BIOCHEMISTRY

STRUCTURE & FUNCTION OF MYOGLOBIN

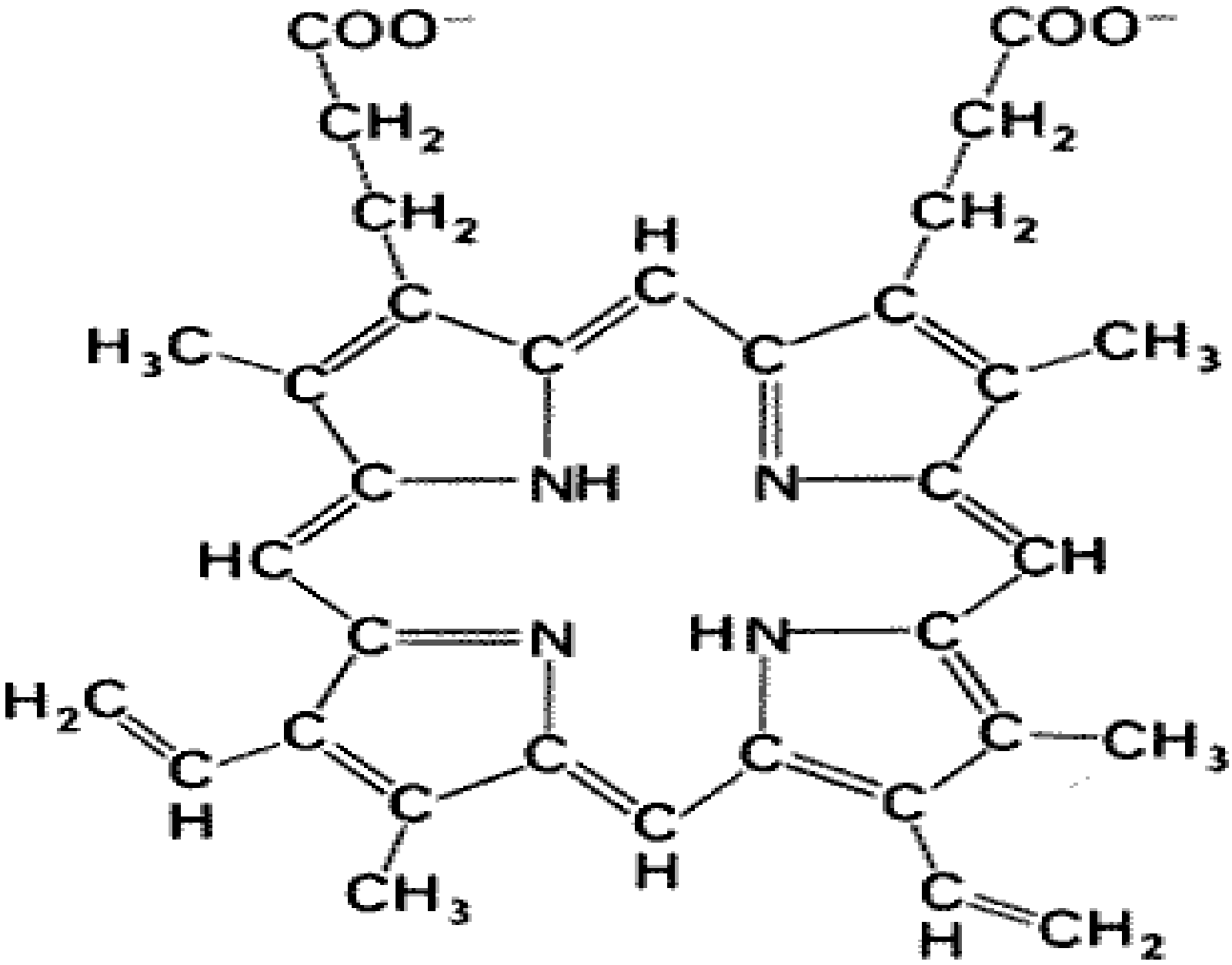
Heme proteins

- These are specialized proteins that contain heme as a tightly bound prosthetic group.

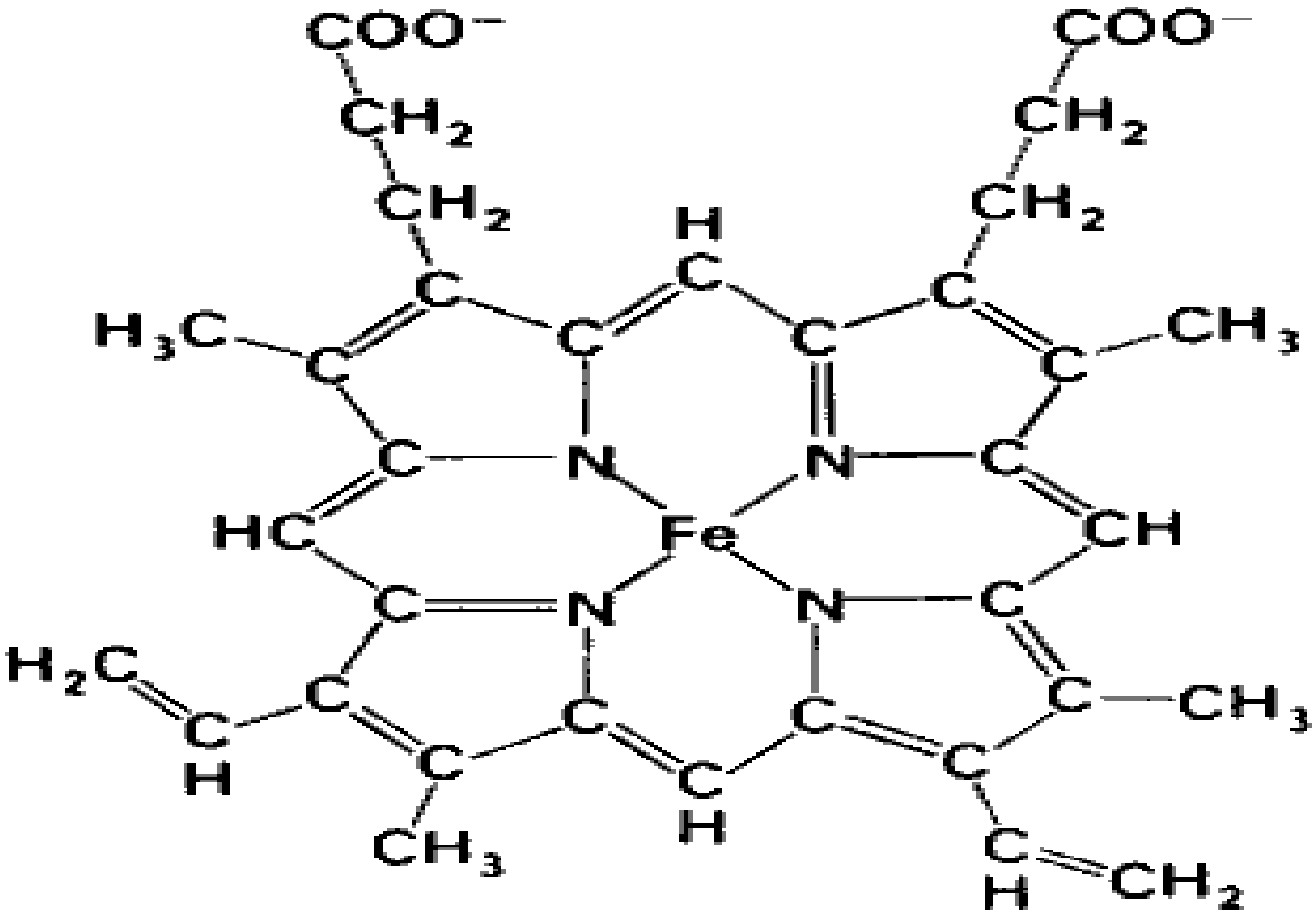
- Role of heme is different in different tissues, e.g.heme group in cytochromes- electron transport carrier.

catalase part of the active site.

hemoglobin and myoglobin- bind oxygen.



Protoporphyrin IX



Heme

(Fe-protoporphyrin IX)

- Myoglobin has been investigated intensely and is the first protein molecule to have been completely described in terms of its three-dimensional geometry.
- This achievement won the British scientist John Kendrew a share in the 1962 Nobel Prize for Chemistry.

MYOGLOBIN

- It is present in heart and skeletal muscle.
- Function as a reservoir of oxygen and as an oxygen carrier.
- It increases the rate of transport of oxygen within the muscle cell.

- Is both a structural and functional relative of hemoglobin.
- The oxygen-transport protein of the blood of higher animals.
- Has the ability to store oxygen by binding it to an iron atom.
- Myoglobin is composed of a single polypeptide chain of **153 amino acid** residues.

- Non polar amino acids are present in the interior of molecule packed by hydrophobic interactions.
- Polar amino acids are present at the surface of molecule and held together by hydrogen bonds, which they form with each other and with water.

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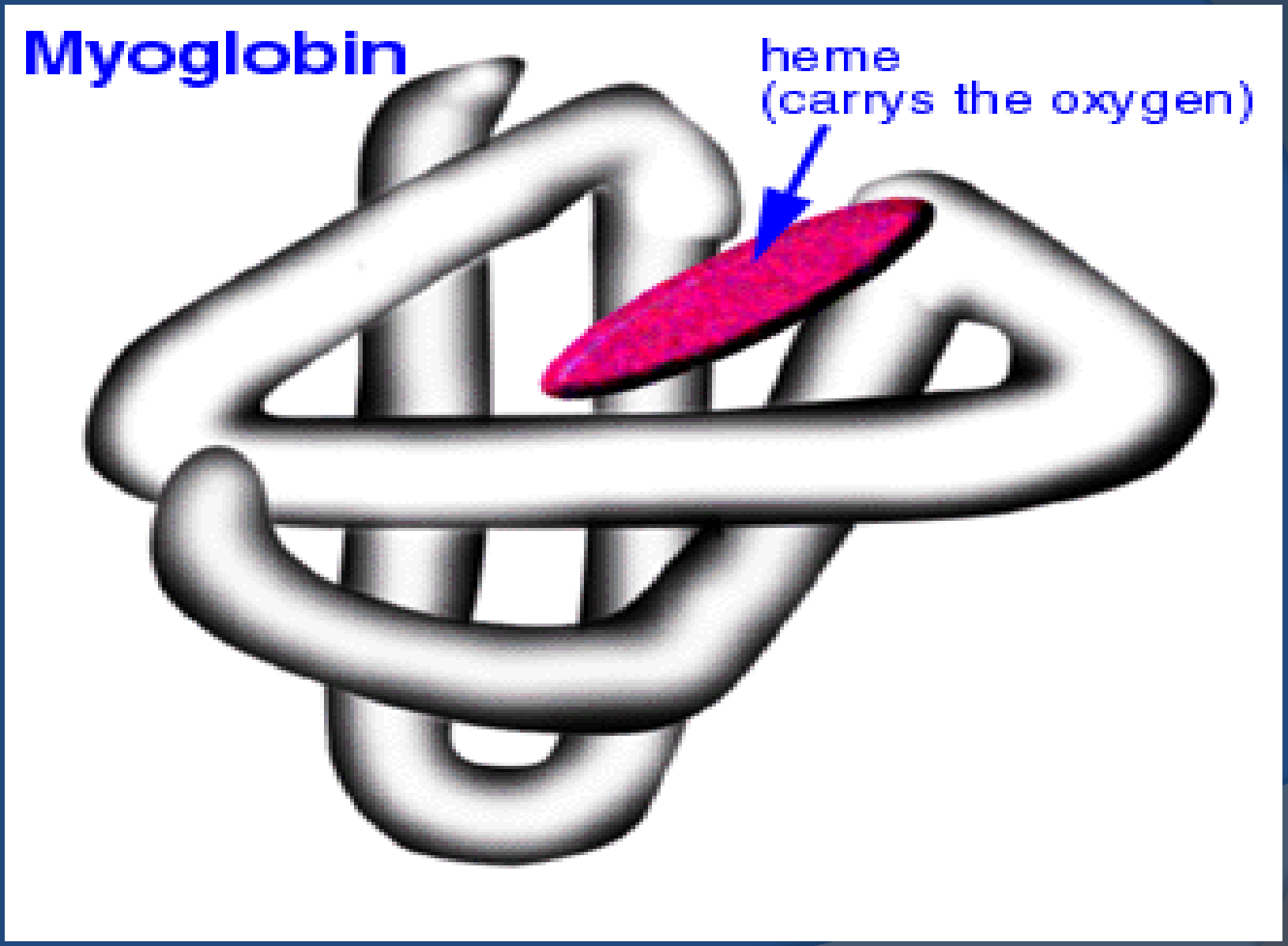

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Structure and bonding

- A Heme group is a flat ring molecule containing carbon, nitrogen and hydrogen atoms, with a single Fe^{2+} ion at the center.
- Without the iron, the ring is called a Porphyrin.
- In a heme molecule, the iron is held within the flat plane by four nitrogen ligands from the porphyrin ring.

- The globin portion provides an environment for the heme that can bind only one oxygen molecule.
- It has eight alpha helices and a hydrophobic core.
- It is the primary oxygen-carrying pigment of muscle tissues.

- Myoglobin contains a porphyrin ring with an iron center.
- There is a *proximal histidine* group attached directly to the iron center.
- And a *distal histidine* group on the opposite face, not bonded to the iron, but it stabilizes the binding of oxygen to the iron.

- This protein does not exhibit cooperative binding of oxygen, since positive cooperativity is a property of multimeric/oligomeric proteins only.

- Myoglobin can bind one molecule of oxygen, because it contains one heme group.
- The oxygen disassociation curve is Hyperbolic for Mb.
- It means that Mb has high affinity for oxygen at all pO_2.

- pO_2 needed to achieve half saturation of the binding site is approx: 1 mm of Hg.
  (26 mm of Hg -Hb).

- Advantage: Mb can bind O_2 released by the Hb in the tissues at low pO_2, and then release it within the muscle cell in response to O_2 demand.

- High concentrations of myoglobin in muscle cells allow organisms to hold their breaths longer.
- Oxygen binds to myoglobin and is released only when the hemoglobin can no longer supply adequate oxygen to muscle cells.

- The distribution of myoglobin among the higher animals is a reflection of its physiological function. It is found abundantly in the tissues of diving mammals, e.g., the whale, the seal, and the dolphin. High concentrations of myoglobin in these animals presumably allows them to store sufficient oxygen to remain underwater for long periods.

- Myoglobin is found abundantly in man in cardiac muscle, which, by virtue of its essential function, must possess the capacity for continued activity when environmental oxygen concentrations are low.

Role in disease

- Myoglobin is released from damaged muscle tissue (rhabdomyolysis), which has very high concentrations of myoglobin.
- The released myoglobin is filtered by the kidneys but is toxic to the renal tubular epithelium and so may cause acute renal failure.