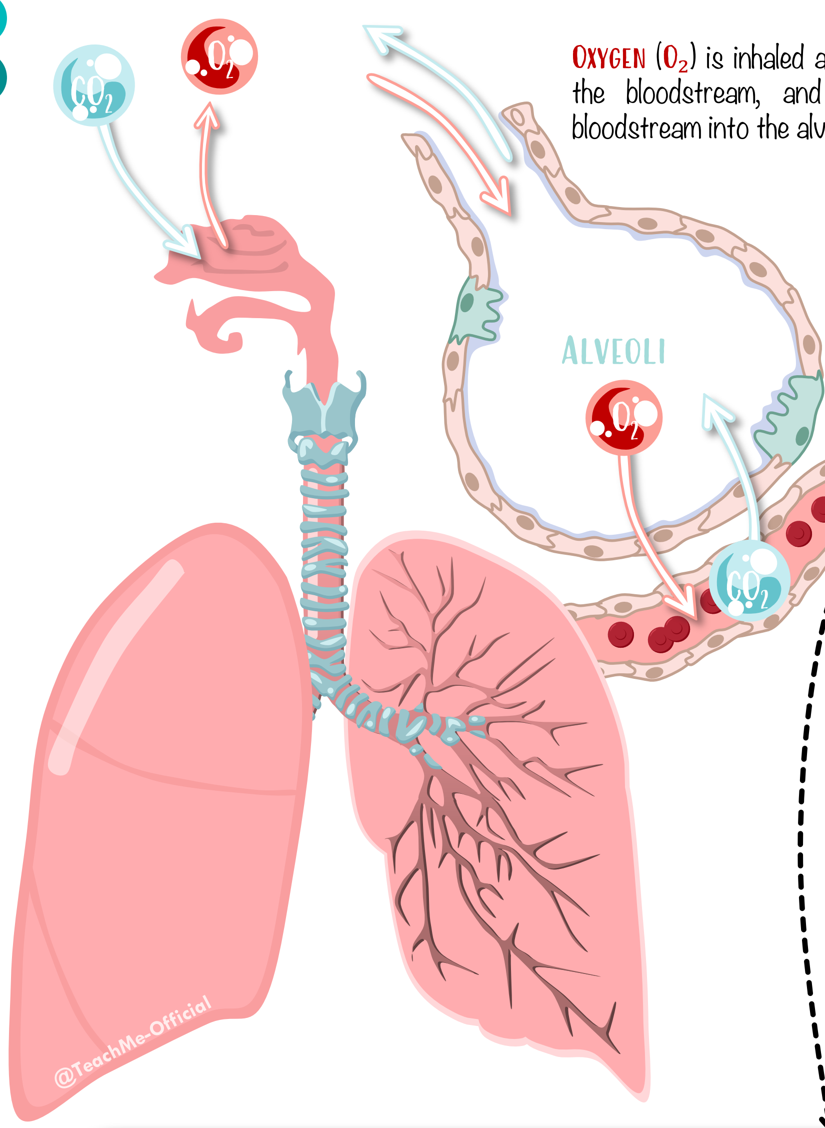
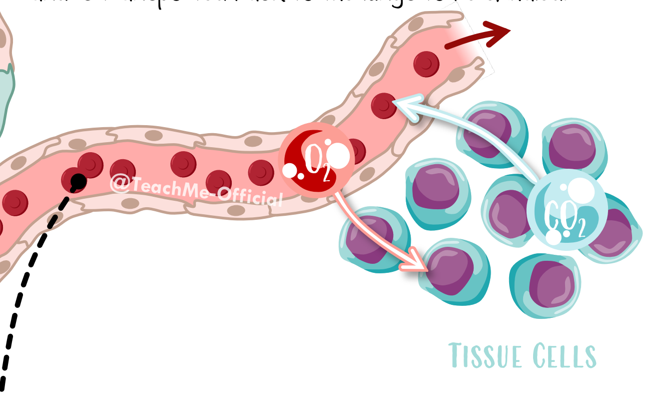
Gas Exchange (HL)



OXYGEN (O_2) is inhaled and reaches the alveoli **where it** moves into the bloodstream, and CARBON DIOXIDE (CO_2) moves from the bloodstream into the alveoli to be exhaled.

ATP

Red blood cells carry O_2 through the bloodstream to the tissue cells where it is used to produce energy (ATP) in cellular respiration. CO_2 is produced as a waste product and is transported back to the lungs to be exhaled.

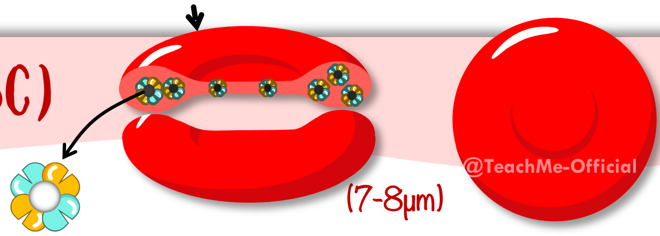


DID YOU KNOW?

When the iron in hemoglobin is bounded to oxygen it turns red – giving blood its characteristic red color.

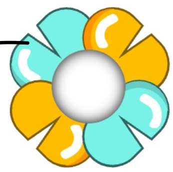
There are 280, 000, 000 hemoglobin in 1 RBC

ERYTHROCYTES (RBC)



HEMOGLOBIN

- Found in Erythrocytes
- Reversibly bind O_2 & CO_2
- **Conjugated Protein**
  - 4 polypeptides (protein)
  - 4 Heme groups (each has an iron)



- Biconcave shape – More efficient gas exchange
- No nucleus - More space for hemoglobin.
- Small & flexible - Pass tiny capillaries

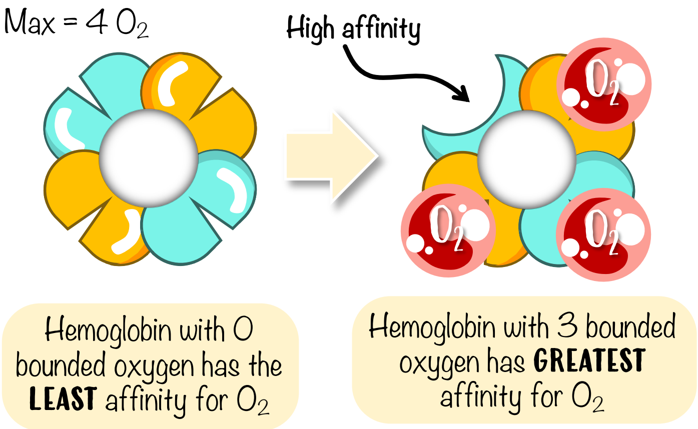
When hemoglobin reversibly binds to an oxygen molecules, it is the iron atom within the heme group that is bonding with oxygen.

Hemoglobin has a total of four iron atoms (one per heme group); hence it can carry four oxygen molecules (saturated).

Gas Exchange

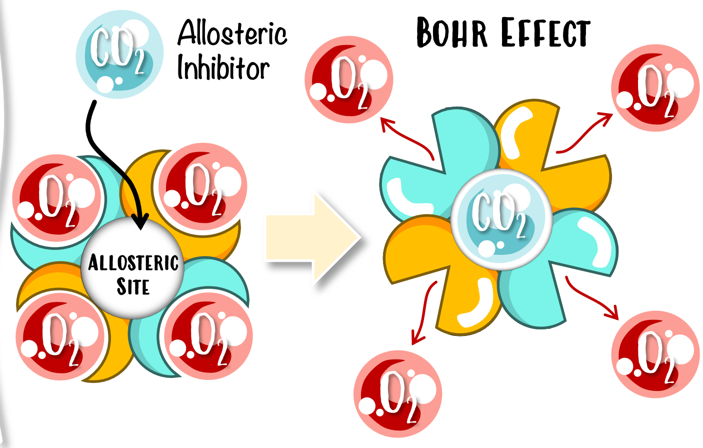
Cooperative binding

The molecular shape of hemoglobin is influenced by its bonding with oxygen molecules. Any oxygen molecule bonded to hemoglobin *increases its attraction* (affinity) for more oxygen.



Allosteric binding

The molecular shape of hemoglobin is influenced by its bonding with carbon dioxide molecules. The resulting shape reduces hemoglobin's affinity for oxygen (increased release of O_2).



Allosteric Inhibitor – An allosteric molecule (here CO_2) that decreases or stops the activity of the enzyme

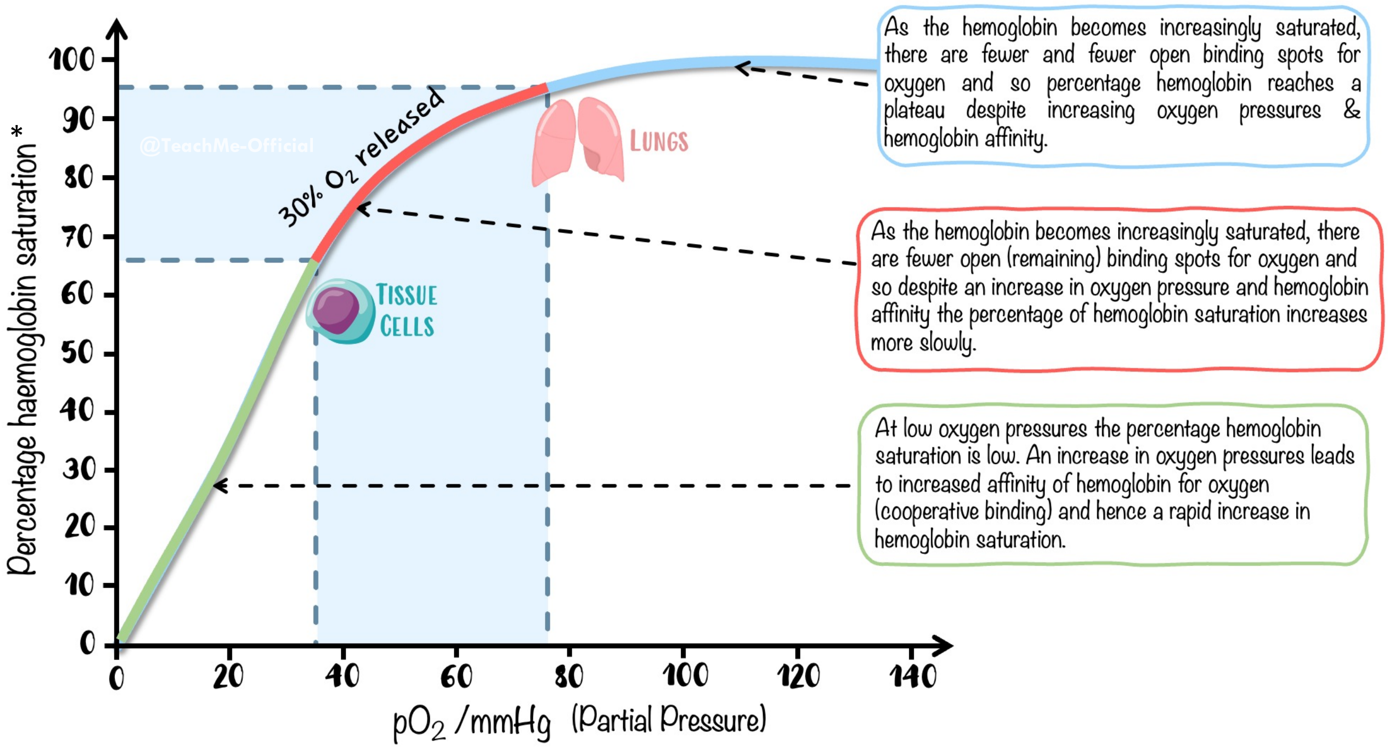
OXYGEN DISSOCIATION CURVE

(for Human adult hemoglobin)

Notice how it is **NOT** linear: it is S-shaped due to cooperative binding of oxygen to hemoglobin.

BIG BRAIN TIP!

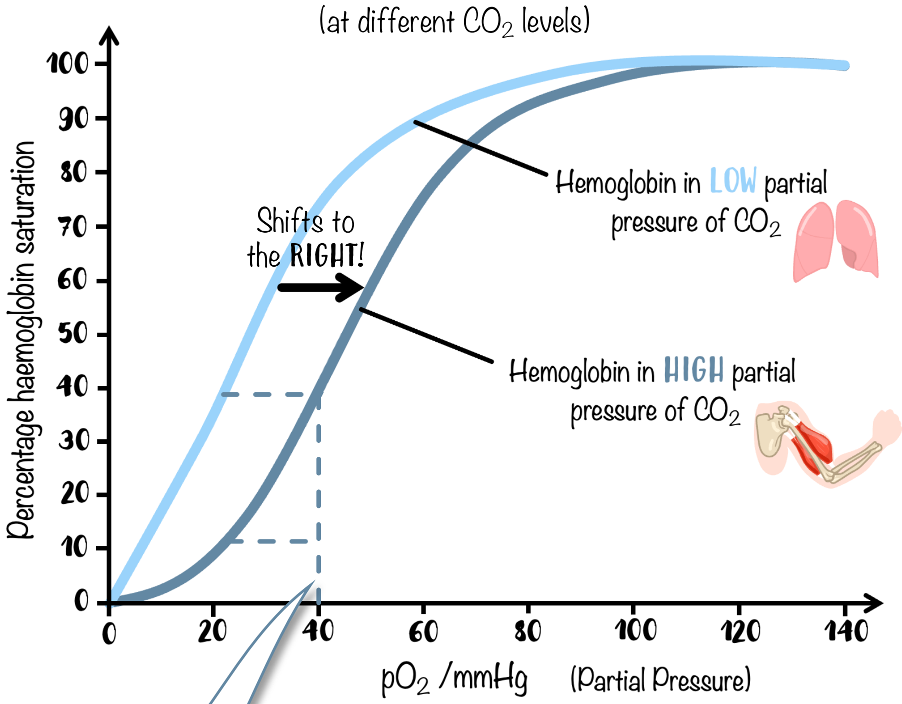
! You do not need to remember the exact mechanism why the curve looks the way it does for the exam, but make sure you can draw the basic shape of the curve.



* *Percentage of hemoglobin that is transporting the maximum of four oxygen molecules.*

Gas Exchange

Oxygen Dissociation Curve
(at different CO_2 levels)



In the presence of increased carbon dioxide, at the same oxygen pressure you will now have a slightly lower hemoglobin saturation. This is because CO_2 causes hemoglobin to have a reduced affinity for O_2.

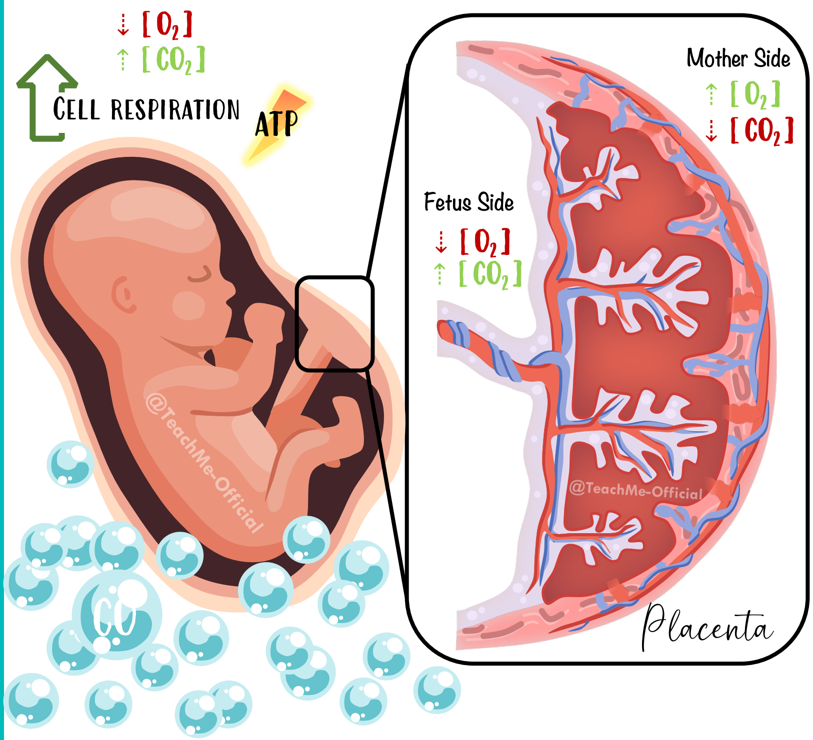
The Bohr Shift

The change in affinity of hemoglobin in the presence of carbon dioxide.

Tissues that are active (cell respiration) such as muscles, use lots of O_2, and make lots of CO_2. They have a high demand for O_2. High CO_2 causes the hemoglobin to have a lower affinity for O_2 and therefor causes its release and diffusion into towards the cells that need it.

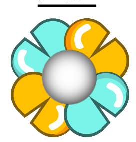
The opposite is true for areas with low CO_2, such as the lungs. The affinity for O_2 is therefor higher in these areas (lung). This makes it easy for hemoglobin to attract oxygen from the lungs into the blood, so that it can be sent somewhere else in the body that needs the oxygen.

Foetal Hemoglobin



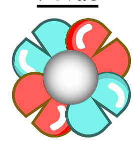
The molecular structure of hemoglobin in a fetus is slightly different compared to adult.

Adult



Lower O_2 Affinity

Fetus

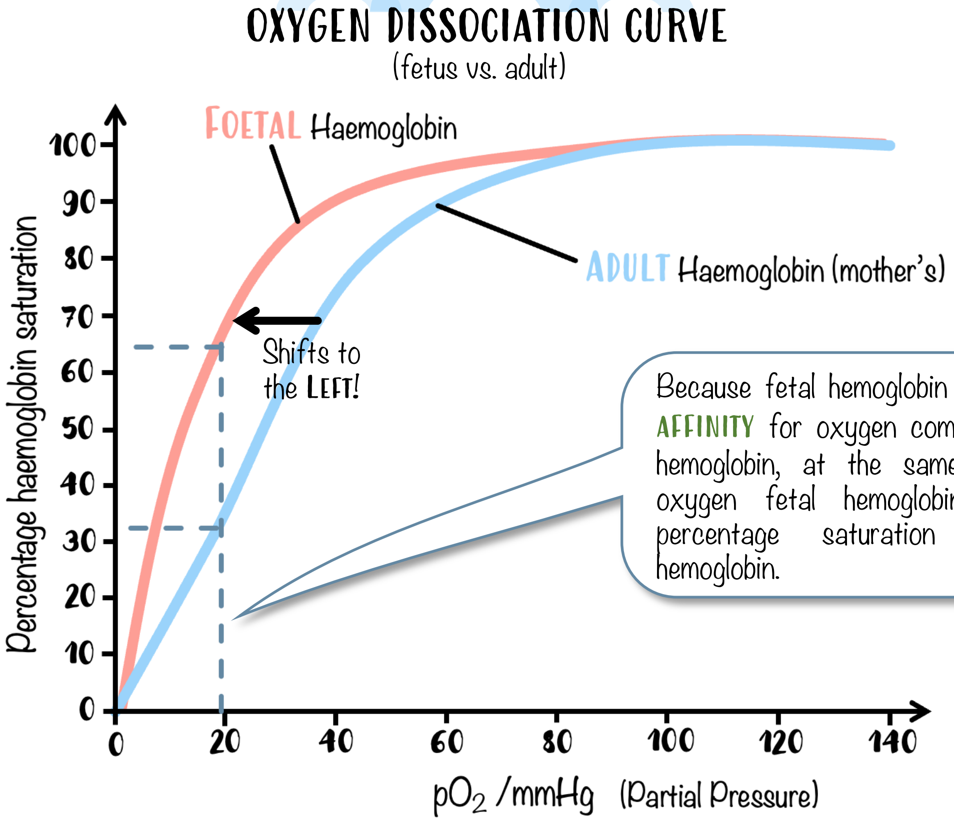


Higher O_2 Affinity

What's the purpose?

- Occurs at the placenta.
- Mother can breathe, the fetus cannot.
- Mother sends O_2 to baby and rids of baby's CO_2.
- Because the baby's hemoglobin has **GREATER AFFINITY**, it can "steal" O_2 from the mother's hemoglobin (that has **LOWER AFFINITY**).
- This is important as the baby has higher oxygen need as it is **ACTIVELY GROWING**.
- Concentration gradient also plays a role.

Gas Exchange



Because fetal hemoglobin has a **HIGHER AFFINITY** for oxygen compared to adult hemoglobin, at the same pressure of oxygen fetal hemoglobin has higher percentage saturation than adult hemoglobin.

notes