouble exhaling.

(f) **Bronchitis** 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 CO_2 concentration in blood. This disease is accelerated by fatigue, malnutrition, cold etc. the patient experiences difficulty in breathing. Here hypertrophy and hyperplasia of bronchi takes place.

(g) **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. This disease is prevalent in either children or elderly persons in old age.

(h) **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.

(i) **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. Tuberculosis bacteria are spread by inhalation and exhalation.

(j) **Coryza :** Common cold, due to rhinoviruses in adult.

(k) **Influenza :** Flu.

(v) **Occupational lung disease :** It is caused because of the exposure of potentially harmful substances. Such as gas, fumes or dusts, present in the environment where a person works. Silicosis and asbestosis are the common examples, which occur due to chronic exposure of silica and asbestos dust in the mining industry. It is characterised by fibrosis (proliferation of fibrous connective tissue) of upper part of lung, causing inflammation.

(a) **Prevention and cure :** Almost all the occupational lung diseases, express symptoms after chronic exposure, *i.e.*, 10-15 years or even more. Not only this, diseases like silicosis and asbestosis are incurable. Hence, the person likely to be exposed to such irritants should adopt all possible preventive measures. These measures include :

(1) Minimizing the exposure of harmful dust at the work place.

(2) Workers should be well informed about the harm of the exposure to such dusts.

(3) Use of protective gears and clothing by the workers at the work place.

(4) Regular health check up.

(5) Holiday from duty at short intervals for the workers in such areas.

(6) The patient may be provided with symptomatic treatment, like bronchodilators and antibiotics, to remove underlying secondary infection.

(vi) **Special respiratory movements**

Cough

(1) It is reflex action stimulation takes place from trachea and lungs.

(2) Centre is medulla oblongata.

(3) Cough is a forcible expiration usually produced after a prolonged inspiration.

(4) When some food particle enters the windpipe instead of oesophagus, it is expelled by a process of coughing.

(5) Air exploded through the mouth.

Sneezing

(1) Reflex action stimulated by olfactory epithelium of nasal chamber.

(2) Sneezing is a forcible expiration, air explodes out through nose and mouth.

Hiccuping

(1) Hiccuping is a noisy inspiration caused by muscular spasm of diaphragm at irregular intervals.

(2) Noise is due to sudden sucking of air through vocal cords.

(3) Stimulation of hiccuping is usually irritation of the sensory nerve endings of the digestive tract.

Yawning : Yawning is a prolonged inspiration. Low oxygen tension in the blood causes yawning.

Terminology

Apnea	Absence of breathing
Eupnea	Normal breathing
Hypopnea	Decreased breathing rate
Hyperpnea	Increased breathing rate
Dyspnea	Painful breathing
Orthopnea	Inability to breathe in a horizontal position
Acapnoea	Absence of CO_2 in blood
Hypocapnea	Deficiency of CO_2 in blood
Hypercapnea	Excess of CO_2 in blood
Hypoxaemia	Lack of O_2 in arterial blood

Anoxia	Absence of O_2 in tissues
Hypoxia	Lack of O_2 in tissues
Tachypnea	Rapid breathing
Costal breathing	Shallow (Chest) breathing

Respiratory pigments

Name of pigment	Colour (oxidised)	Metal	Place	Example
Haemoglobin	Red	*Fe*	RBC	Chordata (Vertebrate)
Haemocyanin	Blue	*Cu*	Plasma	Mollusca and arthropoda
Chlorocruorin	Green	*Fe*	Plasma	Annelida, sabella, serpulids
Haemoerythrin	Red	*Fe*	Corpuscle	Annelida, Sipunculoidea, lingula
Venadium	Green	*Va*	Vanadocytes in Plasma	Urochordata
Echinochrome	Red	*Fe*	Coelomic fluid	Echinodermata
Pinnoglobin	Brown	*Mn*	Coelomic fluid	Pinna
Molpedin	Brown	*Mo*	Coelomic fluid	Holothuria
Heamoglobin	Red	*Fe*	Plasma	Earthworm, nereis, arenicola, chironomas insect, planorbis.
Erythrocruonin	Red	*Fe*	Plasma	Leech

Important Tips

- Protoplasmic respiration refers to the respiration of proteins.
- Polarography is employed to measure the concentration of oxygen in fluid.

- Accumulation of blood in pleural cavity is called haemothorax.
- All pulmonary volume and capacities are about 20-25% less in females than males.
- Accumulation of water is called hydrothorax.
- Accumulation of pus is called pyothorax.
- Accumulation of air is called pneumothorax.
- If chest wall is punctured, then pressure inside the pleural cavity become equal to atmospheric pressure so breathing stops.
- Besides lungs, the term alveolus is associated with bony socket for tooth, and in mammary glands also.
- Vital capacity represents the maximum amount of air one can renewed in respiratory system in a single respiration.
- Values of vital capacity is higher in athletes, sportsmen, mountain dwellers, males than females, young's than olds.
- Pregnancy and some diseases like emphysema, pleural effusion, ascites (collection of water in abdominal cavity) reduce the vital capacity. VC decreases as much as 35% in age 70.
- Measurement of expansion of chest during recruitment of police is done in the hope of getting an idea about vital capacity (greater expansion = greater vital capacity).
- In general, a man respires about 16 - 18 time in a minute.
- A new born child respires 32/min.
- A five year old child respires 26/min.
- A fifty year old man respires 18/min.
- Respiratory rate is lowest while sleeping (10 minute in human), respiratory rate during sitting (12 minute in human).
- No respiratory pigment in cockroach.
- In all vertebrate respiratory pigment is Hb, except ishfish and angula fish larva.
- Orthinolarynology – The branch of medicine deals with the diagnosis and treatment of diseases of the ears, nose and throat.
- Tertiary bronchi also known as segmental bronchi.
- Located in the walls of bronchi and bronchioles within the lungs are receptor sensitive to stretch called bororeceptor or stretch receptor.
- Rhinoplasty – or 'Nose job' surgically change in shape of external nose.
- Smaller the animal higher the respiratory rate.
- Rate of respiration is directly proportional to concentration of CO_2 in blood.
- Inspired air has 20.48 ml. O_2 in its 100 ml.
- Expired air has 15.70 ml. O_2 in its 100 ml.
- Metabolic rate of body is directly proportional to the total pulmonary ventilation.
- Intra aortic balloon pump is inflated by helium.
- In pregnant woman diaphragm does not take part in breathing.

- Respiratory tree is present in Holothurea (Echinodermata) .
- In living fishes (Protopterus, Lepidosiren and Neocaratodus) lungs are present.
- In frog larynx and trachea fused together to for larynngo tracheal chamber.
- Air sacs are presentin birds.
- A copressure of about 0.7 mm mm Hg concentration of 1% in alveolar air can be lethal.
- Medullary respiratory centre is constantly under direct chemical control.
- Impulse for voluntary forced breathing starts in cerebral hemisphere.
- Lungs of frog acts as negative pressure pump, while lungs of mammal acts as positive pressure pump.
- Spirometer also known as respirometer.
- Disorder such as asthma and emphysema can greatly reduce the expiratory reserve volume.
- Fetal lungs contain no air, and so the lung of a still born baby will not float in water.
- At birth, as soon as lungs fills with air, O_2 starts to diffuse from the alveoli into blood, through the interstitial fluid, finally into the cells.
- In general, lung volumes are larger in males, taller persons, younger adults and smaller in females, shorter persons, and the elderly.
- Carbonic, anhydrase is the fastest enzyme.
- Carbon monoxide combines with Hb more rapidly than O_2 to form carboxyhaemoglobin.
- Carbon monoxide has 200-250 times more affinity of Hb as compared to O_2.
- At about 4 weeks fetal development, the respiratory system begins as an outgrowth of endoderm of foregut, known as laryngotracheal bud.
- After 6 months, formation of alveoli of lungs.
- The medullary rhythmicity area in medulla oblongata.
- The pneumotoxic and the apneustic area in pons.
- The function of the medullary rhythmicity area is to control the basic rhytum of respiration.
- If arterial PCO_2 is more than 40 mm Hg, a condition called hypercapnia.
- If arterial PCO_2 is lower than 40 mm Hg, a condition called hypocapnia.
- Double Bohr effect refers to the situation in the placenta where the Bohr effect is operative in both the maternal and foetal circulation.
- Man uses only 25% of the O_2 of inhaled air, where as fishes use 80% O_2 of water.
- Ozone, a strong oxidizing agent, oxidises iron of Hb and forms a stable compound methaemoglobin which can not release O_2.
- The exchange of gases in gills is called bronchial respiration.
- External gills are present in some annelids (e.g. arenicola, amphitrite) young ones of certain insect (e.g., dragonflies, damsel flies) some tailed amphibians (e.g., necturus, siren, proteus) axolotal larva of tiger salamander and tadpole of frog.
- Internal gills are found in prawn, unio, pila, fish and tadpole of frog.
- Counter flow system, is a system for maximum gaseous exchange where blood and water flow in opposite direction (present in gills).

- Cutaneous respiration can occur both in air and water.
- Air bladder, also known as swim bladder found in all bony fishes except lophius and cyanoglossus.
- Air bladder perform the functions of hydrostatic organ, sound production, audition and respiration.
- Air bladder two types i.e. physostomus air bladder (associate with oesophagus by pneumatic duct) e.g., Lepidostelus, lepidosiren, arnia and physoclistous air bladder (without pneumatic duct) e.g., Anabas, cod, toadfish and hadhock.
- Foetal Hb takes O_2 from mother haemoglobin across the placenta due to double Bohr effect.
- The foetal Hb has a sigmoid dissociation curve which is shifted to left relative to adult Hb dissociation curve because they have lower P_{50} (18 to 20 mm Hg) than adult (26.5 mmHg). This means fetal Hb has a higher oxygen affinity.
- In embroys of mammals, respiration takes place by chorion.
- In lungs of birds are capillaries are present in place of alveoli.
- Exchange of O_2 takes place twice in lungs of birds. It is called double respiration.
- Aquatic salamander in lungless amphibians.
- In snakes, only right lung in functional, left lung is reduced.
- In penguins double trachea is present.
- Lungs of frog are air filled chambers and lungs of mammals are spongy.
- Rate of breathing of a normal man during heavy exercise is 40–50 times/minute.
- Diaphragm plays 75% part in breathing (abdominal breathing).
- Ribs and sternum plays 25% part in breathing (thoracic breathing).
- In pregnant females most part during breathing is played by intercostal muscles.
- Whales and other aquactic mammals suffocate on land because their intercostal muscles can not expand their chest due to their massive body weight.
- In elephant, diaphragm plays important role during respiration.
- In monkeys, kangaroo and other jumping animals, intercostal muscles play important role in breathing.
- In hibernating animals breathing rate decreases to a lowest limit.
- At any given pressure the diffusion of CO_2 is 20 times faster than O_2.
- If P_{50} value of Hb rises to 100 mm Hg, a person will die of O_2 deficiency because now Hb will not be able to bind or release O_2.
- **Aging and respiratory system, with advancing age –**

  Alveoli, respiratory tract less elastic.

  Lungs become less elastic.

  Decreases in lung capacity.

  Decreases in 35% vital capacity.

  Decreases level of O_2 in blood.

  Elderly persons are more susceptible to pneumonia, bronchitis, emyphysema.
- **Smoke inhalation injury –** Has three components that occur in sequence

Inhibition of O_2 delivery and utilization.

Upper airway injury from heat.

Lung damage from acid and aldehyde in smoke.

Why smokers have lowered respiratory efficiency.

Nicotine constricts terminal bronchioles and this decreases air flow into and out of lungs.

Carbon monoxide in smoke birds to haemoglobin and reduces its oxygen carrying capacity.

Irritants in smoke cause increased fluid secretion by mucosa of bronchial tree, inhibits the movement of cilia in lining of respiratory system.

Destruction of elastic fibres in lungs.

- **SARS – Severe Acute Respiratory Syndrome –**

SARS is a highly infectious disease caused by corona virus.

Corona virus in RNA virus, its genome was sequenced with in 15 days.

The origin of SARC is from South China, from South China this disease spread to Hongkong.

Bird sellers and presous in contact with birds to suffer from SARS.

Symptoms of infections are flue like symptoms. Fever occurs with dry cough. There is difficult in breathing. Fluid filled in lungs and death occurs with in one week of infection from respiratory failure.

Rate of death was initially 4% but now death rate has increased to 10%.

Line of treatment is quarnatine and ribovinin durgs.

The causative agent of SARS was identified by Dr. Malik Peiris of Microbiology Department of Honkong University.

ASSIGNMENT

RESPIRATION AND RESPIRATORY ORGANS IN DIFFERENT ANIMALS

Basic Level

1. The process of respiration is concerned with
(a) Intake of O_2 (b) Liberation of O_2 (c) Liberation of CO_2 (d) Liberation of energy

2. In anaerobic respiration of muscles, pyruvic acid is changed to
(a) Alcohol (b) Acetaldehyde (c) Acetyl CoA (d) Lactic acid

3. In anaerobic respiration
(a) O_2 is taken in (b) CO_2 is taken in (c) O_2 is given out (d) CO_2 is given out

4. Respiration involves one of the following sets of processes
(a) Inspiration, Exchange of gases, Expiration (b) Aspiration, Inspiration, Expiration
(c) Expiration (d) None of the above

5. Which one respires through gills
(a) Crocodile (b) Whale (c) Frog (d) Prawn

6. Fish brought out of water dies because of
(a) Absence of pressure (b) Inability of respire (c) Inability to feed (d) Rise in temperature

7. Skin is an accessory organ of respiration in
(a) Humans (b) Frog (c) Rabbit (d) Lizard

8. Diffusion of oxygen in tissues of Cockroach occurs through
(a) Blood (b) Integument (c) Tracheae (d) Tracheoles

9. Respiration can be defined as
(a) A catabolic process by which animal cells utilise carbon dioxide, produce oxygen and convert the released energy to ATP.
(b) A catabolic process by which animal cells utilise oxygen, produce carbon dioxide and convert the released energy to ATP.
(c) An anabolic process by which animal cells utilise oxygen and carbon dioxide, to form ATP.
(d) An anabolic process by which animal cells utilise oxygen, produce carbon dioxide and convert the released energy to ATP.

10. In which of the following animals, respiration occurs without any respiratory organ
(a) Fish (b) Frog (c) Cockroach (d) Earthworm

11. Voice in mammal produced
(a) By syrinx (b) By bronchus (c) During inhalation (d) During exhalation

12. Contraction of sternohyal muscles during breathing in frog
(a) Closes the glottis (b) Lowers floor of oral cavity
(c) Raises floor of oral cavity (d) Opens the nostrils

13. The mode of respiration of rabbit is
(a) Cutaneous (b) Mucosal (c) Tracheal (d) Pulmonary

14. The diaphragm in rabbit is a
(a) Gap between the incisor and premolar teeth
(b) Membrane which surrounds and protects the brain
(c) Membrane which lies between the external auditory meatus and tympanic cavity of the ear
(d) Partition of muscular septum separating the thoracic cavity from abdominal cavity

15. Larynx is found in
(a) Both frog and rabbit (b) Neither frog nor rabbit
(c)Frog but not in rabbit (d) Rabbit but not in frog

16. The right lung in rabbit is divided into
(a) 2 lobes (b) 4 lobes (c) 6 lobes (d) 8 lobes

17. In rabbit the inspiration occurs by contraction of
(a) External intercostal muscles and muscles of the diaphragm
(b) Internal intercostal muscles and muscles of the diaphragm
(c) External intercostal muscles only (d)Muscles of the diaphragm only

18. Which of the following has no blood but respires
(a) Earthworm (b) Hydra (c) Cockroach (d) Fish

19. In mammals the ventilation movements of the lungs are governed by
(a) Muscular wall of the lungs (b) Costal muscles
(c) Diaphragm (d) Costal muscles and diaphragm

20. In rabbit the lungs are lodged in
(a) Thoracic cavity (b) Abdominal cavity (c) Pleural cavity (d) Pericardial cavity

21. The adult frog does not respire through
(a) Buccopharyngeal cavity (b)Gills (c) Skin (d)Lungs

22. The total number of lobes in both lungs of rabbit is
(a) Four (b) Six (c) Two (d) Eight

23. In frog, cutaneous respiration takes place
(a) Only on land (b) Only in water with pulmonary respiration
(c) Only in water when pulmonary respiration is not occurring (d) Always

Advance Level

24. The cells which do not respire
(a) Epidermal cells (b) Sieve cells (c) Cortical cells (d) Erythrocytes

25. During hibernation frog performs
(a) Pulmonary respiration (b) Cutaneous respiration
(c) Buccopharyngeal respiration (d) Both cutaneous and pulmonary respiration

26. Insect tracheal system opens to the outside through
(a) Spiral valve (b) Pecten (c) Spiracle (d) Taenidia

27. In crustacea respiration occurs through
(a) Tracheae (b) Gills (c) Book lungs (d) Book gills

28. Book lungs are respiratory structures of

(a) Arachnida (b) Mollusca (c) Mammals (d) Earthworm

29. Match the columns and find correct combination

(A)	Earthworm	(i)	Pulmonary
(B)	Human	(ii)	Bronchial
(C)	Prawn	(iii)	Tracheal
(D)	Insects	(iv)	Cutaneous

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

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

30. In Nereis, gaseous exchange occurs through

(a) Parapodia (b) Gills (c) Lungs (d) Skin

31. A fully grown tadpole larva of frog respires through

(a) Skin (b) Gills (c) Lungs (d) Tail fin

32. True organ of sound production in birds is

(a) Larynx (b) Sound box (c) Vocal sac (d) Syrinx

33. Buccopharyngeal respiration in frog

(a) Is increased when nostrils are closed (b) Stops when there is pulmonary respiration

(c) Is increased when it is catching fly (d) Stops when mouth is opened

34. The right lung of rabbit has four lobes. They are

(a) Anterior lobe, anterior azygous, posterior lobe and right anterior

(b) Posterior lobe, posterior and anterior azygous, right anterior and right posterior

(c) Anterior azygous, right anterior, right posterior and posterior azygous lobe

(d) Anterior lobe, anterior azygous, right anterior and posterior azygous lobe

35. Which mammal lacks true vocal cords

(a) Monkey (b) Donkey (c) Hippopotamus (d) Man

36. Which animal has unpaired lungs

(a) Monkey (b) Whale (c) Some frogs (d) Some snakes

37. Following process is chemically similar to sugar fermentation

(a) Anaerobic respiration (b) Aerobic respiration

(c) Pulmonary respiration (d) Cutaneous respiration

38. Which type of respiration appeared first in the primitive organism and why

(a) Aerobic respiration as it releases more energy

(b) Anaerobic respiration as there was no O_2

(c) Anaerobic respiration because small organism can only do it

(d) Aerobic respiration as no harmful waste products are formed

39. With respect to respiratory apparatus, pick out the incorrect pair / pairs

(a) Insects – Tracheoles (b) Amphibians – Skin and lungs

(c) Starfish – Dermal bronchial (d) Crustacean – Lungs

40. Which structure in mammals does not help in respiration

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

41. Which one of the following can respire in total absence of air (anoxyliosis)

(a) *Amoeba* (b) Bed bug (c) Hydra (d) Tapeworm

42. If a rabbit stops after running 100 metres, then what will be the effect on its body

(a) Gets fatigued due to deposition of pyruvic acid in muscles

(b) Gets fatigued due to deposition of lactic acid in skeletal muscle

(c) Breathing rate increases as lactic acid gets deposited in muscles

(d) Remains unaffected

43. Besides lungs, the term 'alveolus' is associated with

(a) Bony cranium (b) Bony thoracic basket

(c) Bony auditory capsule (d) Bony socket for tooth

44. Which of the following animals possess non-elastic lungs with elastic air sacs connected to them

(a) Reptiles (b) Birds (c) Amphibians (d) Mammals

45. Which structure is not related with respiration in frog

(a) Diaphragm (b) Lungs (c) Skin (d) Buccal cavity

46. **Assertion (A) :** All terrestrial mammals are air breathers.

Reason (R) : Because of terrestrial habitat, they have well developed lungs for air breathing

(a) Both A and R are true and R is a correct explanation of the A

(b) Both A and R are true and R is not a correct explanation of the A

(c) A is true but R is false

(d) Both A and R are false

47. In rabbit, azygous lobes are associated with

(a) Right lung (b) Left lung (c) Both lung (d) None of above

48. When a frog is completely submerged in water it can respire only through

(a) Skin (b) Lungs

(c) Bronchial chamber (d) Buccopharyngeal cavity

49. During pulmonary respiration of frog

(a) Mouth remain closed (b) Mouth remain opened

(c) Mouth opens and closes alternately (d) None of the above

50. The term 'Protoplasmic respiration' refers to the respiration of

(a) Organic acids (b) Carbohydrates (c) Proteins (d) Fats

51. Which of the following tissues requires more oxygen

(a) Skin (b) Brain (c) Bone (d) Intestine

52. Which one of these statements is correct

(a) All animals require a medium for cellular respiration

(b) In all animals oxygen is transported by blood

(c) All animals take oxygen from water or air through gills and lungs

(d) All animals need oxygen for respiration

53. Epithelial lining of the alveoli of frog's lungs facing lung cavity is

(a) Squamous, ciliated (b) Squamous, non ciliated

(c)Columnar, nonciliated (d) Columnar, ciliated

54. A frog must swallow air to expand the lungs, because frog

(a) Has no diaphragm (b) Normally breathes through its skin

(c) Has no vagus nerve (d) Is relatively low form of life

55. The lungs in frog are

(a) Compact spongy masses (b) Thick-walled, nonelastic, hollow bags

(c) Thin-walled, elastic, hollow bags (d) None of these

HUMAN RESPIRATRORY ORGANS

Basic Level

56. Which of the following prevents collapsing of trachea

(a) Muscles (b) Diaphragm (c) Ribs (d) Cartilagenous rings

57. The covering of the lung is called

(a) Pericardium (b) Perichondrium (c) Pleural membrane (d) Peritoneum

58. Trachea and bronchi possess

(a) Incomplete cartilaginous rings (b) Complete cartilaginous rings

(c) Thick muscular wall (d) Thick fibrous wall

59. In human beings the number of lobes in right and left lungs is

(a) 2 and 3 (b) 2 and 2 (c) 3 and 2 (d) 4 and 2

60. Which is the end part of pulmonary or lung division and place of gaseous exchange

(a) Bronchiole (b) Alveolus (c) Air chamber (d) Trachiole

61. Common feature of human and insect trachea is

(a) Noncollapsible wall (b) Supporting rings (c) Ectodermal origin (d) Endodermal origin

62. Which one of the following has the smallest diameter

(a) Right primary bronchus (b) Left primary bronchus

(c) Trachea (d) Respiratory bronchiole

63. Difference between trachea and fallopian tube is

(a) Trachea is related with respiration where as fallopian tube is related with reproduction

(b) Trachea is related with respiration and fallopian tube with excretion

(c) Trachea is related with reproduction and fallopian tube with excretion

(d) Trachea is related with reproduction and fallopian tube with respiration

64. Which is a common passage in swallowing food and breathing

(a) Larynx (b) Gullet (c) Glottis (d) Pharynx

65. Which one is false

(a) Blood from right side of heart is carried to lungs by pulmonary artery

(b) Scurvy is due to vitamin C deficiency

(c) Pancreas is both exocrine and endocrine gland

(d) Pleura is double covering of kidney

66. The most important function of diaphragm of the mammals is

(a) To divide the body cavity into compartment (b) To protect lungs

(c) To aid in respiration (d) To aid in ventilation

67. The function of surfactant is / are

(a) Facilitating lung expansion (b) Maintaining the stable size of the alveoli

(c) To reduce the surface tension on the alveoli (d) All the above

68. The laryngopharynx opens into

(a) Oesophagus (b) Trachea (c) Larynx (voice box) (d) Lungs

69. Thyroid is a cartilagenous plate in

(a) Skull of rabbit (b) Larynx of rabbit

(c) Vertebrae of rabbit (d) Sternum of rabbit

70. Alveolar sac of lungs and villi of intestine have a similar function, it is that

(a) Both have ciliated epithelium (b) Both have blood capillary plexus

(c) Gaseous exchange occurs in both (d) Both increases surface area

71. Vocal cords occur in

(a) Larynx (b) Pharynx (c) Glottis (d) Bronchial tube

72. Adam's Apple represents

(a) Arytenoid cartilage of larynx (b) Cricoid cartilage of larynx

(c) Thyroid cartilage of larynx (d) All of the above

73. Oxygen carried in inhalation ultimately reaches

(a) Bronchioles (b) Bronchus (c) Trachea (d) Alveoli

74. In mammal, voice box is known as

(a) Bronchus (b) Syrinx

(c) Larynx (d) Inhalation and exhalation

75. Number of alveoli in the human lungs is

(a) 300 – 400 million (b) 100 – 150 million (c) 1 – 2 million (d) 100,000 – 150,000

76. Nasal chamber of each half has number of regions

(a) 4 (b) 3 (c) 2 (d) 1

77. The cartilage present in the larynx of rabbit are

(a) Thyroid, cricoid, arytenoid (b)Thyroid, cricoid, epiglottis

(c) Thyroid, cricoid, ethmoid (d)Thyroid, cricoid, palatine

78. What are the functions that are performed by the nasal cavity when air passes through it

(a) Air is warmed (b) Air is humidified

(c) Air is filtered (d) All are true

79. Diaphragm is characteristic of

(a) Mammals (b) Reptiles (c) Birds (d) All vertebrates

80. In man, which of the following structures is analogous to the spiracles of cockroach

(a) Alveoli (b) Bronchioles (c) Lungs (d) Nostrils

Advance Level

81. Match the columns

Column I	Column II
(A) Larynx	*p* Lid of larynx
(B) Trachea	*q* Air sacs
(C) Alveoli	*r* Voice box
(D) Epiglottis	*s* Wind pipe
–	*t* common passage

(a) A–r, B–s, C–q, D–p (b) A–*t*, B–s, C–p, D–q

(c) A–*r*, B–s, C–q, D–t (d) A–*r*, B–t, C–q, D–p

82. Mammalian lungs have numerous alveoli for

(a) Increasing volume of inspired air (b)Keeping the lungs in proper shape

(c) Higher number of muscles to provide greater elasticity

(d)Increasing surface area for gaseous diffusion

83. The alveolar epithelium in the lung is

(a) Nonciliated columnar (b)Nonciliated squamous

(c) Ciliated columnar (d)Ciliated squamous

84. Respiratory system is derived from

(a) Endoderm (b) Mesoderm (c) Ectoderm (d) None of these

85. Lungs have a large number of narrow tubes called

(a) Alveoli (b) Bronchioles (c) Bronchi (d) Alveolar ducts

86. Which one protect the lungs

(a) Ribs (b) Vertebral column (c) Sternum (d) All the above

87. Layer of uneven columnar cells which form tracheal lining are component of

(a) Brush border epithelium (b)Stratified epithelium

(c) Pseudostratified epithelium (d)Ciliated epithelium

88. Epithelium lining of bronchioles is
(a) Pseudostratified columnar (b) Pseudostratified sensory
(c) Squamous sensory (d) Cuboidal and columnar

89. Inner/alveolar surface area of human lungs is
(a) $1 m^2$ (b) $10 m^2$ (c) $100 m^2$ (d) $1000 m^2$

90. The function of tracheal cilia is to
(a) Pass mucus out (b) Pass mucus in (c) Pass air out (d) Pass air in

91. Glottis is opening in the floor of
(a) Diaphragm (b) Buccopharyngeal cavity (c)Trachea (d) None of the above

92. The area of inner surface of bronchiole is
(a) $1 m^2$ (b) $2 m^2$ (c) $5 m^2$ (d) $10 m^2$

93. In the terminal bronchiole which of the following is present
(a) Mucous cells (b) Non ciliated cuboidal epithelium
(c) Only elastic fibres (d) Elastic and reticular fibres

94. The structure which prevents the entry of food into respiratory tract is
(a) Pharynx (b) Larynx (c) Glottis (d) Epiglottis

95. Type of cartilage seen in tracheal wall is
(a) Hyaline cartilage (b) Fibro cartilage (c) Elastic cartilage (d) None of these

96. The surface area of human lung is made larger by alveoli and is approximately the size of a
(a) Dinner plate (b) Table (c) Four-person tent (d) Tennis court

97. The left and right bronchi are
(a) Subdivisions of the trachea (b)Lobes of lungs
(c) Fine branches of the trachioles (d)All of above

VENTILATION , EXCHANGE OF GASES , AIR VOLUME

Basic Level

98. Which energy is consumed in breathing
(a) Mechanical (b) Chemical (c) Bioelectricity (d) Physical energy

99. In human beings, rib case and sternum move upwardly and outwardly during
(a) Exercise (b) Sudden back injury (c) Expiration (d) Inspiration

100. Exchange of gases in lung alveoli occurs through
(a) Active transport (b) Osmosis (c) Simple diffusion (d) Passive transport

101. Lungs have a large number of alveoli for
(a) Having spongy texture and proper shape (b) More surface area for diffusion of gases
(c) More space for increasing volume of inspired air (d)More nerve supply

102. Gases diffuse over the respiratory surface because of
(a) P_{O_2} is more in alveoli than in blood (b) P_{O_2} is more in blood than in tissues
(c) P_{CO_2} is more in alveoli than in blood (d) P_{CO_2} is more in blood than in tissues

103. Tidal volume in human beings is

(a) 1000 ml (b) 1500 ml (c) 500 ml (d) 4.5 litres

104. The greatest quantity of air that can be expired after a maximum inspiratory effort is its

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

105. About 1500 ml of air left in lungs is called

(a) Tidal volume (b) Inspiratory reserve volume

(c) Residual volume (d) Vital capacity

106. Diaphragm present in mammals is

(a) Membrane between external and middle ear (b) Membrane around the brain

(c) Partition between the thoracic and abdominal cavities

(d) Membrane around lungs

107. At the time of inspiration, the diaphragm

(a) Expands (b) Contracts

(c) Relaxes (d) Does not undergo any change

108. Rate of breathing in an adult human is

(a) 10 – 12/min (b) 14 – 18/min (c) 20 – 25/min (d) 25 – 30/min

109. During expiration diaphragm becomes

(a) Flattened (b) Dome-shaped (c) Oblique (d) Normal

110. During inspiration, air passes into lungs due to

(a) Increase in volume of thoracic cavity and fall in lung pressure

(b) Fall in pressure inside the lungs

(c) Increased volume of thoracic cavity (d) Muscular expansion of lungs

111. Respiration rate is the lowest during

(a) Running (b) Playing (c) Eating (d) Sleeping

112. Expiratory muscles contract at the time of

(a) Deep inspiration (b) Normal inspiration and expiration

(c) Forceful expiration (d) Normal expiration

113. Air is breathed through

(a) Trachea $\rightarrow$ lungs $\rightarrow$ larynx $\rightarrow$ pharynx $\rightarrow$ alveoli

(b) Nose $\rightarrow$ larynx $\rightarrow$ pharynx $\rightarrow$ bronchus $\rightarrow$ alveoli $\rightarrow$ bronchioles

(c) Nostrils $\rightarrow$ pharynx $\rightarrow$ larynx $\rightarrow$ trachea $\rightarrow$ bronchi $\rightarrow$ bronchioles $\rightarrow$ alveoli

(d) Nose $\rightarrow$ mouth $\rightarrow$ lungs

114. Which one has the lowest value

(a) Tidal volume (b) Vital capacity

(c) Inspiratory reserve volume (d) Expiratory reserve volume

115. Total vital capacity of lungs is

(a) 1500 ml (b) 2200 ml (c) 5800 ml (d) 500 ml

116. The amount of air that moves in and out of the lungs, with each normal inspiration and expiration is called

(a) Residual volume (b) Vital capacity (c) Tidal volume (d) Tidal capacity

117. The gaseous exchange between blood and air does not occur in

(a) Conductive zone (b) Respiratory zone (c) Transitory zone (d) All the above

118. Breathing differs from respiration by

(a) Both are same and there is not difference

(b) Breathing refers to respiration in human beings whereas respiration occurs in rest of the animals and plants

(c) Breathing refers to chest movements due to inhalation of O_2 and exhalation of carbon dioxide whereas respiration refers to gaseous exchange.

(d) None of these

119. The exchange of gases(O_2 and CO_2) in a mammal takes place in

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

120. What structures are responsible for breathing process

(a) The trachea and alveoli (b)Larynx and bronchi

(c) Ribs and intercostal muscles (d) Intercostal muscles and diaphragm

121. The cellular respiration differs from breathing in that in cellular respiration

(a) Glucose is oxidised to CO_2 and water with release of energy

(b) Oxygen is bound to haemoglobin producing oxyhaemoglobin in the lungs

(c) Oxygen is released into the cells from oxyhaemoglobin

(d) Air rich in oxygen is taken in and air poor in oxygen is given out

122. Which of the following factor is most necessary for a respiratory surface

(a) Moistness (b) Large respiratory surface (c)Rich blood supply (d)Thickness

123. Dead space air is

(a) The amount of air remaining in the alveoli

(b) The amount of air left behind in lungs at the end of deep expiration

(c) The amount of air taken in and out

(d) The air left in the bronchial tree

124. Breathing rate is lowered during eating because

(a) Our lungs do not get enough supply of blood

(b) Swallowing and breathing cannot go together at the same time

(c) Lungs are compressed as stomach enlarges

(d) More energy is required during eating

125. Choose the correct equation

(a) Total capacity of lungs = vital capacity + tidal air

(b) Total capacity of lungs = vital capacity + residual air

(c) Vital capacity of lungs = tidal air + complemental air

(d) Total capacity of lungs = tidal air + complemental air + Supplemental air

126. Which of the following statements is correct

(a) Inspiration is an active process (b)Inspiration is a passive process

(c) Expiration is an active process (d)Both expiration and inspiration are passive processes

127. The maximum amount of air that our lung can normally hold is

(a) Vital capacity (b) Total lung capacity (c) Pulmonary capacity (d) Tidal capacity

128. The blood coming out of lungs is richer than that entering into lungs in

(a) CO_2 (b) O_2 (c) Both (d) None

Advance Level

129. One of the following is a difference between pulmonary respiration of frog and human

(a) Diaphragm and ribs play role in respiration (b) Lungs are respiratory organs

(c) Respiration occurs due to pressure gradient (d) None of the above

130. Normal breathing is called

(a) Apnea (b) Dyspnea (c) Eupnea (d) Hyperpnea

131. Air entering lungs is (1) Warmed (2) Filtered (3) Deprived of some oxygen (4) Enriched with CO_2. What is true

(a) 1, 2, 3 and 4 (b) 1 and 2 (c) 2 and 4 (d) 2 and 3

132. Thoracic cage of man is formed of

(a) Ribs and sternum (b) Ribs, sternum and thoracic vertebrae

(c) Ribs, sternum and lumbar vertebrae (d) Ribs and thoracic vertebrae

133. A person met with an accident and died instantly without any injury to heart, brain, stomach and kidney. One of the following is a reason for his death

(a) Intestine got twisted (b) RBC became coagulated

(c) Stomach stopped digestion (d) Diaphragm got punctured

134. If the thoracic wall but not lungs is punctured

(a) The lungs get inflated (b)The man dies as the lungs get collapsed

(c) The breathing rate decreases (d) The breathing rate increases

135. In mammals ventilation movements of lungs are governed by

(a) Muscular wall of lungs (b) Intercostal muscles

(c) Diaphragm (d) Diaphragm and intercostal muscles

136. In mammals, the body cavity is partitioned into thoracic and abdominal parts by

(a) Liver (b) Lungs (c) Ribs (d) Diaphragm

137. Expiration involves

(a) Relaxation of diaphragm and intercostal muscles

(b)Contraction of diaphragm and intercostal muscles

(c) Contraction of diaphragm muscles

(d) Contraction of intercostal muscles

138. In lungs, air is separated from venous blood by

(a) Squamous epithelium + tunica externa of blood vessel

(b)Squamous epithelium + endothelium of blood vessel

(c) Transitional epithelium + tunica media of blood vessel

(d) Columnar epithelium + 3 layered wall of blood vessel

139. Vital capacity of lungs of an average human is

(a) 3000–4500 ml (b) 1500 – 1800 ml (c) 2000 – 2500 ml (d) 500 – 1000 ml

140. The oxygen concentration of expired air is about

(a) 4% (b) 10% (c) 16% (d) 20%

141. Oxygen and carbon dioxide concentration in the alveolar air is respectively

(a) 16% and 4% (b) 19.8% and 4.6% (c) 21% and 4% (d) 13.1% and 5.3%

142. Which is correct

(a) Respiratory centres are not affected by CO_2

(b) In human vital capacity is just double the expiratory volume

(c) A human lung has 1000 alveoli

(d) During inspiration the lungs act as suction pump

143. Residual air mostly occurs in

(a) Alveoli (b) Bronchus (c) Nostrils (d) Trachea

144. Presence of large number of alveoli around alveolar ducts opening into bronchioles in mammalian lungs is

(a) Inefficient system of ventilation with little of residual air

(b) Inefficient system of ventilation with high percentage of residual air

(c) An efficient system of ventilation with no residual air

(d) An efficient system of ventilation with little residual air

145. Vital capacity of lungs is equal to

(a) IRV + ERV + TV (b) IRV + ERV +TV – RV

(c)IRV + ERV + TV + RV (d) IRV + ERV

146. Which of the following statement best summarizes the relationship between respiratory rate and body size in related animals

(a) Size and respiratory rate are not related in any orderly fashion

(b) Smaller the animal lower the respiratory rate

(c) Smaller the animal higher the respiratory rate

(d) None of these

147. Bucket – handle movements is seen in

(a) 1^{st} rib (b) 3^{rd} rib to 5^{th} rib (c) 6^{th} rib to 10^{th} rib (d) 11^{th} and 12^{th} rib

148. Rate of respiration is directly proportional to

(a) Concentration of oxygen in blood (b) Concentration of carbon dioxide in blood

(c) Oxygen in trachea (d) Diaphragm expansion

149. During forced expiration, actively contracting muscles include the

(a) Diaphragm (b) External intercostals

(c) Abdominal muscles (d) Diaphragm and intestinal muscle

150. Amount of air exchanged in breathing can be measured with a

(a) Spherometer (b) Barometer

(c) Spirometer (d) Sphygmomanometer

151. To the metabolic rate of body total pulmonary ventilation is

(a) Directly proportional (b)Inversely proportional (c)Not related (d) Variable

152. If a person breathes with maximal effort but with his nose and mouth closed, the alveolar pressure can be decreased to as low as

(a) – 80 *mm Hg* (b) + 10 *mm Hg* (c) – 180 *mm Hg* (d) – 250 *mm Hg*

153. During inspiration the enlargement of thoracic cage decreases the pressure in the alveoli to about

(a) – 5 *mm Hg* (b) – 8 *mm Hg* (c) – 15 *mm Hg* (d) – 250 *mm Hg*

154. Blood pressure increases

(a) During early part of inspiration (b) During later part of inspiration

(c) During early part of expiration (d) During later part of expiration

155. Quite breathing is often referred to as

(a) Respiration (b) Abdominal breathing (c) Thoracic breathing (d) Inspiration

156. The breathing rate in a child is

(a) Same as in an adult man (b) Less than in an adult man

(c) More than in an adult man (d) None of the above

157. In rabbit the expiration occurs by the

(a) Contraction of the external intercostal muscles and the relaxation of the muscles of the diaphragm

(b) Contraction of the internal intercostal muscles and the relaxation of the muscles of the diaphragm

(c) Contraction of the internal intercostal muscles only

(d) Relaxation of the muscles of the diaphragm only

158. Lack of breathing is

(a) Apnea (b) Asphyxia (c) Dyspnea (d) Eupnea

TRANSPORT OF GASES

Basic Level

159. Oxygen carried by blood is liberated in

(a) Arteries (b) Capillaries of body (c) Capillaries of lungs (d) Heart

160. For proper transport of O_2 and CO_2 blood should be

(a) Slightly acidic (b) Strongly acidic (c) Strongly alkaline (d) Slightly alkaline

161. Oxygen and carbon dioxide are transported in blood through

(a) Platelets and corpuscles (b)RBCs and WBCs (c) WBCs and serum (d) RBCs and plasma

162. Total oxygen that can be carried by blood is

(a) 1000 – 1200 *ml* (b) 2000 – 3000 *ml* (c) 200 *ml* (d) 100 *ml*

163. In the process of transport of CO_2 which phenomenon occurs between RBCs and plasma

(a) Osmosis (b) Adsorption (c) Chloride shift (d) Absorption

164. CO_2 is transported as

(a) Dissolved in blood plasma (b)As carbonic acid

(c) In carbaminohaemoglobin (d)As carbaminohaemoglobin and carbonic acid

165. Bicarbonate ion is produced inside

(a) Lymphocytes (b) Erythrocytes (c) Neutrophils (d) Basophils

166. Maximum amount 70–75% of carbon dioxide transport occurs as

(a) Dissolved in plasma (b) Carbaminohaemoglobin complex

(c) Bicarbonate (d) None of the above

167. Bicarbonate formed inside erythrocytes passes out into plasma while chloride of plasma pass into erythrocytes. The phenomenon is called

(a) Bicarbonate shift (b) Carbonation

(c) Hamburger phenomenon (d) Carbochlorosis

168. Carbon dioxide entering erythrocytes reacts with water to form carbonic acid. The enzyme is

(a) Carbonic anhydrase (b) Carboxypeptidase (c) Hydrolase (d) Oxidoreductase

169. Maximum amount of Co_2 which originate in cellular respiration transported by blood in lung

(a) In combination with haemoglobin (b) In the form of free CO_2

(c) In the form of bicarbonic acid of H_2CO_3 (d) In the form of bicarbonate ions

170. Chloride shift is required for transport of

(a) Nitrogen (b) Oxygen

(c) Carbon dioxide (d) Carbon dioxide and oxygen

171. Blood does not transport oxygen in

(a) Cockroach (b) Earthworm (c) Frog's tadpole (d) Mammalian foetus

172. Blood entering the lung is rich in

(a) Oxygen (b) Carbon dioxide (c) Urea (d) More RBCs

173. The blood coming out of lungs than entering into lungs is richer in

(a) Carbon dioxide (b) Oxygen (c) (a) and (b) both (d) None of these

174. What would happen if human blood becomes acidic (low pH)

(a) Oxygen carrying capacity of haemoglobin increases

(b) Oxygen carrying capacity of heamoglobin decreases

(c) RBC count increases (d)RBC count decreases

Advance Level

175. Oxygen is transported in vertebrates as

(a) Dissolved in plasma (b) Complexed with haemoglobin

(c) Dissolved in cytoplasm of erythrocytes (d) Absorbed over the RBC

176. Oxygen carrying capacity of blood is

(a) 20% (b) 30% (c) 40% (d) 50%

177. Percentage of oxygen supplied by haemoglobin is

(a) 97% (b) 100% (c) 49% (d) 3%

178. Determination of oxygen carried by haemoglobin is done by

(a) *pH* (b) Partial pressure of oxygen

(c) Partial pressure of carbon dioxide (d) All the above

179. **Assertion :** Haemoglobin is an oxygen carrier.

Reason : Oxygen binds as O^{2-} to Fe of haemoglobin

(a) Both A and R are true and R is a correct explanation of the A

(b) Both A and R are true and R is not a correct explanation of the A

(c) A is true but R is false

(d) Both A and R are false

180. During transport of CO_2, blood does not become acidic due to

(a) Neutralization of H_2CO_3 by Na_2CO_3 (b) Absorption by leucocytes

(c) Blood buffers (d) Non accumulation

181. Oxygenated blood from lungs is carried to the heart by

(a) Pulmonary artery (b) Pulmonary vein (c) Coronary vein (d) Pre-cavals

182. Carbon dioxide is transported from tissues to respiratory surface by only

(a) Plasma and erythrocytes (b) Plasma

(c) Erythrocytes (d) Erythrocytes and leucocytes

183. Concentration of carbonic acid does not increase in blood due to presence of

(a) Na^+ (b) Mg^{2+} (c) Ca^{2+} (d) K^+

184. A higher CO_2, concentration of blood causes

(a) Slow diffusion of O_2 from blood (b) Slow transport of O_2 in blood

(c) Quick diffusion of O_2 from blood (d) Both (a) and (b)

185. Compound soluble in water which does not impede oxygen transportation is

(a) SO_2 (b) SO_3 (c) *CO* (d) *NO*

186. Hypercapnia means excess of ….. in body fluids

(a) Oxygen (b) Carbon dioxide

(c) Calcium (d) Potassium

187. Which of the following shows maximum solubility in blood plasma

(a) Oxygen (b) Carbon dioxide

(c) Carbon monoxide (d) Nitrogen

188. Which one of these in blood adsorbs oxygen in respiration

(a) Blood plasma (b) Leucocytes (c) Erythrocytes (d) Platelets

189. Carbonic anhydrase is found in

(a) Leucocytes (b) Lymphocytes

(c) Erythrocytes (d) Blood plasma

190. Which fact suggests that most O_2 is transported from lungs to the tissues combined with haemoglobin rather than dissolved in blood plasma

(a) O_2 carrying capacity of whole blood is much higher than that of plasma and O_2 content of blood leaving the lungs is greater than that of blood entering the lungs.

(b) Hemoglobin can combine with O_2.

(c) Oxyhaemoglobin can dissociate into haemoglobin and O_2.

(d) Increase in CO_2 concentration decreases the O_2 affinity of haemoglobin.

HAEMOGLOBIN AND OXYHAEMOGLOBIN DISSOCIATION CURVE

Basic Level

191. Amount of oxygen absorbed by one gram of haemoglobin is

(a) 1.34 ml (b) 13.4 ml (c) 20 ml (d) 134 ml

192. A molecule of haemoglobin carries oxygen molecules

(a) 1 (b) 2 (c) 3 (d) 4

193. Haemoglobin is

(a) Vitamin (b) Skin pigment (c) Blood carrier (d) Respiratory pigment

194. The metal associated with haemoglobin is

(a) Sodium (b) Potassium (c) Calcium (d) Iron

195. Haldane believes oxyhaemoglobin to act as

(a) Acid (b) Alkali (c) Buffer (d) None of the above

196. Body tissues obtain oxygen from haemoglobin because of its dissociation in tissues caused by

(a) Low oxygen concentration and high carbon dioxide concentration

(b) Low oxygen concentration

(c) Low carbon dioxide concentration

(d) High carbon dioxide concentration

197. Oxygen haemoglobin dissociation curve will shift to right on decrease of

(a) Acidity (b) Carbon dioxide concentration

(c) Temperature (d) *pH*

198. Hamburger's phenomenon is also known as

(a) HCO'_3 shift (b) Na^+ shift (c) H^+ shift (d) Chloride shift

199. Oxygen dissociation curve of haemoglobin is

(a) Sigmoid (b) Hyperbolic (c) Linear (d) Hypobolic

200. Dissociation curve is connected with

(a) Carbonic anhydrase (b) Carbon dioxide (c) Oxygen (d) Oxyhaemoglobin

201. Which of the following gases makes the most stable combination with the haemoglobin of RBCs

(a) CO_2 (b) *CO* (c) O_2 (d) *N*

202. The percentage of haemoglobin saturated with oxygen will increase if

(a) The arterial *pH* is decreased (b) The temperature is increased

(c) The arterial pO_2 is increased (d) The haemoglobin concentration is increased

203. Carbon monoxide combines with haemoglobin to form

(a) Carboxyhaemoglobin (b)Carbaminohaemoglobin (c)Oxyhaemoglobin (d)None

204. Haemoglobin has least affinity for

(a) Oxygen (b) Carbon dioxide

(c) Carbon monoxide (d) Same affinity for all above

205. Oxyhaemoglobin is an unstable compound because

(a) Haemoglobin is a complex pigmented protein

(b) There is a physical bonding between oxygen and haemoglobin

(c) There is a chemical bonding between oxygen and haemoglobin

(d) One molecule of haemoglobin combines with four molecules of oxygen

206. Which form of iron is found in haemoglobin

(a) In the form of molecule (b)In the form of compound

(c) Fe^{2+} (d) Fe^{3+}

207. Which of the following increases the oxygen affinity of *Hb*

(a) High body temperature (b)Low pCO_2 (c) High blood *pH* (d) Both (b) and (c)

Advance Level

208. Venadium occurs in

(a) Annelida (b) Insecta (c) Urochordata (d) Echinodermata

209. What is percentage of haemoglobin in RBCs

(a) 3% (b) 10% (c) 28% (d) 35%

210. Myoglobin is found in

(a) Lungs (b) Blood

(c) Muscles (d) Red blood corpuscles

211. Two respiratory pigments have been shown to occur together in the blood of certain

(a) Snail (b) Brachiopods (c) Annelids (d) Arthropods

212. During one circuit of blood from lungs to the tissue and back through the circulatory system the percentage of haemoglobin giving the oxygen is

(a) 50% (b) 25% (c) 75% (d) 100%

213. Oxygen dissociation curve of myoglobin is

(a) Hypobolic (b) Hyperbolic (c) Linear (d) Sigmoid

214. Dissociation curve shifts to the right when

(a) O_2 concentration decreases (b) CO_2 concentration decreases

(c) CO_2 concentration increases (d)Chloride concentration increases

215. At higher CO_2 concentration, oxygen dissociation curve of haemoglobin will

(a) Move to left (b) Move to right (c) Become irregular (d) Move upwardly

216. Which one is present in arthropods

(a) Haemoglobin (b) Chlorophyll (c) Haemocyanin (d) Myoglobin

217. Ratio of oxyhaemoglobin and haemoglobin in the blood is based upon

(a) Bicarbonate tension (b) Carbon dioxide tension (c)Carbonate tension (d)Oxygen tension

218. Vanadium containing blood pigment is noticed among

(a) Animal living in polluted water (b)Man returning from moon

(c) Ascidian (d) Echinoderm

219. Pinnoglobin is

(a) *Mn* containing respiratory pigment (b) *Mg* containing respiratory pigment

(c) *V* containing respiratory pigment (d) *Cu* containing respiratory pigment

220. Which statement correctly defines Bohr's effect

(a) Rise in P_{50} with a decreases in CO_2 concentration

(b)Rise in P_{50} with an increase in CO_2 concentration

(c) Rise in P_{50} with an increase in *pH* and decrease in PCO_2

(d) Fall in P_{50} with a decrease in *pH*

221. An increase in the P_{50} of an oxyhaemoglobin curve would result from a decrease in

(a) Oxygen (b) *pH* (c) Metabolism (d) Temperature

222. When, under certain conditions, the P_{50} value of haemoglobin rises, the affinity of the pigment of combining with O_2 will

(a) Remain same (b) Increased (c) Decreased (d) None of these

223. If, under certain conditions, the P_{50} value of haemoglobin rises to 100 *mm Hg*, a person will die of O_2 deficiency because the pigment

(a) Is not loading enough oxygen in lungs

(b) Can load enough oxygen in lungs but can not unload it in tissues

(c) Can neither load nor unload oxygen

(d) Suffers degradation and cannot function normally

224. If O_2 concentration in tissue was almost as high as at the respiratory surface
(a) Oxyhaemoglobin would dissociate to supply O_2 to the tissue
(b) Haemoglobin would combine with more O_2 at respiratory surface
(c) Oxyhaemoglobin would not dissociate to supply O_2 to the tissue
(d) CO_2 will interfere the O_2 transport

225. The breakdown product of haemoglobin is called as
(a) Iron (b) Bilirubin (c) Haemocynin (d) Skatol

CONTROL OF BREATHING

Basic Level

226. Respiratory movements are controlled by
(a) Cerebellum (b) Cerebrum (c) Medulla oblongata (d) Crura cerebri

227. Respiratory centre is situated in
(a) Cerebellum (b) Medulla oblongata (c) Hypothalamus (d) Cerebrum

228. If the CO_2 concentration in the blood increases, the breathing shall
(a) Increase (b) Decrease (c) Stop (d) No affect

229. Respiratory mechanism is controlled by
(a) Central nervous system (b) Sympathetic nervous system
(c) Parasympathetic nervous system (d) Autonomic nervous system

230. The state during which the respiratory centre is inhibited is termed as
(a) Asphyxia (b) Suffocation (c) Anoxia (d) Chocking

Advance Level

231. Pneumatic and inhibitory centres are associated with
(a) Respiration (b) Breathing (c) Inspiration (d) Expiration

232. Respiratory centre of brain is stimulated by
(a) Carbon dioxide content in venous blood (b) Carbon dioxide content in arterial blood
(c) Oxygen content in venous blood (d) Oxygen content in arterial blood

233. Rate of respiration is directly affected by
(a) Concentration of carbon dioxide (b) Oxygen in trachea
(c) Concentration of oxygen (d) Diaphragm expansion

234. Forced deep breathing during rest for some time is followed by temporary stoppage of breathing because of
(a) Little CO_2 in blood (b) High CO_2 content in blood
(c) High oxygen content in blood (d) Little oxygen content in blood

235. Medullary inspiratory centre is under
(a) Nervous control (b) Physical control (c) Chemical control (d) Electric control

236. The impulse for voluntary muscles for forced breathing starts in
(a) Medulla (Pons) (b) Vagus nerve (c) Cerebral hemispheres (d)Spinal cord

237. Rate and depth of respiration shall increase when

(a) Oxygen concentration increases (b) CO_2 concentration increases

(c) HCO_3 concentration increases (d) HCO_3 concentration decreases

238. Deep and prolonged inspiration is due to activity of

(a) Gasping centre alone (b)Apneustic centre

(c) Pneumotaxic centre (d) Apneustic centre working together with gasping centre

239. A person with high fever may be breathing faster than normal. This faster breathing may be due to

(a) Additional requirement of O_2 for germs (b) High temperature of the body

(c) Mental worry of patient (d) Loss of appetite

240. Rate of breathing is increased by

(a) Increase of acidity (b) Increase of alkalinity (c) Hard labour (d) All the above

241. After fast running, man has fast heart beat, slow pulse and shallow breathing. In such conditions he has

(a) Oxygen debt (b) Poisoning due to lactic acid

(c) No pulmonary pressure (d) Weak heart

242. The respiratory centre leading to faster breathing is on account of

(a) Venous blood entering the respiratory centre (b) Arterial blood entering the respiratory centre

(c) Venous blood leaving the respiratory centre (d) Arterial blood leaving the respiratory centre

243. The impulse for voluntary forced breathing starts in

(a) Medulla (b) Vagus nerve (c) Spinal cord (d) Cerebrum

MISCELLANEOUS PROBLEMS

Basic Level

244. Proportion of volume of carbon dioxide released to volume of oxygen absorbed during respiration

(a) Respiratory quotient (b) Respiratory exchange (c) Respiratory activity (d) Respiratory phase

245. Carbon monoxide has greater affinity for haemoglobin as compared to oxygen

(a) 1000 times (b) 200 times (c) 20 times (d) 2 times

246. At high altitude, RBCs of human blood will

(a) Increase in number (b) Decrease in number (c) Decrease in size (d) Increase in size

247. Respiratory quotient is not less than one in

(a) Carbohydrates (b) Proteins (c) Fats (d) Normal diet

248. Asthma is caused due to

(a) Infection of trachea (b) Infection of lungs

(c) Bleeding into pleural cavity (d) Spasm in bronchial muscles

249. In carbon monoxide poisoning there is

(a) Increase in carbon dioxide concentration (b) Decrease in oxygen availability

(c) Decrease in free haemoglobin (d) None of the above

250. One reason for emphysema is

(a) Liquor consumption (b) Smoking (c) Drug addiction (d) Heavy exercise

251. Asphyxia occurs due to

(a) Rise in level of CO_2 (b) Fall in level of CO_2 (c) Rise of O_2 level (d) Fall in O_2 level

252. Which of the following disease is associated with lungs

(a) Bronchitis (b) Pneumonia (c) Asthama (d) All the above

253. If a man from sea coast goes to Everest peak then

(a) His breathing and heart beat will increase (b) His breathing and heart beat will decrease

(c) His respiratory rate will decrease (d) His heart beat will decrease

254. An irritation of the nasal mucosa may result in

(a) Coughing (b) Sighing (c) Hiccuping (d) Sneezing

255. Mountain sickness is due to

(a) O_2 is decreased progressively with the rise in altitude so fall in O_2 of the blood produces this symptom

(b) Stimulation of the nervous system at higher altitude

(c) Muscular fatigueness

(d) All of the above

256. A person at 15000 feet above sea level develops certain symptoms in 8-24 hours, these are

(a) Breathlessness and headache only

(b) Dizziness and irritation only

(c) Nausea, vomiting, mental fatigueness, a bluish tinge on skin, nails and lips

(d) All of the above

257. Anoxia is a condition when

(a) Lungs collapse (b) Lungs get inflated

(c) Respiratory centre is inhibited (d) Lungs get damaged due to some disease

258. When some food particle enters the windpipe instead of oesophagus it is expelled by the process of

(a) Sneezing (b) Coughing (c) Yawning (d) Hiccuping

259. During strenuous exercise, which of the following change occurs **[CPMT 2000]**

(a) Glucose is converted into glycogen (b) Glucose is converted into pyruvic acid

(c) Starch is converted into glucose (d) Pyruvic acid is converted into lactic acid

Advance

260. In an organism utilizing carbohydrates as source of energy anaerobically, the R.Q. is likely to be **[AIIM**

(a) 0.7 (b) 1.0 (c) 0.9 (d) Infinity

261. Which is correct **[MP PMT 1993]**

(a) Respiratory centres are not affected by CO_2 (b) In humans vital capacity is just double the expiratory volume

(c) A human lung has 10^3 alveoli (d) During inspiration the lungs act as suction pump

262. Metabolic rate will be highest in **[Haryana PMT 2001]**

(a) Elephant (b) Rat (c) Horse (d) Human

263. Hiccough (hiccup) is due to activity of **[Manipal 2001]**

(a) Intercostal muscles (b) Food in air tract

(c) Diaphragm (d) Inadequate oxygen in environment

264. Inflammation of the lung covering causing severe chest pain is

(a) Emphysema (b) Pleurisy (c) Asphyxia (d) Hypoxia

265. When the oxygen supply to the tissues is inadequate, the condition is **[DPMT 1999]**

(a) Hypoxia (b) Asphyxia (c) Pleurisy (d) Anoxia

266. Reduction in respiratory surface of the lungs due to break down of partition in the alveoli is known as

(a) Asphyxia (b) Bronchitis (c) Asthma (d) Emphysema

267. What is usually present at the time of asphyxiation

(a) Oxyhaemoglobin (b) Methaemoglobin

(c) Carbaminohaemoglobin (d) Haemoglobin without oxygen

268. The R.Q. is more than one when the respirable matter is **[DPMT 1985]**

(a) Proteins (b) Fats (c) Organic acids (d) starch

269. Exposure to carbon monoxide (from coal gas) is extremely dangerous and can kill a patient because **[KCET 1**

(a) The compound carboxyhaemoglobin (*COHb*) it forms with haemoglobin can gradually clot the blood resulting in circulatory failure

(b) *COHb* reduces the ability of blood for transport oxygen by rupturing a vast majority of erythrocytes

(c) *COHb* greatly modifies the structure of haemoglobin, thus making it lose its affinity for oxygen

(d) None of the above

270. Coughing

(a) Is a essential process (b) Serves to keep their air pressure free of foreign matter (c) Is a reflex reaction under nervous control (d) All the above

271. Intra aortic balloon pump is inflated by **[JIPMER (Med.) 2002]**

(a) Hydrogen (b) Oxygen (c) Helium (d) Chlorine

272. Low oxygen tension in the blood causes

(a) Coughing (b) Yawning (c) Hiccuping (d) Sneezing

273. Number of RBCs per unit volume of blood is likely to be higher in a person living at high altitudes, because **[CPMT 1974, 84]**

(a) Air clean and unpolluted (b) More sunshine is available

(c) Air is less dense (d) Vegetation gives out more O_2

274. One mole glucose on complete oxidation yields energy **[MP PMT 1997]**

(a) 686 *cal* (b) 68,600 *cal* (c) 6,86,000 *cal* (d) 68,60,000 *cal*

275. The diabetic patient shows

(a) High respiratory quotient (b) Low respiratory quotient

(c) Zero respiratory quotient (d) None of these

276. Complete bronchus obstruction results in

(a) Collapse of the portion of the lung supplied by the bronchus (b) A rise in intrapleural pressure on the affected side

(c) An increase in physiological dead space (d) Vasodilation of alveoli supplied by the bronchus

277. Cyanosis is

(a) Lack of oxygen in body fluids

(b) Difficult or heavy breathing

(c) Excess of carbon dioxide in the body fluids

(d) 'Skin turning blue' due to excessive amount of deoxygenated haemoglobin in the skin blood vessels

278. The decompression sickness is

(a) Respiration under depression

(b) Sickness develops after coming over the sea surface from a great depth

(c) Sickness develops after attaining a high altitude

(d) Sickness develops after coming on earth surface from the mines

279. Polarography is employed to measure the concentration of which gas in a fluid

(a) Oxygen (b) Carbon dioxide (c) Hydrogen (d) Nitrogen

ANSWER

ASSIGNMET (BASIC & ADVANCE LEVEL)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
d	d	d	a	d	b	b	d	b	d	d	b	d	d	a	b	a	b	d	c
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
b	b	d	d	b	c	b	a	b	a	b	d	d	c	c	d	a	b	d	d
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
d	b	d	b	a	a	a	a	a	c	b	a	d	a	c	d	c	a	c	b
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
b	d	a	d	d	d	d	c	b	d	a	c	d	c	a	b	a	d	a	d
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
a	d	b	a	b	d	c	d	c	a	c	d	b	d	a	d	a	b	d	c
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
b	a	c	c	c	c	b	b	b	a	d	c	c	a	c	c	a	c	d	d
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
a	c	d	b	b	a	b	b	a	c	b	b	d	b	d	d	a	b	a	c
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
d	d	b	d	a	c	c	b	c	c	a	a	a	b	b	c	b	a	b	d
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
d	a	c	d	b	c	c	a	d	c	a	b	b	b	b	a	a	b	c	c
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
b	a	a	c	a	b	b	c	c	a	a	d	d	d	a	b	d	d	a	d
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
b	c	a	b	c	c	d	c	c	c	c	b	b	c	b	c	b	c	a	b
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
b	c	c	c	b	c	b	a	a	c	b	a	a	a	c	a	b	d	b	a

241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
a	b	d	a	b	a	a	d	c	b	a	d	a	d	a	c	a	b	d	d
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	
d	b	c	b	a	d	b	c	c	d	c	b	c	c	b	a	d	b	a	