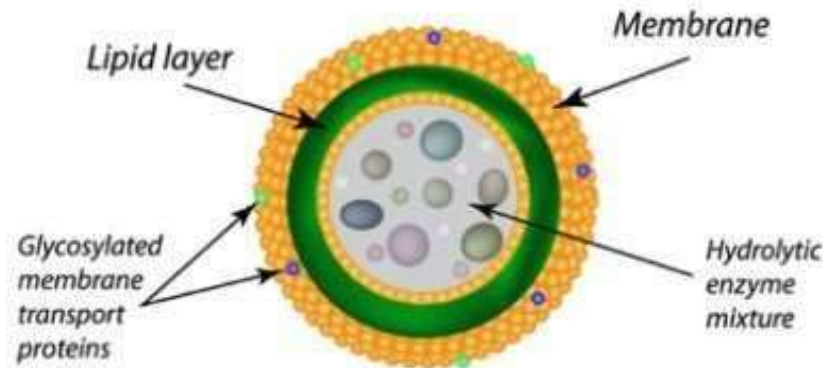


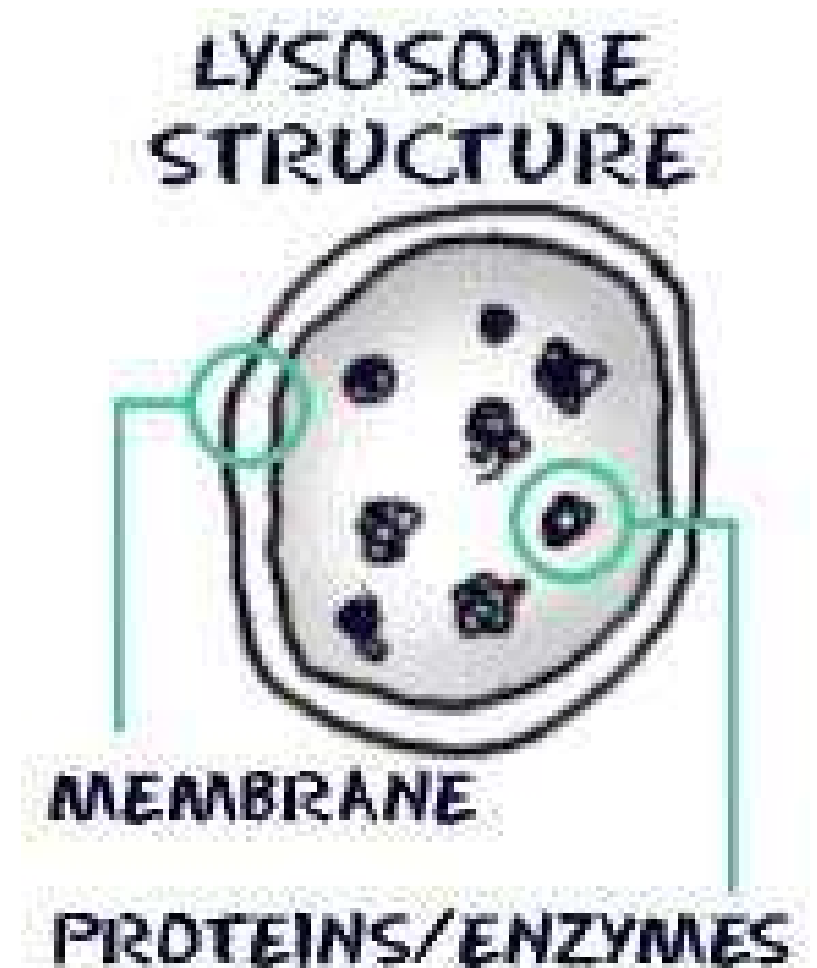
LYSOSOMES

Lysosome

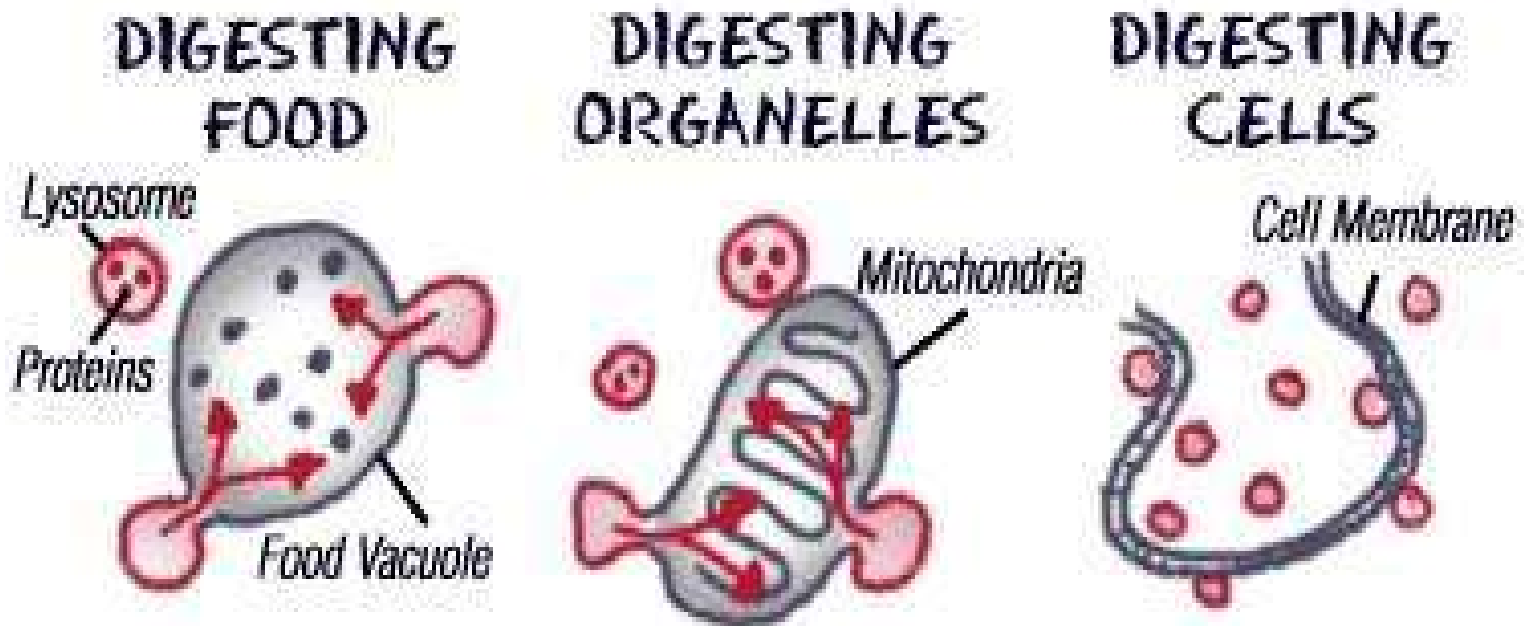


Introduction

- Lysosomes are cell organelles found both in plant and animal cells as well as in protozoa but they are absent in bacteria (which have periplasmic space instead of lysosomes), located between the plasma membrane and the cell wall which plays a role similar to lysosomes.
- In 1949, De Duve using cell fractionation technique, isolated a class of particles which were found to have a high content of ACID PHOSPHATASE and other HYDROLYTIC ENZYMES. Because of these hydrolytic properties these particles were called LYSOSOMES (Gr lysis = dissolution; soma = body)



- Lysosomes are an animal cell's digestive organelles and its main function is **INTRACELLULAR and EXTRACELLULAR DIGESTION**. These organelles function in one of the following ways:
- Digestion of food or various materials taken by phagocytosis or pinocytosis .
- Digestion of parts of the cell by Autophagy (Auto= self ; Phagy =eating)
- Breakdown of extracellular material by the release of enzymes into the surrounding medium.



Properties of lysosomes

- A typical lysosome contains at least 50 different hydrolytic enzymes (produced in the RER and targeted to this organelle)
Taken together lysosomes can hydrolyze virtually every type of biological macromolecule.
- All these enzymes share an important property i.e; all of them have their optimal activity at an acidic pH and therefore are **ACID HYDROLASES**. This pH optima of the enzymes is suited to the low pH of the lysosomal compartment which is approx. 4.6.



- An important property of lysosomes is their STABILITY in the cell. THE ENZYMES ARE ENCLOSED IN A MEMBRANE AND ARE NOT READILY AVAILABLE TO THE SUBSTRATE.
- The yield of enzymes is low after mild homogenization but increases when the particles are treated with hypotonic solutions.
- This LATENCY of lysosomal enzymes is due to the presence of membranes.
- Lysosomal membranes contain a variety of highly glycosylated integral proteins whose carbohydrate chains form a protective lining which shields the membrane from attack by the enclosed enzymes and also protects the rest of the cell from the destructive effects of the enzyme.
- Under pathological conditions the membrane becomes labile with catastrophic consequences.

Lysosomal enzymes:

1. HYDROLASES ACTING ON ESTER BONDS:

- I. Arylestrase
- II. Acid phosphatase
- III. Phosphodiesterase I
- IV. Triglycerol lipase
- V. Phospholipase A₁
- VI. Phospholipase A₂
- VII. Cholestrol esterase
- VIII. Deoxyribonuclease II
- IX. Ribonuclease II
- X. Sphingomyelin phosphodiesterase
- XI. Arylsulphatase A
- XII. Arylsulphatase B
- XIII. Chondroitin sulphatase

2. HYDROLASES ACTING ON GLYCOSYL COMPOUNDS:

- I. Lysozyme
- II. Neuroaminidase
- III. Alpha glucosidase
- IV. Beta glucosidase
- V. Alpha galactosidase
- VI. Beta galactosidase
- VII. Alpha mannosidase
- VIII. Beta mannosidase
- IX. Alpha-N-acetylglucosaminidase
- X. Beta-N—acetylglucosaminidase
- XI. Alpha-N-acetyl galactosaminidase
- XII. Beta-N-acetyl galactosaminidase
- XIII. Alpha-L-fucosidase
- XIV. L-iduronidase

POLYMORPHISM

- The most remarkable morphological characteristic of lysosome is its **polymorphism** regarding its size and its internal structure
- According to the current interpretation , polymorphism is the result of primary lysosome with the different materials which are phagocytized by the cell.
- At present , four types of lysosomes are recognized of which only the first one is **PRIMARY LYSOSOME** and the other three may be grouped as **SECONDARY LYSOSOMES**.

1) Primary lysosomes :

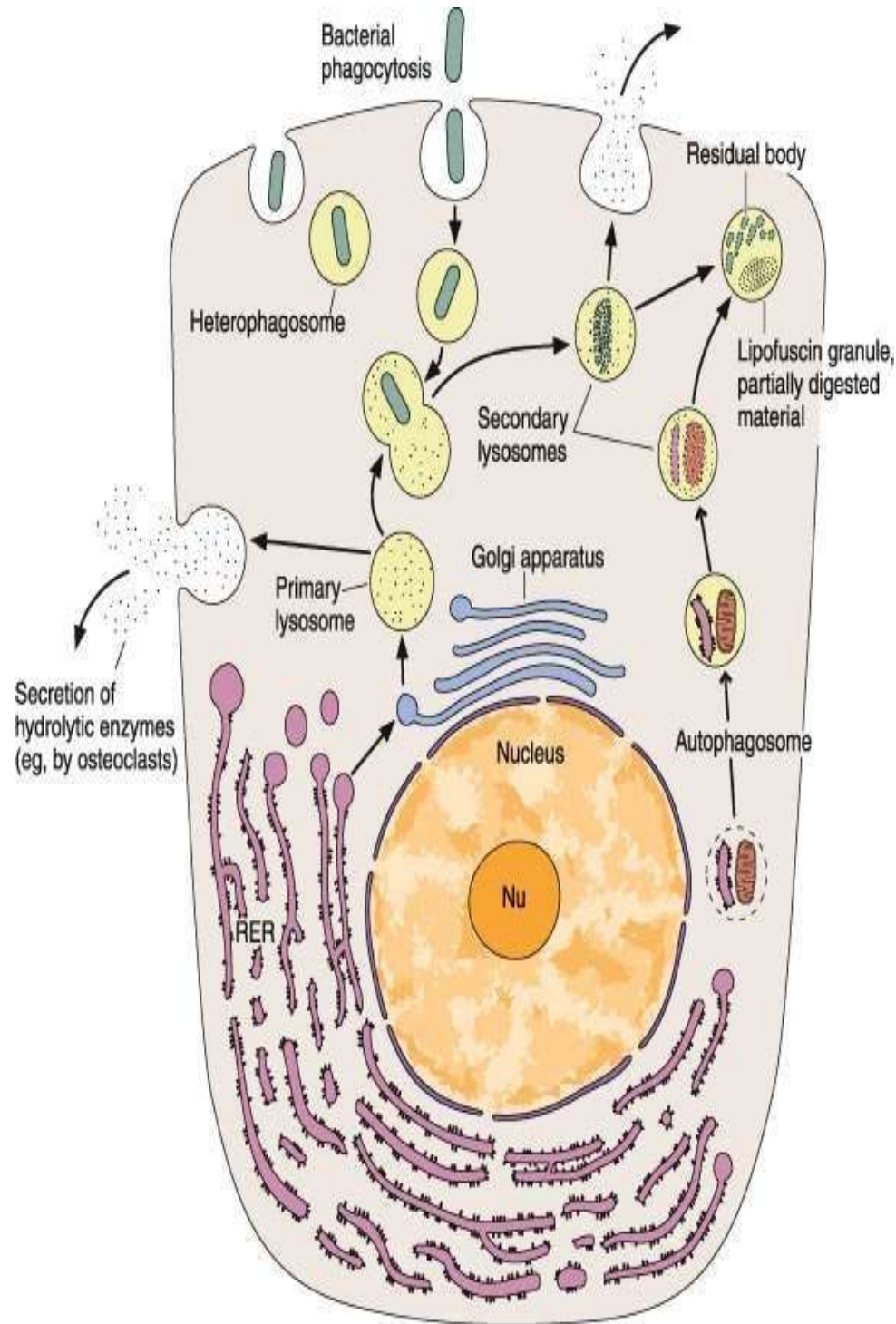
- This is a small body whose enzymatic content is synthesized by the ribosome. From there the enzymes penetrate via the E.R to the Golgi complex, in which the first acid phosphatase reaction takes place. The primary lysosome may be charged preferentially with one type of enzyme.

2) Secondary lysosome :

- Full complement of acid hydrolases is present in them. The secondary lysosomes are the following types:

a) Heterophagosome / Digestive vacuole :

- This results from the phagocytosis or pinocytosis of foreign material by the cell. The digestive vacuole contains positive phosphatase reaction. The engulfed material is progressively digested by the hydrolytic enzymes which have been incorporated into the lysosome.
- Under ideal conditions, digestion leads to products of low molecular weight, which pass through the lysosomal membrane and are incorporated into the cell to be used again in many metabolic pathway.



b) Residual Body

- This is formed if the digestion is incomplete. In amoeba and other protozoans, the residual body is eliminated by defecation. In other cells, they may remain for a long time within the cytoplasm as a lipofuscin granule.

c) Autophagic vacuole/ cytolysosome/ autophagosome

- Lysosomes regularly engulf bits of cytosol which is degraded by a mechanism called Microautophagy
- During starvation the liver cells show numerous autophagic vacuole. This is a mechanism by which cell degrades its own constituents such as mitochondria and ER



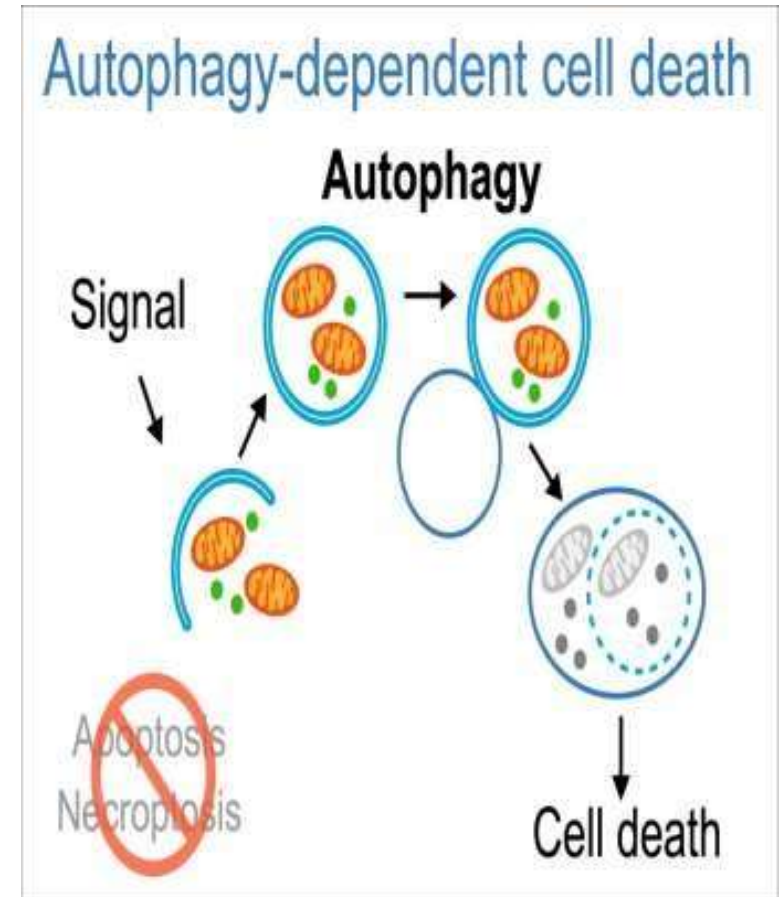
Functions of lysosomes

1. Intracellular Digestion

- Within the secondary lysosomes, the ingested material or those resulting from autophagy are subjected to reaction of many hydrolases. Carbohydrates are hydrolysed to monosaccharides, proteins into dipeptides

2. Autophagy

- lysosomes bring about the renovation and turn over of cell components. Cytoplasmic organelles become surrounded by membranes of SER and lysosomal enzymes are discharged into the autophagal vacuoles and the organelles are digested. Autophagy is a mechanism by which less important cell components are broken down to facilitate survival

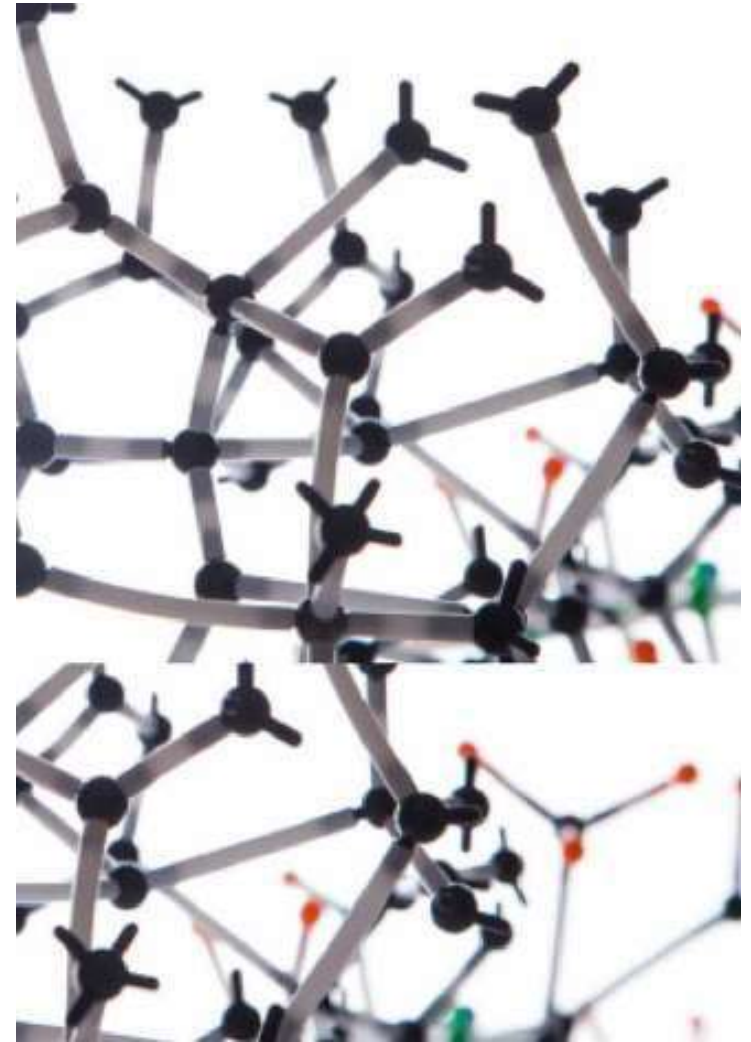


3. Removal of cell and extra cellular material during developmental process

- Lysosomal bring about shedding or remodeling of tissues with the removal of whole cells and extra cellular material during developmental process

4. Release of lysosomal enzymes into the extra cellular medium

- The contents of the primary lysosomes may be released into the extra cellular medium by the process of exocytosis. This process is activated by parathyroid hormone and inhibited by calcitonin



5. Release of thyroid hormone

- Thyroid hormones (T3 & T4) are released from large protein molecule called thyroglobulin stored within the thyroid follicles

6. Leucocyte granules are of lysosomal nature

- All leucocytes of vertebrates contain granules which have many of the lysosomal enzymes. Monocytes have few lysosomes but when they enter the tissue and are transformed into macrophages they gain lysosomes.



Activated macrophage

7. Lysosomes important in germ cells and fertilization

- The acrosome of spermatozoan can be considered as the specialized lysosome which contains PROTEASE and HYALURONIDASE and abundant ACID PHOSPHATE. During fertilization, hyaluronidase disperses the cells of cumulus oophorus and protease digests zone pellucida making a channel through which the sperm nucleus penetrates the egg.
- In eggs lysosomes play a role in digestion of stored reserves

LYSOSOME

