



Histology Lecture (1)

Introduction to Histology and Cell Structure

Med433

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Objectives:

- **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.**

INTRODUCTION

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

LM (Light Microscope)

EM (Electronic Microscope)

Colored

Black & White

x1,000

x1,000-x100,000

- 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)**.

Eosin (Acidic)

Hematoxylin (Basic)

Reacts with

Cytoplasm
(90% Basic – 10% Acidic)

Nucleus (Acidic)

Reason

Cytoplasm is mostly basic → Acidophilic

Nucleus is Acidic → Basophilic

Color

Pink (It is sometimes Purple because of the acidic 10%)

Always **dark blue**

Image



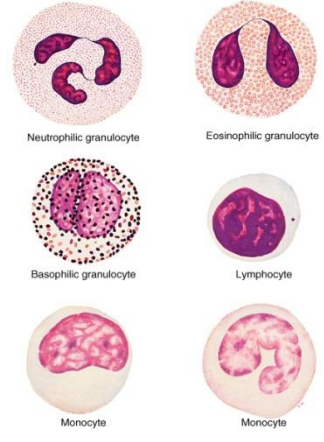
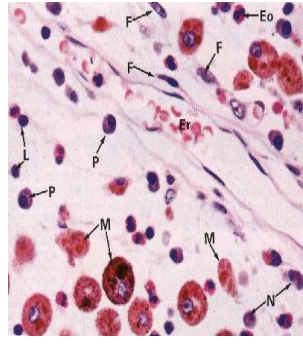
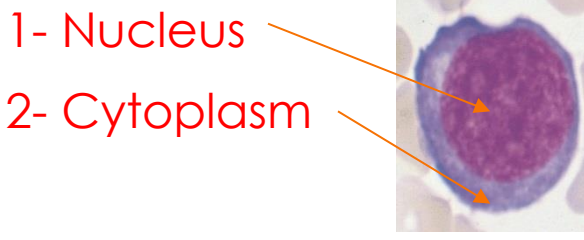
Clarification

Cytoplasm is mostly basic but it contains some ribosomes and acidic particles so it can be stained blue lightly (i.e. the purple color)

The nucleus contains the DNA and RNA which are acidic; therefore, it is acidic

THE CELL:

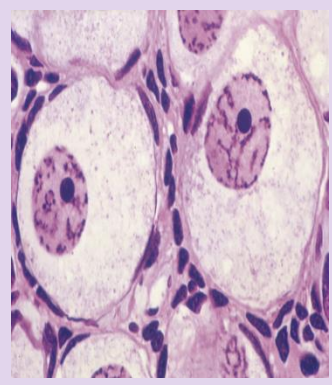
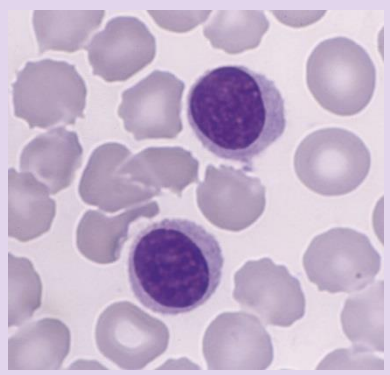
- It is the **structural & functional unit** of all living tissues.
- Cells have different shapes & sizes.
- THE CELL is made of:



Level of Nuclei:

**Dark Nucleus
(Deeply-stained nucleus)**

Vesicular (open face) Nucleus



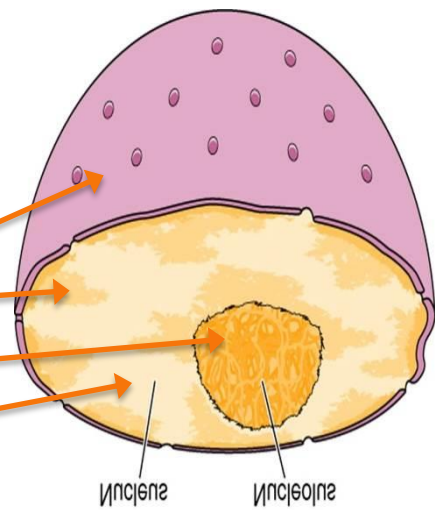
Deeply stained nucleus

Stained nucleus + Nucleolus

■ NUCLEUS:

Formed of:

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



(This is the nucleus, not the cell)

■ Functions of the Nucleus:

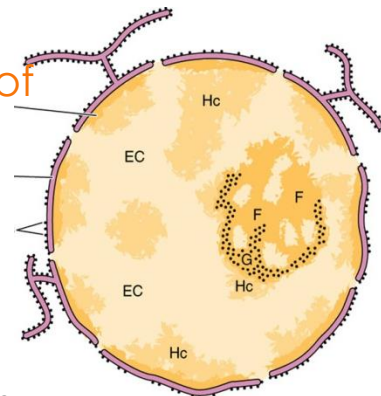
1. Essential for **cell division** and **vitality**.
2. Storage site of the **genetic information**.
3. The site of **formation of the 3 types of RNA**.

■ Components of Nucleus:

1. Nuclear Envelope

A double membrane (3 layers) with many pores.
(Pores allow different substances to pass in & out of nucleus)

- a) **Outer membrane**. (Rough due to ribosomes)
- b) **Inner membrane**. (Rough due to peripheral chromatin)
- c) **Nuclear pores**: provide communication between nucleus and cytoplasm.



2. Chromatin

Formed of **DNA**.

(Its is either attached to the inner membrane of the nucleus "peripheral" or scattered in the nucleoplasm "islands")

2 Forms:

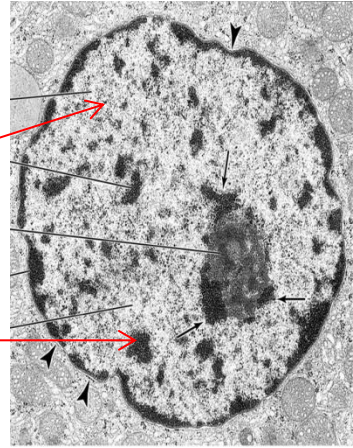
Euchromatin: extended **active** chromatin (pale).

Heterochromatin: condensed **inactive** chromatin (dark)

Functions:

Carries genetic information.

Directs protein synthesis.



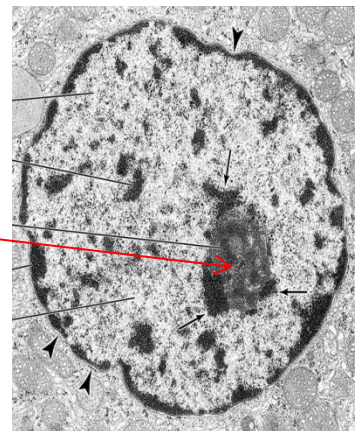
3. Nucleolus

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

- Usually one.

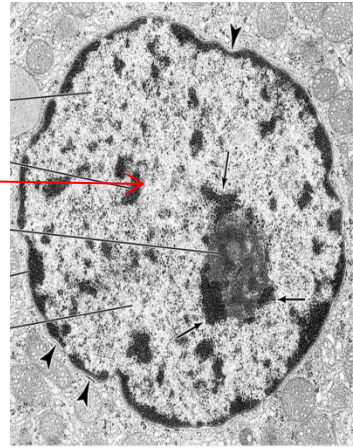
- **Function:**

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



4. Nucleoplasm

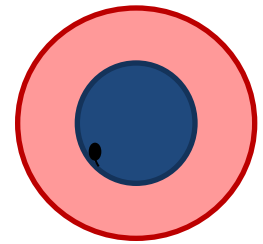
- It is a **clear fluid medium** in which all the contents of the nucleus are embedded.



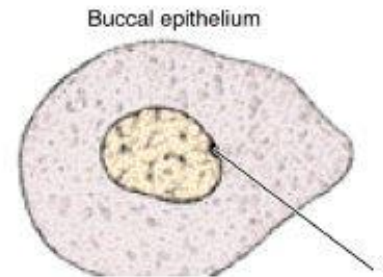
Function:

- 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.
- Location: Adherent to inner aspect of **female somatic cells**
- E.g.: Buccal Epithelial Cells
- Shape: Drumstick (extending from the nucleus)
- Represents **one of the 2 X chromosomes** which is **inactive** in normal females (XX)
- Abnormalities:-



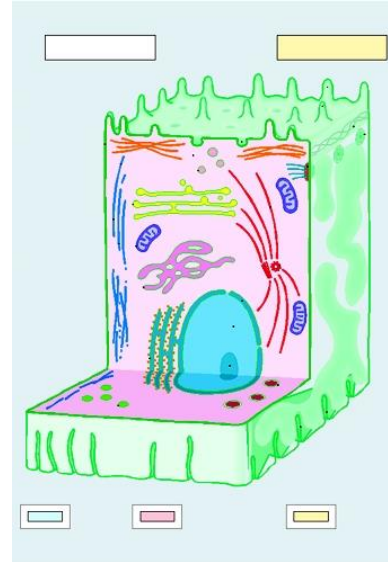
- 1) Females: Absence → Turner's Syndrome (XO)
- 2) Males: Presence → Klinefelter's Syndrome (XXY)

CYTOPLASM

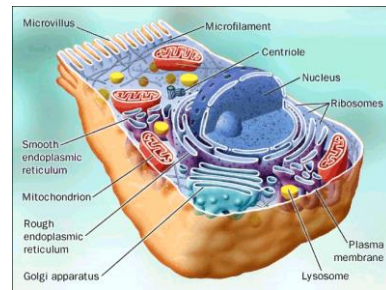
- is formed of:

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 (remnant waste product of long living cells)



■ 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, separated by a light one (trilaminar appearance).



Chemical Structure

A) Phospholipid Molecules

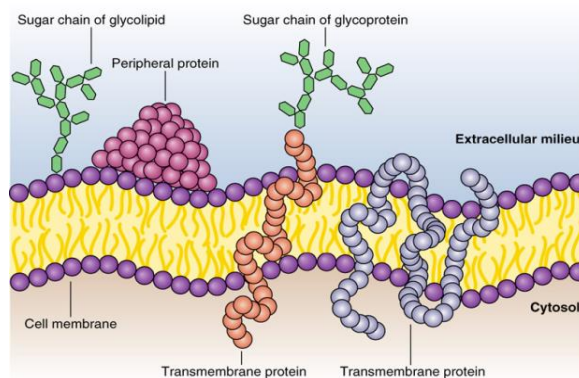
- Arranged in 2 layers

B) Protein Molecules

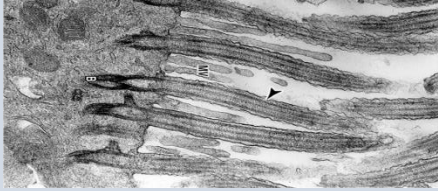
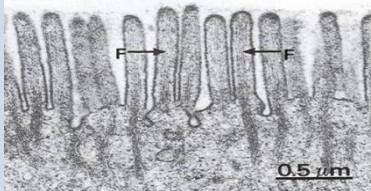
- a) Peripheral protein
- b) Integral protein

c) Carbohydrate Molecules

- Attached to either proteins or lipids (Glycoproteins & Glycolipids) forming the surface or cell coat (**Glycocalyx**):
 - 1- Protection of the cell.
 - 2- Cell recognition & Adhesion

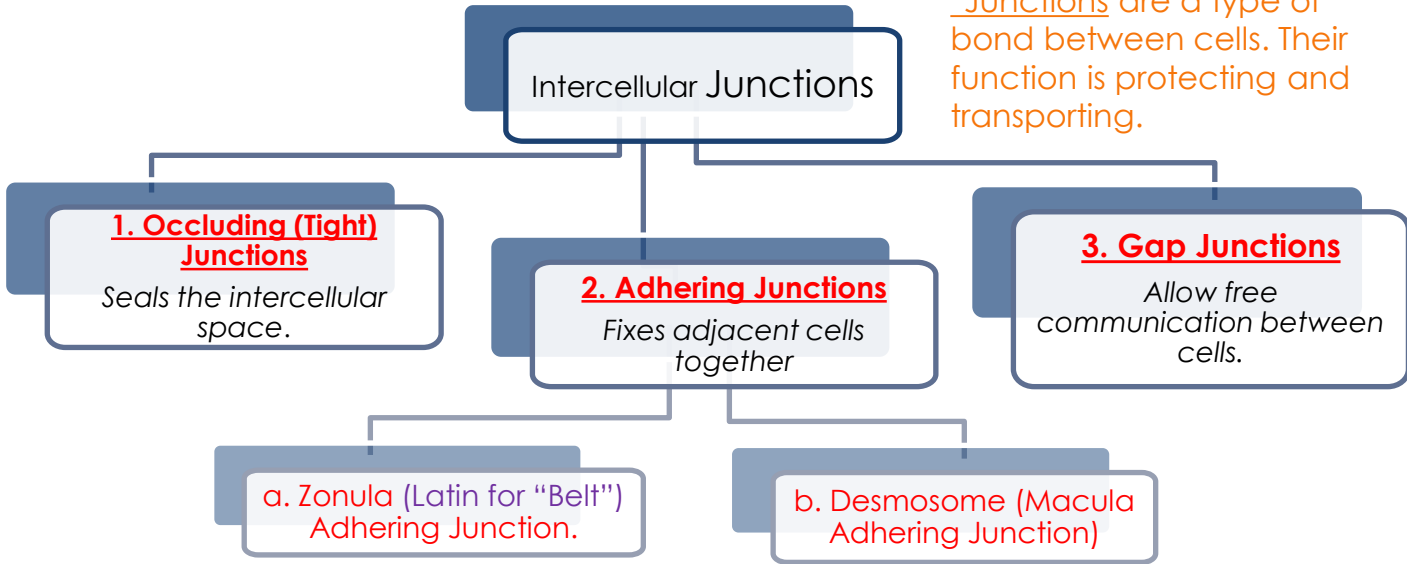


Specialization (A)

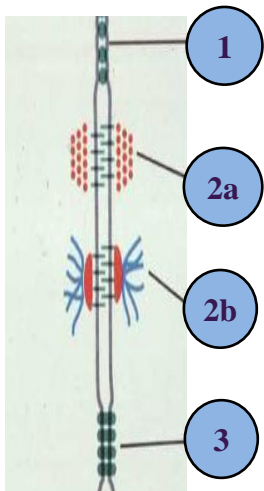
	Cilia	Microvilli
		
<u>Shape:</u>	Long motile (متحرك) hair like structures surrounded by cell membrane.	Cylindrical cytoplasmic projections of apical surface (They don't move like Cilia)
<u>Function:</u>	Movement	Increase surface area
<u>Core:</u>	Microtubules (9 doublets + 2 central = 20 شكلها كأنها بار و نبتة)	Actin Filaments
<u>Location:</u>	Trachea	Intestines
<u>Reason for location:</u>	To push dust and particles upwards and out of the body. (It is covered with mucus)	To help absorb nutrients

Specialization (B)

*Junctions are a type of bond between cells. Their function is protecting and transporting.



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



1) Joining of cell membranes together, forming a virtually impermeable barrier to fluid (E.g. Stomach cells to prevent acid from going into cell).

2) Two cells come together and the membranes attach by filaments made up of glycoproteins.

2a. Appear as bands encircling the cells.

2b. Appear as spots of attachment.

3) The cells come close together making a tube like structure between them.

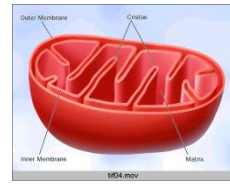
- Cell junctions consist of multiprotein complexes that provide contact between neighboring cells or between a cell and the extracellular matrix.

- build up the paracellular barrier of epithelia & control the paracellular transport.

- abundant in epithelial tissues

- important in reducing stress placed upon cells

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**.

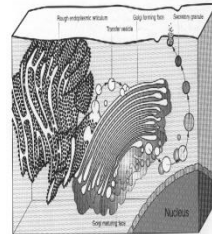
Functions:

- 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**.

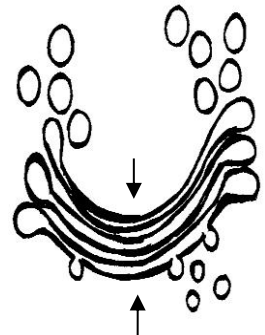
*Mitochondria is the only organelle that contains DNA

*The number of folds in mitochondria is directly proportional with its activity

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.**

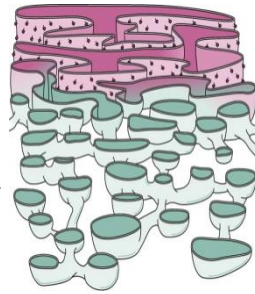
Endoplasmic Reticulum (ER) :

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

• There are 2 types:

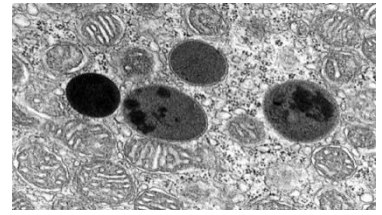
– Rough (rER).

– Smooth (sER).



	Rough Endoplasmic Reticulum (rER)	Smooth Endoplasmic Reticulum (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- <u>Synthesis</u> of proteins by ribosomes on its outer surface. 2- Transfer vesicles transfer the formed protein to Golgi .	1- <u>Synthesis</u> of lipids & cholesterol . 2- <u>Synthesis</u> of steroid hormones , e.g. cortisone. 3- Helps muscle contraction , by acting as a calcium pump. 4- Detoxification of drugs & toxins (in liver)

Lysosomes:

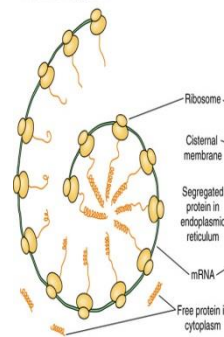


- **The digestive apparatus** of the cell.
- Contain **hydrolytic enzymes**.
- Originate from mature surface of the Golgi apparatus, while their hydrolytic enzymes are formed in the rough endoplasmic reticulum.
- **Function:** **intracellular digestion** of ingested material or old organelles.

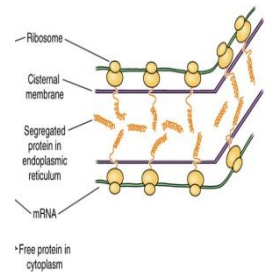
Ribosomes:

- **LM:** Basophilic cytoplasm is due to numerous ribosomes.
- Consists of: **rRNA + Proteins = Ribosomes**
- **EM:** Formed of 2 subunits.
- **Found:** **Free** in the cytoplasm (may form polyribosomes [**Found in groups**]) OR **attached to rER**.
- **Formed:** **in the nucleolus**.
- **Function:** **Protein synthesis**

A Free polyribosomes, whose proteins remain in the cytoplasm

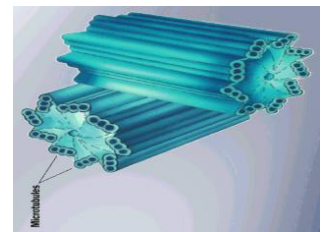


B Bound polyribosomes, showing protein synthesis and segregation into the rough endoplasmic reticulum



Centrioles

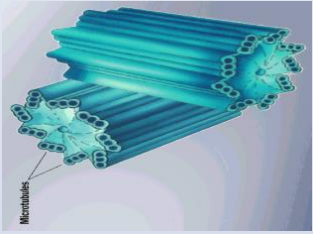
- **Structure:** **2 cylinders**, perpendicular to each other.
- Wall is made of **9 triplets** of microtubules (i.e. **9x3= 27 microtubules**.) ((The bundles are attached together by Dynein protein))
- **Functions:**
 - 1- Essential for **cell division**. (Not present in nerve cells, that's why they are unable to divide)
 - 2- Formation of **cilia** and **flagella**.



Microtubules-Containing Organelles

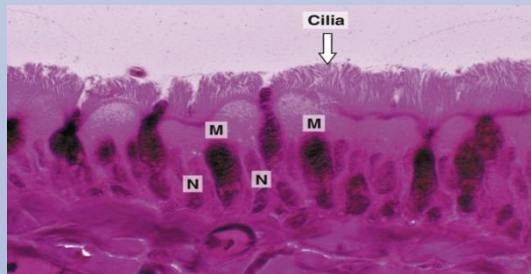
Centrioles

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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 singlet** of microtubules ($9 \times 2 + 2 = 20$ microtubules)
- **Function:** **movement of particles or fluids** on the free surface of the cell **in one direction.**



Flagella

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

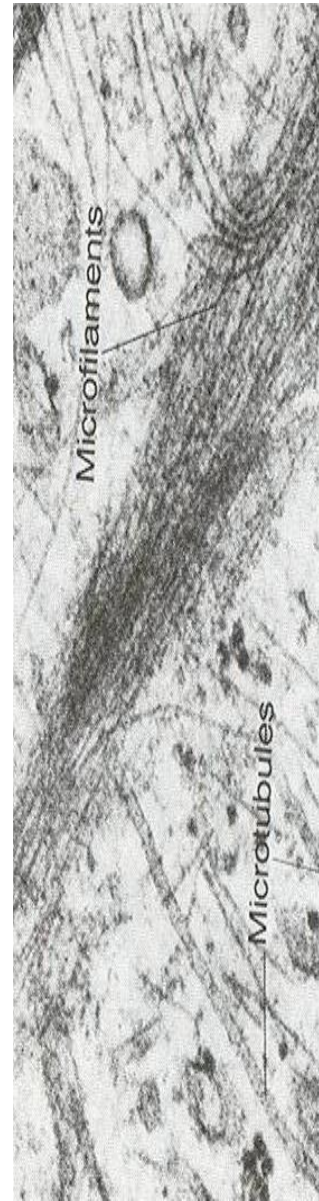


Clinical application

- **Immotile cilia syndrome:**
 - **Disorders:**
 - infertility in male
 - chronic respiratory tract infection in both sexes.
 - **Cause:** 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.



organ	function
Mitochondria	Generation of ATP, forming their own proteins and undergo self replication.
Rough ER	Synthesis of proteins, Transfer vesicles to golgi
Smooth ER	Synthesis of lipid ,cholesterol and steroid hormones.Helps muscle contraction, Detoxification of drugs& toxins
Golgi Apparatus	Sorting, modification & packaging of proteins. , Formation of lysosomes and Secretory vesicles.
Lysosomes	intracellular digestion
Ribosomes	Protein synthesis
Centrioles	Essential for cell division, Formation of cilia and flagella.
Cytoskeleton	Maintains shape of the cell , Help in transporting .

MCQs

a) *Function of the nucleus:*

1. Storage of genetic information
2. Synthesis of protein
3. Movement

b) *Flagella is found in:*

1. Trachea
2. Sperm
3. Intestines

c) *Ribosomes are formed in:*

1. The nucleolus
2. The cytoplasm
3. RER

d) *The junction which seals the space between cells:*

1. Zonula junctions
2. Gap junctions
3. Occluding Junctions

Answers:
a) 1 b) 2 c) 1 d) 3