CYTOCHROMES
ELECTRON TRANSFER

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CYTOCHROMES

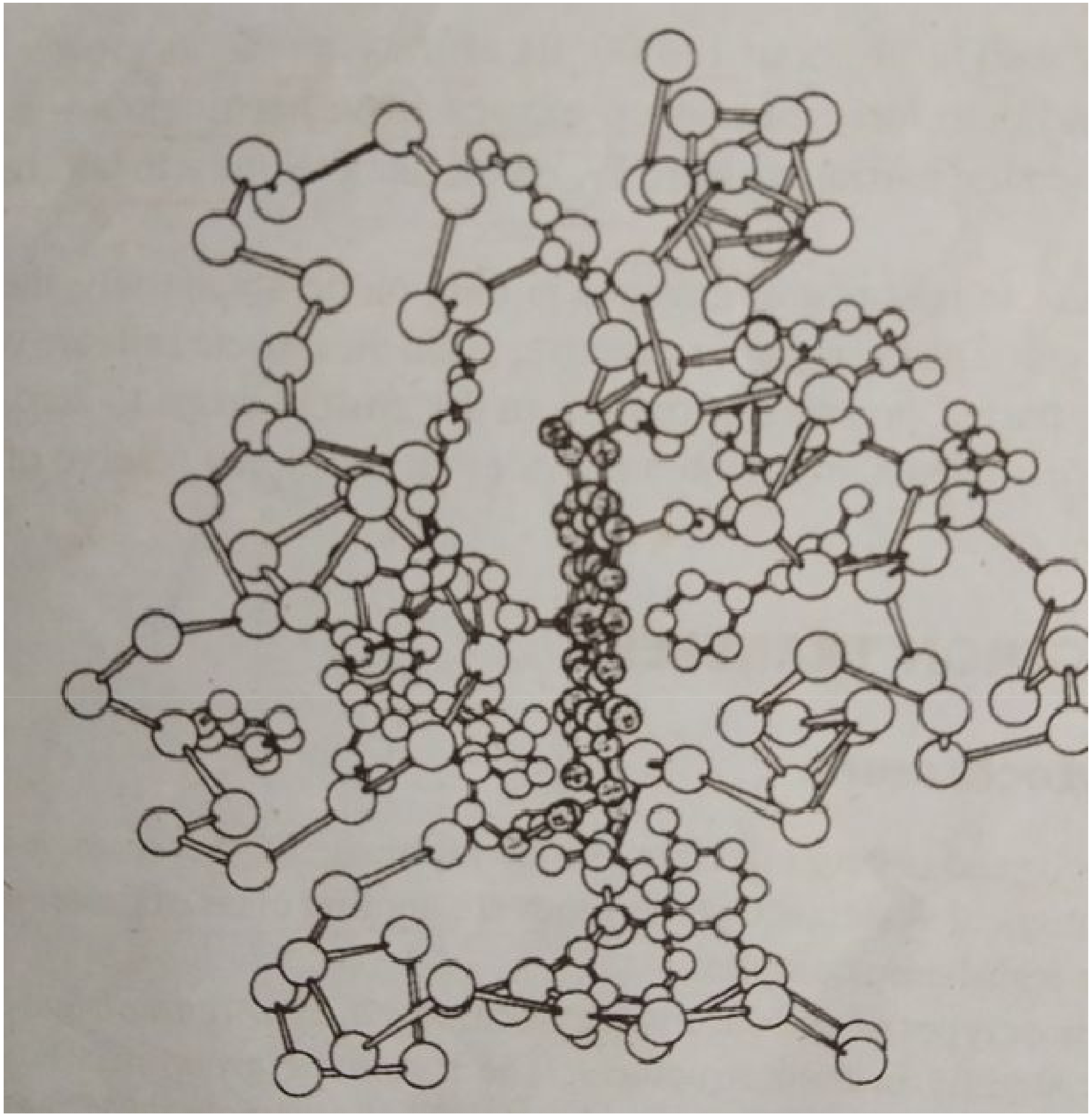
The porphyrin ring ligand is very effective as a chelating agent ; therefore, it is found in a number of biological systems .

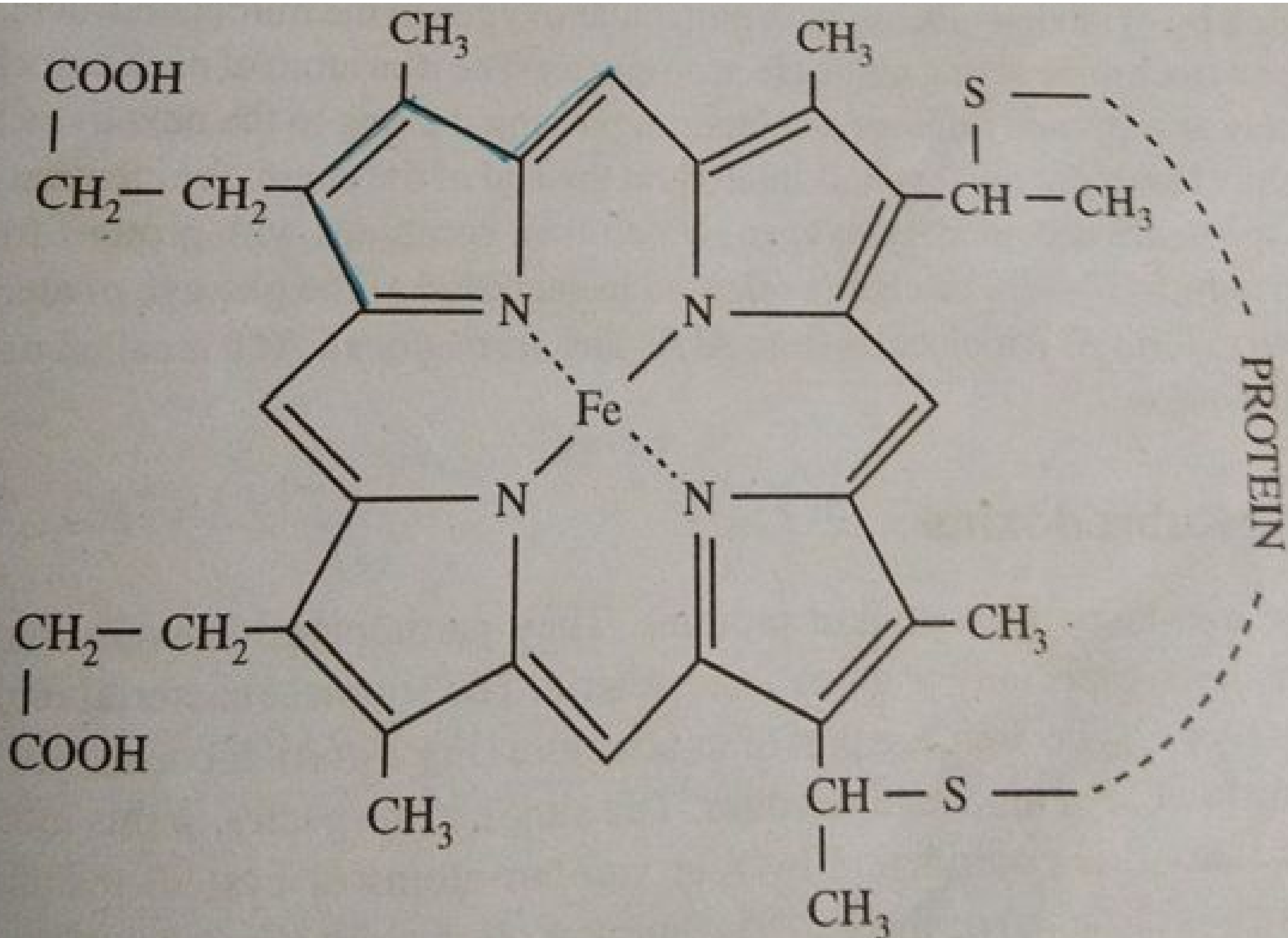
Cytochrome are another class of proteins, which are built up of the iron-heme complex.

There are three types of cytochromes, cytochromes a, cytochromes b, and cytochromes c, they differ slightly in their structures .

The prosthetic group in all cytochromes comprises four heme units.

The molecular weight of a cytochromes is about 12,400.




COOH
CH2— CH2
CH3
CH3
S
CH — CH3
N
N
Fe
N
N
PROTEIN
CH2— CH2
COOH
CH3
CH3
CH — S
CH3

As in hemoglobin, in cytochromes, each Fe is bonded to four N atoms in each porphyrin ring and the fifth site is occupied by a N atom from the associated protein .

The sixth site is occupied by a S atom of an amino acid , which is a part of a protein.

In this , the ligands above and below the porphyrin ring are the methionine group and histidine group of the protein, respectively .

The iron in this system forms an octahedral complex. Both the histidine and methionine groups are firmly bonded to the metal ion unlike the water ligand in hemoglobin; Therefore, these ligand cannot be displaced by oxygen or other ligands.

The cytochrome acts as electron carriers .

The iron in them is in the low- spin state and undergoes rapid ,reversible redox reaction ;

$$Fe^{3+} + e^- = Fe^{2+}$$

These reactions are coupled to the oxidation of carbohydrates.

For example, energy is released by oxidizing glucose with molecular oxygen in the mitochondria in living cells, the cytochromes acting as the electron carrier .

The iron atom of each cytochromes alternately accepts and releases an electron, passing it along to the next cytochromes at a slightly lower energy level;

Ultimately, at the end of the chain the electrons, their energy spent, are accepted by oxygen, which then combines with protons from the solution to form water .

The energy released in each step of the passage of electron is harnessed to form ATP molecules from ADP. This formation of ATP is called oxidative phosphorylation .

Rubredoxins

These are non- heme iron – sulphur proteins.

They participate in several biological redox reactions, especially in anaerobic bacteria.

The simplest bacterial rubredoxin contains $(Cys\text{-}S)_4$ Fe units as a part of its structure.

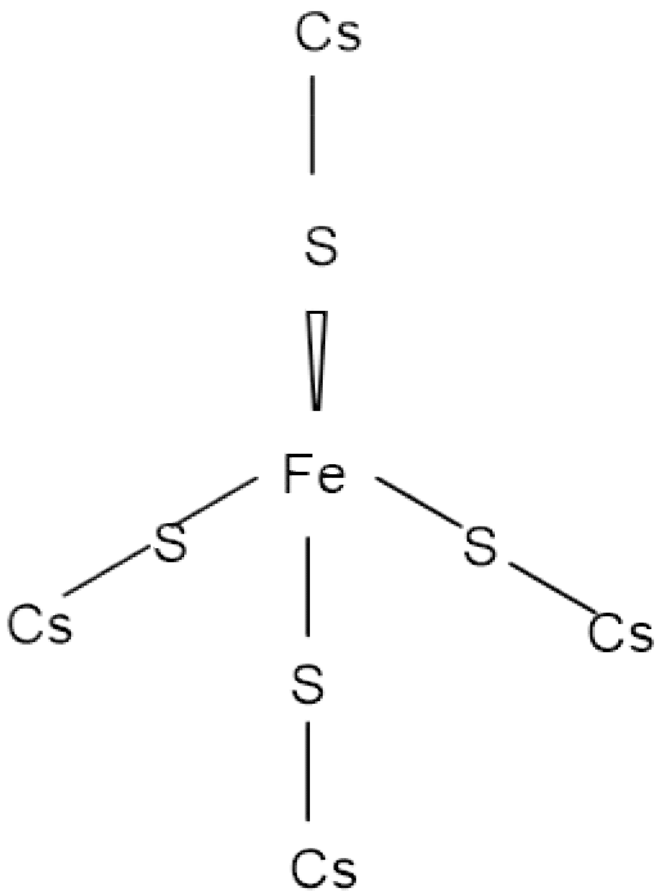
It consists of a single peptide chain of 53 amino acids residues.

The single iron species in this molecules is in the +3 state;

It is coordinated by four sulphur atoms of cystein residues .

This coordination is close to tetrahedral. The sulphur atoms in it are non labile ; they are not lost on treatment with an acid .

Bacterial Rubredoxin



Ferredoxins

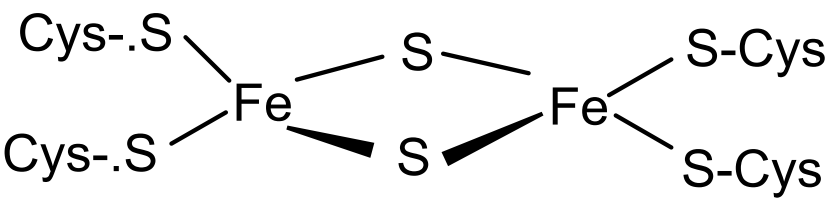
Ferredoxins are a group of non–heme iron proteins : These effect electron transfer in plants and bacteria.

These are iron complexes and serve the same biological function that cytochromes do in animals. However , these have much lower molecular weights (6000-12,000).

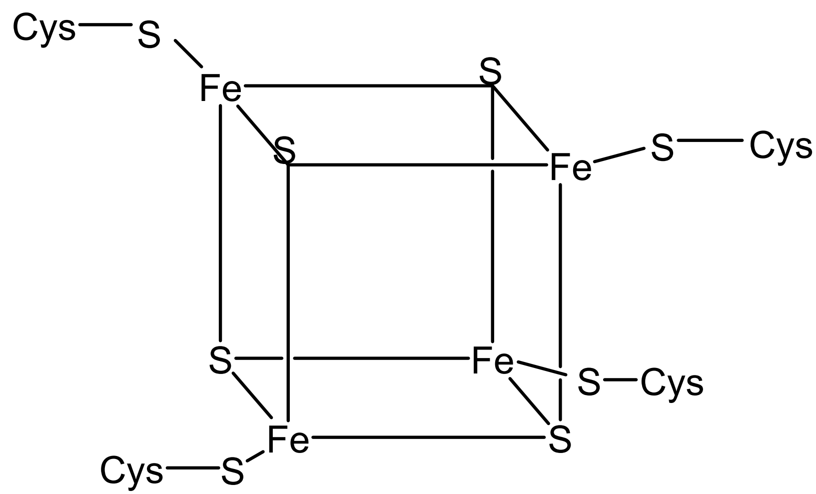
A ferredoxin molecules may contains one, two, four or eight iron atoms. The simplest of these is bacterial Rubredoxins , $(Cys\text{-}S)_4Fe$.

The ferredoxin, which helps photosynthesis in higher plants has a bridge structure (with Fe_2S_2).

Another type of ferredoxin molecule found in certain bacteria has a cubane – like cluster of four iron atoms , four labile sulphur atoms and four cysteine ligands.



Photosynthetic ferredoxin



Cubane like bacterial ferredoxin