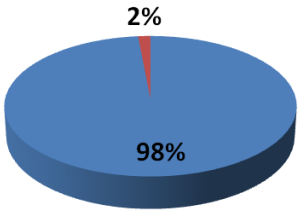
Oxygen transport :

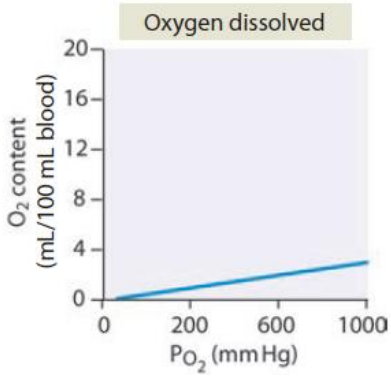


Oxygen is transported in blood in two forms :

1. Dissolved form 2 % in the plasma of the blood
2. Combined with hemoglobin 98%

1) Dissolved O_2 :

- The amount of O_2 dissolved in the blood ↑ with ↑ PO_2 in a linear relationship.
  The volume of dissolved O_2 is very small but has a great functional importance → it determines P_{O2} in the blood which affects the quantity of O_2 that will combine with Hb.



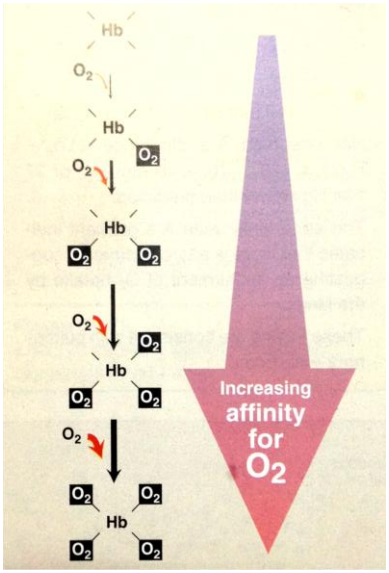
2) **Combined with Hb** :

I. Hb structure:

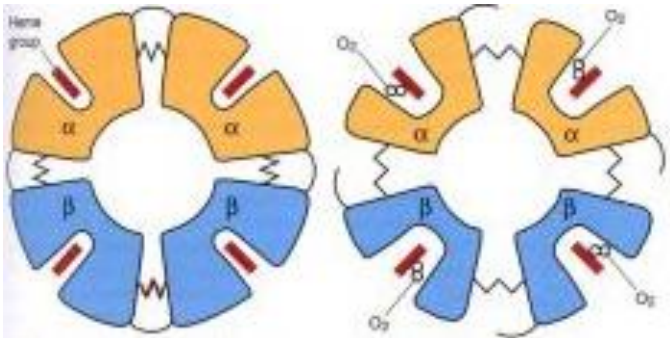
- consists of 4 subunits each one contains Heme attached to globin chain
- globin : in hemoglobin A (normal Hb in adult contains two α and two β globin chain) .
- Heme group contains a reduced form of ferrous iron Fe++ which can bind with O2.

II. Hb O2 binding :

- The binding of O2 is **reversible and it is oxygenation not oxidation** (the iron stays in ferrous state)
- When all 4 heme sites bind to O2 →Hb molecule is fully saturated
- **Deoxy Hb** presents in a **tense (T) configuration in which the globin units are tightly bound and it** has low affinity for O_2 .



- binding of first O_2 molecule →conformational changes in the Hb molecule (the bonds holding the globin units are released) **→relaxed (R) configuration** →↑ its **affinity to O_2** 500 folds by exposing more O_2 binding sites . The affinity to O_2 increases with binding of the subsequent O2 molecules (**positive cooperativity**). In tissue the reaction is reversed →release O2



T -configuration R- configuration

III. O2 carrying capacity of Hb :

- Is the maximal amount of O2 that can be carried by Hb
- Average adult Hb concentration is 15 g /dl
- Each gram of Hb contains 1.34 ml of O2→ maximal carrying capacity of 100% saturated Hb is **20 ml O_2/100ml blood**

IV. Saturation of Hemoglobin with Oxygen (SaO2) :

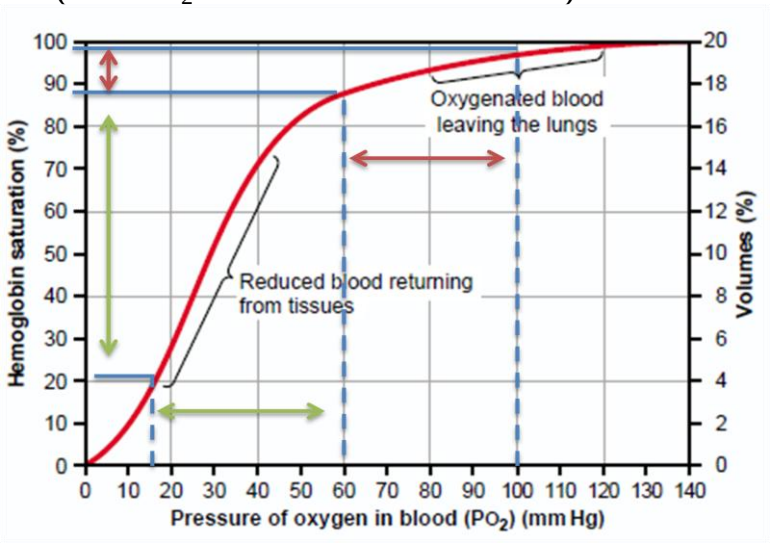
- Is The percentage of all the available Hb binding sites that are saturated with oxygen .
- SaO2 can be monitored by non invasive way using **pulse oximeter**
- **PO_2** level in the blood determines the level of Hb saturation with O2 .
- In systemic arteries where PO2 95mmHg →Hb saturation is 97%

V. O2 –Hb dissociation curve

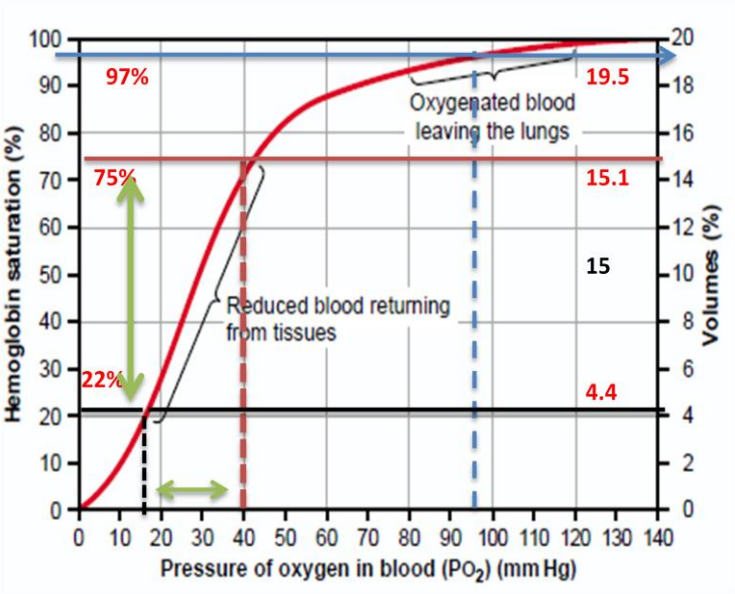
- It is a s-shape curve(sigmoid) represents the relation between the partial pressure of oxygen (x axis) and the Hb -oxygen saturation (y-axis).

- The dissociation curve explains Hb binding to O_2 at high Po_2 in the lung and releasing of O2 to the tissues at low Po_2.

- The two most important parts of the curve are :
  - **Flat upper part** :PO_2 (100-60 mmHg) at the level of the lung where the Hb picks up O_2 molecules , In this part :large changes in PO_2 level →only minimal changes in Hb saturation : How?
    - When the PO2 level ↓to as low as 60 mmHg → Hb saturation only ↓8% to be 89% saturated (ex: in high altitude)
    - If the P_{O2} ↑>100 mmHg → only 3% ↑ in Hb saturation →100 %
  - **Middle steep part** (15-60 mmHg) at the level of tissue where O_2 is delivered :
    Small change in PO2 level → large change in Hb saturation (more O_2 is delivered to the tissue) .



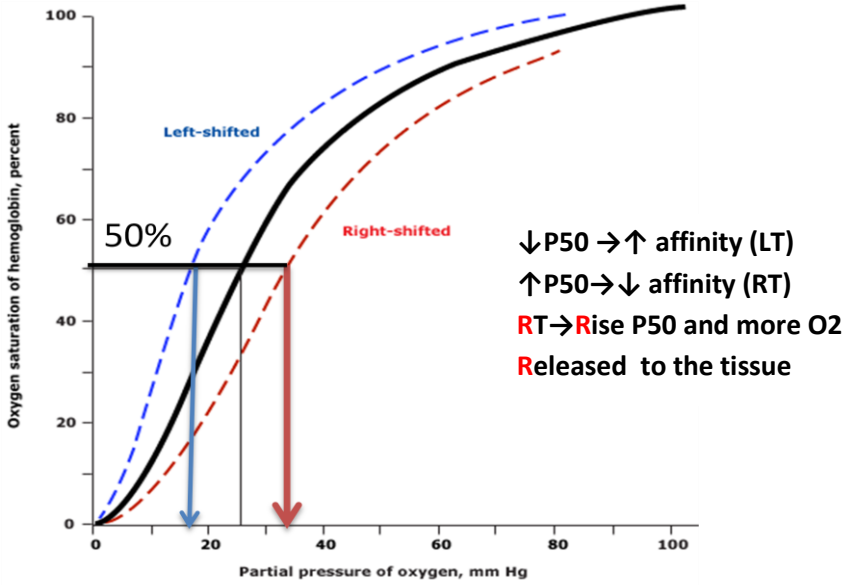
- At resting condition : after blood pass through tissue capillaries where PO_2 is 40 mm Hg→(Hb saturation↓ to 75%)→ Deliver 5 ml O_2 for each 100 ml blood
- During exercise : level of PO2 ↓ to as low as 15 mmHg →↓Hb saturation to be around 20→ giving about 15 ml of oxygen for each 100 ml blood .



Factors affecting O2-Hb dissociation curve :

- O2-Hb disassociation curve is not fixed , it shifts to the right or left from its position (change the affinity of Hb to O2) according to the tissue condition

- P_{50} is an indicator for Hb affinity. it is the PO2 level at which Hb is 50% saturated , at normal condition P50 = 26 mmHg.
  - ↑P50 →more PO_2 is needed to make Hb 50% saturated .it occurs when curve shifts to the right (low affinity)
  - ↓P50 →less PO_2 is needed to make Hb 50 % saturated .it occurs when the curve shifts to the left (high affinity)



26 mmHg