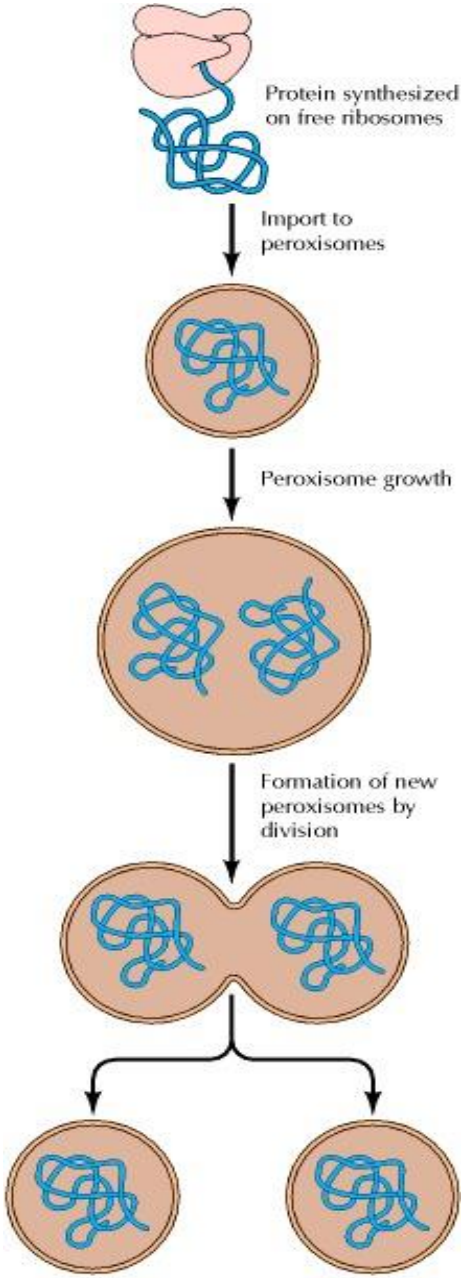
Peroxisome

- **It was first described by a Swedish doctoral student, J. Rhodin in 1954 as microbodies.**
- **Peroxisomes were identified as organelles by the Belgian cytologist Christian de Duve in 1965.**
- **It is a specialized metabolic compartment bounded by a single membrane.**
- **Peroxisomes are small, membrane-enclosed vesicles that provide a safe environment for a variety of reactions in which hydrogen peroxide is used to inactivate toxic molecules.**

Peroxisomes form in two different ways:

- **de novo synthesis by budding from the ER and growth and division of preexisting peroxisomes.**
- **They are assembled from proteins that are synthesized on free ribosomes and then imported into peroxisomes as completed polypeptide chains.**



Proteins destined for peroxisomes are synthesized on free ribosomes and imported into preexisting peroxisomes as completed polypeptide chains. Protein import results in peroxisome growth and the formation of new peroxisomes by division of old ones

- **Peroxisomes are diverse organelles, and even in the various cell types of a single organism they may contain different sets of enzymes.**
- **They can also adapt remarkably to changing conditions.**

➢ **For example:**

Yeast cells grown on sugar, have small peroxisomes But when some yeasts are grown on methanol, they develop large peroxisomes that oxidize methanol.

- **Peroxisomes contain at least 50 different enzymes, which are involved in a variety of biochemical pathways in different types of cells.**

- **Like mitochondria, peroxisomes are major sites of oxygen utilization. Approximately 20% of the oxygen consumption of the liver is used in peroxisomal activity.**

Function

- **Peroxisomes carry out oxidation reactions leading to the production of hydrogen peroxide. Because hydrogen peroxide is harmful to the cell, peroxisomes also contain the enzyme catalase, which decomposes hydrogen peroxide either by converting it to water or by using it to oxidize another organic compound.**
- **Peroxisome enzymes use molecular oxygen to remove hydrogen atoms from specific organic substrates (designated here as R) in an oxidative reaction that produces hydrogen peroxide (H_2O_2):** $RH_2 + O_2 \longrightarrow R + H_2O_2$

- ***Catalase*** **utilizes the H_2O_2 generated by other enzymes in the organelle to oxidize a variety of other substrates including phenols, formic acid, formaldehyde, and alcohol by the "peroxidative" reaction: $H_2O_2 + R' H_2 \rightarrow R' + 2H_2O$**

  This type of oxidative reaction is particularly important in liver and kidney cells, where the peroxisomes detoxify various toxic molecules that enter the bloodstream.

- **In addition, when excess H_2O_2 accumulates in the cell, catalase converts it to H_2O through the reaction:**

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

- **Peroxisomes also have an important role in the synthesis of specialized phospholipids required for nerve cell myelination.**

➢ **In animal cells, cholesterol is synthesized in peroxisomes as well as in the ER.**

➢ **In the liver, peroxisomes are involved in the synthesis of bile acids, which are derived from cholesterol.**

➢ **In addition, peroxisomes contain enzymes required for the synthesis of plasmalogens, a family of phospholipids in which one of the hydrocarbon chains is joined to glycerol by an ether bond rather than an ester bond.**

- **Peroxisomes are also important in plants.**

For example:

- **One type is present in leaves, where it catalyzes the oxidation of a side product of the crucial reaction that fixes CO_2 in carbohydrate, this process is called *photorespiration* because it uses up O_2 and liberates CO_2.**
- **Other type of peroxisome is present in germinating seeds, where it has an essential role in converting the fatty acids stored in seed lipids into the sugars needed for the growth of the young plant.**

Diseases

- **Numerous genetic disorders of peroxisome function have been identified. These can be divided into two categories:**

➢ **The first category includes disorders resulting from a defect in a single peroxisomal enzyme such as X-linked adrenoleukodystrophy (X-ALD).**

In X-ALD, there is an accumulation of very long chain fatty acids in the brain and adrenal cortex because of a defect in a membrane protein that transports these fatty acids into the peroxisomes.

Excess long chain fatty acids in the brain destroy the myelin sheath surrounding nerve cells.

- **The second category is a set of disorders that result from a deficiency in the biogenesis of the peroxisome and affects all of the metabolic pathways of the peroxisome. These disorders are known as peroxisomal biogenesis disorders and include Zellweger's syndrome.**

Zellweger's syndrome is a fatal genetic disorder where the defect lies in an inability to import proteins into the peroxisome.