Chapter 17 (BREATHING AND EXCHANGE OF GASES)

Multiple Choice Questions

Q1. Respiration in insects is called direct because '

(a) The cells exchange $0_2/C0_2$ directly with the air in the tubes
(b) The tissues exchange $0_2/C0_2$ directly with coelomic fluid
(c) The tissues exchange $0_2/C0_2$ directly with the air outside through body surface
(d) " Tracheal tubes exchange $0_2/C0_2$ directly with the haemocoel which then exchange with tissues
Ans: (d) Respiration in insects is called direct because tracheal tubes exchange $0_2/C0_2$ directly with the haemocoel which then exchange with tissues.

Q2.A person suffers punctures in his chest cavity in an accident, without any damage to the lungs, its effect could be
(a) Reduced breathing rate
(b) Rapid increase in breathing rate
(c) No change in respiration
(d) Cessation of breathing
Ans: (d)A person suffers punctures in his chest cavity in an accident, without any damage to the lungs, its effect could be cessation of breathing.

Q3. It is known that exposure to carbon monoxide is harmful to animals because
(a) It reduces $C0_2$ transport
(b) It reduces 0_2 transport
(c) It increases $C0_2$ transport
(d) It increases 0_2 transport
Ans: (b) CO is a poisonous gas which binds with Hb more rapidly than 0_2 to form carboxyhaemoglobin. CO makes .the most stable combination with the Hb of blood. CO has 200-250 times more affinity for Hb as compared to 0_2. When the inhaled air contains CO gas then a person suffers from suffocation because product cannot dissociate so decreases free oxygen. So it reduces 0_2 transport.

Q4. Mark the true statement among the following with reference to normal breathing.
(a) Inspiration is a passive process whereas expiration is active
(b) Inspiration is an active process whereas expiration is passive
(c) Inspiration and expiration are active processes
(d) Inspiration and expiration are passive processes
Ans: (b) Inspiration is an active process whereas expiration is passive.

Q5. Mark the incorrect statement in context to 0_2 binding to Hb.
(a) Lower pH
(b) Lower temperature
(c) Lower $pC0_2$
(d) Higher $p0_2$
Ans: (a) 0_2 binding to Hb occurs in the following conditions: lower temperature, lower $pC0_2$ and higher $p0_2$.

Q6.Mark the correct pair of muscles involved in the normal breathing in humans
(a)External and internal intercostal muscles
(b)Diaphragm and abdominal muscles
(c)Diaphragm and external intercostal muscles
(d) Diaphragm and intercostal muscles
Ans: (d) Diaphragm and intercostal muscles involved in the normal breathing in humans. ,

Q7. Incidence of Emphysema—a respiratory disorder is high in cigarette smokers. In such cases
(a) The bronchioles are found damaged
(b) The alveolar walls are found damaged
(c) The plasma membrane is found damaged
(d) The respiratory muscles are found damaged
Ans: (b) Emphysema is a chronic disorderin which alveolar walls are damaged due to which respiratory surface is decreased.

Q8. Respiratory **process is regulated by certain specialised centres in the brain. One of the following listed centres can reduce the inspiratory duration upon stimulation**
(a) Medullary inspiratory centre (b) Pneumotaxic centre
(c) Apneustic centre (d) Chemosensitive centre
Ans: (b) Pneumotaxic centre can reduce the inspiratory duration upon stimulation.

Q9. $C0_2$ dissociates from carbaminohaemoglobin when

(a) $pC0_2$ is high and $p0_2$ is low

(b) $p0_2$ is high and $pC0_2$ is low

(c) $pC0_2$ and $p0_2$ are equal

(d) None of the above

Ans: (b) $C0_2$ dissociates from carbaminohaemoglobin when $p0_2$ is high and $pC0_2$ is low,

Q10. In breathing movements, air volume can be estimated by .

(a) Stethoscope

(b) Hygrometer

(c) Sphygmomanometer

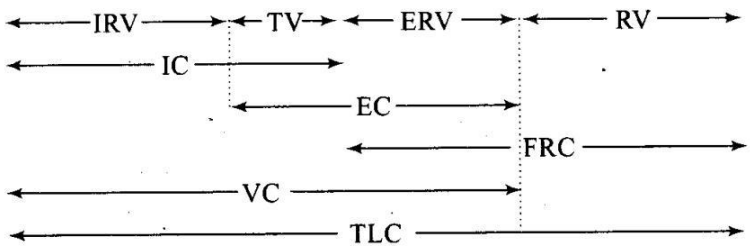
(d) Spirometer

Ans: (d) In breathing movements, air volume can be estimated by spirometer.

Q11.From the following relationships between respiratory volumes and capacities, mark the correct option.

(a)	(i) Incorrect	(ii) Incorrect	(iii) Incorrect	(iv) Correc
(b)	(i) Incorrect	(ii) Correct	(iii) Incorrect	(iv) Correct
(c)	(i) Correct	(ii) Correct	(iii) Incorrect	(iv) Correct
(d)	(i) Correct	(ii) Incorrect	(iii) Correct	(iv) Incorrect

Ans. (b)



i. Inspiratory Capacity (IC) = Tidal Volume + Inspiratory Residual Volume (IRV) ,
iii. Residual Volume (RV) = TLC – VC

Q12. The oxygen-haemoglobin dissociation curve will show a right shift in case of

(a) High $pC0_2$

(b) High$p0_2$

(c) Low $pC0_2$

(d) Less H^+ concentration

Ans: (a) Curve shift is right in following conditions: (1) Decrease in $p0_2$, (2) Increase in $pC0_2$ (Bohr effect), (3) Increase in body temperature, (4) Increase in H^+ ion concentration, (5) Decrease in pH, (6) Increase in 2, 3 diphosphoglycerate.

Q13. Match the following and mark the correct options

Animal		Respiratory organ	
A.	Earthworm	(0	Moist cuticle
B.	Aquatic Arthropods	(ii)	Gills
C.	Fishes	(iii)	Lungs
D.	Birds/Reptiles	(iv)	Trachea

(a) A—(ii), B—(i), C—(iv), D—(iii)
(b) A—(i), B—(iv), C—(ii), D—(iii)
(c) A—(i), B—(iii), C—(ii), D—(iv)
(d) A—(i), B—(iv), C—(ii), D—(iii)

Ans: (d)

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C.	Fishes	(ii)	Gills
D.	Birds/Reptiles	(iii)	Lungs

Very Short Answer Type Questions
Q1. Define the following terms
a. Tidal volume
b. Residual volume
c. Asthma
Ans: a. Tidal volume: Volume of air inspired or expired during a normal respiration. It is approx. 500 mL, i.e., a healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.
b. Residual volume: Volume of air remaining in the lungs even after a forcible expiration. This averages 1100 mL to 1200 mL. Residual air mainly occurs in alveoli.
c. Asthma: Asthma is a difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles. In asthma, due to flattening of
tracheal vessels, alveoli are deprived of oxygen. Asthma is characterised by spasm in bronchial muscle.

Q2. A fluid-filled double membranous layer surrounds the lungs. Name it and mention its important function.
Ans: Pleural fluid is found in between the two membranes of lung and it reduces the friction on the lung surface.

Q3. Name the primary site of exchange of gases in our body?
Ans: Alveoli

Q4. Cigarette smoking causes emphysema. Give reason.
Ans: Cigarette smoking causes damage of the alveolar walls leading to decreased respiratory surfaces for exchange of gases.

Q5. What is the amount of 0_2 supplied to tissues through every 100 mL of oxygenated blood under normal physiological conditions?
Ans: 5 mL of oxygen/100 mL of oxygenated blood.

Q6. A major percentage (97%) of 0_2 is transported by RBCs in the blood. How does the remaining percentage (3%) of 0_2 transported?
Ans: Through Plasma

Q7. Arrange the following terms based on their volumes in an ascending order

a. Tidal Volume (TV)

b. Residual Volume (RV)

c. Inspiratory Reserve Volume (IRV)

d. Expiratory Capacity (EC)

Ans: a. Tidal Volume (TV): 500 mL

b. Residual Volume (RV): 1100 mL-200 mL

c. Inspiratory Reserve Volume (IRV): 2500 mL-3000 mL

d. Expiratory Capacity (EC): 1500 mL-1600 mL

Q8. Complete the missing terms

a. Inspiratory Capacity (IC) = _____+ IRV

b. _____ = TV + ERV

c. Functional Residual Capacity (FRC) = ERV + _____

Ans. a. Inspiratory Capacity (IC) = TV + IRV

b. EC = TV + ERV

c. Functional Residual Capacity (FRC) = ERV + RV

Q9. Name the organs of respiration in the following organisms:

a. Flatworm

b.Birds

c. Frog

d. Cockroach

Ans: a. Flatworm—Entire body surface

b. Birds—Lung

c. Frog—Lung and moist skin

d. Cockroach—Tracheal tubes

Short Answer Type Questions

Q1. State the different modes of $C0_2$ transport in blood.

Ans: Nearly 20-25% of $C0_2$ by RBCs

Nearly 70% of $C0_2$ as bicarbonates Nearly 7% of $C0_2$ as dissolved state in plasma

Q2. Compared to 0_2, the diffusion rate of $C0_2$ through the diffusion membrane per unit difference in partial pressure is much higher. Explain.

Ans: Solubility is an important factor deciding diffusion rate. As the solubility of $C0_2$ is 20-25 times higher than 0_2, diffusion of $C0_2$ through the diffusion membrane per unit difference in partial pressure is much higher.

Q3. For completion of respiration process, write the given steps in sequential manner**.** .

1. **Diffusion of gases (0_2 and $C0_2$) across alveolar membrane.**
2. **Transport of gases by blood.**
3. **Utilisation of 0_2 by the cells for catabolic reactions and resultant release of $C0_2$.**
4. **Pulmonary ventilation by which atmospheric air is drawn in and $C0_2$ rich alveolar air is released out.**
5. **Diffusion of 0_2 and $C0_2$ between blood and tissues.**

Ans: Respiration involves the following steps:

1. Breathing or pulmonary ventilation by which atmospheric air is drawn in and $C0_2$ rich alveolar air is released out.
2. Diffusion of gases (0_2 and $C0_2$) across alveolar membrane.
3. Transport of gases by the blood.
4. Diffusion of 0_2 and $C0_2$ between blood and tissues.
5. Utilisation of 0_2 by the cells for catabolic reactions and resultant release of $C0_2$.

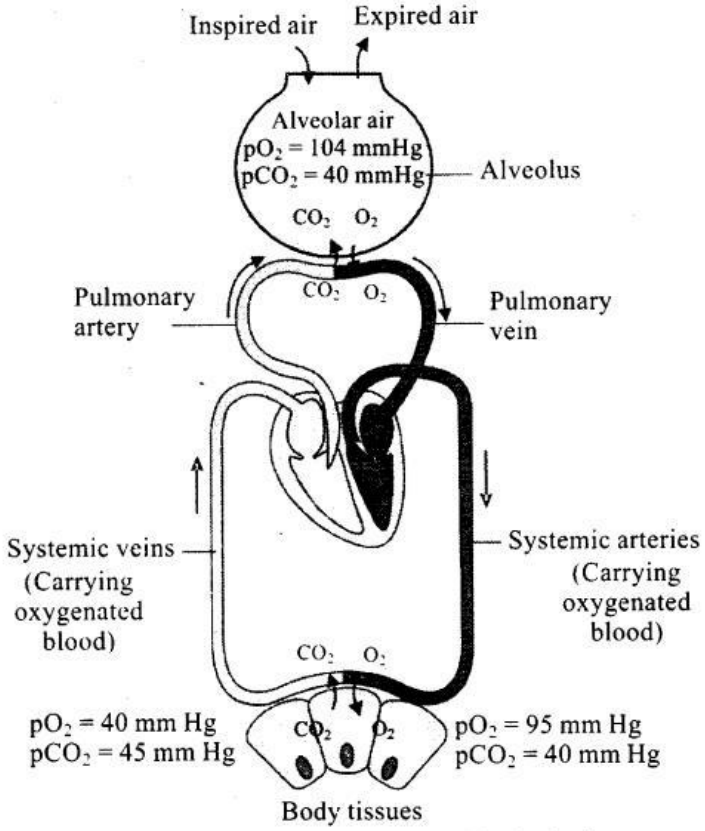
Long Answer Type Questions

Q1. Explain the transport of 0_2 and $C0_2$ between alveoli and tissue with a diagram.
Ans:

- **Transport of gases:** Blood is the medium of transport for 0_2 and $C0_2$. About 97% of 0_2 is transported by RBCs in the blood. The remaining 3% of 0_2 is carried in a dissolved state through the plasma. Nearly 20-25% of $C0_2$ is transported by RBCs whereas 70% of it is carried as bicarbonate. About 7% of $C0_2$ is carried in a dissolved state through plasma.
- **Transport of oxygen:** Haemoglobin is a red coloured iron containing pigment present in the RBCs. 0_2 can bind with haemoglobin in a reversible manner to form oxyhaemoglobin. Each haemoglobin molecule can carry a maximum of four molecules of 0_2. Binding of oxygen with haemoglobin is primarily related to partial pressure of 0_2. Partial pressure of $C0_2$, hydrogen ion concentration and temperature are the other factors which can interfere with this binding. A sigmoid curve is obtained when percentage saturation of haemoglobin with 0_2 is plotted against the $p0_2$. This curve is called the Oxygen dissociation curve and is highly useful in studying the effect of factors like $pC0_2$, H^+ concentration, etc., on binding of 0_2 with haemoglobin. In the alveoli, where there is high $p0_2$, low $pC0_2$, lesser H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low $p0_2$, high $pC0_2$, high H^+ concentration and higher temperature exist, the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin. This clearly indicates that 0_2 gets bound to haemoglobin in the lung surface and gets dissociated at the tissues. Every 100 mL of oxygenated blood can deliver around 5 mL of 0_2 to the tissues under normal physiological conditions.
- **Transport of carbon dioxide:** $C0_2$ is carried by haemoglobin as carbamino-haemoglobin (about 20-25%). This binding is related to the partial pressure of $C0_2$. $p0_2$ is a major factor which could affect this binding. When $pC0_2$ is high and $p0_2$ is low as in the tissues, more binding of carbon dioxide occurs whereas, when the $pC0_2$ is low and $p0_2$ is high as in the alveoli, dissociation of $C0_2$ from carbamino-haemoglobin takes place, i.e., $C0_2$ 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

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

At the tissue site where partial pressure of $C0_2$ is high due to catabolism, $C0_2$ diffuses into blood (RBCs and plasma) and forms $HC0_2$ and H^+. At the alveolar site where $pC0_2$ is low, the reaction proceeds in the oppositedirection leading to the formation of $C0_2$ and H_20. Thus, $C0_2$ trapped as bicarbonate at the tissue level and transported to the alveoli is released out as $C0_2$. Every 100 mL of deoxygenated blood delivers approximately 4 mL of $C0_2$ to the alveoli.



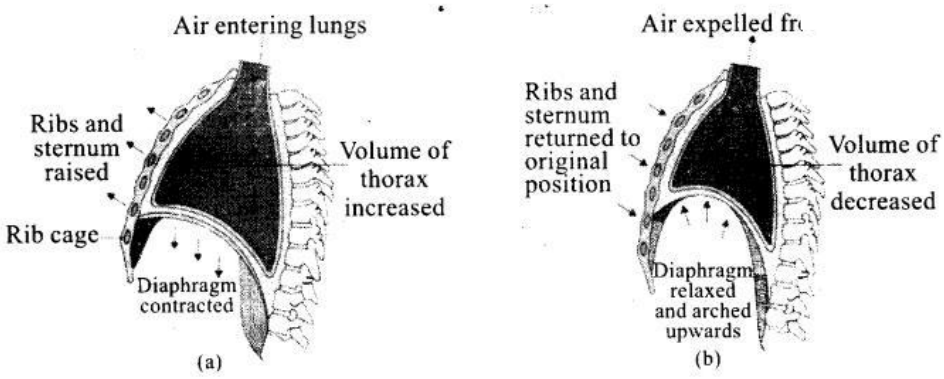
Exchange of gases at the alveolus and the body tissues with blood and transport of oxygen and carbon dioxide

Q2. Explain the mechanism of breathing with neat labelled sketches.

Ans: Breathing involves two stages:

a. Inspiration: Inspiration is initiated by the contraction of diaphragm, which increases the volume of thoracic chamber in the anteroposterior axis. The contraction of external inter-costal muscles lifts up the ribs and the sternum causing an increase in the volume of thoracic chamber in the dorso-ventral axis also. Such an increase in thoracic volume leads to a similar increase in pulmonary volume resulting in decreased intra- pulmonary pressure to less than atmospheric pressure. This causes the movement of external air into the lungs, i.e., inspiration.

b. Expiration: The inter-costal muscles return the diaphragm and sternum to their normal positions with relaxation of the diaphragm. This reduces the thoracic volume and thereby the pulmonary volume. As a result an increase in intra-pulmonary pressure to slightly above the atmospheric pressure causes the expulsion of air from the lungs i.e., expiration.



Q3. Explain the role of neural **system in** regulation **of respiration.**

Ans: Human beings have a significant ability to maintain and moderate the respiratory rhythm to suit the demands of the body tissues. This is done by the neural system. A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily

responsible for this regulation. Another centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm centre. Neural signal from this centre “can reduce the duration of inspiration and thereby alter the respiratory rate. A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to C02 and hydrogen ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated. Receptors associated with aortic arch and carotid artery also can recognise changes in C02 and H+ concentration and send necessary’ signals to the rhythm centre for remedial actions. The role of oxygen in the regulation of respiratory rhythm is quite insignificant.