Lysosomes and peroxisomes

Lysosomes are membrane-enclosed organelles that contain an array of enzymes capable of breaking down all types of biological polymers, proteins, nucleic acids, carbohydrates, and lipids. Lysosomes function as the digestive system of the cell, serving both to degrade material taken up from outside the cell and to digest obsolete components of the cell itself. In their simplest form, lysosomes are visualized as dense spherical vacuoles and surrounded by a membrane that maintains an acidic environment within the interior via a proton pump. , but they can display considerable variation in size and shape as a result of differences in the materials that have been taken up for digestion. In plant cells and some protists, the function of lysosomes and many other tasks is performed by vacuoles. Lysosomes were discovered by the Belgian cytologist Christian de Duve in 1955.

Where are Lysosomal Enzymes made?

Lysosomes comprise of over 50 different enzymes. They are synthesized in the rough endoplasmic reticulum. The lysosomal enzymes are classified into six main types namely **Nucleases, Proteases, glycosidases, lipases, phosphatases** and **sulphatases**. All of the enzymes of the lysosome are **acid hydrolases**

Once synthesized, the enzymes are brought in from the Golgi apparatus in tiny vesicles or sacs, which then merges with bigger acidic vesicles.

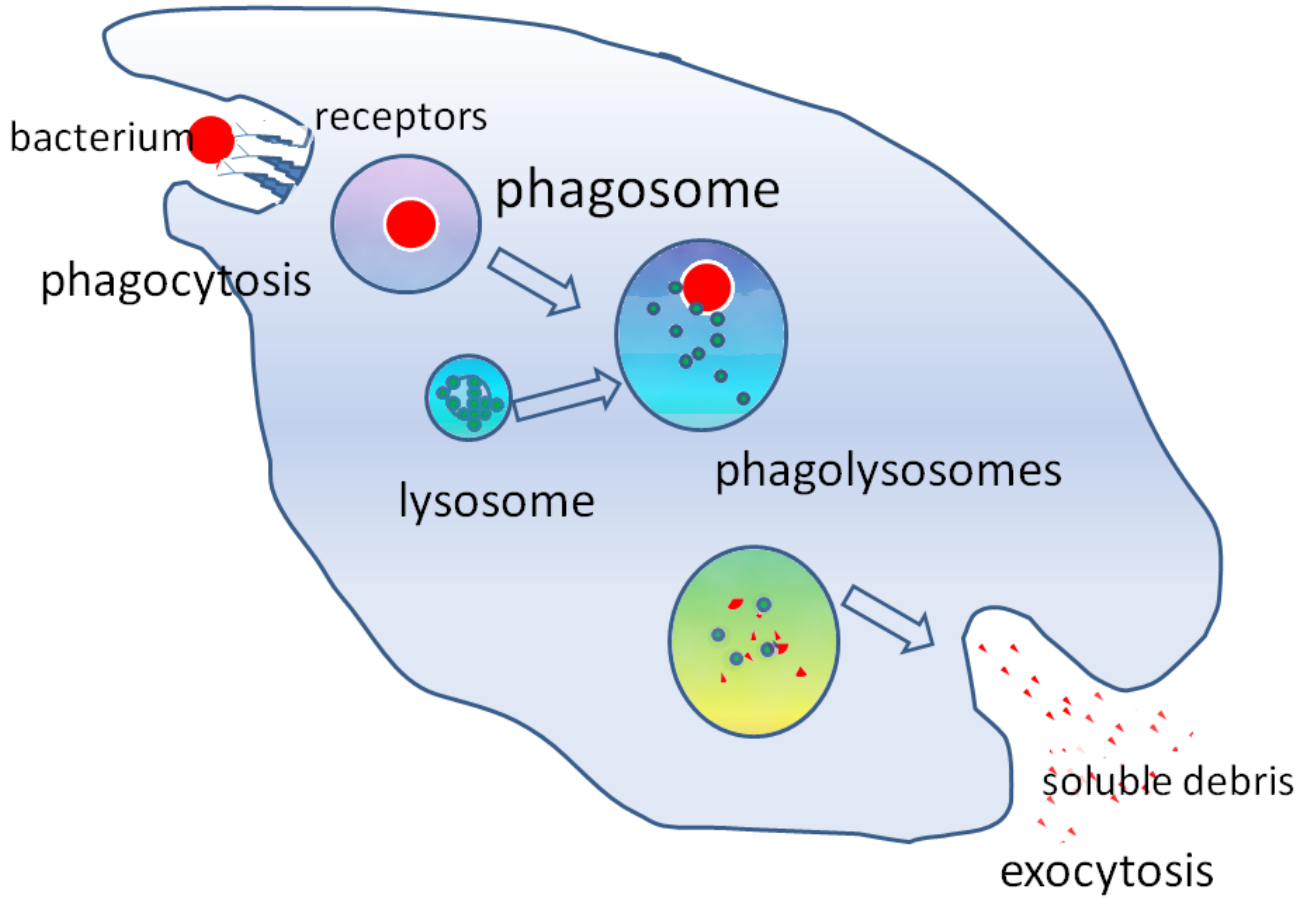
Lysosomes originate by budding off from the membrane of the trans-Golgi network, a region of the Golgi complex responsible for sorting newly synthesized proteins, which may be designated for use in lysosomes, endosomes, or the plasma membrane. The lysosomes then fuse with membrane vesicles that derive from one of three pathways: endocytosis, autophagocytosis, and phagocytosis.

Endocytosis: In this process the cell membrane engulfs portions of the external medium, forms an almost complete sphere around it, and then draws the membrane-bounded vesicle, called an endosome, into the cell. In endocytosis a portion of the plasma membrane is invaginated and pinched off forming a membrane-bounded vesicle called an **endosome or phagosome**. Endocytosis requires energy in the form of ATP and therefore is active processes.

Fate of endosome and phagosome

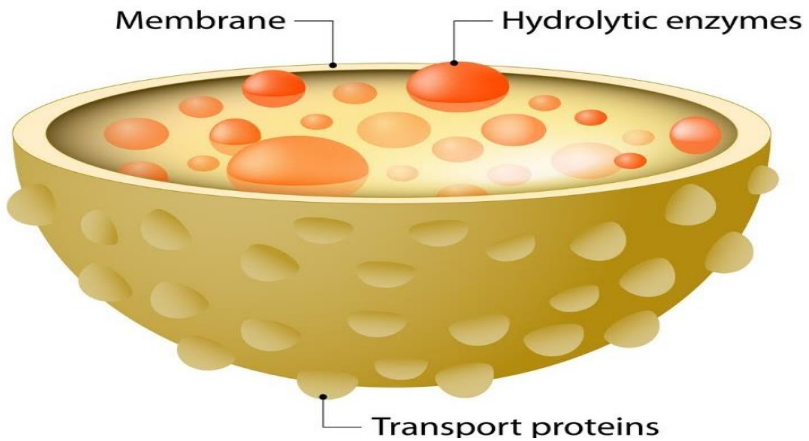
Endosome and phagosome contain useful or harmful materials to the cell, the materials of the endosome and phagosome will lysed by action of enzymes within the lysosome. Therefore, many extracellular particles and molecules ingested by cells end up in lysosomes.

Endocytosis



Autophagy: the degradation of worn, abnormal, or malfunctioning cellular components that takes place within organelles known as lysosomes. Autophagy serves housekeeping functions, enabling the breakdown and recycling of cellular materials, and helps balance energy demands during periods of stress. The term **autophagy** was introduced in 1963 by Belgian cytologist and biochemist **Christian René de Duve**, whose work also provided the first evidence for the involvement of lysosomes in the autophagic process.

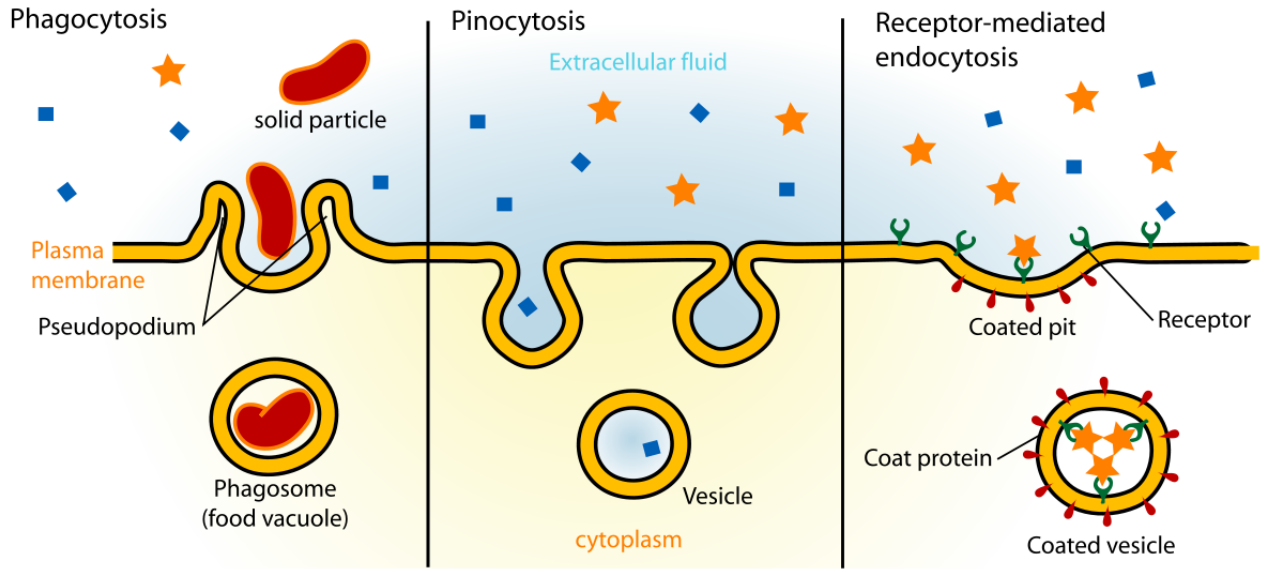
Phagocytosis: process by which certain living cells called phagocytes ingest or engulf other cells or particles. The phagocyte may be a free-living one-celled organism, such as an amoeba, or one of the body cells, such as a white blood cell. In some forms of animal life, such as amoebas and sponges, phagocytosis is a means of feeding. In higher animals phagocytosis is chiefly a defensive reaction against infection and invasion of the body by foreign substances (antigens).

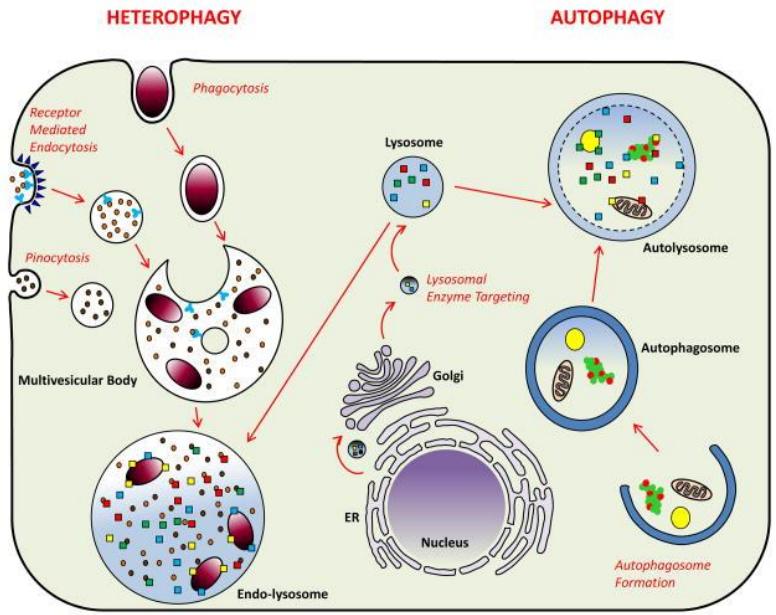


Lysosomes and intracellular digestion

The extracellular particles are taken up, in a process called phagocytosis (cellular eating), into phagosomes, which fuse with lysosomes. Also, the extracellular fluid and macromolecules are taken up, in a process called endocytosis (pinocytosis or cellular drinking), into smaller endocytic vesicles, which deliver their contents to lysosomes via endosomes.

Cells have an additional pathway that supplies materials to lysosomes, which called autophagy. The autophagy is used to degrade old parts of the cell: the cell eats itself. The process involves the surrounding of the organelle with a double membrane, creating an autophagosome, which then fuses with a lysosome. Autophagy of organelles and cytosolic proteins increases when eukaryotic cells are starved.





Heterophagy?

Peroxisomes

Peroxisomes: are small, single-membrane-enclosed organelles that contain enzymes involved in a variety of metabolic reactions, including several aspects of energy metabolism. Although peroxisomes are morphologically similar to lysosomes, they are assembled, like mitochondria and chloroplasts, from proteins that are synthesized on free ribosomes and then imported into peroxisomes as completed polypeptide chains. Although peroxisomes do not contain their own genomes, they are similar to mitochondria and chloroplasts in that they replicate by division.

Peroxisomes (microbodies) were first described by a Swedish doctoral student, J. Rhodin in 1954. They were identified as organelles by **Christian de Duve** and Pierre Baudhuin in 1966. De Duve and co-workers discovered that peroxisomes contain several oxidases involved in the production of hydrogen peroxide (H2O2) as well as **catalase** involved in the decomposition of H2O2 to oxygen and water.

Peroxisome Functions

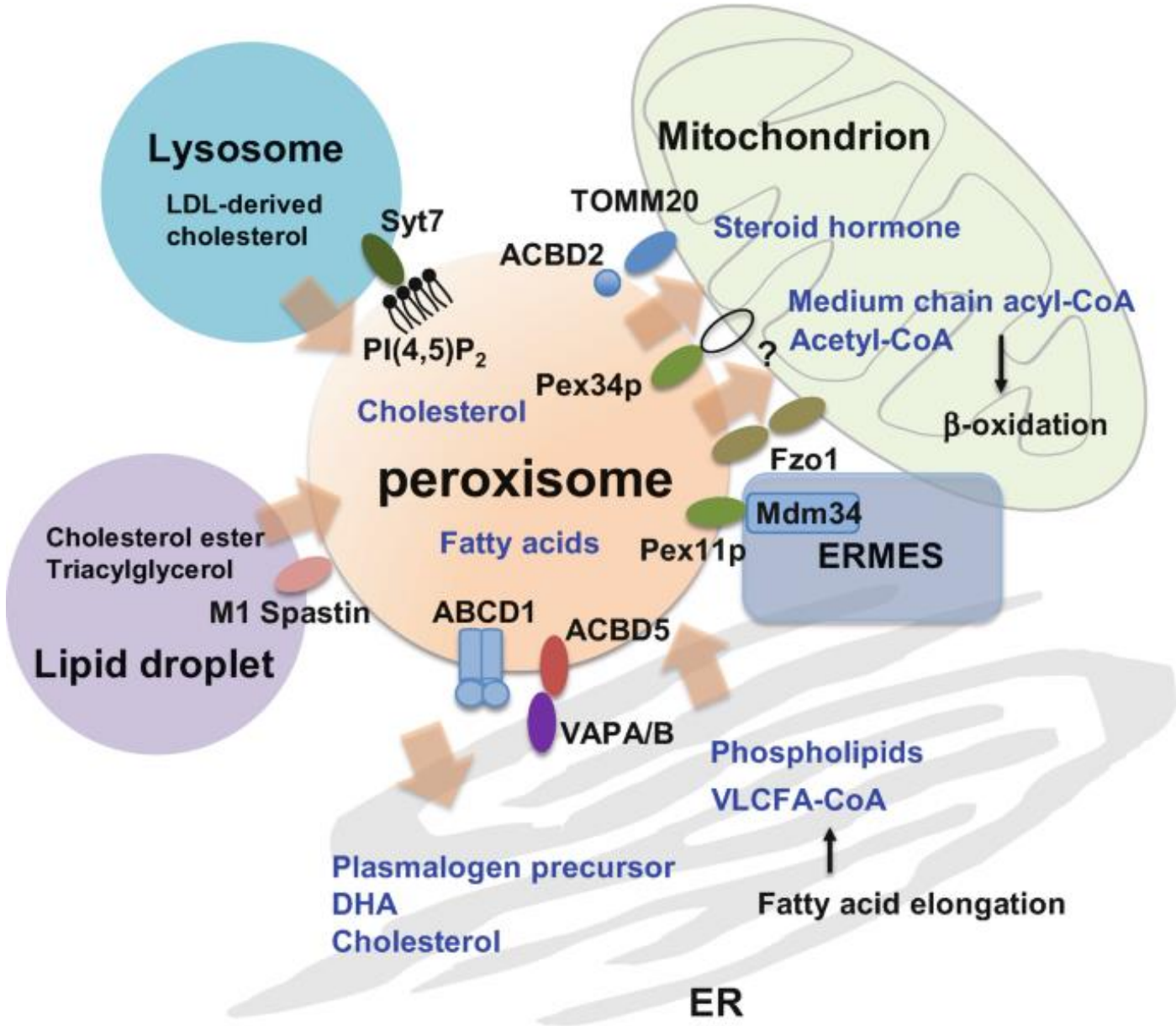
The main function of peroxisome

-They take part in various oxidative processes.

-They take part in lipid metabolism and catabolism of D-amino acids, polyamines and bile acids.

-The reactive oxygen species such as peroxides produced in the process is converted to water by various enzymes like peroxidase and catalase.

-In plants, peroxisomes facilitate photosynthesis and seed germination. They prevent loss of energy during photosynthesis carbon fixation.


Lysosome
LDL-derived cholesterol
Syt7
PI(4,5)P2
Mitochondrion
TOMM20
ACBD2
Steroid hormone
Medium chain acyl-CoA
Acetyl-CoA
?
β-oxidation
Pex34p
Cholesterol
peroxisome
Fzo1
Mdm34
ERMES
Pex11p
Fatty acids
Cholesterol ester
Triacylglycerol
M1 Spastin
Lipid droplet
ABCD1
ACBD5
VAPA/B
Phospholipids
VLCFA-CoA
Fatty acid elongation
Plasmalogen precursor
DHA
Cholesterol
ER