OXYGEN HEMOGLOBIN DISSOCIATION CURVE

Oxygen hemoglobin dissociation curve demonstration a progressive increase in the percentage of hemoglobin bound with oxygen as the blood PO_2increases, which is called the percent saturation of hemoglobin.

1. The percent saturation of hemoglobin varies with partial pressure of oxygen. If partial pressure of oxygen is plotted in X-axis against percent saturation of hemoglobin in Y-axis, the curve obtained is called Oxygen – Hemoglobin dissociation curve which is sigmoid in shape.
2. The curve can be divided into two parts:
   a. A steep portion at lower PO_2(<60 mm Hg)
   b. A plateau-like flat portion at PO_2higher than 60 mm Hg.
3. At a $PO_2$of 60 mm Hg, hemoglobin is almost 90% saturated and from this point towards the right, the curve is almost horizontal meaning that the percent saturation of hemoglobin increases very little with farther increase in PO_2.
4. As the a PO_2falls below 60 mm Hg, the curve becomes steep and the percent saturation of Hb drops sharply.

This means that in this stage, slightest drop in PO_2leads to remarkable desaturation and liberation of oxygen.

Indeed, unloading of oxygen from blood to tissues takes place at this part of the curve and delivery of oxygen to tissues is facilitated. This part of the curve also helps in loading of oxygen to hemoglobin in the lungs.

5. When the blood passes through the tissue capillaries, the blood still looses several milliliters of oxygen to the tissues which automatically reduces the PO_2capillary blood to a value only a few millimeters greater than the normal 40 mm Hg.

FACTORS SHIFTING THE OXYGEN HEMOGLOBIN DISSOCIATION CURVE

Several factors shift the oxygen hemoglobindissociation curve to the right: -

1. Increased PCO_2
2. Decreased Ph
3. Increased 2-3 DPG
4. Increased temperature

IMPORTANCE OF SHIFTING THE OXYGEN-HEMOGLOBIN DISSOCIATION CURVE-

1. A decrease in pH or increase inCO_2 tension causes a rightward shift ofoxygen hemoglobin dissociation curve, which helps in increased release of oxygen to tissues. Conversely a rise in pH shifts the curve to the left.
2. IncreasedCO_2concentration lowers pH and thereby causes a rightward shift of oxygen- hemoglobin dissociation curve.
3. When pH is diminished, i.e., in acidosis, H^+ions bind to the histidine residues of Hb, bringing about a conformational change which decrease the affinity of the Hb towards oxygen.
4. 2-3 diphosphoglycerate (DPG), produced by glycolysis, is a metabolically important phosphate compound present in the blood but in different concentrations under different metabolic conditions. 2-3 diphosphoglycerate binds with β-chains of hemoglobin and this binding decreases the affinity of β-chain chains towards oxygen.
5. A rise in temperature shifts the curve to the right. Conversely a fall in temperature shifts the curve to the left.

When the curve is shifted to the right, a higher $PO_2$is required for hemoglobin to bind a given amount of oxygen. Conversely when the curve is shifted to the left, a lower $PO_2$is required to bind a given amount of oxygen. A convenient index of such shifts is the P_{50}, the PO_2at which hemoglobin is half saturated with oxygen. The higher theP_{50}, the lower is the affinity of hemoglobin for oxygen.

Note- It has been found that during increased physical and muscular activity a localized increase in temperature, results in considerable liberation of oxygen to the tissues.

BOHR EFFECT

The decrease in oxygen affinity of hemoglobin when the pH of blood falls is called the **Bohr effect** and is closely related to the fact that deoxygenated hemoglobin (deoxyhemoglobin) binds H^+ more actively than does oxyhemoglobin. The pH of blood falls as its CO_2 content increases, so that when the PCO_2 rises, the curve shifts to the right and the P_{50}rises. Most of the unsaturation of hemoglobin that occurs in the tissues is secondary to the decline in the PO_2, but an extra 1%-2% unsaturation is due to the rise in PCO_2 and consequent shift of the dissociation curve to the right.

SIGNIFICANCE OF BOHR EFFECT-

1. As the blood passes through the lungs,CO_2diffuses from the blood into the alveoli. This reduces the blood PCO_2 and decreases the hydrogen ion concentration because of the resulting decrease in blood carbonic acid. Both these effects shift theoxygen hemoglobin dissociation curve to the left and upward. Therefore, the quantity of oxygen that binds with the hemoglobin at any given alveolar PO_2 now becomes considerably increased, thus allowing oxygen transport to the tissues.

2. When blood reaches the tissue capillaries exactly the opposite effects occur. CO_2 entering the blood from the tissues shifts the curve rightward, which displays oxygen from the hemoglobin and therefore delivers increased amounts of oxygen to the tissues at a higher PO_2 than would otherwise occur.