PEROXISOMES

Peroxisome

- Discovered by Christian de Duve in 1967
- Peroxisomes (also called microbodies) are organelles found in virtually all eukaryotic cells.
- The name peroxidase was applied because this organelle is specifically involved in the formation and decomposition of hydrogen peroxide
- Peroxisome is also found in protozoa,yeast,and many cell types of higher plants.

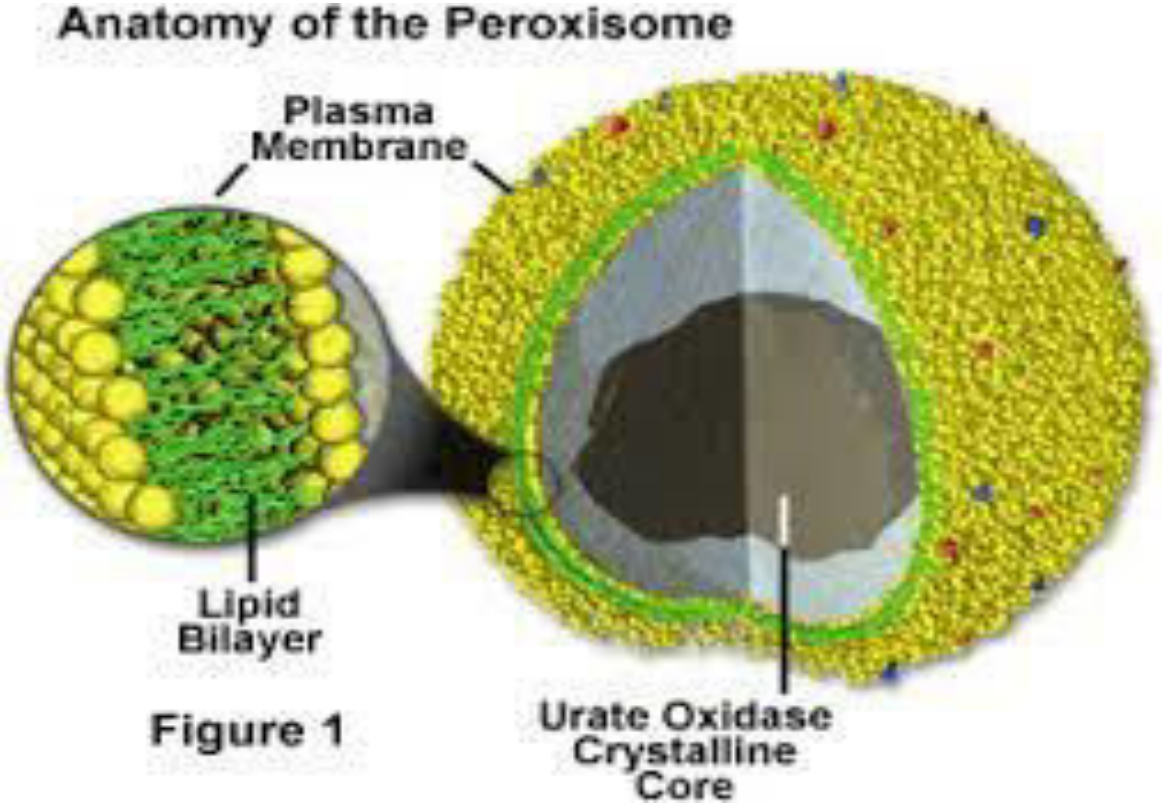
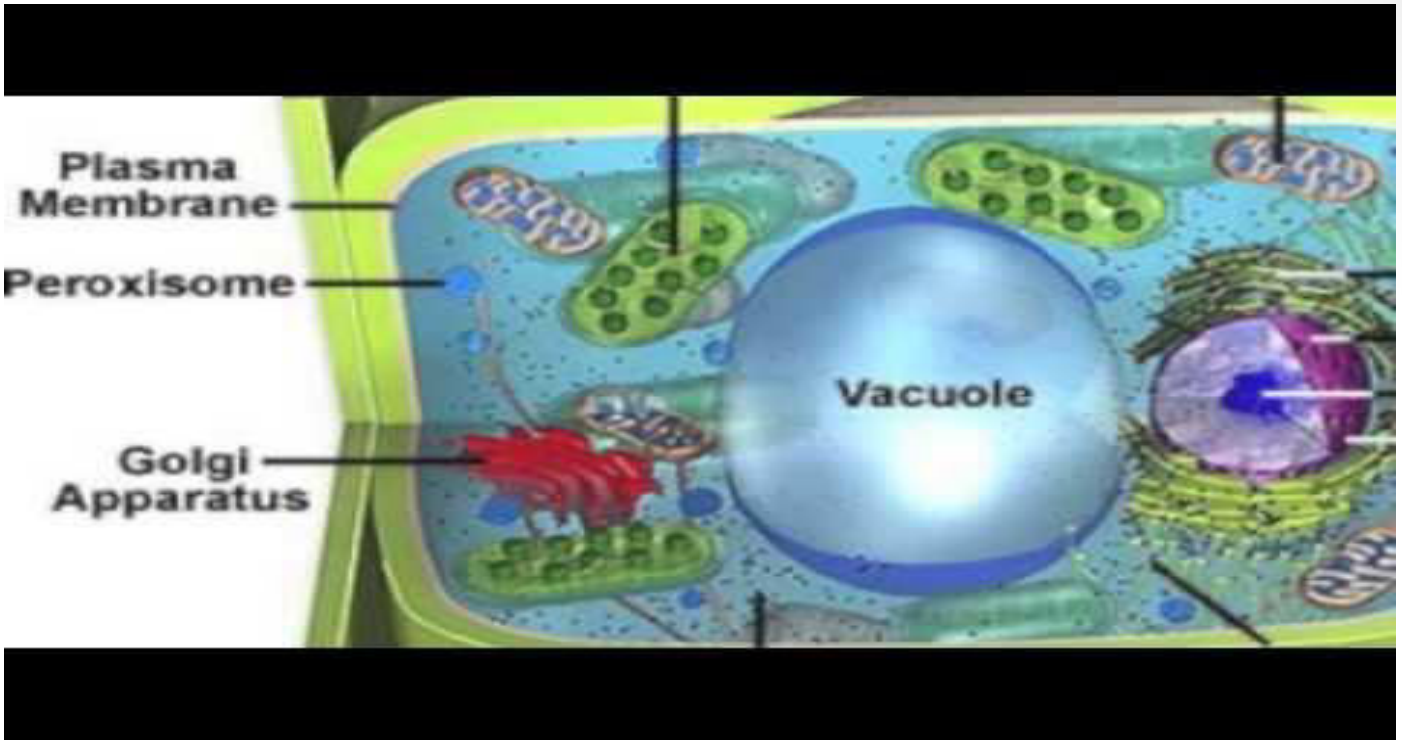

Anatomy of the Peroxisome
Plasma Membrane
Lipid Bilayer
Urate Oxidase Crystalline Core

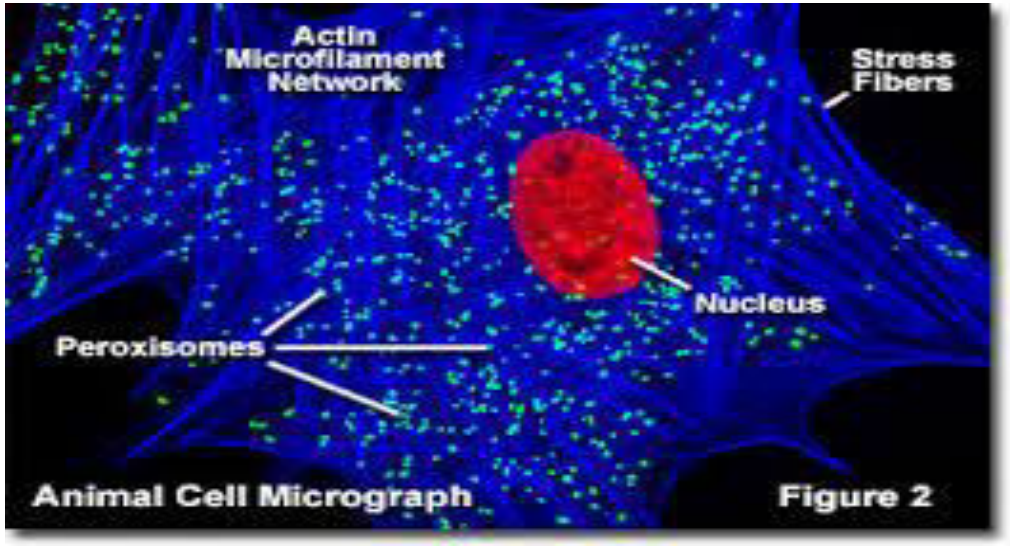
Figure 1

Structure

- Peroxisome are ovoid granules limited by a single membrane.
- They contain fine,granular substance.
- Its diameter is 0.6 to 0.7µm.
- The number of peroxixomes per cell varied between 70 and 100.
- In many tissues peroxixomes show a crystal-like body made of tubular subunits.
- Peroxisomes are created by taking in proteins and lipids from the **cytoplasm** of the cell.



Electron micrograph of peroxisome



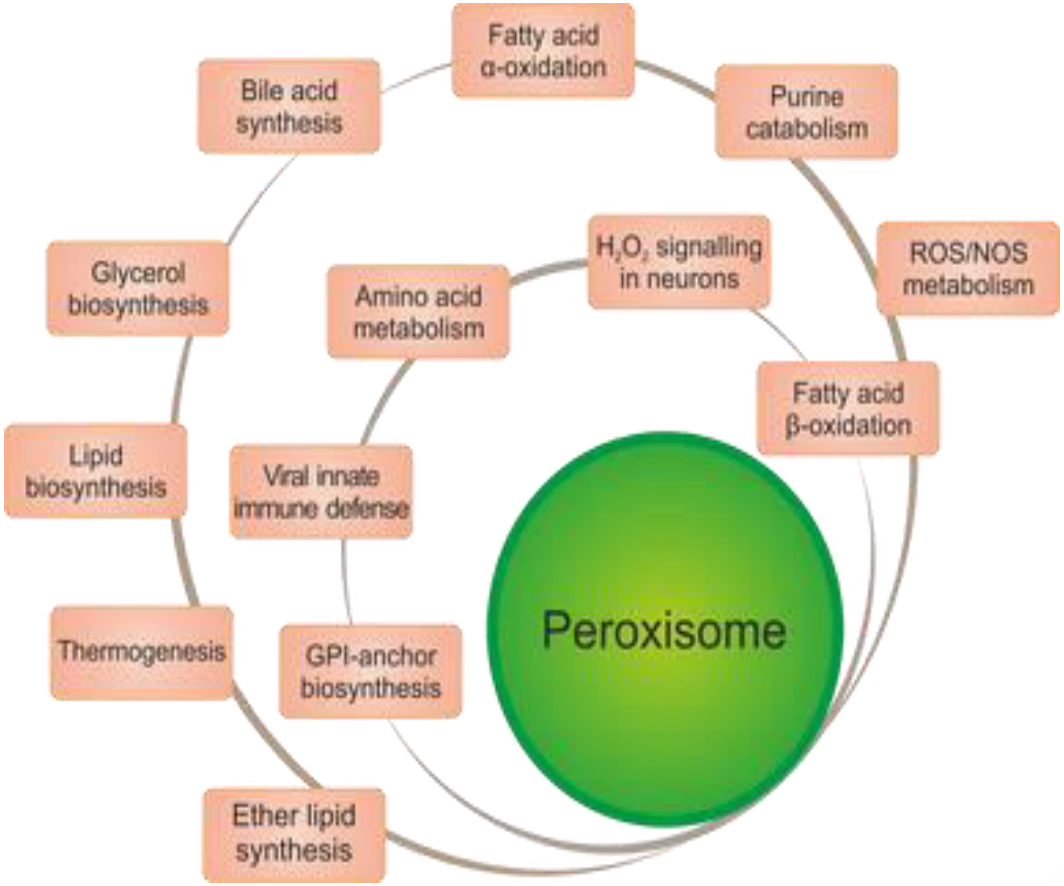
- The influx of proteins and lipids makes the peroxisome grow in size.
- Once the peroxisome is large enough, it divides through fission to create two peroxisomes.
- They are bound by a single membrane instead of a double membrane like most organelles.
- It is a single membrane-bound organelle with lipids and proteins that act as enzymes.
- Peroxisome as a whole grows slowly and is destroyed by autophagy with a life span of 5 to 6 days.

Functions

- **Peroxisomes are involved in catabolism of :**
- **Very long chain fatty acids,**
- **Branched chain fatty acids**
- **D-amino acids, and polyamines**
- **Reduction of reactive oxygen species – specifically hydrogen peroxide.**
- **And biosynthesis of plasmalogens.**
- **They also contain approximately 10% of the total activity of two enzymes in the pentose phosphate pathway, which is important for energy metabolism.**

- **Other known peroxisomal functions include the glyoxylate cycle in germinating seeds ("glyoxysomes").**
- **photorespiration in leaves,**
- **glycolysis in trypanosomes("glycosomes"),**
- **and methanol and/or amine oxidation and assimilation in some yeasts.**
- **Peroxisomes Use Molecular Oxygen and Hydrogen Peroxide to Perform Oxidative Reactions.**

- Like mitochondria, peroxisomes are major sites of oxygen utilization.
- Peroxisomes might have served to lower the intracellular concentration of oxygen, while also exploiting its chemical reactivity to perform useful oxidative reactions.



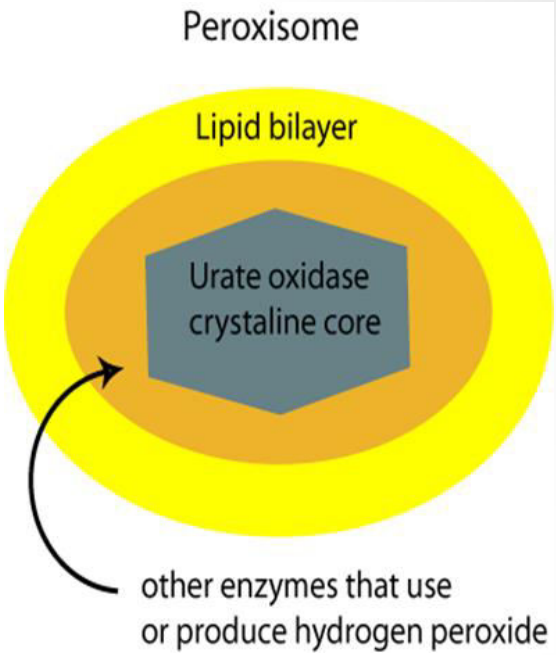
Microperoxixomes

- In contrast to the core containing peroxixomes found in liver and kidney
-
- Others that are smaller and lack a core.
- Lack core
- Found in all cells..

Mixed model of peroxixome biogenesis:

- Their membrane proteins are mainly synthesized on membrane-bound ribosomes.
- The peroxixomal enzymes are made in the cytosol on free ribosomes and are translocated into the organelle.
- Most are exists without connection to the ER.

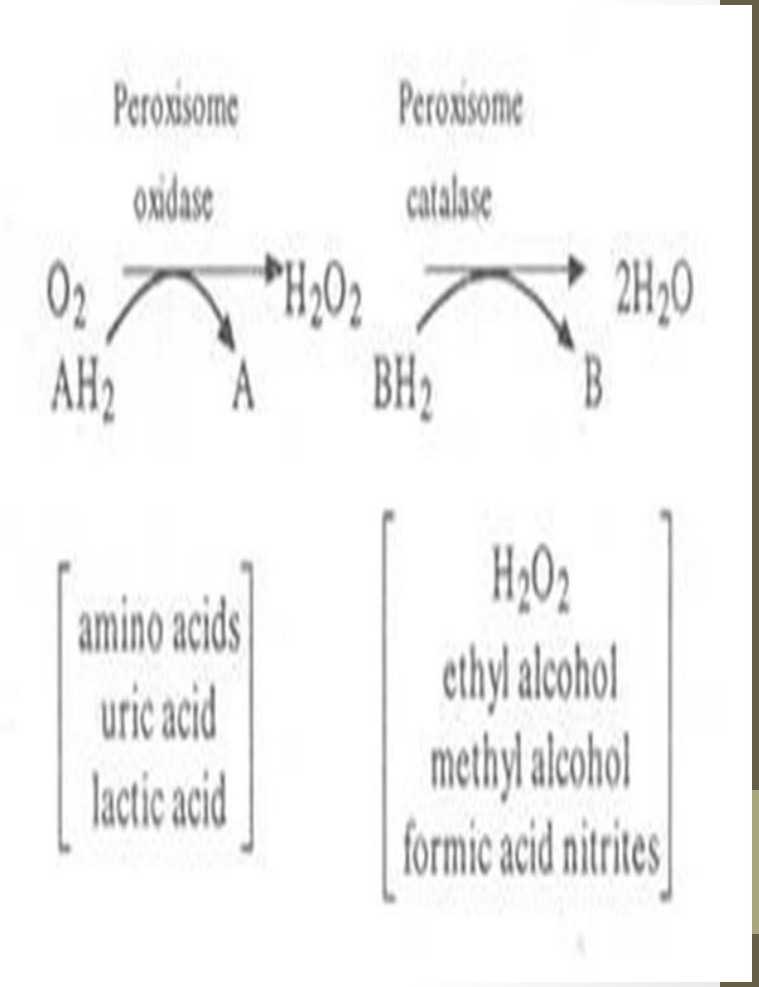
Metabolic Funtions



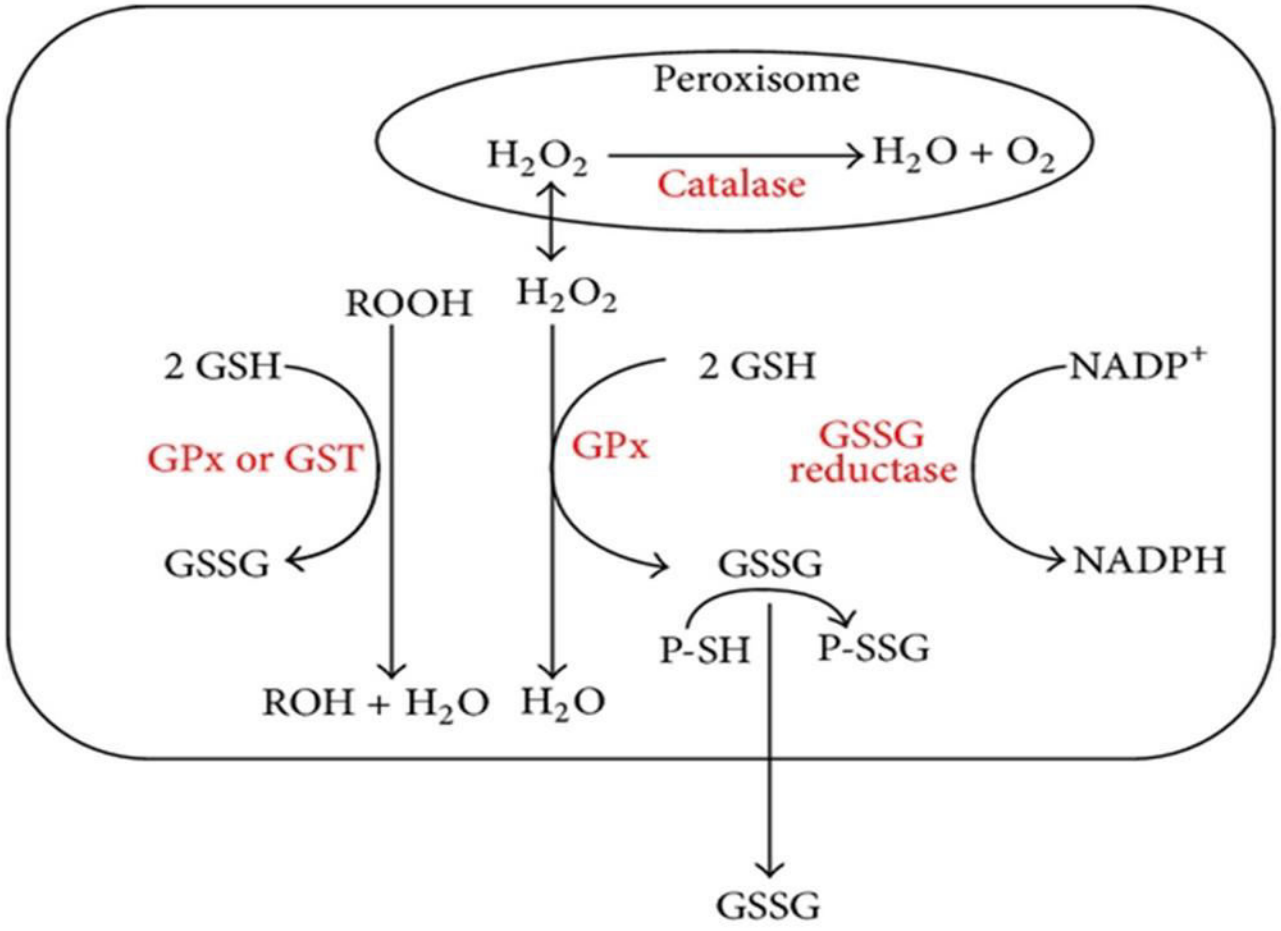
- Beta-oxidation.
- Formation of plasmalogen
- Production of bileacids
- Enzymes of peroxisomes
- Oxidative enzymes
- Enzymes produce H2O2 used by Catalase
- Higher plants anti-oxidative enzymes

Enzymes involved in H2O2 metabolism

- 4 enzymes present
- Urateoxidase
- D-amino oxidase
- α hydroxylic acid oxidase
- Catalase

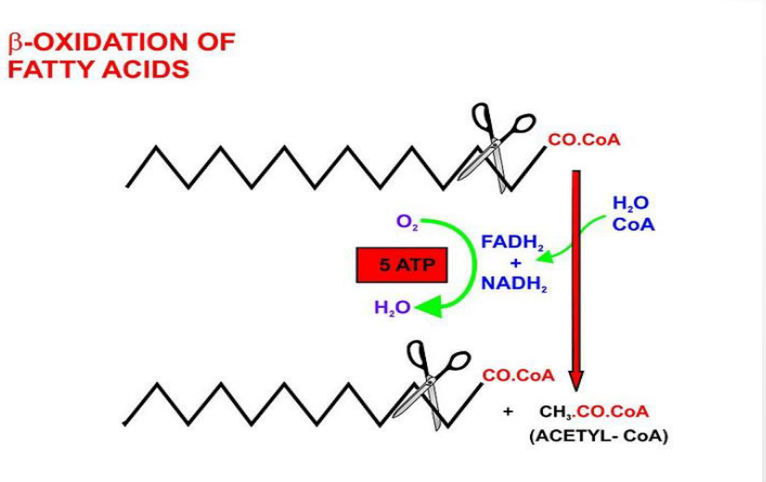


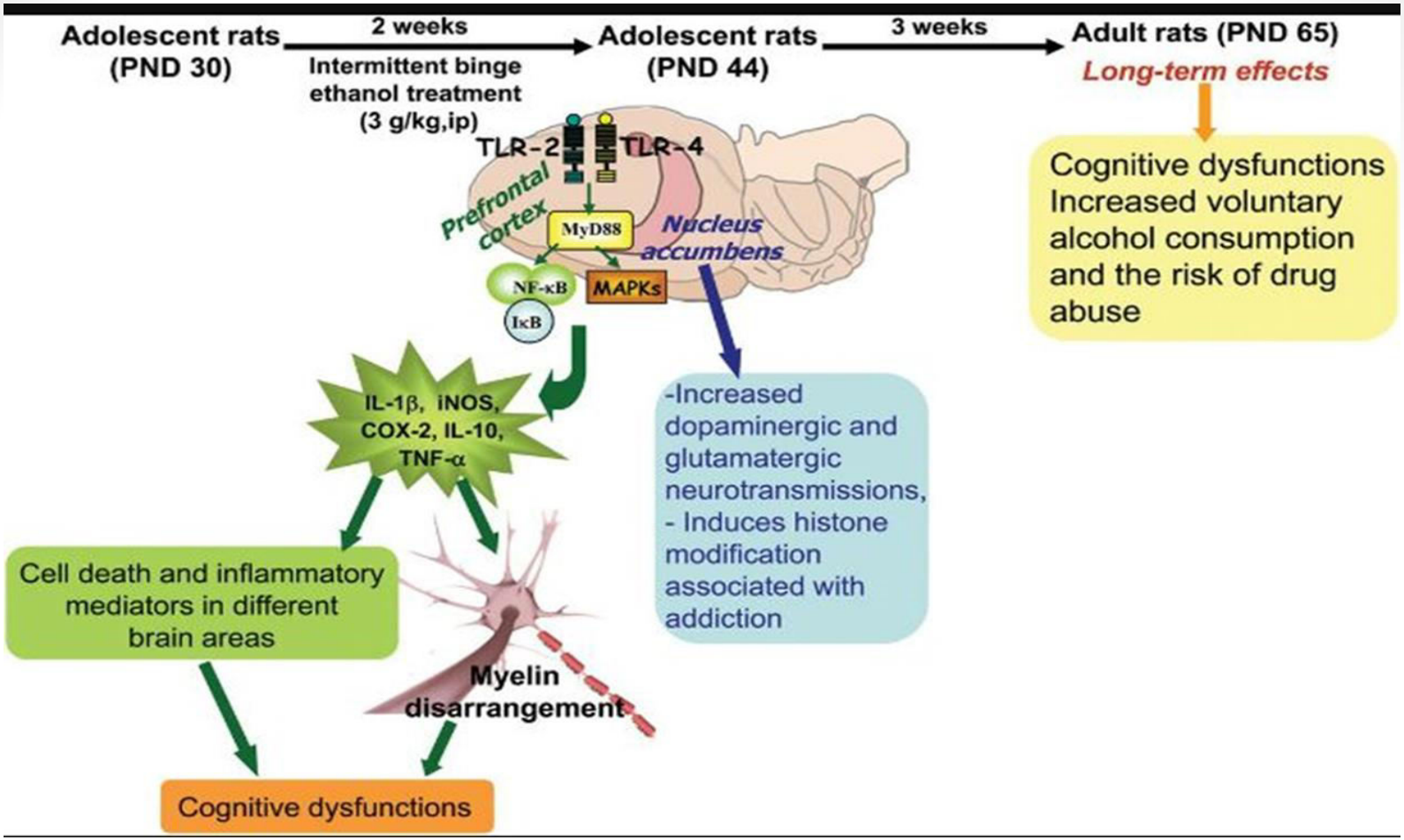
How are hydrogen peroxide molecules formed in a cell?



β-oxidation

- Enzymes synthesized on free ribosome
- Oxidize fattyacid & form Acetyl COA
- Involved in thermogenesis
- Concentrated in brown fat
- Hibernating animals

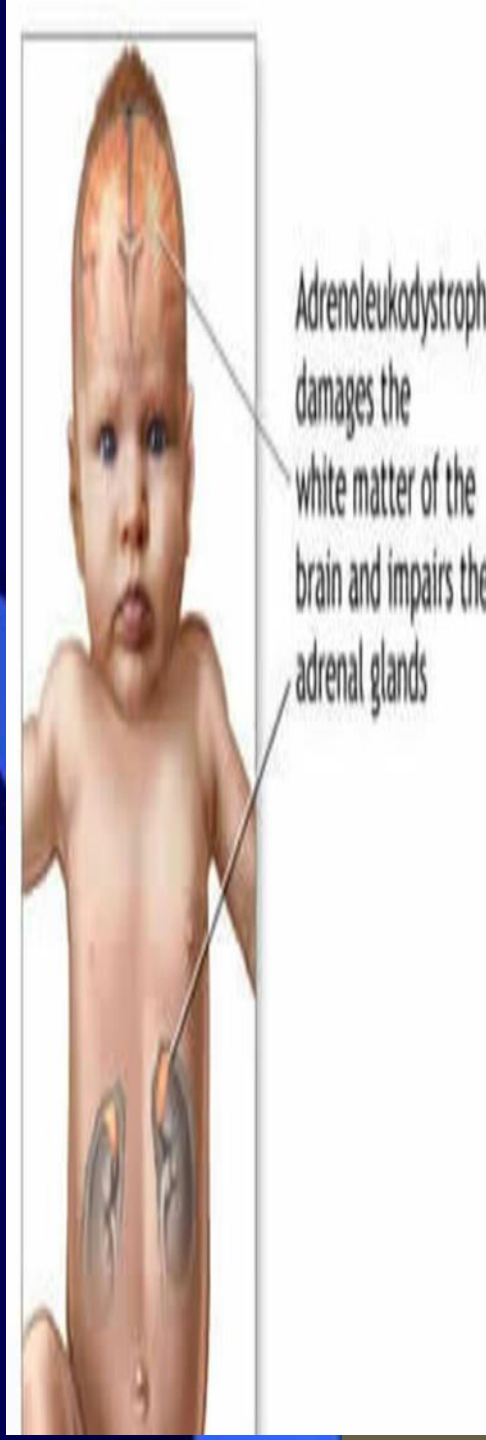




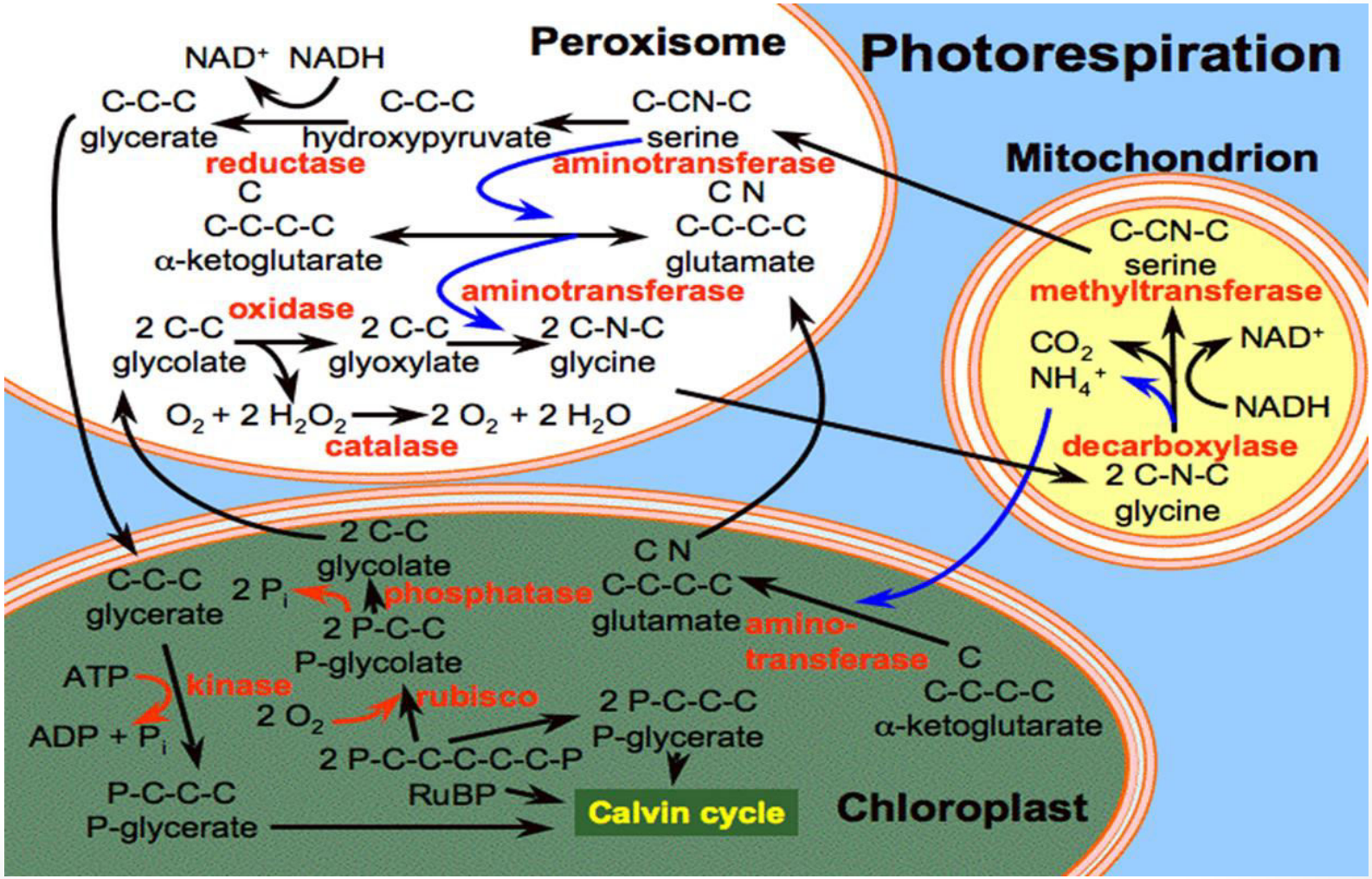
Neuroimmune Activation and Myelin Changes in Adolescent Rats Expose.

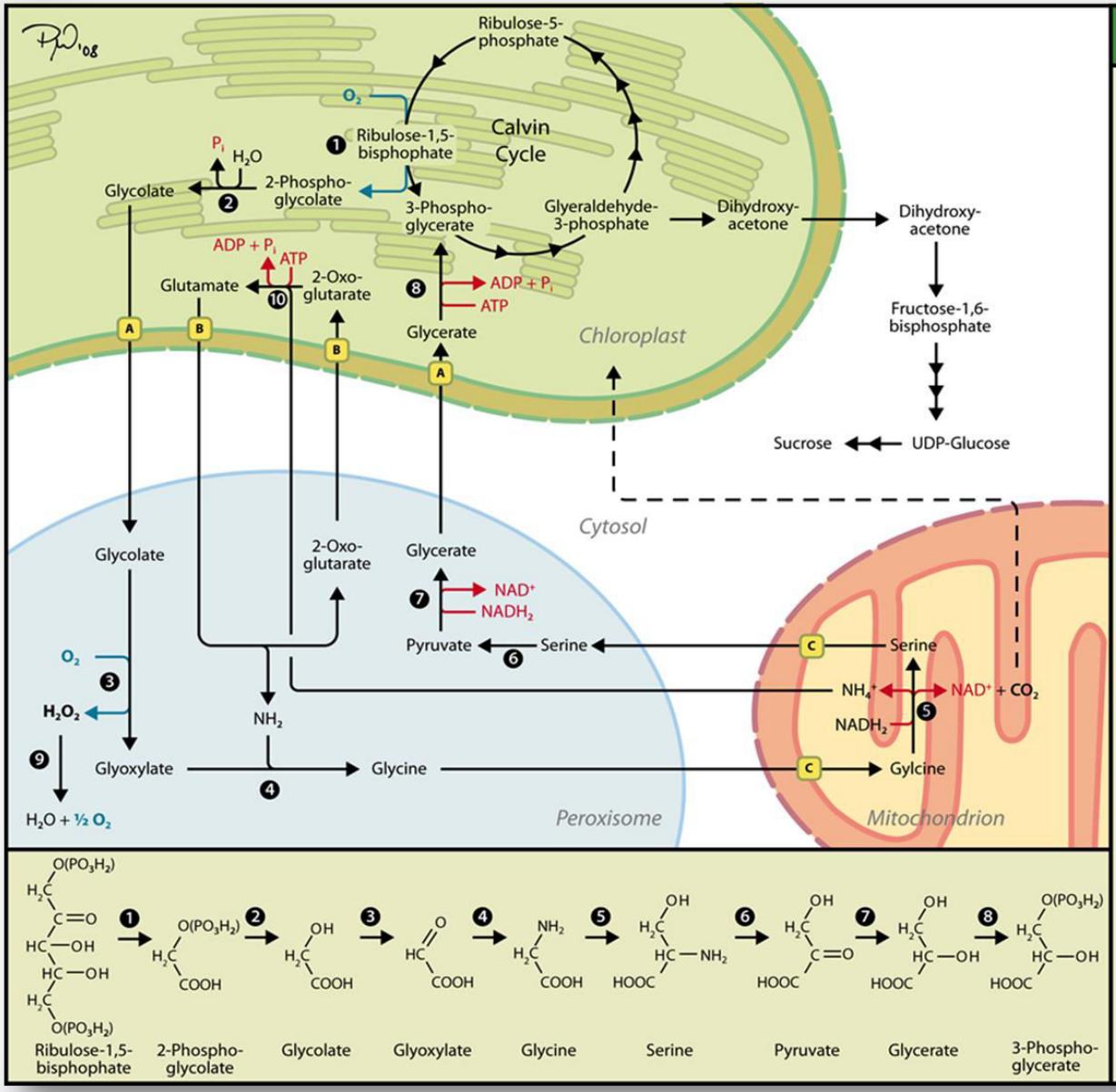
Examples of Peroxisomal Disorders

- Zellweger syndrome – biogenesis defect
- X-linked adrenoleukodystrophy –single protein defect
  - "Lorenzo's Oil"
- Rhizomelic chondrodysplasia punctata – skeletal disorder



Plant peroxisomes respire in the light





Photorespiration

Enzymes

1. RubisCO
2. Phosphoglycolate phosphatase
3. Glycolate oxidase
4. Glutamate-Glyoxylate aminotransferase
5. Glycine decarboxylase complex
6. Serin-Glyoxylate aminotransferase
7. Pyruvate reductase
8. Glycerate kinase
9. Catalase
10. Glutamate synthase & Glutamine synthetase

Translocators

- A Glycerate-Glycolate translocator
- B Malate-Glutamate/2-Oxoglutarate translocator
- C Amino acid translocator

Abbreviations

P_i /(PO_3H_2)	*Phosphate*
ATP/ADP	*Adenintri/diphosphate*
$NADH_2$	*Nicotinamide adinine dinucleotide*
NH_4^+	*Ammonium*
NH_2	*Amino group*
H_2O_2	*Hydrogen peroxide*
RubisCO	*Ribulose-1,5-bisphosphate carboxylase/oxygenase*

Not drawn to scale! Enzymes and some compounds not directly involved in photorespiration are omitted for clarity.

Buchanan BB, Gruissem W, Jones RL (2000). Biochemistry and Molecular Biology of Plants. *Am Soc Plant Phys* (Rockville).

Ribulose-1,5-bisphophate → 2-Phospho-glycolate → Glycolate → Glyoxylate → Glycine → Serine → Pyruvate → Glycerate → 3-Phospho-glycerate

Plants peroxisome

- Functions change with development
- Germinating seeds → act as glyoxysome
- Seed transition → accumulate enzymes for photorespiration
- Leaf → photorespiration

Involvement of Peroxisomes in Biotin Biosynthesis in Fungi

- **Fungi**
- Essential for metabolic processes and physiological functions.
- Involed in
- β-oxidation of fatty acids
- Secondary metabolism
- Glyoxysome formation