B.Sc Second year Zoology (Honours)

Paper-4

Dr. Mirza Imteyaz Baig

Structure of Haemoglobin

The role of haemoglobin is rather similar to a delivery truck driver. This is because haemoglobin loads oxygen, transports oxygen and then finally unloads oxygen.

The process by which haemoglobin loads oxygen is called associating, and this occurs in regions of high oxygen concentrations – the lungs. Here the oxygen and haemoglobin combine forming oxyhaemoglobin.

The process in which haemoglobin unloads oxygen is called disassociating, and occurs in regions of low oxygen concentrations – in tissues. Here oxyhaemoglobin splits back into oxygen and haemoglobin.

Therefore the reversible reaction can be summarised by the equation:

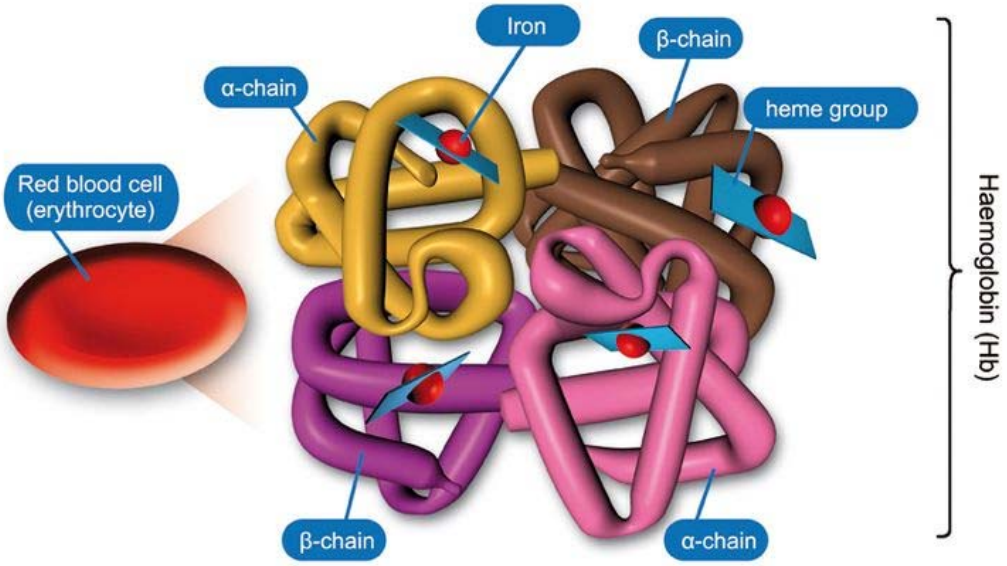
Oxygen + Haemoglobin ⇌ Oxyhaemoglobin

Structure:

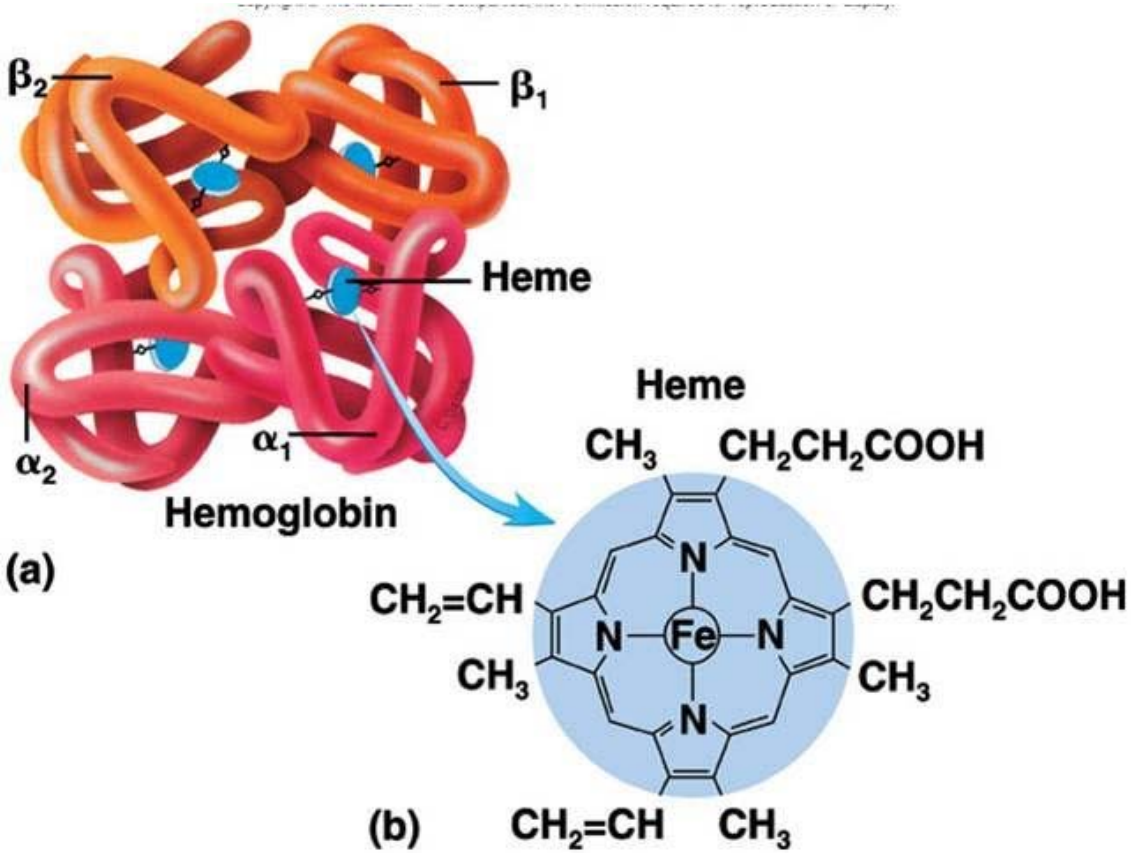
Haemoglobin is a large protein molecule folded around four iron atoms and it has a quaternary structure. A quaternary structure is where two or more polypeptide chains join together due to chemical bonds which could be ionic, covalent or hydrogen bonds.

In the case of haemoglobin there are four polypeptide chains. Each one of these polypeptide chains contains a haem group which is able to bind to one oxygen molecule. Therefore four oxygen molecules can be transported by each haemoglobin molecule. In every red blood cell there are approximately 270 million haemoglobin molecules and so each red blood cell can carry about 1080 million oxygen molecules!

Structure of haemoglobin



Each erythrocyte (RBC) contains ~270 million haemoglobin molecules



The Chemical Properties and Distributions of the Respiratory Pigments

- The four chemical classes of respiratory pigments are all metalloproteins. They bind reversibly with O_2 at specific O_2-binding sites associated with the metal atoms in their molecular structures.
- In hemoglobins, the unit molecule consists of heme bonded with protein (globin). The heme structure—an iron (ferrous) porphyrin—is identical in all hemoglobins. The globin, however, varies widely among species and among different molecular forms of hemoglobin within any single species.
- Hemoglobins are the most common and widespread respiratory pigments, occurring in at least nine phyla. Virtually all vertebrates have blood hemoglobin. The blood-hemoglobin molecules of vertebrates are usually tetramers consisting (in adults) of two α-globin and two β-globin unit molecules; they always occur in red blood cells. Although many invertebrates also have hemoglobins in blood cells, some invertebrates have hemoglobins dissolved in their blood plasma.
- Hemocyanins are the second most common of the respiratory pigments in animals. They contain copper and turn bright blue when oxygenated. There are two types of hemocyanins, which are of separate evolutionary origin: arthropod hemocyanins (occurring in crabs, lobsters, crayfish, horseshoe crabs, spiders, and some other arthropods) and mollusc hemocyanins (occurring in squids, octopuses, many snails, and some other molluscs). Hemocyanins are always dissolved in the blood plasma.
- Chlorocruorins, which are similar to hemoglobins, occur in only four families of marine annelid worms, and are always dissolved in the blood plasma.
- Hemerythrins are non-heme, iron-containing respiratory pigments that have a limited and scattered distribution, occurring in three or four different invertebrate phyla.