BREATHING AND EXCHANGE OF GASES

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

Respiration involves the following steps :-

(i) Breathing or puhmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.
(ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.
(iii) Transport of gases by blood.
(iv) Diffusion of O_2 and CO_2 between blood and tissues.
(v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2.

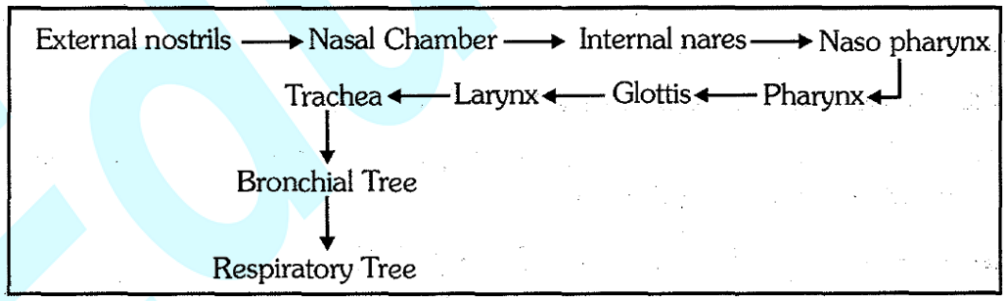
RESPIRATORY ORGANS

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

HIMAN RESPIRATORY SYSTEM

(1) Respiratory tract.
(2) Lungs

Respiratory tract – Apassage by which air enters into lungs



1. Nose and Nasal- passage-

Human have a pair of external nostrils opening out above the upper lip.
External nares open in vestibule region present in anterior part of nasal passage.
Vestibule posteriorly connected with nasal chambers.
Nasal passage is functionaly divided into 3 regions :

(i) Vestibular region : Skin, hair, sebaceous glands.·
(ii) Respiratory region : Lined by PSCCGE.
(iii) Olfactory region : Lined by Neurosensory epithelium (Olfactory ithelium/ Schneidarian membrane)

2. Bucco-pharyngeal cavity -

- It is divided into two parts. Anterior part is called the Buccal-cavity and the posterior part is called Pharyngeal cavity. Between the buccal and the Nasal cavity, hard palate followed by soft palate is present. The terminal part of soft plate is called Uvula. This divides the pharyngeal-cavity incompletely into two chambers. Upper chamber is the Nasopharyngeal chamber and the Lower chamber is Oropharyngeal chamber.
- At the time of swallowing of food, the Uvula lifts up and covers the internal-nares and so prevents the food from entering the nasal-passage. In the oro pharyngeal chamber, 2 slit like apertures are present. Dorsal-pore is called the gullet which opens into the oesophagus, so this is the path of food. Ventral-pore is called the glottis and it opens into the Larynx and so this is the respiratory-passage.
- Near the glottis, a flat elastic cartilage called the Epiglottis is present. At the time of swallowing of food, this cartilagenous flap covers the glottis. During swallowing breathing stops.
- Pharynx is the only part where food and air passage mix together. (Pharynx is the common passage for food and air)

3. Larynx (voice producing organ) :- Larynx is a cartilagenous box which helps in sound production and hence called the sound box.

Larynx is made up of following cartilages :

1. **Thyroid cartilage :** Single, Largest, C-shaped, Dorsally incomplete, hyaline cartilage.
2. **Cricoid cartilage :** Single, Signet ring shaped, below thyroid cartilage, hyaline cartilage.
3. **Arytenoid cartilage :** One pair, pyramid shape cartilage, hyaline cartilage.
4. **Cartilage of Santorini :** One pair, node like cartilage, present at the end of arytenoids cartilage, Elastic cartilage

In larynx two pair of vocal cords are present for sound production :

(i) Anterior pair is called as false vocal cord. These are composed of membranes. They are pink in colours & they don't help in phonation. They provide moisture to true vocal cords.

(ii) Posterior pair :- It is true vocal cords. They are composed of sheath of yellow fibrous connective tissue.

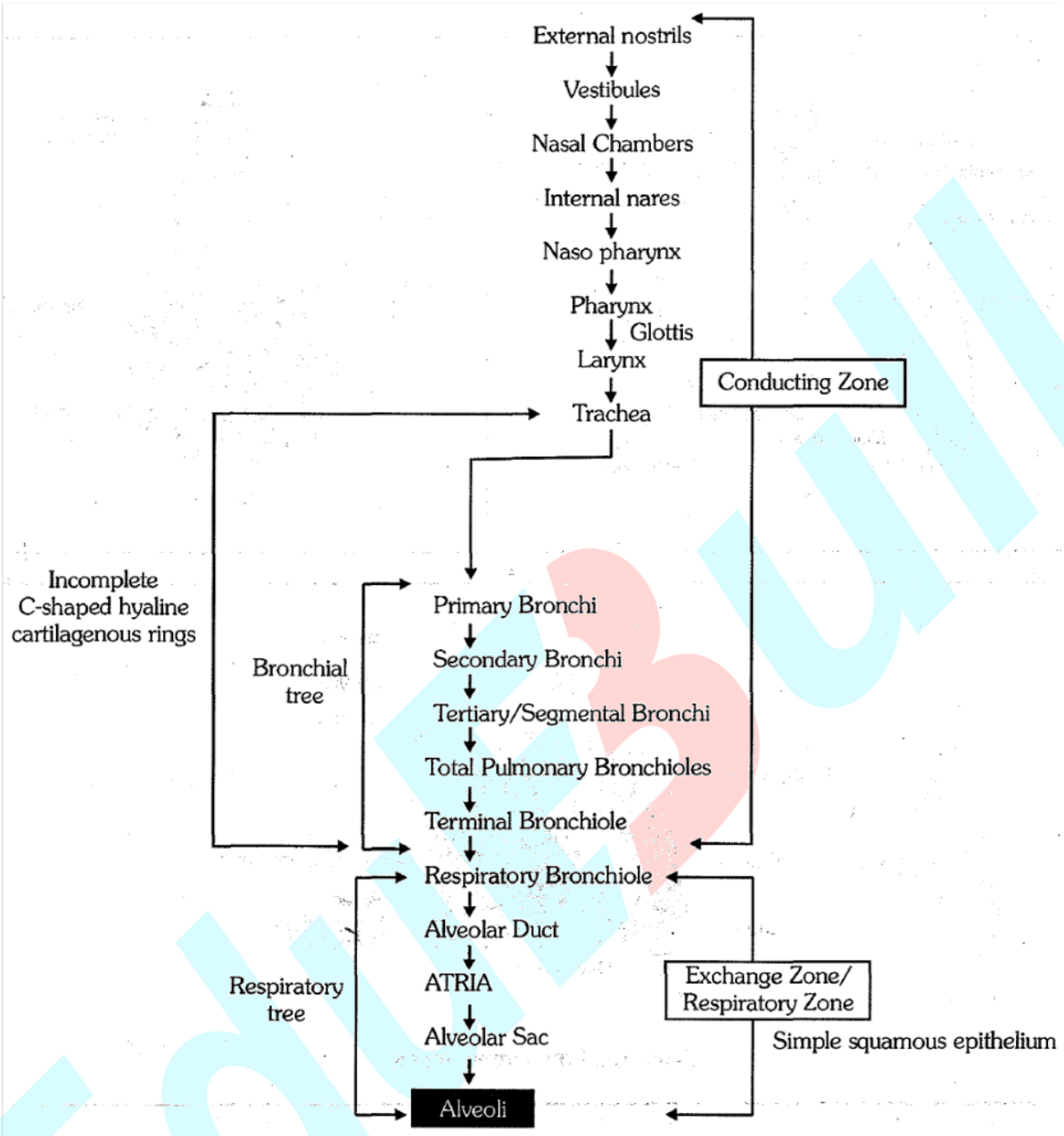
4. TRACHEA :

- It is a 10-12 cm long straight tube extending upto the mid thoracic cavity.
- In the trachea 16-20 'C' shaped cartilagenous rings are present which prevent trachea from collapsing. These rings are incomplete on dorsal surface of trachea.

5. Bronchial tree (B. T.) & Respiratory Tree (R. T.)

- When trachea enter into thoracic cavity, it divides into two branches called as primary bronchus at the level of fifth thoracic vertebra. Branches of primary bronchus upto terminal bronchioles makes bronchial tree.
- Terminal bronchioles divide to form respiratory bronchioles & branches of respiratory bronchioles makes respiratory tree.
- In bronchial tree, cartilage rings are present, while these are absent in respiratory tree .
- Gaseous exchange occurs in respiratory tree while it is absent in bronchial tree .
- Volume of air which is filled in B. T. is dead space volume, which doesn't take a part in gaseous exchange. (150 ml)

There are two zones. (i) Conducting zones (ii) Exchange zone

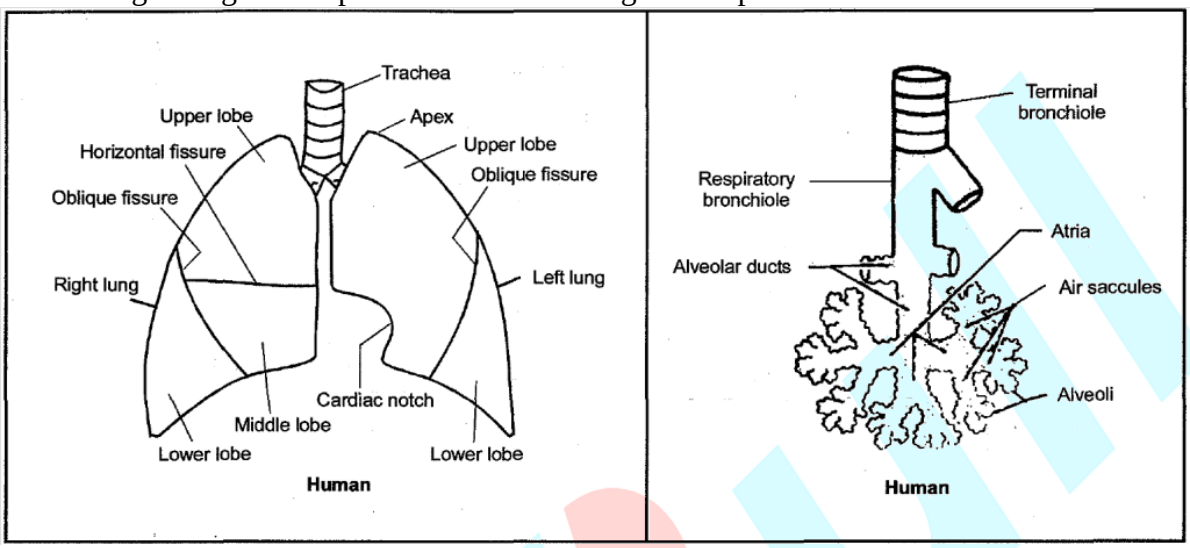


- Exchange zone is the actual site of diffusion of O_2 and CO_2 between blood and atmospheric air.
- The conducting zone transports the atmospheric air to the alveoli, clears it from foreign particles. Humidifies and also brings the air to body temperature.

Lungs: A pair of lungs are present in the thoracic-cavity. Lungs are covered by a double-membrane which are called the Pleural-membranes. Outer membrane is the Parietal Pleura and inner-membrane is the Visceral-pleura. Both these membranes are derived from the mesoderm. The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface. In between both the membranes a very narrow cavity called Pleural-cavity is present. In this cavity a very thin layer of Pleural fluid is present. Pleural fluid reduces friction on the lung surface. Sometimes due to bacterial infection

the amount of this fluid increases. So, the organism feels a difficulty in breathing and sever chest pain (dyspnoea). This is termed as pleuricy or pleural effusion disease.

♦ In human right lung made up of 3 lobes & left lung made up of 2 lobes.



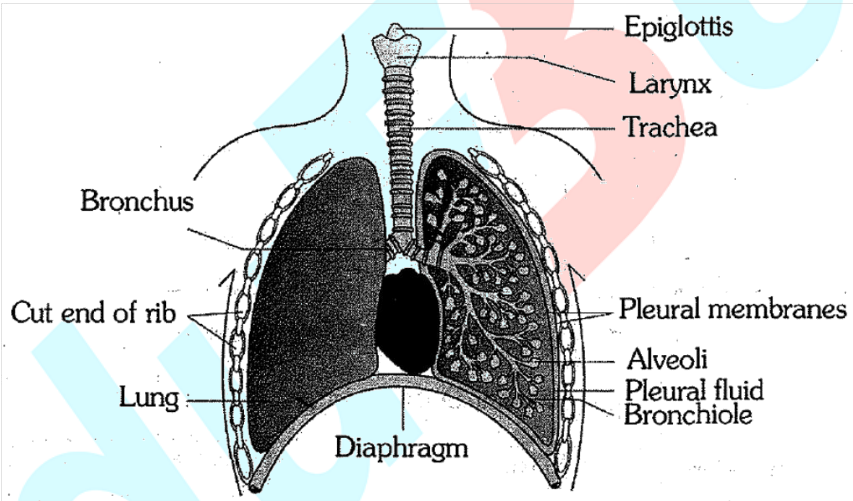


Diagram of the human lungs

HUMAN

Right lung (625 gm)
- 3 lobes
  - anterior lobe
  - middle lobe
  - posterior lobe

Left lung (575 gm)
- 2 lobes
  - left anterior
  - left posterior

- Structural & functional unit of lungs is called alveoli
- Approximately 300 million alveoli are present in both lungs in total.

- Inner (alveolar) surface area of both lungs is approximately 70-100 m^2 in total.
- Wall of alveoli consist of two layers, outer layer is composed of yellow fibrous C.T., inner layer is composed of simple squamous epithelium
- Squamous cells of alveoli are called as Pneumocytes.
- Most of these pneumocytes are type-I which help in gaseous exchange while few pneumocytes are type-II which are larger in size, secrete LECITHIN (Phospholipid) and this acts as surfactant which prevents collapsing of alveoli by reducing its surface tension.

♦ **Internal surface of alveoli is termed as the Respiratory surface.** It is derived from the endoderm of the embryo.

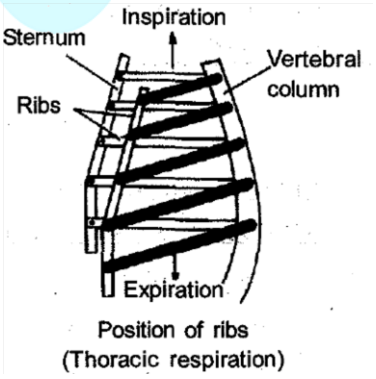
♦ Phagocyctic cells in alveoli are called dust cells.

♦ Mammalian lungs are solid and spongy. There is no central cavity.

♦ Muscles are absent in the lungs of mammals. So the power of self-contraction and self-expansion is absent in these lungs. (Sucken lungs)

Thoracic cage :- Coverings of thoracic cavity makes thoracic cage.

Anterior surface	-	Clavicle bones. Neck
Posterior surface	-	Diaphragm.
Dorsal surface	-	Vertebral column & ribs
Ventral surface	-	Sternum & ribs.
Lateral surface	-	Ribs



Position of ribs (Thoracic respiration)

Diaphragm :- A muscular septum which is found only in mammals and crocodile. Normal shape of diaphragm is dome like which divides body cavity in two parts upper thoracic cavity & lower abdominal cavity.
Radial muscles are present in diaphragm. By the contraction in these muscles, diaphragm become flattened in shape, so, volume of thoracic cavity increases in anterior posterier axis.

Intercostal muscles (ICM) :-

Space between two ribs is called intercostal space in which 2 types of muscles are present

–External ICM. (EICM) **–Internal ICM. (IICM)**

EICM :- By the contraction in this muscles, rib & sternum shifts upward and outward so thoracic volume increase in dorso-ventral axis. So they help in inspiration.

BEGINNER'S BOX - 1

1. Larynx is a modified portion of
(1) Pharynx (2) Trachea (3) Bronchus (4) Lungs

2. Cartilaginous rings in trachea are incomplete at which surface.

(1) Dorsal (2) Ventral (3) Lateral (4) Ventrolateral

3. Wall of alveoli is composed of
(1) Simple squamous epithelium (2) Simple cuboidal epithelium
(3) Pseudostratified epithelium (4) Simple columnar epithelium

4. The structure which prevents the entry of food into respiratory tract is
(1) pharynx (2) Larynx (3) Glottis (4) Epiglottis

5. In which part of lungs gaseous exchange takes place in human :-
(1) Trachea & alveolar duct (2) Trachea & bronchi
(3) Alveolar duct & alveoli (4) Alveoli & Trachea

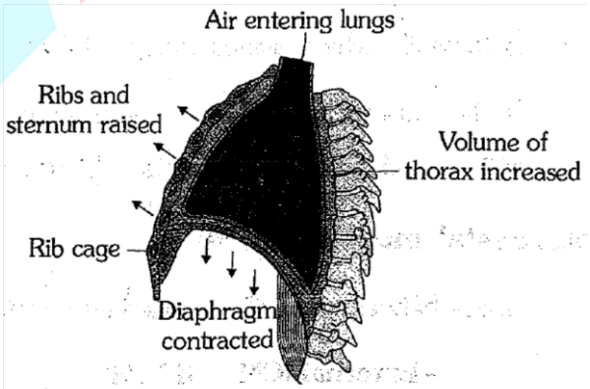
6. Respiratory organ of insects are :
(1) General Body surface (2) Book lungs
(3) Lungs (4) Tracheal tubes

7. In human lungs are divided into lobes
(1) 3 right & 2 left lobes (2) 2 right & 3 left lobes
(3) 2 right & 2 left lobes (4) 3 right & 3 left lobes

8. Arytenoid cartilage in larynx are
(1) Elastic (2) Hyaline (3) Calcified (4) All of these

MECHANISM OF BREATIHING

- Breathing involves two stages : inspiration during which atmospheric air is drawn in and expiration by which the alveolar air is released out.
- Inspiration can occur if the pressure within the lungs (intra pulmonary pressure) is less then the atmospheric pressure so there is a negative pressure in the lungs than the atmospheric pressure. Similarly, expiration takes place when the intra-pulmonary pressure is higher than the atmospheric pressure.



Mechanism of Breathing showing Inspiration

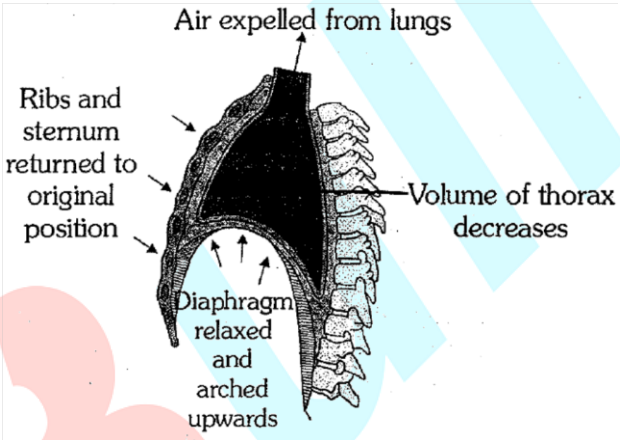
INSPIRATION

- Inspiration is an active process .
- Normally it takes around 2 seconds.
- At the time of inspiration, contraction in diaphragm and external intercostal muscles takes place.
- Diaphragm becomes flat and is pushed towards abdominal cavity.

- Sternum moves towards ventral and anterior direction.
- Ribs move towards outside and ventral side. As a result of all these reactions, the volume of thoracic cavity is increased. So the pressure of pleural fluid over lungs is decreased. Due to the spongy nature, lungs expand. As a result of this, air pressure in the lungs is decreased as compared to atmospheric pressure. Now air rushes from outside, through respiratory track and fill is the lungs.

EXPIRATION

- Normal expiration is a passive activity. It takes around 3 seconds. During expiration, contraction (in any muscle) does not take place. During expiration, relaxation in diaphragm and external intercostal muscles takes place. As a result of this relaxation, diaphragm, sternum and ribs attain their actual (normal) position. Due to which the volume of thoracic cavity is decreased and pressure of thoracic cage on lungs is increased. Thus air which was filled in lungs goes outside through respiratory tract. Normal breathing is also called Abdominal breathing.



Mechanism of Breathing showing Expiration

- We have the ability to increase the strength of inspiration and expiration with the help of additional muscles. This is called forceful breathing.

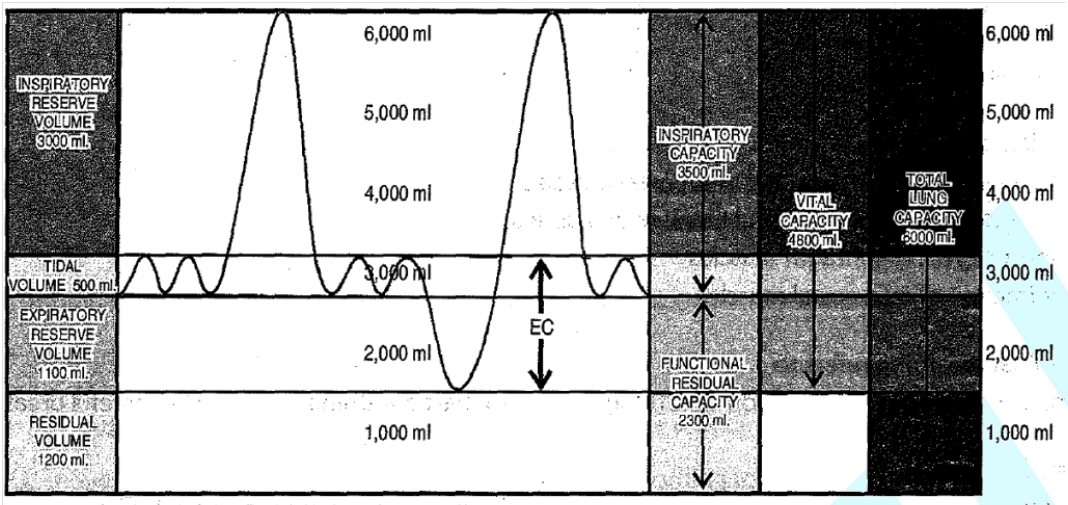
RESPIRATORY VOLUME AND CAPACITIES

The volume of air involved in breathing movements can be estimated by using a spirometer which helps in clinical assessment of pulmonary functions.

1. **Tidal volume [T.V.] -** It is amount of air inspired or expired during normal breathing. Its value for man is 500 ml. Whole inspired air does not reach up to lungs. The portion of air which remains in the respiratory tract is called Anatomical dead-space volume. Its value for man is 150 mi.
   A healthy man can inspire or expire approximately 6000 to 8000 ml of air per minute.

2. **Inspiratory Reserve Volume** [I.R.V.] - Volume of air a person can inspire by forcible inspiration over tidal volume. It's value is 2500 to 3000 ml

3. **Expiratory reserve volume** [E.R.V.] - It is the amount of air expired over tidal volume by most forceful expiration. Its value is 1100-1200 mi.
4. **Residual volume -** [R. V.] - It is the amount of air that remains inside lungs after forceful expiration. Residual volume can not be given out of lungs. Its value is 1100-1200 mi.



Spirogram of pulmonary volumes and capacities

PULMONARY CAPACITIES

1. **Inspiratory capacity-** [I C.] - Total volume of air a person can inspire after a normal expiration.
   I.C. = I.R.V. + T.V.
   = 3000 ml + 500 ml
   I.C. = 3500 ml

2. **Expiratory capacity (EC):** Total volume of air a person can expire after a normal inspiration.
   I.C. = TV + ERV

3. **Functional Residual capacity** IFRC] - It is the amount of air that normally remains inside lungs after normal expiration. In it expiratory reserve volume and residual volume are included
   FRC = ERV + RV
   = 1000 ml + 1200 ml
   FRC = 2200 to 2500 ml

4. **Vital capacity-** [V.C.]- It is the amount of air that can be expired by most forceful expiration after a deepest inspiration. Inspiratory reserve volume expiratory reserve volume and tidal volume are included in it.
   V.C. = IRV + ERV + TV
   = 3000 ml + 1000 ml + 500 ml
   = 4500 ml (4300 to 4800 ml)

5. **Total lung capacity-** Total volume of air that can accomodated in the lungs at the end of forced inspiration.
   TLC = IRV + TV + ERV + RV
   = 3000 + 500 + 1000 + 1200
   TLC = 6000 ml (approx) (5700 to 6000 ml)

BEGINNER'S BOX - 2

1. If expiratory reserve volume is 1100 ml residual volume is 1200 ml and tidal volume is 500 ml, what shall be the functional residual capacity

(1) 1600 ml (2) 2800 ml (3) 2300 ml (4) 1200 ml

2. Air filled in dead space is
(1) 150 cc (2) 350 cc (3) 500 cc (4) 1500 cc

3. Very high number of alveoli present in a lung is meant for
(1) More space for increasing volume of inspired air
(2) More area for diffusion
(3) Making the organ spongy
(4) Increasing nerve supply

4. Expiration involves
(1) Relaxation of diaphragm and intercostal muscles
(2) Contraction of diaphragm and intercostal muscles
(3) Contraction of diaphragm muscles
(4) Contraction of intercostal muscles

5. Abdominal breathing refers to
(1) Normal breathing (2) Slow breathing
(3) Fast breathing (4) forceful breathing

6. Residual volume is :
(1) lesser than tidal volume (2) greater than inspiratory volume
(3) greater than vital capacity (4) greater than tidal volume

7. Vital capacity of lungs is
(1) TV + IRV + ERV (2) TV + IRV + RV
(3) TV + ERV (4) IRV + ERV

8. Match the items in column I with column II and choose the correct option

Column-I	**Column-II**
(A) Tidal volume	(i) 2500 to 3000 mL of air
(B) Inspiratory reserve volume	(ii) 1000 mL of air
(C) Expiratory reserve volume	(iii) 500 mL of air
(D) Residual volume	(iv) 3400 to 4800 mL air
(E) Vital capacity	(v) 1200 mL of air

	A	**B**	**C**	**D**	**E**
(1)	(iii)	(iv)	(ii)	(i)	(v)
(2)	(iii)	(i)	(ii)	(v)	(iv)
(3)	(iii)	(i)	(iv)	(v)	(iv)
(4)	(iv)	(iii)	(ii)	(i)	(v)

EXCHANGE OF GASES

♦ Alveoli are the primary sites of exchange of gases. Exchange of gases also occur between blood and tissues.
Exchange of gases in the lungs is done between alveolar air and deoxygenated blood, ·

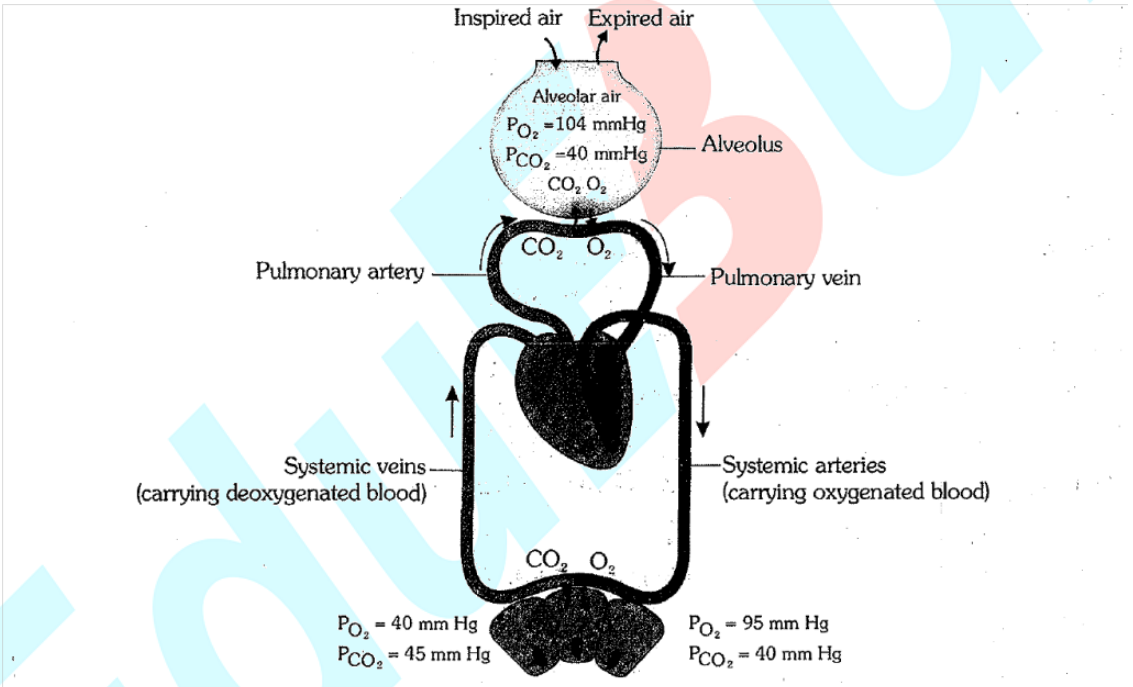
- Gaseous exchange is a passive activity. It is done by simple diffusion.
- Diffusion pressure for every gas (in blood or in air) is called partial pressure. At the time of diffusion, gases move from high partial pressure to low partial pressure.

Table of partial pressure (in mm Hg) of oxygen and carbon dioxide :-

Respiratory Gas	Atmospheric Air	Alveoli	Deoxygenated Blood	Oxygenated Blood	Tissues	Inside the cell	Expired Air
O_2	159	104	40	95	40	20	120
CO_2	0.3	40	45	40	45	50	27

The partial pressure of O_2 in alveolar air [P_{O_2}] is 104 mm Hg, its value in arterial blood is 40 mm Hg. So oxygen goes from alveolar air to arterial air

- In alveolar air, partial pressure of CO_2 [P_{CO_2}] is 40 mm Hg and its value in deoxygenated blood is 45-46 mm Hg. So CO_2 moves from arterial blood to alveoli. In this way, according to partial pressure exchange of gases takes place in the lungs.



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

- Diffusing capacity depends on solubility of gases, thickess of the respiratory membrane and partial pressure difference.
- As the solubility of CO_2 is 20-25 times higher than that of O_2, the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher compared to that of O_2.
- **Diffusion membrane is made up of three major layers :-**
  (i) Thin squamous epithelium of Alveoli.
  (ii) Endothelium of Blood capillaries.
  (iii) Basement substances in between them.

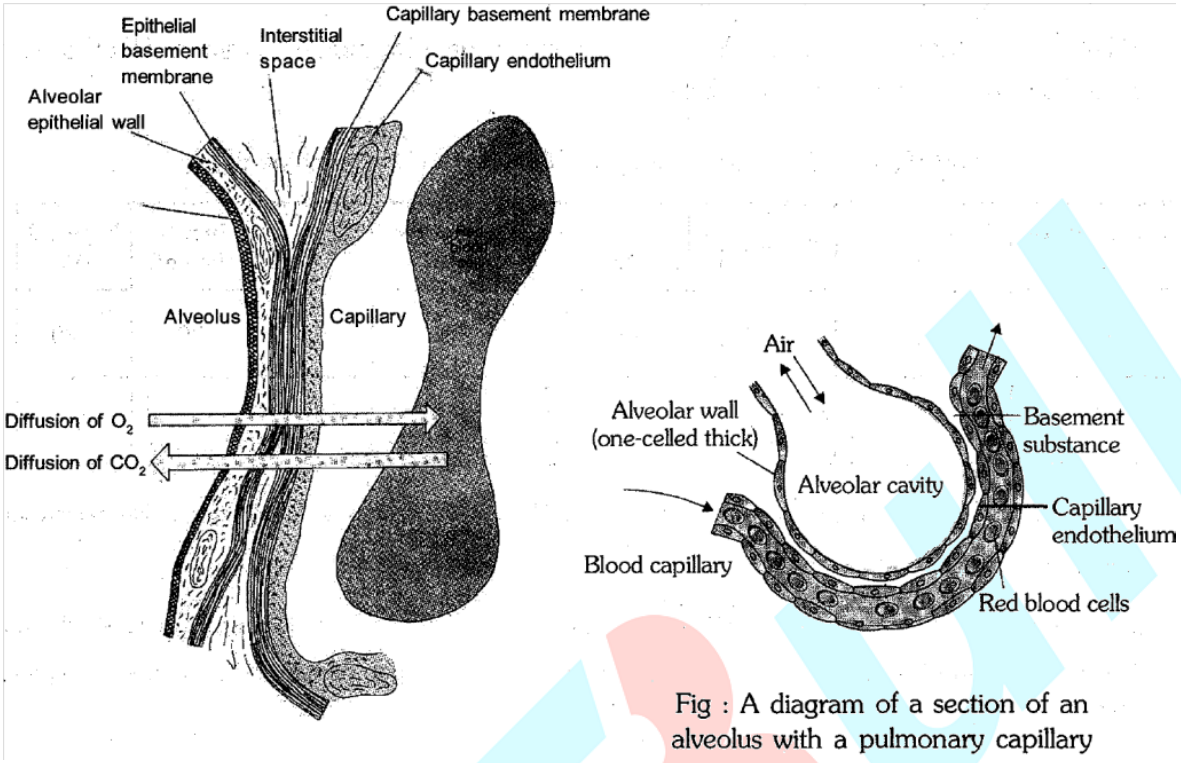


Fig : A diagram of a section of an alveolus with a pulmonary capillary

TRANSPORT OF GASES

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

Transport of oxygen

$$Hb_4 + 4O_2 \rightleftharpoons \begin{matrix}\text{in Alveoli} \\ \text{in Tissues}\end{matrix} \quad Hb_4O_8$$

- As much oxygen comes in the blood from air, it is approximately 3% dissolves in the blood plasma. Remaining 97% oxygen combines with haemoglobin to form oxyhaemoglobin. O_2 can bind with Hb in a reversible manner to form oxyhaemoglobin.
- Haemoglobin is a red coloured iron containing pigment present in the RBC.
- Haemoglobin is made up of 4 units. Each unit has 1 Fe in +2 state. Each haemoglobin molecule can carry a maximum of four molecules of O_2.
- 1 gm of haemoglobin transports 1.34 ml of oxygen. 100 ml (1 dL) of blood contains normally 15 gm of haemoglobin, so 100 ml blood transports approximately 20 ml of oxygen.
- In a conducting cycle blood gives its 25% O_2 to tissues. So every 100 ml of oxygenated blood can deliver around 5 ml of O_2 to tissue under normal physiological condition.
- Binding of oxygen with haemoglobin is primarly related to partial pressure of O_2. But PCO_2, hydrogen ion concentration and temperature are the other factors which can interfere with this binding.
- Oxygen does not oxidise haemoglobin. Formation of oxyhaemoglobin is a process of oxygenation. The valency of iron is 2 in Oxyhaemoglobin. Some gases (e.g. Ozone) oxidise haemoglobin. This oxidised haemoglobin is called Methamoglobin. This type of gases are environmental pollutant.

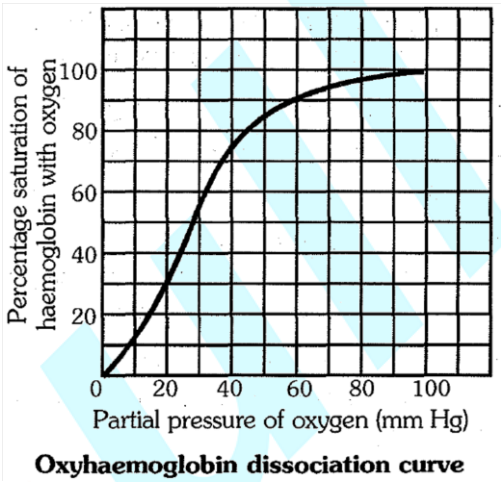
- At the time, oxyhaemoglobin reaches upto the tissues it dissociates. O_2 freed from it goes into the tissue fluid from blood. In place of it, CO_2 from tissue fluid comes into blood. Gaseous exchange between blood and tissue is called internal respiration or tissue respiration. It is also done by simple diffusion.

OXYGEN DISSOCIATION CURVE

1. A graph is plotted between O_2 concentration and percentage saturation of haemoglobin with this curve is called Dissociation curve.

2. Dissociation curve is sigmoid shape.

3. This curve is highly useful in studying the effect of factors like P_{CO_2}, $H^{\pm}$ concentration, temperature on binding of O_2 with Haemoglobin.



Oxyhaemoglobin dissociation curve

- **Shift to left** Means that increase in affinity between O_2 and Hb.
- **Shift to Right** Means that decrease in affinity between O_2 and Hb and dissociation of oxyhaeinoglobin.
- In tissue following conditions are favourable for dissociation of oxygen from oxyhaemoglobin:
  - (i) Low PO_2
  - (ii) High PCO_2
  - (iii) High H^+ concentration
  - (iv) Low pH
  - (v) Higher temperature.
- In the alveoli high PO_2, low PCO_2, Lesser H^+ concentration and lower temperature factors are favourable for the formation of oxyhaemoglobin.

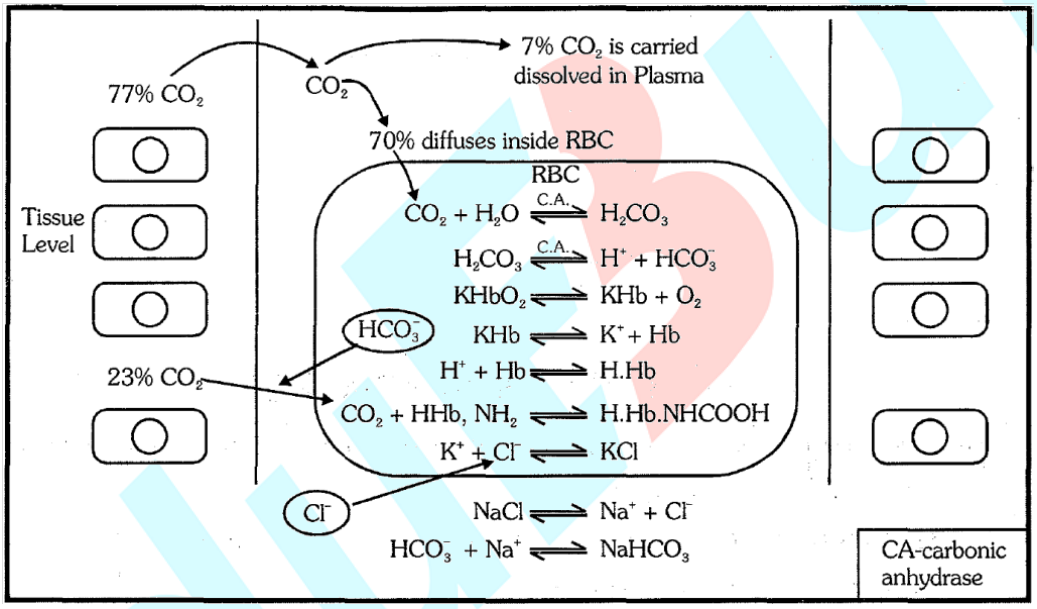
GOLDEN KEY POINTS

- P_{50} value – P_{O_2} at which the Hb is 50% saturated with O_2. Higher the P_{50}, lower is the affinity of Hb for O_2. A rise in P_{CO_2}, $H^{\oplus}$ cone. increases the value of P_{50}.
- 2, 3 diphosphoglycreate (2, 3 DPG) – a susbtance formed during glycolysis.
  ↑ 2, 3 DPG will cause dissociation of oxyhaemoglobin.
- **Bohr's effect:** Dissodation of oxyhaemoglobin due to high CO_2 concentration in tissue is called Bohr's effect.
- During heavy exercise 100 ml blood delivered 15 ml O_2 to muscle.
- Hb cannot take up O_2 beyond a saturation level of 97%.

TRANSPORT OF CARBON DIOXIDE

- The blood transports carbon dioxide comparatively easily because of its higher solubility.
- There are three ways of transport of carbon dioxide.
  - **(a) In dissolved state :** Approximately 5-7 per cent of carbon dioxide is transported, being dissolved in the plasma of blood.
  - **(b) As Carbamino haemoglobin :** About 20-25% C02 react with the amine group of Haemoglobin and form carbamino-haemoglobin.
  - **(c) In the form of bicarbonate:** Bulk of CO_2 is transported by plasma as bicarbonate.

- Carbon dioxide produced by the tissues, diffuses into the RBCs, where it reacts with water to form carbonic acid (H_2CO_3). This reaction is catalysed by the enzyme, Carbonic anhydrase. RBCs contain a very high concentration of this enzyme & minute quantity is present in plasma too.
- Now carbonic acid dissociates into Hydrogen (H^+) and bicarbonate (HCO_3^-) ions .
- The hydrogen ions (H^+) released from carbonic acid combine with haemoglobin and form haemoglobinic acid (H.Hb)
- The majority of bicarbonate ions (HCO_3^-) formed within the erythrocytes diffuse out into the plasma along a concentration gradient. In the plasma HCO_3 combine with Na^+ and form Sodium bicarbonate ($NaHCO_3$).
  Nearly 70% CO_2 transported by plasma as $NaHCO_3$ form.
- In response of HCO_3^- chloride ions (Cl^-) diffuse from plasma into the etythrocytes to maintain the ionic balance. Thus, electrochemical neutrality is maintained. This is called Chloride shift or Hamburger Phenomenon.



- When the deoxygenated blood reaches the alveoli of the lung, then carbaminohaemoglobin, and sodium bicarbonate dissociated because PCO_2 is low and PO_2 is high in the alveoli.
- This dissociation is stimulated by oxyhaemoglobin. This CO_2 freed from blood goes into atmosphere. The effect of oxyhaemoglobin on the dissociation of these compounds is known as Haldane effect. In this reaction oxyhaemoglobin acts like a strong acid i.e, it frees H^+ in the medium.
- Every 100 ml deoxygenated blood delivers around 4 ml CO_2 to alveoli.

BEGINNER'S BOX - 3

1. Oxygen haemoglobin dissociation curve will shift to right on decrease of
(1) Acidity (2) Carbon dioxide concentration
(3) Temperature (4) pH

2. Body tissues obtain O_2 from oxyhaemoglobin because of its dissociation in tissues caused by
(1) Low oxygen concentration and high CO_2 concentration
(2) High O_2 concentration
(3) Low CO_2 concentration

(4) High CO_2 concentration

3. Partial pressure of carbon dioxide in Alveoli, atmospheric air and tissues will be :-
(1) (0.3, 40, 45) mmHg (2) (40, 0.3, 45) mmHg
(3) (0.3, 104, 28) mmHg (4) (104, 159, 40) mmHg

4. One haemoglobin carries how many molecules of O_2 ?
(1) 4 (2) 2 (3) 6 (4) 8

5. Haemoglobin-oxygen dissociation curve is-
(1) Hyperbolic (2) Sigmoid (3) Straight (4) Constant

6. CO_2 is transported mainly as :
(1) Carbaminohaemoglobin (2) Oxyhaemoglobin
(3) Bicarbonate (4) carboxyhaemoglobin

7. Every 100 ml deoxygenated blood delivers around _____ CO_2 to alveoli:-
(1) 20 ml (2) 4 ml (3) 5 ml (4) 25 ml

8. How much oxygen, blood supplies to tissues in one circulation in normal condition :-
(1) 75% (2) 4% (3) 25% (4) 20%

REGULATION OF RESPIRATION

- Human beings have a significant ability to maintain and moderate the respiratory rhythm to suit the demand of the body tissues. This is done by neural system.

- The respiratory rhythm centre in the Medulla is primarily responsible for this regulation.
Following respiratory groups regulate respiration :-
  (i) The **dorsal respiratory group (DRG)** is present in the dorsal portion of medulla oblongata. The signals from these neurons generate the basic respiratory rhythm. The nervous signal released from this group is transmited to the diaphragm & EICM.
  (ii) The **ventral respiratory group (VRG)** of neurons are located anterolateral to the dorsal respiratory group. During normal respiration, this remains inactive.
  In the enhanced respiratory drive, the respiratory signal of this group contributes to fulfil the demand by regulating both inspiration and expiration. Few of the neurons of this group control inspiration, while few other control expiration, thus regulating both.
  (iii) The **pneumotaxic centre** is located on pons. It is called switch off point of inspiration. Neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate. When this center send strong signal then lungs are filled partially.

- **Hering Breuer reflex arch :**
In the walls of terminal bronchioles and atria stretch receptors are present, which are normally inactive but they become active when alveoli are filed with maximum air. The Heiring Breuer reflex arch now becomes activated and sends inhibitory signals to the inspiratory centre to switch off inspiration. This prevents the alveoli from over stretching and bursting. Thus Hering Breuer reflex arch is a protective reflex which works only when normal mechanism of switch off of inspiration does not work timely due to any reason.

- A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this centre which in turn can signal the rhythm centre and increase breating rate. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

- Aortic body and carotid body are chemoreceptors associated with aortic arch and carotid artery. They also can recognise changes in CO_2 and H^{+-} concentration.

- The activity of respiratory centre is also affected by body temperature and blood pressure. Whenever body temperature is increased or blood pressure goes high, respiratory centre becomes more activated and this increases the respiration rate.

Respiratory Disorders

1. **Asthma** is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles.
2. **Bronchitis** is a disorder of bronchi in which there is regular swelling and itching of bronchi and is characterised by regular coughing.
3. **Emphysema** is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking.
4. **Occupational Respiratory Disorders :** In certain industries, especially those involving grinding or stone breaking, so much dust is produced that the defense mechanism of the body cannot fully cope with the situation.
   Long exposure can give rise to inflammation leading to fibrosis (proliferation of fibrous tissues) and thus causing serious lung damage. Workers in such industries should wear protective masks.

GOLDEN KEY POINTS

- **Hypoxia -** Low O_2 supply to tissues.

- **Asphyxia -** It is the state of suffocation due to high CO_2 conc^n or low O_2 concentration.

- **Physiological shunt -** Not entire amount of blood which enters the lungs via pulmonary arteries actually reaches in the walls of alveoli. 2% of the total blood actually never passes through the walls of alveoli, instead it enters the venule side from arteriole side via the conduction zone in lungs. So this blood never gets oxygenated. This is shunted blood (2% of total) This means that only 98% of the blood which enters the lungs actually gets oxygenated. This phenomenon of By pass of alveoli by 2% of total blood is called as physiological shunt. It is normally present in all human beings.

- One molecule of haemoglobin combine with four molecules of carbon monoxide gas to form carboxyhaemoglobin. Its colour is cherry red. Due to this it reduces.

- One molecule of myoglobin has lFe^{++} ions metal.

- Foetal haemoglobin differs from adult haemoglobin in structure. Foetal haemoglobin has higher affinity for O_2 than adult haemoglobin. When PO_2 is low. Foetal Hb can carry upto 30% more O_2 than maternal Hb. So dissociation curve for foetal Hb will appear on the left side.

- Bowman's glands are present in human naral cavity.

BEGINNER'S BOX - 4

1. The impulse for voluntary muscles for forced breathing starts in
(1) Medulla oblongata (2) Vagus nerve
(3) Cerebellum (4) Cerebrum

2. Respiratory centre of brain is stimulated by
(1) Carbon dioxide content in venous blood (2) Carbon dioxide content in arterial blood
(3) Oxygen content in venous blood (4) Oxygen content in arterial blood

3. Respiratory rhythm centre is present in :
(1) Cerebellum (2) Cerebrum
(3) Medulla oblongata (4) Pons

4. Hiccough (hiccup) is due to activity of
(1) Intercostal muscle (2) Food in air tract
(3) Diapharagm (4) Inadequate oxygne in environment

5. Pneumotaxic centre is present on
(1) Pons (2) Medulla (3) Cerebrum (4) Cerebellum

6. Asthma is a respiratory disease caused due to
(1) Infection of trachea (2) Infection of lungs
(3) Bleeding into pleural cavity (4) Spasm in bronchial muscles

7. When CO_2 concentration in blood increases, breathing becomes -
(1) There is no effect on breathing (2) Slow and deep
(3) Faster (4) Shallower and slow

8. Haemoglobin shows maximum affinity with:-
(1) Carbon monoxide (2) Carbon dioxide
(3) Oxygen (4) Ammonia

ANSWERS KEYS

BEGINNER'S BOX - 1

1.	(2)	**2.**	(1)	**3.**	(1)	**4.**	(4)	**5.**	(3)	**6.**	(4)	**7.**	(1)
8.	(2)												

BEGINNER'S BOX - 2

1.	(3)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(1)	**6.**	(4)	**7.**	(1)
8.	(2)												

BEGINNER'S BOX - 3

1.	(4)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(2)	**6.**	(3)	**7.**	(2)
8.	(3)												

BEGINNER'S BOX - 4

1.	(4)	**2.**	(2)	**3.**	(3)	**4.**	(3)	**5.**	(1)	**6.**	(4)	**7.**	(3)
8.	(1)												