



بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

Introduction to Histology and Cell Structure

Content & Objectives

In this lecture you are expected to learn:

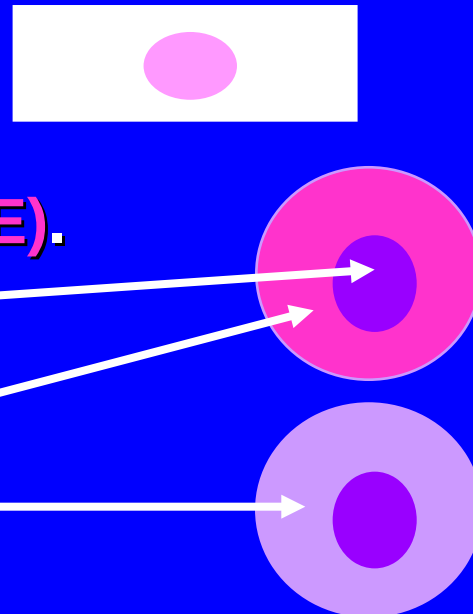
- What is histology and how it is studied?
- Composition of the cell: Light microscopic (L/M) and electron microscopic (E/M) and function of each component:
 - Nucleus.
 - Cytoplasm:
 - » Organelles: membranous and non-membranous.
 - » Inclusions.

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).

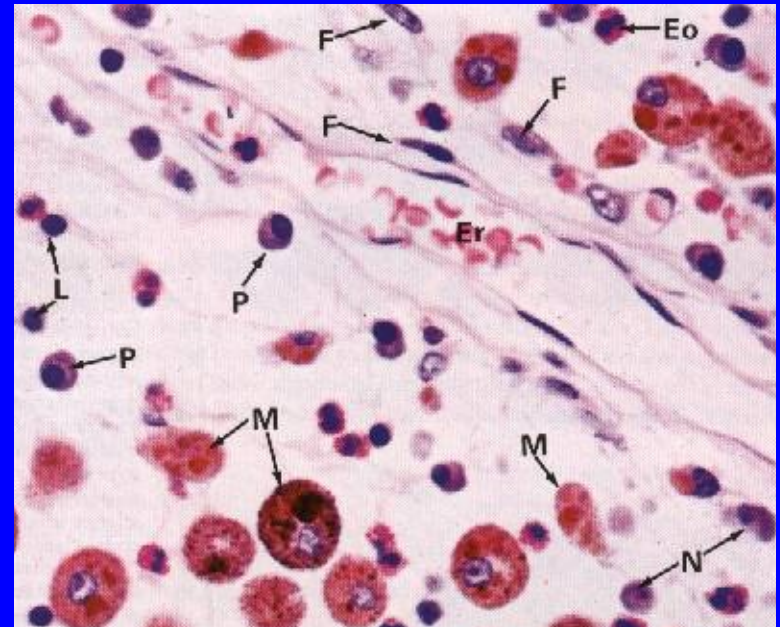


THE CELL

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

1- Nucleus

2- Cytoplasm

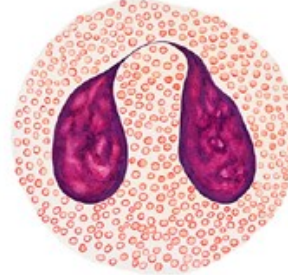


NUCLEUS (L/M)

Shape of nuclei



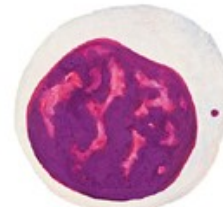
Neutrophilic granulocyte



Eosinophilic granulocyte



Basophilic granulocyte



Lymphocyte



Monocyte

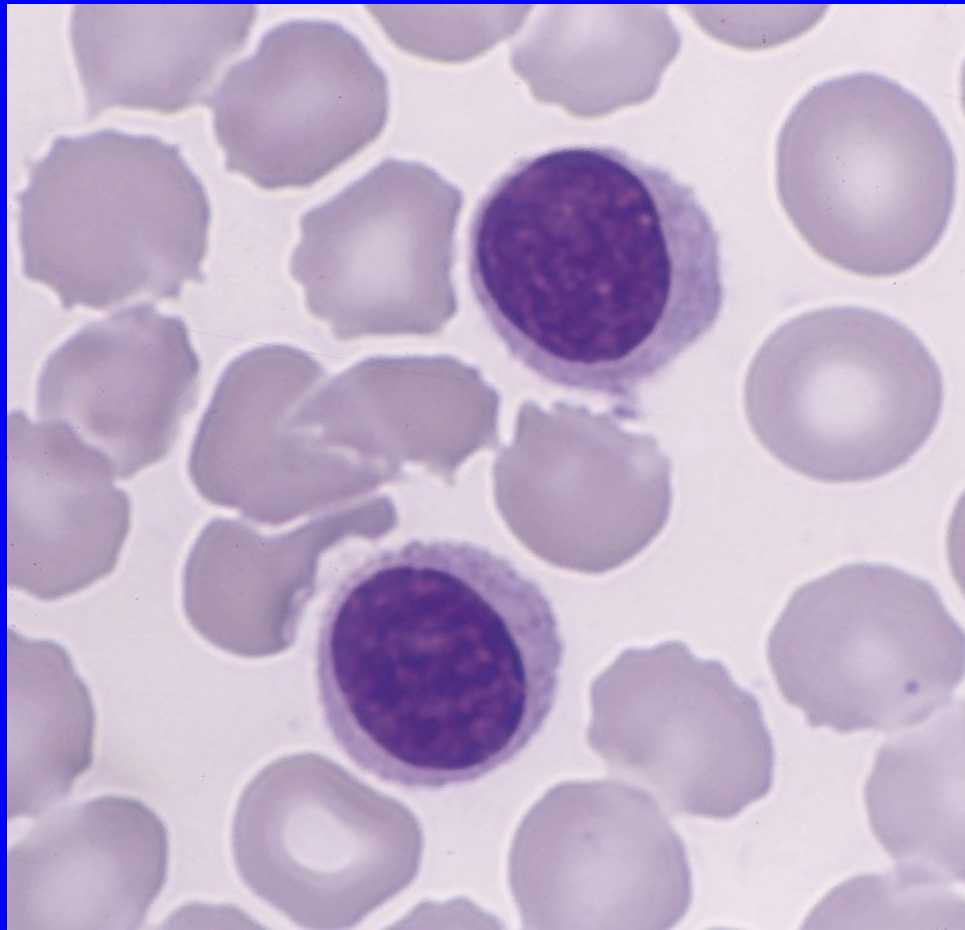


Monocyte

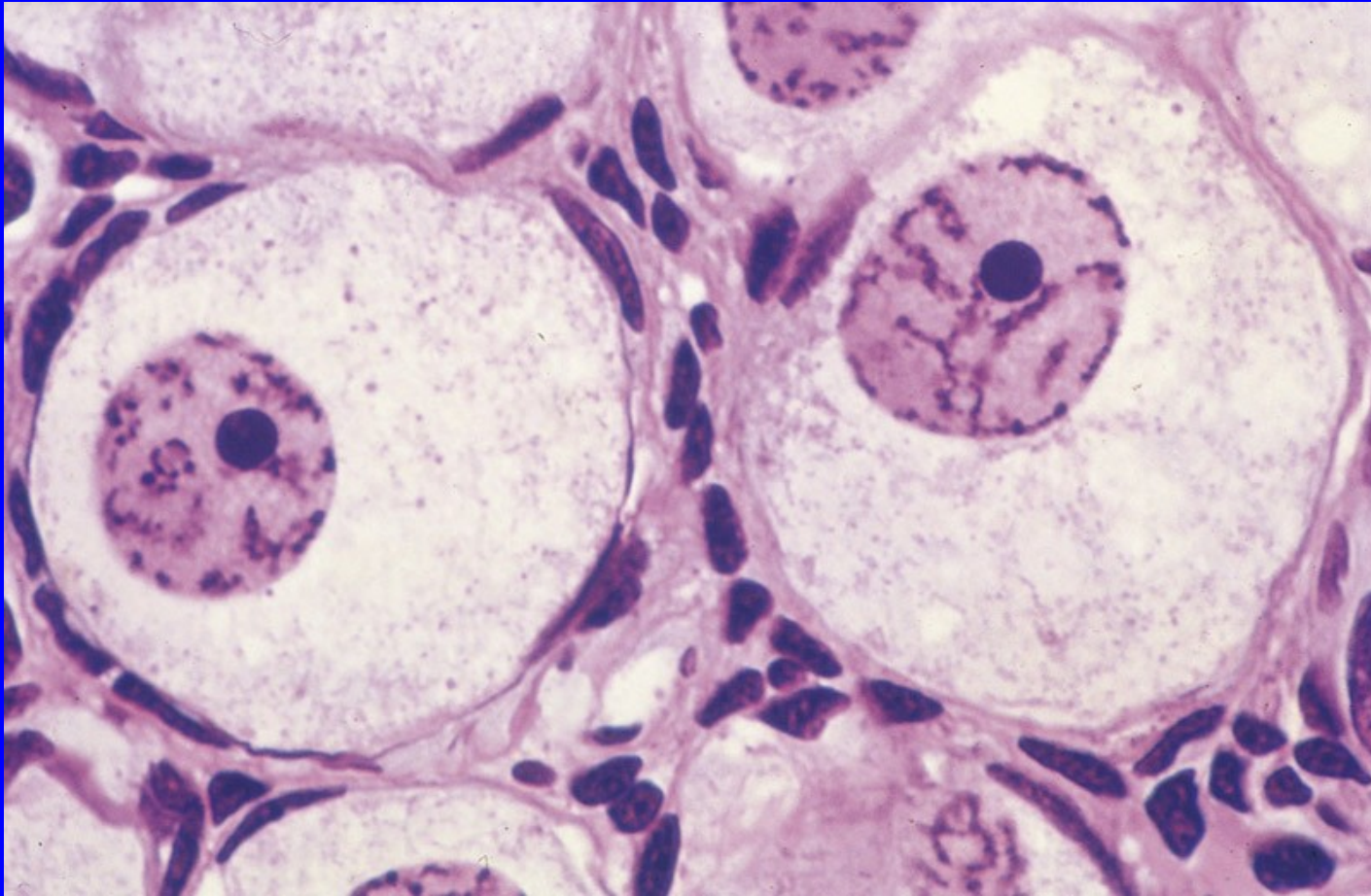
Appearance of nuclei

(1) Dark Nucleus (Deeply-stained nucleus)

Deeply basophilic Nucleus

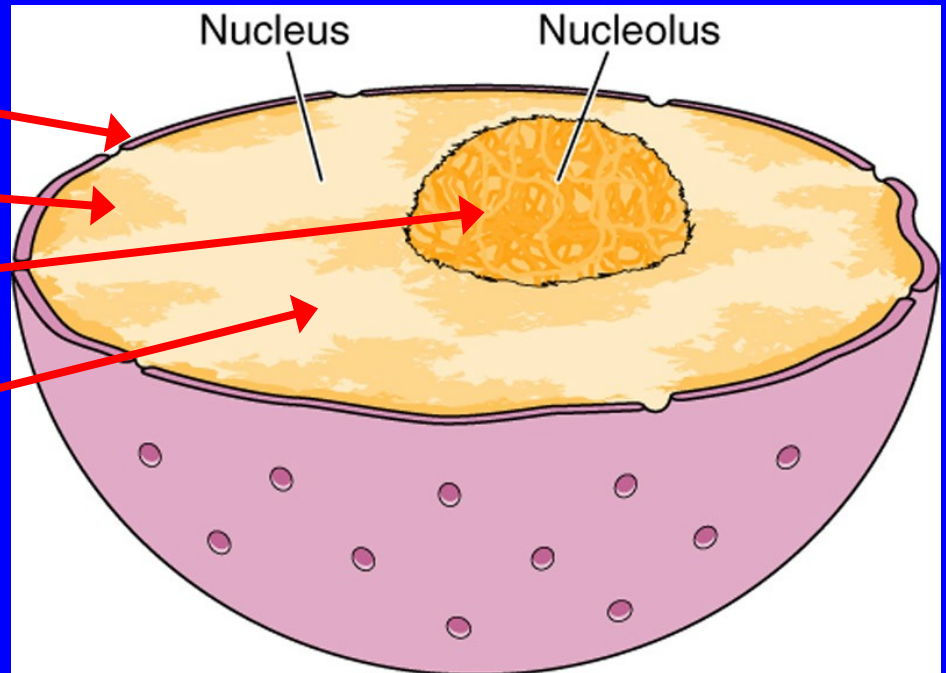


(2) Vesicular (open face) Nucleus



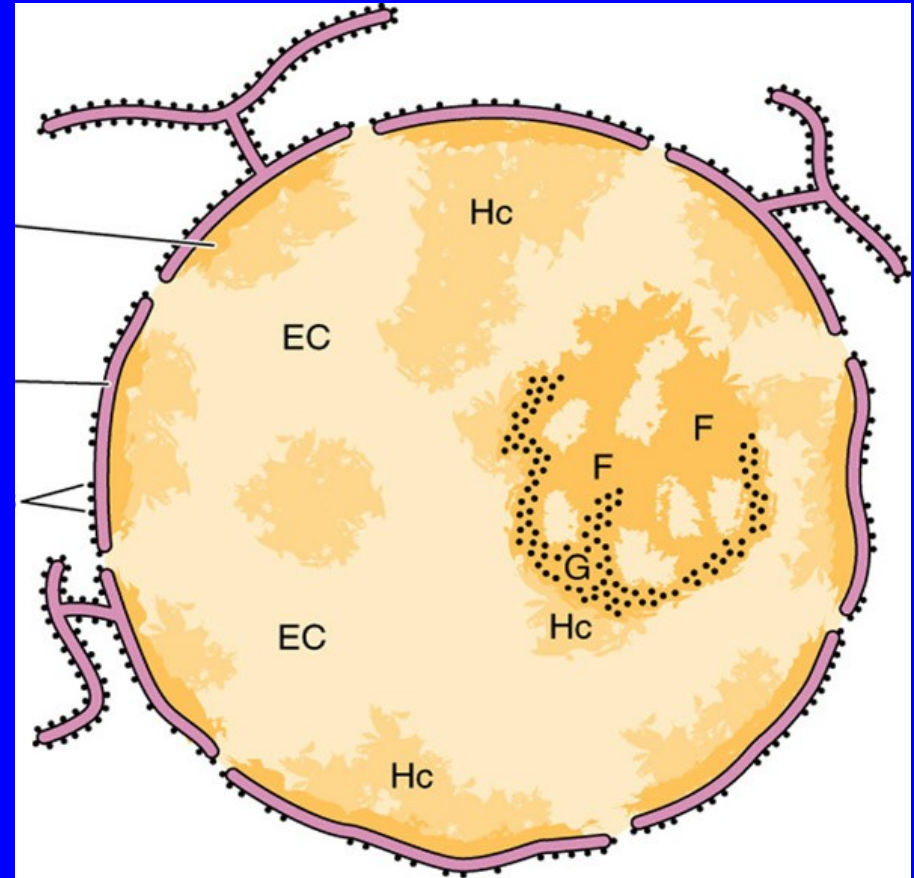
NUCLEUS (E/M)

- **Formed of:**
 1. Nuclear envelope
 2. Chromatin
 3. Nucleolus
 4. Nucleoplasm



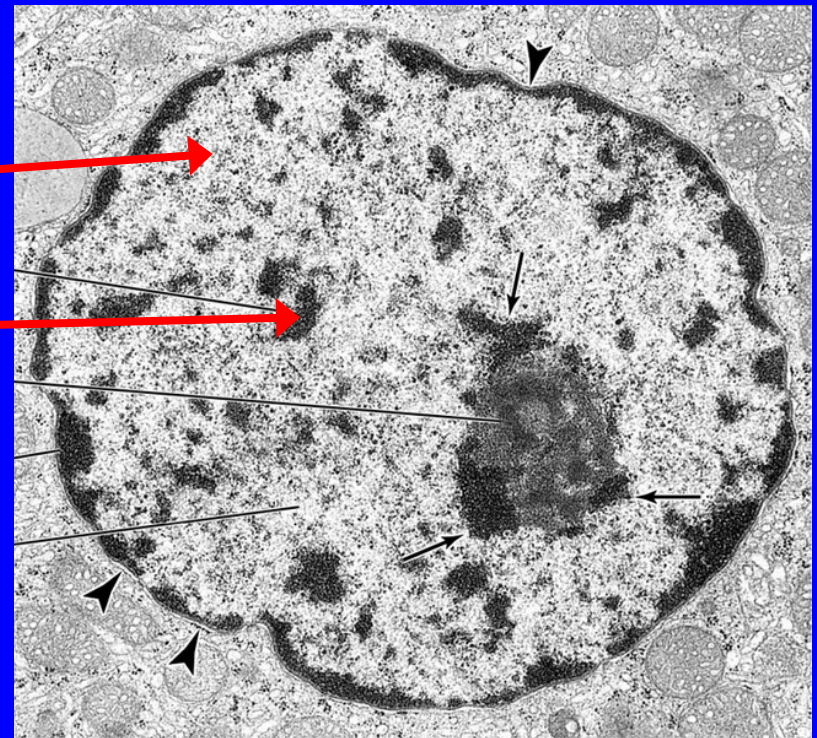
1. Nuclear Envelope

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



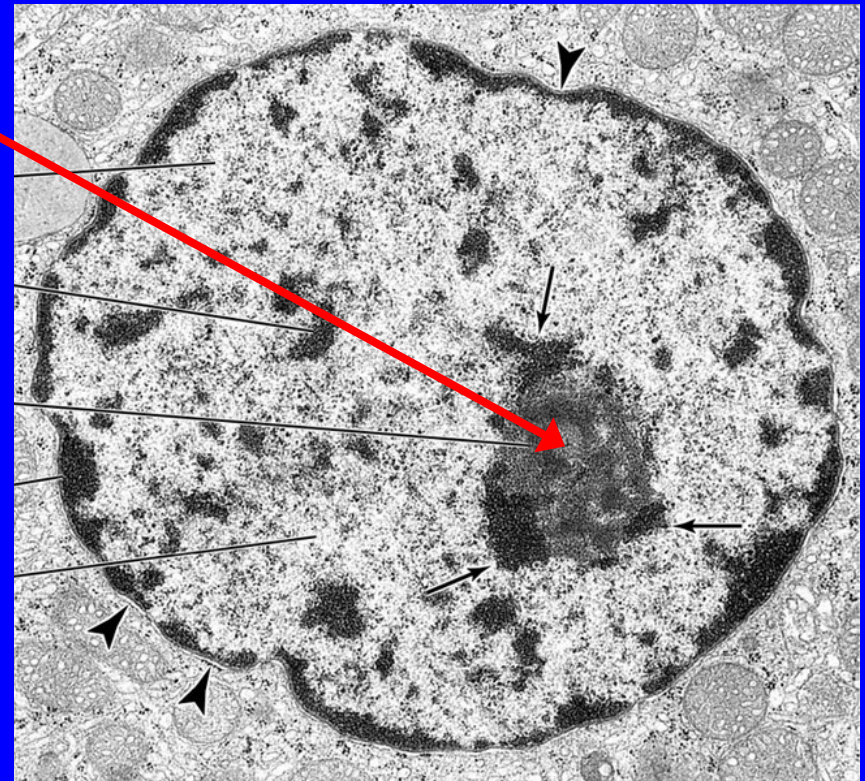
2. Chromatin

- 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.

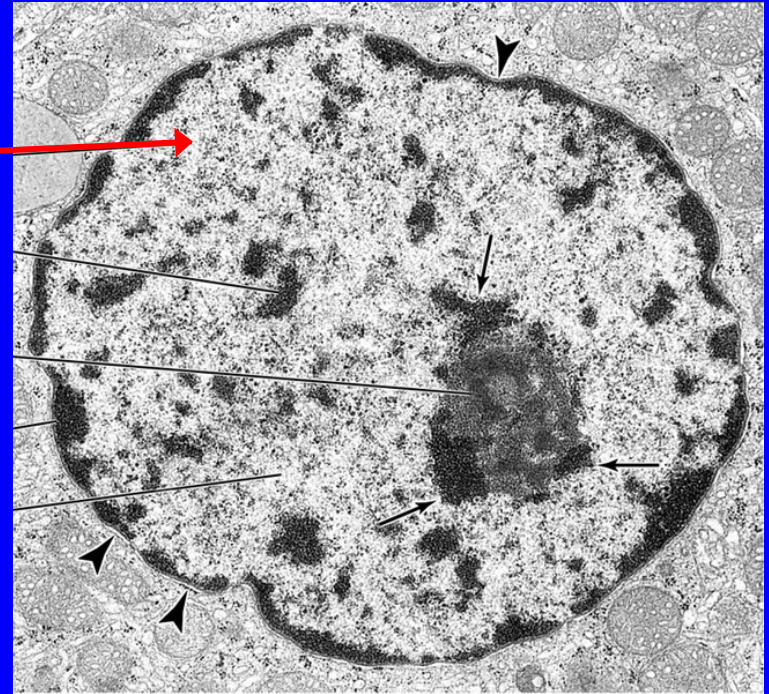


4. Nucleoplasm

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

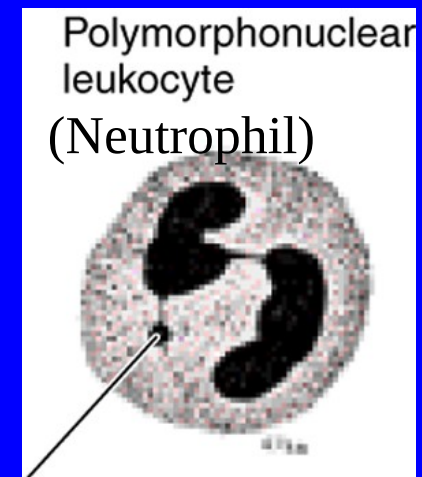
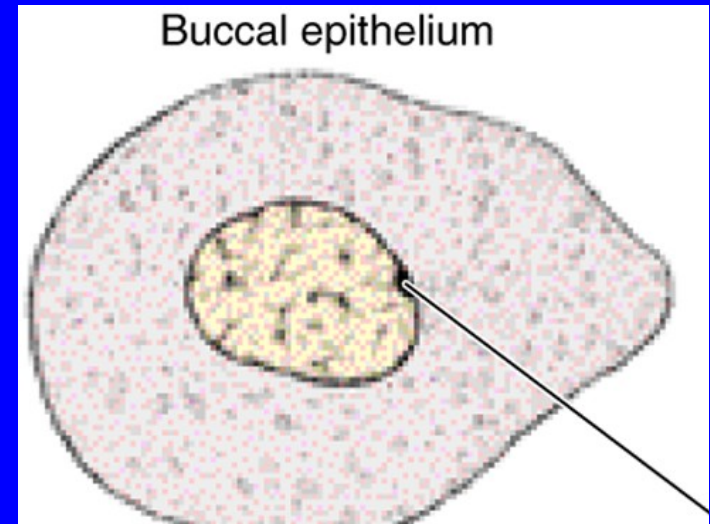
Function:

- 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.



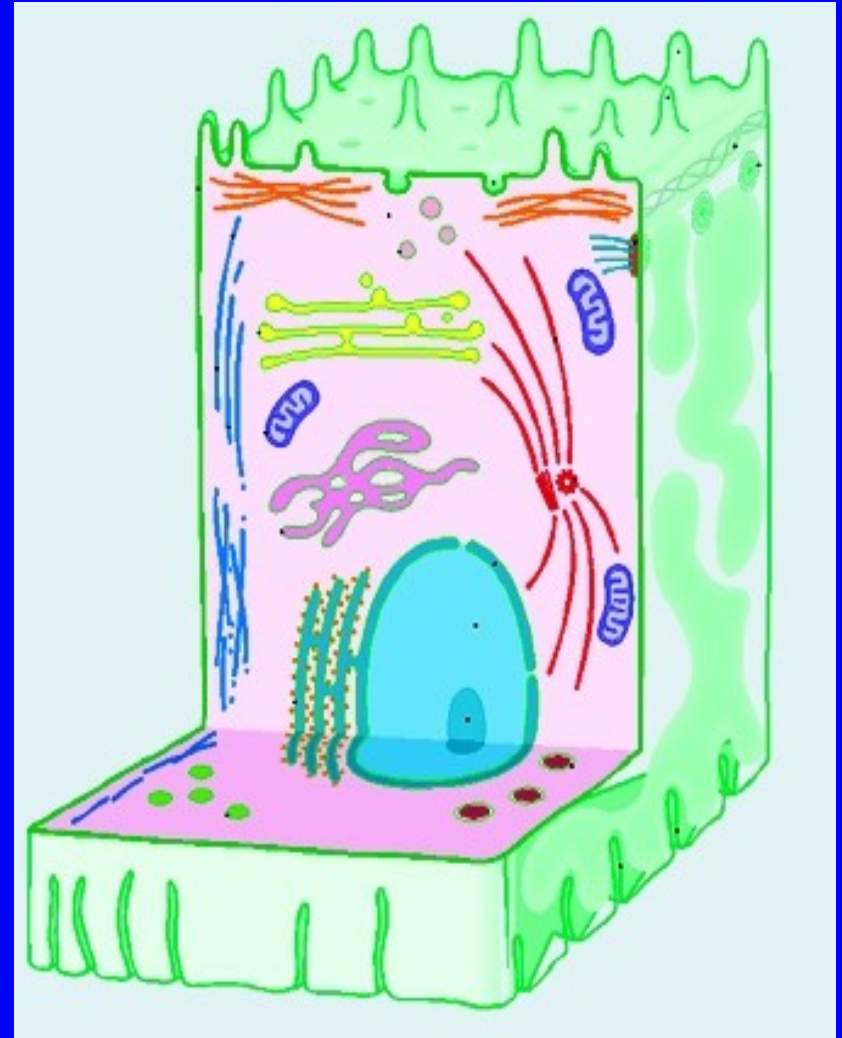
Functions of the Nucleus

- 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.



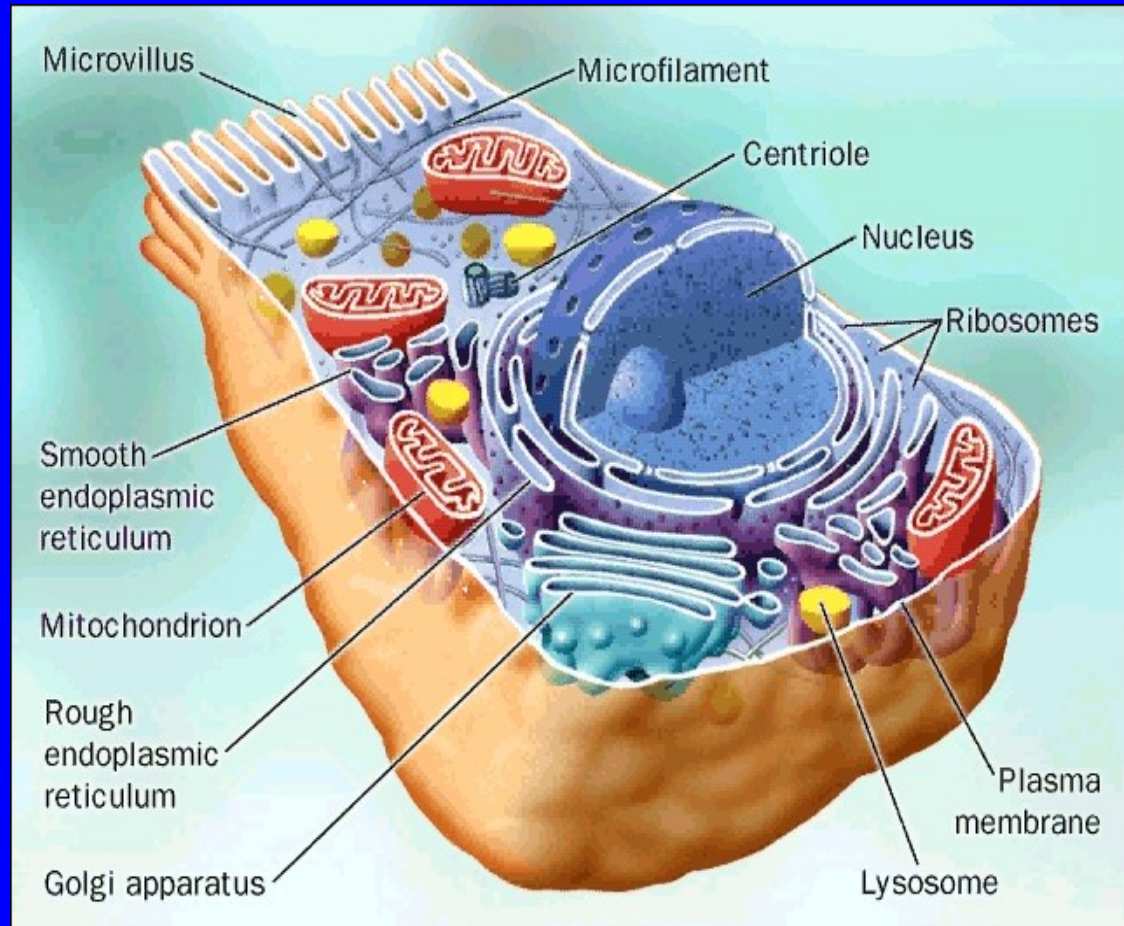
CYTOPLASMIC ORGANELLES

A. Membranous:

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

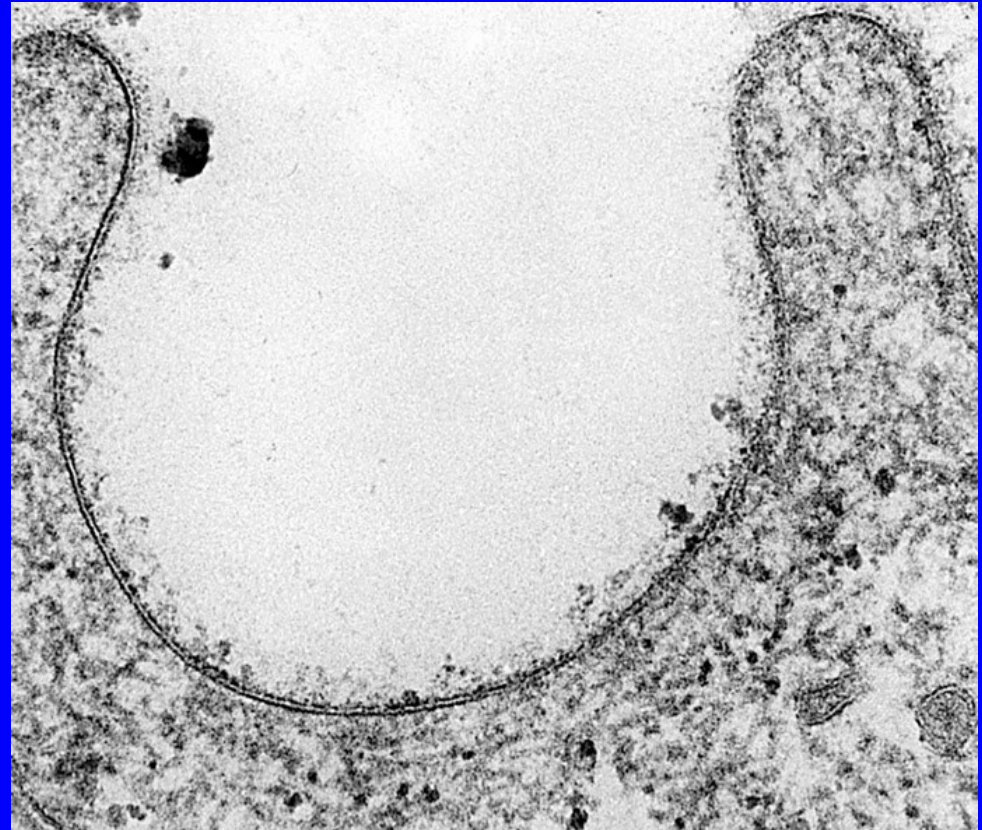
B. Non-membranous:

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



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

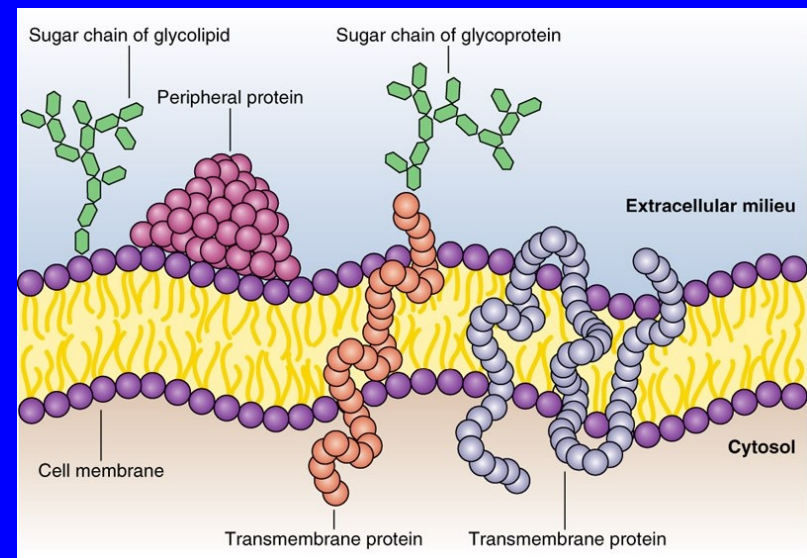
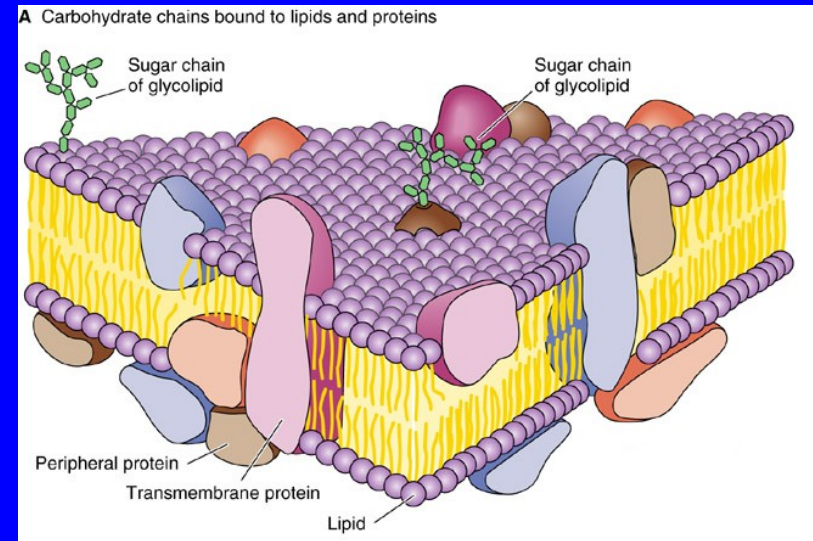
3- Carbohydrate molecules:

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

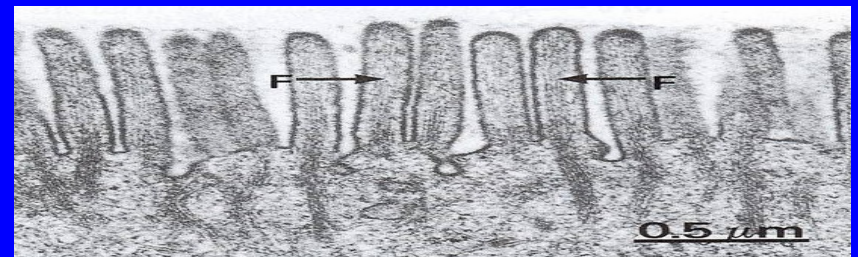
Specializations:

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.



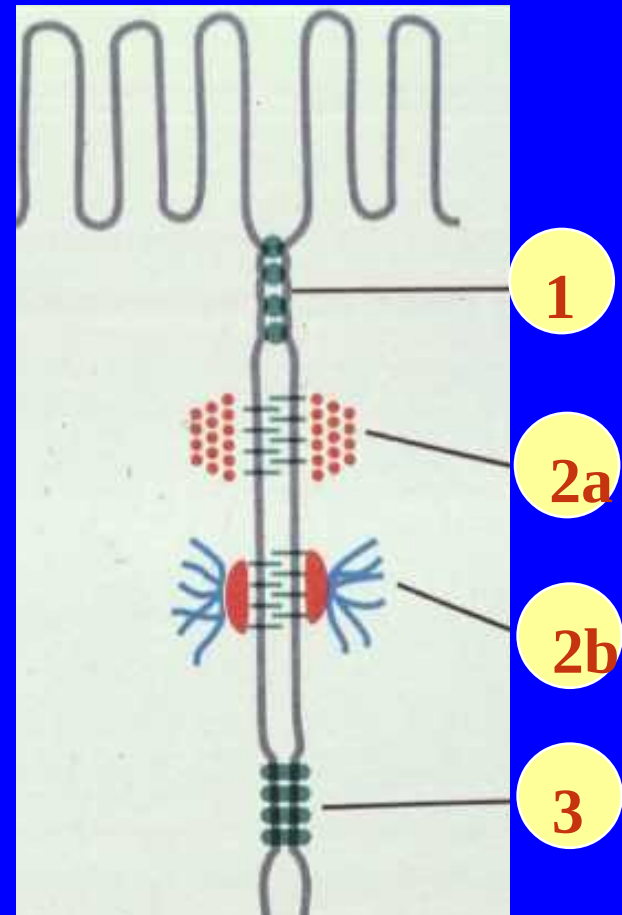
Cell Membrane

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**.

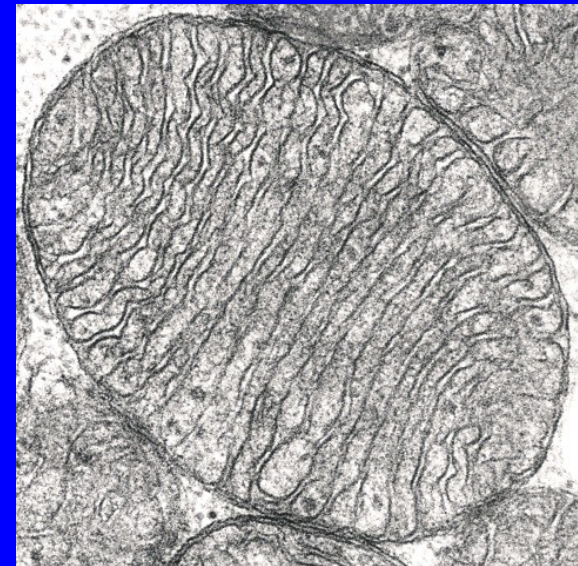
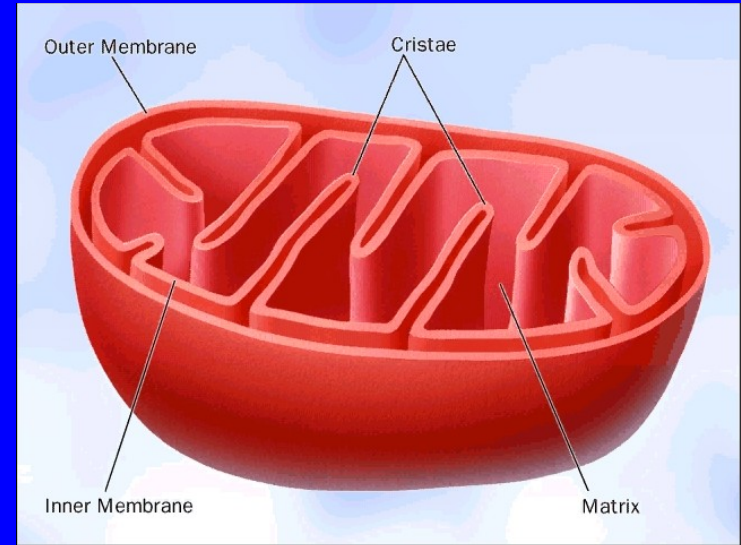


Mitochondria

- 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**.

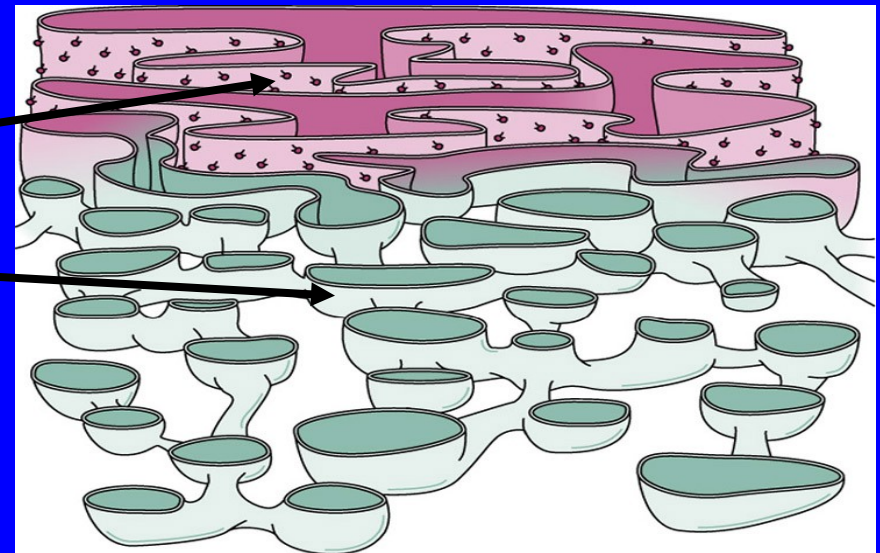
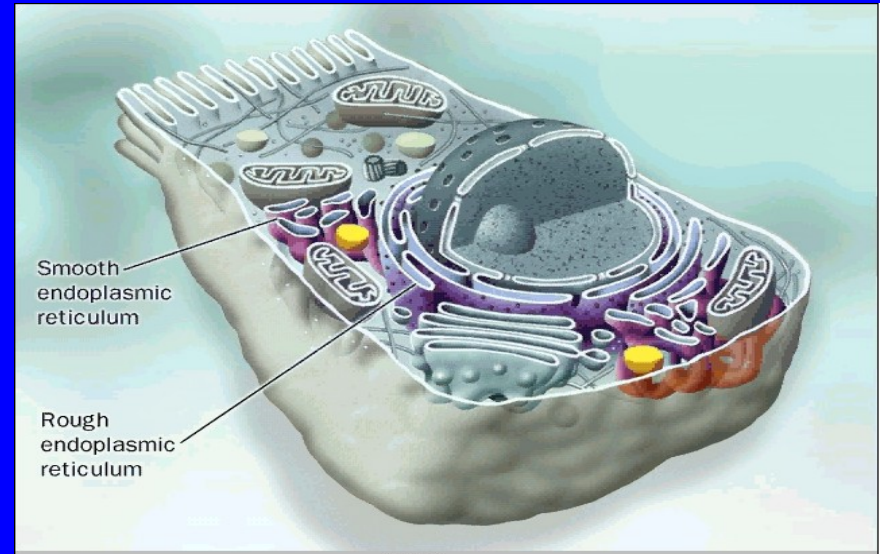
Functions:

- 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**.



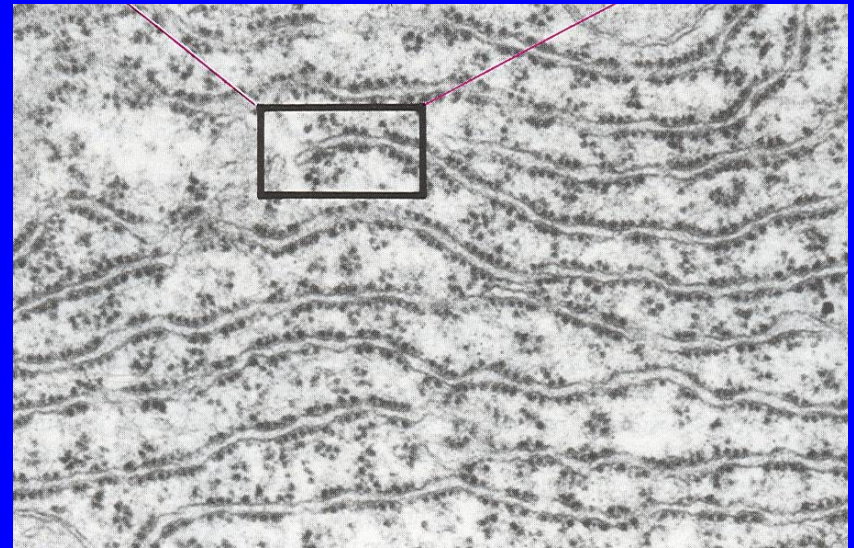
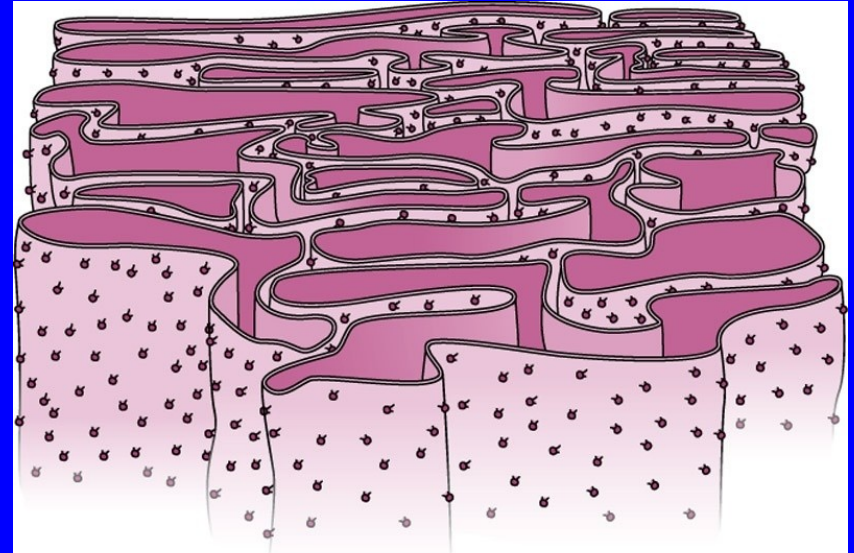
Endoplasmic Reticulum (ER)

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



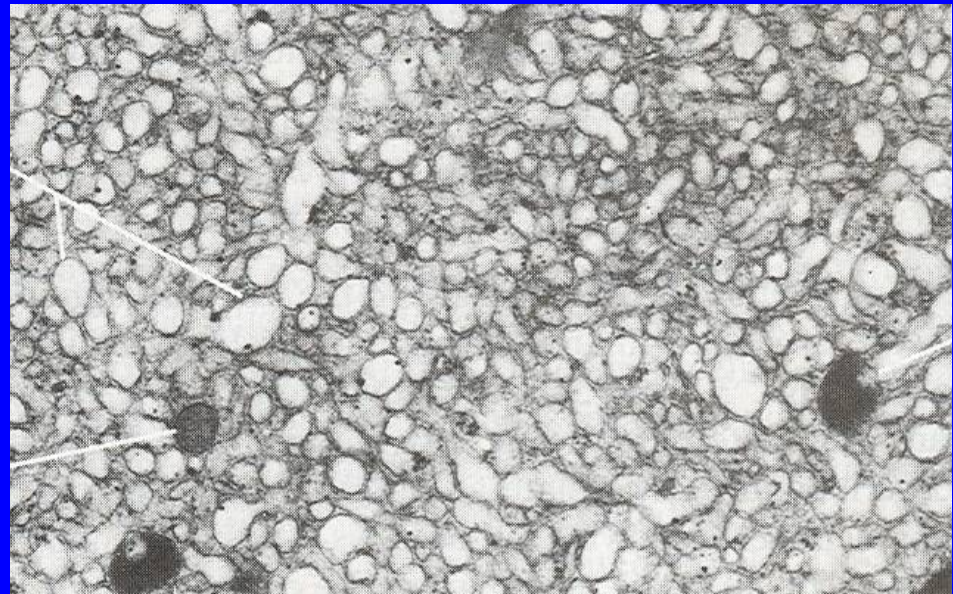
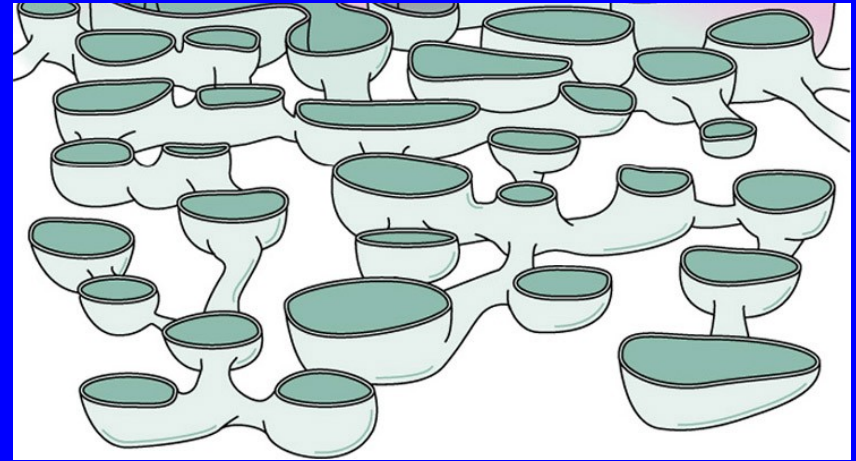
Rough Endoplasmic Reticulum

- 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.

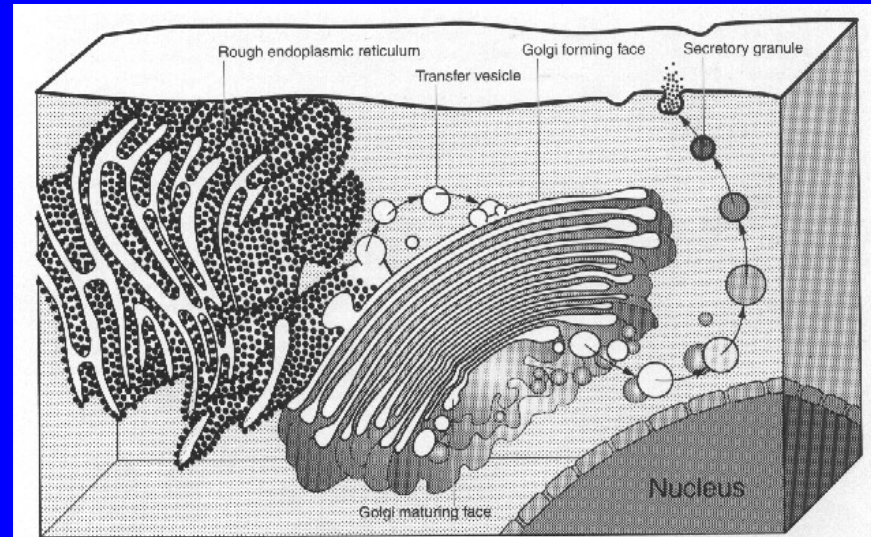
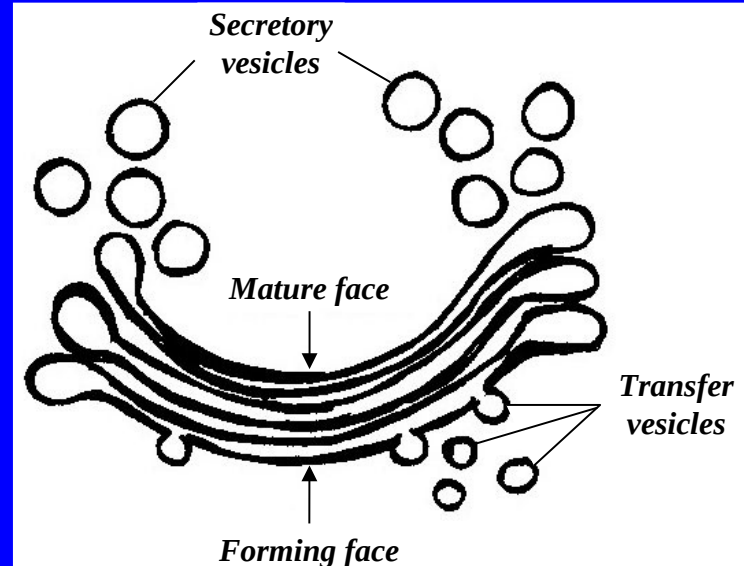


Golgi Apparatus

- 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.

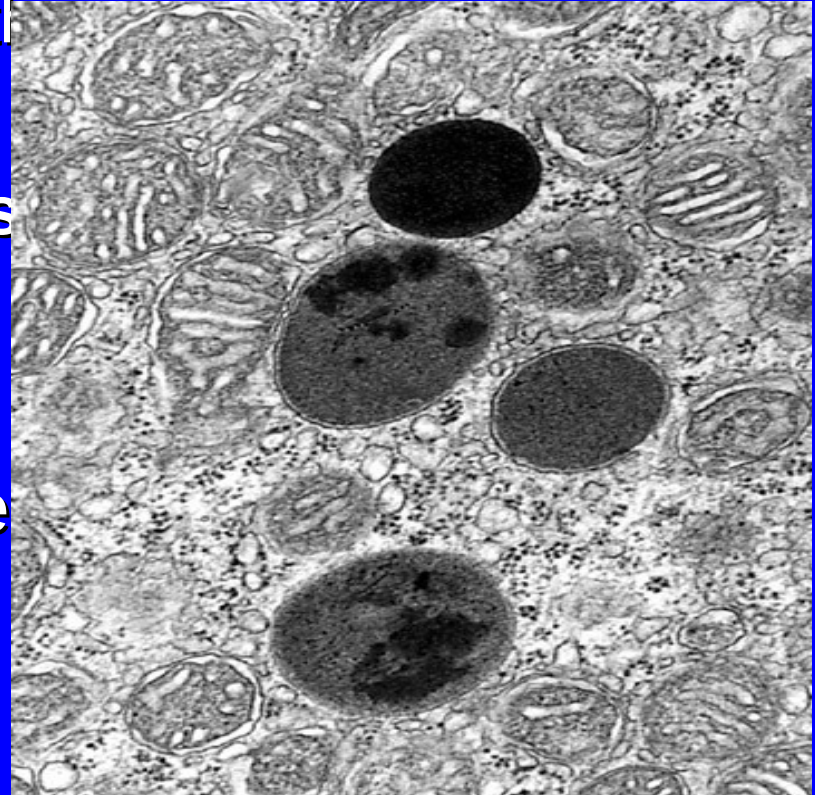
Functions:

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



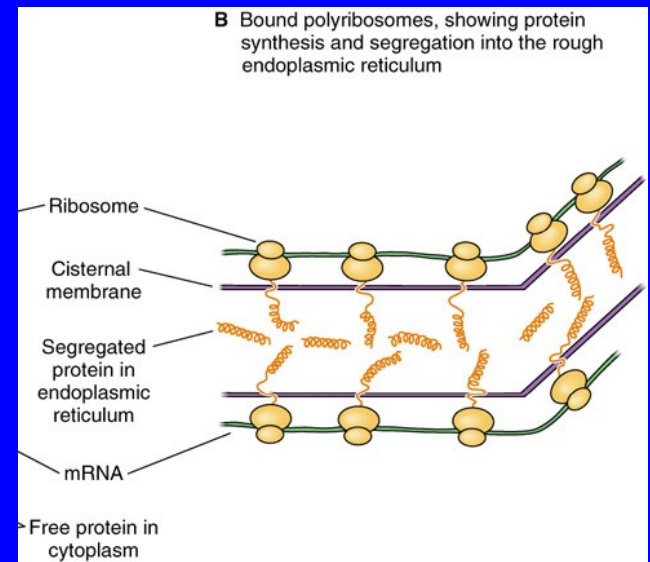
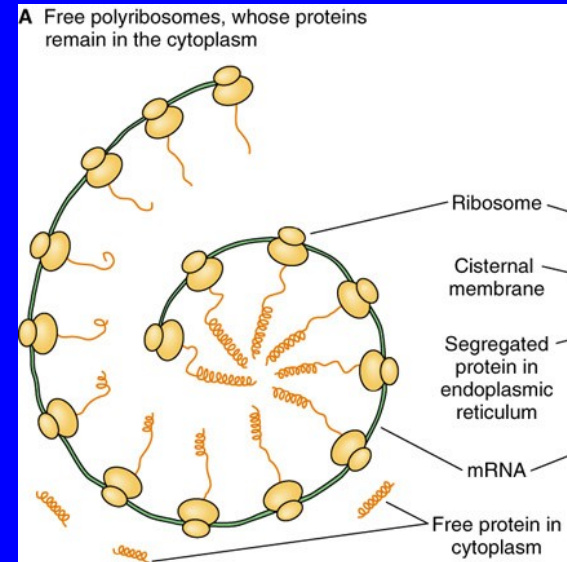
Lysosomes

- 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.



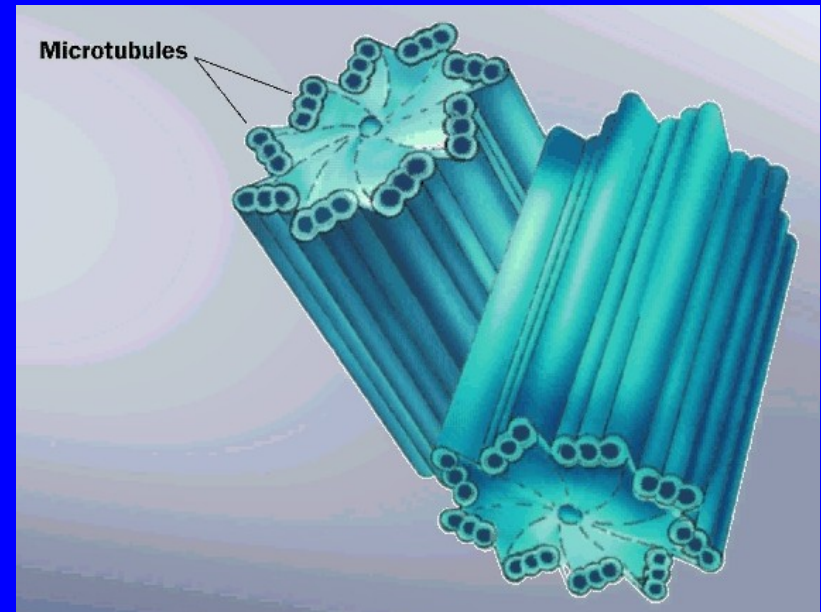
Ribosomes

- **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_

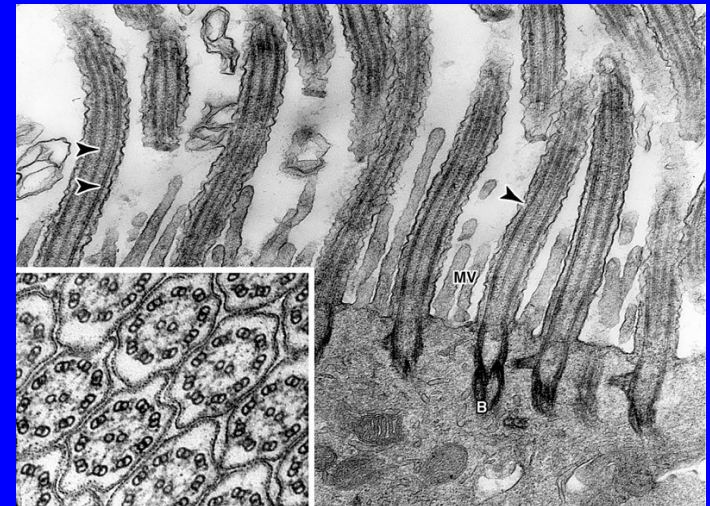
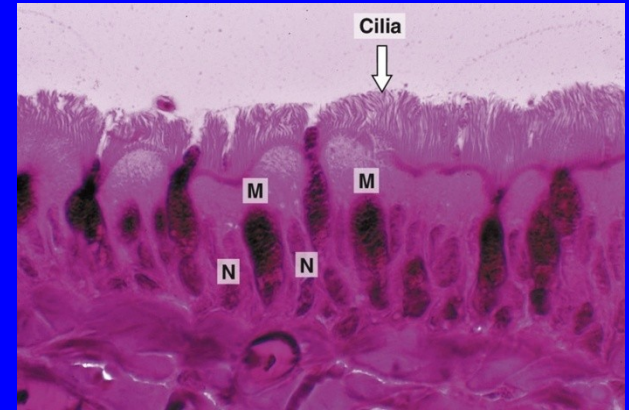
1. **Centrioles:** see before.

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.

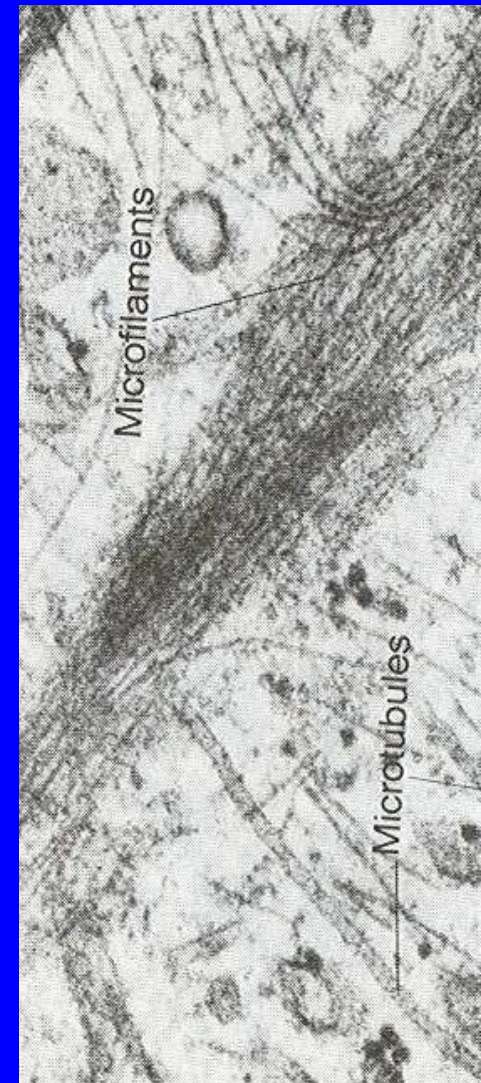


Clinical application

- **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.