

CBSE Class 11 Biology
NCERT Solutions
Chapter 17
Breathing and exchange gases

1. Define vital capacity. What is its significance?

Ans. Vital Capacity (VC): The maximum volume of air a person can breathe in after a forceful expiration is called Vital Capacity. This is also defined as the maximum volume of air a person can breathe out after a forceful inspiration. $VC = ERV + TV + IRV$.

Vital capacity of a person gives important clues while diagnosing a lung disease. Measurement of this capacity helps the doctor to decide about the possible causes of the diseases and about the line of treatment.

2. State the volume of air remaining in the lungs after a normal breathing.

Ans. Functional Residual Capacity (FRC): The volume of air which remains in the lungs after a normal expiration is called Functional Residual Capacity. $FRC = ERV + RV$.

$ERV = 1000$ to 1100 ml

$RV = 1100$ to 1200 ml

So, $FRC = 2100$ to 2300 ml

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

Ans. The exchange part of the respiratory system is composed of the alveoli and their ducts. Actual diffusion of O_2 and CO_2 (between blood and atmospheric air) takes place in the exchange part of the respiratory system. The thin membrane of the alveoli is suited for diffusion of gases, while other parts of the respiratory system are not structured to serve this purpose. Hence, diffusion of gases takes place in the alveolar region only and not in the other parts of the respiratory system.

4. What are the major transport mechanisms for CO₂? Explain.

Ans. The binding of carbon dioxide with haemoglobin is related to partial pressure of CO₂. The partial pressure of O₂ is a major factor which can affect this binding. In the tissues, pCO₂ is higher than pO₂ and hence more binding of carbon dioxide occurs at the tissue level. In the alveoli, pCO₂ is lower than pO₂ and hence dissociation of carbamino-haemoglobin takes place in the alveoli.

5. What will be the pO₂ and pCO₂ in the atmospheric air compared to those in the alveolar air ?

- (i) pO₂ lesser, pCO₂ higher
- (ii) pO₂ higher, pCO₂ lesser
- (iii) pO₂ higher, pCO₂ higher
- (iv) pO₂ lesser, pCO₂ lesser

Ans. (ii) pO₂ higher, pCO₂ lesser

6. Explain the process of inspiration under normal conditions.

Ans. Inspiration is initiated by the contraction of diaphragm. The contraction of diaphragm increases the volume of thoracic chamber in the antero-posterior axis. The external inter-costal muscles contract to lift up the ribs and the sternum. This causes an increase in the volume of the thoracic chamber in the dorso-ventral axis. The overall increase in the thoracic volume results in a similar increase in pulmonary volume. The increase in pulmonary volume decreases the intra-pulmonary pressure to less than the atmospheric pressure. This pressure gradient forces the air from outside to move into the lungs and inspiration takes place.

7. How is respiration regulated?

Ans. The regulation of respiration is done by the neural system. The respiratory rhythm centre is present in the medulla and is mainly responsible for the regulation of respiration.

Another region; called pneumotaxic centre is present in the pons. The pneumotaxic centre can moderate the functions of the respiratory rhythm centre.

A chemosensitive area is situated adjacent to the rhythm centre. This is highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this chemosensitive area.

This; in turn; gives signal to the rhythm centre to make necessary adjustments in the respiratory process so that these substances can be eliminated. Receptors associated with aortic arch and carotid artery can also recognize changes in CO_2 and H^+ concentration. These receptors send necessary signals to the rhythm centre for corrective actions. It is important to remember that the role of oxygen in the regulation of respiratory rhythm is quite insignificant.

8. What is the effect of pCO_2 on oxygen transport?

Ans. Binding of oxygen with haemoglobin is mainly related to the partial pressure of O_2 . Partial pressure of CO_2 , hydrogen ion concentration and temperature are the other factors which can interfere with this binding. Increased partial pressure of CO_2 can increase haemoglobin's affinity towards oxygen and vice-versa is also true.

9. What happens to the respiratory process in a man going up a hill?

Ans. A man going uphill has to exert more effort to climb. This increases the consumption of oxygen. As a result, the partial pressure of oxygen in haemoglobin decreases which creates more demand for oxygen. This is compensated by an increased breathing rate.

10. What is the site of gaseous exchange in an insect?

Ans. Insects have a network of tubes through which air is transported within the body. These tubes are called tracheae. The tracheae open on the lateral surface of the animal through minute pores; called spiracles.

11. Define oxygen dissociation curve. Can you suggest any reason for its sigmoidal pattern?

Ans. When percentage saturation of haemoglobin with O_2 is plotted against pO_2 , we get a sigmoid curve. This curve is called Oxygen Dissociation Curve.

Oxygen has a high affinity with haemoglobin. Binding of initial molecules of oxygen is difficult, but binding of subsequent molecules becomes easier. This is evident by the rising trend in the initial phases of the sigmoid curve. Once the oxygen binding reaches its optimum level, haemoglobin cannot take up any more oxygen molecules and hence the graph shows a plateau phase. These are the reasons for S-shape of the graph.

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

Ans. Lack of adequate oxygen supply to whole body or a part is called hypoxia. Hypoxia generally happens because of a mismatch between oxygen demand and oxygen supply in body parts..

13. Distinguish between

(a) IRV and ERV

(b) Inspiratory capacity and Expiratory capacity

(c) Vital capacity and Total lung capacity

Ans. (a) IRV and ERV - The additional volume of air which can be forcefully inspired is called IRV, while the additional volume of air forcefully expired is called ERV. In a normal adult, the IRV is about 2500 ml to 3000 ml, while the ERV is about 1000 ml to 1100 ml.

(b) Inspiratory capacity and Expiratory capacity - The total volume of air which can be inspired after a normal expiration is called Inspiratory Capacity, while the total volume of air which can be expired after a normal inspiration is called expiratory capacity. $IC = TV + IRV$, while $EC = TV + ERV$.

(c) Vital capacity and Total lung capacity - The maximum volume of air which a person can breathe in after a forced expiration is called Vital Capacity, while the total volume of air accommodated in the lungs at the end of a forced inspiration is called Total Lung Capacity.

$$VC = ERV + TV + IRV$$

$$\text{TLC} = \text{RV} + (\text{ERV} + \text{TV} + \text{IRV})$$

14. What is Tidal volume? Find out the Tidal volume (approximate value) for a healthy human in an hour.

Ans. Tidal Volume (TV): The volume of air inspired or expired during a normal respiration is called Tidal Volume. It is approximately 500 ml in a healthy man. This means that a healthy adult can inspire or expire about 6 to 8 litre of air per minute.

Tidal Volume = 500 ml,

Respiration rate = 12 per minute

Hence, Tidal Volume in 1 hour = $500 \text{ ml} \times 12 \times 60 \text{ minute} = 360000 \text{ ml} = 360 \text{ litre}$