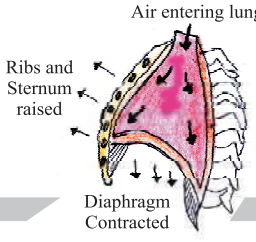


Chapter - 17 Breathing and Exchange of Gases

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 in by lungs and diffused 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 taken in/given out 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.

Residual volume (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.

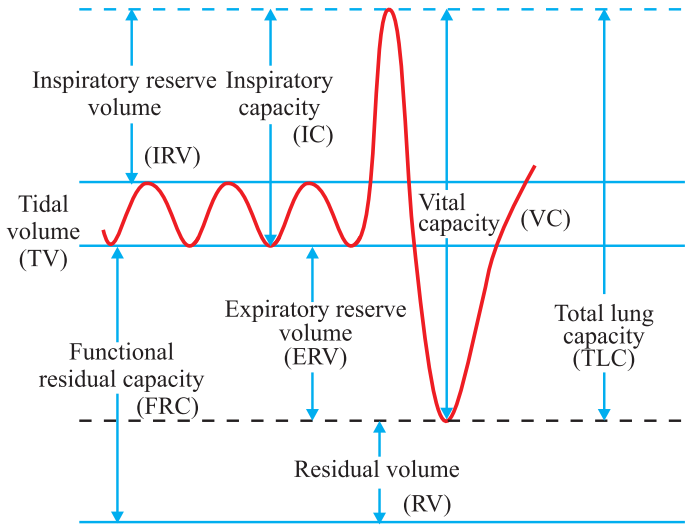
Expiratory Capacity—Total Volume of air a parson can expire after a normal inspiration E.C. = TV + ERV

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'



Various pulmonary air volumes

Steps involved in respiration—

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

(ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane & blood vessel (capillaries).

(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.

Respiratory organs in animals :

(i) Protozoans, annelids Frogs—**Body surface**

(ii) Fishes, tadpole stage of frog and many other aquatic animals—**Gills** (Branchial Respiration)

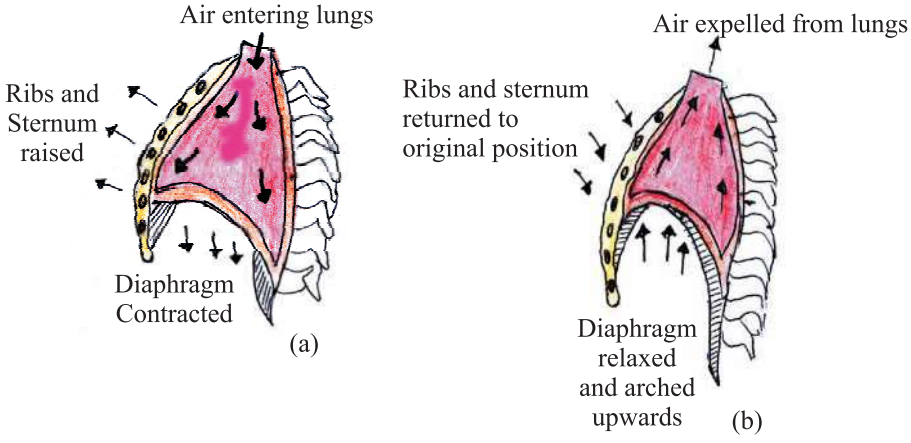
(iii) Insects and a few other arthropods—**Tracheal tubes**

(iv) All land vertebrates (amphibians, reptiles, aves and mammal)—**Lungs.** (Pulmonary Respiration)

Conditions required for (cutaneous respiration)

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

Mechanism of Breathing



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

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

Human Respiratory Tract :

A pair of external nostrils → nasal chamber through nasal passage → pharynx → 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.

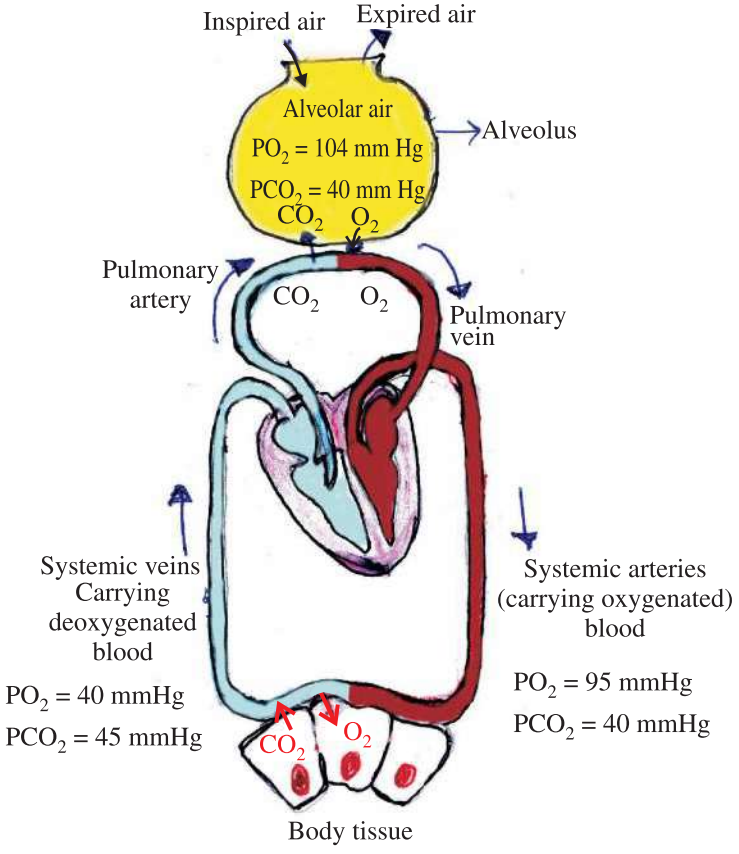
Physiology of Respiration :

(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 — (i) About 3% of O_2 in dissolved state through plasma.

(ii) As oxyhaemoglobin : 97% of O_2 diffuses from plasma into RBCs. Haemoglobin carry 1-4 molecules of O_2.

$$Hb_4 + 4O2 \underset{\text{TISSUE}}{\overset{\text{LUNGS}}{\rightleftharpoons}} Hb_4\,O_8$$
Oxyhaemoglobin

Oxygen dissociation curve

- A sigmoid curve showing relationship between the % of saturation of haemoglobin with oxygen in blood and pO_2 of the blood.
- Fully saturated each gram of haemoglobin combines with nearly 1.34 ml of oxygen.
- H^+ concn., CO_2 tension, temperature affect the curve. Increase in their concentration decreases the affinity of hemoglobin for oxygen.

(c) Transport of CO_2

(i) As solution – 7% of CO_2 dissolves and carried by the plasma.

(ii) As Bicarbonate – 70% of CO_2 in RBCs combines with water form carbonic acid. Carbonic acid dissociates into bicarbonate ions and H^+, Carbonic anhydrase enzyme help in these reactions.

$$CO_2 + H2O \underset{\text{anhydrase}}{\overset{\text{Carbonic}}{\rightleftharpoons}} H_2CO_3 \underset{\text{anhydrase}}{\overset{\text{Carbonic}}{\rightleftharpoons}} HCO^-_3 + H^+$$

(iii) As carbaminohaemoglobin – 23% CO_2 combines in RBC with amino group of haemoglobin, form carbaminohaemoglobin.

Regulation of Respiration

- Respiratory rhythm centre in medulla of brain responsible for this regulation.
- Pneumotaxic centre in pons region moderates function of respiratory rhythm centre.
- Chemosensitive area adjacent to rhythm centre is highly sensitive to CO_2 and H^+ ions.

- Increase in CO_2 and H^+ ions activates this centre, which in turn signal the rhythm centre to make necessary adjustments and respiratory process by which these substances can be eliminated.

Disorders of Respiratory System

- Emphysema– chronic disorder in which alveolar walls damaged due to cigarette smoking
- Asthma–difficulty in breathing due to inflammation of bronchi or bronchioles,
- Occupational disorders– people working in stone grinding or breaking industries, the dust produced damage the defence system of body leading to servere lung damage.

Questions

(SRT) Select Response Type Question (1 mark each)

1. The organ in human respiratory system producing sound is
   (a) Pharynax (b) Alveoli
   (c) Larynx (d) Ear drum
2. One Haemoglobin molecule carries
   (a) 2 oxygen molecule (b) 3 oxygen molecule
   (c) six oxygen molecule (d) oxygen moelcule
3. The double membranous layer which surround the lung is
   (a) Mucosa (b) Muscularis
   (c) Pleura (d) Serosa

Very Short Answer Questions (1 mark each)

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. How is carbon dioxide transported in blood?

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.

Case Based/Source/Competency focussed Question

(4 Marks each)

21. Breathing is a physical phenomenon where oxygen from the atmosphere is exchanged with the carbon dioxide produced by the cells. Various organisms

have different mechanisms for breathing depending upon their needs and habitat. For example, lower invertebrates like sponges exchange gases by simple diffusion while earthworms use cuticle and insects have a network of tubes to transport atmospheric air within the body. Special vascularized structures called gills are used by aquatic arthropods and molluscs whereas vascularised bags called lungs are used by terrestrial forms for the exchange of gases. Fishes use gills while birds and mammals have lungs and amphibians use their moist skin to exchange gases.

1. **Assertion (A) :** Breathing is different from respiration.

   Reason (R) : Breathing is physical and respiration is biochemical.

   (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

   (b) If both (A) and (R) are true, but (R) is not the explanation of (A)

   (c) If (A) is true but (R) is false

   (d) If both (A) and (R) are false

2. Why is the mechanism of breathing different for different organisms?

   (a) To meet their needs

   (b) To help them adapt to their environment

   (c) To suit their mode of life

   (d) All of the above

3. What special name is given to the vascularised bags of terrestrial animals and vascularised structures of aquatic arthropods and molluscs?

   (a) Gills and lungs respectively

   (b) Lungs and trachea respectively

   (c) Lungs and gills respectively

   (d) Gills and trachea respectively

4. How do lower invertebrates like sponges exchanges gases?

   (a) Diffusion

(b) Osmosis

(c) Breathing

(d) Cuticle exchange

5. **Assertion :** The larynx is called the sound box.

   Reason : The larynx is a cartilaginous box that helps in sound production.

   (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

   (b) If both (A) and (R) are true, but (R) is not the explanation of (A)

   (c) If (A) is true but (R) is false

   (d) If both (A) and (R) are false

(Select Response Type) Assertion reasoning type questions : (1 marks each)

DIRECTIONS : In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

(b) If both (A) and (R) are true, but (R) is not the explanation of (A)

(c) If (A) is true but (R) is false

(d) If both (A) and (R) are false

22. **Assertion :** Most fishes, when out of water die of suffocation.

    Reason : Atmospheric air contains far less oxygen content then the dissolved oxygen in water.

23. **Assertion :** Aerobic animals are not truly aerobic.

    Reason : They produce lactic acid anaerobically.

24. **Assertion :** During inspiration pressure of air falls in the thorax.

    Reason : There is a rise in the volume of the thorax during inspiration.

25. **Assertion :** Symptoms of emphysema develops when a person living on planes ascends and stays on a mountain.

Reason : Air pressure and partial pressure of oxygen increases with the rise in altitude.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (c) Larynx (Sound box)
2. (d) Four molecules of O_2.
3. (c) Pleura. It reduces the friction and the two pleura together protect the lungs.

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answers (1 mark each)

4. Alveoli of lungs.
5. Cigarette smoking damages alveolar walls due to alveolar sacs abnormal distension, 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. NCERT Text Book Class XI Biology.
12. NCERT Text Book Class XI Biology.
13. (a) Body surface (b) lungs (c) skin and lungs (d) Network of trachea
14. 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 Support Material Points to remember.

17. Refer Support Material Points to remember.

Long Answers-II (5 marks each)

18. Refer Support Material Points to remember.

19. Refer Support Material Points to remember.

20. Refer Support material 'Points to remember' of this chapter.

21. 1. (a)
    2. (d)
    3. (c)
    4. (a)
    5. (a)

Short Answers-II (3 marks each)

22. (c)

23. (a)

24. (a)

25. (d)