

Haemoglobin

PDB 2HHB

Function of haemoglobin

The Protein Databank (PDB) has a good description of the function of haemoglobin, available at <http://pdb101.rcsb.org/motm/41>. Using this information and/or other resources of your choice, answer the following questions:

In which tissue is haemoglobin found? In which cells?

Haemoglobin is found the blood (tissue), in red blood cells/erythrocytes.

What is its function?

It transports molecular dioxygen from the lungs to the rest of the body (via the blood).

What do the 'oxy-' and 'deoxy-' prefixes mean when referring to oxyhaemoglobin and deoxyhaemoglobin, respectively?

Oxyhaemoglobin is the O₂-bound form of haemoglobin whereas deoxyhaemoglobin is simply haemoglobin unbound to O₂.

Structure of deoxyhaemoglobin

Open the EzMol start page (<http://www.sbg.bio.ic.ac.uk/~ezmol/index.html>). To visualise the structure of deoxyhaemoglobin, load PDB 2HHB.

What organism is the protein from?

Human (Homo sapiens).

What is the resolution of the structure? Explain briefly the concept of resolution in protein structure.

The structure has a resolution of 1.74Å, which means that two atoms that are at least 1.74Å away from each other can be distinguished, but two atoms closer than 1.74Å will be seen as one 'blob'.

Describe the quaternary structure of haemoglobin by answering the following questions:

How many chains are there in the protein? What are the names of those chains?

The protein contains 4 chains: 2 α-chains (141 residues) and 2 β-chains (146 residues).

What is the cofactor of haemoglobin? What metal ion does it contain? (You may use other online resources to find this information).

The cofactor is a haem molecule, containing an iron ion.

Colour the different chains of haemoglobin and produce a figure highlighting each chain and the position of each cofactor, as in Figure 1.

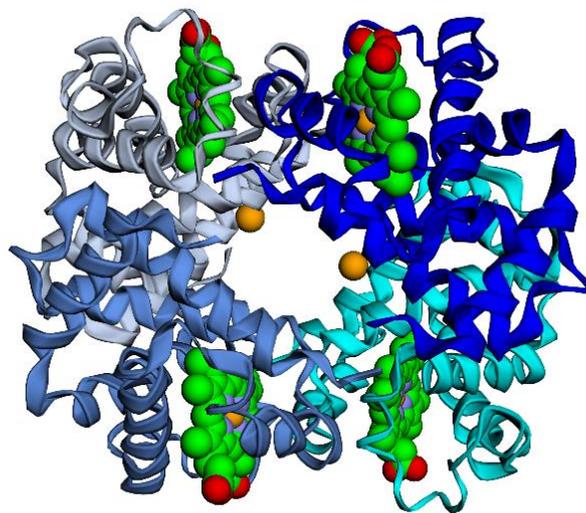


Figure 1 | The four chains of deoxyhaemoglobin, each in a different shade of blue. The haem cofactors are shown as spheres.

Colour the surface of the protein according to hydrophobicity, using a colour scheme that conveys the information clearly, such as in Figure 2.

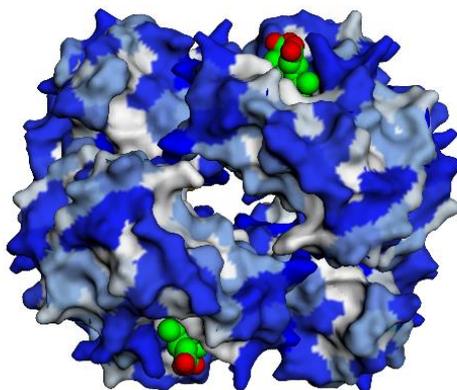


Figure 2 | Deoxyhaemoglobin shown as a surface coloured according to local hydrophobicity. White: high hydrophobicity; light blue: intermediate hydrophobicity; dark blue: low hydrophobicity (hydrophilic patches).

Do you think haemoglobin is found in a hydrophobic or hydrophilic environment?

Haemoglobin is found in the hydrophilic cytosol of erythrocytes (red blood cells), which is consistent with the hydrophilic nature of its surface.

Describe the secondary structure of deoxyhaemoglobin by answering the following questions:

What secondary structure elements are present in the protein?

The protein contains α -helices and coils.

How many α -helices are present in the α - and β -chains? How many coil regions?

α -chains: 6 α -helices and 7 coil regions. β -chains: 5 α -helices and 6 coil regions.

What interactions stabilise secondary structure elements?

Secondary structure elements like α -helices and β -sheets are stabilised by hydrogen bonds.

Generate a figure highlighting the secondary structure elements of an α -chain and a β -chain. To do so, hide the other α and β -chains and use different colours for each type of secondary structure.

You can move on to the more advanced worksheet on oxygen binding to haemoglobin. You are advised to keep a tab open with PDB 2HHB as you will need to compare oxyhaemoglobin with the deoxyhaemoglobin structure you have just studied.