

The background features a vibrant green color palette. The upper portion is dominated by several bright green leaves with detailed vein patterns, some in sharp focus and others blurred. Below the leaves, the background transitions into a series of concentric, soft-focus ripples, suggesting water. The overall composition is clean and naturalistic.

*Professor/ Raeissa Mohammad*

# **Introduction to Histology and Cell Structure**

# Content & Objectives

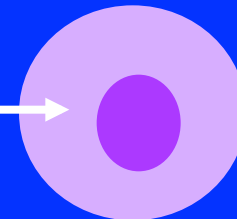
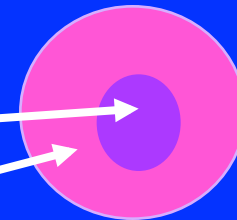
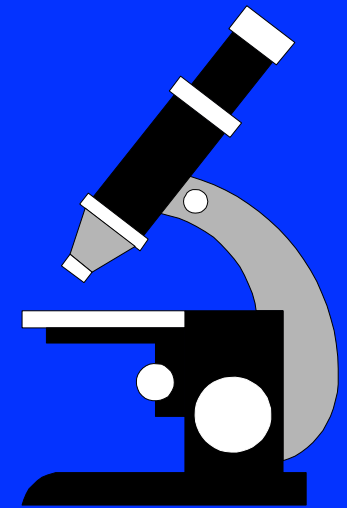
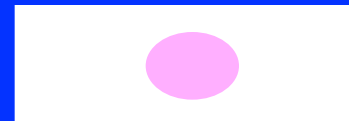
In this lecture you are expected to learn:

- What is histology and how it is studied?
- Composition of the cell: **Light microscopic (L/M) and electron microscopic (E/M)** and function of each component:
  - Nucleus.
  - Cytoplasm:
    - » Organelles: membranous and non-membranous.
    - » Inclusions.

# INTRODUCTION

- Histology is the microscopic study of normal tissues.
- Types of microscopes: LM & EM
- Organs are made of tissues and tissues are made of cells.
- Thin sections are cut and mounted on glass slides. Sections are stained with Hematoxylin (H) and Eosin (E).

- Nucleus is always blue (basophilic).
- Cytoplasm may be red (acidophilic), or blue (basophilic).

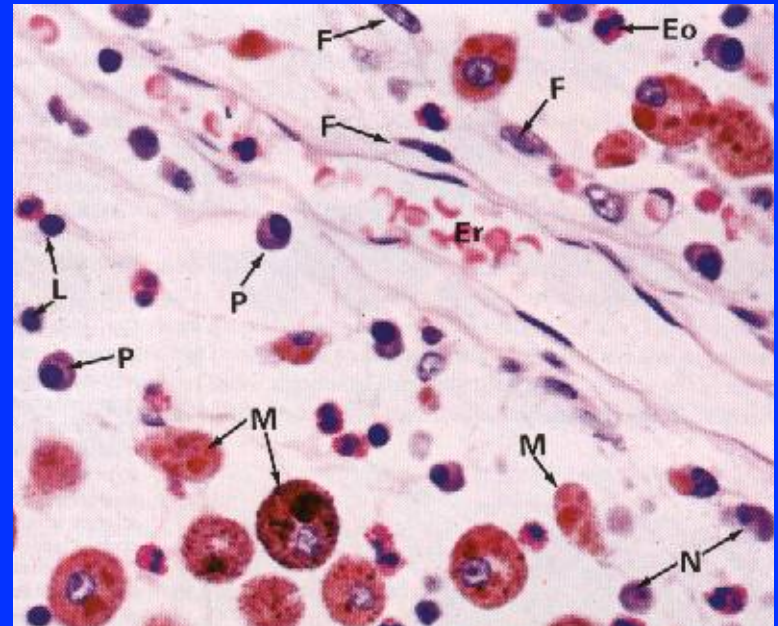


# THE CELL

- It is the **structural & functional unit** of all living tissues.
- Cells have **different shapes & sizes**.
- THE CELL is made of:

1- Nucleus

2- Cytoplasm



# NUCLEUS (L/M)

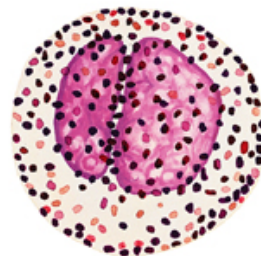
## Shape of nuclei



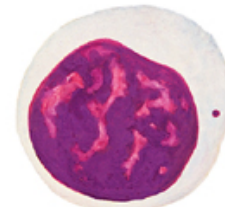
Neutrophilic granulocyte



Eosinophilic granulocyte



Basophilic granulocyte



Lymphocyte



Monocyte

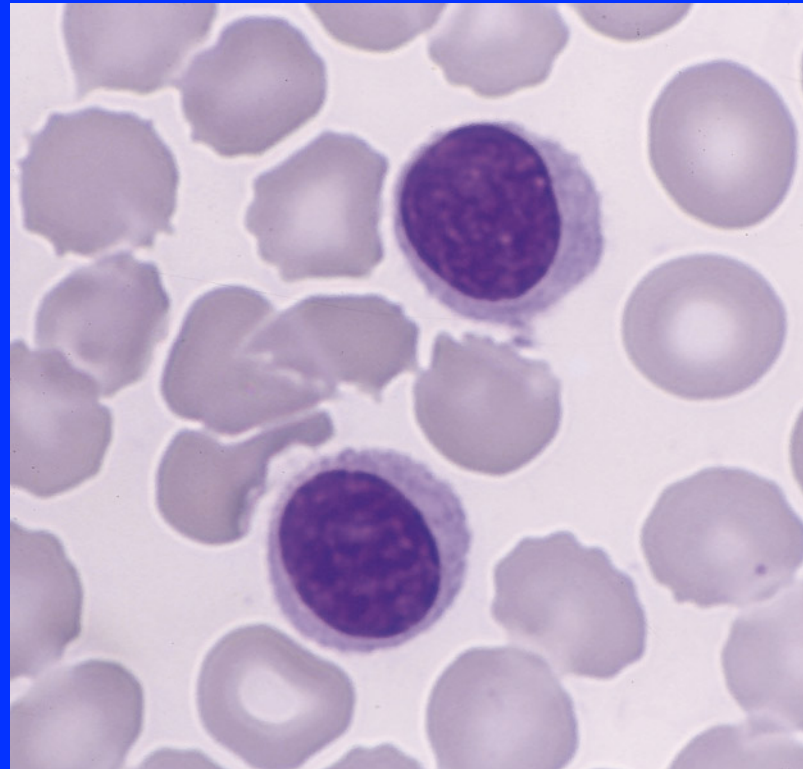


Monocyte

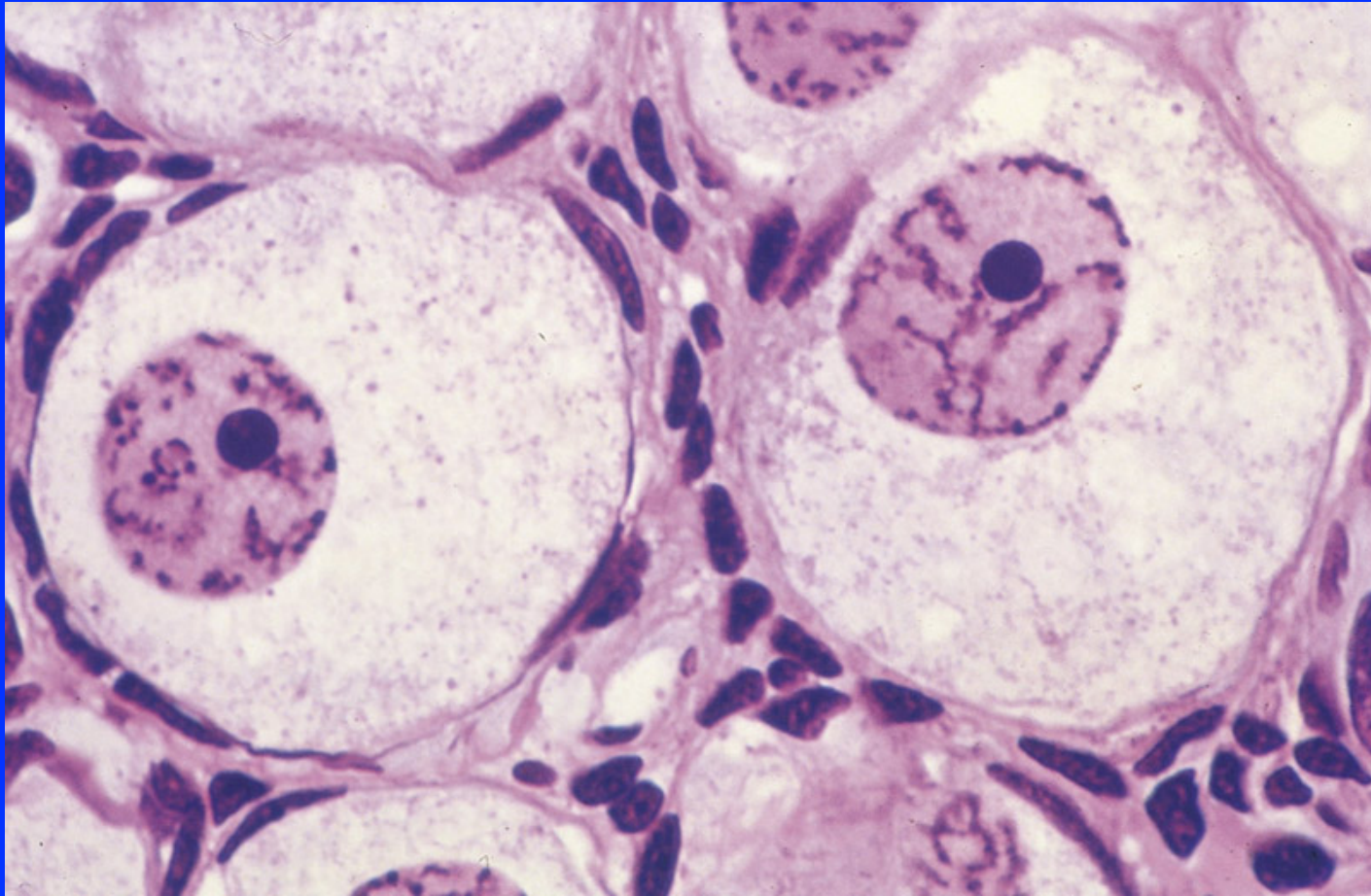
# Appearance of nuclei

## (1) Dark Nucleus (Deeply-stained nucleus)

Deeply basophilic Nucleus



## **(2) Vesicular (open face) Nucleus**

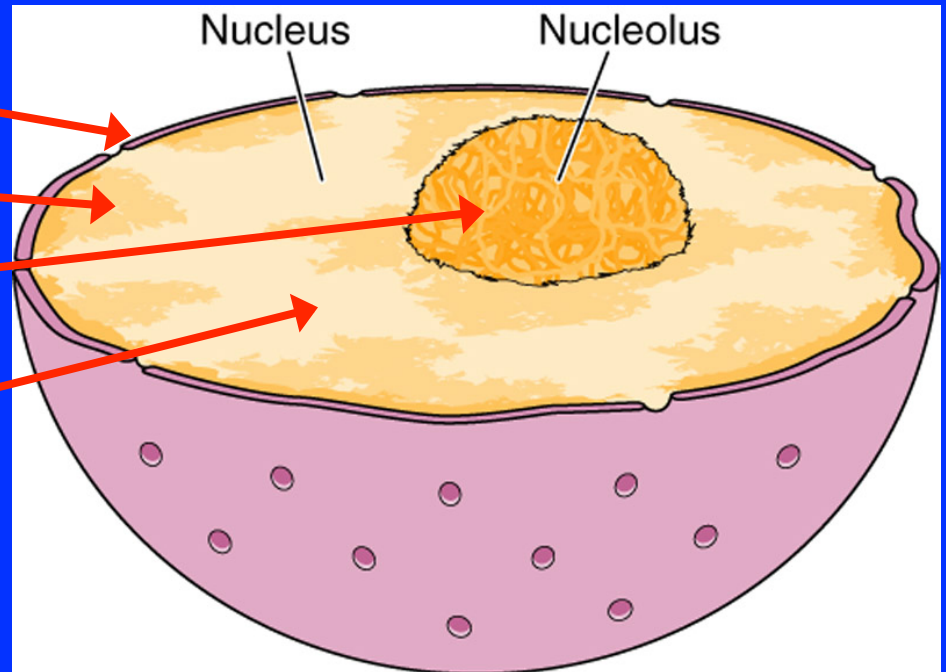




# NUCLEUS (E/M)

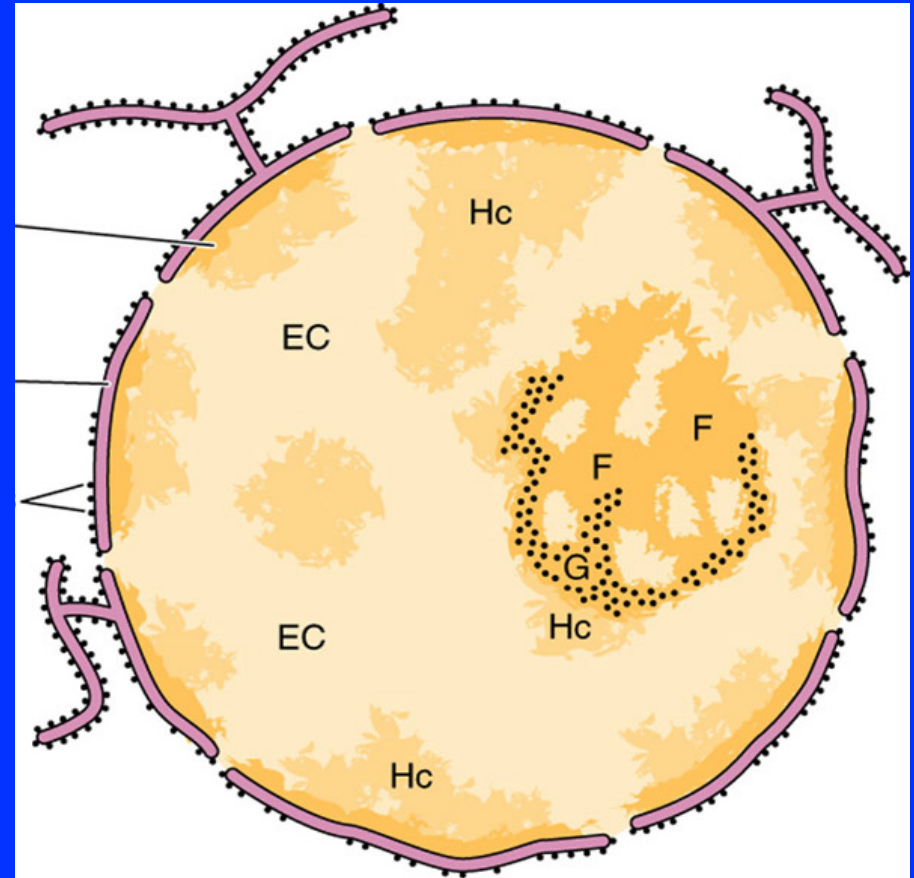
## ■ Formed of:

1. Nuclear envelope
2. Chromatin
3. Nucleolus
4. Nucleoplasm



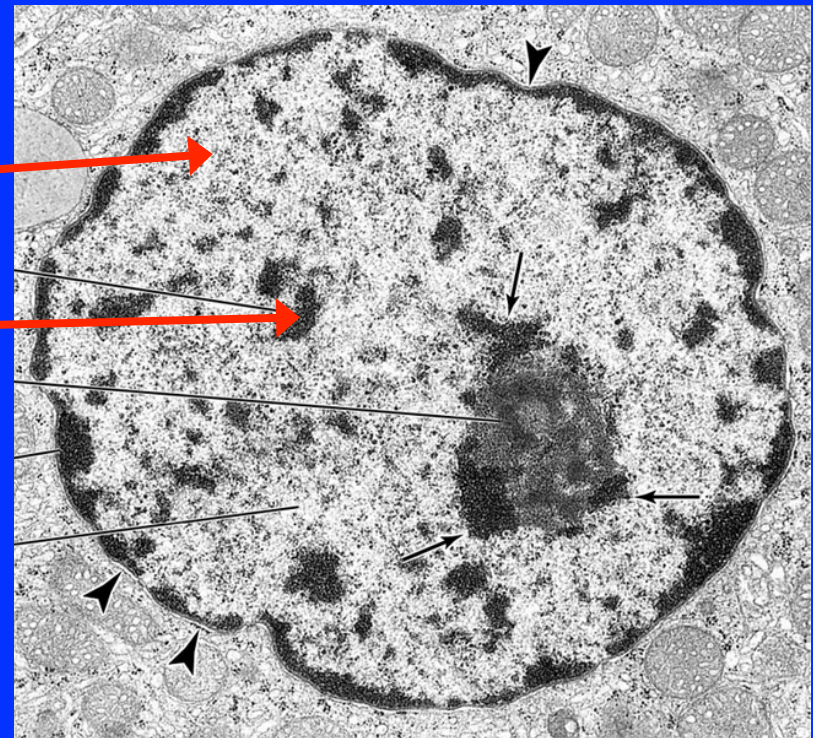
# 1. Nuclear Envelope

- A double membrane with many pores.
  - a) Outer membrane.
  - b) Inner membrane.
  - c) Nuclear pores: provide communication between nucleus and cytoplasm.



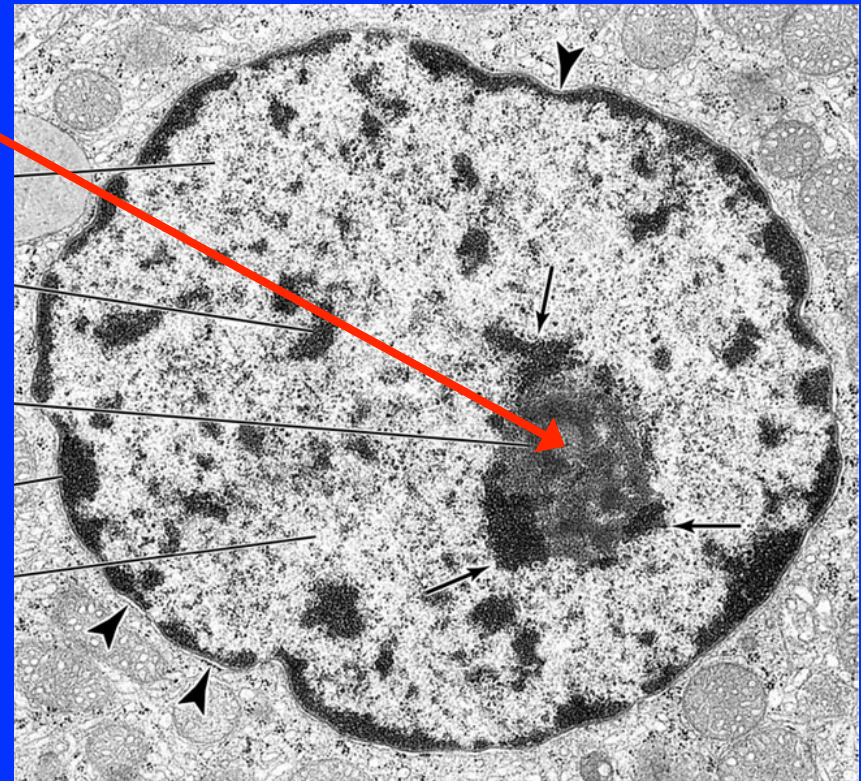
# 2. Chromatin

- Formed of DNA.
- 2 Forms:
  - Euchromatin: extended active chromatin (pale = electron-lucent areas).
  - Heterochromatin: condensed inactive chromatin (dark = electron dense areas).
- Functions:
  - Carries genetic information.
  - Directs protein synthesis.



# 3. Nucleolus

- **E/M:** It is mostly dark mass (electron-dense) not surrounded by a membrane.
- Usually one.
- **L/M:** It is a spherical dark basophilic mass.
- **Function:** formation of ribosomal RNA (rRNA), which is responsible for protein synthesis in the cytoplasm.

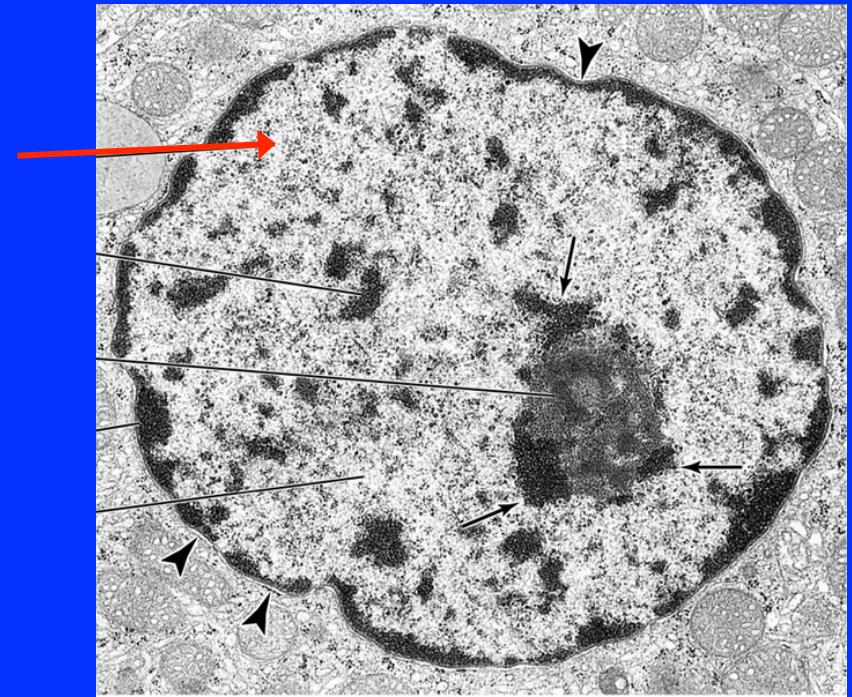


# 4. Nucleoplasm

- It is a clear fluid medium in which all the contents of the nucleus are embedded.

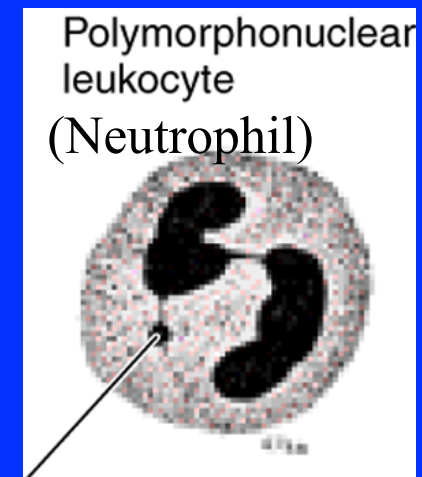
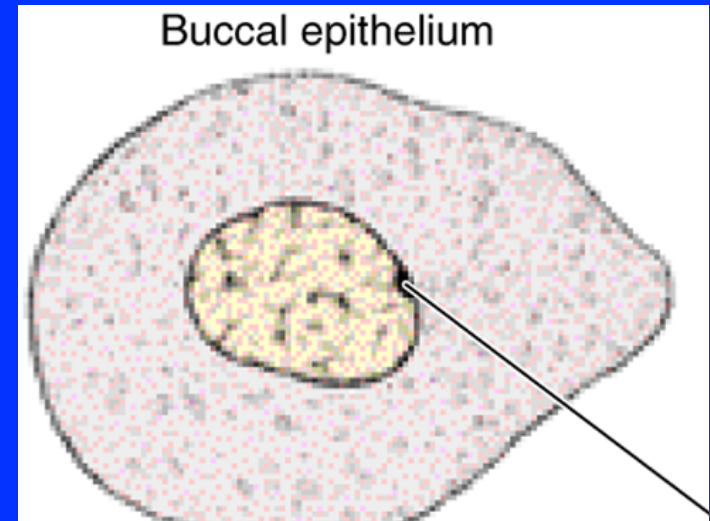
## Function:

- Provides a **medium for movement** of 3 types of RNA (ribosomal, messenger and transfer RNA) from the nucleus to the cytoplasm.



# Sex Chromatin (Barr Body)

- A dark stained mass of chromatin, usually adherent to the inner aspect of the nuclear envelope of female somatic cells e.g. Buccal epithelial cells.
- A drumstick mass protruding from the nucleus of neutrophils.
- Represents one of the two X chromosomes which is inactive (condensed) in normal female .
- Seen in normal female cells.
- Absent in females with Turner's syndrome XO.
- Seen in males with Klinefelter's syndrome XXY.



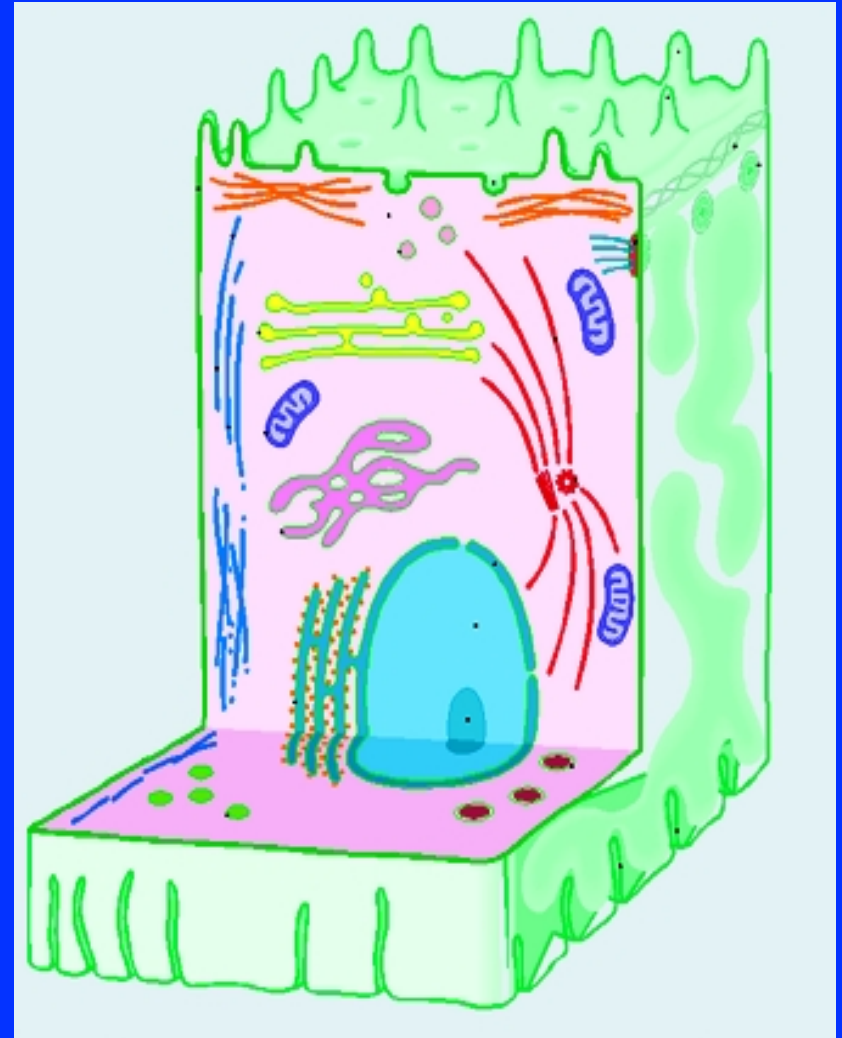
# Functions of the Nucleus

- 1- It is essential for the **vitality** and **division** of the cell.
- 2- It is the site of storage of **genetic information**.
- 3- It is the site of formation of the **three types of RNA**.

# CYTOPLASM

is formed of:

- 1- **ORGANELLES**: They are specialized structures, **ESSENTIAL** for vital processes of the cell.
- 2- **INCLUSIONS**: They are **not essential** for vitality of cells. may be present or absent. Examples are lipids, glycogen and pigments like melanin & lipofuscin.





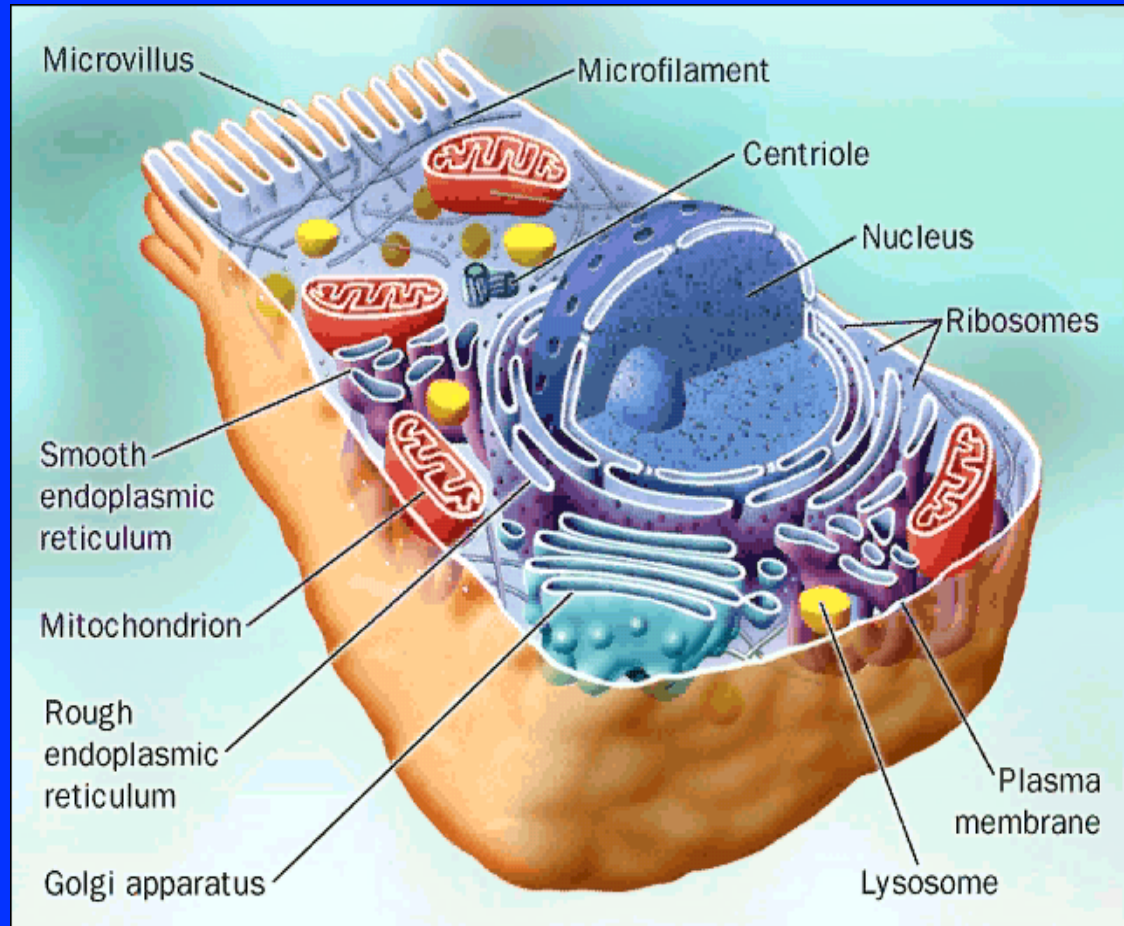
# CYTOPLASMIC ORGANELLES

## A. Membranous:

1. Cell membrane.
2. Mitochondria.
3. Endoplasmic reticulum (rough & smooth).
4. Golgi apparatus.
5. Lysosomes.
6. Secretory vesicles.

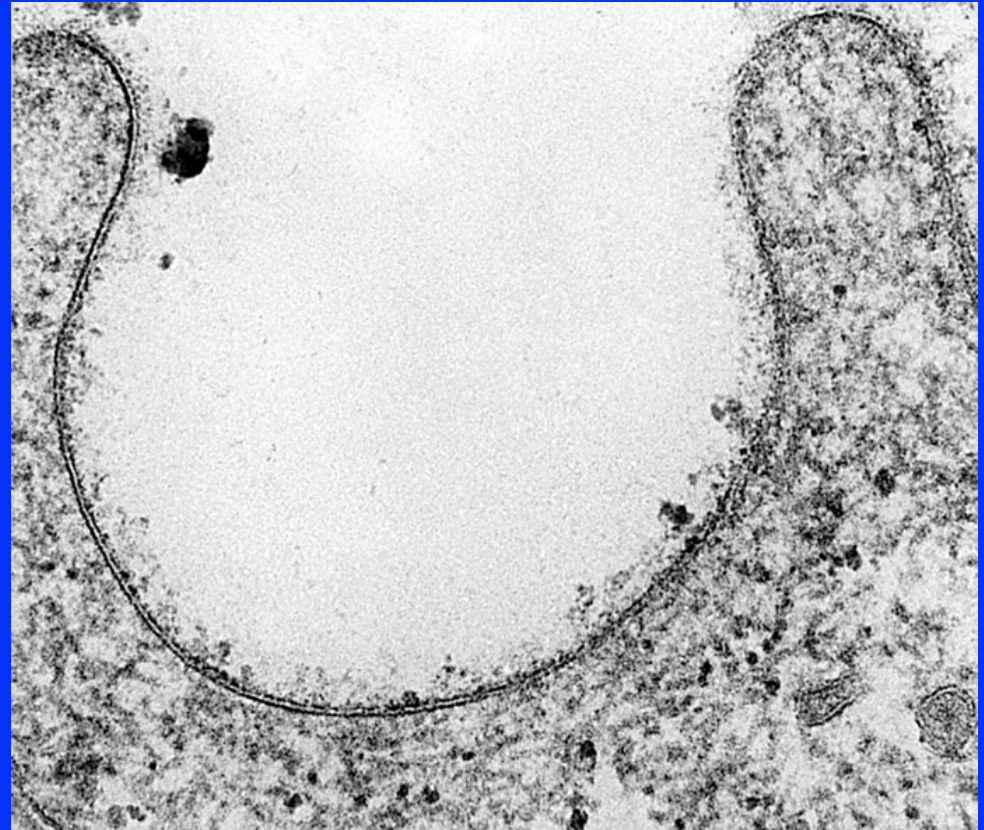
## B. Non-membranous:

1. Ribosomes.
2. Centrioles.
3. Cilia & Flagella.
4. Filaments:  
Actin, Myosin & Intermediate filaments.
5. Cytoskeleton (actin, intermediate filaments & microtubules).



# Cell Membrane

- A very thin membrane that surrounds the cell.
- **LM**: Not visible.
- **EM**: appears as 2 dark lines (electron dense), separated by a light one (electron-lucent). (**trilaminar appearance**).
- **Function**: selective barrier.



# Cell Membrane

## Chemical Structure:

### 1- Phospholipid molecules:

arranged in 2 layers.

### 2- Protein molecules:

a) Peripheral protein

b) Integral protein

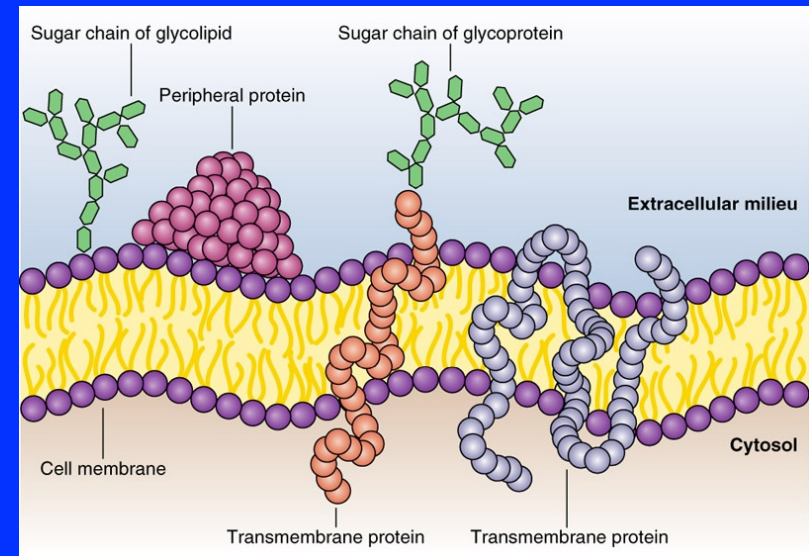
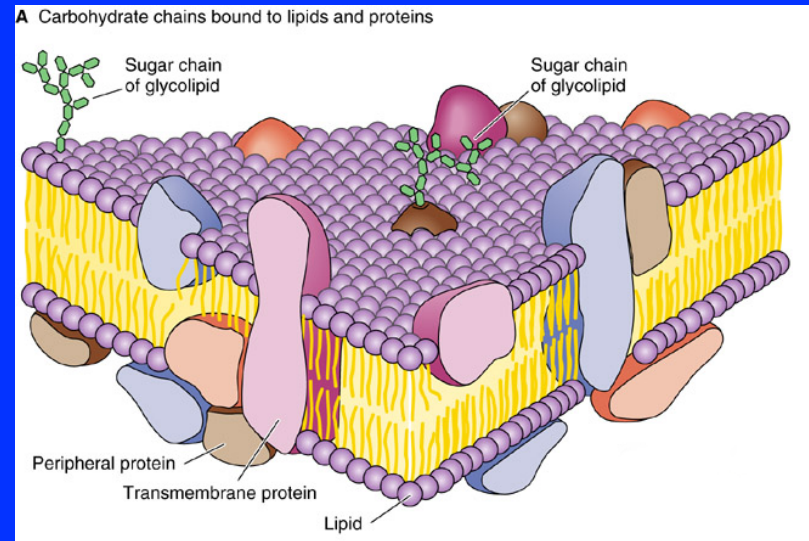
### 3- Carbohydrate molecules:

attached to either proteins or lipids (**glycoproteins** and **glycolipids**), forming the surface or cell coat

**(Glycocalyx):**

a) Protection of the cell.

b) Cell recognition and adhesion.



# Cell Membrane

## Specializations:

### Cilia:

- Long motile hair-like structures surrounded by cell membrane.
- Their core is formed of **microtubules**.

### Microvilli (Brush border):

- Cylindrical cytoplasmic projections of apical surface to increase surface area.
- Their core contains **actin** filaments.



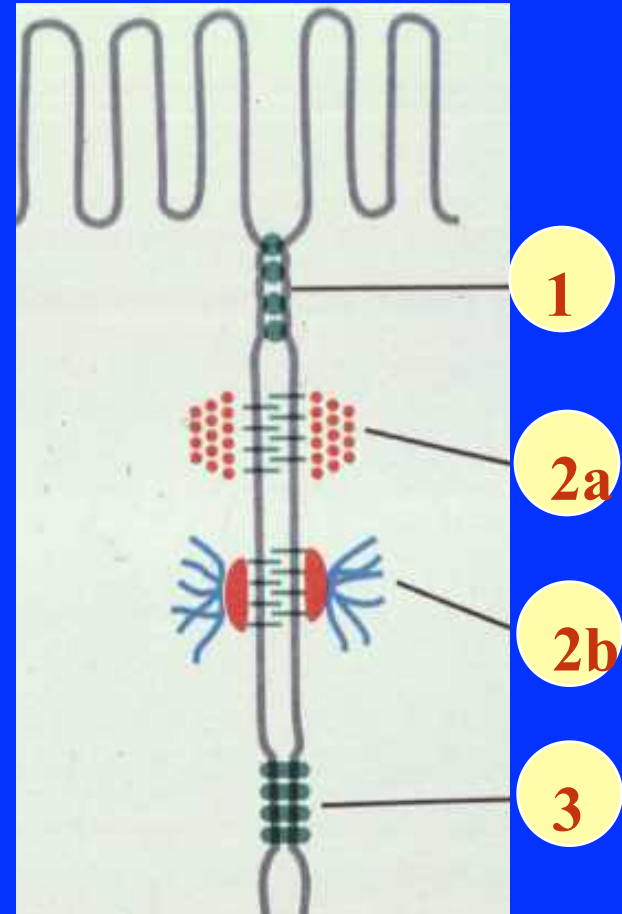
# Cell Membrane

## Specializations:

### Intercellular Junctions:

1. Occluding (Tight) Junction: seals the intercellular space.
2. Adherening Junction: fixes adjacent cells together:
  - a. Zonula Adhering Junction.
  - b. Desmosome (Macula Adherening Junction).
3. Gap junction: Allow free communication between the cells.

When a combination of 1 , 2a and 2b is present, this is called a **junctional complex**.

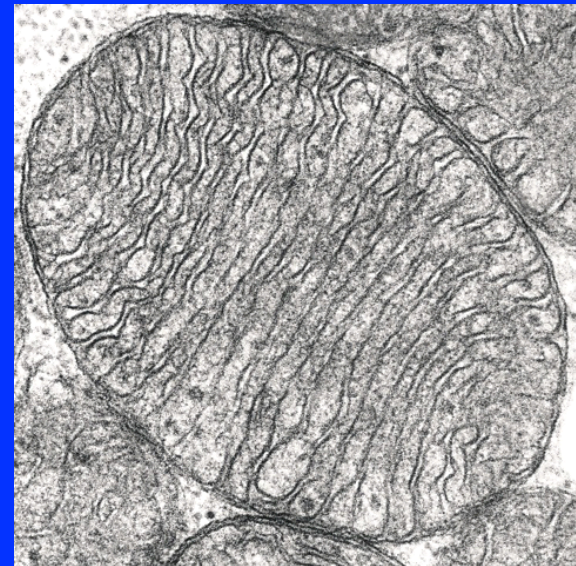
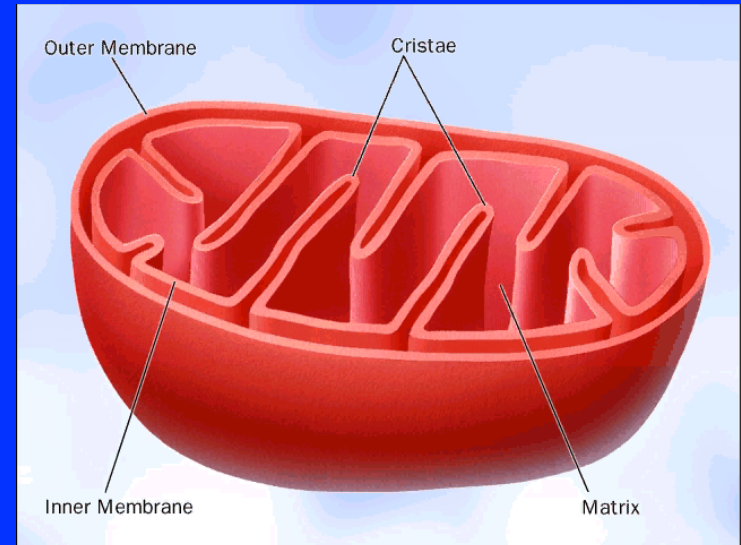


# Mitochondria

- Each mitochondrion is rod-shaped .
- The wall is composed of 2 membranes.
- The outer is smooth, the inner is folded to form **cris**tae.
- The cavity is filled with mitochondrial matrix, which contains enzymes. Also contains its own **DNA**.

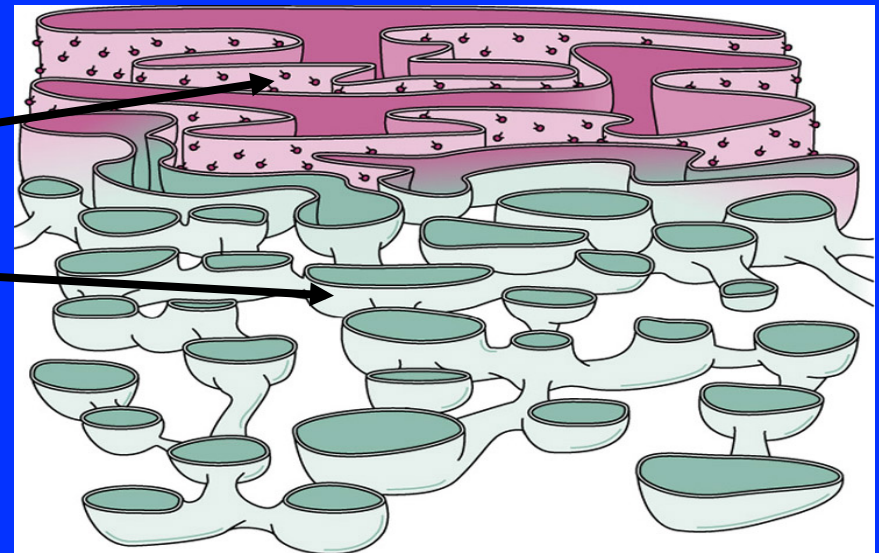
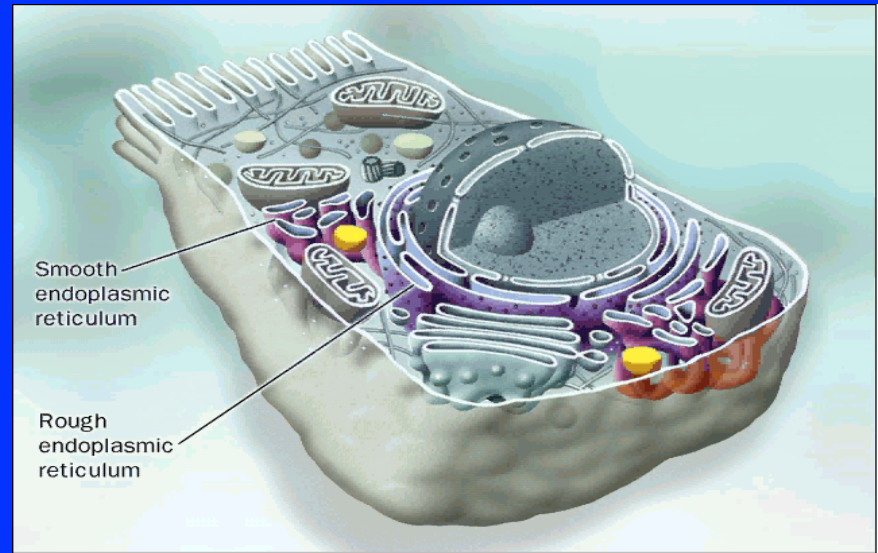
## Functions:

- 1- Generation of **ATP** which is the source of energy for the cell. They are called **the power-house** of the cell.
- 2- They can form their **own proteins** and undergo **self replication**.



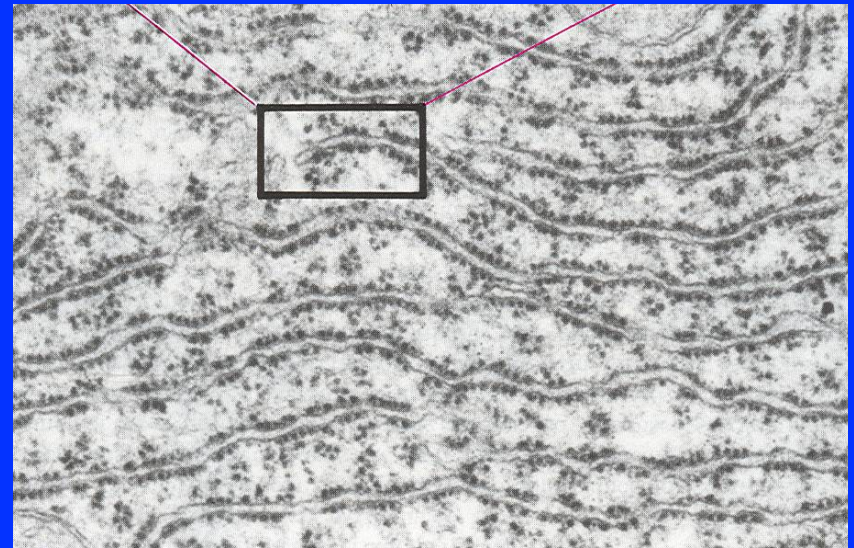
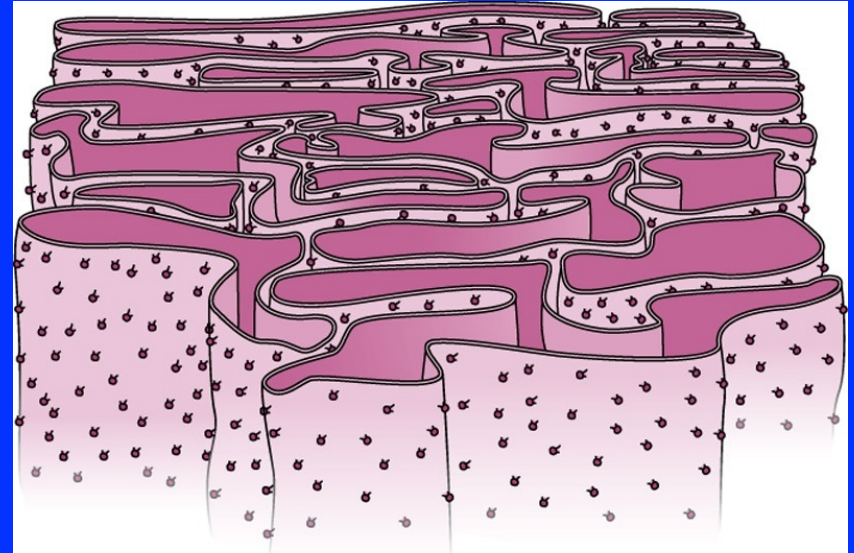
# Endoplasmic Reticulum (ER)

- It is a system of communicating membranous tubules, vesicles, and flattened vesicles (cisternae).
- There are 2 types:
  - Rough (rER).
  - Smooth (sER).



# Rough Endoplasmic Reticulum

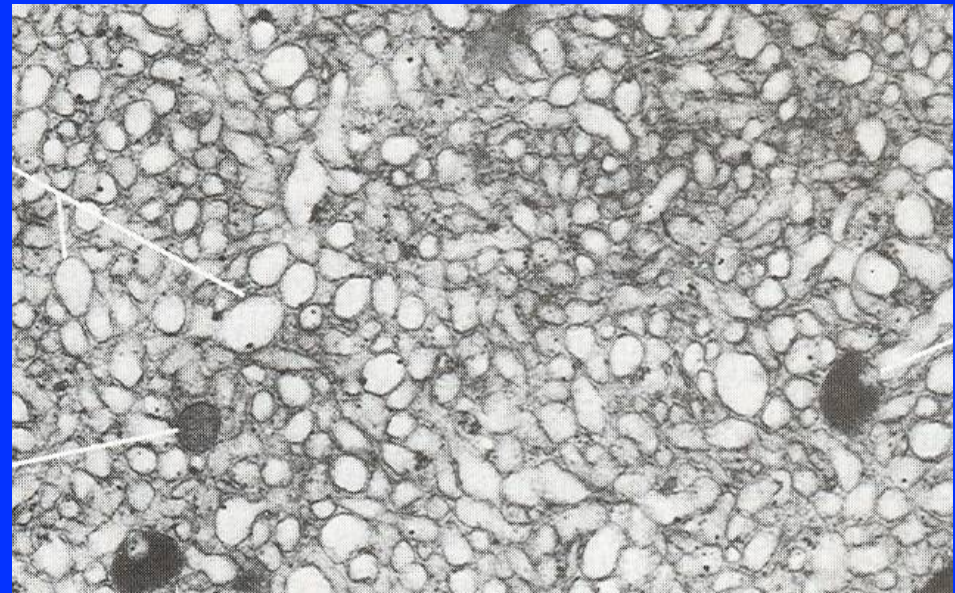
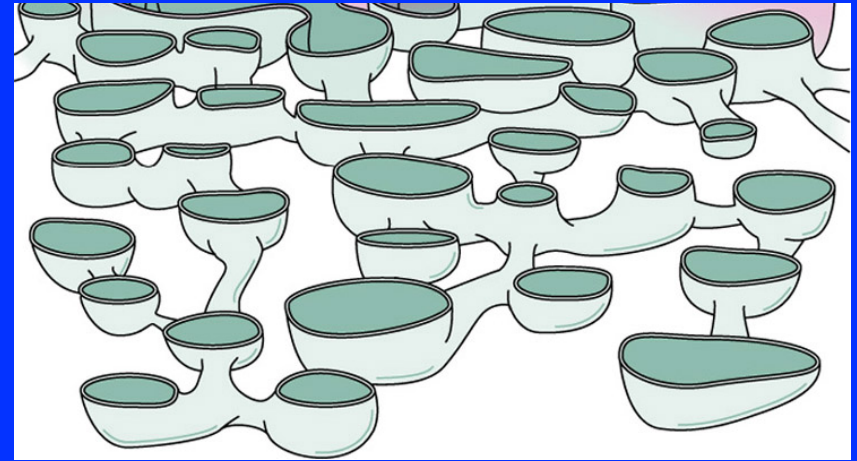
- Membranous sheets of flattened tubules & vesicles with ribosomes on the surface.
- **Functions:**
  1. **Synthesis of proteins** by ribosomes on its outer surface.
  2. **Transfer vesicles** transfer the formed protein to Golgi.





# Smooth Endoplasmic Reticulum

- Membranous tubules and vesicles, with **no** ribosomes on the surface.
- **Functions:**
  1. Synthesis of **lipids** & **cholesterol**.
  2. Synthesis of **steroid** hormones, e.g. cortisone.
  3. Helps **muscle contraction**, by acting as a calcium pump.
  4. **Detoxification** of drugs & toxins.

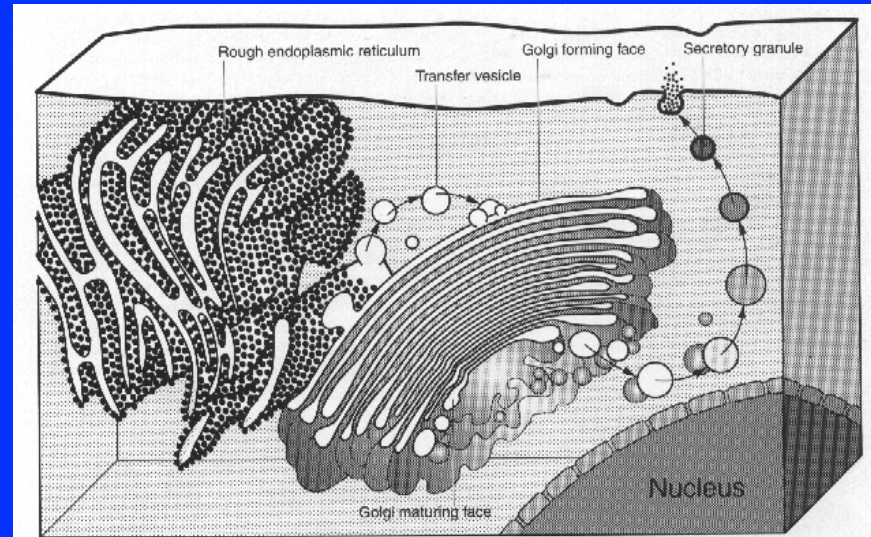
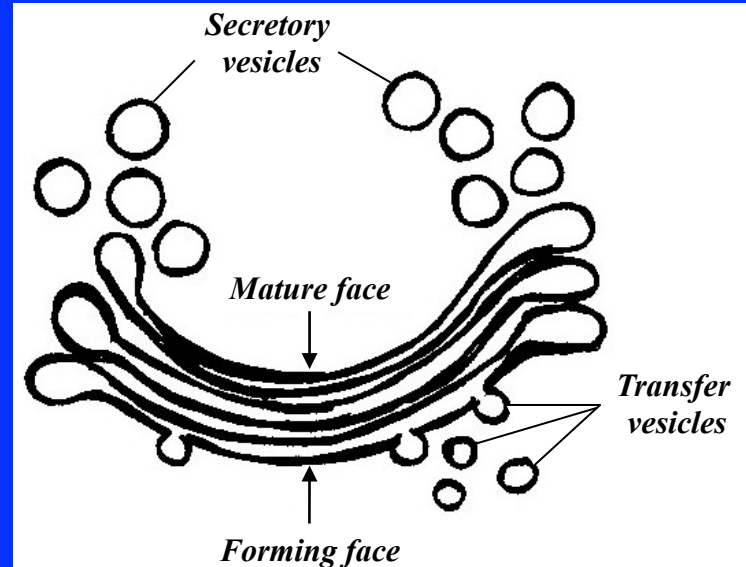


# Golgi Apparatus

- The secretory apparatus of the cell.
- Consists of stacked saucer-shaped flattened vesicles.
- Each vesicle has two faces: Convex (forming) face, receives transfer vesicles. Concave (mature) face, forms secretory vesicles.

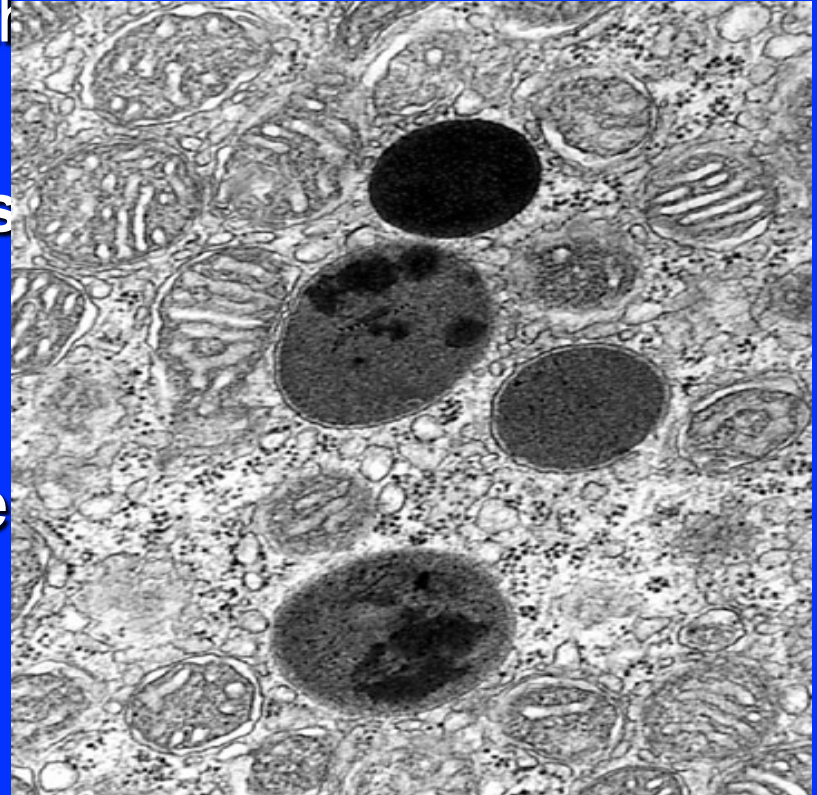
## Functions:

1. Sorting, modification & packaging of proteins.
2. Secretory vesicles formation.
3. Formation of lysosomes.



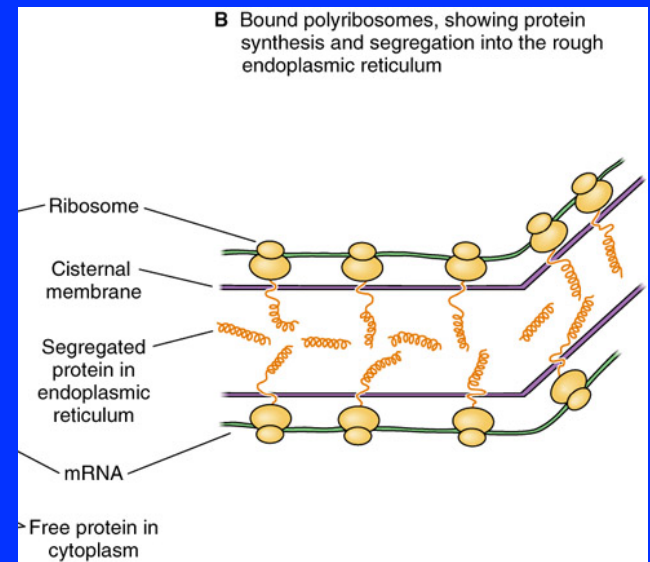
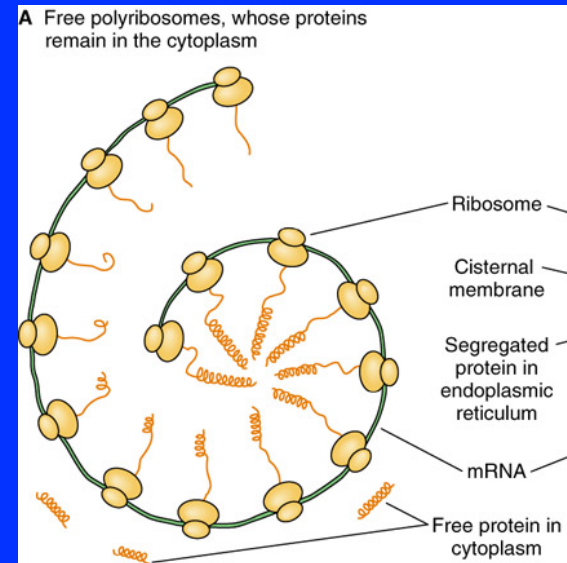
# Lysosomes

- The digestive apparatus of the cell.
- **E/M:** Spherical membranous vesicles.
- Contain **hydrolytic enzymes**.
- Originate from mature surface of the Golgi apparatus, while their hydrolytic enzymes are formed in the rough endoplasmic reticulum.
- **Function:** intracellular digestion of ingested material or old organelles.



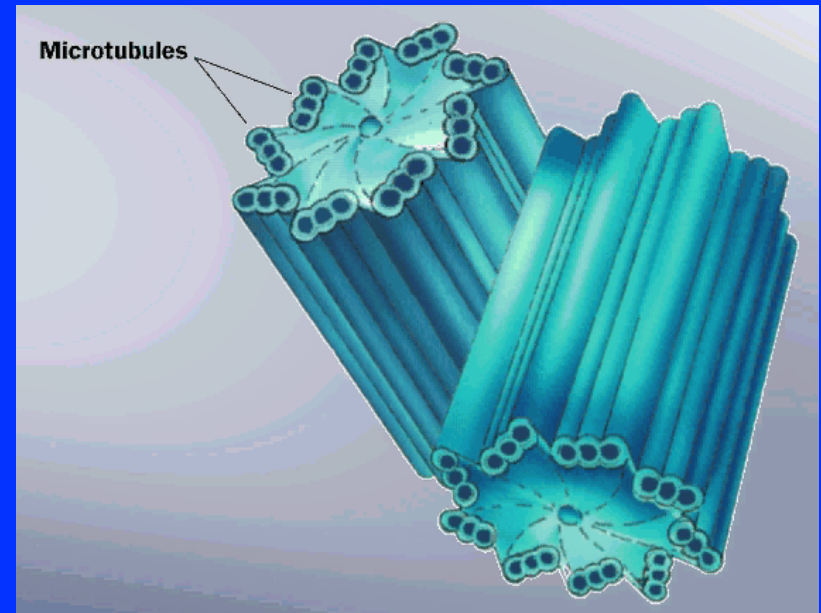
# Ribosomes

- **LM:** Basophilic cytoplasm is due to numerous ribosomes .
- Consist of ribosomal RNA (rRNA), combined with proteins.
- **EM:** Formed of 2 subunits.
- Free in the cytoplasm (may form polyribosomes) or attached to rER.
- Formed in the nucleolus.
- **Function:**  
**Protein synthesis**



# Centrioles

- **2 cylinders**, perpendicular to each other.
- Wall is made of 9 triplets of microtubules, i.e. **27 microtubules**.
- **Functions:**
  - 1- Essential for **cell division**.
  - 2- Formation of **cilia** and **flagella**.



# Microtubules-Containing Organelles

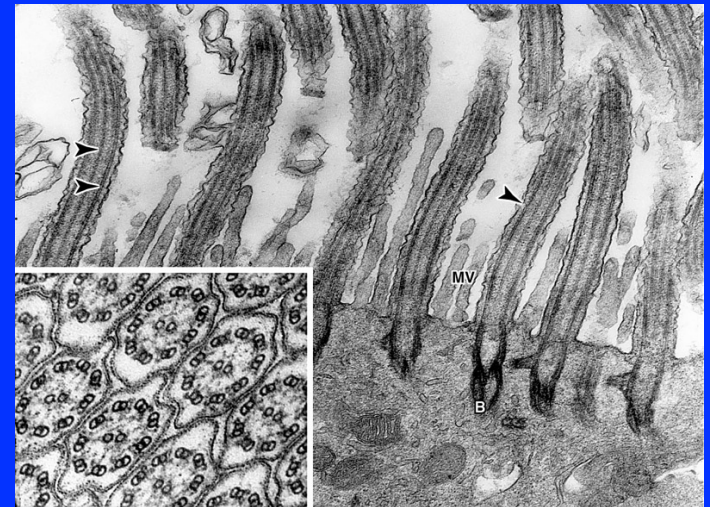
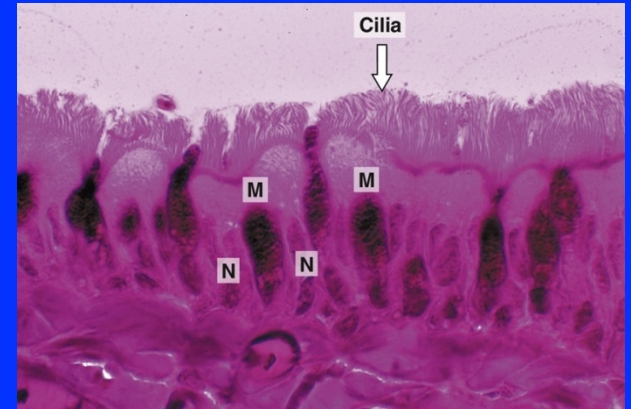
1. **Centrioles:** see before.

## 2. **Cilia:**

- Hair-like striations on the free surface of some cells.
- Basal body is similar to centriole.
- Shaft is formed of 9 doublets and 2 central singlets of microtubules, i.e. **20 microtubules**..
- **Function:** movement of particles or fluids on the free surface of the cell in one direction.

## 3. **Flagella:**

- Longer and larger than cilia.
- Form the tails of sperms.
- **Function:** important for movement of the sperms.

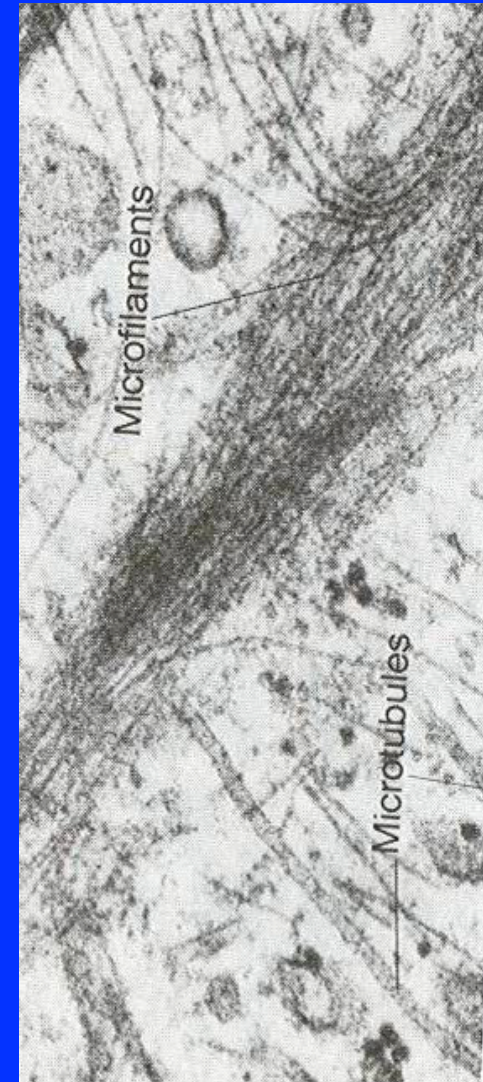


# Clinical application

- **Immotile cilia syndrome:**
  - **Disorder that causes infertility in male and chronic respiratory tract infection in both sexes.**
  - **is caused by immobility of cilia and flagella induced by deficiency of dynein.**
  - **Dynein protein is responsible for movements of cilia and flagella.**

# Cytoskeleton

- It is the structural skeleton of the cell.
- **Functions:**
  - Maintains shape of the cell.
  - Helps transport of material within the cell.
- **Consists of:**
  - **Microfilaments** (actin).
  - **Intermediate filaments**, e.g. Keratin.
  - **Microtubules**.





# Suggested Histology References

- For Theoretical:
  - Color Textbook of Histology,  
L.P. Gartner and J.L. Hiatt,  
Latest Edition.
- For Practical:
  - Di Fiore's Atlas of Histology,  
V.P. Eroschenko,  
Latest Edition.