CHPATER 8

8.0 LYSOSOMES.

8.1 Introduction

i) Lysosome are hydrolytic particles – first named lysosomes by deDuve in 1955.
ii) They were first observed in a electronic microscope by Alex Noyikoff.
iii) Lysosomes contain hydrolytic enzymes (lysosomes and enzymes) such ribonuclease, Deoxyribonuclease, glycoronidase , cathepsin etc.

Formation of Lysosomes.

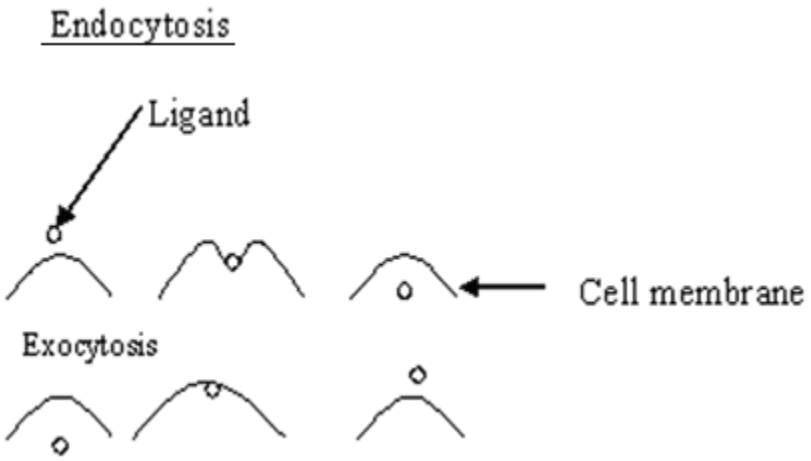
Formed from glucoproteins synthesised by ribosomes. The mannose of these glycoproteins are phosphorylated to produce mannose – 6 – phoshpate groups. The glycoprotein are packaged by Golgi apparatus into vesicles which later become lysosomes.

8.2 Functions of lysosomes.

i) Degrade major biological macromolecules (foreign matter) taken up by endocytosis e.g proteins, nucleic acids, polysaccharides and lipids.
ii) Lysosomes have specific structures which makes them resistant to self – hydrolysis.
iii) Destruction of worn out organelles (autophagy)
iv) Breakdown of cellular structures associated with cell death (autolysis).
v) Digestion of extracellular materials.
v) Used in hydrolysis of proteins difficulty to hydrolyse through proteinaceous chamber pathyway.

8.3 Endocytosis.

This is uptake of extracellular materials trapped in membrane vesicles that pinch off from the plasma membrane.



8.3.1 Definition of some terms

i) Phagocytosis – refers to uptake of materials which form vesicles and consists of large particles (visible by light microscope).

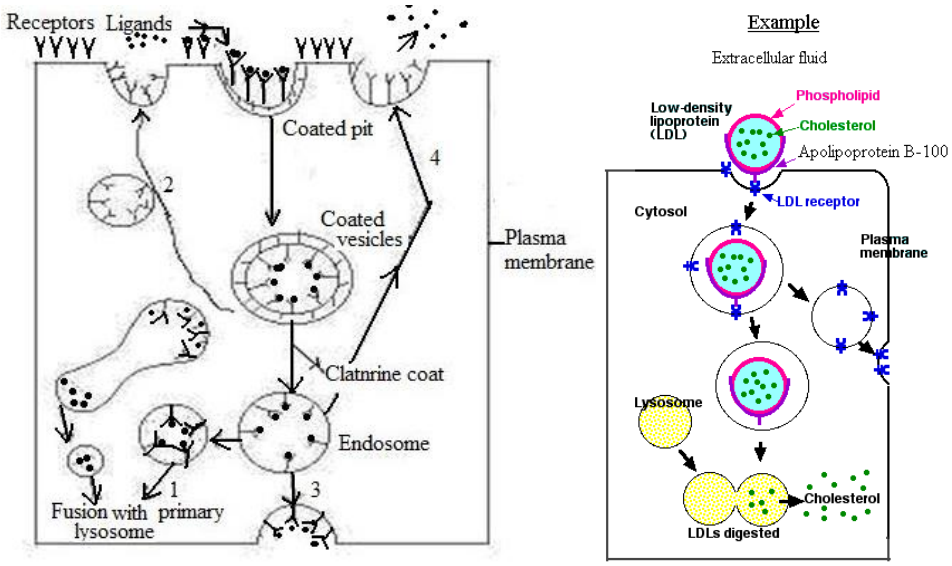
ii) Pinocytosis – refers to uptake of all other matter including small particles and soluble macromolecules such as antibodies, hormones and toxins.
For endocytosis to take place there must be interaction between the material being ingested and the plasma membrane binding site.

iii) Primary lysosomes: Are lysosomes which are not yet involved in digestive activity (have not encountered with endosomes).

iv) **Secondary lysosomes:** Are lysosomes fused with endosome resulting in production of larger vesicles
Residual body – are indigested substances which accumulate in secondary lysosomes.
Residual body are eventually expelled out of the cell by exocytosis (fuse with plasma membrane and expelled out).

8.3.2 Process of receptor mediated endocytocis.

Interaction of ligand with appropriate membrane receptor. Lateral movement of the receptor – ligand complexes toward specific regions of plasma membranes known as coated pits. The coated pits are predominantly on the cytoplasmic surface with a protein called clathrin.



i) Clathrin interacts with other proteins to form a polyhedral cage surrounding the coated pit.
ii) Ligands receptor complexes invaginates and pinches from the plasma membrane releasing the coated vesicles into the interior of the cell.
iii) Clathrin coat is shed off to form uncoated vesicles called an endosome.
iv) Endosome is processed — ligands and receptor may both be degraded or ligands may be degraded and receptor is recycled back into the plasma membrane e.t.c.

v) Microtubules are said to be involved in organized movement of the lysosomes.

Example of Endocytosis; Ingestion and destruction of invading bacteria by polymorphonuclear leukocytes.

i) Bacteria are got by phagocytosis.
ii) Hydrolytic enzymes are discharged in the ingested bacteria to destroy them.
iii) Due to destruction , leukocytes themselves die.
iv) Sometimes bacteria survive inside the phagocytic cells and multiply.

Endocytosis is also useful in uptake of useful extracellular substances into the cell e.g. developing egg cells use endocytosis to accumulate yolk proteins from the blood stream storing these nutrients for use later in embryonic development.

Home work; Explain how the cell destroy foreign material by the process of receptor mediated endocytosis (use diagram).

8.4 Autophagy and Autolysis.

Definition : is a membrane trafficking that delivers cytoplasmic cargo to the vacuoles or lysosome for degradation and recycling (selective destruction of unwanted cellular material). Materials result from aging or damaged organelles.

8.4.1 Types of Autophagy

i) Microautophagy : This operates by protruding or imaginating a portion of vacular membrane to engulf cytosol or organelle e.g. it has been indicated to destroy peroxisomes
ii) Macroautophagy: involve formation of sequestering vesicle in the cytosol. Transport vesicles from macroautophagy are called macroautophagosome. Macroautophagosome employ double membrane mechanism. This enables complete separation of macroautophagosome cargo from cytoplasm environment. Autophagosome fuses with the vacuole to release the inner membrane vesicle, called autophagic bodies in the vacuolar lumen. Hydrolases disintegrate the membrane of autophagic bodies and process their cargo to building blocks for resuse.
iii) Cytoplasmic to vacuole targeting (Cvt) – it is biosynthetic vacuole trafficking pathway similar to macroautophagy pathway. Cvt vesicle is made of a double membrane. It fuses with the vacuole release the inner membrane vesicle, called Cvt bodies in the vacuolar lumen.
iv) Pexophagy : is a selective autophagy of peroxisomes. It operates both as micropexophagy and macropexophagy depending on the environment. It similar to other types of autophagy except that ist cargo is peroxisome.

8.4.1 Advantages.

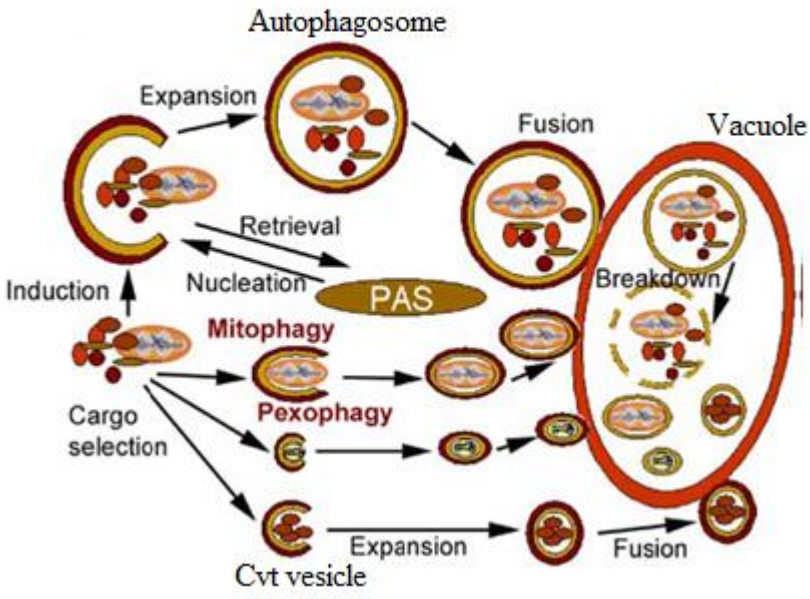
i) Removes unwanted organelles.
ii) Allows chemical building blocks generated during organelles destruction to be recycled for other purposes.

8.4.2 Process of Autophagy

i) Organelles target for destruction are wrapped by one or more layers of smooth Endoplasmic Recticulum to form a autophagic vacuole (resulting vesicle).
ii) Autophagic vacuole fuses with primary lysosome to form a secondary lysosome in which digestion of organelles take place

Autophagic lysosome – refers to secondary lysosome containing materials of intracellular origin
Heterophagic - refers to secondary lysosome containing materials taken by endocytosis.

Autophagy - Cytoplasm to vacuole targeting pathway



8.5 Autolysis

This is the destruction of complete cell structure (rather than selected organelles).

8.5.1 Importance.

Plays important role in the development of certain organ systems and body structures e.g. metamorphosis of a tadpole into a frog requires destruction of tadpole's tail .

8.6 Extarcellular digestion by hydrolytic enzyme.

i) Sometimes hydrolytic enzyme may be in some instances be secreted into the extracellular space. *Example.* During fertilization , penetration of the sperm head through the outer layer surrounding the egg surface is aided by the released hydrolytic enzymes from the Golgi complex of the sperm cell.

ii) Detrimental effects of hydrolytic enzymes released from the cell-Example Vitamin A increases liability of the lysosomal membrane and promotes discharge of hydrolases from the cell.
People who take excess of vitamin A have their connective tissue damaged and spontaneous bone fractures.

8.7 Lysosome storage disease.

Several genetic diseases affecting children are as a result of excessive accumulation of polysaccharide and lipids into the cells.

Example of genetic diseases

i) Type II glycogenosis - result from deficiency of lysosomal enzyme β– glucosidase which catalyses hydrolysis of glycogen to oligosaccharides and glucose. Absence of β – glucosidase cause undigested glycogen to accumulate within the lysosome.

ii) Many defective lysosome enzymes lead to accumulation of glycolipids— Glycolipids are highly concentrated around the brain tissues. Defective lysosomal enzymes for digestion of glycolipids leads to severe mental retardation.