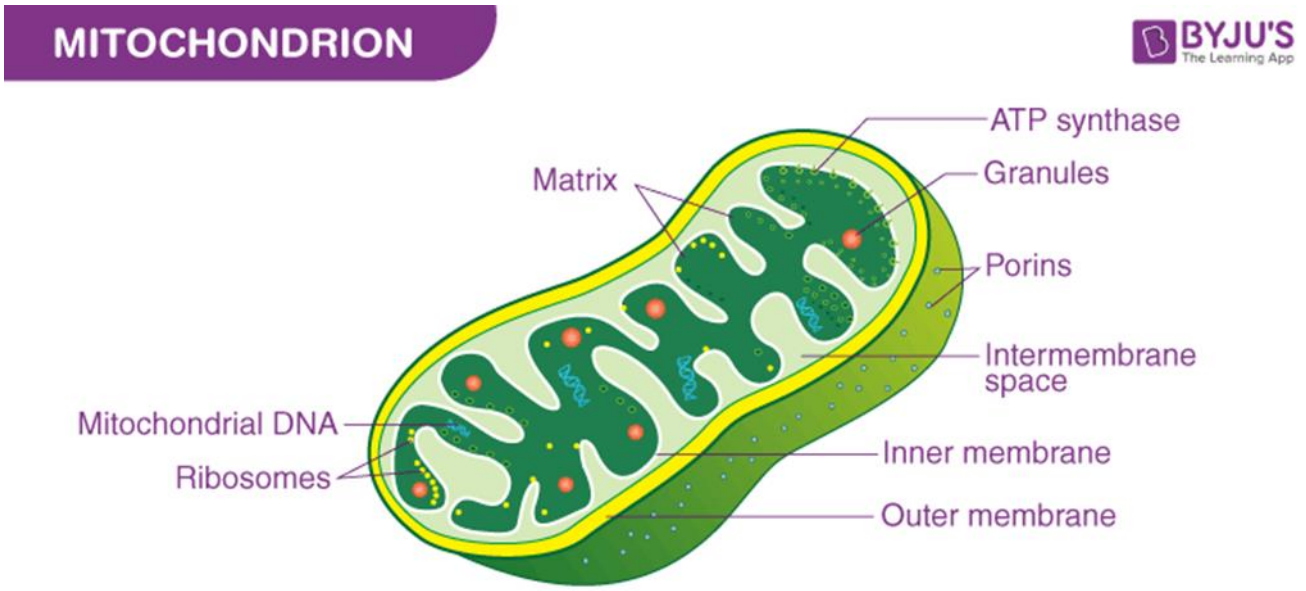
Eukaryotic cell organelles:

- Mitochondria (morphology, structure)

Popularly known as the "**Powerhouse of the cell**," mitochondria (singular: mitochondrion) are a double membrane-bound organelle found in most eukaryotic organisms. They are found inside the cytoplasm and essentially function as the cell's "digestive system."

They play a major role in breaking down nutrients and generating energy-rich molecules for the cell. Many of the biochemical reactions involved in cellular respiration take place within the mitochondria. The term 'mitochondrion' is derived from the Greek words "***mitos***" and "***chondrion***" which means "**thread**" and "**granules-like**", respectively. It was first described by a German pathologist named Richard Altmann in the year 1890.



The diversity of mitochondrial arrangements, which arise from the organelle being static or moving, or fusing and dividing in a dynamically reshaping network, is only beginning to be appreciated. While significant progress has been made in understanding the proteins that reorganise mitochondria, the physiological significance of the various arrangements is poorly understood. The lack of understanding may occur partly because mitochondrial morphology is studied most often in cultured cells. The simple anatomy of cultured cells presents an attractive model for visualizing mitochondrial behaviour but contrasts with the complexity of native cells in which elaborate mitochondrial movements and morphologies may not occur. Mitochondrial changes may take place in native cells (in response to stress and proliferation), but over a slow time-course and the cellular function contributed is unclear. To determine the role mitochondrial arrangements play in cell function, a crucial first step is characterization of the

interactions among mitochondrial components. Three aspects of mitochondrial behavior are described in this review: (1) morphology, (2) motion and (3) rapid shape changes.

Structure of Mitochondria

- The mitochondrion is a double-membraned, rod-shaped structure found in both plant and **animal cell.**
- Its size ranges from 0.5 to 1.0 micrometre in diameter.
- The structure comprises an outer membrane, an inner membrane, and a gel-like material called the matrix.
- The outer membrane and the inner membrane are made of proteins and phospholipid layers separated by the intermembrane space.
- The outer membrane covers the surface of the mitochondrion and has a large number of special proteins known as porins.

Cristae

The inner membrane of mitochondria is rather complex in structure. It has many folds that form a layered structure called cristae, and this helps in increasing the surface area inside the organelle. The cristae and the proteins of the inner membrane aid in the production of ATP molecules. The inner mitochondrial membrane is strictly permeable only to oxygen and ATP molecules. A number of chemical reactions take place within the inner membrane of mitochondria.

Mitochondrial Matrix

The mitochondrial matrix is a viscous fluid that contains a mixture of enzymes and proteins. It also comprises ribosomes, inorganic ions, mitochondrial DNA, nucleotide cofactors, and organic molecules. The enzymes present in the matrix play an important role in the synthesis of ATP molecules.

Functions of Mitochondria

The most important function of mitochondria is to produce energy through the process of **oxidative phosphorylation.** It is also involved in the following process:

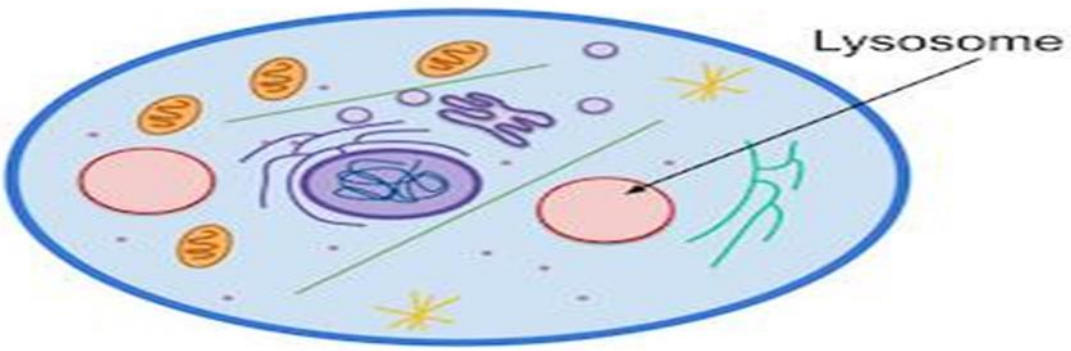
1. Regulates the metabolic activity of the cell
2. Promotes the growth of new cells and cell multiplication
3. Helps in detoxifying ammonia in the liver cells
4. Plays an important role in apoptosis or programmed cell death
5. Responsible for building certain parts of the blood and various hormones like testosterone and oestrogen

6. Helps in maintaining an adequate concentration of calcium ions within the compartments of the cell
7. It is also involved in various cellular activities like cellular differentiation, cell signalling, cell senescence, controlling the cell cycle and also in cell growth.

8. Disorders Associated With Mitochondria
9. Any irregularity in the way mitochondria function can directly affect human health, but often, it is difficult to identify because symptoms differ from person to person. Disorders of the mitochondria can be quite severe; in some cases, they can even cause an organ to fail.
10. **Mitochondrial diseases:** Alpers Disease, Barth Syndrome, Kearns-Sayre syndrome (KSS)

-lysosomes (types, function).

Lysosomes are specialized membrane-bound organelles found in eukaryotic cells, primarily animal cells. They function as the cell's waste disposal and recycling system, breaking down various types of biomolecules through enzymatic digestion. Here's an overview of the types and functions of lysosomes:



Types of Lysosomes:

1. ****Primary Lysosomes****:

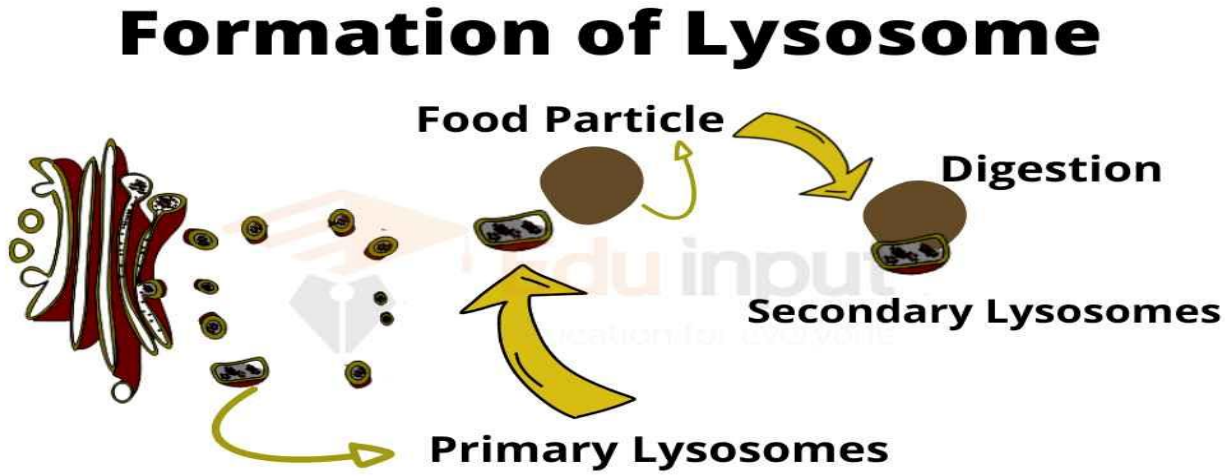
- Formed by the Golgi apparatus and contain inactive hydrolytic enzymes.

- These lysosomes have not yet fused with any substrate or target for digestion.

2. ****Secondary Lysosomes**** (also called Heterolysosomes or Digestive Vacuoles):

- Formed when primary lysosomes fuse with a vesicle containing material to be degraded, such as a phagosome (which holds engulfed particles) or endosome.

- These lysosomes actively digest and break down the material.



3. **Autophagic Lysosomes**:

- Involved in the process of **autophagy**, where lysosomes break down damaged or old organelles within the cell.

- Helps in cellular recycling and maintenance by digesting the cell's own components.

4. **Residual Bodies**:

- After digestion is complete, undigested material may remain in the lysosome, which is then termed a residual body.

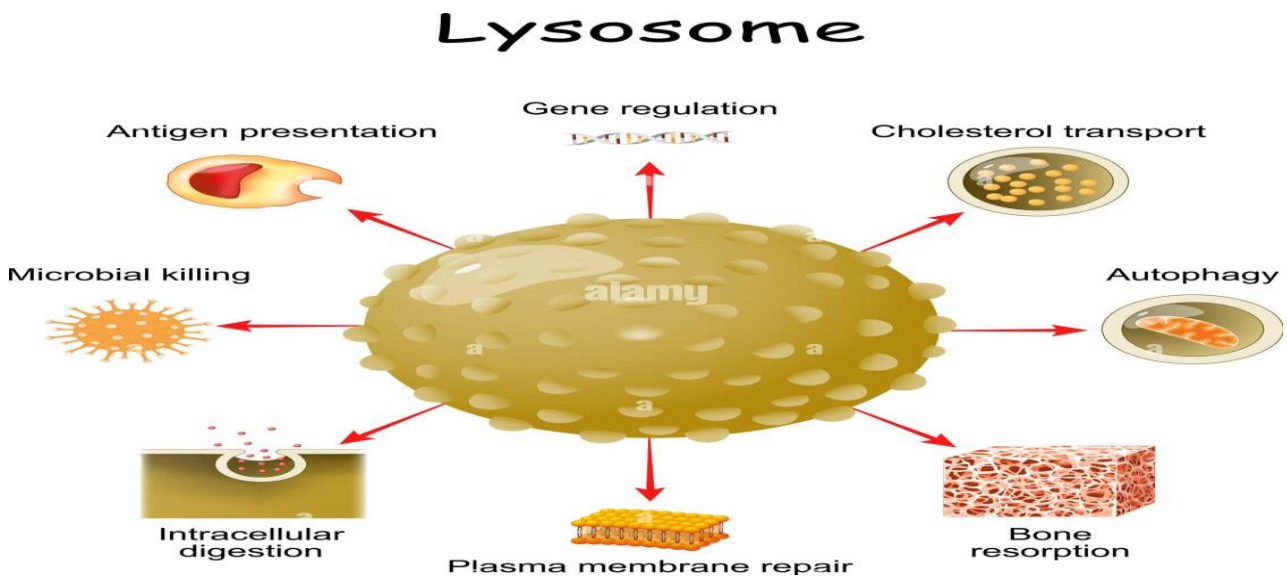
- These can be expelled from the cell through **exocytosis** or retained as lipofuscin (age pigments).

Functions of Lysosomes:

1. **Intracellular Digestion**:

- Lysosomes contain over 50 different hydrolytic enzymes, such as proteases, lipases, nucleases, and glycosidases, which can break down proteins, lipids, nucleic acids, and carbohydrates.

- They digest cellular debris, bacteria, viruses, and worn-out cell components through processes like **phagocytosis** (cell eating) and **endocytosis** (intake of molecules).



2. **Autophagy**:

- Lysosomes play a crucial role in **autophagy**, a process where cells degrade their own damaged organelles or protein aggregates, thereby recycling components for reuse.

- This is essential for maintaining cellular homeostasis and responding to nutrient starvation.

3. ****Apoptosis (Programmed Cell Death)****:

- Lysosomes are involved in the regulation of **apoptosis** by releasing enzymes that can help break down cellular components during cell death, helping in the controlled dismantling of the cell.

4. **Defense Mechanism**:

- Lysosomes protect the cell by digesting harmful pathogens like bacteria and viruses, a process known as **phagocytosis** in immune cells like macrophages.

5. **Cell Membrane Repair**:

- Lysosomes can help in the repair of the plasma membrane by sealing any damage through the fusion of vesicles with the membrane, which contributes to the integrity of the cell.

6. **Metabolic Functions:**

- In some cases, lysosomes participate in metabolic processes by breaking down stored molecules like glycogen, or in specialized cells like hepatocytes (liver cells) that manage detoxification.

7. ****Exocytosis**:**

- After digestion, waste material or undigested substances are expelled from the cell by the lysosome fusing with the plasma membrane, a process known as **lysosomal exocytosis**.

Importance of Lysosomes:

Lysosomes play a vital role in maintaining cellular health by disposing of waste and recycling materials. Defects in lysosomal function are associated with several diseases, collectively known as **lysosomal storage diseases** (e.g., Tay-Sachs, Gaucher's disease), where specific enzymes are deficient or malfunctioning, leading to the accumulation of undigested substances.

lysosomes are essential organelles responsible for breaking down cellular waste, recycling materials, and maintaining cellular health, making them indispensable for the survival and proper functioning of eukaryotic cells.

1. What is the main function of mitochondria?

a) Protein synthesis

b) Energy production

c) Cell signaling

d) Waste removal

e) Gene transcription

2. Mitochondria are known as the:

a) Digestive system of the cell

b) Powerhouse of the cell

c) Brain of the cell

d) Waste disposal system

e) Skeleton of the cell

3. The term ‘mitochondrion’ is derived from Greek words meaning:

a) Power and energy

b) Thread and granules

c) Structure and energy

d) Cell and nucleus

e) Tube and ATP

4. Mitochondria have how many membranes?

a) One

b) Two

c) Three

d) Four

e) None

5. The inner folds of the mitochondrial membrane are called:

a) Tubules

b) Cristae

c) Matrix

d) Vesicles

e) Vacuoles

6. Which process primarily occurs within the mitochondria?

a) Photosynthesis

b) Glycolysis

c) Oxidative phosphorylation

d) Transcription

e) Active transport

7. What is the space between the inner and outer mitochondrial membranes called?

a) Intermembrane space

b) Matrix

c) Cristae

d) Cytosol

e) Vacuole

8. Mitochondria produce energy in the form of:

a) ATP

b) ADP

c) NADPH

d) DNA

e) RNA

9. Which of the following is found in the mitochondrial matrix?

a) Ribosomes

b) DNA

c) Enzymes

d) All of the above

e) None of the above

10. The inner membrane of mitochondria is selectively permeable to:

a) Proteins

b) Oxygen and ATP

c) Glucose

d) Fatty acids

e) Water

11. Mitochondria play a key role in:

a) Osmosis

b) Apoptosis

c) Photosynthesis

d) Protein folding

e) Cellular adhesion

12. The outer mitochondrial membrane contains special proteins known as:

a) Porins

b) Channels

c) Enzymes

d) Cristae

e) None of the above

13. Which function is NOT associated with mitochondria?

a) Energy production

b) Photosynthesis

c) Apoptosis

d) Calcium regulation

e) Detoxification of ammonia

14. The mitochondrial matrix contains:

a) Plasma

b) Ribosomes

c) Golgi bodies

d) Vacuoles

e) Peroxisomes

15. Mitochondrial diseases like Alpers Disease are caused by:

a) Overproduction of ATP

b) Irregular mitochondrial function

c) Excessive oxidative stress

d) Apoptosis

e) Enzyme inhibition

16. What role does the mitochondrial cristae play?

a) Detoxifying chemicals

b) Increasing surface area for ATP production

c) DNA replication

d) Synthesizing proteins

e) Storing calcium

17. Mitochondria assist in the regulation of which ion?

a) Calcium

b) Potassium

c) Sodium

d) Chloride

e) Iron

18. Mitochondria are involved in the synthesis of which hormone?

a) Insulin

b) Estrogen

c) Cortisol

d) Dopamine

e) Melatonin

19. Which part of the mitochondrion contains enzymes that are crucial for ATP synthesis?

a) Outer membrane

b) Inner membrane

c) Cristae

d) Ribosomes

e) Porins

20. Mitochondrial fission and fusion are important for:

a) DNA replication

b) Mitochondrial health and distribution

c) Cell division

d) Protein synthesis

e) Detoxification

Lysosomes

21. Lysosomes are mainly responsible for:

a) Energy production

b) Protein synthesis

c) Waste digestion

d) DNA replication

e) Photosynthesis

22. Lysosomes are found primarily in:

a) Plant cells

b) Animal cells

c) Prokaryotes

d) Fungi

e) Viruses

23. The enzymes inside lysosomes function best in which condition?

a) Alkaline

b) Acidic

c) Neutral

d) Basic

e) Extreme heat

24. Lysosomes originate from:

a) Golgi apparatus

b) Endoplasmic reticulum

c) Mitochondria

d) Nucleus

e) Ribosomes

25. What is the function of primary lysosomes?

a) Autophagy

b) Contain inactive enzymes

c) Digestion of food particles

d) Exocytosis

e) Apoptosis

26. Secondary lysosomes are formed by the fusion of:

a) Primary lysosomes and endosomes

b) Ribosomes and vesicles

c) Golgi bodies and peroxisomes

d) Vacuoles and nucleosomes

e) Rough ER and primary lysosomes

27. The process of recycling damaged or old organelles by lysosomes is called:

a) Phagocytosis

b) Autophagy

c) Apoptosis

d) Endocytosis

e) Exocytosis

28. What are the digestive enzymes in lysosomes collectively called?

a) Catalases

b) Hydrolytic enzymes

c) Lipases

d) Proteases

e) Nucleases

29. Lysosomes help in the breakdown of which substances?

a) Proteins

b) Lipids

c) Nucleic acids

d) All of the above

e) None of the above

30. Lysosomes are involved in which type of cell death?

a) Apoptosis

b) Necrosis

c) Cytolysis

d) Autolysis

e) Phagocytosis

31. The autophagic process involves:

a) Digestion of external particles

b) Degradation of damaged organelles

c) Cell membrane repair

d) Protein synthesis

e) Photosynthesis

32. What are residual bodies in lysosomes?

a) Undigested material left in the lysosome

b) Partially digested proteins

c) Vacuoles containing nutrients

d) Fully digested food particles

e) Lipid vesicles

33. Lysosomes aid in the immune system by:

a) Synthesizing antibodies

b) Digesting pathogens

c) Transmitting signals

d) Releasing histamine

e) Storing toxins

34. Lysosomes help repair which structure?

a) Plasma membrane

b) Mitochondria

c) Nucleus

d) Golgi apparatus

e) Endoplasmic reticulum

35. Exocytosis in lysosomes refers to:

a) Breakdown of food particles

b) Expelling waste materials out of the cell

c) Digestion of cellular debris

d) Protein synthesis

e) DNA replication

36. In what type of cells are lysosomes highly abundant?

a) Muscle cells

b) Macrophages

c) Neurons

d) Epithelial cells

e) Skin cells

37. Lysosomes also participate in:

a) DNA replication

b) Cellular detoxification

c) Cell cycle control

d) Photosynthesis

e) Nerve transmission

38. What is a lysosomal storage disease?

a) Excess energy production in lysosomes

b) Deficiency of enzymes in lysosomes

c) Defective protein synthesis

d) Uncontrolled autophagy

e) Cell membrane defects

39. Tay-Sachs disease is associated with malfunctioning:

a) Mitochondria

b) Lysosomes

c) Ribosomes

d) Golgi bodies

e) Nucleus

40. Gaucher's disease is caused by:

a) Malformed mitochondria

b) Enzyme deficiency in lysosomes

c) Apoptosis failure

d) Protein misfolding

e) DNA damage