



# NEET Biology

## Short Notes

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## **BREATHING AND EXCHANGE OF GASES**

In this article, we are providing short notes on Breathing and exchange of gases which is an important chapter for NEET 2019. This is an important section to pay attention from the unit Human physiology as every year **2-3 questions** are asked from this chapter. Let's begin with the brief introduction of Respiration.

### **INTRODUCTION**

The process of breathing can be defined as the inhalation of the oxygen from the atmospheric air into the respiratory organs and the exhalation of the carbon dioxide from the respiratory organs into the atmospheric air.

### **INSPIRATION**

It requires an increase in the volume of the lungs so that the pressure decreases and the air can be drawn in. It occurs with the help of the following structures:

1. Diaphragm: It flattens and pushes towards the abdomen due to the contraction of the muscles. This rises the volume of the thoracic cavity.
2. External intercostal muscles: These are present between the rib bones that surround the lungs. Their contraction results in pulling upward the ribs and the sternum. This outward movement of the bones allows the lungs to expand and increase in volume. These muscles are responsible for the quiet inhalation.

Increase in the volume of the lungs, results in decrease in the internal pressure which create a pressure gradient between the internal respiratory organs and the atmospheric air. Thus, the air is inhaled to the low pressure in the lungs from the high atmospheric pressure.

The air follows the following path during inhalation:

Nostrils - Nasal cavity - Internal nares - pharynx - larynx - trachea - bronchi - bronchioles - alveolar ducts - alveoli

### **EXPIRATION**

It requires a decrease in the volume of the lungs so that the pressure in the lungs increases and the air can be exhaled. It occurs with the help of the following structures:

1. Diaphragm: It relaxes and is pulled up towards the thoracic cavity. It acquires a dome shape and decreases the volume of the thoracic cavity.
2. Internal intercostal muscles: These muscles contract and push the ribs and the sternum inwards. This results in the decreasing volume of the lungs. These muscles are responsible for the exhalation.
3. Abdominal muscles: The internal oblique and external muscles contract and make the visceral organs to push against the diaphragm which results in decreased volume of the thoracic cavity.

The air follows the following path during the exhalation:

Alveoli - Alveolar ducts - bronchioles - bronchi - trachea - larynx - pharynx - internal nares - nasal cavity - nostrils

### **TRANSPORT OF OXYGEN**

After the inhalation, the oxygen has to be transported to the tissues from the alveoli. The transportation occurs in the following ways:

1. As oxyhaemoglobin  
The haemoglobin is the respiratory pigment present in the red blood cells. It shows cooperative binding with the oxygen. In the alveoli, 100 mmHg is the partial pressure of oxygen, in the blood, it is 45 mmHg. Because of pressure gradient, the oxygen moves into the plasma of the blood and is taken up by the haemoglobin.



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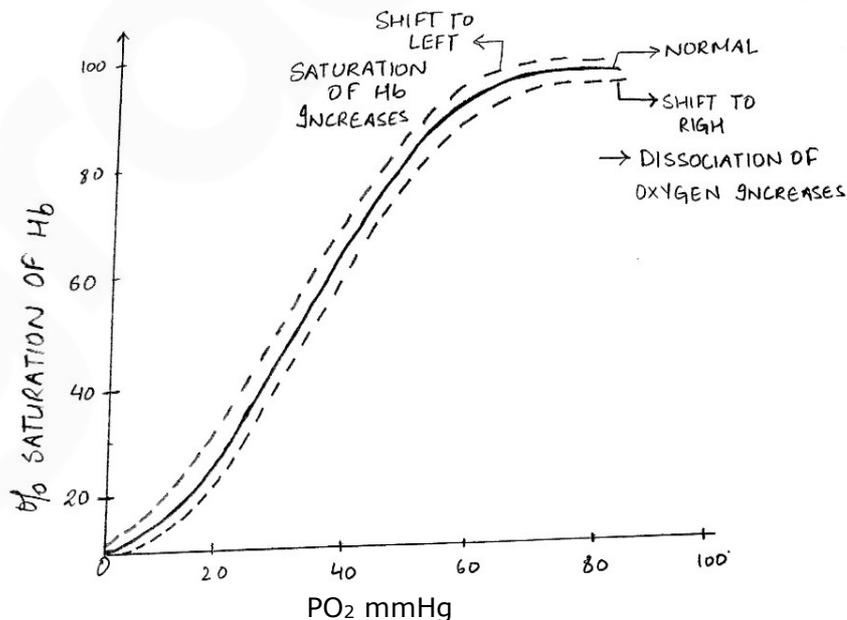
Each haemoglobin is made up of four sub-units and each unit binds with one oxygen molecule. So, four oxygen molecules are required for combining with haemoglobin to form the oxyhaemoglobin. About 97% of oxygen transportation occurs by means of oxyhaemoglobin. There is an average of 15 grams of haemoglobin in 100 ml of blood. 1 gram of haemoglobin can hold 1.34 ml of oxygen. Therefore, 100 ml of blood carried 20 ml of oxygen under the normal conditions

- As dissolved gas  
About 3% of the oxygen is transported as dissolved gas in the plasma.

### OXYGEN DISSOCIATION CURVE

When the oxygen combines with the haemoglobin, a sigmoid curve is obtained, which is termed as the oxygen dissociation curve (Fig.1). The amount of haemoglobin in combination with oxygen is called the saturated haemoglobin. When the curve shifts to the left, the saturation increases while the saturation decreases when the curve shifts to the right. In the tissues, the following conditions make the curve shift to the right and oxygen is dissociated from the haemoglobin to be available to the tissues:

- pH  
The increased amount of  $H^+$  ions due to the increased carbon dioxide concentration in the tissues. The increased pH accelerates the dissociation of the oxygen from the haemoglobin and the curve shifts to the right. This is termed as the Bohr's Effect.
- Decrease in partial pressure of the  $O_2$   
The tissues have a scarcity of the oxygen due to the cellular respiration which decreases the  $pO_2$ . This is responsible for the dissociation of the oxyhaemoglobin.
- Temperature  
The cellular respiration releases heat which is given off in the form of thermal heat from the tissues. This increase the temperature which makes the curve to shift to the right and the oxygen dissociates.
- 2,3-Bisphosphoglycerate (2,3-BPG)  
It is a product of the cellular respiration. An increased concentration of 2,3-BPG binds to the haemoglobin and does not allow the oxygen to remain associated with it.



**Fig-1: Oxygen Dissociation Curve**



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### FOETAL HAEMOGLOBIN

It does not contain the beta subunits as seen in the adult haemoglobin. Instead, the gamma subunits are present that increase the affinity to the oxygen more than the adult haemoglobin.

### MYOGLOBIN

It is a storage pigment found in the red muscles fibres. It has a single subunit that directly binds with one oxygen molecule. the oxygen-myoglobin curve is hyperbolic (Fig. 2). Due to its high affinity with the oxygen, it stores the excess oxygen in the blood and releases it during the strenuous exercise when the  $pO_2$  is as low as 20 mmHg.

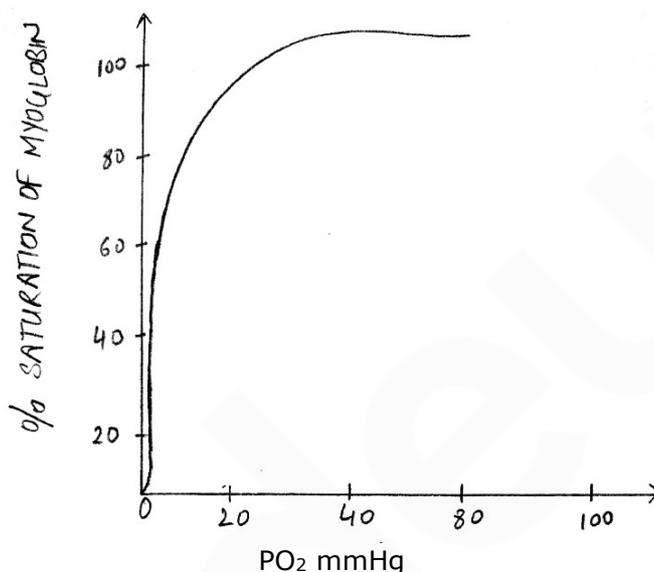


Fig-2: Oxygen Myoglobin Curve

### CARBON MONOXIDE POISONING

The CO has 250 times more binding affinity with the haemoglobin than oxygen. When the CO is inhaled, it combines with the haemoglobin to form the carboxyhaemoglobin. The carboxyhaemoglobin also binds to the oxygen but does not act as the transport pigment. It does not release the  $O_2$  at the tissues level. Thus, despite the presence of the  $O_2$ , the tissues do not get the oxygen and they suffocate due to hypoxia. This is called the CO poisoning. In extreme conditions, it leads seizures, coma and death.

### TRANSPORT OF CARBON DIOXIDE

The  $CO_2$  produced due to the cellular respiration in the tissues is transported to the alveoli for exhalation by the following methods:

1. In the dissolved form  
 $CO_2$  has more solubility than the  $O_2$ , so almost 7% of  $CO_2$  is transported as dissolved gas in the plasma.
2. As bicarbonates  
 The  $CO_2$  enters the red blood cells and is combined with water in the presence of an enzyme called the carbonic anhydrase to form the carbonic acid. The carbonic acid quickly dissociates into the bicarbonate and hydrogen ions. The bicarbonate ions are transported out of the red blood cells through an antiport with the chloride ions. Thus, the chloride ions enter the RBCs while bicarbonate ions enter the plasma. This is called the chloride shift or the Hamburger's phenomenon. Almost 70% of the  $CO_2$  is transported in the form of the bicarbonate ions.



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3. As carbaminohaemoglobin

Around 23% of the  $\text{CO}_2$  combines with the amine radical of the haemoglobin to form the carbaminohaemoglobin. 100 ml of blood can deliver 4 ml of  $\text{CO}_2$ . This is called the Haldane effect, according to which, the unloading of the  $\text{O}_2$  due to increase in pH favours the uptake of  $\text{CO}_2$ .

**FACTORS AFFECTING THE BINDING OF CARBON DIOXIDE WITH HAEMOGLOBIN**

- ❖ The  $\text{CO}_2$  combines with the amine radical of the haemoglobin as compared to the haem group which is occupied by the  $\text{O}_2$ . So, the affinity of Hb is lesser to  $\text{CO}_2$  than the  $\text{O}_2$ .
- ❖ The partial pressure of the oxygen in the alveoli causes the dissociation of the Hb from the  $\text{CO}_2$ .

**SEVERE ACUTE RESPIRATORY SYNDROME (SARS)**

The causative agent is Human Coronavirus (HCV) which spreads through contact, secretions and cockroaches. Cold and dry cough, headache, appetite loss, fever, hypoxia etc. are some of the symptoms of the disease. The diagnosis occurs with ELISA. There is no medicine directly effective against the virus. Preventive measures are advised to be followed.

**RESPIRATORY DISORDERS**

1. Asthma: it is the inflammation of the respiratory tract caused due to infection or allergies.
2. Emphysema: It is the reduction of the alveolar area that affects the gaseous exchange.
3. Fibrosis: It is an occupational respiratory disorder which causes proliferation of the fibrosis connective tissue. Silicosis, Black lung disease and asbestoses are the types of fibrosis.
4. Pleurisy: It is the inflammation of the pleural membrane.
5. High-pressure nervous syndrome: It occurs in divers due to inhalation of helium-oxygen mixture.
6. Atelectasis: It refers to the closure of the lungs either completely or partially. It is generally caused due to anaesthesia.
7. Altitude sickness: It refers to the inability of the haemoglobin to combine with the oxygen due to decreased atmospheric oxygen at the altitude like mountains. It results in hypoxia.

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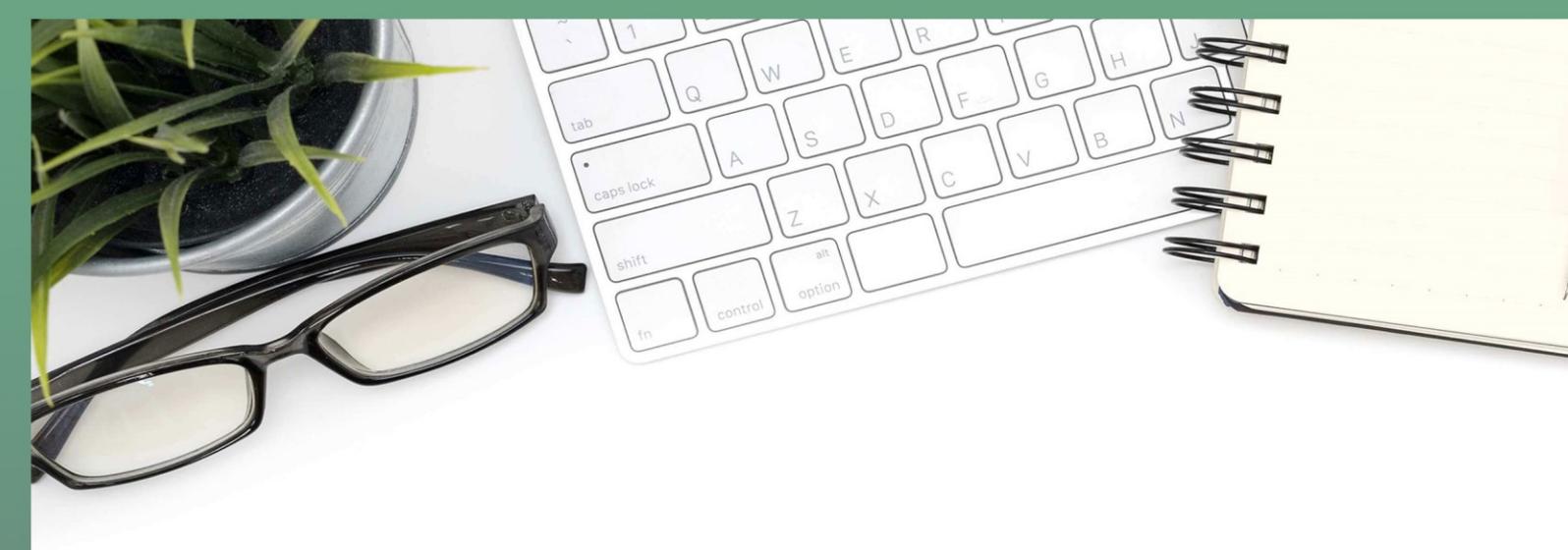
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