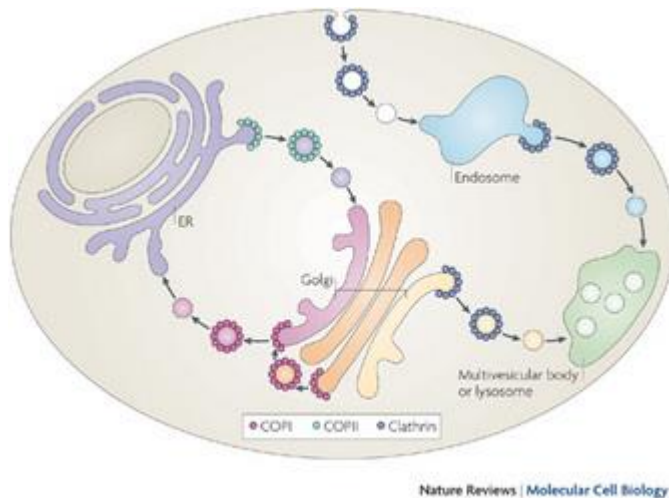


# Lysosomes



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## 1. Introduction

Lysosomes are membrane-bound cytoplasmic organelles containing hydrolytic enzymes responsible for **intracellular digestion**. They were discovered in 1955 by **Christian de Duve**, who also coined the term “lysosome”.

They are commonly called the “**suicidal bags**” of the cell because they contain powerful digestive enzymes.

## 2. Occurrence

- Present in **all eukaryotic animal cells**
- Rare in plant cells (plants contain vacuoles with similar function)
- Abundant in:
  - Phagocytic cells (macrophages, neutrophils)

- Liver cells
- Kidney cells

### 3. Structure of Lysosomes

1. **Shape:** Spherical or oval
2. **Size:** 0.1 – 1.2  $\mu\text{m}$  in diameter
3. **Membrane:**
  - Single membrane
  - Contains transport proteins
  - Protects cytoplasm from digestive enzymes
4. **Internal Content:**
  - Acidic matrix ( $\text{pH} \approx 4.5\text{--}5$ )
  - Contains hydrolytic enzymes

### 4. Chemical Composition

#### A. Enzymes (Acid Hydrolases)

About 50+ enzymes including:

- Proteases (digest proteins)
- Lipases (digest lipids)
- Nucleases (digest nucleic acids)
- Amylases (digest carbohydrates)
- Phosphatases
- Sulfatases

These enzymes function optimally in **acidic pH**.

#### B. Lysosomal Membrane

- Lipoprotein in nature
- Contains proton pumps ( $\text{H}^+$  ATPase) to maintain acidic pH

### 5. Formation of Lysosomes

Lysosomes originate from the **Golgi apparatus**.

1. Enzymes synthesized in Rough ER
2. Transported to Golgi apparatus
3. Packaged into vesicles
4. Vesicles bud off forming primary lysosomes

## **6. Types of Lysosomes**

### **1 Primary Lysosome**

- Newly formed
- Contains inactive enzymes
- Not involved in digestion yet

### **2 Secondary Lysosome**

- Formed by fusion of primary lysosome with food vacuole
- Active digestion occurs

### **3 Residual Body**

- Contains undigested material
- May be exocytosed

### **4 Autophagic Vacuole**

- Digests worn-out organelles
- Process called **Autophagy**

## **7. Functions of Lysosomes**

### **1. Intracellular Digestion**

Digest food particles inside the cell.

### **2. Heterophagy**

Digestion of foreign material (bacteria, viruses).

### **3. Autophagy**

Removal of damaged organelles.

#### **4. Autolysis**

Self-destruction of cell under pathological conditions.

#### **5. Defense Mechanism**

Important in immunity (macrophages).

#### **6. Extracellular Digestion**

Example: Bone resorption by osteoclasts.

## **8. Lysosomal Storage Diseases**

Caused due to deficiency of specific lysosomal enzymes.

Examples:

1. **Tay-Sachs disease**
  - Deficiency of Hexosaminidase A
  - Affects nervous system
2. **Gaucher disease**
  - Deficiency of Glucocerebrosidase
  - Enlargement of spleen and liver
3. **Pompe disease**
  - Deficiency of acid maltase

## **9. Significance of Lysosomes**

- Maintain cellular cleanliness
- Prevent accumulation of waste
- Important in programmed cell death (apoptosis)
- Play role in embryonic development
  
- Mitochondria evolved from **aerobic bacteria**
- Evidence:
  - Own DNA
  - 70S ribosomes
  - Binary fission

- Double membrane

## 10. Biogenesis and Division

- Divide by **binary fission**
- Semi-autonomous
- Some proteins synthesized in cytoplasm

## 11. Types of Mitochondria (Based on Shape)

- Filamentous
- Granular
- Rod-shaped
- Spherical

## 12. Mitochondrial Disorders

- Caused by mutation in mtDNA
- Examples:
  - Leber's Hereditary Optic Neuropathy (LHON)
  - Myoclonic epilepsy
- Affect high-energy organs (brain, muscles)

## 13. Comparison: Mitochondria vs Chloroplast

Feature	Mitochondria	Chloroplast
Function	Respiration	Photosynthesis
DNA	Present	Present
Found in	All eukaryotes	Plants only
Cristae/Grana	Cristae	Grana

## 14. Conclusion

Mitochondria are essential organelles responsible for **energy production**, metabolic regulation, and apoptosis.

Their semi-autonomous nature supports the **endosymbiotic theory** and shows their evolutionary importance.