

# Lecture 1 :

# Introduction to Histology and Cell Structure

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# Objectives :

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- 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:
  1. Nucleus
  2. Cytoplasm
- Organelles:
  1. membranous and non-membranous
  2. Inclusions

# Introduction :

**Histology** : Histology is the microscopic study of normal tissues.

**Types of microscopes:** LM & EM

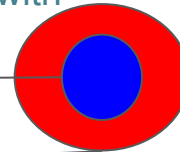
LM : Produce colourful images .

EM : Produce black and white images .



Thin sections are cut and mounted on glass slides. Sections are stained with **Hematoxylin (H)** and **Eosin (E)**.

- Nucleus is always **Blue (basophilic)**
- Cytoplasm can be **Red (acidophilic)** , or **Blue (basophilic)** .



#note :  
The cytoplasm becomes **basophilic** only when it's full of ribosomes.

# 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

# note :

Nucleus has many shapes as well  
few cells are dinucleotide

# NUCLEUS (L/M)

Shape of nuclei :



Neutrophilic granulocyte



Eosinophilic granulocyte



Basophilic granulocyte



Lymphocyte



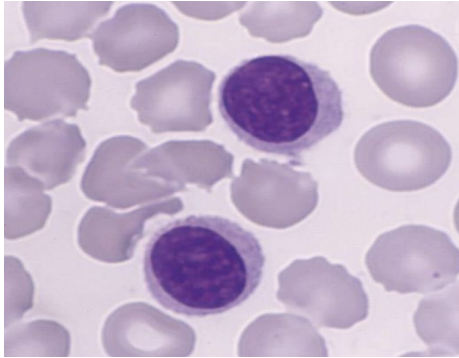
Monocyte



Monocyte

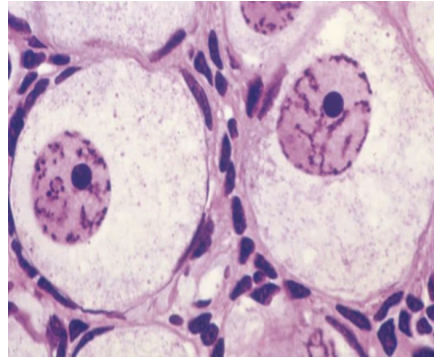
# Appearance of nuclei :

Dark Nucleus (Deeply-stained Nucleus) Deeply Basophilic Nucleus



Inactive cell because the nucleus contains heterochromatin

Vesicular (Open Face) Nucleus



Active cell because the nucleus contains Euchromatin

# The Nucleus:

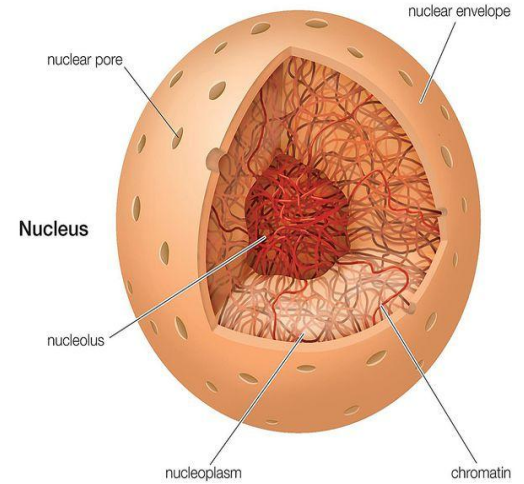
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## Formed of :

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

## Function of the nucleus :

- It's essential for the vitality and **division of the cell**
- It's the site of **storage of genetic information**
- It's the site of **formation of the three types of RNA (rRNA , mRNA , tRNA)**



# Nuclear envelope :

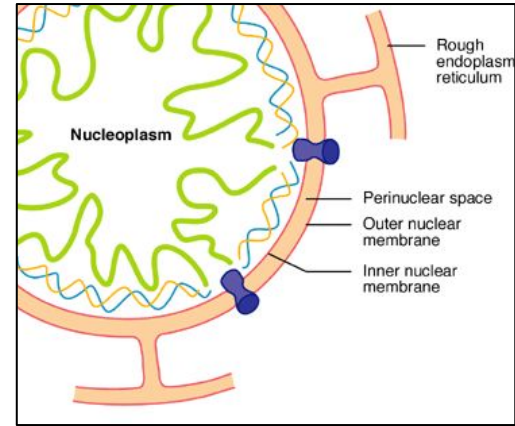
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## Definition:

A **double membrane** with many pores surrounds the Nucleus .

## Formed of :

- 1- Outer membrane
- 2- Inner membrane
- 3- Nuclear pores ( provide communication between nucleus and cytoplasm)



#note :

\* the only double membrane surrounded structures in the cell are Nucleus and Mitochondria .

# Chromatin :

Formed of **DNA** and **protein**

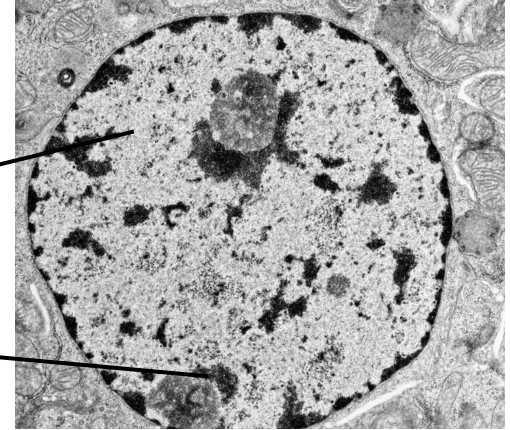
Two forms of chromatin :

1. **E**uchromatin : extended **a**ctive chromatin  
electron-lucent areas =(pale)

2. **H**eterochromatin : condensed **i**nactive chromatin  
electron-dense areas (dark)

Functions of chromatin

- Carries genetic information .
- Directs protein synthesis .





### 3- Nucleolus:

- **E/M** : appear mostly as dark mass (**electron-dense**) (the largest one).
- **L/M** : appear as spherical dark **basophilic** mass.
- Usually one .
- **Not surrounded by a membrane .**

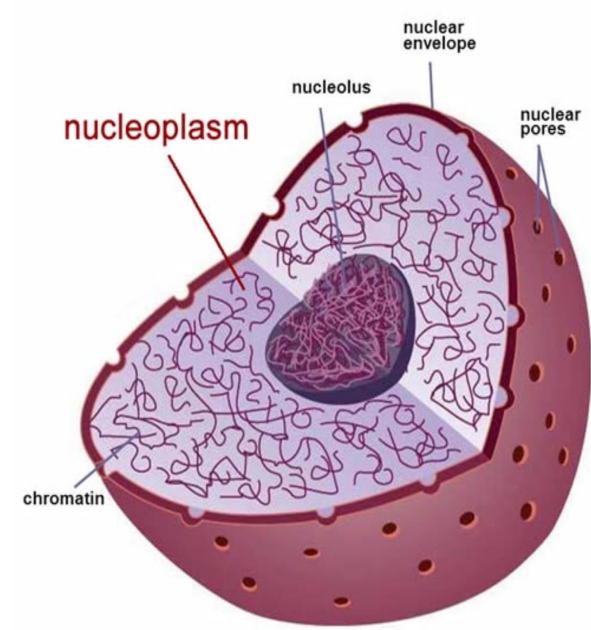
**Function** : formation of **ribosomal** RNA (rRNA) witch responsible for protein synthesis in the cytoplasm .

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### 4- Nucleoplasm:

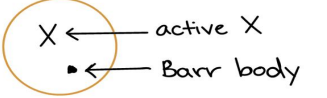

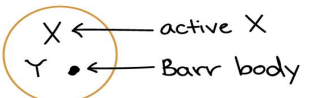
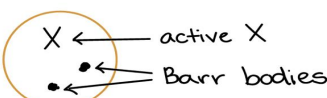
It is a clear fluid medium in which all the contents of the nucleus are embedded.

**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 (heterochromatin).
- Seen in normal female cells.
- Absent in normal males cells .
- Absent in females with Turner's syndrome XO.
- Seen in males with Klinefelter's syndrome XXY.

XX female	 <p>X ← active X ● ← Barr body</p>
XY male	 <p>X ← active X (the only X) Y</p>
XXY male (Klinefelter)	 <p>X ← active X Y ● ← Barr body</p>
XXX female (triple X)	 <p>X ← active X ● ● ← Barr bodies</p>



# Cytoplasm is formed of

<b>Organelles:</b>	They are specialized structures , <b>essential</b> for vital processes of the cell.
<b>Inclusions:</b>	They are <b>not essential</b> for vitality of cells , may be present or absent.  <b>Examples</b> are lipids , glycogen and pigments like melanin & lipofuscin.

<b>Membranous :</b>	cell membrane mitochondria endoplasmic reticulum golgi apparatus lysosomes secretory vesicles
<b>non-membranous:</b>	Ribosomes Centrioles cilia and Flagella Filaments (actin, myosin intermediate filaments). Cytoskeleton (Actin, Intermediate filaments, Microtubules).

# A) Membranous Cell Membrane:

A very thin membrane that surrounds the cell. Acts a **Selective Barrier**.

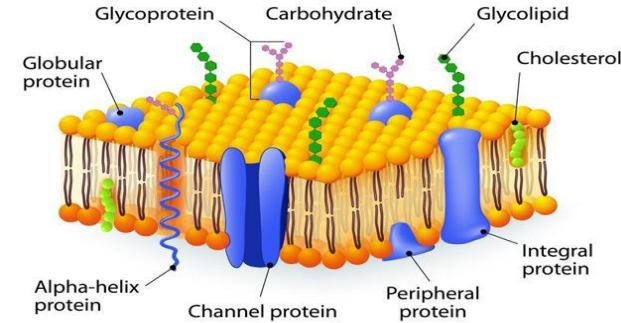
Chemical structure of cell membrane :

Phospholipid molecules:	Protein molecules:	Carbohydrate molecules:
arranged in 2 layers(bilipidlayers).	a) Peripheral protein b) Integral protein	attached to either proteins( <b>glycoproteins</b> ) or lipids( <b>glycolipids</b> ), forming the <b>surface or cell coat</b>

FUNCTION of (**Glycocalyx**)

- Protection of the cell
- Cell recognition and adhesion

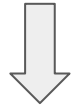
## CELL MEMBRANE



How does the cell membrane appear under the microscope ?



LM (Light Microscope) :  
Not visible



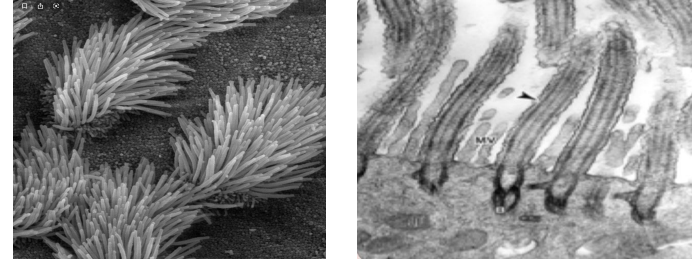
EM(Electron Microscope):2dark lines separated by a light line ( Trilaminar appearance ) .

# Specializations of cell membrane:

## Specializations of cell membrane:

### Cilia:

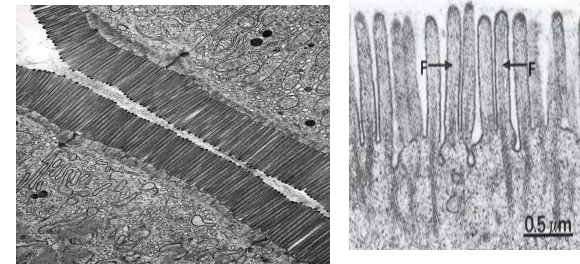
Long motile hair-like structures surrounded by cell membrane.  
Their core is formed of **microtubules**.



Cilia

### Microvilli (Brush border):

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



Microvilli

# Mitochondria:

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

## Function:

- 1) Generation of ATP “ they are called the power house “
- 2) They can form their own proteins and undergo self replication. **because they have their own DNA**

## Mitochondria Structural Features

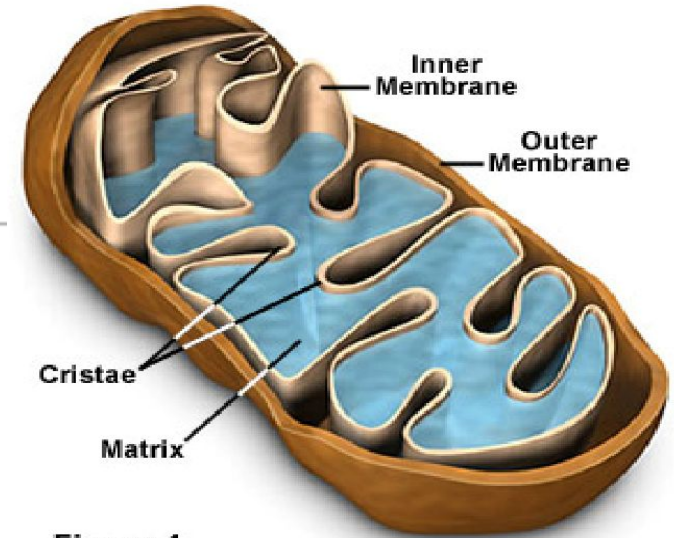
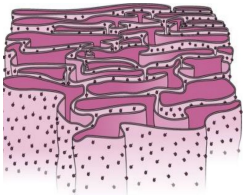
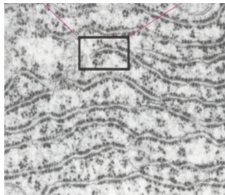
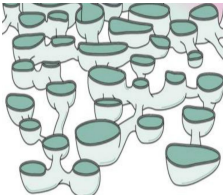
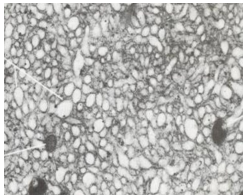


Figure 1

# Endoplasmic Reticulum:

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

Extra information:  
Smooth ER is more abundant in the liver because of its ability in detoxification

Type of Endoplasmic Reticulum	
ROUGH ENDOPLASMIC RETICULUM	SMOOTH ENDOPLASMIC RETICULUM
 	 
Membranous sheets of flattened tubules & vesicles with ribosomes on the surface.	Membranous tubules and vesicles, with <b>NO</b> ribosomes on the surface.
<b>FUNCTION:</b> 1) Synthesis of proteins by ribosomes on its outer surface. 2) Transfer vesicles transfer the formed protein to Golgi.	<b>FUNCTION:</b> 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.

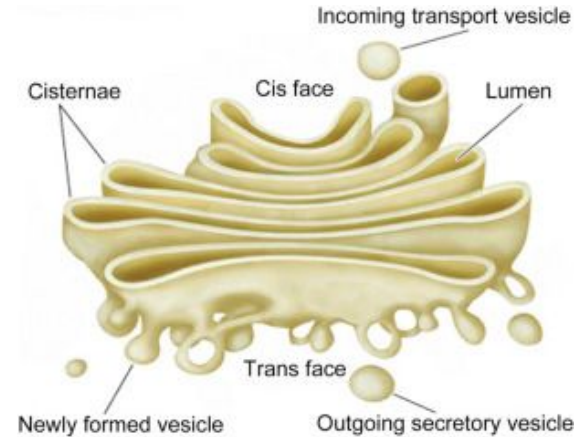
Each vesicle has two faces:

→ **Convex** (forming) **face**: receives transfer vesicles.

→ **Concave** (mature) **face**: forms secretory vesicles.

## Function:

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



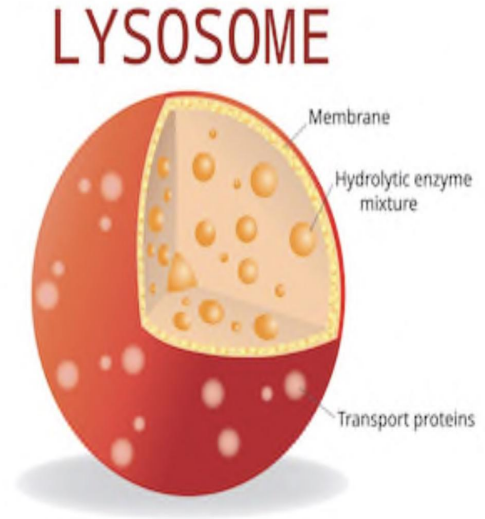


# Lysosomes:

- **The digestive apparatus of the cell.**
- in E/M (electron microscopic): it seems like **Spherical membranous vesicles.**
- Contain **hydrolytic enzymes** “enzymes which break bonds apart”
- 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 “the material which came out of the cell” or old organelles.



## B)non-Membranous

### Ribosomes:

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

### Function:

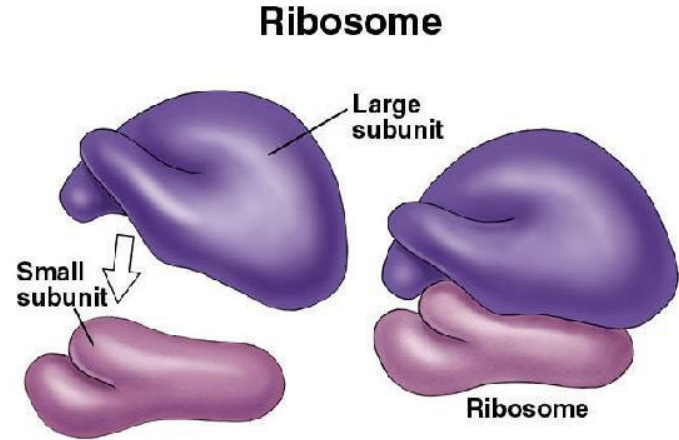
#### Protein synthesis

\*Hint

rRNA synthesized in nucleolus

assembles with a protein to form a subunit in nucleus

combines with another subunit to form ribosome in cytoplasm

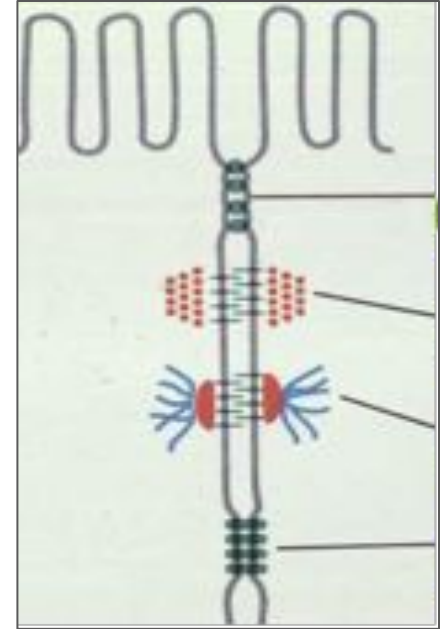


# Intercellular junctions

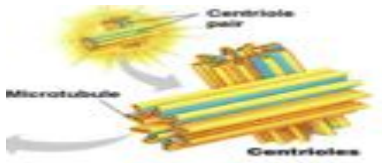
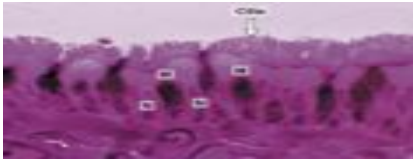

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1. **Occluding (Tight) Junction:** seals the intercellular space.
2. **Adherening Junction:** fixes adjacent cells together:
  - a) Zonula Adhering Junction.
  - b) Desmosome (Macula Adherening Junction).
3. **Gap junction:** Allow free communication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

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



# Microtubules-Containing Organelles:

Centrioles	Cilia	Flagella
 <p>Centriole pair Microtubule Centrioles</p>		
<ul style="list-style-type: none"><li>- 2 cylinders, perpendicular to each other.</li><li>- Wall is made of 9 triplets of microtubules, i.e. 27 microtubules</li></ul>	<ul style="list-style-type: none"><li>- Hair-like striations on the free surface of some cells.</li><li>- Basal body is similar to centriole.</li><li>- Shaft is formed of 9 doublets and 2 central singlets of microtubules, i.e. 20 microtubules.</li></ul>	<ul style="list-style-type: none"><li>Longer and larger than cilia.</li><li>- Form the tails of sperms.</li></ul>
<p><b>Functions:</b></p> <ol style="list-style-type: none"><li>1- Essential for cell division.</li><li>2- Formation of CILIA and FLAGELLA.</li></ol>	<p><b>Function:</b></p> <p>Movement of particles or fluids on the free surface of the cell in one direction.</p>	<p><b>Function:</b></p> <p>Important for movement of the sperms.</p>

# Cytoskeleton:

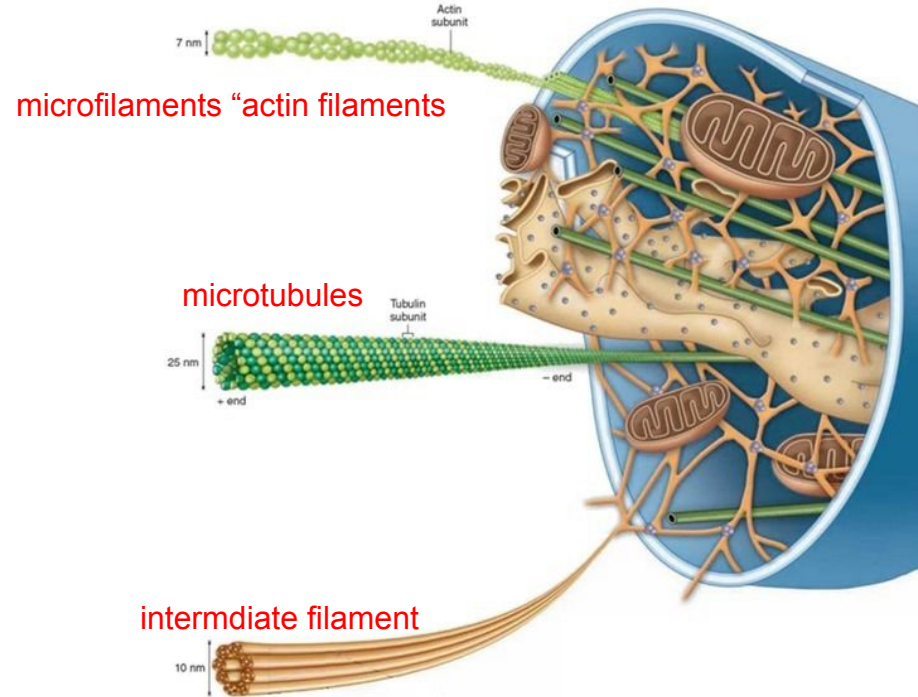
- It is the structural skeleton of the cell

## Consists of:

- Microfilaments (actin). and they are thin.
- Intermediate filaments ,e.g. Keratin
- Microtubules and they are thick.

## Function:

- Maintains shape of the cell.
- Helps transport of material within the cell.



# Clinical application:

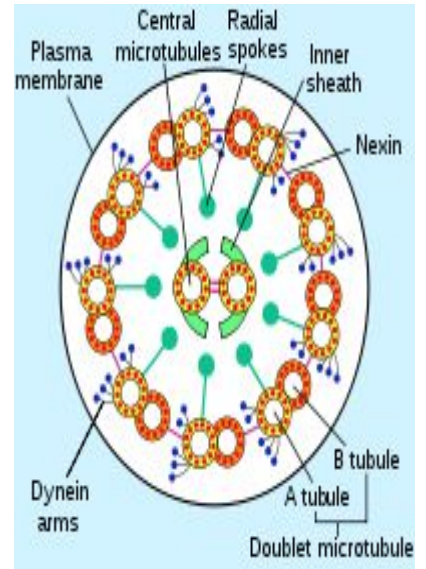
\*infertility: عقم

immobility: not moving

## 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.**

\*Hint  
This syndrome infects flagella as well, although the name doesn't contain flagella name.



# MCQs:

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Q1: it's the structural and functional unit of all living tissues?

1. The nucleus
2. The cell
3. Mitochondria
4. Nuclear envelope

Q2: provides a medium for movement of 3 types of RNA?

1. Nucleoplasm
2. Barr body
3. Flagella
4. Cilia

Q3: Composed of 2 membranes ?

1. Mitochondria
2. Nucleus
3. Cell membrane
4. Both 1&2

Q4: which part of the cell compartment is more abundant in the liver ?

1. Rough ER
2. Smooth ER
3. Golgi apparatus
4. Centrioles

- Answers :
- Q1 : 2
- Q2 : 1
- Q3 : 4
- Q4 : 2

## Team members

- Afnan AlMohsen
- Sumo Abdulrahman
- Yazeed Alomar
- Mohamed Albabtain
- Nourah Alklaib
- Mariam Alruhaimi
- Abdulmohsen Albeshar
- Mohammed Benhji
- Sarah Alobaid
- Joud Alarifi
- Abdullah Alburikan
- Mohamed Alquhidan
- Nawaf Alshahrani

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## Team leaders

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Any future corrections will be in  
the editing file :Click [Here](#)