# CHAPTER – 14

## BREATHING AND EXCHANGE OF GASES

## EXERCISES

### 2 Mark Questions

**Q1: What is the site of gaseous exchange in an insect?**
Answer: Tracheae (Tracheal respiration) is the site of gaseous exchange in an insect.

**Q2: What happens to the respiratory process in a man going up a hill?**
Answer: Rate of breathing will increase in order to supply sufficient oxygen to blood because air in mountainous region is deficient in oxygen.

**Q3: State the volume of air remaining in the lungs after a normal breathing.**
Answer: When a person breathes normally, the amount which remains in the lung after normal expiration, is called functional residual capacity. It is the sum of residual volume and the expiratory reserve volume (FRC = RV + ERV). It is about 2100 – 2300 mL of air.

**Q4: What is the effect of $pCO_2$ on oxygen transport?**
Answer: Increase in $pCO_2$ tension in blood brings rightward shift of the oxygen dissociation curve of haemoglobin thereby decreasing the affinity of haemoglobin for oxygen. This effect is called Bohr's effect. It plays an important role in the release of oxygen in the tissues.

### 4 Mark Questions

**Q1:Define vital capacity. What is its significance?**
Answer: Vital capacity is defined as the maximum volume of air a person can breathe in after a forced expiration or the maximum volume of air a person can breathe out after a forced inspiration. It represents the maximum amount of air one can renew in the respiratory system in a single respiration. Thus, greater the vital capacity more is the energy available to the body.

**Q2:Diffusion of gases occurs in the alveolar region only and not in the other parts of respiratory system. Why?**

Answer: For efficient exchange of gases, respiratory surface must have certain characteristics such as (i) it must be thin, me ist and permeable to respiratory gases (ii) it must have large surface area, (iii) it must be highly vascular. Only alveolar region has these characteristics. Thus, diffusion of gases occurs in this region only.

**Q3:What are the major transport mechanisms for $CO_2$? Explain.**

Answer: Nearly 20-25 percent of $CO_2$ is transported by haemoglobin of RBCs, 70 percent of it is carried as bicarbonate ion in
plasma and about 7 percent of $CO_2$ is carried in a dissolved state through plasma. $CO_2$ is carried by haemoglobin as carbamino- haemoglobin. This binding is related to the partial pressure of $CO_2$.

**Q4:Have you heard about hypoxia? Try to gather information about it, and discuss with your friends.**

Answer: Hypoxia is a condition of oxygen shortage in the tissues. It is of two types:
(i) Artificial hypoxia: It results from shortage of oxygen in the air as at high altitude. It causes mountain sickness characterised by breathlessness, headache, dizziness and bluish tinge on skin.
(ii) Anaemic hypoxia: It results from the reduced oxygen carrying capacity of the blood due to anaemia or carbon monoxide poisoning. In both cases, less haemoglobin is available for carrying $0_2$.

**Q5:Define oxygen dissociation curve. Can you suggest any reason for its sigmoidal pattern?**

Answer: The relationship between the partial pressure of oxygen ($pO_2$) and percentage saturation of the haemoglobin with oxygen ($O_2$)is graphically illustrated by a curve called oxygen haemoglobin dissociation curve (also called oxygen dissociation curve).
The sigmoidal pattern of oxygen haemoglobin dissociation curve is the result of two properties which play significant role in the transport of oxygen. These two properties are:
(i) Minimal loss of oxygen from haemoglobin occurs above p02 of 70-80 mm Hg despite significant changes in tension of oxygen beyond this. This is depicted by

relatively flat portion of the curve.
(ii)Any further decline in p02 from 40 mm Hg causes a disproportionately greater release of oxygen from the haemoglobin. It results in the steeper portion of the curve and causes the curve to be sigmoid.

## 7 Mark Questions

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**Q2:What is tidal volume? Find out the tidal volume (approximate value) for a healthy human in an hour.**

Answer: Tidal volume is the volume of air inspired or expired with each normal breath. This is about 500 mL in an adult person. It is composed of about 350 mL of alveolar volume and about 150 mL of dead space volume. The alveolar volume consists of air that reaches the respiratory surfaces of the alveoli and engages in gas exchange. The dead space volume consists of air that does not reach the respiratory surfaces.
A healthy man can inspire or expire approximately 6000 to 8000 mL of air per

minute. Therefore, tidal volume for a healthy human in an hour is 360 – 480 mL of air.

**Q3:Distinguish between**

**(a) IRV and ERV**

**(b) Inspiratory capacity and expiratory capacity.**

**(c) Vital capacity and total lung capacity.**

Answer:

(a) Differences between IRV and ERV are as follows:

| | IRV | ERV |
|---|---|---|
| (i) | It is the extra amount of air that can be inspired forcibly after a normal inspiration. Thus it is forced inspiration. | It is the extra amount of air that can be expired forcibly after a normal expiration. Thus it is forced expiration. |
| (ii) | It is about 2500 to 3000 mL of air. | It is about 1000 ml to 1100 mL of air. |

(b)Differences between inspiratory capacity and expiratory capacity are as follows:

| | Inspiratory capacity | Expiratory capacity |
|---|---|---|
| (i) | It is the total volume of air that can be inhaled after a normal expiration. | It is the total volume of air a person can expire after a normal inspiration. |
| (ii) | It includes tidal volume and the inspiratory reserve volume (IC = TV + IRV). | It includes tidal volume and expiratory reserve volume (EC = TV + ERV). |
| (iii) | It is about 3000 to 3500 mL of air. | It is about 1500 to 1600 mL of air. |

(c) Differences between vital capacity and total lung capacity are as follows:

| | Vital capacity | Total lung capacity |
|---|---|---|
| (i) | It is the amount of air which one can inhale and exhale with maximum effort. | It is the total amount of air present in the lungs and the respiratory passage after a maximum inspiration. |
| (ii) | It is the sum of tidal volume, inspiratory reserve volume and expiratory reserve volume (VC = TV + IRV + ERV). It varies from 4 – 4.6 litres in a normal adult person. | It is the sum of the vital capacity and the residual volume (TLC = VC + RV). It is 5100 to 5800 mL. |

**Q4:How is respiration regulated?**

Answer: Respiration is under both nervous and chemical regulation.

The respiratory centre in brain is composed of groups of neurons located in the medulla oblongata and pons varolii. The respiratory centre regulates the rate and depth of the breathing.

Dorsal respiratory group of neurons are located in the dorsal portion of the medulla oblongata. This group of neurons mainly causes inspiration.

Ventral group of neurons are located in the ventrolateral part of the medulla oblongata. These can cause either inspiration or expiration.

Pneumotaxic centre is located in the dorsal part of pons varolii. It sends signals to all the neurons of dorsal respiratory group and only to inspiratory neurons of ventral respiratory group. Its job is primarily to limit inspiration. Chemically, respiration is regulated by the large numbers of chemoreceptors located in the carotid bodies and in the aortic bodies. Excess carbon dioxide or hydrogen ions mainly stimulate the respiratory centre of the brain and increases the inspiratory

and expiratory-signals to the respiratory muscles. Increased $C0_2$ lowers the pH resulting in acidosis. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

## Multiple Choice Questions

1. **Respiration in mature mammalian erythrocytes are _____**
    1. Linear
    2. Absent
    3. Anaerobic
    4. Aerobic

    Answer: Anaerobic

2. **_____ is not a characteristic feature of the respiratory surface**
    1. Dry
    2. Thin
    3. Permeable
    4. Moist

    Answer: Dry

3. **Human skin cannot function as a respiratory organ because**
    1. It is not permeable to O2 and CO2
    2. It is rather thick
    3. It is dry
    4. All of the above

    Answer: All of the above

4. **In cockroaches, inspiration occurs with _____**
    1. Relaxation of tergo-sternal muscles

2. Relaxation of abdominal muscles
3. Neither (1) nor (2)
4. Both (1) and (2)

Answer: Both (1) and (2)

5. **Pick out the statement that is wrong with respect to insects**
    1. Abdominal muscles do not take part in respiration
    2. When abdominal muscles relax, the air is drawn in through spiracles and tracheoles
    3. Contracting abdominal muscles drive the air out through the spiracles
    4. Both (2) and (3)

    Answer: Abdominal muscles do not take part in respiration

6. **Where does the exchange of gases occur in birds?**
    1. Air sacs only
    2. Air sacs and Lungs
    3. Lungs only
    4. First in air sacs and then in the lungs

    Answer: Lungs only

7. **Spiracles in cockroaches are analogous to _____ in humans**
    1. Trachea
    2. Nostrils
    3. Lungs
    4. None of the above

    Answer: Nostrils

8. **Where are the conchae located?**
    1. Auricle
    2. Brachioles
    3. Nasal Chambers
    4. Ville

    Answer: Nasal Chambers

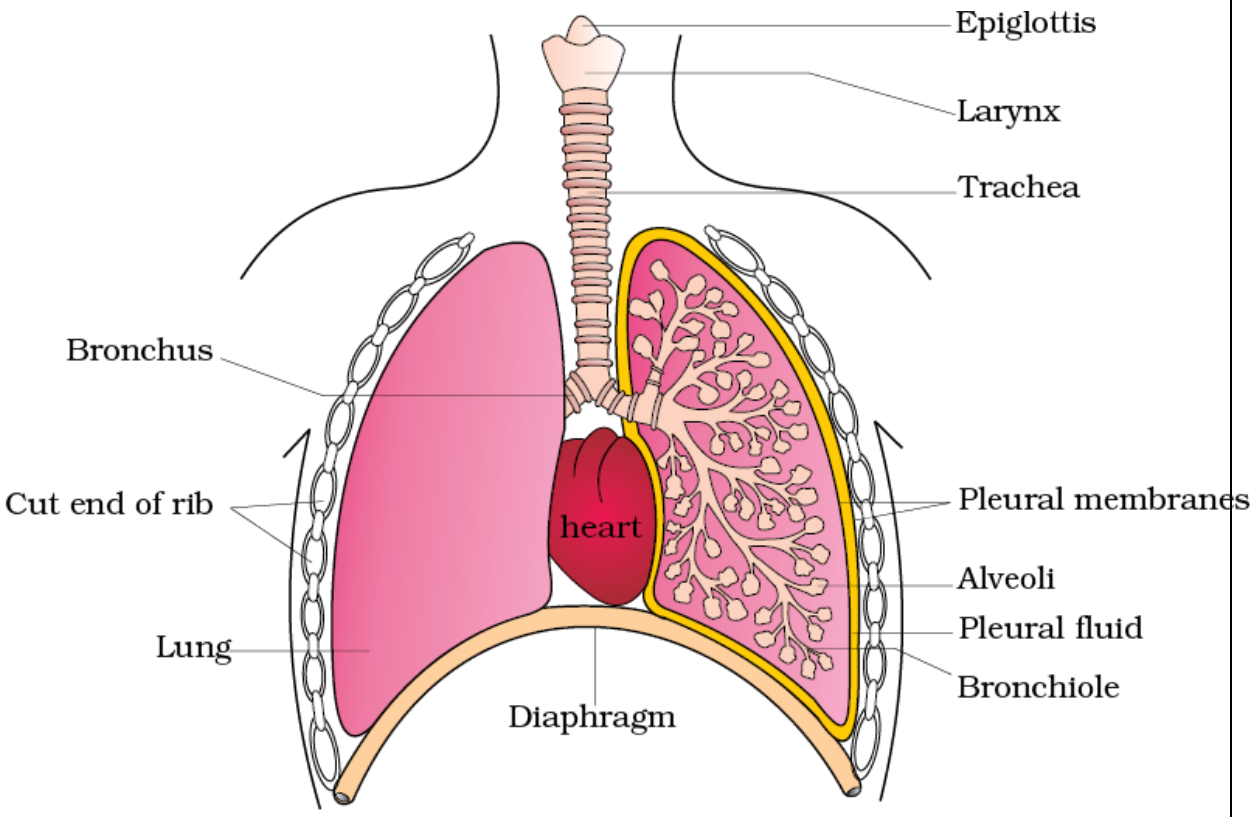
9. **Laryngeal prominence is also known as _____**
    1. Adam's Apple
    2. Epiglottis
    3. Thyroids
    4. Laryngitis

    Answer: Adam's Apple

10. **Glottis opens on the floor of**
    1. Pharyngeal cavity
    2. Diagraphram
    3. Trachea
    4. None of the above

    Answer: Pharyngeal cavity

## DIAGRAMS




## SUMMARY

Cells utilise oxygen for metabolism and produce energy along with substances like carbon dioxide which is harmful. Animals have evolved different mechanisms for the transport of oxygen to the cells and for the removal of carbon dioxide from there. We have a well developed respiratory system comprising two lungs and associated air passages to perform this function. The first step in respiration is breathing by which atmospheric air is taken in (inspiration) and the alveolar air is released out (expiration). Exchange of O2 and CO2 between deoxygenated blood and alveoli, transport of these gases throughout the body by blood,