

Aspects of Vertebrate Respiration

Countercurrent exchange in fish gills

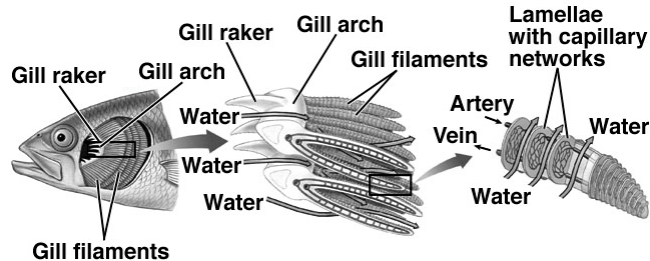
the most efficient respiratory system

Four gill arches on each side of head - each with two rows of gill filaments - divided into thin lamellae that project into flow of water

Movement of water across lamellae occurs in only one direction

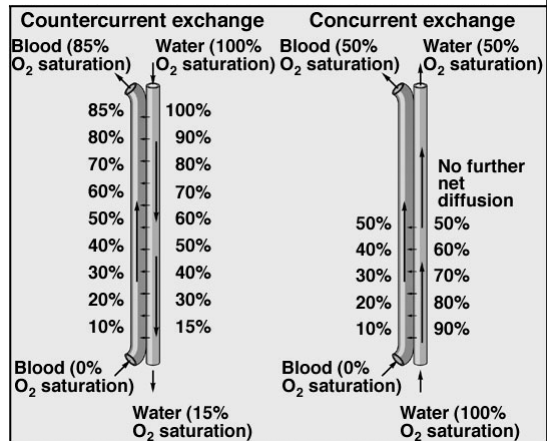
Direction of blood circulation runs opposite that of water flow

Countercurrent flow maximizes difference in oxygen concentration between water and blood



Countercurrent exchange results in blood always being exposed to water with a higher oxygen concentration
a diffusion gradient is maintained across surface of gill
allows blood to become up to 85% saturated with oxygen

A concurrent exchange system would allow no greater than 50% saturation



How Hemoglobin Works

Oxygen concentration of blood depends on oxygen concentration of the air or water from which it comes

Blood plasma can contain only 3 ml O₂/liter

Whole blood contains nearly 200 ml O₂/liter

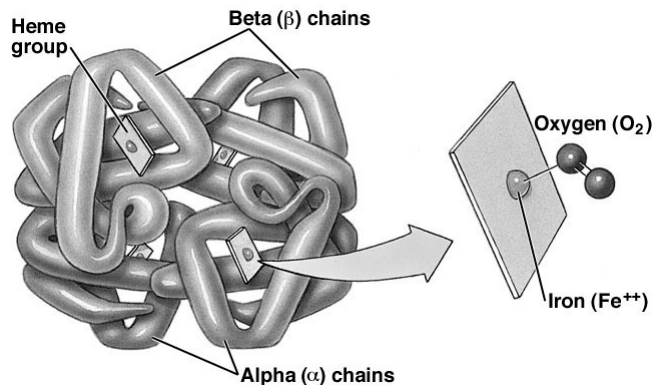
Most oxygen bound to hemoglobin inside red blood cells

Hemoglobin - an O₂ carrier protein - found in most animals

Has 4 polypeptide subunits

Each subunit has an iron containing heme group

O₂ can be carried by each subunit

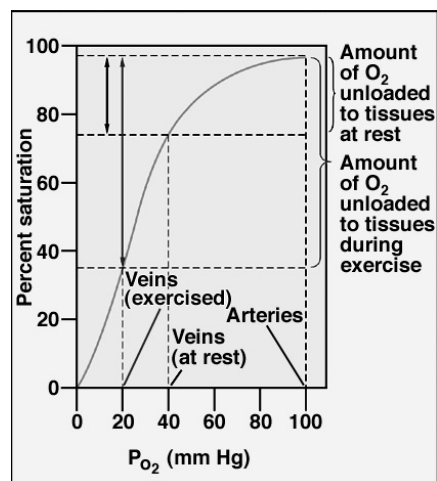


Hemoglobin picks up O₂ in lungs - becomes oxyhemoglobin
bright red color

Hemoglobin releases O₂ at tissues - becomes deoxyhemoglobin
dark red color - looks blue under skin

Hb has asymptotic loading curve

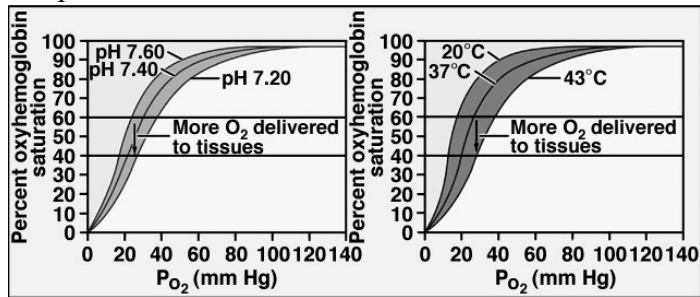
- completely deoxygenated Hb will take up the first and second O₂ molecules easily but picks up the third and fourth less easily
- completely oxygenated Hb dumps the fourth and third O₂ molecule reservedly but dumps the second and first more readily
- allows low amounts of O₂ to be delivered to resting tissue and large amounts to active tissue



Hb is sensitive to pH and temperature

low pH or high temperature results in a change in the loading curve - the curve shifts to the right

allows greater O₂ delivery to tissue that have low pH or high temperature



Low pH in tissues is associated with active metabolism - through production of CO₂ and lactic acid

