

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.

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.

The pressure contributed by an individual gas in a mixture of gases. It is represented as pO_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 Resrve colume (IRV) : Additional volume of air inspired by a forcible inspiration. 2500 ml to 300 ml.

Expiratory Reserve Volume (ERV) : Additional volume of air, a person can expire by a forcible volume (RV) volume of air remaining in the lungs even after a forcible expiration (1100 mL to 1200 mL)

PURMONARY CAPACITES : Use in clinical diagnosis.

$$\text{Inspiratory capacity (IC)} = (\text{TV} + 1 \text{ RV})$$

$$\text{Expiratory Capacity (E.C)} = (\text{T.V} + \text{ERV})$$

Functional Residual Capacity (FRC) = (ERV + RV)

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

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

Steps involved in respiration –

- (i) Breathing or pulmonary respiration
- (ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.
- (iii) Transport of gases by the blood
- (iv) Diffusion of O_2 and CO_2 between blood and tissues.
- (v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2 .

MECHANISM OF BREATHING

Inspiration :

It is the pressure within the lungs (intra-pulmonary 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 diaphragm increases the volume of thoracic chamber in antero-posterior axis.
- ◆ The contraction of external intercostal 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.
- ◆ It forces the air outside to move in to the lungs, *i.e.*, inspiration.

Expiration :

Relaxation 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.

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) **General body surface** - Protozoans, annelids
- (ii) **Gills** - Fishes, tadpole stage of frog and many other aquatic animals.
- (iii) **Air bladder** - Bony fishes (Lung fishes)
- (iv) **Tracheae or Tracheal Tube** - Insects and a few other arthropods.
- (v) **Lungs** - All land vertebrates (amphibians, reptiles, aves and mammal)

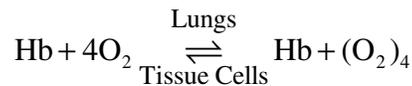
Intercostal muscles : The muscles present between the ribs.

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

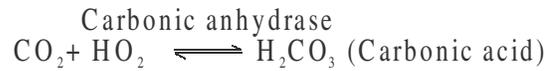
(b) **Transport of O_2 by the blood** - about 10% of CO_2 forms carbonic acid with water of plasma.



Haemoglobin
deoxygenated

Oxyhaemoglobin

(c) Transport of CO₂ in the blood :-



about 20% of CO₂ is transported by combining with free amino group of Haemoglobin, in RBC.



70% of CO₂ is transported as bicarbonates of sodium (NaHCO₃) and potassium (KHCO₃)

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 of exchange of gases.
7. What is the role of oxyhaemoglobin after releasing molecular oxygen in the tissues?

Short Answer Questions-II (2 marks each)

8. Draw a labelled diagram of a section of an alveolus with a pulmonary capillary.
9. Following is the table showing partial pressure (in mm Hg) of oxygen and carbon dioxide at different parts involved in diffusion in comparison to those in atmosphere. Fill in the blanks - a, b, c and d.

Respiratory gas	Atmospheric air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissue
O ₂	a	104	40	d	40
CO ₂	0.3	b	c	40	45

10. What are occupational respiratory disorders? What are their harmful effects? What precautions should a person take to prevent such disorders?

Short Answer Questions-I (3 marks each)

11. Explain the role of neural system in regulation of respiration in human.

Long Answer Questions (5 marks each)

12. With the help of labelled diagram explain the structure of human respiratory system.
13. Explain the mechanism of breathing with the help of labelled diagram involving both stages - inspiration and expiration.
14. Explain the process of exchange of gases with the help of a diagrammatic representation of human respiratory system.

ANSWERS

Very Short Answers (1 mark)

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 carbamino-haemoglobin to transport CO_2 .

Short Answers -II (2 marks)

8. Refer fig 17.4, page 273 (NCERT - Class XI Biology)
9. Refer Table 17.1 page 272 (NCERT Class XI Biology)
10. Refer page 276 (NCERT - Class XI Biology)

Short Answers Questions-I (3 marks)

11. Refer page 275 (17.5) (NCERT Class XI- Biology)

Long Answer (5 marks)

12. Refer content 17.1.1 page 29, diagrams 17.1, page 29 (NCERT - Class XI Biology)
13. Refer content 17.2 and fig 17.2 page No. 270-271 (NCERT - Class XI Biology)