

Non Membranous Organelles



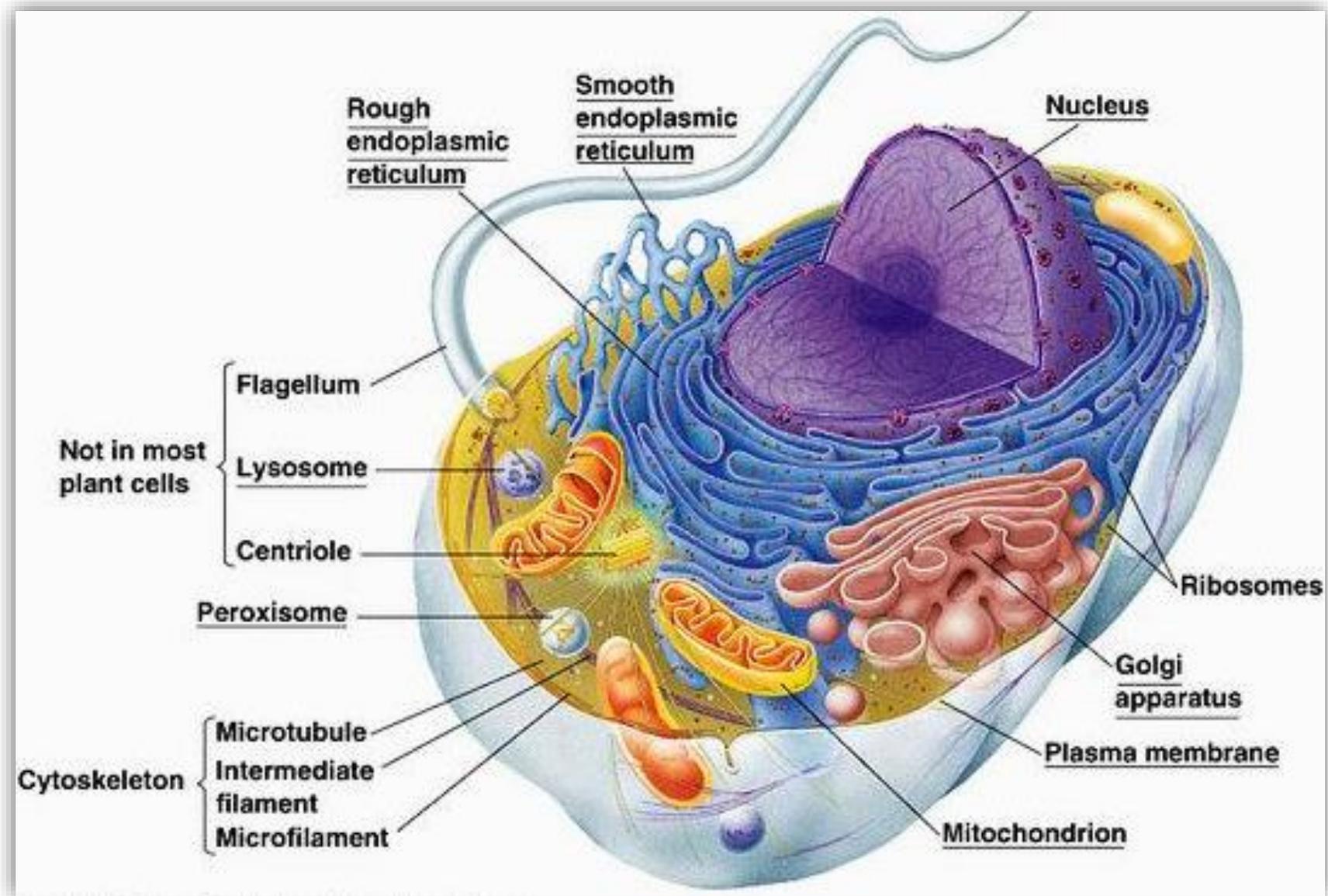
Cell Biology

Semester 1, Year 1

Dr . Amira Osman

Associate professor of Human histology & Cell Biology

NON-MEMBRANOUS ORGANELLES



Intended Learning Outcomes (ILOs)

By the end of the lecture the student will be able to:

Recognize the structure & function of ribosomes

Discuss cytoskeleton

Describe microfilaments

Describe intermediate filaments

Discuss structure of microtubules

Recognize structure & functions of centrioles

Compare cilia & flagella

RIBOSOMES

Non-membranous cell organelles concerned with **protein synthesis** in the cell.

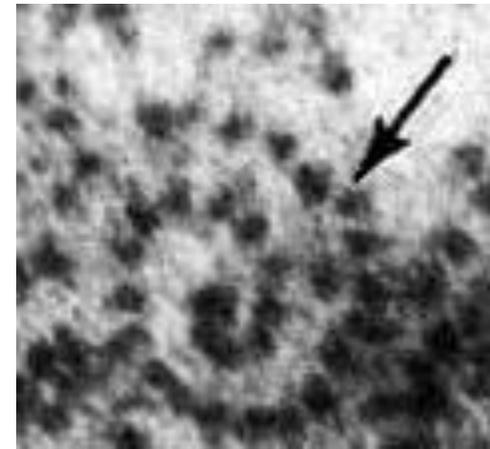
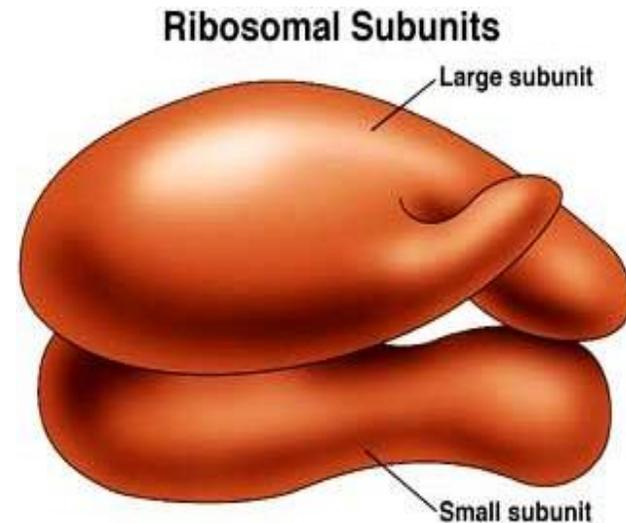
LM:

- **Individual** → **Could not** be resolved.
- **Large number** → **basophilia (rRNA)**.
 - ✓ **Diffuse basophilia** (distributed all over the cytoplasm).
 - ✓ **Basal basophilia** (localized at the basal part of the cell).
 - ✓ **Spotty basophilia** (isolated bodies).

RIBOSOMES

EM:

- Very small **spherical** bodies, **20-30 nm** in diameter.
- Each ribosome appears as an **electron dense granule**
- Each ribosome is composed of **two subunits (small and large)**.
- Each subunit is composed of **rRNA + proteins**.
- They may be held together by **mRNA** forming **polyribosomes**.

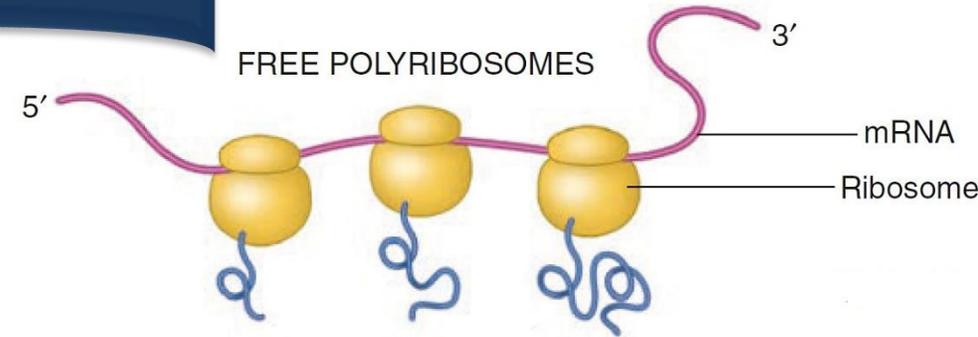


RIBOSOMES

Types & Functions:

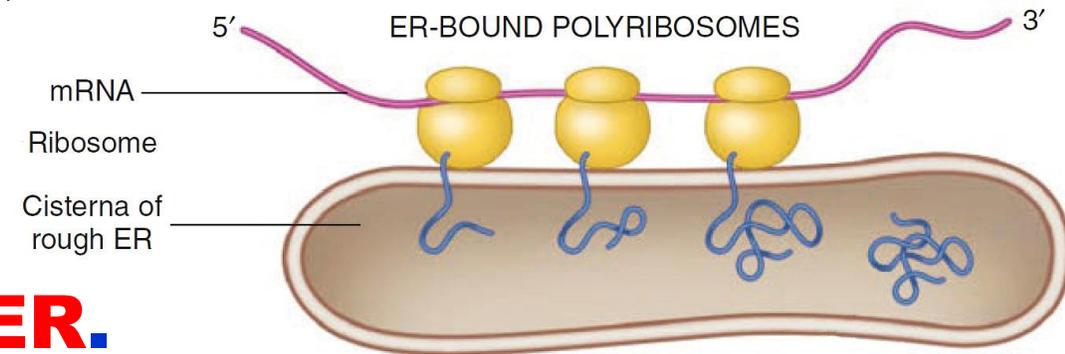
A. Free ribosomes.

- **Scattered** individually in the cytoplasm.
- Synthesize proteins for the **use of the cell** e.g., cytoplasmic matrix, nuclear & mitochondrial proteins.



B. Attached ribosomes.

- Bound to membranes of the **ER**.
- Synthesize **secretory, lysosomal & cell membrane** proteins.



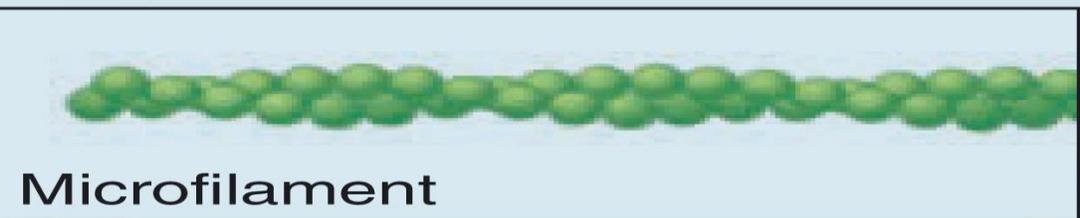
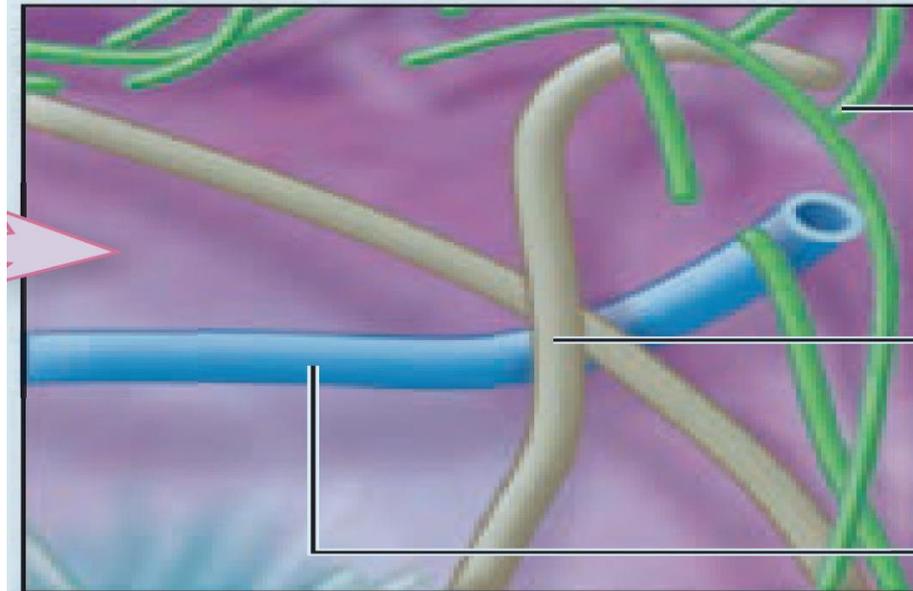
Cytoskeleton

It is the structural framework within the cytosol

Microfilaments

**Intermediate
filaments**

Microtubules



Cytoskeleton

General Functions:

A. Structural:

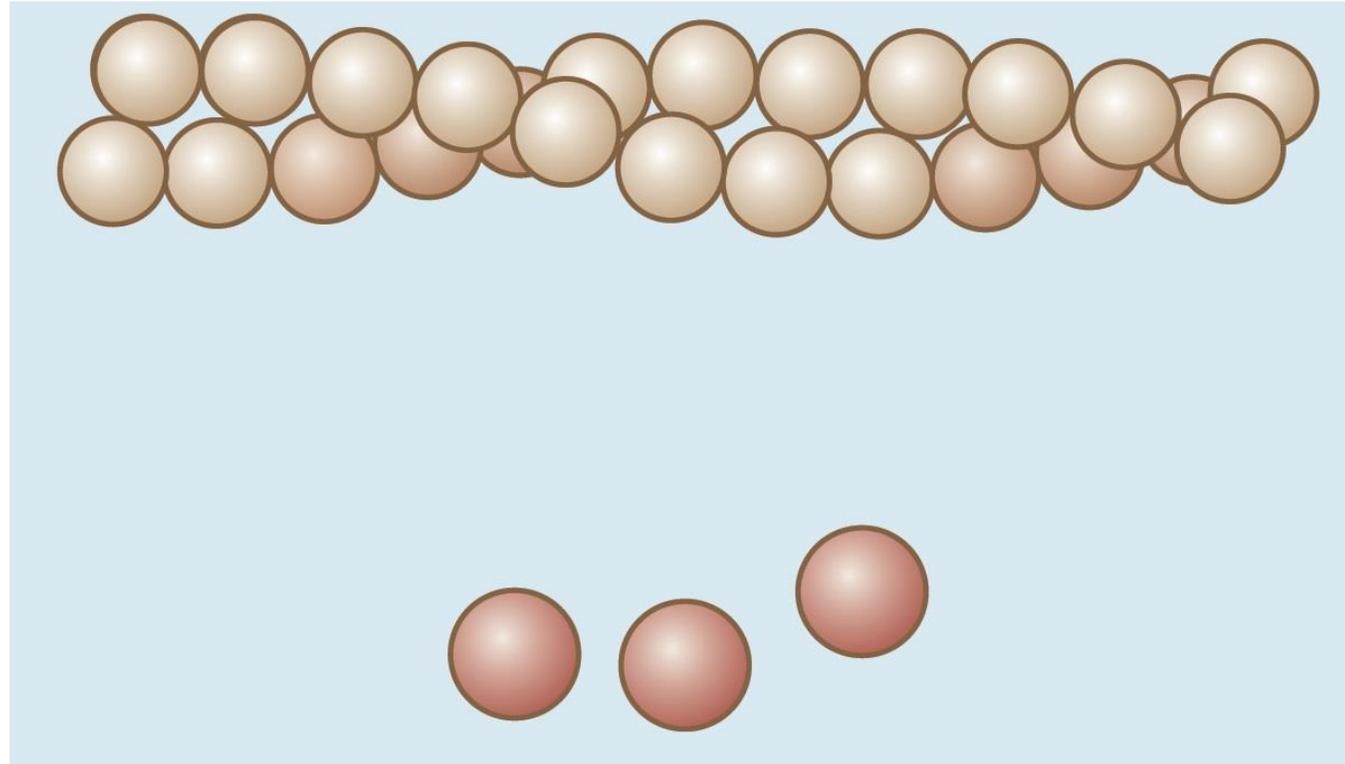
1. Provides structural support to cell.
2. Maintain the shape of the cell.
3. Stabilizes junctions between cells.

B. Movement:

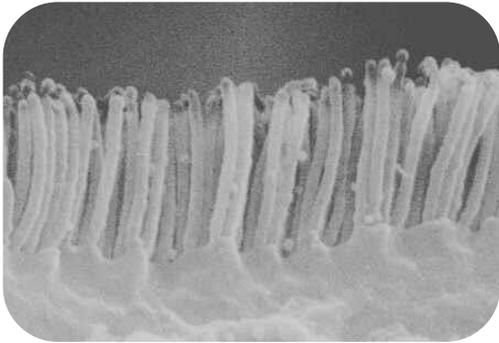
1. Cytosol streaming & cell motility.
2. Movement of organelles & materials throughout cell.
3. Movement of chromosomes during cell division.

Microfilaments (Actin filaments)

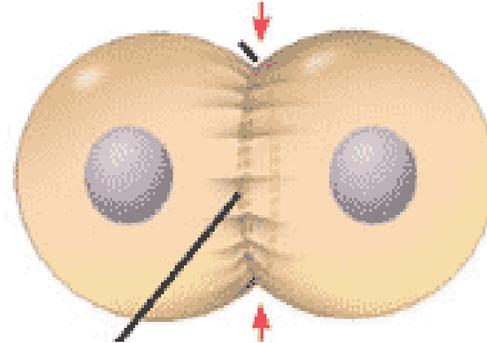
- **5-7 nm** in diameter.
- **Composed of globular actin monomers (G actin) linked into a double helix (F actin).**



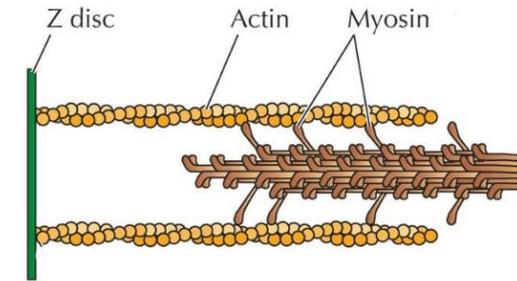
Distribution & functions of actin filaments



Form the **rigid core**
of **microvilli**



Form **contractile ring**
during **cell division**



In **muscles**, for
contraction



In **blood platelets**, for
clot retraction



In **cell cortex**,
for **locomotion**

Intermediate Filaments

• **8-10 nm** in diameter.

Functions:

1- **Supporting** and maintaining the shape of the cells.

2- Important for **transmission of forces** in smooth muscles.

Types:

Desmin: in muscle

Vimentin: in mesenchymal cells

Keratin: in epithelium

Glial Fibrillary Acidic Protein (GFAP): in glial cells

Neurofilaments: in neurons

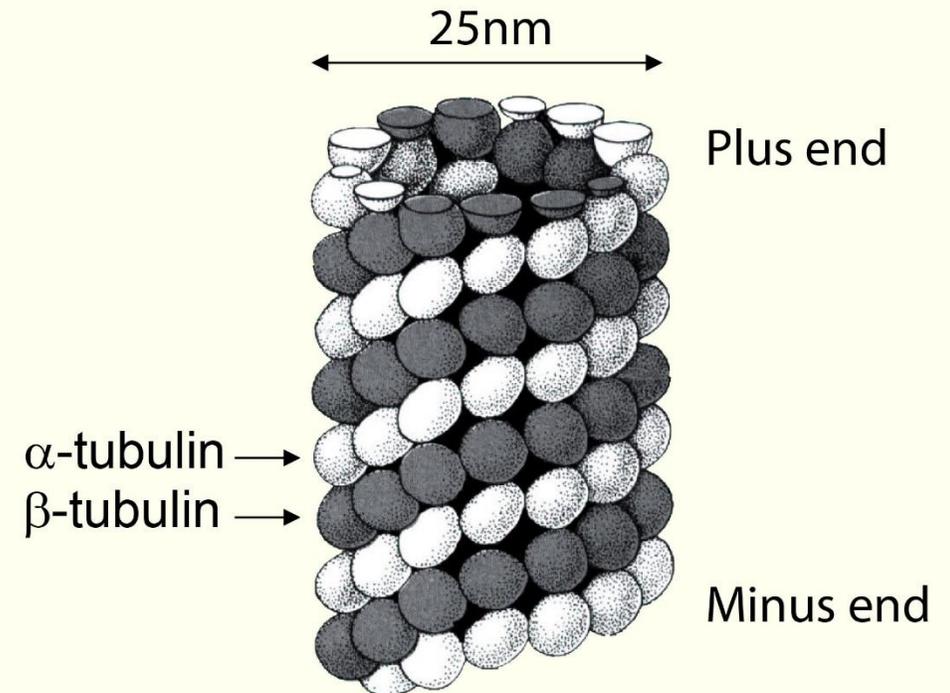
Microtubules

Nonbranching, rigid, hollow, pipe-like non-membranous organelle of unfixed length, but of uniform diameter.

EM:

- **They appear as hollow tubules.**
- **Their outer diameter is 25 nm**
- **Their wall thickness is 5 nm.**

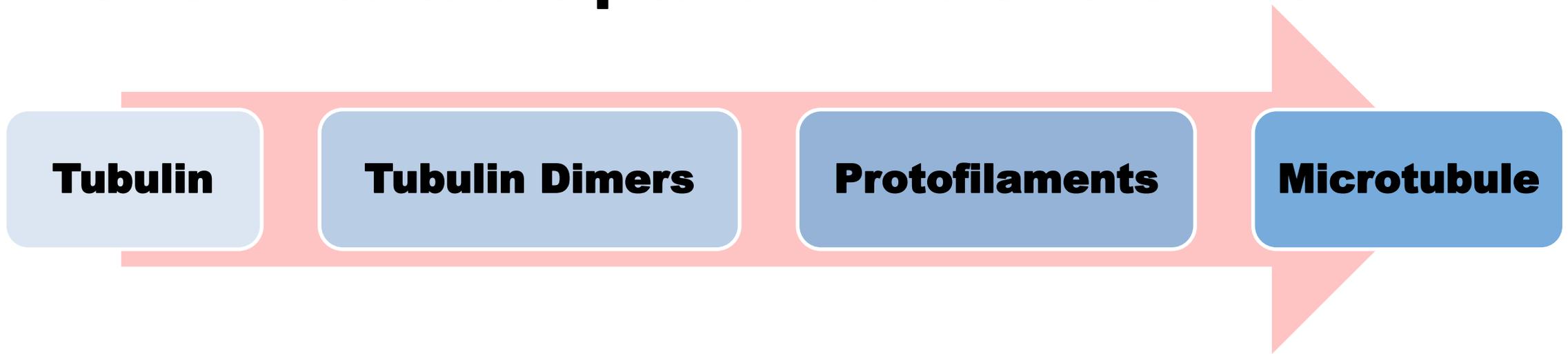
Microtubule Schematic



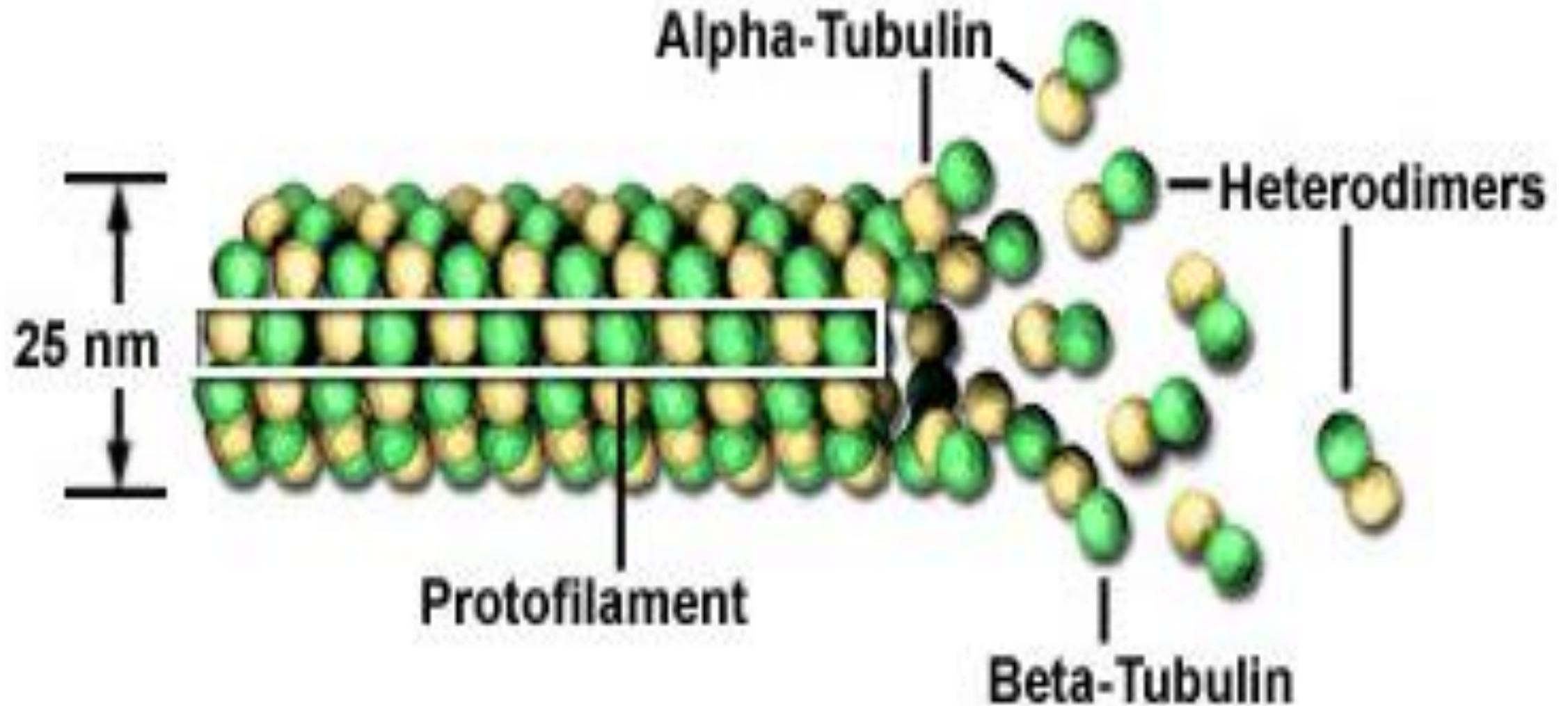
Microtubules

Structure:

- The wall consists of **13 protofilaments**.
- Each protofilament consists of a linear arrangement of **tubulin dimers**.
- Each dimer consists of **α** and **β** tubulin protein subunits that are linked **end-to-end**, so that an **α** tubulin of one dimer is linked to the **β** tubulin of the next dimer.



Microtubules



Microtubules

- **Polymerization of tubulins into microtubules is directed by **microtubule organizing centers (MTOCs)**.**
- **The dominant MTOC in most cells is the **centrosome**, which is organized around centrioles.**
- **The length of microtubules changes dynamically as tubulin dimers are added or removed in a process of **dynamic instability**, with continuous cycles of **polymerization** and **depolymerization**.**
- **Polymerization and depolymerization are in **equilibrium**.**

Microtubules

Functions:

- 1. Support and maintain the shape of the cell (particularly its asymmetry).**
- 2. Cell elongation & migration.**
- 3. They are the main structural component of centrioles, cilia and flagella & their movement.**
- 4. They form the mitotic spindle.**
- 5. They act as guiding tracks for intracellular transport of material and organelles like railroad tracks.**

Centrioles

Non-membranous cell organelle important for **cell division**.

LM:

❖ **Number:**

- ✓ **Nondividing cells:** **one pair** perpendicular to each other.
- ✓ **During cell division:** duplication → **two pairs** .

❖ **Site:** **juxtannuclear** (near the nucleus).

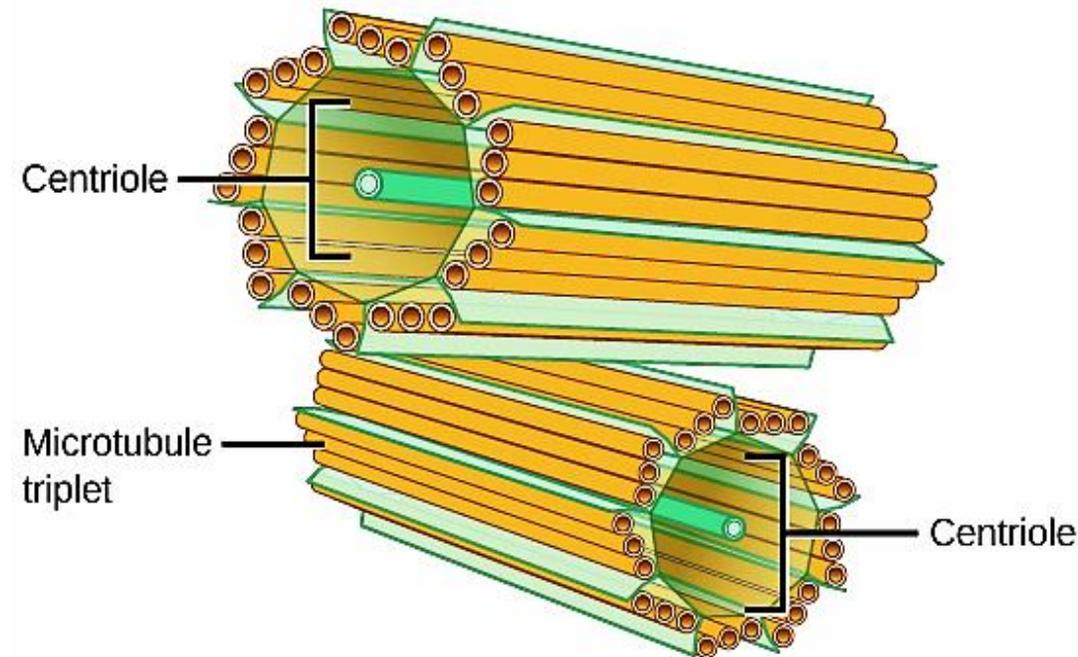
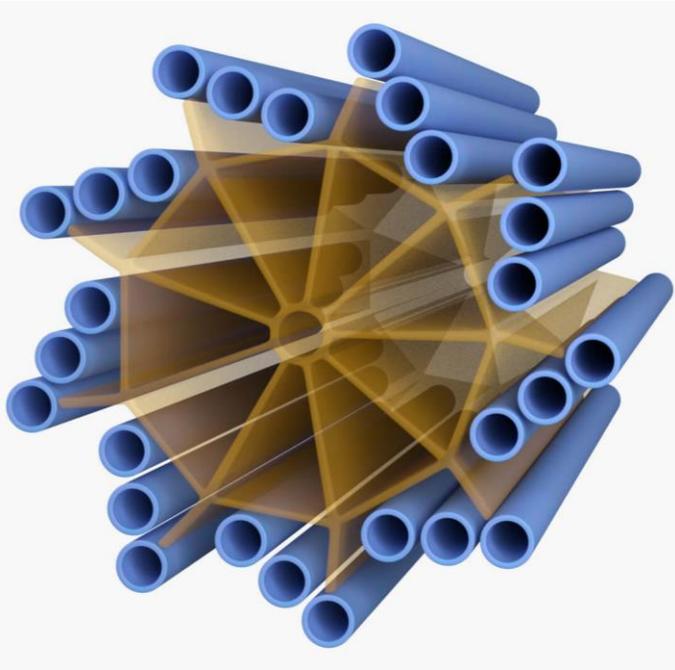
❖ **Stain:**

- ✓ **H&E:** **could not** be demonstrated.
- ✓ **Iron H.:** two **dark blue** stained granules in a clear zone of cytoplasm.

Centrioles

EM:

- Each centriole appears as a **short cylinder of $0.2\ \mu\text{m}$ diameter & $0.5\ \mu\text{m}$ length.**
- The wall of each centriole is composed of **27 microtubules** arranged in **9 triplets.**



Centrioles

Functions:

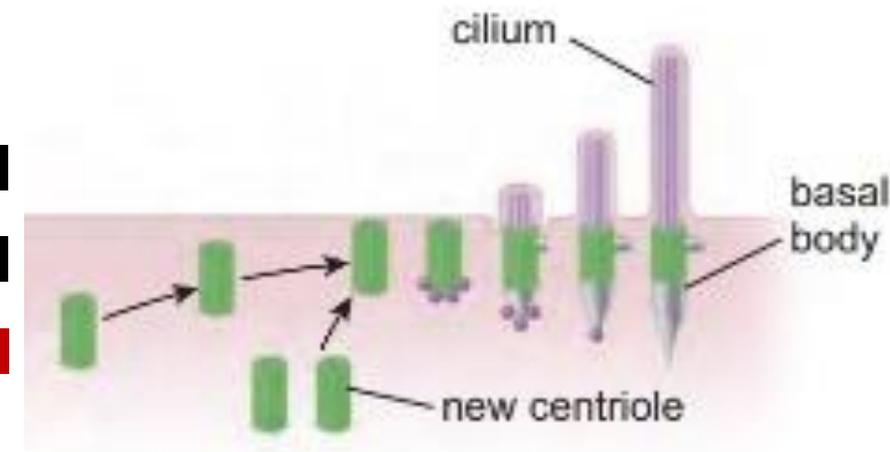
1. Play an important role in **cell division**.

The area of cytoplasm around the centrioles is the site for assembly of the microtubules of the **mitotic spindle**.

2. It acts as a **center** about which cell organelles are **polarized**.

3. Cilia formation

Each centriole replicates and gives several **procentrioles** which migrate to the apical part of the cell where they act as **basal bodies** of cilia.



Cilia

Non-membranous hair like organelle projecting from the free surface of certain cells e.g. trachea and fallopian tube.

LM:

Could be seen **vaguely** on the surface of the cell facing the lumen or cavity.



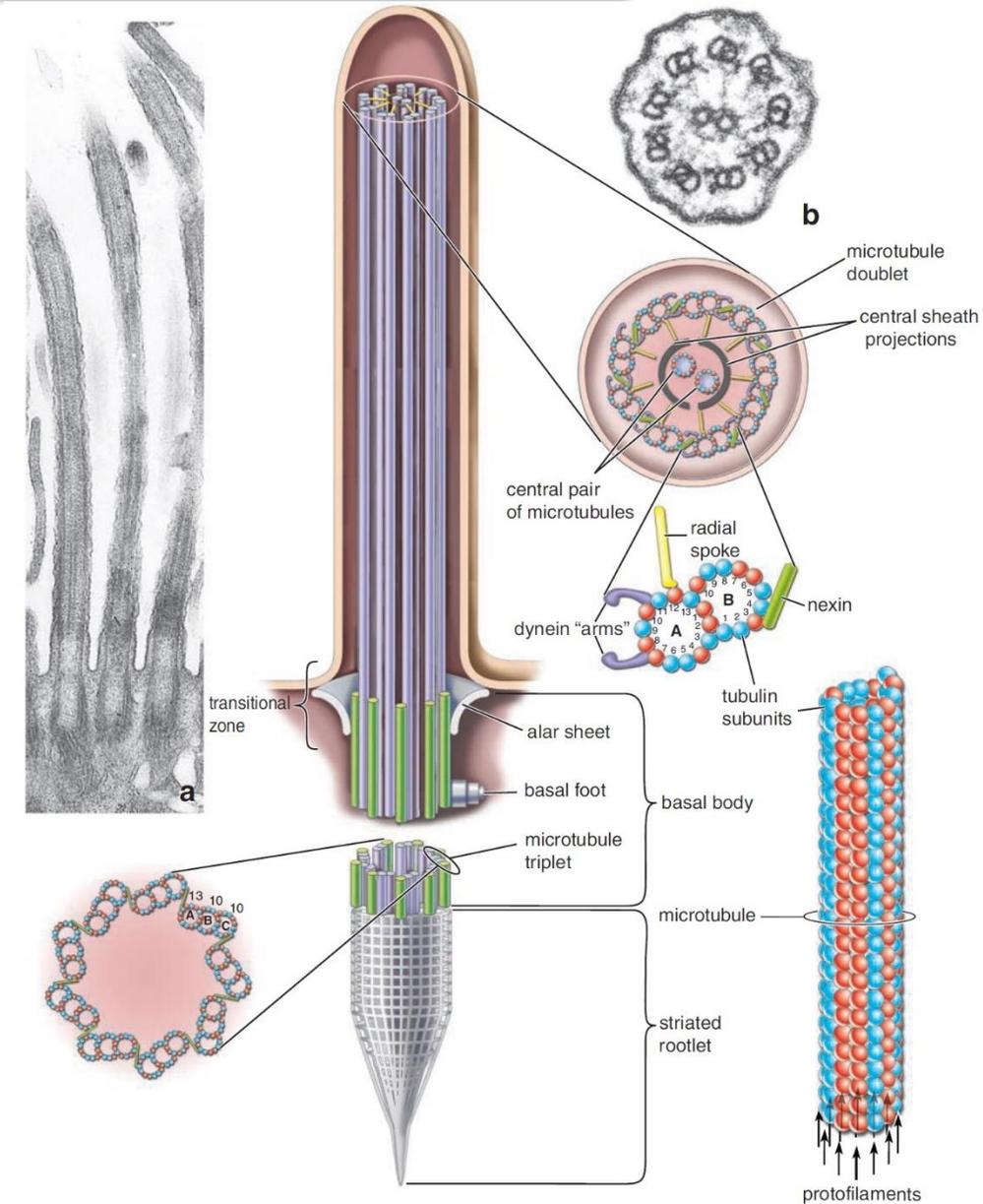
Cilia

EM:

- **5-10 μm length x 0.2 μm diameter.**
- **They may be several hundreds / cell.**

❖ Shaft (axoneme):

- It contains **9 peripheral doublets** of microtubules extending & **central 2 singlet microtubules** surrounded by a central sheath.
- Each doublet is formed of **subunit-A & subunit-B**.
- Two **dynein arms** are projecting from subunit-A.
- Dynein arms have **ATPase** activity.

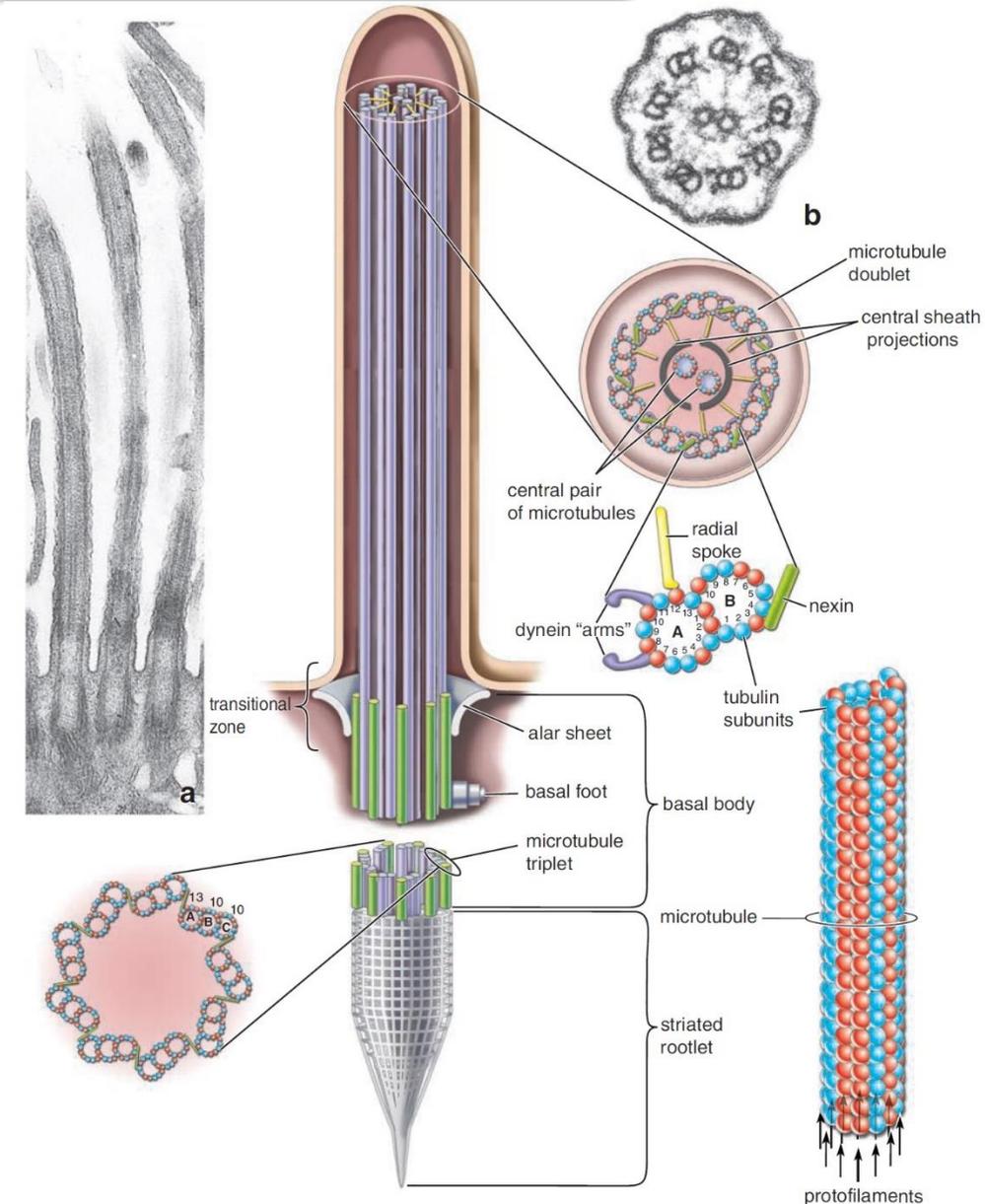


Cilia

EM:

❖ Basal body:

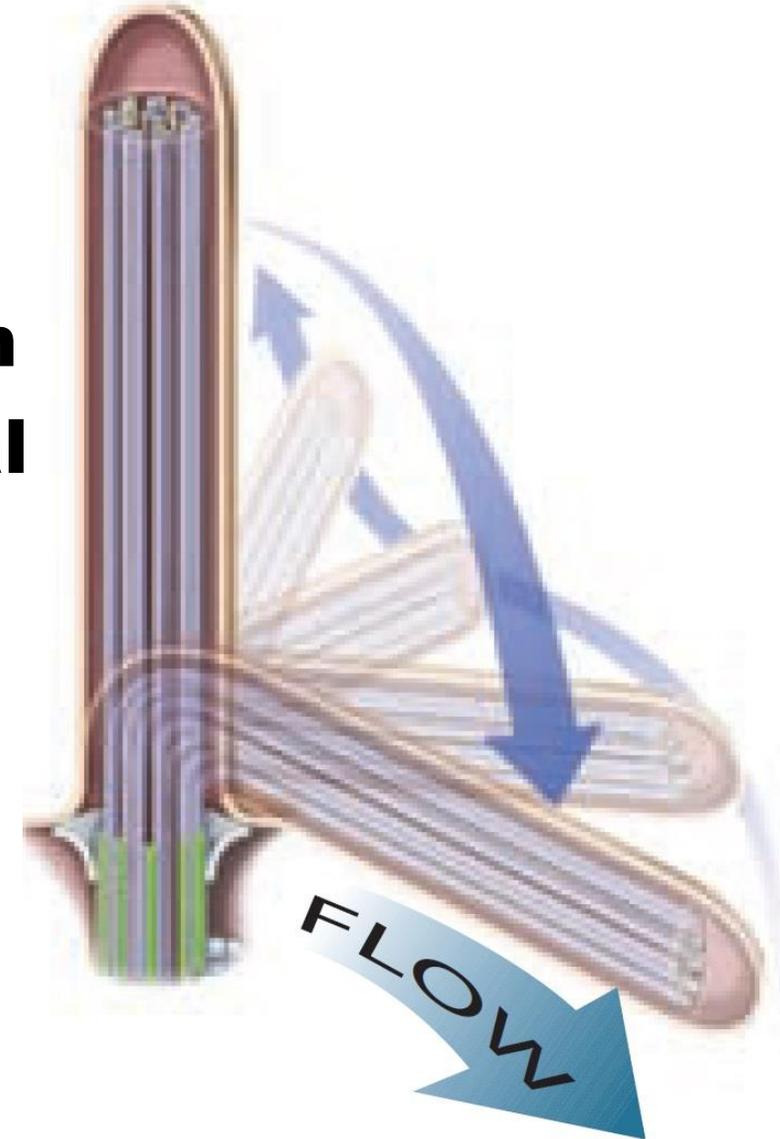
- It is a **short cylindrical** structure.
- Identical to **centriole**.
- Its wall contains **9 triplets** of microtubules.
- Longitudinal protofilaments projects deeply into cytoplasm forming **rootlets** anchoring the it to the cytoskeleton of the apical cytoplasm.



Cilia

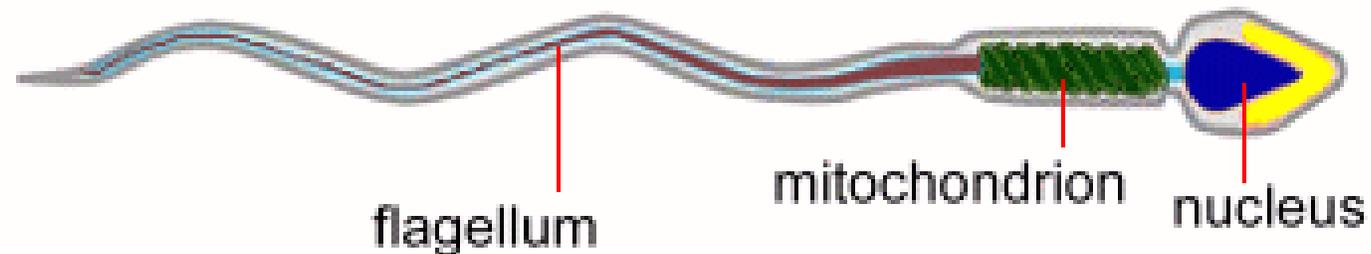
Functions:

- Cilia are **beating rhythmically** in one direction.
- Move a thin film of **fluid** or **mucous** which is present on the surface of the epithelial cell
- Ciliary movement is composed of **rapid forward** movement followed by **slow recovery** stroke.
- The energy needed for movement is derived from **dynein arms**.



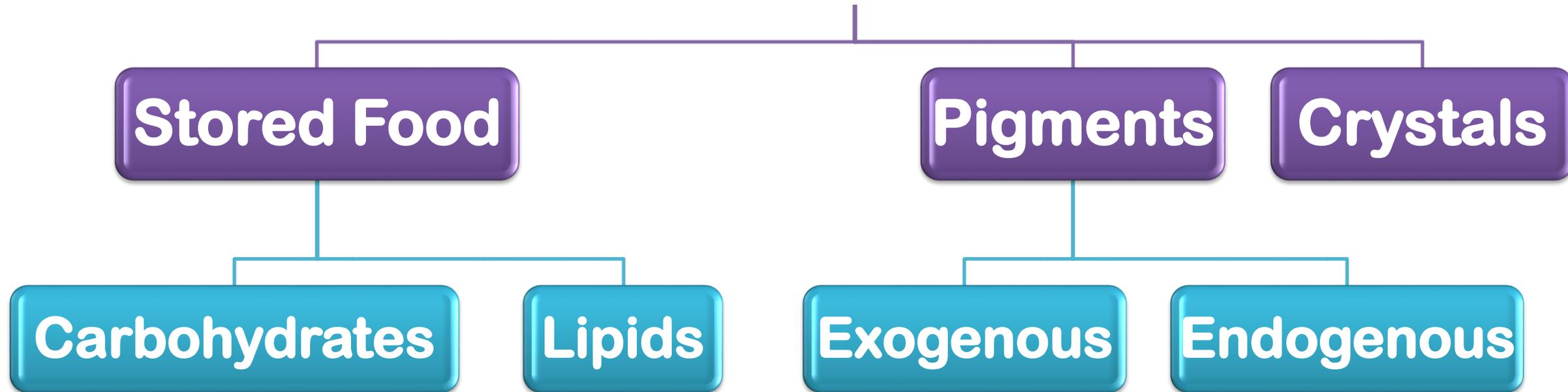
Flagella

- ❖ **Long flagellum extends from fully differentiated sperm**
- ❖ **Similar to cilia, but:**
 - **Longer than cilia (200 nm).**
 - **One flagellum / cell.**
 - **They have whip-like swimming (undulating) movement.**



CELL INCLUSIONS

- They are the **non-living** contents of the cytoplasm.
- They are either **products of metabolism** or substances that are **taken inside** the cell from its surrounding.

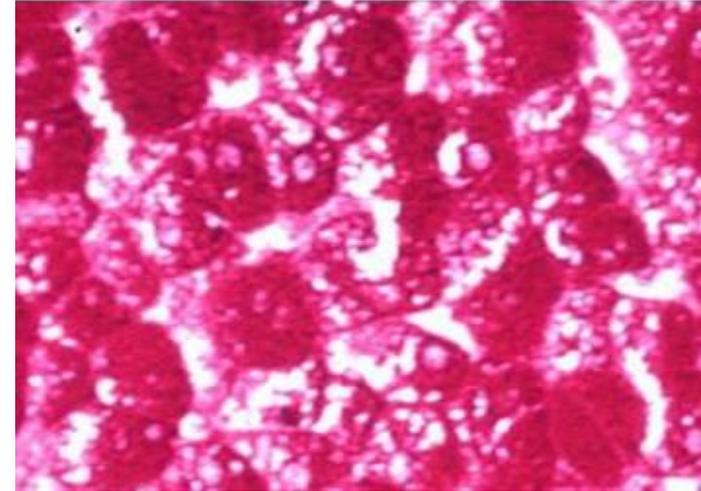


Carbohydrates

Stored in the cell as **glycogen** granules.

LM:

- ✓ H&E: small irregular **vacuoles**.
- ✓ PAS stain: **magenta**.
- ✓ Best's carmine: **red**.

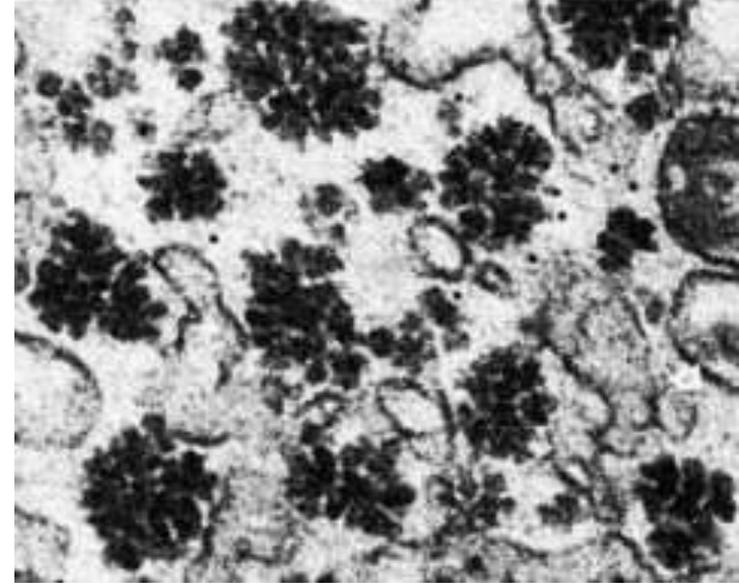


Carbohydrates

EM:

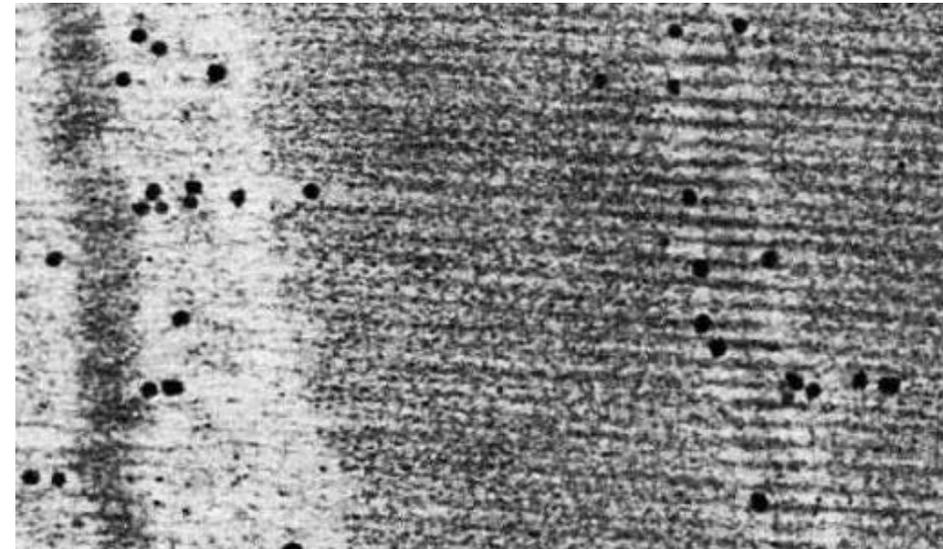
❖ Alpha glycogen:

- In liver cells.
- Aggregated electron dense particles forming rosettes.



❖ Beta glycogen:

- In muscle fibers.
- Single electron dense granules.

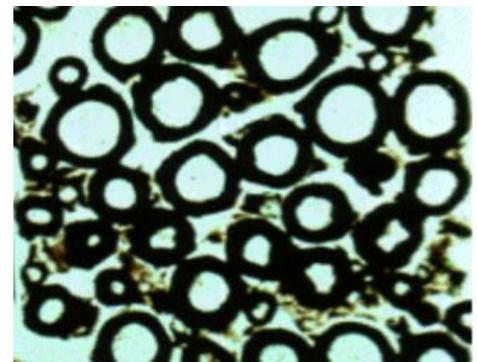
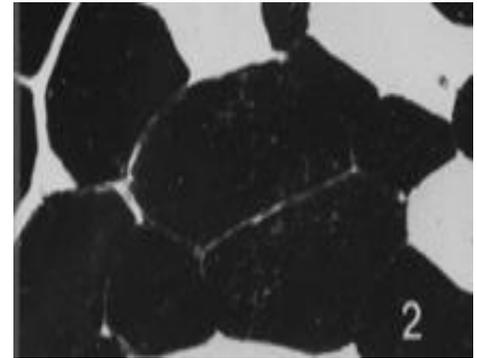
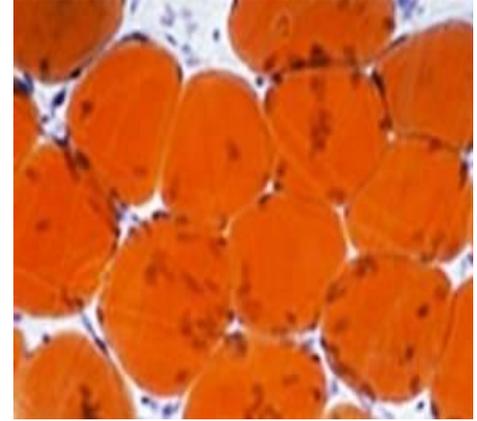


Lipids

Stored in the cell as **small droplets** in **liver cells** or large globules as in **connective tissue fat cell**.

LM:

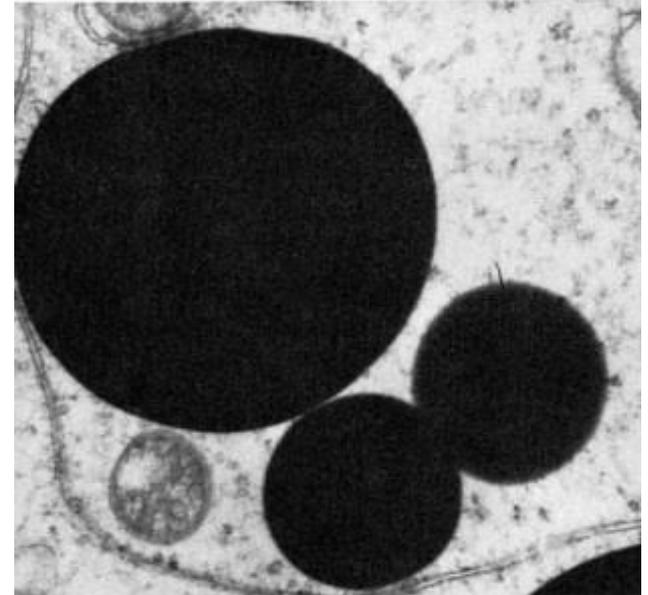
- ✓ H&E: **empty spaces.**
- ✓ Special stains:
 - **Sudan III:** **orange**
 - **Sudan black:** → **black**
 - **Osmic acid:** → **black**



Lipids

EM:

- ❖ **Spherical globules**
- ❖ **Not** surrounded by membrane.
- ❖ Different grades of **electron densities**.



Exogenous Pigments

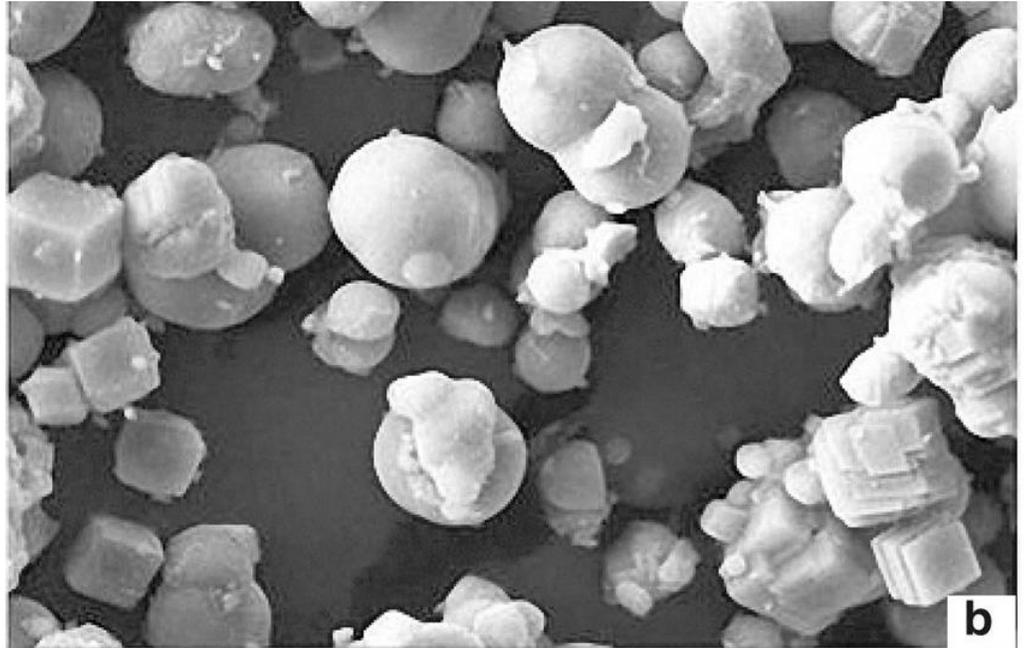
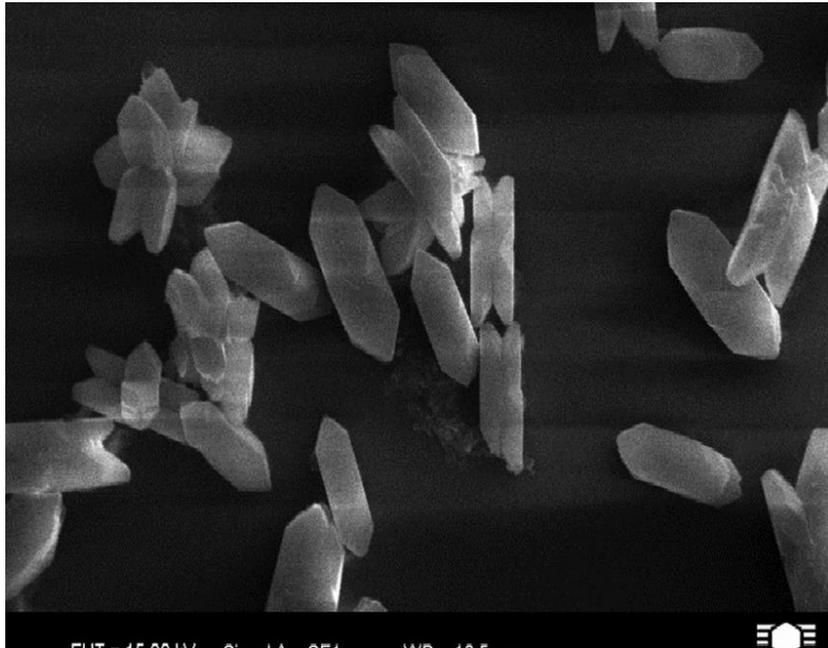
- ✓ Dust & carbon: in lung cells.
- ✓ Carotene pigments: taken with food as in carrots.
- ✓ Tattoo marks: dyes are injected under the skin & taken by phagocytic cells.

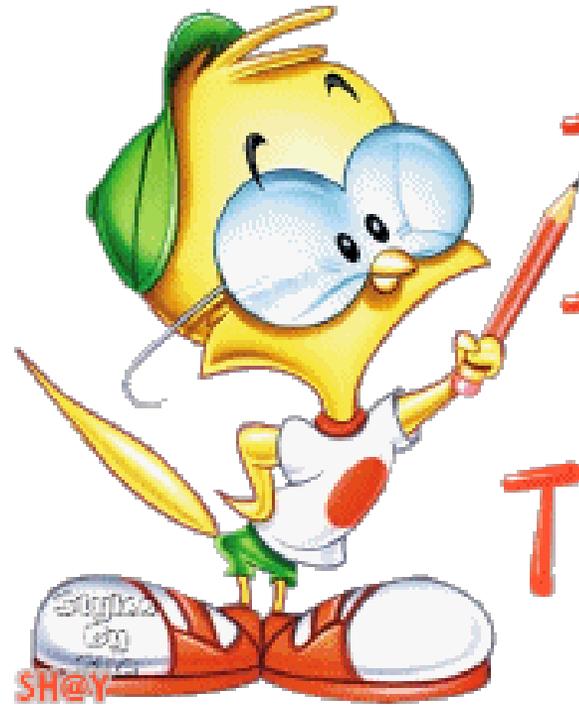
Endogenous Pigments

- ✓ Hemoglobin: in RBCs.
- ✓ Melanin: in the cells of skin, hair and eyes.
- ✓ Lipofuscin pigment: in long lived cells; cardiac muscle & nerve cells.

Crystals

- ❖ They are present in certain **pathological conditions**.
- ❖ e.g., **calcium oxalate** and **calcium carbonate** crystals.





Thank You
Thank You
Thank You!!!!