NCERT TEXTBOOK QUESTIONS FROM SOLVED

1. Define vital capacity. What is its significance?
Solution: 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.

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

3. Diffusion of gases occurs in the alveolar region only and not in the other parts of respiratory system. Why?
Solution: For efficient exchange of gases, respi: atory 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.

4. What are the major transport mechanisms for CO_2? Explain.
Solution: CO_2 is carried by haemoglobin as carbamino-haemoglobin (about 20-25 per cent). This binding is related to the partial pressure of CO_2 . pO_2 is a major factor which could affect this binding. When pCO_2 is high and pO2 is low as in the tissues, more binding of carbon dioxide occurs whereas, when the pCO_2 is low and pO_2 is high as in the alveoli, dissociation of CO_2 from carbamino-haemoglobin takes place, i.e., CO_2 which is bound to haemoglobin from the tissues is delivered at the alveoli.
RBCs contain a very high concentration of the enzyme, carbonic anhydrase and minute quantities of the same is present in the plasma too. This enzyme facilitates the following reaction in both directions.

$$CO_2 + H_2O \xrightleftharpoons{\text{Carbonic anhydrase}} H_2CO_3 \xrightleftharpoons{\text{Carbonic anhydrase}} HCO_3^- + H^+$$

At the tissue site where partial pressure of CO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3^- and H^+, . At the alveolar site where pCO_2 is low, the reaction proceeds in the opposite direction leading to the formation of CO_2 and H_2O. Thus, CO_2 trapped as bicarbonate at the tissue level and transported to the alveoli is released out as CO_2 as shown in above figure. Every 100 ml of deoxygenated blood delivers approximately 4 ml of CO_2 to the alveoli.

5. What will be the pO2 and pCO_2 in the atmospheric air compared to those in the alveolar air?
(i) pO_2 lesser, pCO_2 higher
(ii) pO_2 higher, pCO_2 lesser
(iii) pO_2 higher, pCO_2 higher
(iv) pO_2 lesser, pCO_2 lesser
Solution: (ii) Air that has entered the alveoli through the bronchioles is called alveolar air. It has the same partial pressure of CO_2 and O_2 as is in the atmospheric air. Then, there occurs gaseous exchange between the adjacent blood capillaries and the alveoli. CO_2 diffuses from blood into the alveolar air and O_2 diffuses from alveolar air to the blood. As a result, new alveolar air has higher pCO_2 and lesser pO_2, than the atmospheric air.

6. Explain the process of inspiration under normal conditions.
Solution: Inspiration is initiated by the contraction of diaphragm which increases the volume of thoracic chamber in the antero-posterior axis. The contraction of external inter-costal muscles lifts up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis. The overall increase in the thoracic volume causes a similar increase in pulmonary volume. An 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?
Solution: 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 CO_2 lowers the pH resulting in acidosis. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.

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