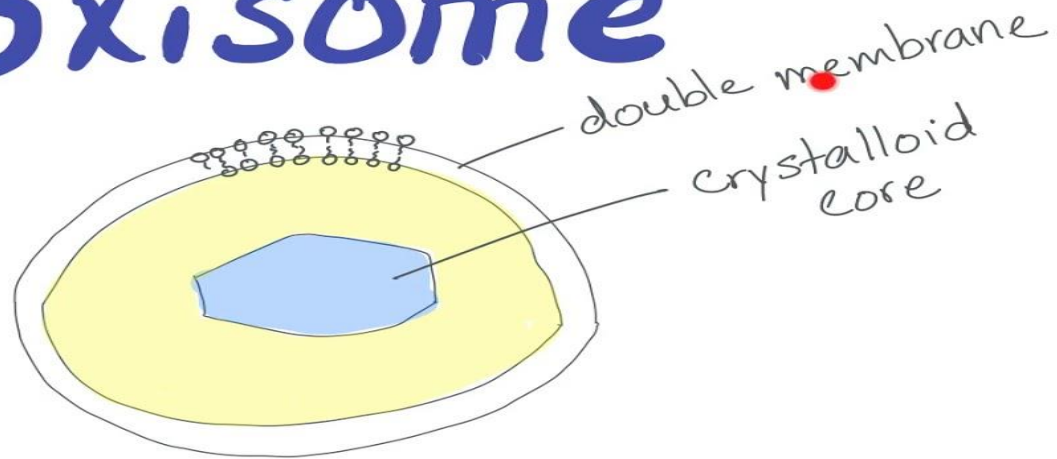


PEROXISOMES/ MICROBODY/ CYTOSOME

Peroxisome



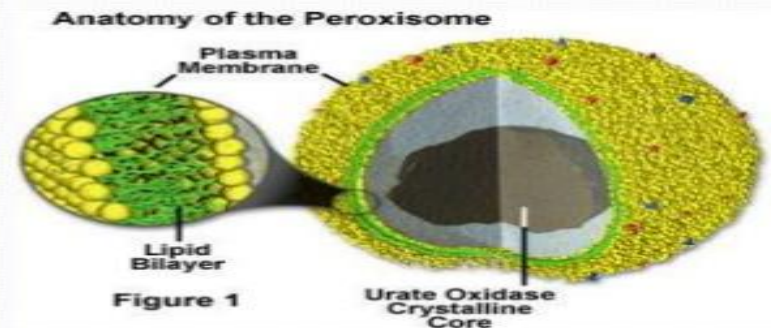
IInd Semester
Zoology (Hons) 1st year
Cell Biology

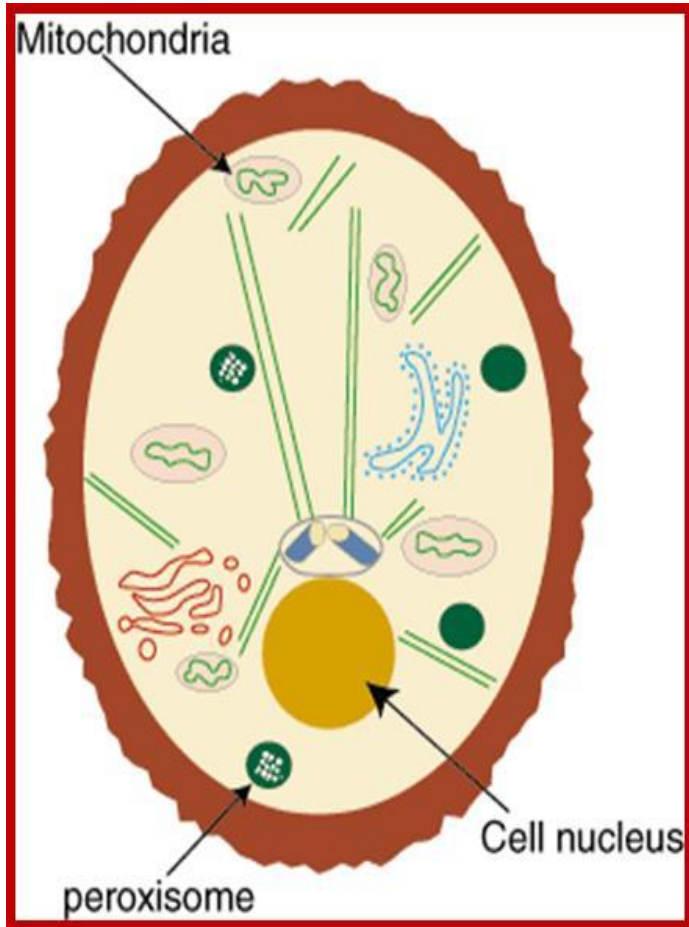
-DR. RANJANA SETH

- Discovered by **De Duve** and his colleagues , Peroxisomes are simple membrane bound vesicles with a diameter of 0.1 to 1.0 micrometers , which contains a dense , crystalline core of oxidative enzymes
- Peroxisomes are multifunctional organelles containing more than **50 enzymes** involved in diverse activities.
- These organelles were so named because they are the **site of synthesis and degradation of hydrogen peroxide** , a **highly reactive and toxic oxidizing agent**.

Structure of Peroxisome

- They are particles of about 100-500 nm in diameter.
- A lipid bilayer membrane surrounds which regulates what enters and exits the peroxisome.
- Inside a dense matrix.
- Urate oxidase crystalline core.





- Unlike Lysosomes , peroxisomes are NOT derived from E.R and therefore **are not a part of the endomembrane system.**
- Peroxisomes are found ubiquitously in eukaryotic cells and are especially prominent in **MAMMALIAN LIVER** and **KIDNEY cells** , in algae and **PHOTOSYNTHETIC CELLS** of plants and in **GERMINATING SEEDLINGS** of plant species that store fats in their seeds.
- **The role of peroxisomes are not as well understood in animals as they are in plant cells .**

• **The important enzymes present in peroxisomes are :**

- a) Catalase
- b) D- amino acid oxidase
- c) Urate oxidase
- d) Glycolate oxidase
- e) Luciferase

Regardless of where they occur , peroxisomes are characterized by the presence of **catalase , an enzyme that plays a vital role in the breakdown of hydrogen peroxide .**

Hydrogen peroxide is a potentially toxic compound that is formed in a variety of oxidative reactions catalysed by **oxidases (which are located in peroxidases along with catalase) . Thus , the generation and degradation of hydrogen peroxide occurs in the same organelle thereby protecting the other parts of the cell from exposure to this toxic compound .**

- *Functions of peroxisomes*

A)Hydrogen peroxide metabolism:

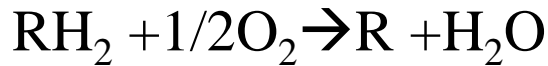
The most obvious role of peroxisomes is detoxification of hydrogen peroxide. The oxidases present in peroxidases vary in the specific reactions they catalyse but all of them share the property of transferring electrons from their specific substrates to oxygen and form hydrogen peroxide .

The hydrogen peroxide formed is broken down by the enzyme catalase in two ways:

1)Catalytic mode

2)Peroxidative mode

- Catalytic mode
- Usually catalase functions in this mode in which one molecule of H_2O_2 is oxidized to O_2 and the second one is reduced to water . The overall reaction becomes :



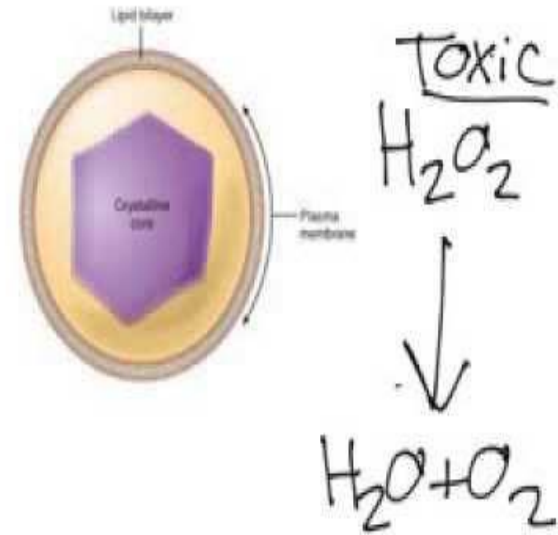
Peroxidative mode :

Alternately catalase functions in the second mode in which hydrogen peroxide is reduced to water using electrons derieved from an **organic donor**

The overall reaction becomes :



Catalase is the most abundant protein (representing upto 15% of protein content of the organelle) , thus every molecule of hydrogen peroxide will be promptly degraded .



B) Detoxification of toxic compounds :

- In its peroxidative mode catalase can use as its electron donor a variety of substances including **methanol , ethanol , formic acid , formaldehyde , nitrites and phenols**. Since all these compounds are harmful to the cells , their detoxification by catalase is of vital importance . **Prominent peroxisomes of liver and kidney are thought to be important in such detoxification reactions.**

C) Oxidation of fatty acids:

Peroxisomes in many animal tissues have enzymes necessary to oxidize fatty acids. This process called Beta-oxidation also occurs in mitochondria. About 25-50% of the fatty acid oxidation in animal tissues occurs in peroxisomes and the rest in mitochondria.

Peroxisomal Beta-oxidation is especially important in the catabolism of fatty acids with especially long carbon chains.

D) Metabolism of nitrogen containing compounds

:

Peroxisomes of most animals except primates contain an enzyme called urate oxidase (also called uricase) needed to oxidize urate, a purine formed during the catabolism of nucleic acids and some proteins.



For this oxygen is required and hydrogen peroxide is formed (which is then metabolised by catalase) and allantoin is further metabolised and excreted as allantoinic acid.

- Other peroxisomal enzymes like **aminotransferases** (which catalyze the transfer of **amino group from amino acids to alpha keto acids**) help in the synthesis and degradation of amino acids by moving amino group from one molecule from another .

E)Breakdown of unusual substances :

Some of the substrates for peroxisomal oxidases are rare compounds for which the cell has no other degradative pathways such as D- Amino acids which are not recognised by enzymes which degrade L-Amino acids .

- Some fungi are capable of metabolising **alkanes** , short term hydrocarbon compounds found in oil and other petroleum products .
- These fungi may be useful for cleaning up **oil spills that would otherwise contaminate the environments.**

Plant peroxisomes

- In plants and algae , peroxisomes are involved in several specific aspects of energy metabolism

Leaf Peroxisomes

- Cells of leaves and other photosynthetic tissues are characterized by the presence of large , prominent **leaf peroxisomes** often seen in close contact with chloroplasts and mitochondria .
- **This spatial proximity reflects the mutual involvement of these three organelles in photorespiration , a light dependent process that occurs only in photosynthetic tissue.**
- Photorespiration involves the uptake of oxygen and release of carbondioxide thereby decreasing the net amount of carbon converted into organic form by photosynthetic tissue. Several of the key enzymes of photorespiration are localized to leaf peroxisomes .

Glyoxysomes

- A functionally distinct type of plant peroxisomes occurs transiently in seedlings of plant species that store carbon and energy reserves in the seeds as fats , mainly triglycerides.
- In these species , stored triglycerides are metabolized and converted to sucrose during post germinative development by a sequence of events which includes Beta-oxidation of fatty acids as well as glyoxylate cycle.
- All the enzymes needed for these process are localized to specialized peroxisomes called Glyoxysomes .
- Glyoxysomes are found only in tissues in which fat is stored in cotyledons or endosperm . They are present for a relatively short period of time (a week or so) required for the seedling to deplete its supply of stored fats .
- Glyoxysomes have been reported to appear again in senescent tissues of some plant species to degrade lipids derived from the membranes of senescent cells.

Peroxisome biogenesis

- Like any other organelle , peroxisome biogenesis occurs by the division of pre – existing peroxisomes .
- This raises a question as to how the enzymes and other proteins present in the matrix or membranes get there ?
- The answer is that the proteins destined for peroxisomes are synthesized not on membrane bound ribosomes (RER) but on the ribosomes of the cytosol and then enter preexisting peroxisomes as full length polypeptides. A process mediated by specific membrane proteins. This mode of protein import is known as **post –translational protein import**