The Cytology

Dr.Emad Al-Radhi
Ph.D. Molecular cytology

Lysosomes

Definition

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Lysosomes are simple one membrane bound sacs filled with about 40 different hydrolytic digestive enzymes and are particularly abundant in cells with great phagocytic activity(e.g., macrophages, neutrophiles). Although the nature and activity of lysosomal enzymes vary depending on the cell type, the most common are acid hydrolyases such as proteases, nucleases, phosphatases, phospholipases, sulfatasesand ß-glucuronidase.

The Structure & functions of lysosomes

Lysosome bounded by a single lipoprotein membrane. They are globular having a diameter of 0.2 to 0.8 microns. The lipoprotein membrane insulates the enzymes from the rest of the cell (protected) because the enzymes have optimal activity at an acidic pH (~5). Any leaked lysosomal enzymes are practically inactive at the pH of cytosol (~7.2) and harmless to the cell.

Lysosomal enzymes can hydrolyze proteins, fats, polysaccharides, and nucleic acids. These enzymes are synthesized by the Rough Endoplasmic Reticulum (RER) and then sorted into secretory vesicles (lysosomes) in the Golgi apparatus. Material taken from the cellular environment by endocytosis is digested when lysosomes fuse with the membrane of **phagosome or pinocytic vesicle**.

The endocytosed material mixes with the hydrolytic enzymes, a proton pump in the lysosomal membrane is activated to lower internal pH, and digestion follows. The composite structure is now termed a *secondary* or *heterolysosome*. Heterolysosomes are generally 0.2-2μm in diameter and present a heterogeneous appearance in the TEM because of the wide variety of materials they may be digesting .Lysosomes use enzymes to recycle the cell's own organelles and macromolecules, a process called **autophagy** and the lysosome is called **autophagolysosomes**.

The morphological heterogeneity of lysosomes is attributable in part to the fact that they represent various stages in a dynamic process of intracellular digestion. Small granules with relatively homogeneous content are called **primary lysosomes**, an inactive storage form or ready reserve of hydrolytic enzymes not yet involved in digestive events. Somewhat larger bodies with a heterogeneous content that may include recognizable residues of ingested material are heterophagic vacuoles (heterophagolysosomes, or secondary lysosomes) formed by fusion of primary lysosomes with endocytosis vacuoles. As digestion of the contents of the heterophagic vacuoles progresses, they are reduced in size and become residual bodies (mainly contain indigestible lipid materials so it is called *lipofuscin pigmented substances*) filled with granules of varying size and density in an amorphous matrix and usually found in old age cells.

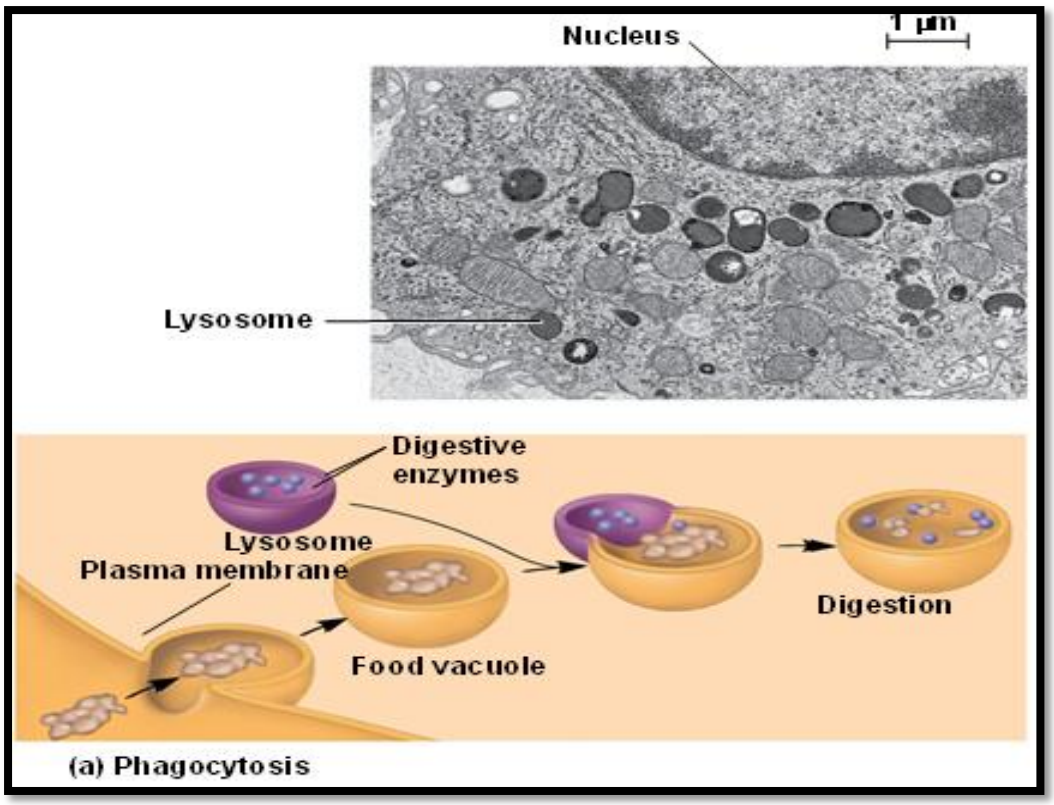

Figure: Phagocytosis by heterophagolysosomes.

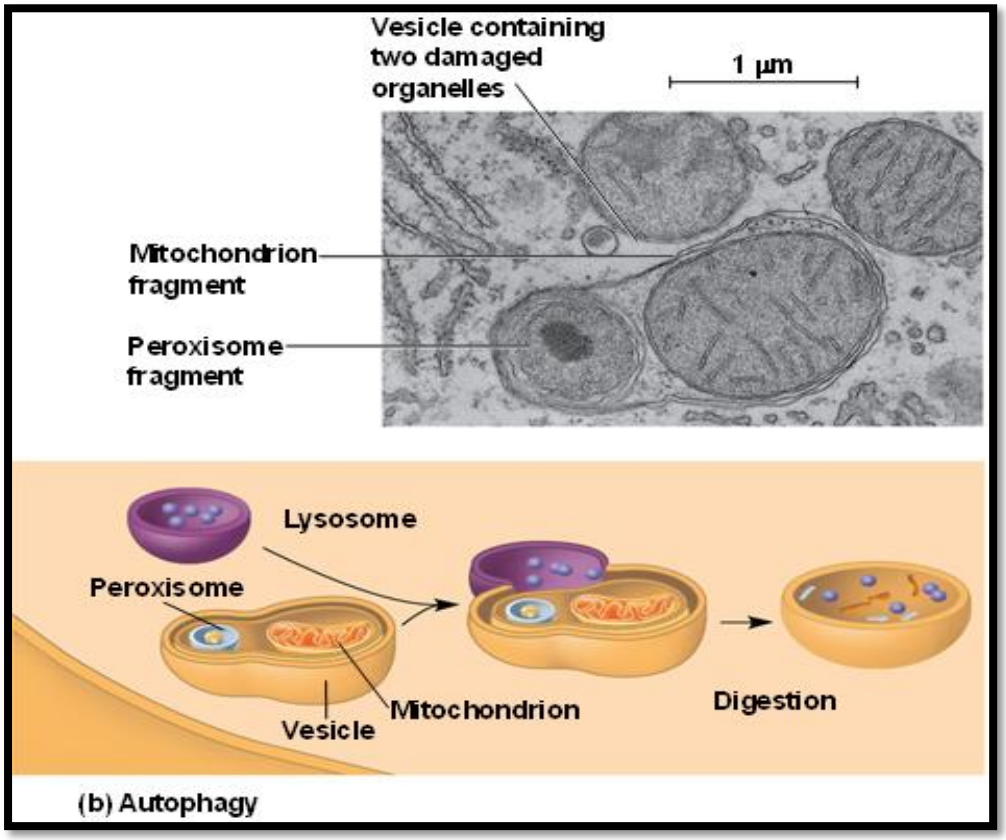

Figure: Phagocytosis by autophagolysosomes.

Peroxisomes or microbodies

Peroxisomes are similar in appearance to lysosomes, but the two have different origins. Lysosomes are generally formed in the Golgi complex, whereas peroxisomes self-replicate. Peroxisomes (microbodies) are spherical, simple membrane-bound vesicle with a diameter of 0.5 um. They uyilize oxygen but do not produce ATP and do not participate directly in cellular metabolism.

Definition

Perixisomes oxidize specific organic substances by removing hydrogen atoms that are transferred to molecular oxygen. Peroxisomes contain enzymes for degrading amino acids and fatty acids. These reactions produce a toxic hydrogen peroxide; (H_2O_2) as a byproduct of cellular metabolism, a substance potentially damaging to the cell which is immediately broken down by **catalase.**

The functions of Peroxisomes

Peroxisomes are multifunctional organelles, containing more than 50 enzymes involved in such diverse activities as the oxidation of very-long-chain fatty acids ***(oxydase***) and the synthesis of **plasmalogens**(abnormal phospholipid).

The peroxisomes of the liver and kidney are particularly large and abundant, reflecting the functions of these organs in lipid metabolism and management of metabolic waste products.

The Main functions of peroxisomes are :

1- Hydrogen peroxide (H_2O_2) is a poison, but the peroxisome has enzyme that converts H_2O_2 to water.
2- Some peroxisomes break fatty acids down to smaller molecules that are transported to mitochondria for fuel.
3- They detoxify alcohol and other harmful compounds,thus, it exists extensively in the liver cells.
4- Initiate the production of phospholipids, which are typically used in the formation of membranes.
5- Peroxisomes also play a role in the production of bile acids and proteins.

Vesicles are small, membrane bound storage sacs. They can be used to move materials into or out of the cell. While the vacuoles are bigger storage sacs.

Centrosome

Centrosome is a zone of cytoplasm, usually centrally located in the cell adjacent to the nucleus and often surrounded by the Golgi apparatus. The centrosome acts as a nucleation center for microtubules which radiate from here towards the cell periphery. It contains a pair of **centrioles**embedded in a matrix of tubulin subunits, and are arranged with their long axes at the right angles to each other.

Centrioles are rod-shaped bodies near the nucleus that functions in cell division. They help to organize the cell and divide the cell contents during this process. Centrioles act as **microtubule organizing center** for the microtubules of the spindle which controls distribution of chromosomes to the daughter cells .

The Structure of centriole

Each centriole is cylindrical in form, consisting of nine triplets of parallel microtubules. The pattern is so named because a ring of nine microtubules (triplets) are arranged at right angles to one another. Each triplet consist of an inner (complete) microtubule (A), which is circular in cross section, and two further (incomplete) microtubules (B and C), which are C shaped .

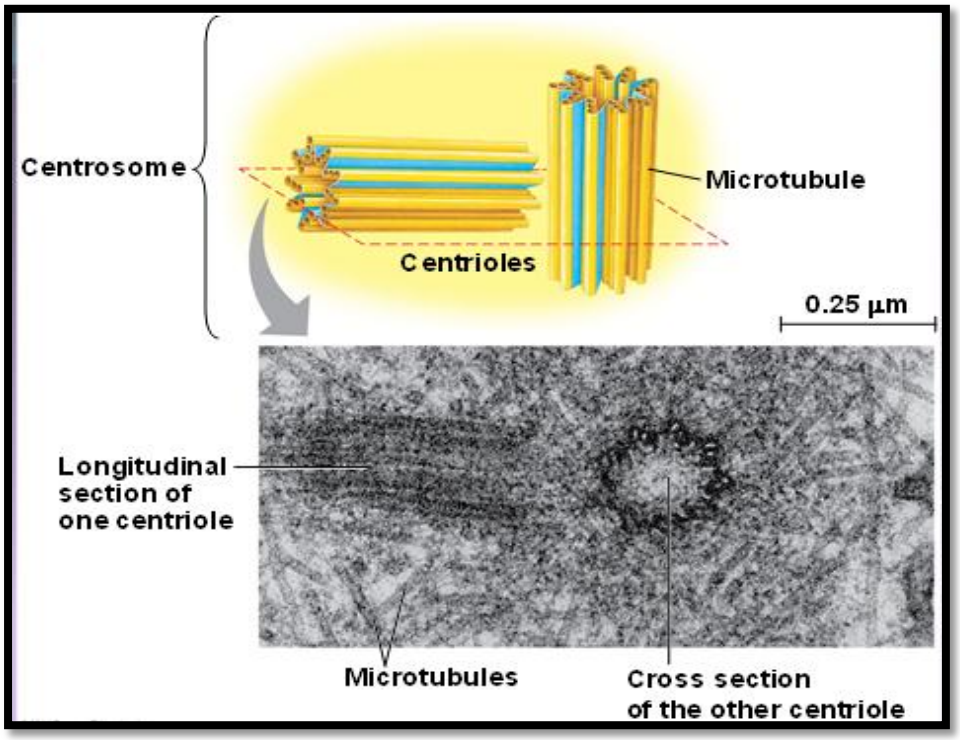

Figure : Structure of centriole

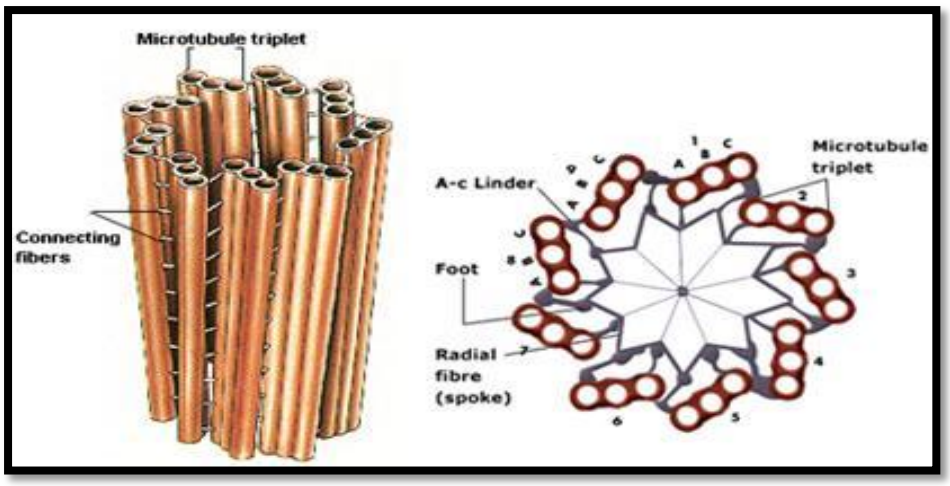

Figure : Ultrastructure of the centriole.

Centrioles replicate in interphase stage of mitosis and they help to organize the assembly of microtubules during cell division. Centrioles called (basal bodies) that form cilia and flagella.

Centrioles and basal bodies

Basically these are the same thing; a centriole is made up of nine (9) sets of triplet microtubules. A centriole is commonly found in the centrosome. The centriole is a short cylinder-like structure while Basal bodies are commonly found just beneath the plasma membrane. Centrioles seem to determine the position of the pericentriolar material, which in turn affects the polarity of the cell.

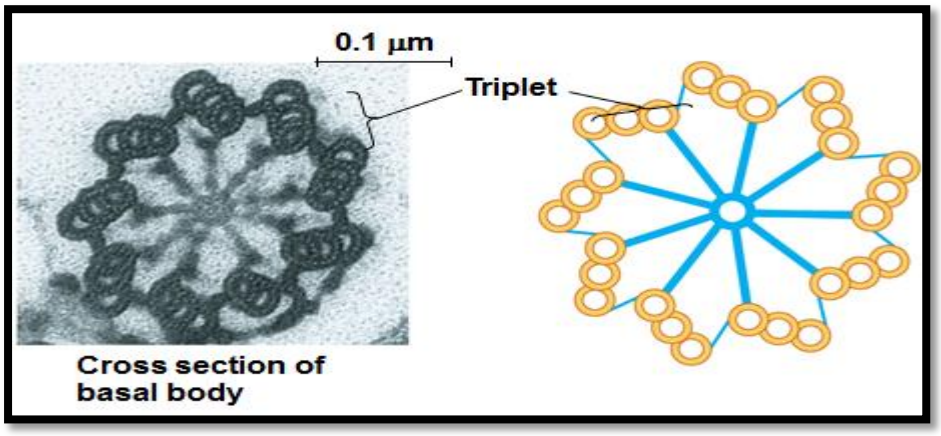

Figure : Basal body and centriole structure.