Breathing and Exchange of Gases

CHAPTER 17

NCERT FOCUS

ANSWERS

Topic 1

1. 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. Tidal volume is the volume of air inspired or expired with each normal breath. This is about 500 mL in an adult person. A healthy man breathe about 12-14 times per minute.

Thus, he can inspire or expire approximately 6000 to 8000 mL of air per minute. Therefore, tidal volume for a healthy human in an hour will be = 6000 to 8000 mL × (60 min) = 3.6×10^5 mL to 4.8×10^5 mL

Hence, the hourly tidal volume for healthy human is approximately 360 - 480 Litre.

3. Inspiration is a process by which fresh air enters the lungs. The diaphragm, intercostal muscles and abdominal muscles play an important role. The muscles of the diaphragm and external intercostal muscles are principle muscles of inspiration. Volume of thoracic cavity increases by contraction of diaphragm and external intercostal muscles. During inspiration, relaxation of abdominal muscles also occurs which allows compression of the abdominal organs by diaphragm. Thus, overall volume of the thoracic cavity increases and as a result, there is a decrease of the air pressure in the lungs. The greater pressure outside the body now causes air to flow rapidly into the lungs. The sequence of air flow is:

External nares → Nasal chambers → Internal nares → Pharynx → Glottis → Larynx → Trachea → Bronchi → Bronchioles → Alveolar ducts → Alveoli.

4. Tracheoles (Tracheal respiration) is the site of gaseous exchange in an insect.

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

S.No.	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 to 1100 mL of air.

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

S.No.	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:

S.No.	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 is the sum of the vital capacity and the residual volume (TLC = VC + RV).
(iii)	It varies from 3400 – 4800 mL in a normal adult person.	It is about 5000 to 6000 mL.

Topic 2

1. Alveoli is the site of gaseous exchange as wall of alveoli is very thin and has rich network of blood capillaries. Alveolar wall is like a sheet of flowing blood and is called respiratory membrane, which allows diffusion of respiratory gases.

2. Transport of carbon dioxide **:**

(i) In dissolved form : About 7% of CO_2 gets dissolved in the blood plasma and is carried in solution to the lungs.

(ii) As bicarbonate : About 70% of carbon dioxide is converted to bicarbonate ions (HCO_3^-) and transported to plasma. CO_2 diffuses into RBCs, combines with water and

form carbonic acid, in the presence of an enzyme carbonic anhydrase.

(iii) As carbaminohaemoglobin : About 23% of CO_2 is carried by haemoglobin as carbaminohaemoglobin. CO_2 reacts with amine radicals (NH_2) of haemoglobin to form unstable compound carbaminohaemoglobin.

3. (ii) : Partial pressure of O_2 and CO_2 (mmHg) are as follows:

	Atmospheric air	Alveoli
O_2	159	104
CO_2	0.3	40

4. Carbon dioxide on being released in blood reacts with water to form carbonic (H_2CO_3) acid. It dissociates into H^+ ions and HCO_3^- ions. Released H^+ ions lower the pH of blood and induce dissociation of oxyhaemoglobin to give up more O_2. This phenomenon of increase in CO_2 concentration resulting in increased dissociation of oxyhaemoglobin is known as Bohr effect.

5. 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) Any decline in pO_2 beyond 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.

(ii) Minimal loss of oxygen from haemoglobin occurs above pO_2 of 70–80 mm Hg despite significant changes in tension of oxygen beyond this. This is depicted by relatively flat portion of the curve.

Topic 3

1. 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.

(a) Medullary respiratory centres :

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

(ii) Ventral respiratory group of neurons are located in the ventro-lateral part of the medulla oblongata. These can cause either inspiration or expiration.

(b) Pons respiratory centres

(i) 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.

(ii) Apneustic centre is located in lower part of the pons varolii. 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.

2. On going up a hill, the rate of breathing will increase in order to supply sufficient oxygen to blood because the air in mountainous region is deficient in oxygen due to low partial pressure of oxygen.

3. Hypoxia is a condition of oxygen shortage in the tissues, thus also commonly called altitude hypoxia. Many factors such as air at reduced barometric pressure at high altitude, drowning, carbon monoxide, etc. can cause oxygen deficiency in the body resulting in hypoxia. It is of two types:

(i) Hypoxic hypoxia : It results from the shortage of oxygen in the air at high altitude. It causes mountain sickness characterised by breathelessness, headache, dizziness and bluish tinge on skin.

(ii) Anemic 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 O_2.

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