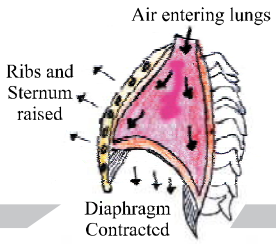


Chapter - 17 Breathing and Exchange of Gases

Points To Remember

Breathing : (External respiration) The process of exchange of O_2 from the atmosphere with CO_2 produced by the cells.

Carbamino haemoglobin : Compound formed in RBCs when CO_2 combine with haemoglobin.

Inspiration : Oxygen from fresh air taken by lungs and diffuses into the blood.

Expiration : CO_2 given up by venous blood in the lungs is sent out to exterior.

Respiration : The sum total of physical and chemical processes by which oxygen and carbohydrates (main food nutrient) etc are assimilated into the system and the oxidation products like carbon dioxide and water are given off.

Diaphragm : A muscular, membranous partition separating the thoracic cavity from the abdominal cavity.

Hypoxia—Shortage of oxygen in tissues.

Partial Pressure—The pressure contributed by an individual gas in a mixture of gases. It is represented as pO_2 for oxygen and pCO_2 for carbondioxide.

Pharynx : The tube or cavity which connects the mouth and nasal passages with oesophagus. It has three parts (i) Nasopharynx (anterior part) (ii) Oropharynx (middle part) and (iii) Laryngopharynx (posterior part which continues to larynx)

Adam's Apple : The projection formed by the thyroid cartilage and surrounds the larynx at the front of the neck.

Tidal volume (TV) : volume of air during normal respiration (500 mL.)

Inspiratory Reserve Volume (IRV) : Additional volume of air inspired by a forcible inspiration. 2500mL to 3000mL.

Expiratory Reserve Volume (ERV) : Additional volume of air, a person can expire by a forcible expiration.

(RV) volume of air remaining in the lungs even after a forcible expiration (1100 mL to 1200 mL)

PULMONARY CAPACITIES : Use in clinical diagnosis.

Inspiratory capacity (IC) = (TV + IRV) Total volume of air a person can inspire after a normal expiration.

Expiratory Capacity—Total Volume of air a parson can expire after a normal inspiration E.C. = TV + ERV

Functional Residual Capacity—Volume of air that will remain in lungs after a normal expiration (FRC) = (ERV + RV)

Vital Capacity (VC) = (ERV + TV + IRV) or the maximum volume of air a person can breath out after a forced inspiration.

Total Lung Capacity : It includes RV, ERV, TV and IRV or vital capacity + residual volume.

Pulmonary—Anything associated with the lungs is given the prefix 'pulmonary' **steps involved in respiration**—

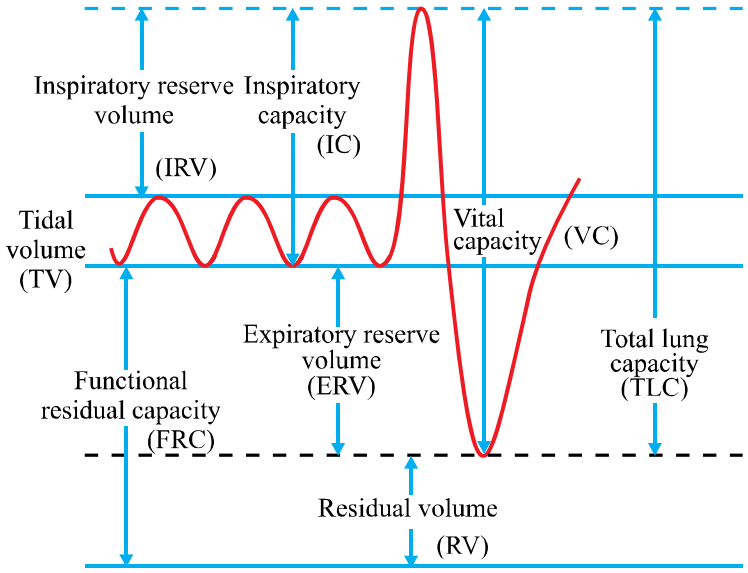
(i) Breathing or pulmonary ventilation (intake or atmospheric air and releasing out CO_2 rich alveolar air)

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

(iii) Transport of gases by the blood.

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

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



Various pulmonary air volumes

Mechanism of Breathing

Inspiration :

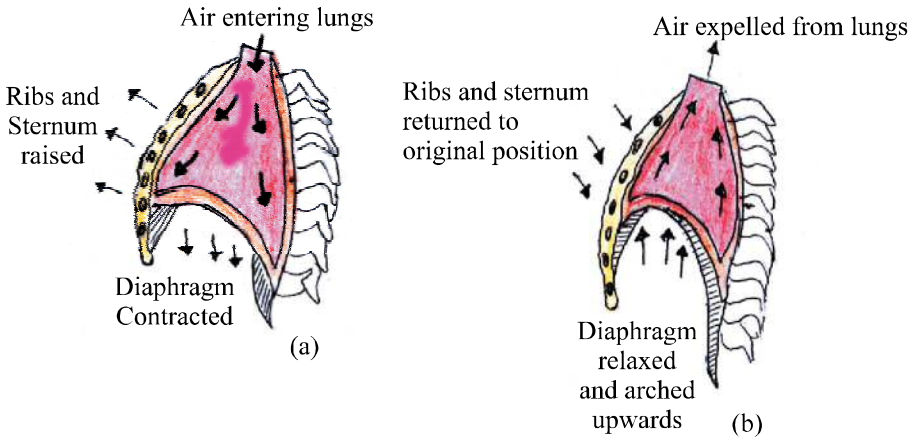
If the pressure within the lungs (intrapulmonary pressure) is less than the atmospheric pressure, *i.e.,* there is negative pressure in the lungs with respect to the atmospheric pressure.

- The contraction of diagphragm increases the volume of thoracic chamber in the antero-posterior axis.
- The contraction of external intercoastals muscles lifts up the ribs and the sternum causing an increase in the volume of thoracic chamber in the dorso ventral axis.
- It causes an increase in pulmonary volume decrease the intra-pulmonary pressure to less than the atmospheric pressure.
- If forces the air out side to move in to the lungs, *i.e.,* inspiration.

Expiration :

Relexation of diaphragm and sternum to their normal positions and reduce the thoracic and pulmonary volume.

- It increases in intrapulmonary pressure slightly above the atmospheric pressure.
- It causes the expulsion of air from the lungs, *i.e.,* expiration.



Mechanism of breathing showing (a) Inspiration (b) Expiration

Inspiration	Expiration
Contraction of diaphragm and external intercostal muscles ↓ Increase in the volume of thoracic chamber ↓ Lungs expand ↓ Pressure inside the lungs fall ↓ Air rushes in	Relaxation of diaphragm and sternum ↓ Decrease in the volume of thoracic chamber ↓ Lungs contract ↓ Pressure inside the lings increase ↓ Air rushes out

Respiratory Tract :

A pair of external nostrils → nasal chamber through nasal passage → nasopharynx → glottis → larynx → trachea → Left and right primary bronchi → secondary and tertiary bronchi → bronchioles → vascularised bag like structures (alveoli) or air-sacs. Each lung is covered with double layered membrane known as pleura with pleural fluid between them.

Respiratory organs in animals :

(i) Protozoans, annelids Frogs—**Body surface**
(ii) Fishes, tadpole stage of frog and many other aquatic animals—**Gills**
(iii) Insects and a few other arthropods—**Tracheal tubes**
(iv) All land vertebrates (amphibians, reptiles, aves and mammal)—**Lungs.**

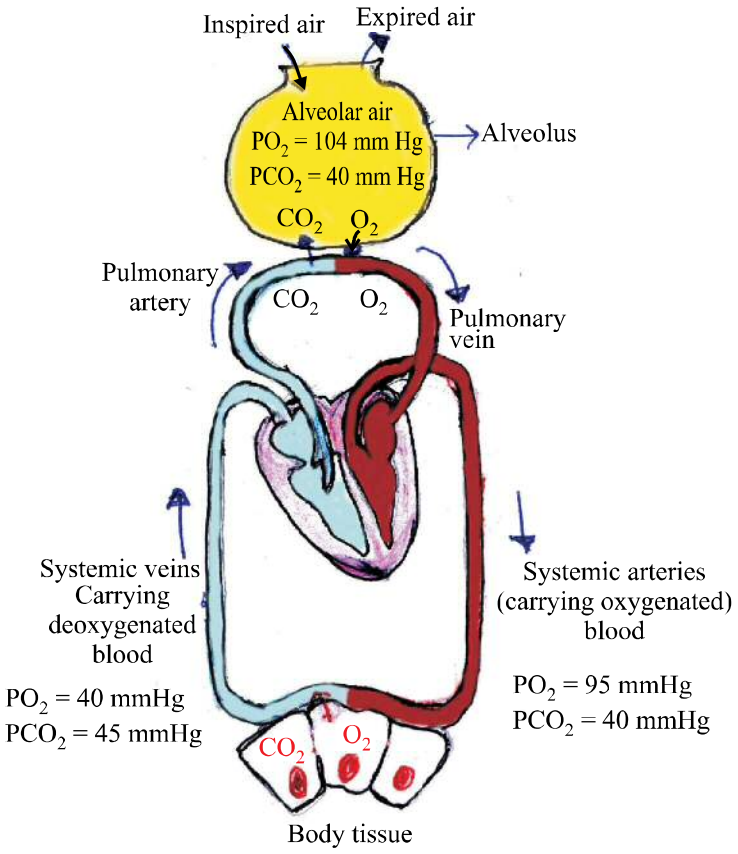
Conditions required for cutaneous respiration

Skin should be moist and thin. It should be highly vascularised.

Physiology of Respiration :

(a) Exchange of gases—Diffusion of gases takes place from the region of higher partial pressure to lower (lesser) partial pressure)

(i) pO_2 in alveolar air = 104 mm Hg.
(ii) pO_2 in venous blood = 40 mm Hg.
O_2 diffuses from alveoli to venous blood.
(iii) pCO_2 in venous blood = 45 mm Hg.
pCO_2 in alveolar air = 40 mm Hg.
CO_2 diffuses from venous blood to alveoli



(b) Transport of O_2 by the blood—About 10% of CO_2 forms carbonic acid with water of plasma.

$$Hb_4 + 4O_2 \underset{\text{Tissue Cells}}{\overset{\text{lungs}}{\rightleftharpoons}} Hb_4O_8$$

Purple Haemoglobin — Oxyhaemoblobin

(c) Transport of CO_2 in the blood—

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

About 20% of CO_2 is transported by combining with free amino group of Haemoglobin in RBC.

70% of CO_2 is transported as bicarbonates of sodium ($NaHCO_3$) and potassium ($KHCO_3$)

Regulation of Respiration

A specialised centre in medulla of brain controls the respiratory rhythm. Another region in the pons region of the brain called **pneumotaxic centre** can moderate the functions of respiratory rhythm centre. Neural signal from pneumotaxic centre can reduce the duration of respiration thereby increasing the respiratory rate. Chemosensitive area present near the rhythm centre, aortic arch can sense the change in CO_2 & H^+ concentration, which in turn send signal to rhythm centre to make necessary adjustment so that those substances can be eliminated.

Questions

Very Short Answer Questions (1 mark each)

1. Name the organ in human respiratory system which produces sound.
2. How many oxygen molecules can be carried out by one haemoglobin molecule.
3. Give the name and function of a fluid filled double membranous layer which surrounds the lungs.
4. Which organ of our respiratory system acts as primary site of exchange of gases ?
5. Cigarette smoking causes emphysema. Give reason.
6. Name the principle or process of exchange of gases.
7. What is the role of oxyhaemoglobin after releasing molecular oxygen in the tissues ?
8. Name the muscles which facilitate breathing.
9. How is the entry of food prevented in the respiratory tract ?
10. About 97% of O_2 is transported by RBCs in the blood. How does the remaining 3% of O_2 transported ?

Short Answer Questions (2 marks each)

11. Draw a labelled diagram of a section of an alveolus with a pulmonary capillary.
12. Following is the table showing partial pressure (in mm Hg) of oxygen and carbondioxide) at different parts involved in diffusion in comparison to those in atmosphere. Fill in the blank – a, b, c and d.

Respiratory gases	Atmospheric air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissue
O_2	(a)	104	40	(d)	40
CO_2	0.3	(b)	(c)	40	45

13. Name the organs of respiration in the organisms.
    (a) Flatworms (b) Birds (c) Frog (d) Cockroach
14. What are occupational respiratory disorders ? What are their harmful effects ? What precautions should a person take to prevent such disorders ?
15. How is respiration different from breathing ?

Short Answer Questions-II (3 marks each)

16. Explain the role of neural system in regulation of respiration is human.
17. Explain the neural control of respiration in human.

Long Answer Questions (5 marks each)

18. With the help of labelled diagram explain the structure of human respiratory system.
19. Explain the mechanism of breathing with the help of labelled diagram involving both stages—inspiration and expiration.
20. Explain the process of exchange of gases with the help of a diagrammatic representation in human respiratory system.
21. A NGO has reported about children below the age of 16 years working in a tobacco factory. On reading this news in paper, what will be your reaction ? Would you like these children to continue working over there why/why not ?

Answers

Very Short Answers (1 mark each)

1. Larynx (Sound box)
2. Four molecules
3. Pleuron. It reduces the friction and keeps the two pleura together and the lungs inflated.

4. Alveoli of lungs.
5. Cigarette smoking damages alveolar walls due to alveolar sacs remaining filled with air leading to decreased respiratory surface for exchange of gases.
6. Diffusion.
7. Amino group of reduced haemoglobin combines with CO_2 forming carbaminohaemoglobin to transport CO_2.
8. External and internal intercostals muscles, situated between ribs.
9. During swallowing a cartilaginous flap like structure called epiglottis covers the glottis and prevents the entry of food into respiratory tract.
10. In simple solution form through plasma.

Short Answers-I (2 marks each)

11. Refer fig 17.4, page 273 (NCERT Text Book Class XI Biology)
12. Refer fig 17.1, page 272 (NCERT Text Book Class XI Biology)
13. (a) Body surface (b) lungs (c) skin and lungs (d) Network of trachea
14. Refer fig 276 (NCERT Text Book Class XI Biology)
15. Slow oxidation of food to release energy is called respiration while breathing is a biophysical process which is the first step of respiration.

Short Answers-II (3 marks each)

16. Refer page 275 (17.5) (NCERT Text Book Class XI Biology)
17. Refer content 17.5 regulation of respiration on page no. 275 (NCERT Text book XI Biology)

Long Answers-II (5 marks each)

18. Refer content 17.1.1 page 29, diagrams 17.1, page 29 (NCERT Text Book Class XI Biology)
19. Refer content 17.2 and fig 17.2 page 270–271 (NCERT Text Book Class XI Biology)
20. Refer content 17.3 and fig 17.3 page 272–273 (NCERT Text Book Class XI Biology)
21. It is very painful to know about such things prevalent in our society. As a biologist I know long exposure to tobacco particles in air will give rise to inflammation leading to fibrosis and thus can damage the lungs severely. So I would not like the children to continue working over there.