

Lecture Objectives:

By the end of the lecture, you are expected to learn:

- What is histology and how it is studied
- Composition of the cell and function of each component:
 - Nucleus
 - Cytoplasm: (organelles: membranous and non-membranous, inclusions)

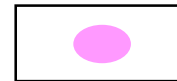
Histology Lecture (1): Introduction to Histology and Cell Structure

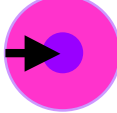
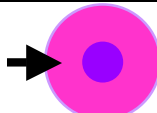
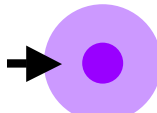
note:

- **RED = Important**
- **Orange = Explanation or clarification**
- **Purple = Extra**

Introduction:

- Histology: the **microscopic** study of **normal** tissues.
- Types of microscopes: **LM** (**light microscope**) & **EM** (**electronic microscope**) " EM is used for high magnifications "
- **Organs** are made of **tissues** & tissues are made of **cells**. " Cells -> tissues -> organs -> system "
- Thin sections are cut and mounted on glass slides.
- Sections are stained with **Hematoxylin (H)** (**basic dye**) and **Eosin (E)** (**acidic dye**)



Staining	Color	Reason	Image	Clarification
Nucleus	always blue (or deep pink)	Basophilic (love basic dye)		Since nucleus contains DNA and RNA which are acids then it's acidic and attracted to basics.
Cytoplasm	may be red (or deep pink) or blue	basophilic or acidophilic	 	Cytoplasm mostly basic -> acidophilic But if it contains ribosomes (e.g. secretion cells) or any acidic particle -> basophilic

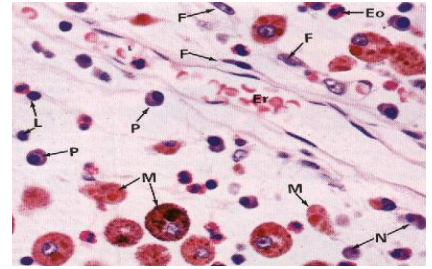
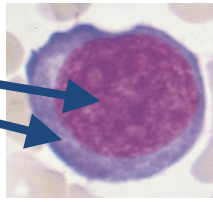
THE CELL

It is the **structural & functional** unit of all living tissues.

Cells have **different shapes & sizes**.

THE CELL is made of:

- 1- Nucleus
- 2- Cytoplasm



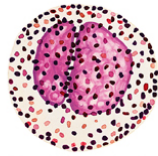
Shape of nuclei (we don't have to memorize them .. it's only important to know the fact that there are different shapes)



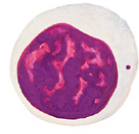
Neutrophilic granulocyte



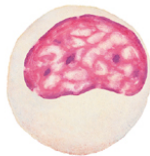
Eosinophilic granulocyte



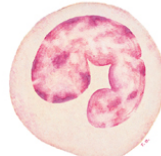
Basophilic granulocyte



Lymphocyte



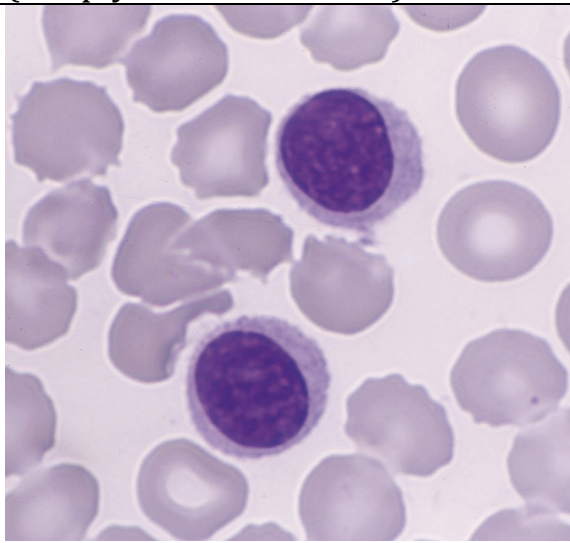
Monocyte



Monocyte

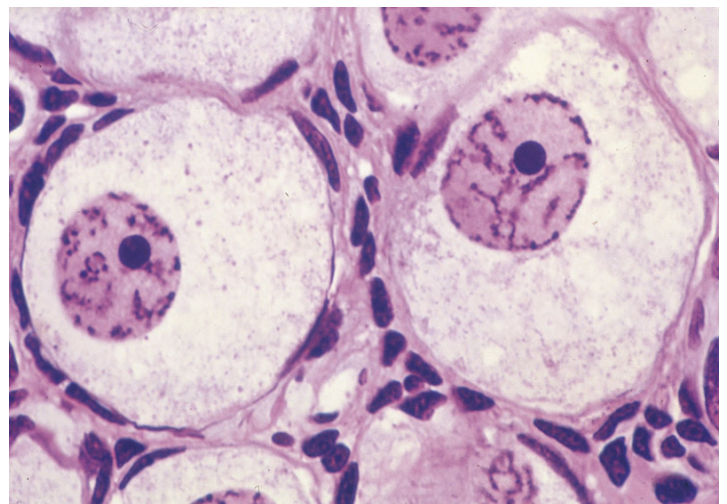
Level of nuclei

Dark Nucleus
(Deeply-stained nucleus).



We can't see the nucleolus

Vesicular (open face) Nucleus (more active)



the nucleolus is clear

Components of the cell in correlation with their functions:

- Nucleus.

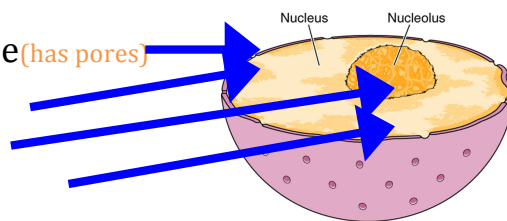
- Cytoplasm:

- Membranous cytoplasmic organelles.
- Non membranous cytoplasmic organelles.
- Specializations of the cell membrane.
- Microtubules-containing organelles.
- Cytoskeleton.
- Cytoplasmic inclusions.

NUCLEUS

Formed of:

- ❖ Nuclear envelope (has pores)
- ❖ Chromatin
- ❖ Nucleolus
- ❖ Nucleoplasm



* Cytoplasm surrounding the nucleus from outside, but Nucleoplasm within the nucleus.

* The function of the pores is to allow different substances to pass in or out the nucleus

* The chromatin is either attached to the nucleolus or to the inner nuclear envelope.

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**.

Components of nucleus:

1- Nuclear Envelope

Structure:

A double membrane with many pores.

- a) **Outer membrane. (rough due to ribosomes)**
- b) **Inner membrane. (rough due to presence of peripheral chromatin)**
- c) **Nuclear pores.**

function of Nuclear pores:

provide communication between nucleus and cytoplasm.

2- Chromatin

Structure:

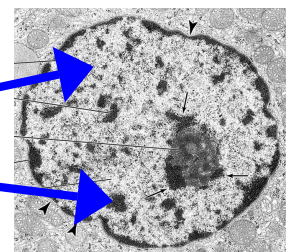
Formed of **DNA**.

2 Forms:

- **Euchromatin:** Extended **active** chromatin -> (**pale**).
- **Heterochromatin:** condensed **inactive** chromatin -> (**dark**)

Functions:

- Carries genetic information.
- Directs protein synthesis



3- Nucleolus

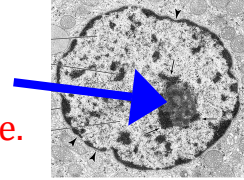
Structure:

It is a spherical dark **basophilic** mass **not surrounded by a membrane**.

Usually one.

Function: formation of ribosomal RNA (rRNA), which is responsible for protein synthesis in the cytoplasm.

So :(nucleolus ->rRNA -> protein *in the cytoplasm*)



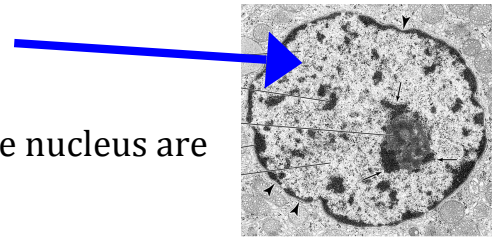
4- Nucleoplasm

Structure:

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.

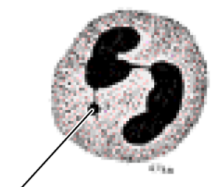
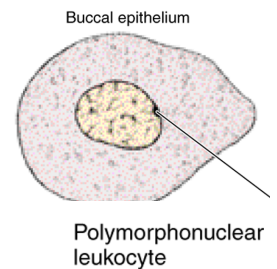


Sex Chromatin (Barr Body) *Clinical Application*

- 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. (XX)
- Absent in females with Turner's syndrome XO.
- Seen in males with Klinefelter's syndrome XXY.

Normal female = one Barr body.

Normal male = no Barr body.



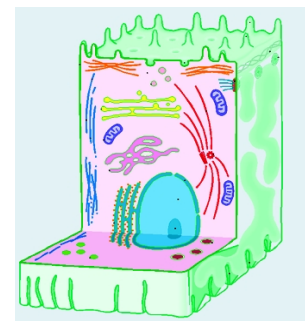
CYTOPLASM

is formed of:

1-INCLUSIONS: الزادات

They are **not essential** for vitality of cells. may be present or absent.

Examples are **lipids, glycogen and pigments** like melanin & lipofuscin (**remnant waste product of long living cells**).



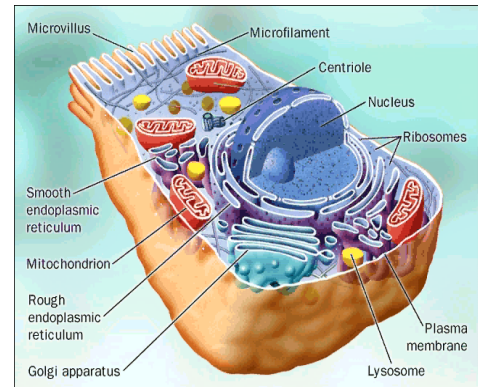
2-ORGANELLES: They are specialized structures, **essential** for vital processes of the cell: (organelles are existed in ALL cells but in different amounts e.g. mitochondria exist excessively in liver cells, also existed in skin cells but in smaller amount)

A. Membranous: (surround by membrane)

- Cell membrane.
- Mitochondria.
- Endoplasmic reticulum (rough & smooth).
- Golgi apparatus.
- Lysosomes.
- Secretory vesicles

B. Non-membranous:

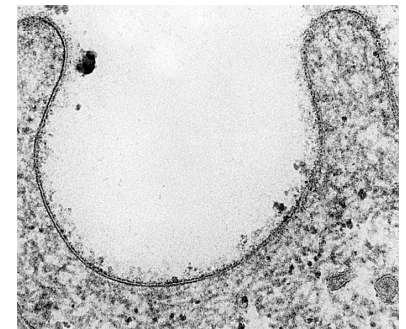
- Ribosomes.
- Centrioles.
- Cilia & Flagella.
- Filaments: Actin, Myosin & Intermediate filaments.
- Cytoskeleton (actin, intermediate filaments & microtubules).



Cell Membrane

Structure:

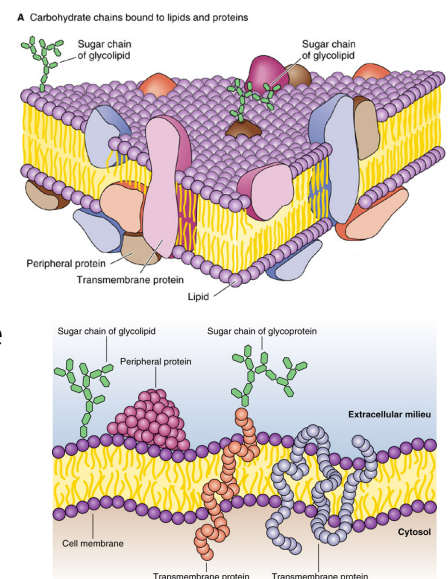
- A very thin membrane that surrounds the cell.
- **LM: Not visible.**
- **EM: appears as 2 dark lines, separated by a light one (trilaminar appearance) = 3 layers.**



Function: selective barrier.

Chemical Structure:

- 1- **Phospholipid molecules:** arranged in **2 layers**.
- 2- **Protein molecules:**
 - a) **Peripheral protein**
 - b) **Integral protein**
- 3- **Carbohydrate molecules:** Carbohydrate + proteins = **(glycoproteins)** & Carbohydrate + lipids = **(glycolipids)** → forming the **surface or cell coat (glycocalyx):**
 - a) Protection of the cell.
 - b) Cell recognition and adhesion. -> act as a **receptor**



➤ Cell Membrane specializations

1) Cilia:

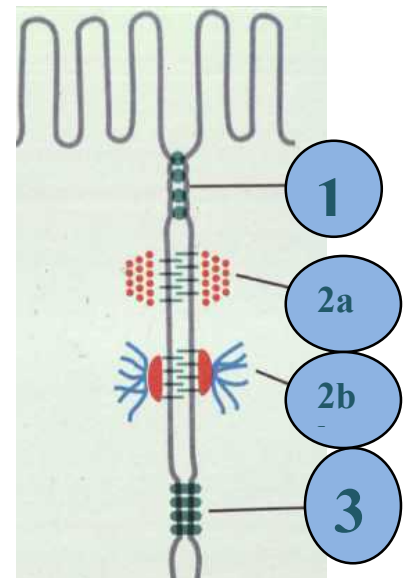
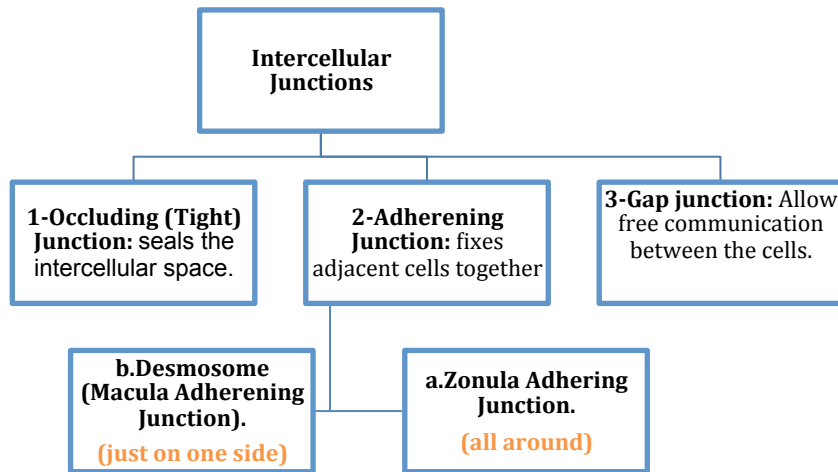
- Long motile hair like structures surrounded by cell membrane.
- **Their core: microtubules.**
- Function : movement.

2) Microvilli (Brush border):

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



3) Intercellular Junctions:



الـ (Junctions):

عبارة عن نوع من الترابط بين الخلايا وهدفه الحماية ونقل المواد بين الخلايا .

1 هو اندماج الـ (Cell Membrane)

لخليتين متجاورتين بحيث تصبح المسافة بين الخلايا شبه معدومة.

2 خليتين تلتصق مع بعضها البعض بمادة (سيميمنتق) ويرتبط الغشاء الخلوي بالغشاء الآخر عن طريق خيوط مكونة من (جلايكوبروتين) .

وهناك 3 أنواع من الالتصاق:

1 زنيولا 2a : يرتبط جزء من الخلية على شكل (حزام كامل يحيط بالخلية) مع خلايا أخرى.

2 فاشيا: يرتبط جزء من الخلية على شكل (جزء من حزام يحيط بالخلية) مع خلايا أخرى.

3. مكيولا 2b : يرتبط جزء من الخلية على شكل (دائرة صغيرة) مع خلية أخرى

3 تقترب الخلايا من بعضها وتكون انابيب بين الخليتين.

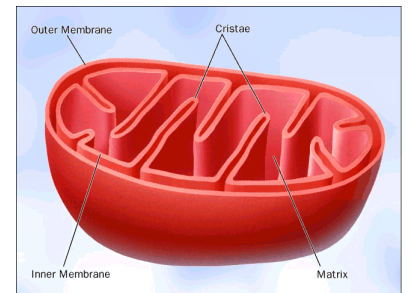
- When a combination of 1 , 2a and 2b is present, this is called a **junctional complex**.

➤ Membranous cytoplasmic organelles

1) Mitochondria

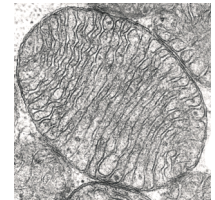
Structure:

- rod-shaped .
- The wall is composed of **2** membranes.
- The outer (**regular shaped**) is smooth; the inner (**not regular**) 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**.



*(Mitochondria is the only organelle contains DNA)

*(the number of folds in mitochondria is directly proportional with its activity)

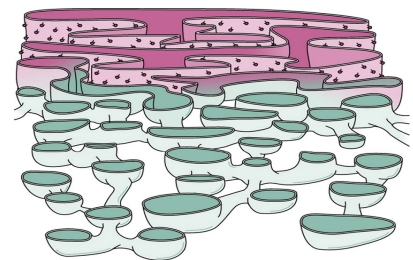
2) Endoplasmic Reticulum (ER)

It is a system of communicating membranous tubules, vesicles, and flattened vesicles (cisternae).

There are 2 types:

Rough (rER).

Smooth (sER).



	rER	sER
structure	Membranous sheets of flattened tubules & vesicles with ribosomes on the surface	Membranous tubules and vesicles, with no ribosomes on the surface.
function	1. Synthesis of proteins by ribosomes on its outer surface. 2. Transfer vesicles transfer the formed protein to Golgi	Synthesis of lipids & cholesterol . Synthesis of steroid hormones, e.g. cortisone. Helps muscle contraction , by acting as a calcium pump. Detoxification of drugs & toxins.
image		

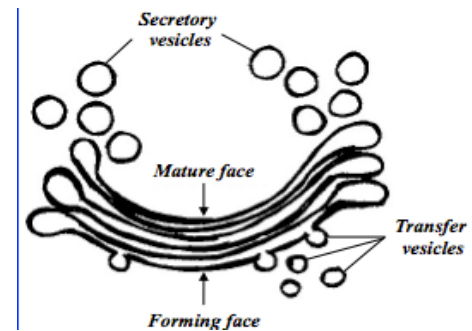
Q : mention one or two sites for this organelle ? (sER)

- 1- Muscles
- 2- 2- liver

3) Golgi Apparatus

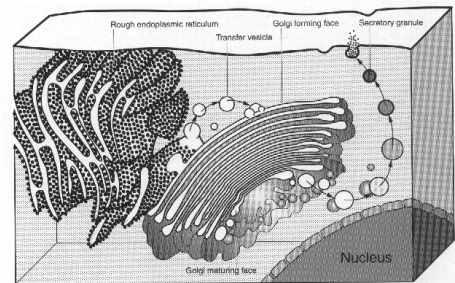
Structure:

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



Functions:

1. **Sorting, modification & packaging** of proteins.
2. **Secretory vesicles** formation. (secretory vesicles would go outside the cell)
3. **Formation of lysosomes**. (lysosomes remain inside the cell)

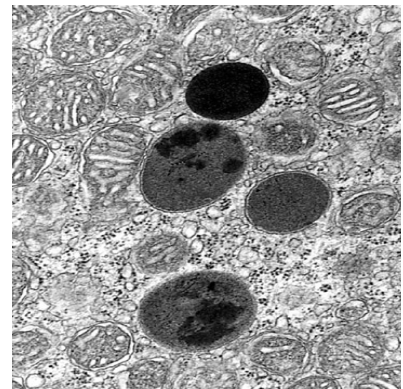


4) Lysosomes

Structure:

- The **digestive apparatus of the cell**.
- 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.



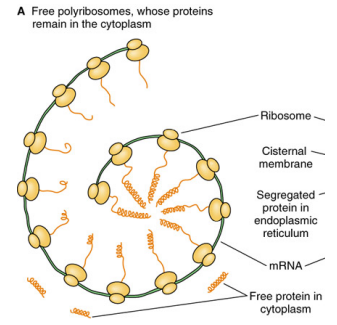
➤ Non membranous cytoplasmic organelles.

1) Ribosomes

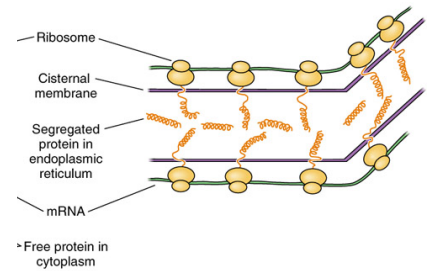
- LM: Basophilic cytoplasm is due to numerous ribosomes.
- Consist of ribosomal RNA (rRNA), combined with proteins. → **ribosomes=rRNA+protiens**
- EM: Formed of 2 subunits.
- free in the cytoplasm (may form polyribosomes) or attached to rER. (When Ribosomes are in the cytoplasm they are found either scattered or in groups which is called polyribosomes)
- Formed in the nucleolus.

Function:

Protein synthesis



B Bound polyribosomes, showing protein synthesis and segregation into the rough endoplasmic reticulum



2) Centrioles

Structure :

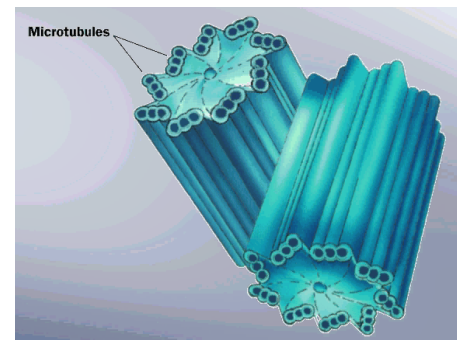
- 2 cylinders, perpendicular to each other.
- Wall is made of **9 triplets** of microtubules (**9x3=27 microtubules**).

Functions:

- 1- Essential for **cell division**.
- 2- Formation of **cilia and flagella**.

* centrioles exist in all types of cells except nerve cells and that's why they are unable to divide

* They are consist of 9 bundles each is formed of 3 microtubules attached together by protein called dynein



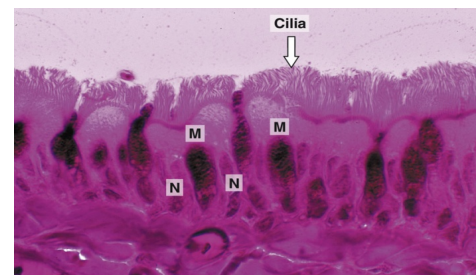
➤ **Microtubules-Containing Organelles**

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.** (**9x2=18 + 2 =20**)

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.



Immotile Cilia Syndrome (Kartagener's Disease))*clinical app.*:

- Disorder that causes:
 - Infertility in male
 - Chronic respiratory tract infection in both sexes
- It 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.**

***Side Note: Microfilaments are weak (not as strong as microtubules) and that's why they always appear in bundles and not single)**

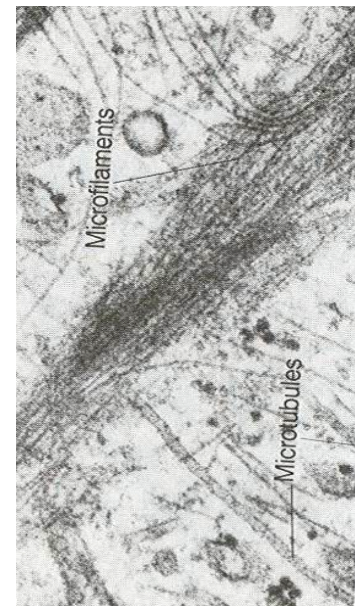


Table for the functions from Modhi Al Dughaiter:

functions	
Nuclear pores	provide communication between nucleus and cytoplasm
Chromatin	-Carries genetic information. -Directs protein synthesis.
Nucleolus	formation of ribosomal RNA (rRNA), which is responsible for protein synthesis in the cytoplasm
Nucleoplasm	Provides a medium for movement of 3 types of RNA (ribosomal, messenger and transfer RNA) from the nucleus to the cytoplasm.
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.
Cell Membrane	Selective barrier.
Mitochondria	1- <u>Generation of ATP</u> which is the source of energy for the cell. They are called the powerhouse of the cell. 2-They can form their own proteins and undergo self-replication.
Rough Endoplasmic Reticulum	1.Synthesis of proteins by ribosomes on its outer surface. 2.Transfer vesicles transfer the formed protein to Golgi.
Smooth Endoplasmic Reticulum	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	1.Sorting, modification & packaging of proteins. 2.Secretory vesicles formation. 3.Formation of lysosomes.
Lysosomes	Intracellular digestion of ingested material or old organelles.
Ribosomes	<u>Protein synthesis</u>
Centrioles	1- Essential for cell division. 2- Formation of cilia and flagella.
Cilia:	Movement of particles or fluids on the free surface of the cell in one direction.
Flagella	Important for movement of the sperms.