Haemoglobin

Lecture-7

- Haemoglobin (Hb), protein constitutes 1/3 of the red blood cells.
- 65% at erythroblast stage.
- 35% at reticulocyte stage
- Normal concentration of Hb in the blood:
- adult males 13.5 – 16.5 g/dL
- adult females 12.5 – 15 g/dl.
- Approximately 6.25 G (90 mg/kg) of Hb are produced and destroyed in the body each day.
- Two parts - Heme - Globin

Structure

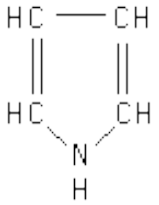
- Globular molecule.
- MW 68,000
- Protein – Globin
- Iron containing pigment – Haem.

Globin

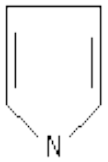
- Protein in Hb.
- 4 polypeptide chains.
- Two α- chains – 141 amino acids
- Two β chains -146 amino acids.
- Normal adult Hb is HbA (α_2 β_2)

Haem

- It is a Fe-porphyrin complex called iron-protoporphyrin IX. The porphyrins are complex compounds with a tetrapyrrole structure.

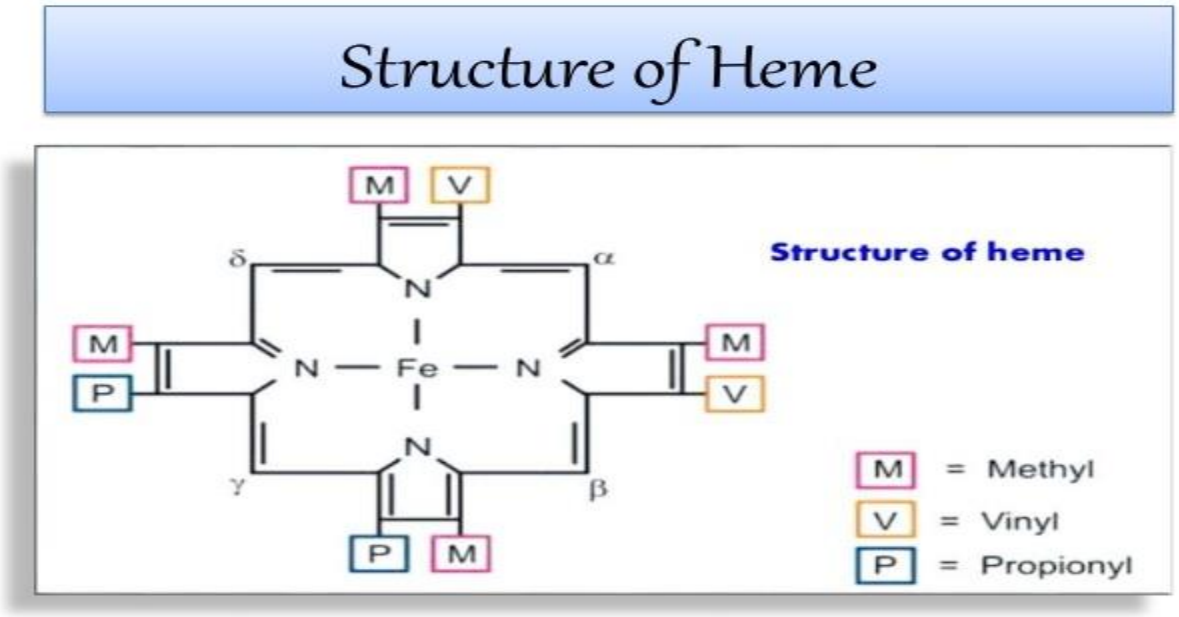


Pyrrole



Abbreviated version of pyrrole

- Four such pyrroles called I to IV, are combined through –CH= bridges, called as methyne bridges to form a porphyrin nucleus.



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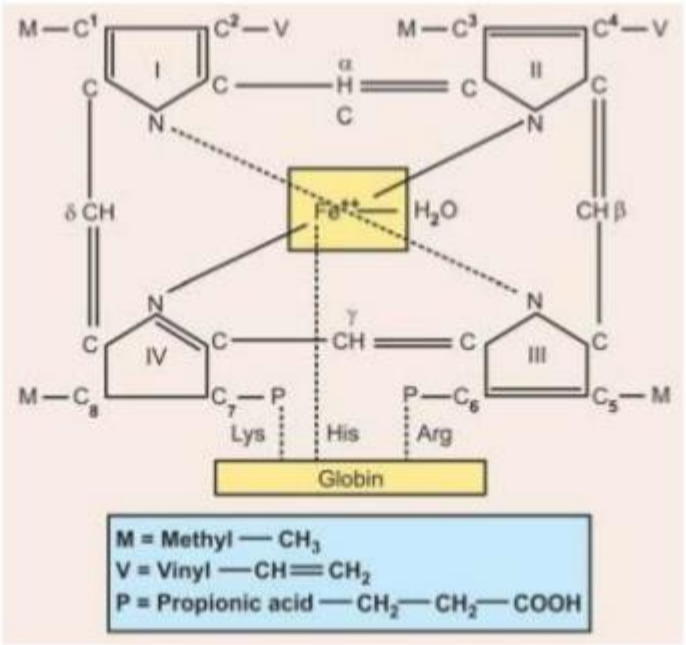


Iron

- Ferrous form (Fe^{+2}).
- The iron is attached to the nitrogen of each pyrrole ring.

Attachment of haem to globin

- One molecule of Hb contains four units of haem, each attached to one of the four polypeptide chain.
- There are four haem in one Hb, so there are four iron atoms in one molecule of Hb which can carry four molecules of oxygen.

FUNCTIONS

Transport of oxygen from lungs to tissues

- In the lungs, one molecule of O_2 is attached to sixth covalent bond of Hb to form oxyhaemoglobin HbO_2.
- Hb (deoxygenated haemoglobin) + $O_2 \rightarrow HbO_2$ (Oxygenated haemoglobin)

- Oxygenation of first haemmolecule in HB increases the affinity of second haem for oxygen which in turn increases the affinity for third and so on.
- Affinity of Hb for oxygen depends on pH, temperature, concentration of 2,3-bisphosphoglycerate.

Transport of CO_2 from tissues to lungs

- CO_2 is transported by combining with amino acids of the globin part and not with iron.

Control of pH of the blood

- Most important acid – base buffer system of the blood.

TYPES OF HAEMOGLOBIN

Varieties of haemoglobin

- Physiological varieties
- Haemoglobinopathies

Physiological varieties

- Adult haemoglobin

a) Haemoglobin A [HbA($\alpha_2\beta_2$)- Main form of Hb in adult.

b) Haemoglobin A_2 [HbA_2 ($\alpha_2\delta_2$)- Minor form of Hb in adult (25%).

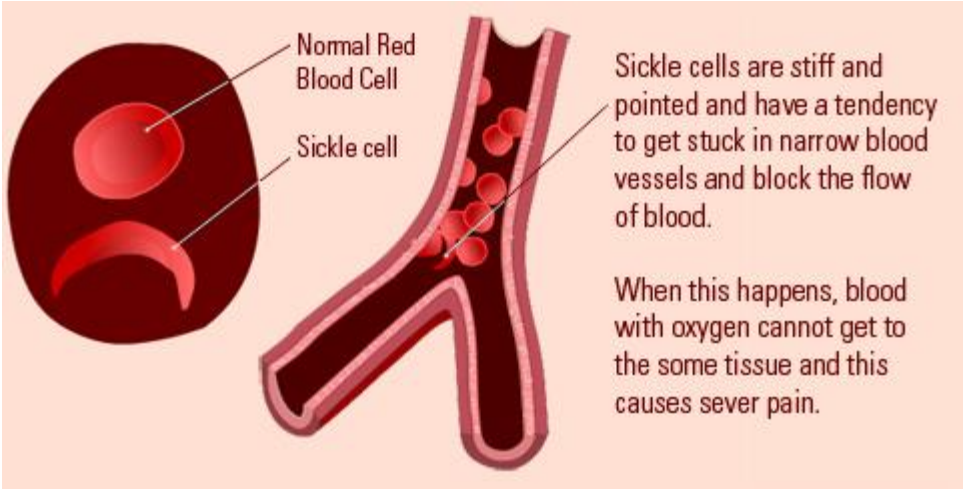
- Fetal haemoglobin of haemoglobin F [HbF($\alpha_2\gamma_2$)] present in fetus. Disappears after 2-3 months after birth.

Haemoglobinopathies

- Abnormal haemoglobins – disorders of globin synthesis.
- Formation of abnormal polypeptide due to substitution of synthesis of globin polypeptide as in thalassaemia.

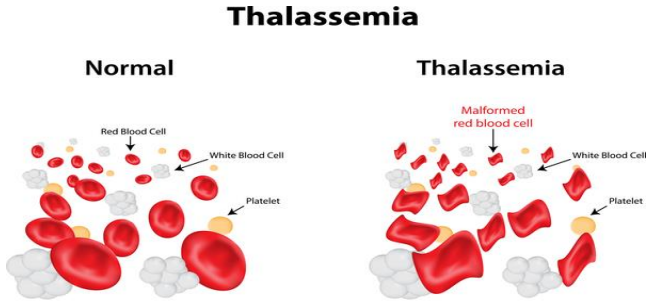
Sickle cell haemoglobin

- Common haemoglobinopathy
- Hb is transformed due to substitution of valine for glutamic acid at position 6 in the β chain of HbA.


Normal Red Blood Cell
Sickle cell
Sickle cells are stiff and pointed and have a tendency to get stuck in narrow blood vessels and block the flow of blood.
When this happens, blood with oxygen cannot get to the some tissue and this causes sever pain.

Thalassemia

- Defect in the synthesis of polypeptide chain α and β of HbA.
- Depending on whether α or β chains are not synthesized, α or β thalassemia may occur.
- β thalassemia is more common. Two classes, thalassemia major or thalassemia minor.



Oxyhaemoglobin

- Hb reacts with oxygen to form oxyhaemoglobin.
- Unstable and reversible
- Iron in ferrous state


THE END