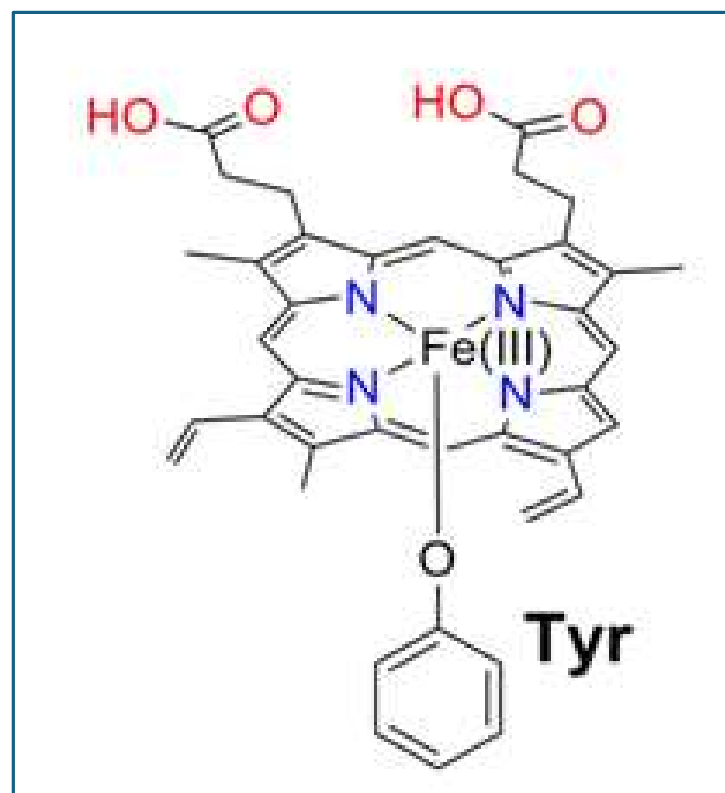
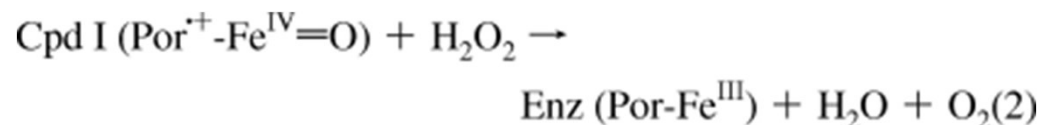
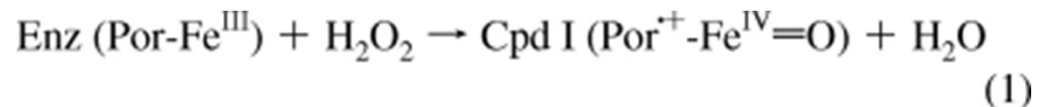


Catalase

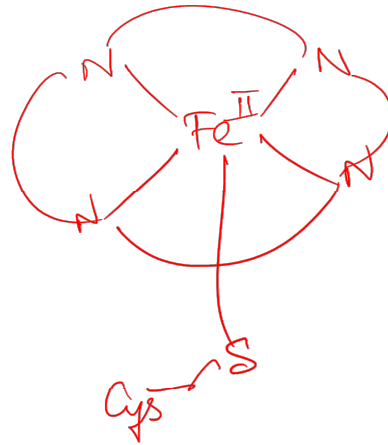
- ✓ Heme catalases, present in almost all aerobically respiring organisms, play an important role in defending cells against oxidative damage by degrading hydrogen peroxide (H_2O_2) to water and oxygen
$$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$$
- ✓ Catalases have been implicated as an important factor in inflammation, mutagenesis, prevention of apoptosis, and stimulation of a wide spectrum of tumors.
- ✓ Evidence from kinetics studies indicate that once catalase COMPOUND I (cpd I) forms, it rapidly reacts with a second molecule of H_2O_2 to generate O_2 and a water molecule.



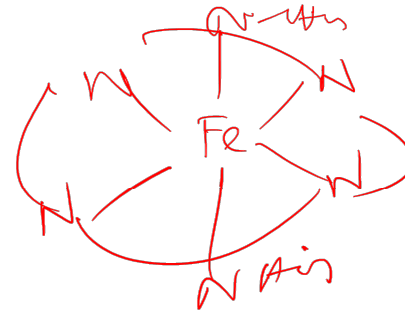
Hemoglobin
Oxygen transport



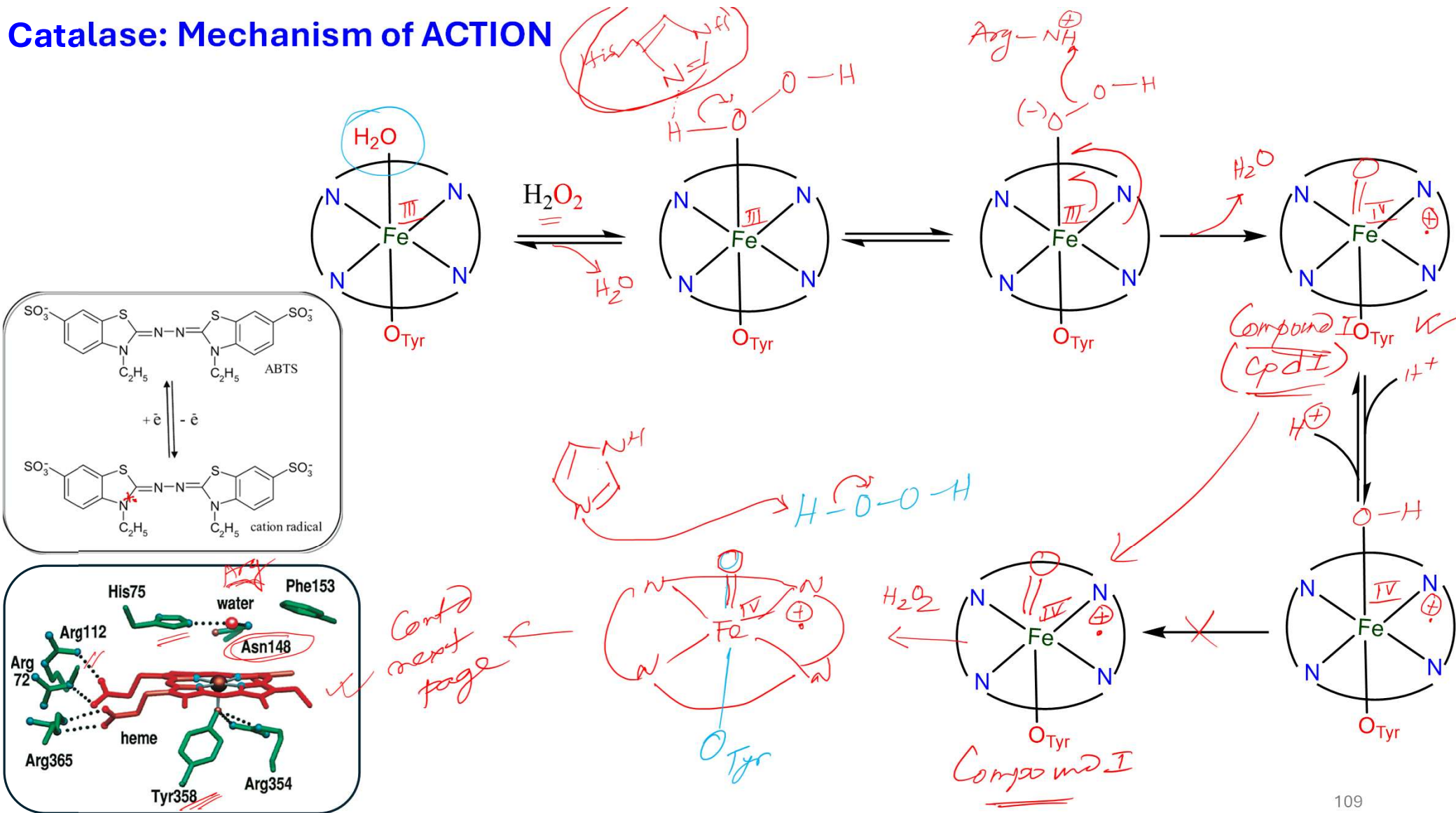
Cytochrome P450
metabolism protein

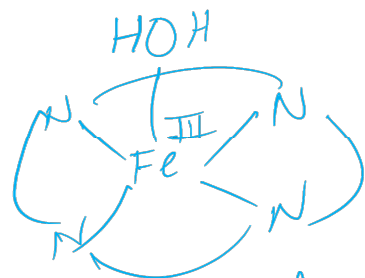
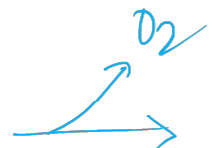
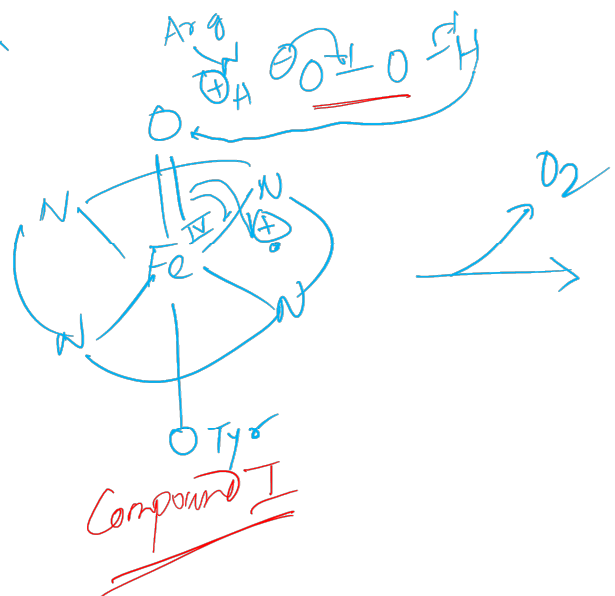
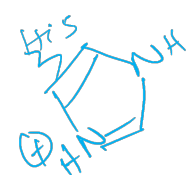


Cytochromes
e⁻ transport



Catalase: Mechanism of ACTION





ready for next step
Catalase again can take up
another H_2O_2

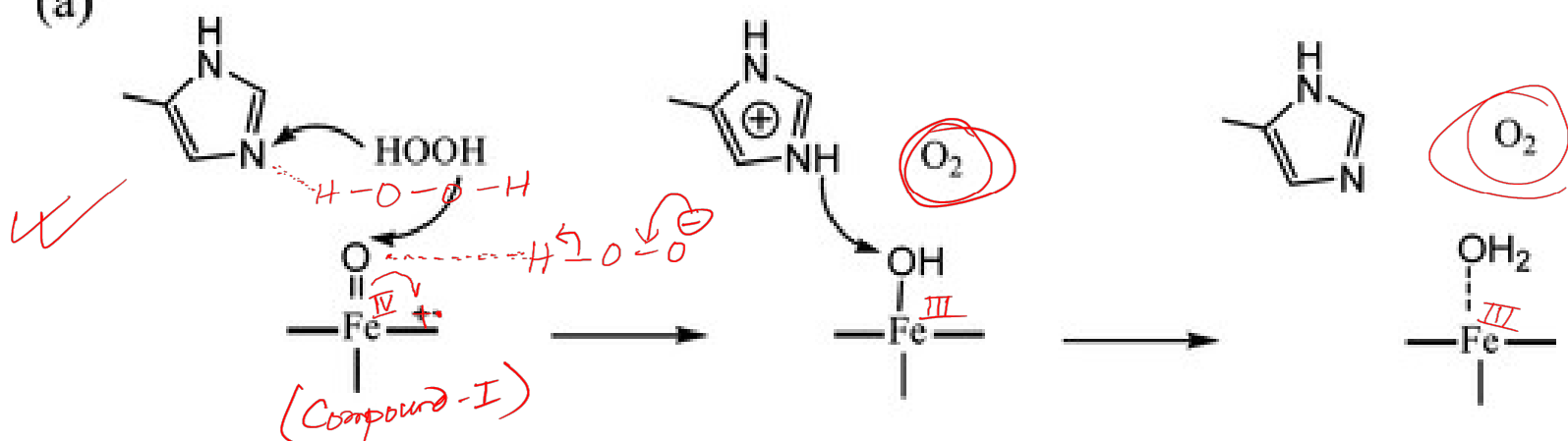
Proposed mechanisms of Cpd I reduction

J. Am. Chem. Soc. 2009, 131, 33, 11751–11761

The His-mediated mechanism

(a)

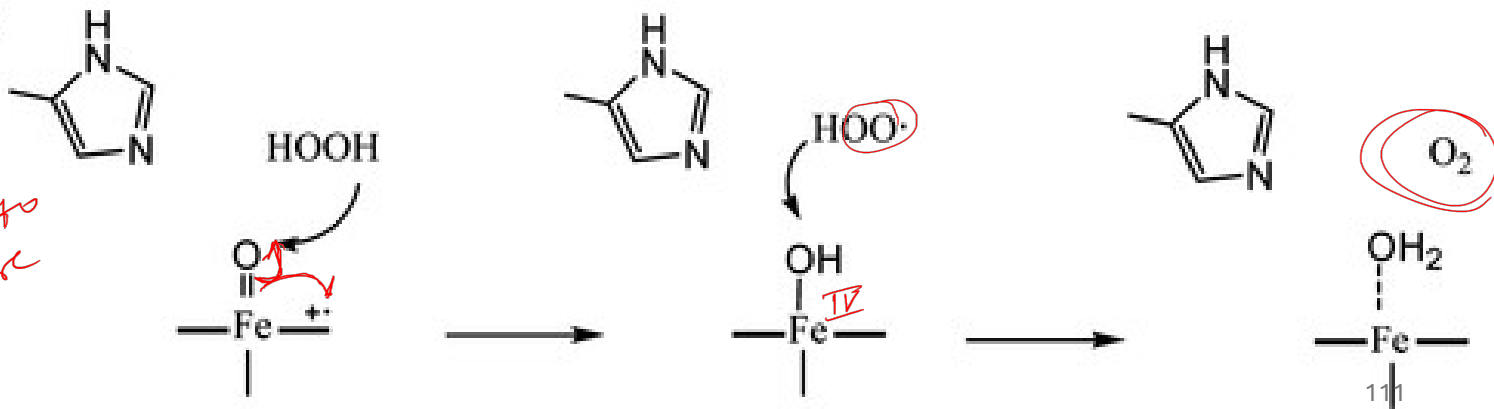
Arginine
Histidine



The direct mechanism

(b)

less favored
pathway
when it comes to
catalase

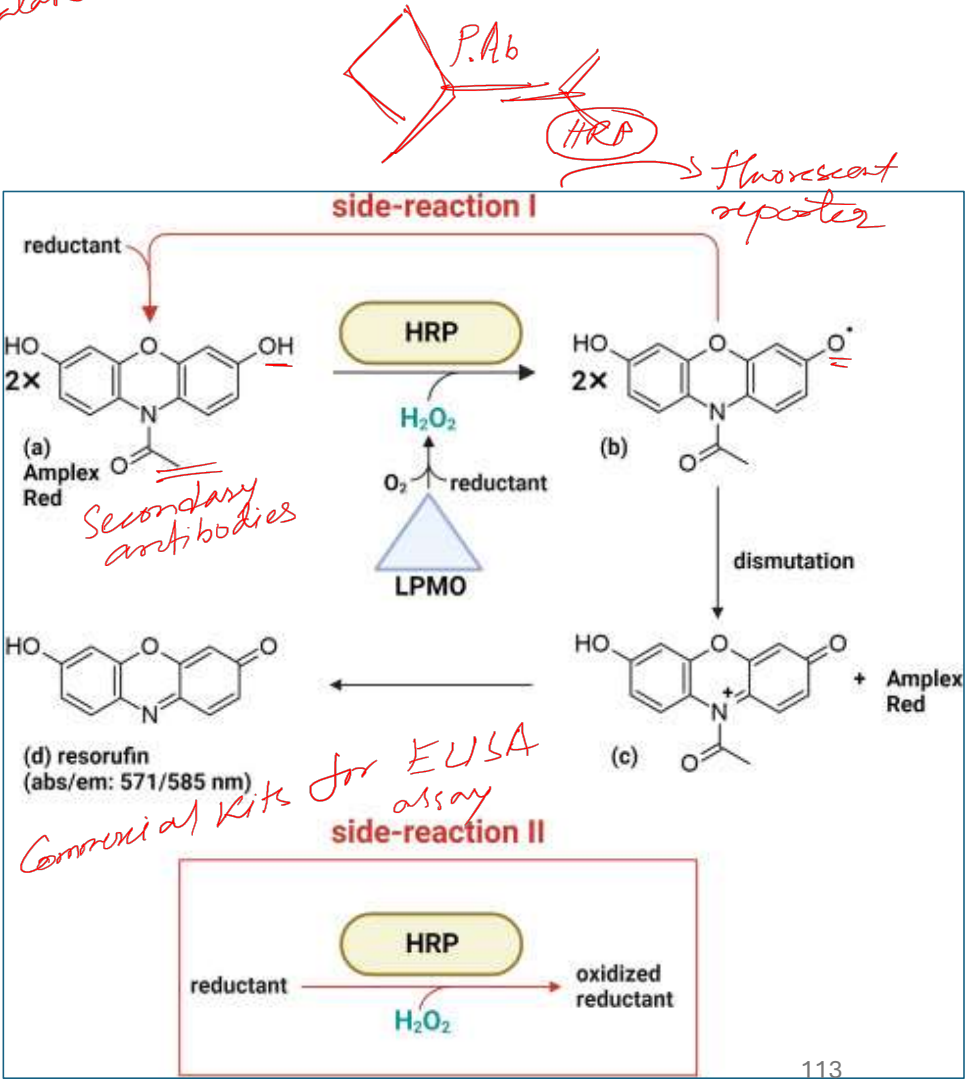
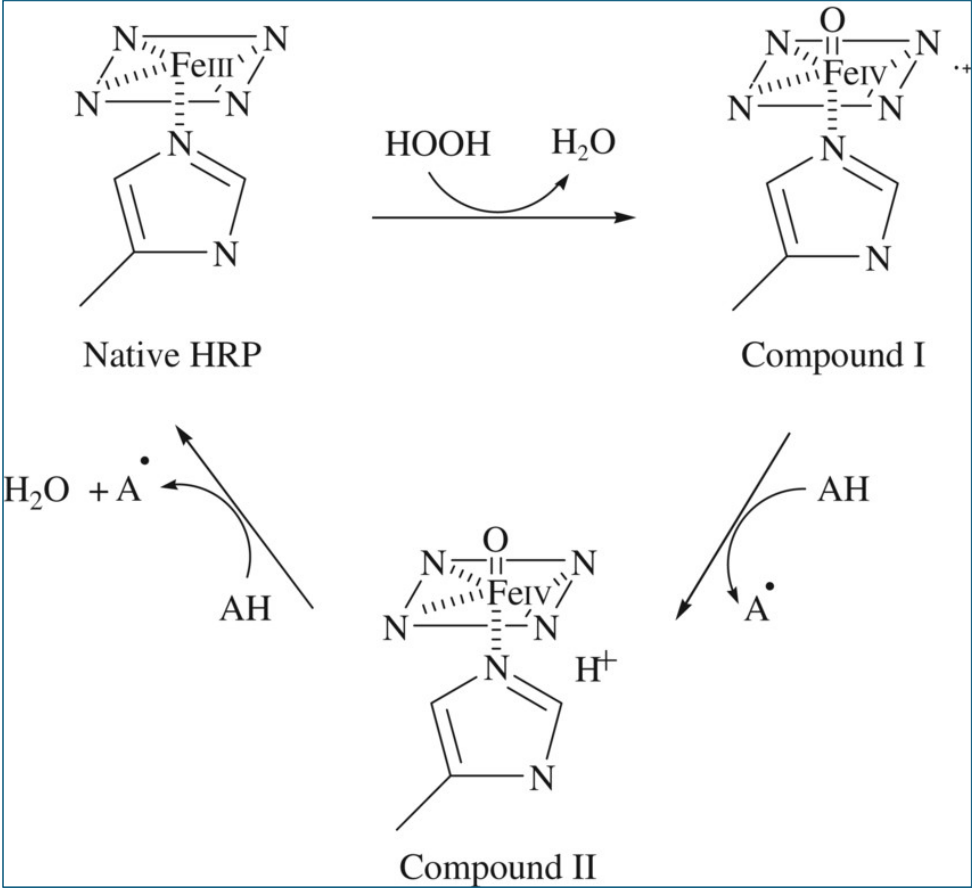


What is probed and known ?

1. Exclusive formation of $^{18}\text{O}_2$ and $^{16}\text{O}_2$ from a 50:50 mixture of $\text{H}_2^{16}\text{O}_2$ and $\text{H}_2^{18}\text{O}_2$ indicates that O_2 is formed by two-electron oxidation of H_2O_2 without breaking the O-O bond. There are two possible mechanisms on the formation of O_2 in the reaction of H_2O_2 and compound I without showing $^{18}\text{O}/^{16}\text{O}$ scrambling
2. Mechanism A shows an ionic reaction via initial proton abstraction with the help of the distal histidine acting as a general acid-base catalyst *→ I favour this pathway*
3. A similar deprotonation process is involved in the formation of compound I. In mechanism B the reaction starts by a hydrogen atom transfer from H_2O_2 to the ferryl species to yield a radical intermediate. The hydrogen abstraction by the ferryl intermediate has been proposed for the alkane hydroxylation by cytochrome P450, its model complexes, and even in non-heme enzymes .

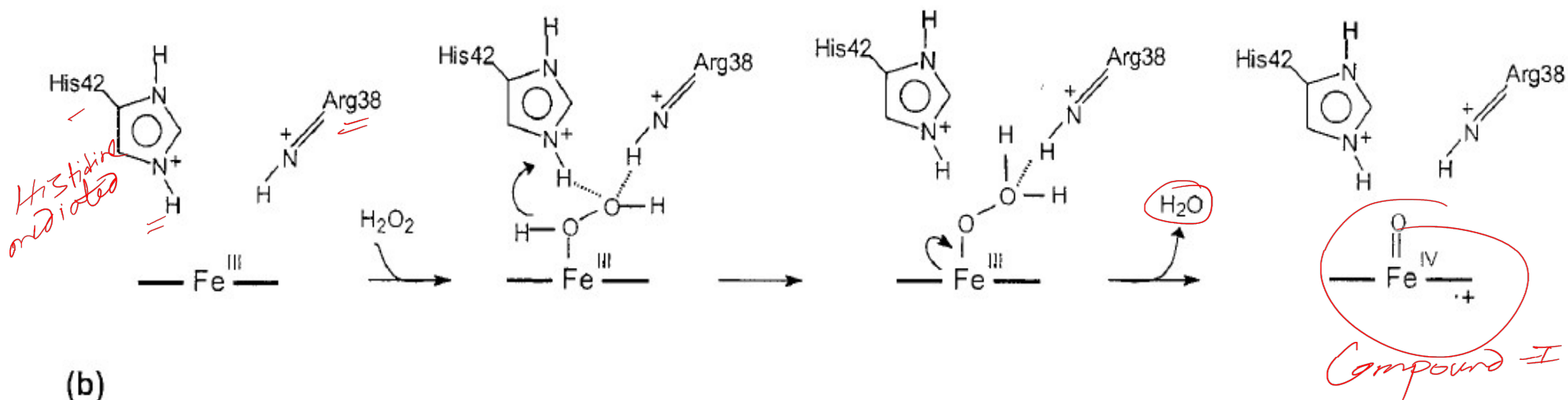
Horse-Radish peroxidase

less active than catalase
TOF_{HRP} < TOF_{catalase}

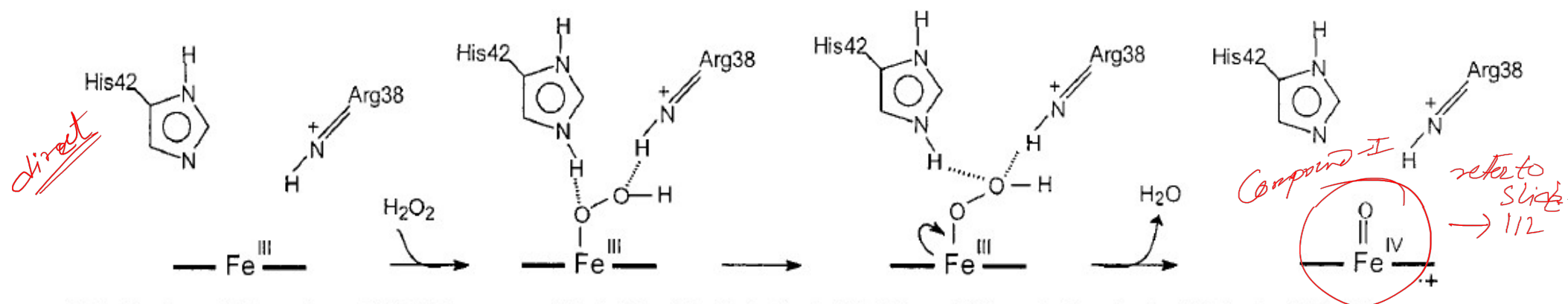


Scheme 5. Role of Distal Heme Pocket Residues of HRPC in Compound I Formation^a

(a)

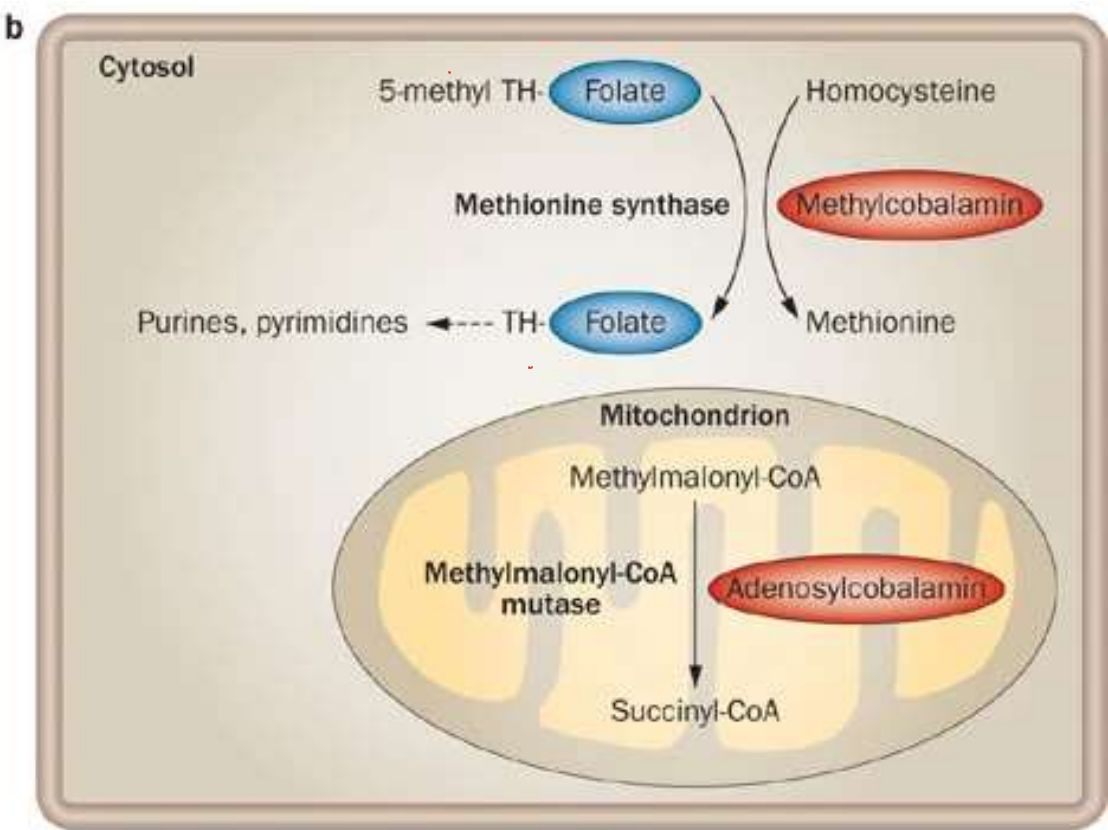
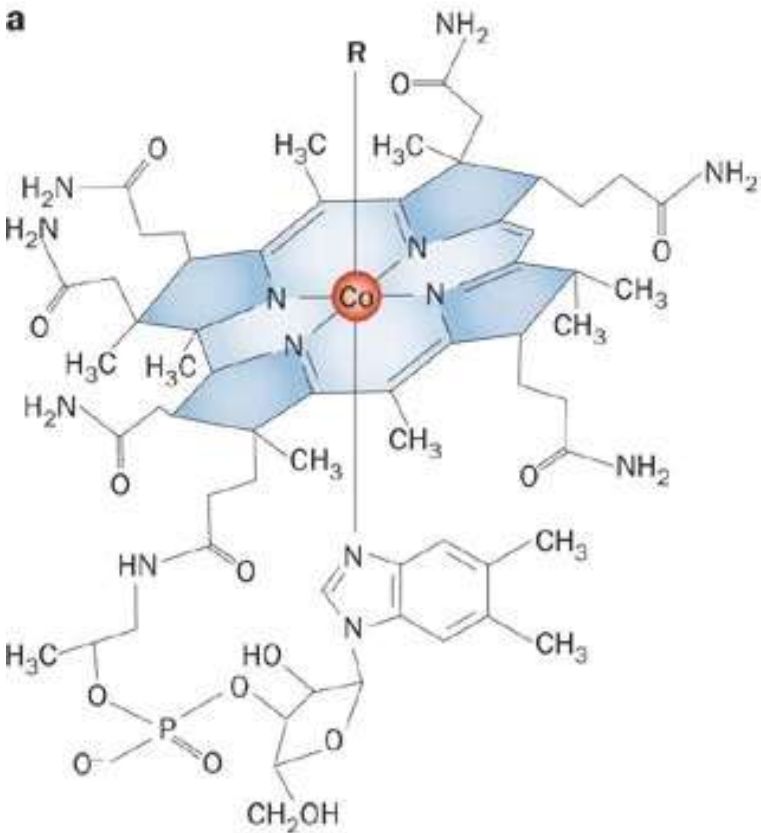


(b)



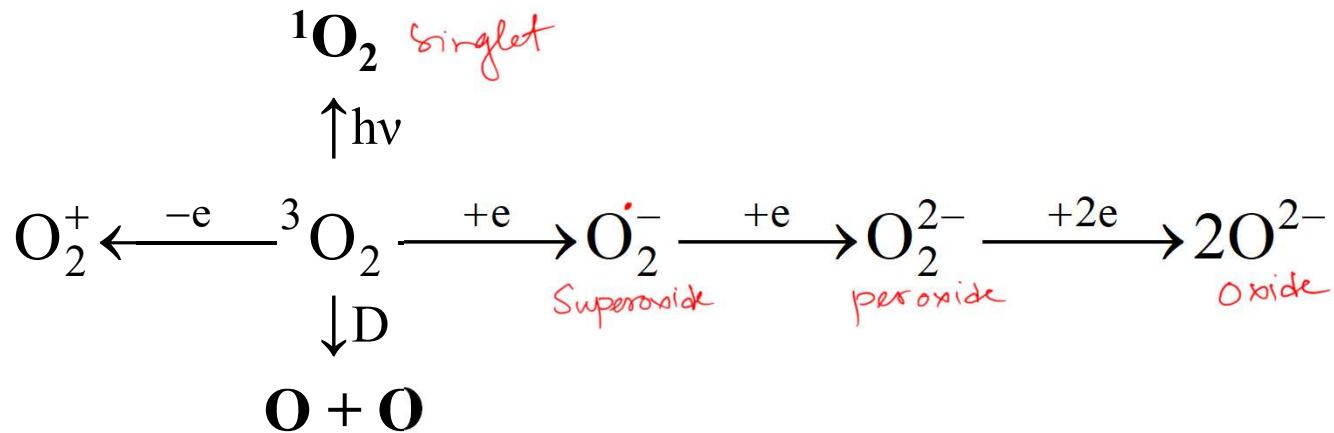
^a Mechanism of formation of HRPC compound I at (a) acid pH (cationic His42) and (b) neutral or basic pH (neutral His42).

Vitamin B₁₂

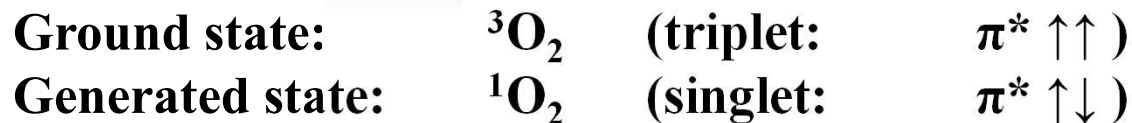


Cyanocobalamin: This is the most common form of B₁₂ used in supplements and fortified foods because it is the most stable and cost-effective to produce. The cyanide portion is attached to the central cobalt atom within the molecule. When the body processes cyanocobalamin, it releases the cyanide, which is then detoxified and safely excreted in the urine.

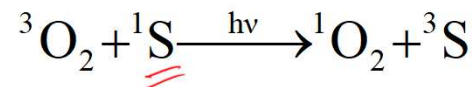
Activation and reactions of the oxygen molecule



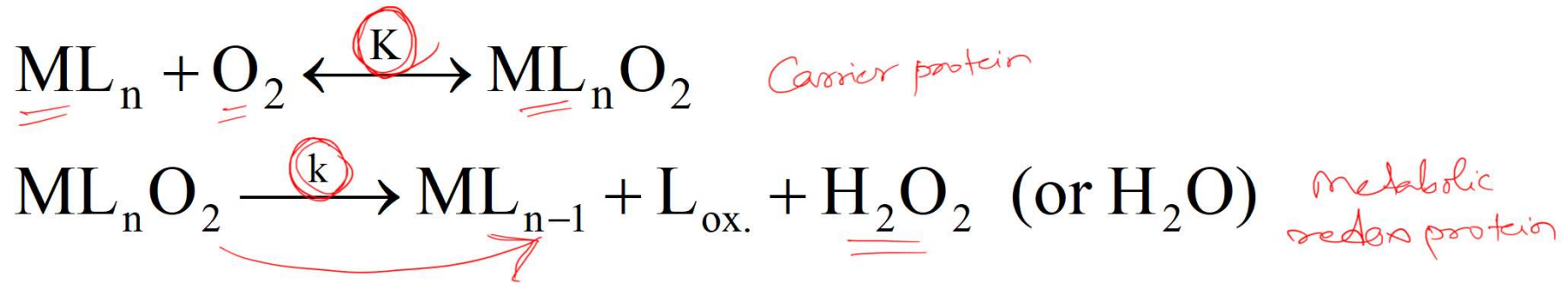
1. Generated states:



The generated state is usually formed through a „mediator molecule” (photosensibilisator, S):



Interactions of the Oxygen molecule with metal complexes

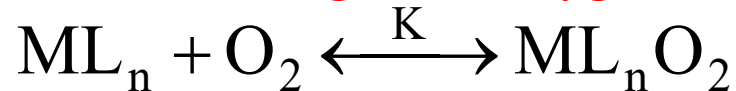


Two extreme possibilities:

1. “K” is high and “k” is low: oxygen carrier complexes
(e.g. hemoglobin, myoglobin, hemocyanin, etc.)
2. “K” is low, but “k” is high: redox catalysis
(e.g. oxygenases, oxidases, etc.)

Reactions of the oxygen molecule in biology I.

1. Reversible binding of the oxygen molecule:

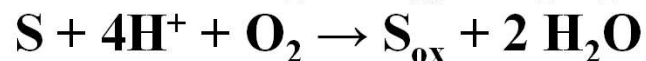
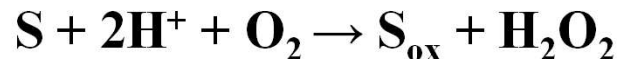


Binding of oxygen in different forms:

- ✓ - $\text{M}^{n+} + \text{O}_2 \leftrightarrow \text{M}^{n+}\text{O}_2 \longrightarrow$ (molecular form)
- ✓ - $\text{M}^{n+} + \text{O}_2 \leftrightarrow \text{M}^{n+1}(\text{O}_2^-) \longrightarrow$ (superoxide radical)
- ✓ - $\text{M}^{n+} + \text{O}_2 \leftrightarrow \text{M}^{n+2}(\text{O}_2^{2-}) \longrightarrow$ (peroxide, monomer)
- ✓ - $\text{M}^{n+} + \text{O}_2 \leftrightarrow (\text{M}^{n+1})_2(\text{O}_2^{2-})$ (peroxide, dimer)

2. Oxidases (dehydrogenases)

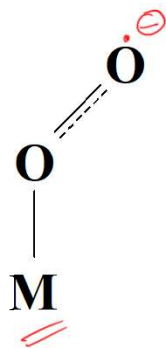
(Oxygen is reduced to peroxide or to water, it does not build in the substrate)



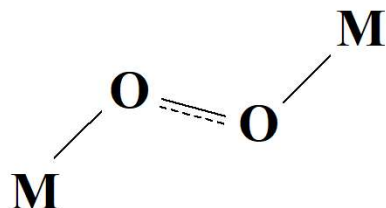
(e.g. cytochrome c oxidase, blue copper oxidases, etc.)

The possible binding modes of O_2

as superoxo ligand

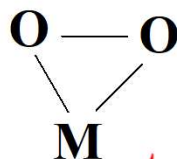


Bended (end-on)



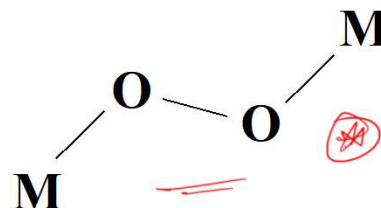
bridging

as peroxo ligand



mononuclear
corroles or
bimetric complexes

side-on

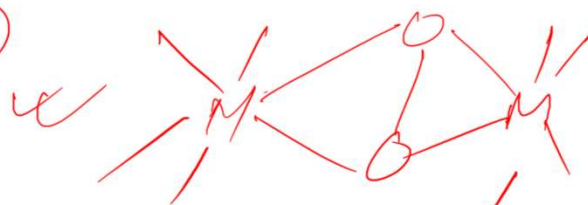


bridging

Two mononuclear
complex
come together

or a dinuclear
complex favouring
such oxygen bridging

class test on 11 Nov 25
5-6 pm during class time
6-7 pm (ideal answers discussion)



upto this slide is class test-II
no questions from class test -I syllabus