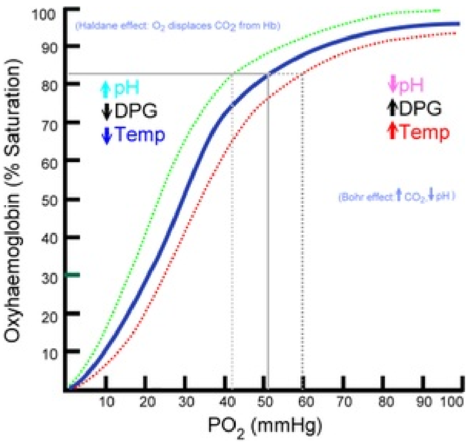
CO2 transport by blood

This article has been translated from WikiSkripta; ready for the **editor's review**.

CO2 is produced during oxidative metabolism and released from the tissues into the blood by a pressure gradient. In the blood it is transported physically dissolved, bounded to proteins, or as a bicarbonate molecule.

CO_2 values

In arterial blood, pCO2 is about **40 mmHg**[1]. After blood passes through the tissues, pCO_2 increases to **46 mmHg**[1]. One liter of blood yields ***1.8 mmol***[1] CO_2.



Oxyhaemoglobin dissociation curve

- 12% is physically dissolved;
- 11% is carbaminohemoglobin;
- 27% is bicarbonate in erythrocytes;
- 50% is plasma bicarbonate.

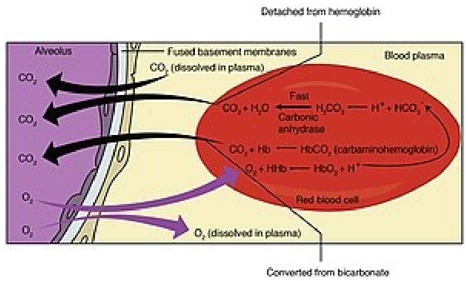
CO2 reversibly binds to the NH2 group of hemoglobin = forms carbaminohemoglobin.

The key reaction for transport is

$$\mathbf{CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+}$$

which is very slow in the plasma. On the erythrocyte membrane it is catalyzed by carbonic anhydrase and is much faster (takes < 1s). The dissociation produces a different gradient of bicarbonate within the erythrocyte and in the plasma. HCO3- in venous blood transfers from erythrocyte to plasma due to the ***Chloride shift***. Hydrogen ions hardly pass through the erythrocyte membrane, increasing the acidity of the internal environment and are bounded to hemoglobin.

Chloride shift (Hamburger phenomen)



Chloride shift

Most of the CO2 produced in the tissues is transported to the lungs in the form of HCO3-. The bicarbonate anion is formed mainly in erythrocytes (to a limited extent also in plasma), where carbonic acid H2CO3 is formed from CO2 and H2O, which dissociates into the bicarbonate anion HCO3- and the hydrogen cation H+. Most free hydrogen cations react with reduced hemoglobin, while bicarbonate anions are transferred from the red blood cell to the plasma in exchange for chloride anions. This exchange is referred to as chloride shift. The entry of chloride anions into erythrocytes is accompanied by a shift of water, resulting in a slight increase in the volume of erythrocytes in the venous blood. Therefore, the haematocrit of venous blood is slightly higher than that of arterial blood.

Haldane effect

Binding of O2 to hemoglobin in the lungs reduces the affinity for CO2. Thus, carbon dioxide is released in the lungs and is exhaled.

In the tissue, H+ binds to hemoglobin. This causes the saturation curve of hemoglobin for O2 to shift to the right and O2 is more easily released. At the same time, the binding of hydrogen cations increases the affinity for CO2.

Links

Related artickles

- Transport of O2 and CO2 in the blood

Sources

1. KITTNAR, Otomar, et al. Lékařská fyziologie. 1. vydání. Praha: Grada, 2011. 790 s. ISBN 978-80-247-3068-4.