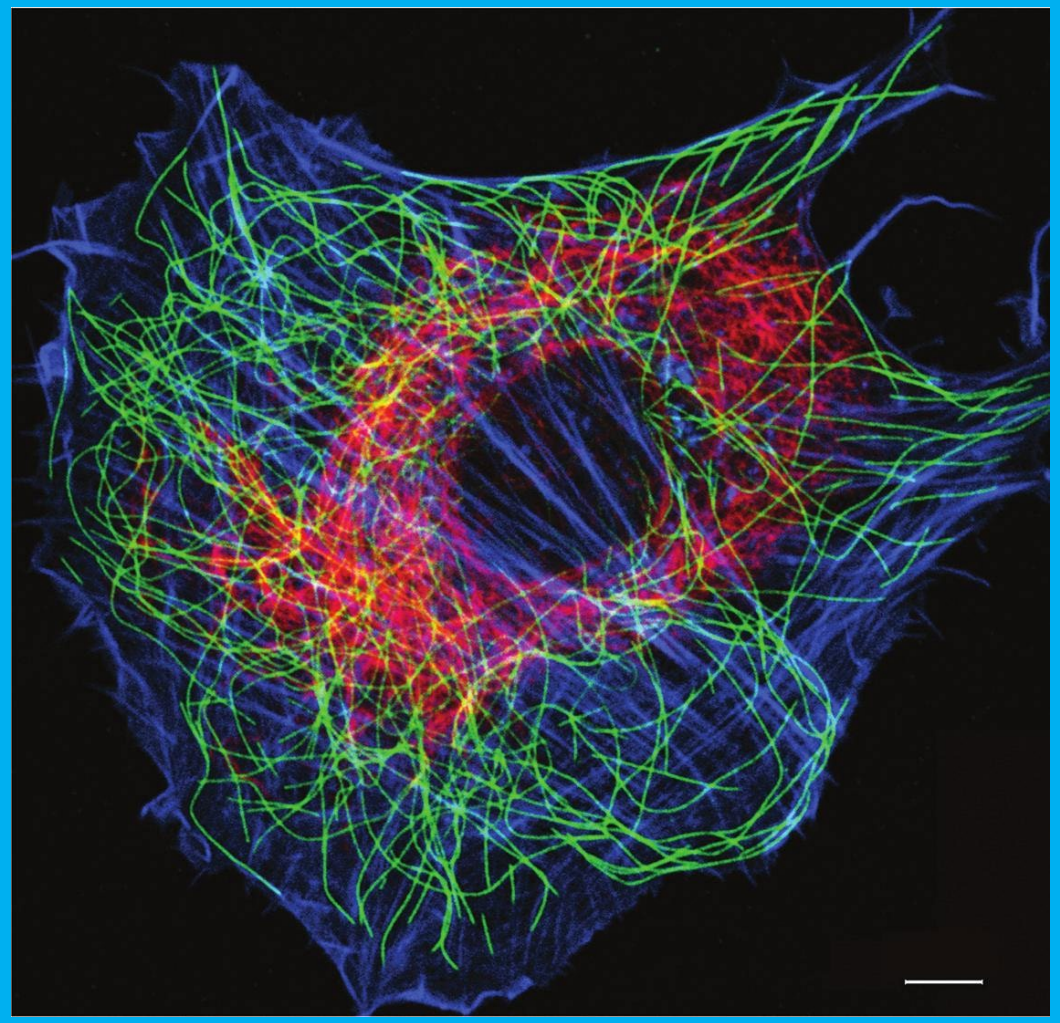
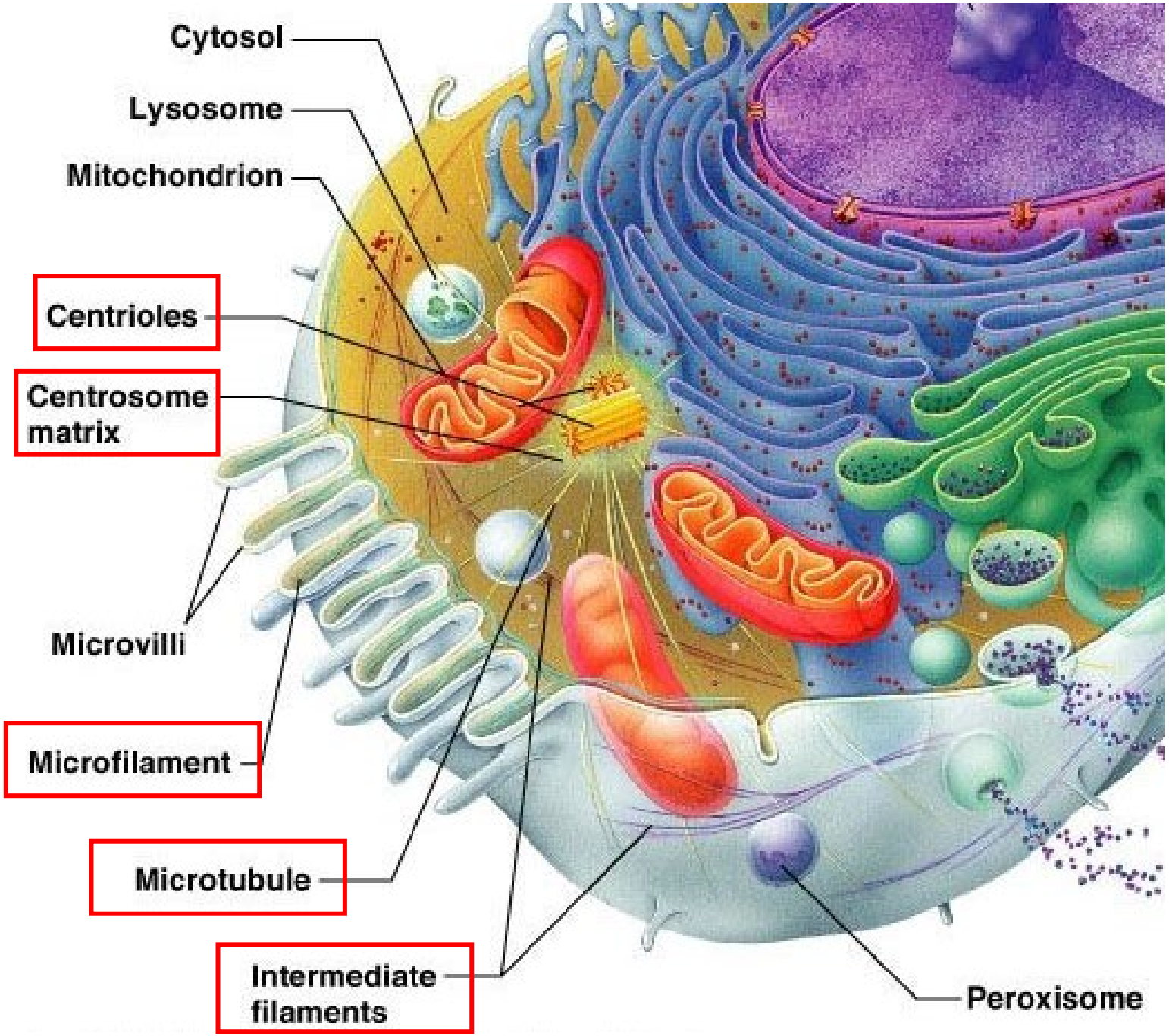


Cytoskeleton

Marjorie D. Shaw, Ph.D.

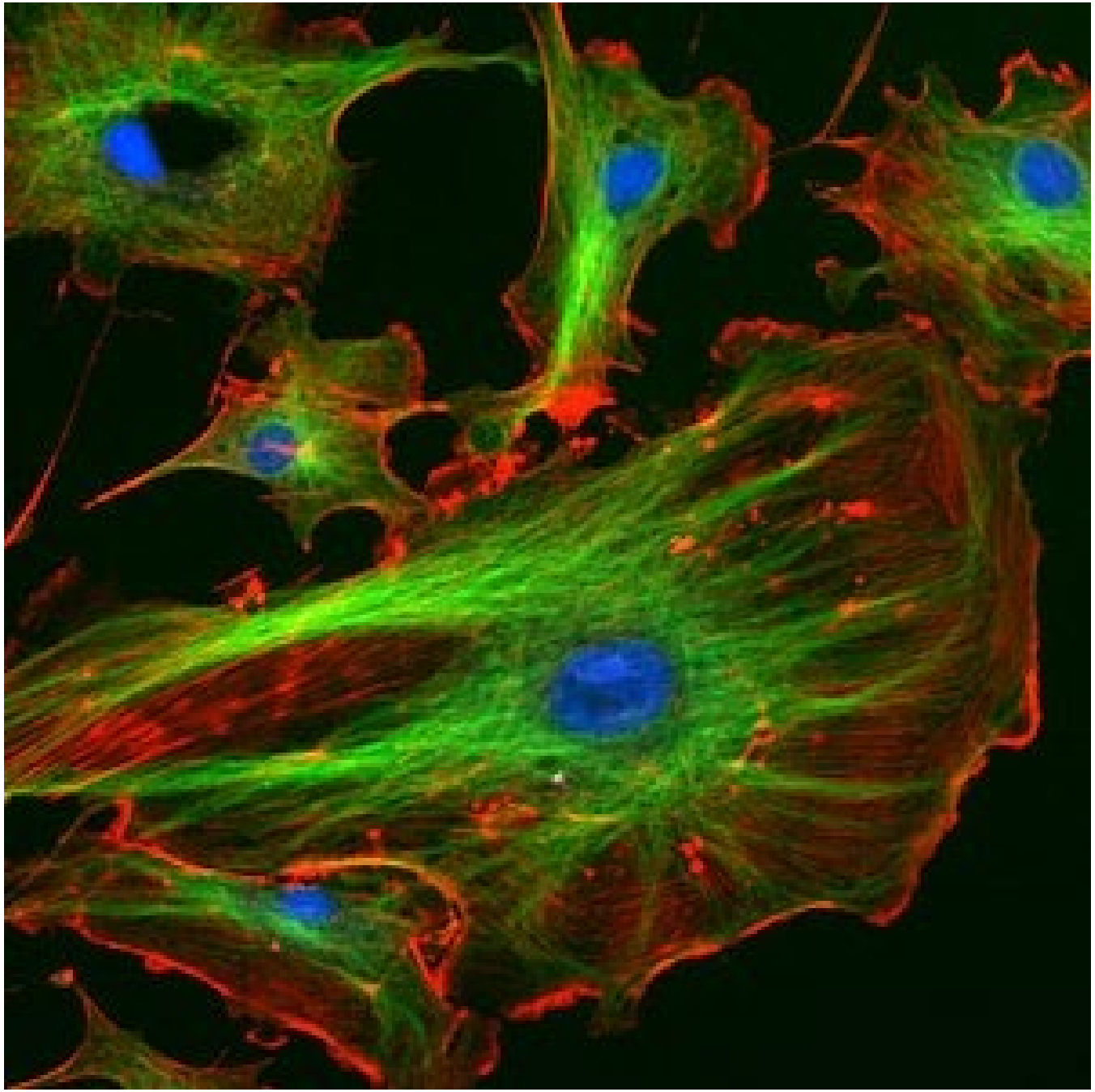
OLLI Fall 2023

Study Group : 426


Cytosol
Lysosome
Mitochondrion
Centrioles
Centrosome matrix
Microvilli
Microfilament
Microtubule
Intermediate filaments
Peroxisome

Dynamic Framework

Protein filaments that provide cell shape, allow locomotion, move organelles around within the cell, transport vesicles, and allow cells to divide and attach to other cells or substrata.



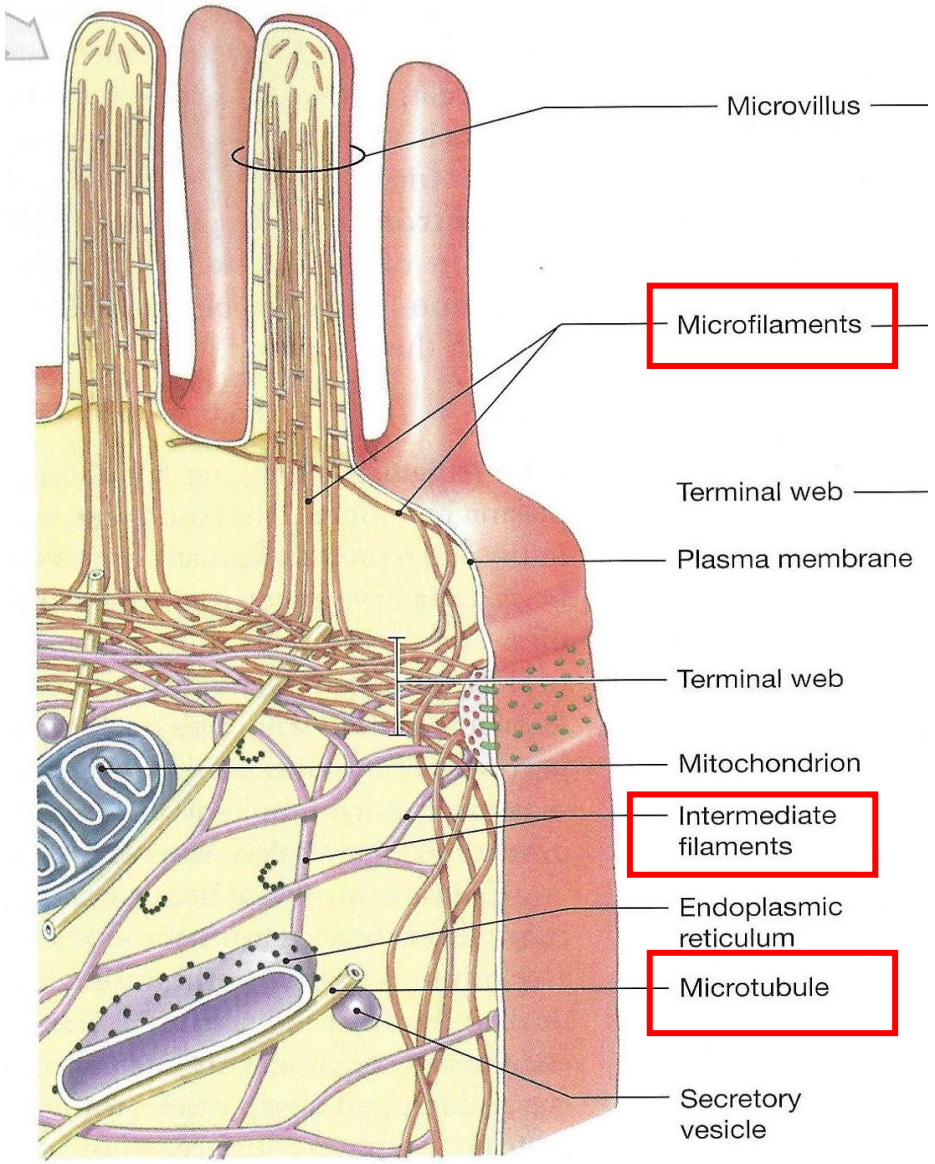
Green: microtubules
Red: microfilament (actin)
Blue: nucleus

3 types:

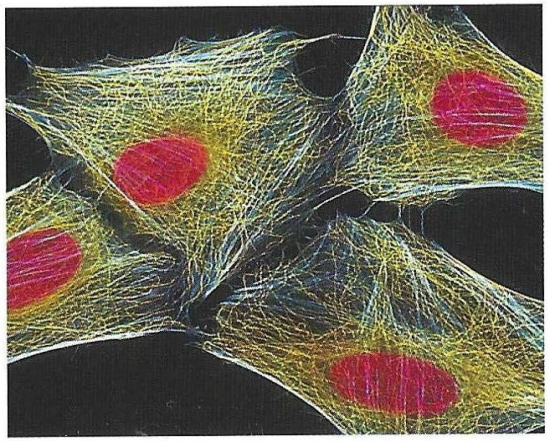
Microtubules: movement of organelles, cilia, cells

Intermediate filaments: stability

Microfilaments: Movement, shape and anchoring of cells, support membrane



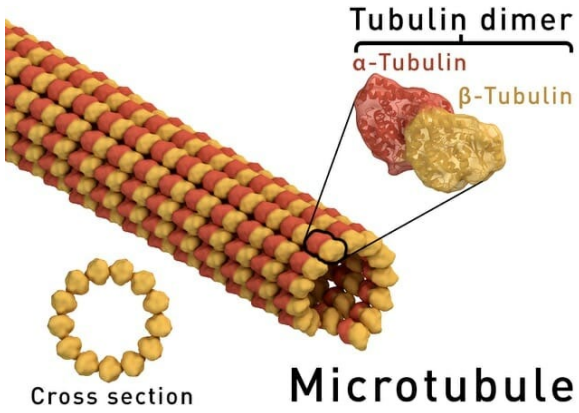
a The cytoskeleton provides strength and structural support for the cell and its organelles. Interactions between cytoskeletal components are also important in moving organelles and in changing the shape of the cell.

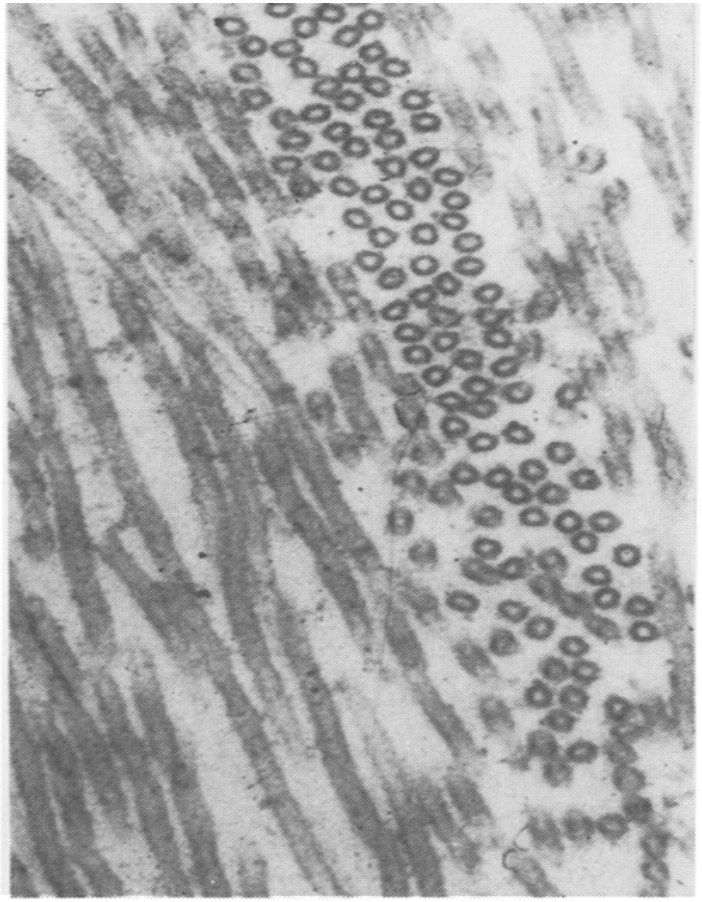


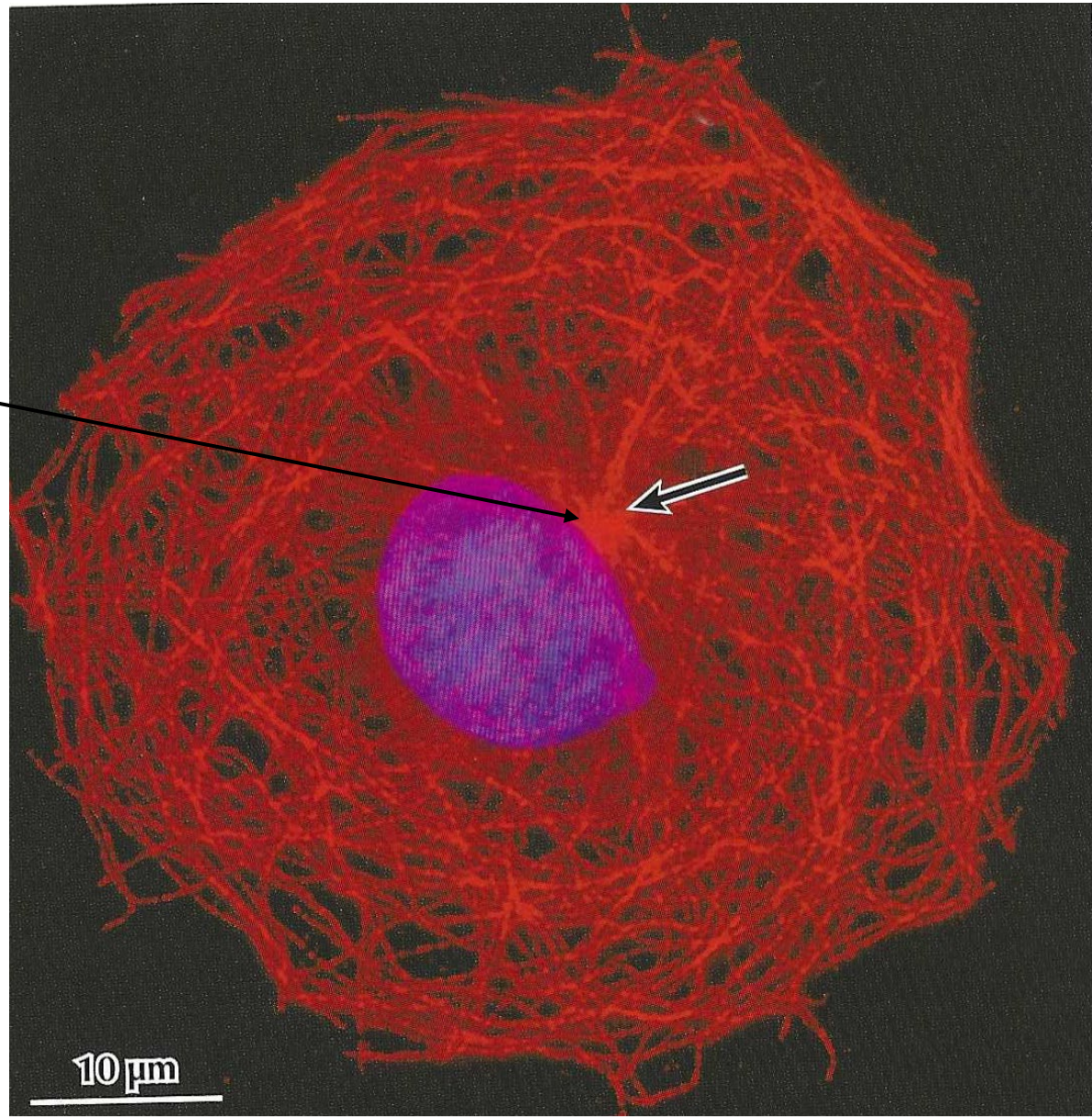
c Microtubules (yellow) in a living cell, as seen after special fluorescent labeling (LM × 3200).

1. Microtubules

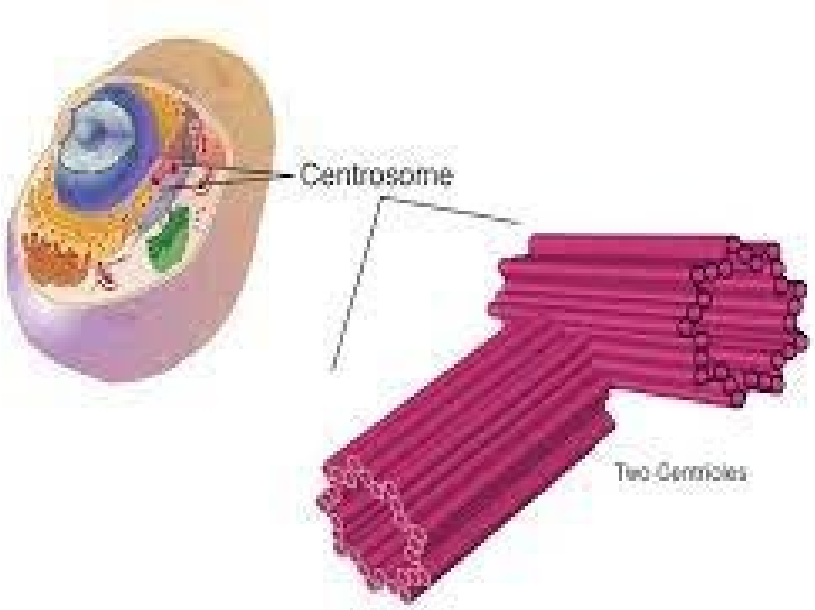
Hollow tubes made of tubulin protein, assembled mostly in **centrosome**

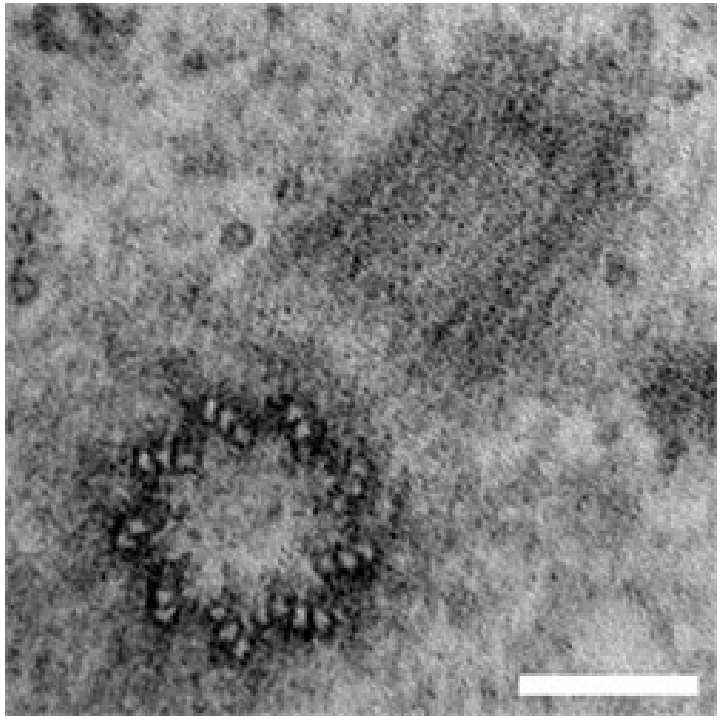


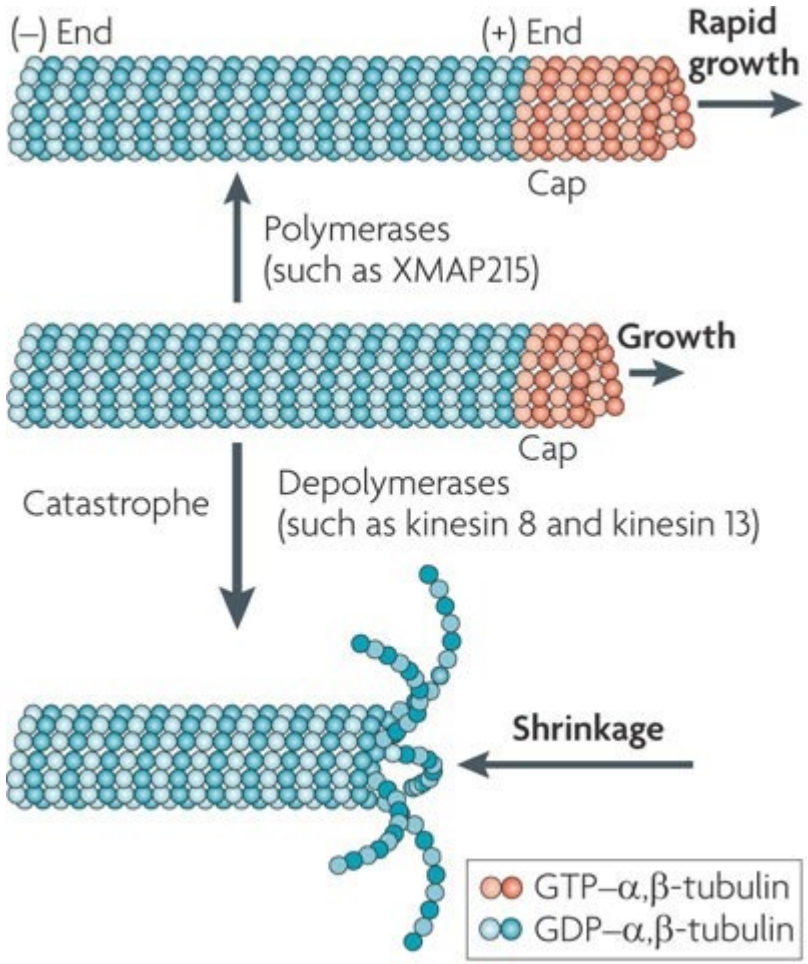




Centrosome



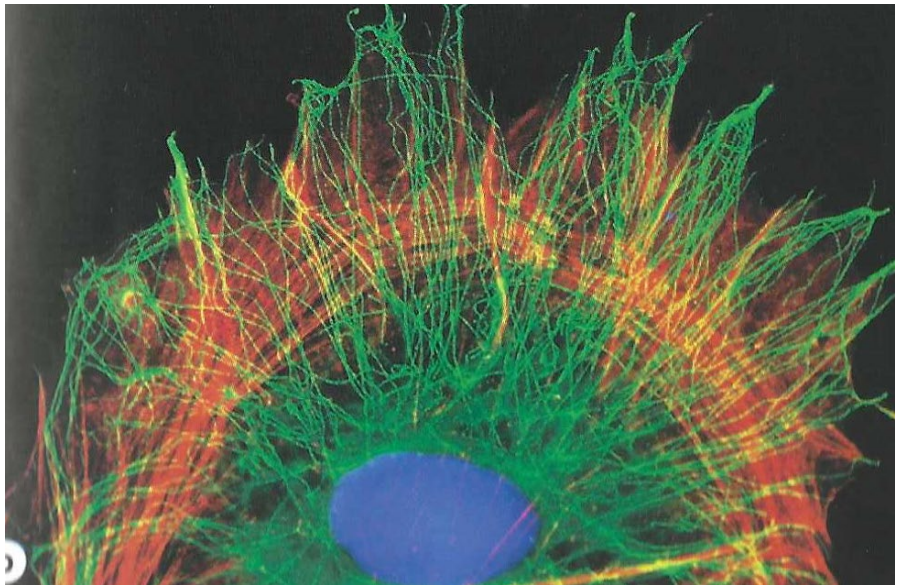




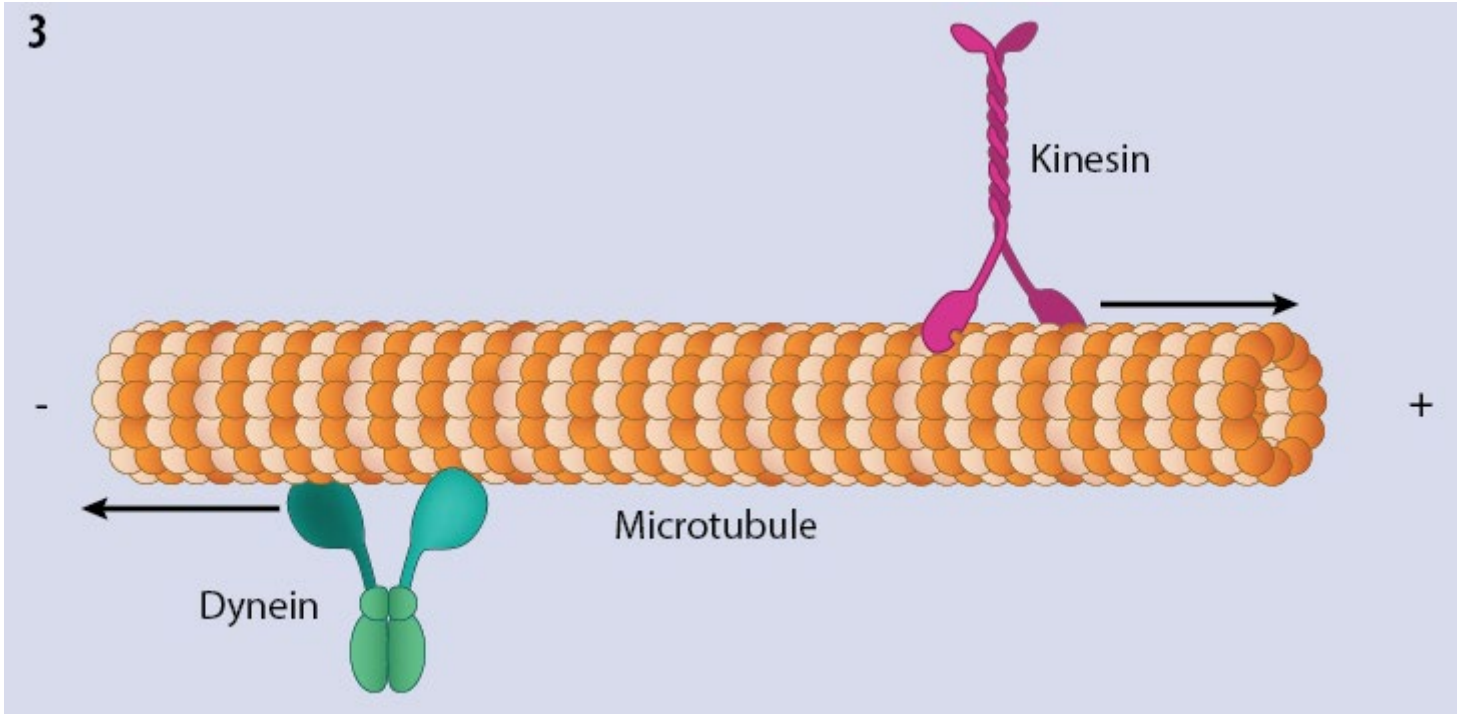
Composed of 2 **centrioles** at right angles; each contains 9 sets of microtubule triplets. Most microtubules are *dynamic*, growing out from one end; others stable.

Functions of microtubules

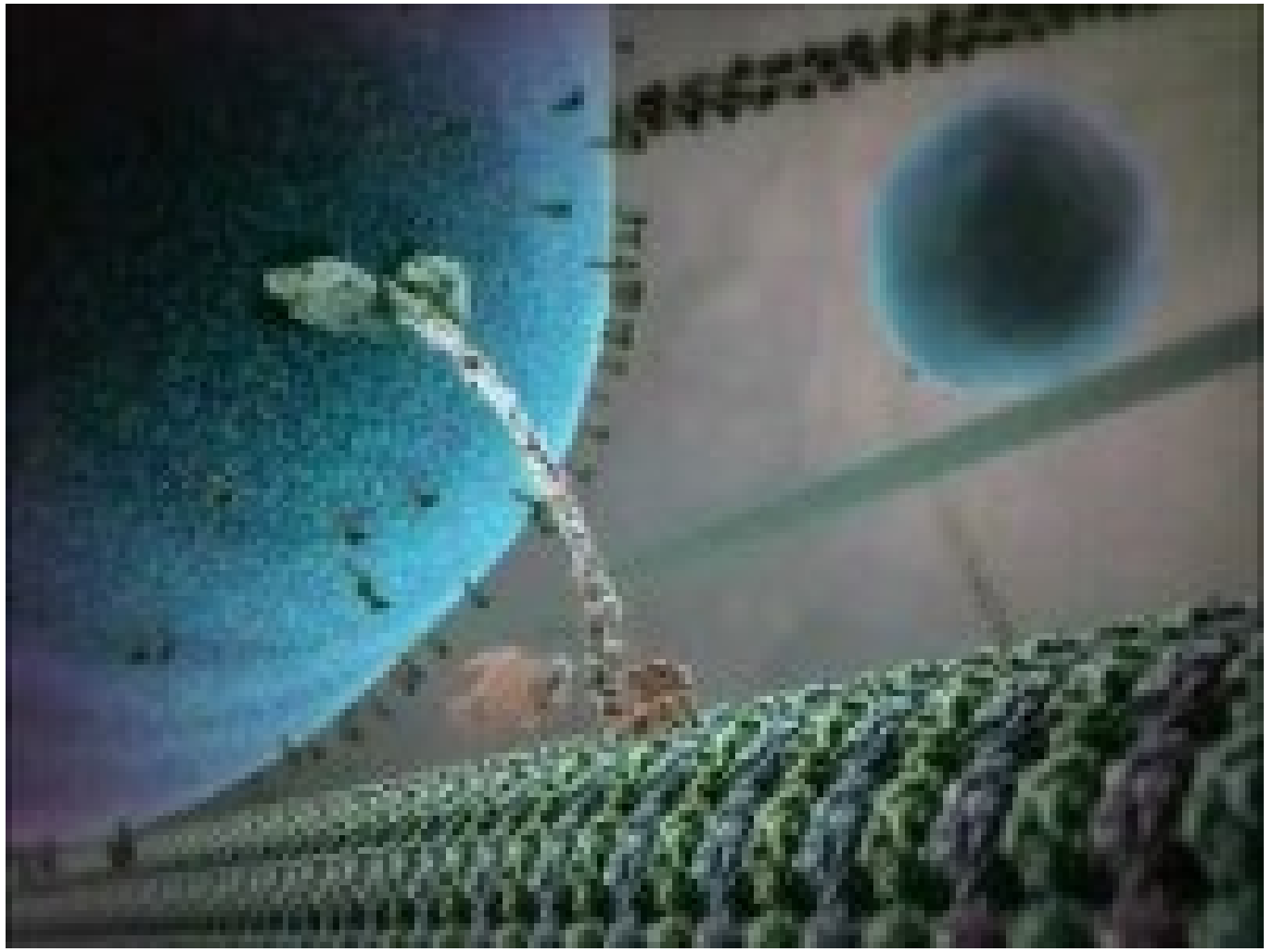
1: **transport organelles** within the cell. Use *kinesin* to transport cargo away from nucleus; *dynein* toward nucleus. Transport vesicles for secretion, mitochondria to where they are needed, chromosomes in dividing cells, etc.



Green: microtubules
Red: microfilaments

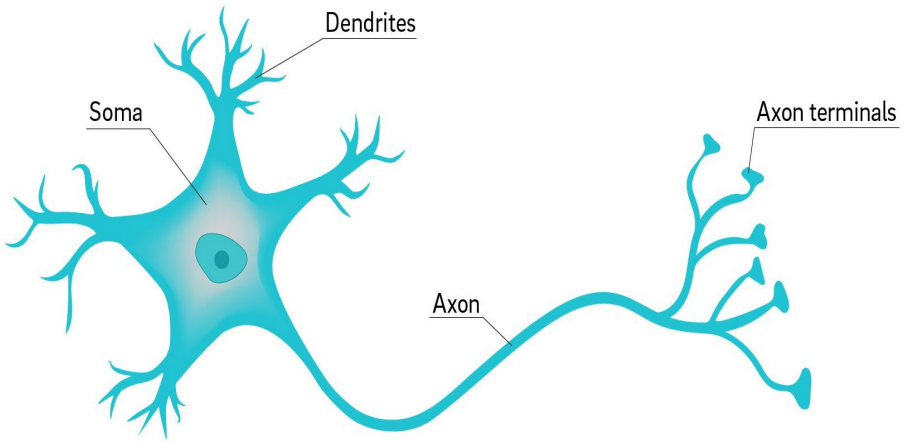


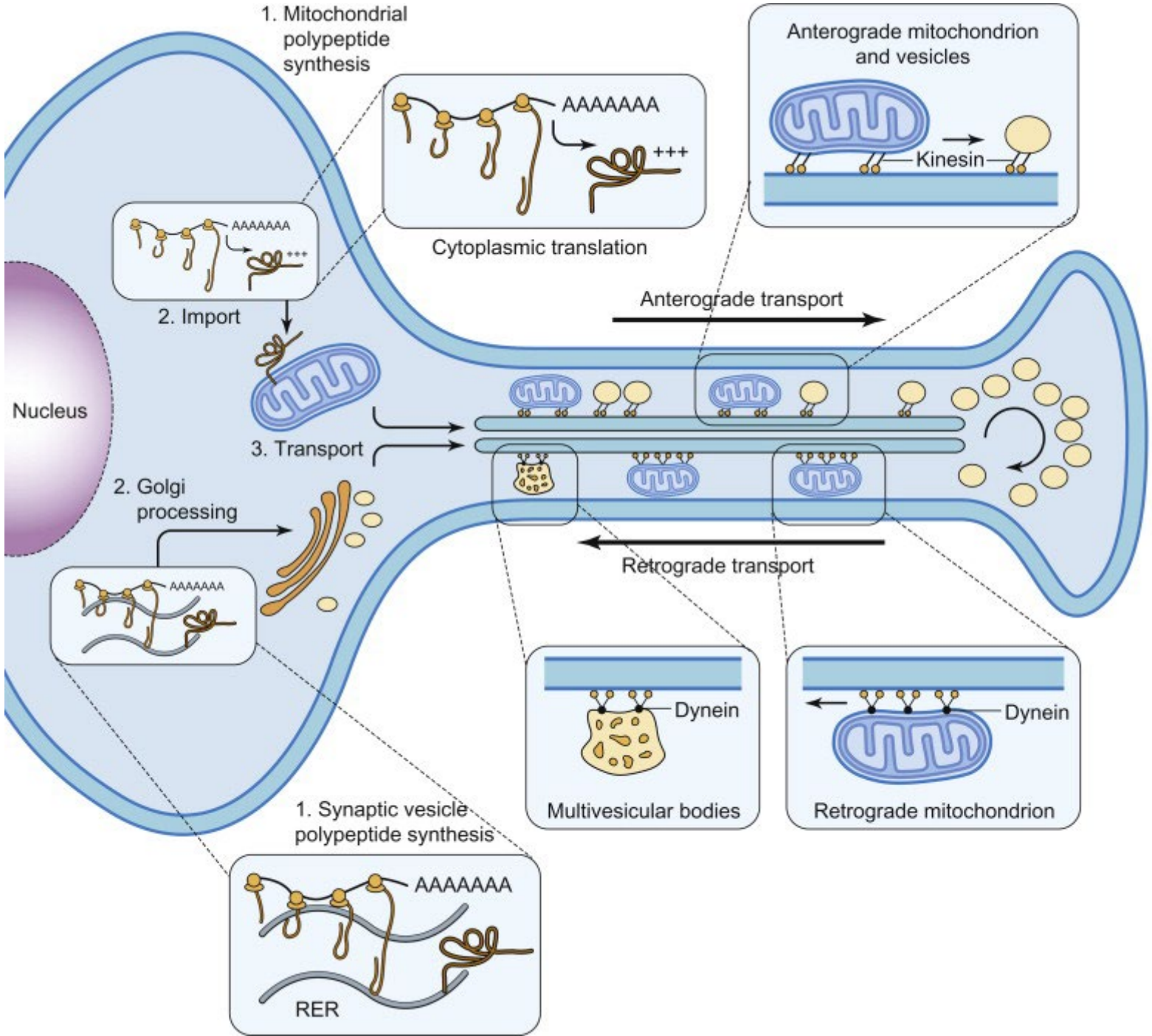
Motor protein transporting a vesicle



Axon transport

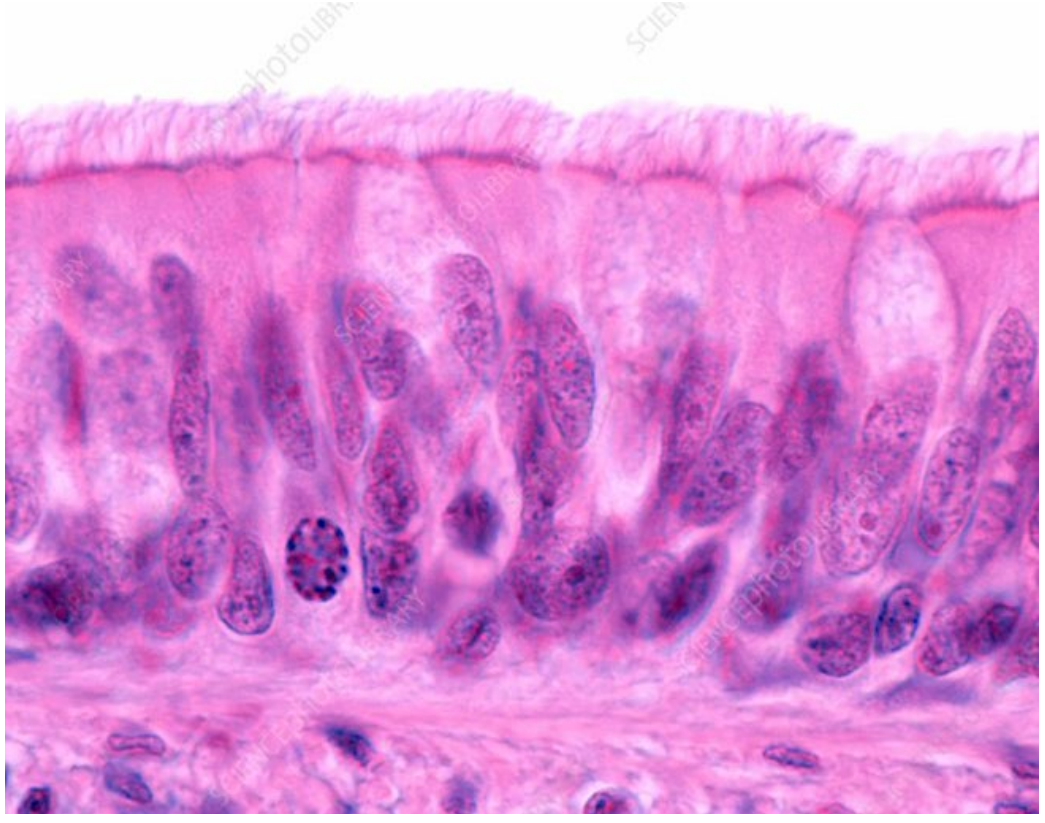
Transport mitochondria and vesicles of neurotransmitter to axon terminals.

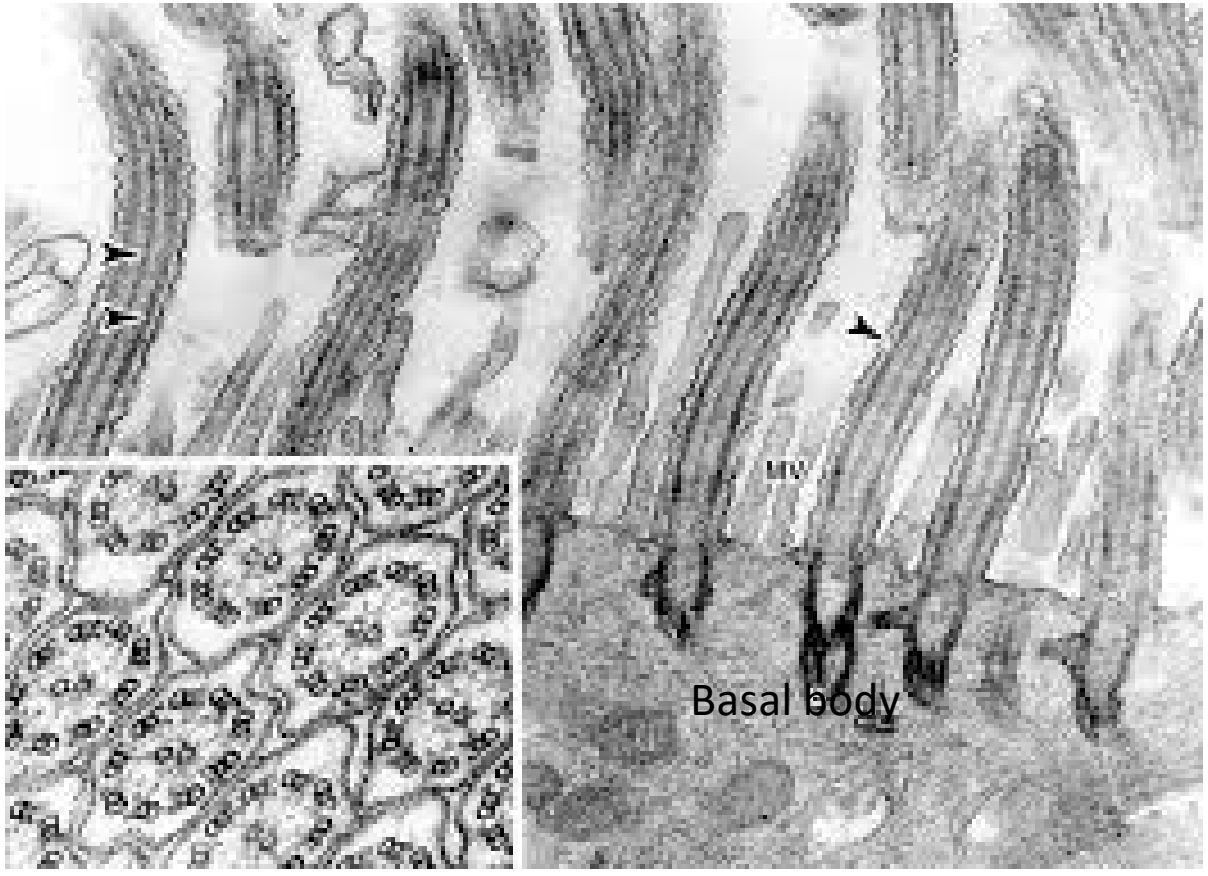




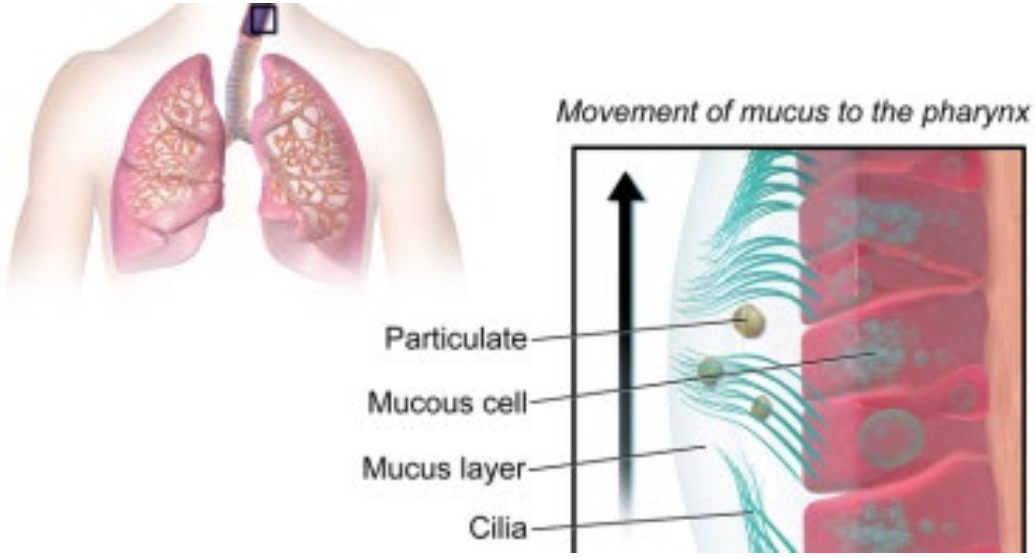
Function of microtubules

2. **Produce movements of cell surface**: *cilia and flagella*. Anchored by basal bodies (buds from centrosome).

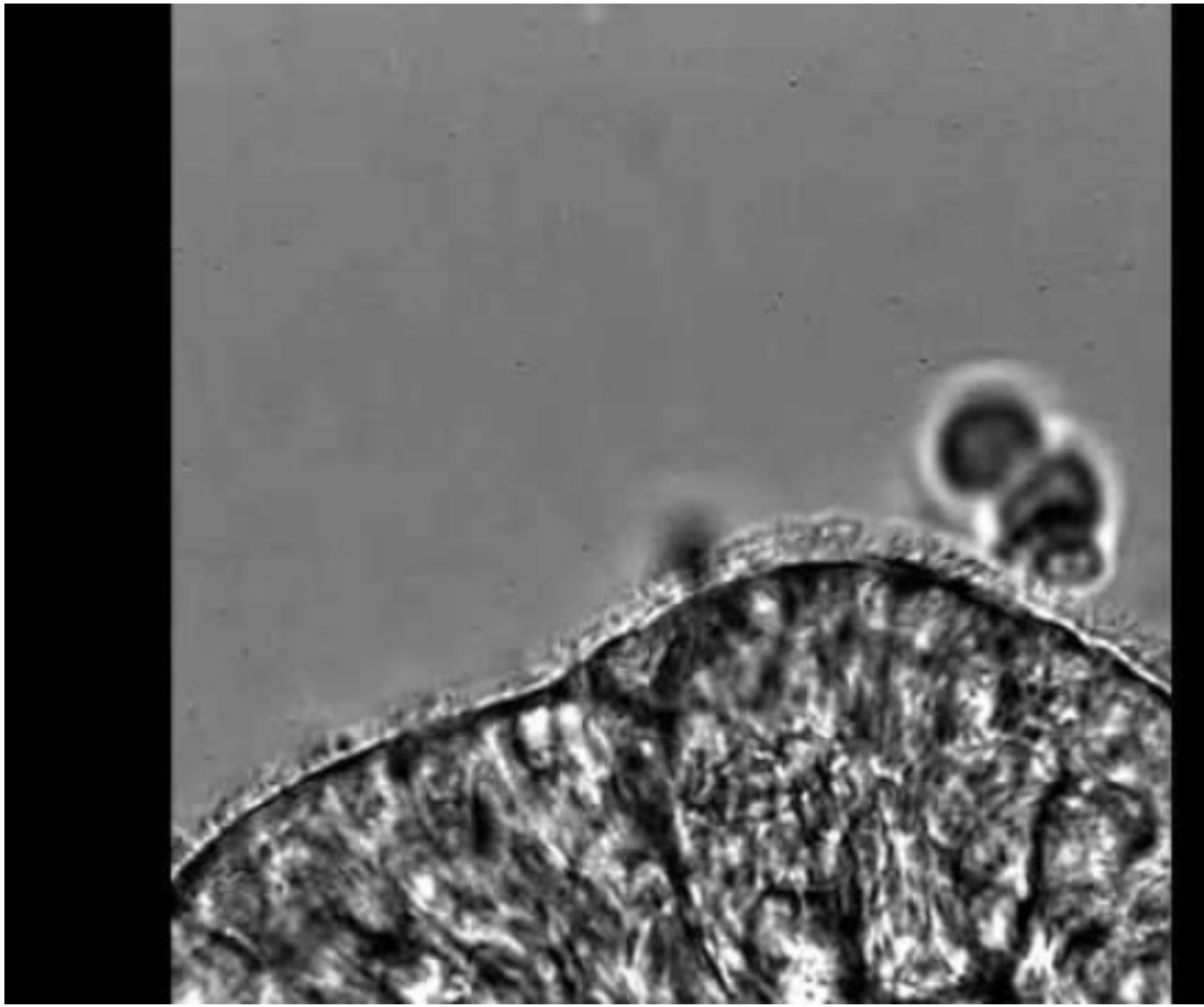




Functions of cilia



Move mucus and particulates out of respiratory system; paralyzed by smoking; coughing.

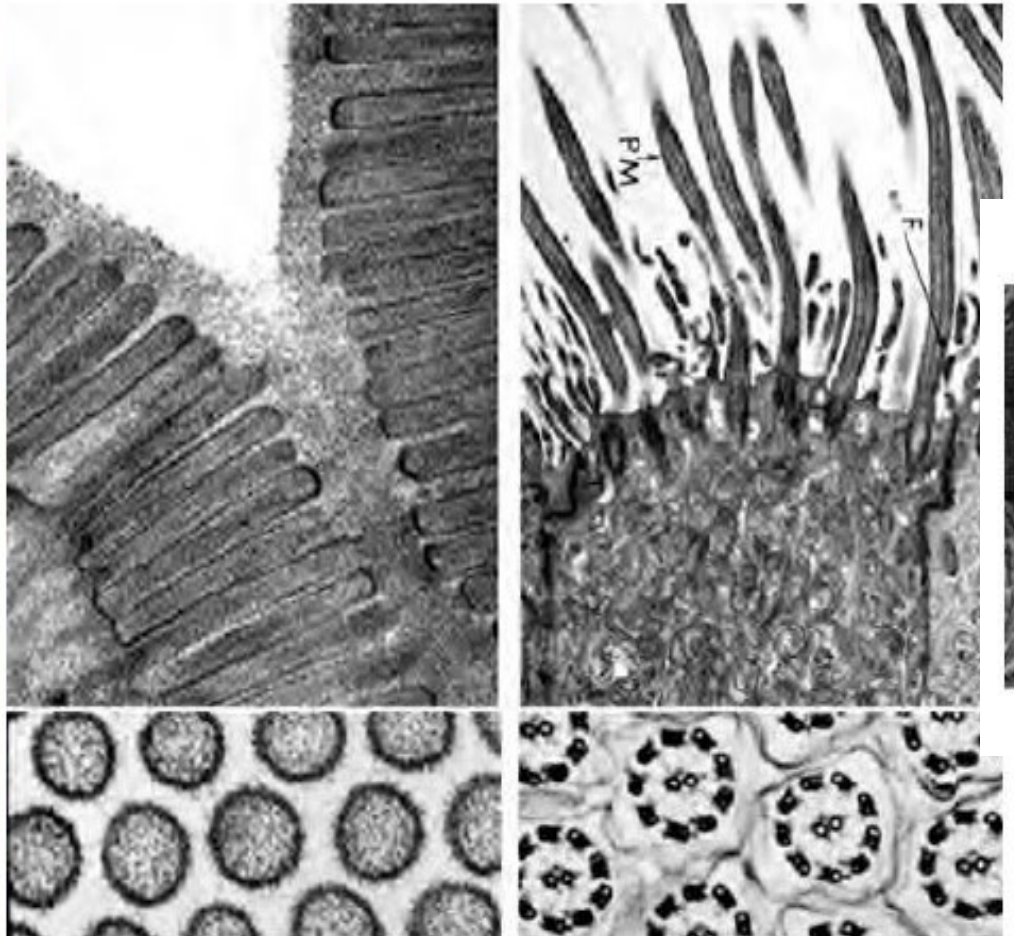


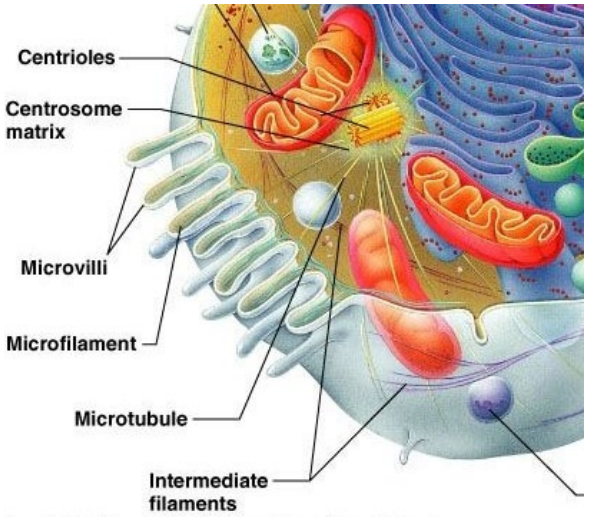
Cilia in bronchi

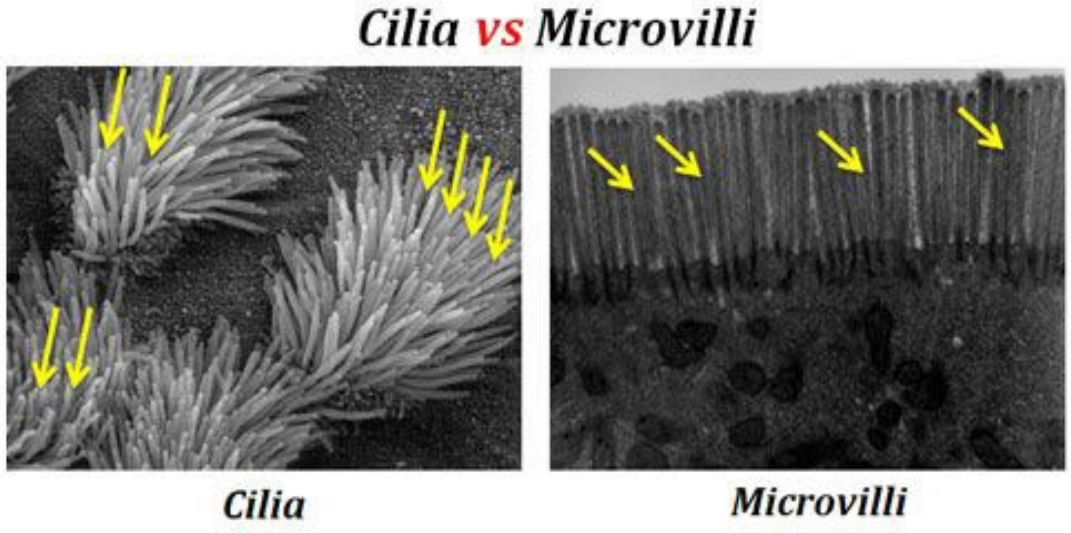
Fallopian tube: increased risk of ectopic pregnancy.

Move ova along the fallopian tube

Cilia vs microvilli

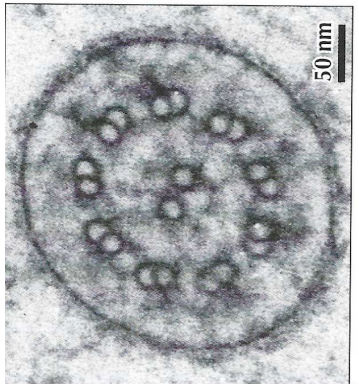


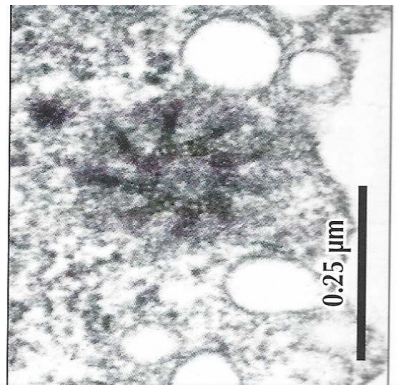


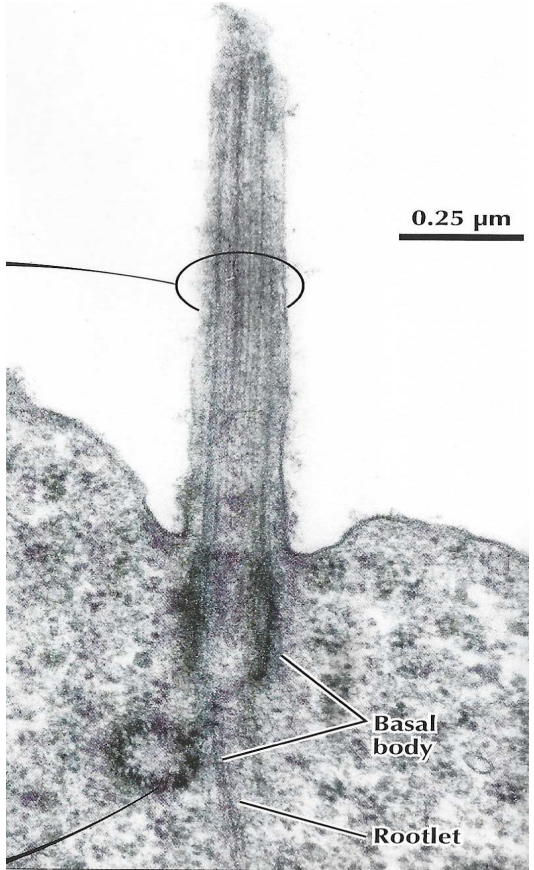


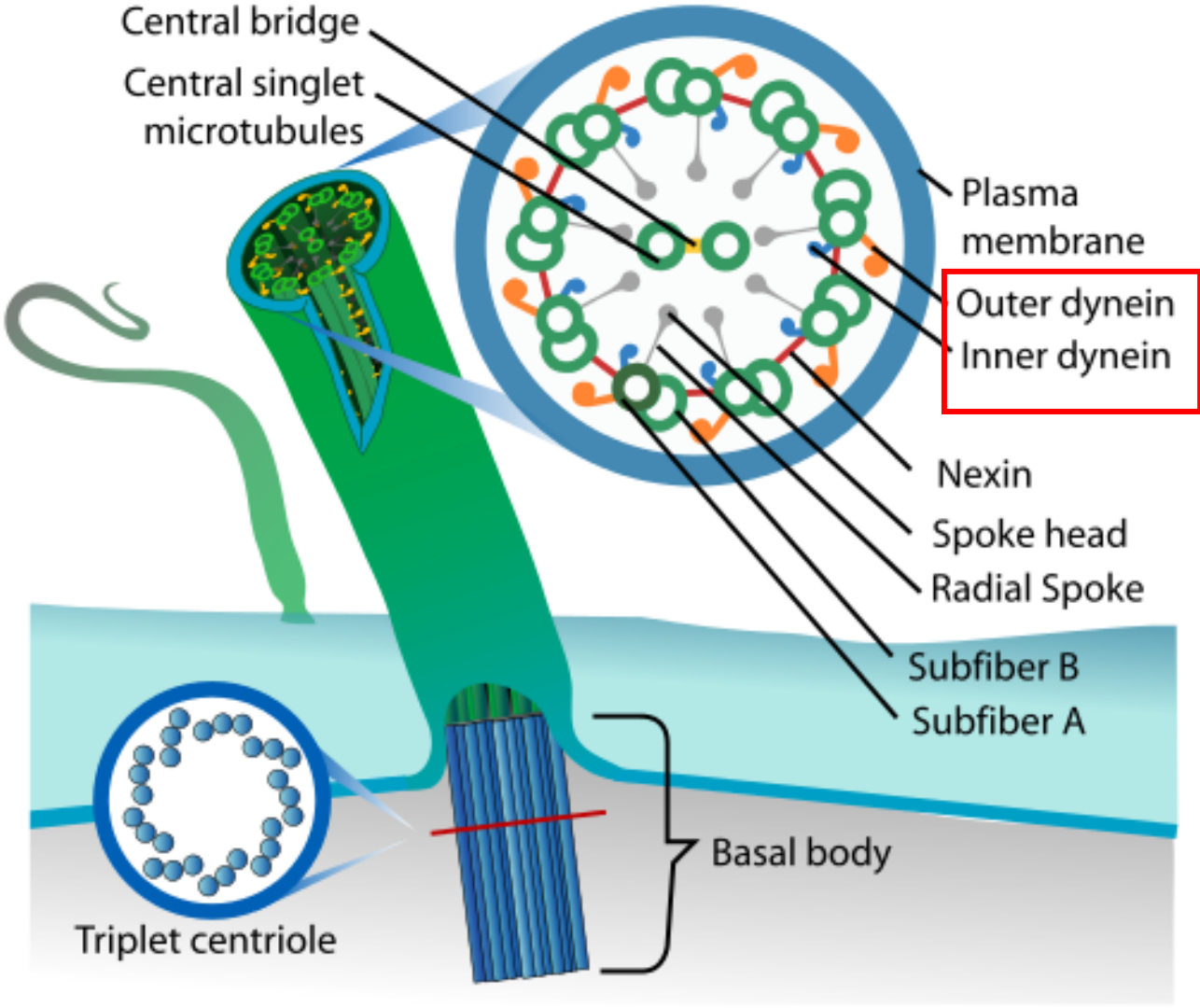
Ciliary movement

Basal body (miniature centriole) creates 9+2 arrangement of microtubules connected by **dyneins**, which force MT to slide against each other.



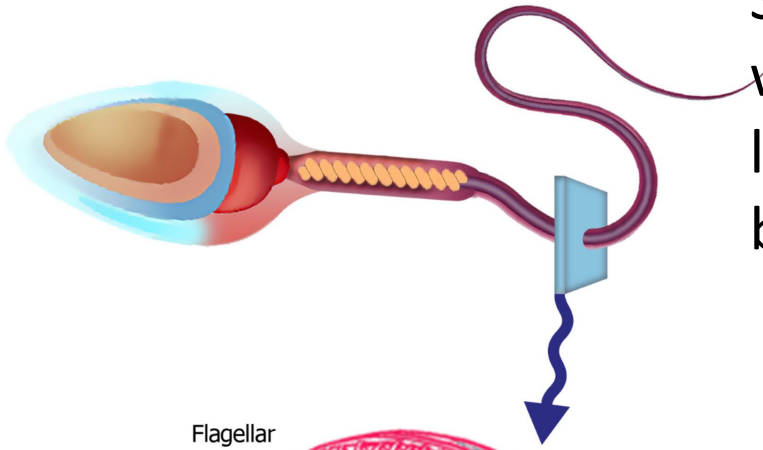




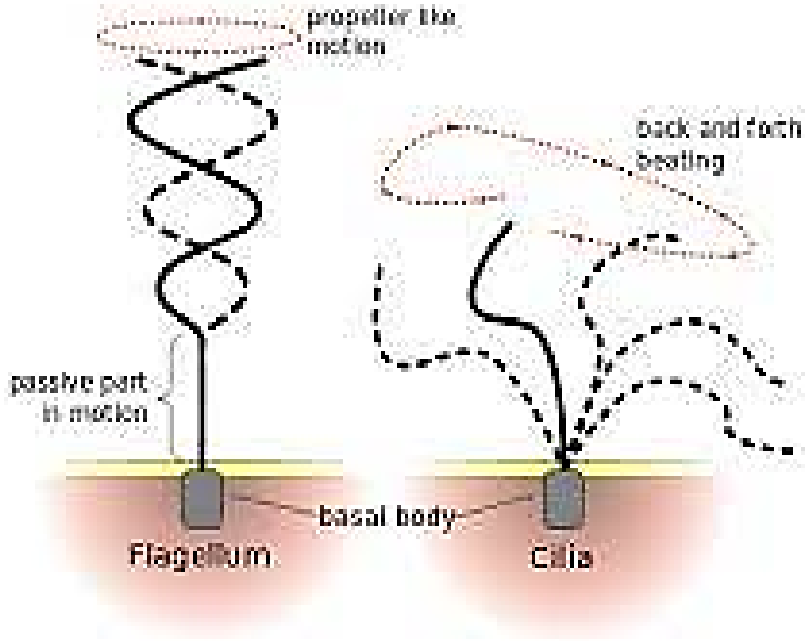


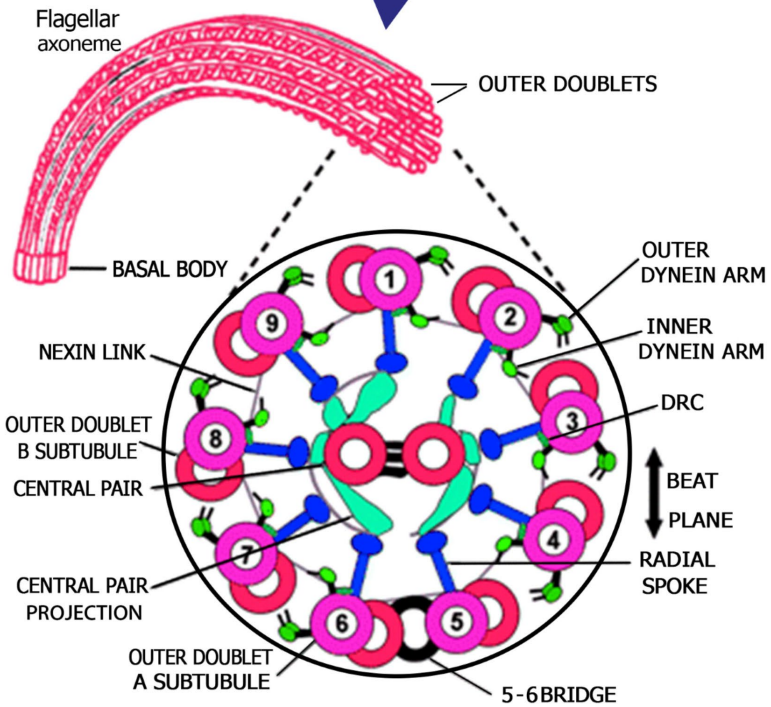
Flagella

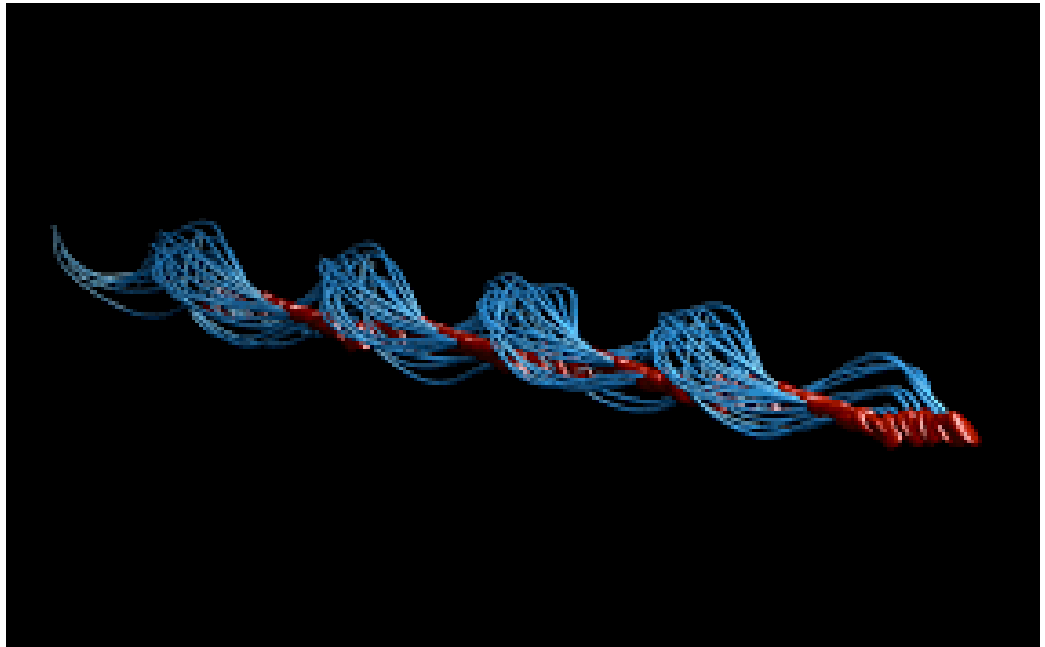
Super cilia



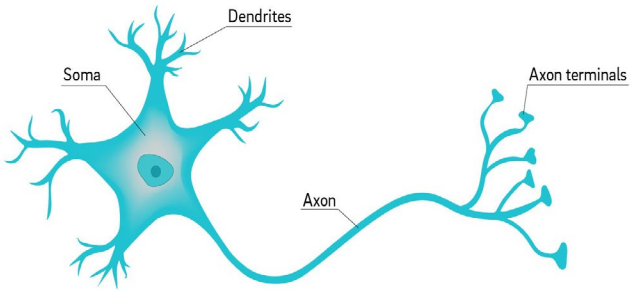
Sperm move with corkscrew-like propulsion by flagella



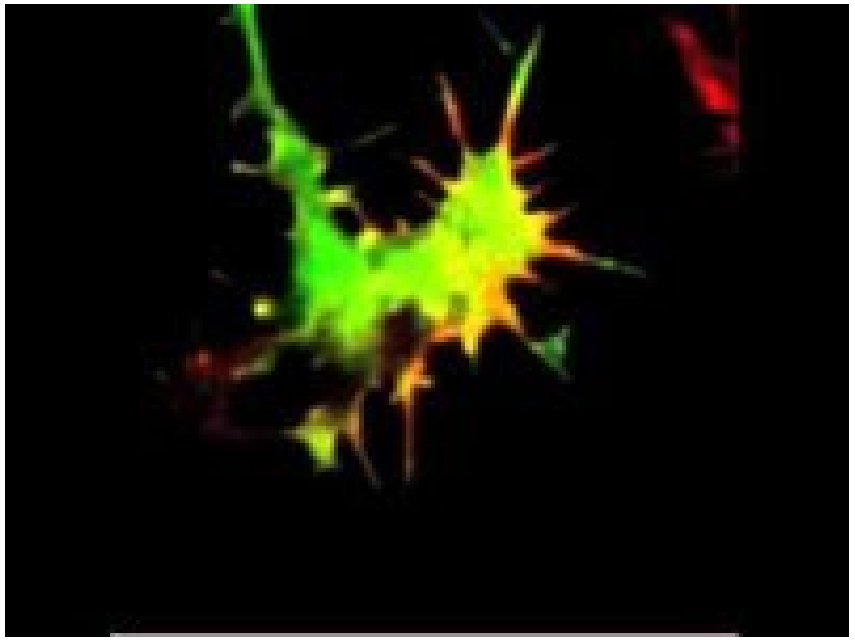


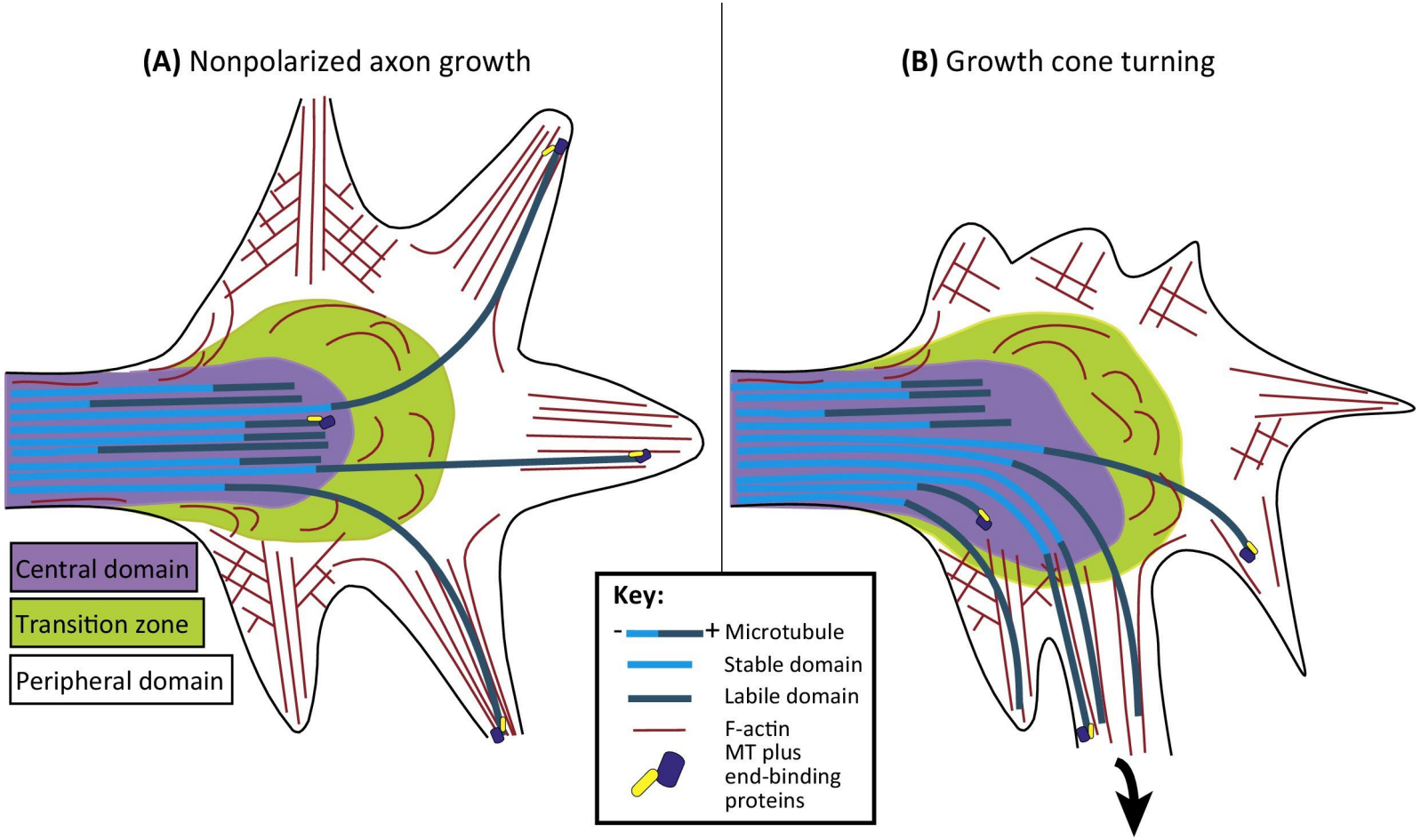


Function of microtubules



3. Steer growth cones of axons of developing nerve cells



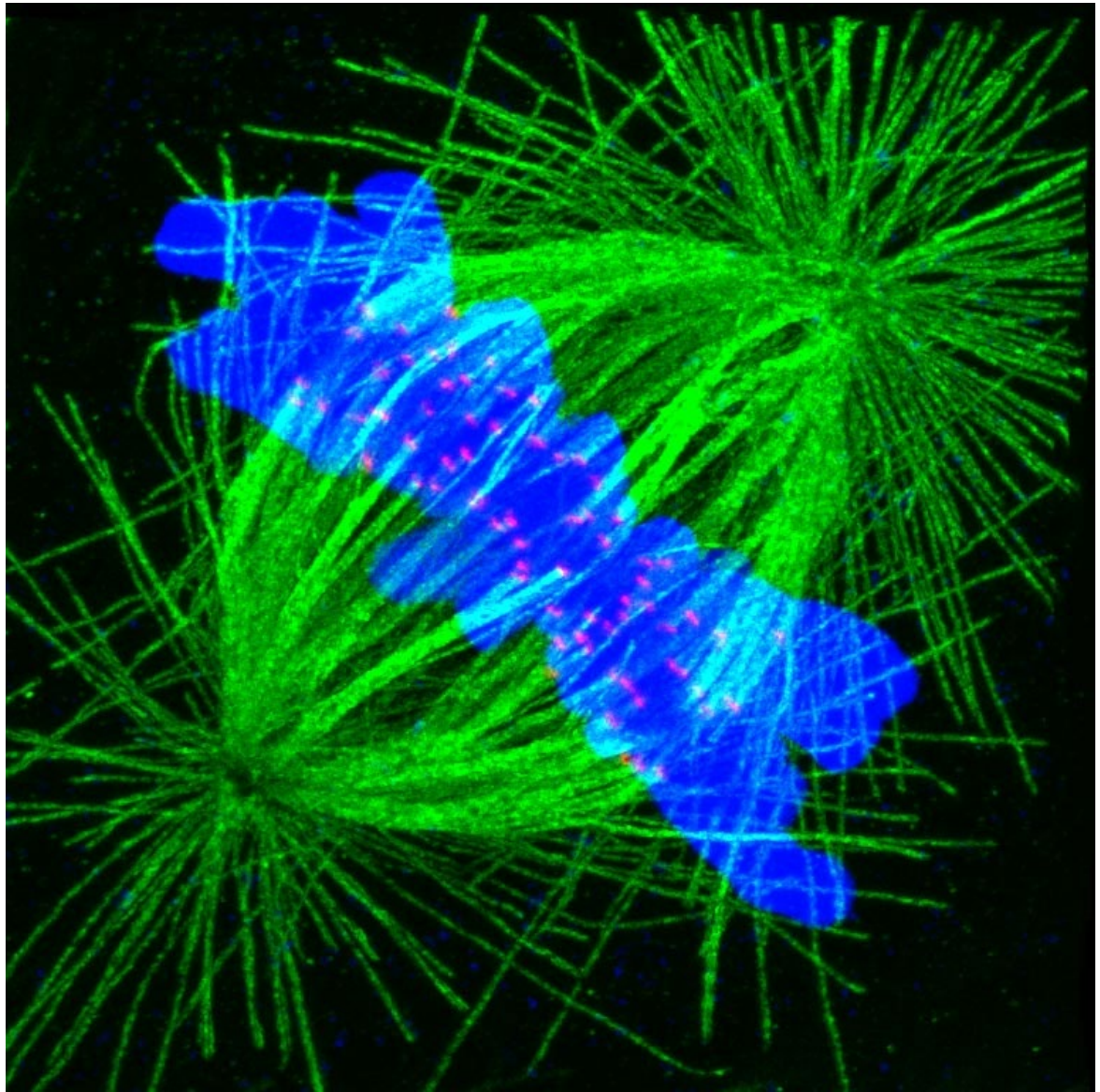


Trends in Neurosciences

Function of Microtubules

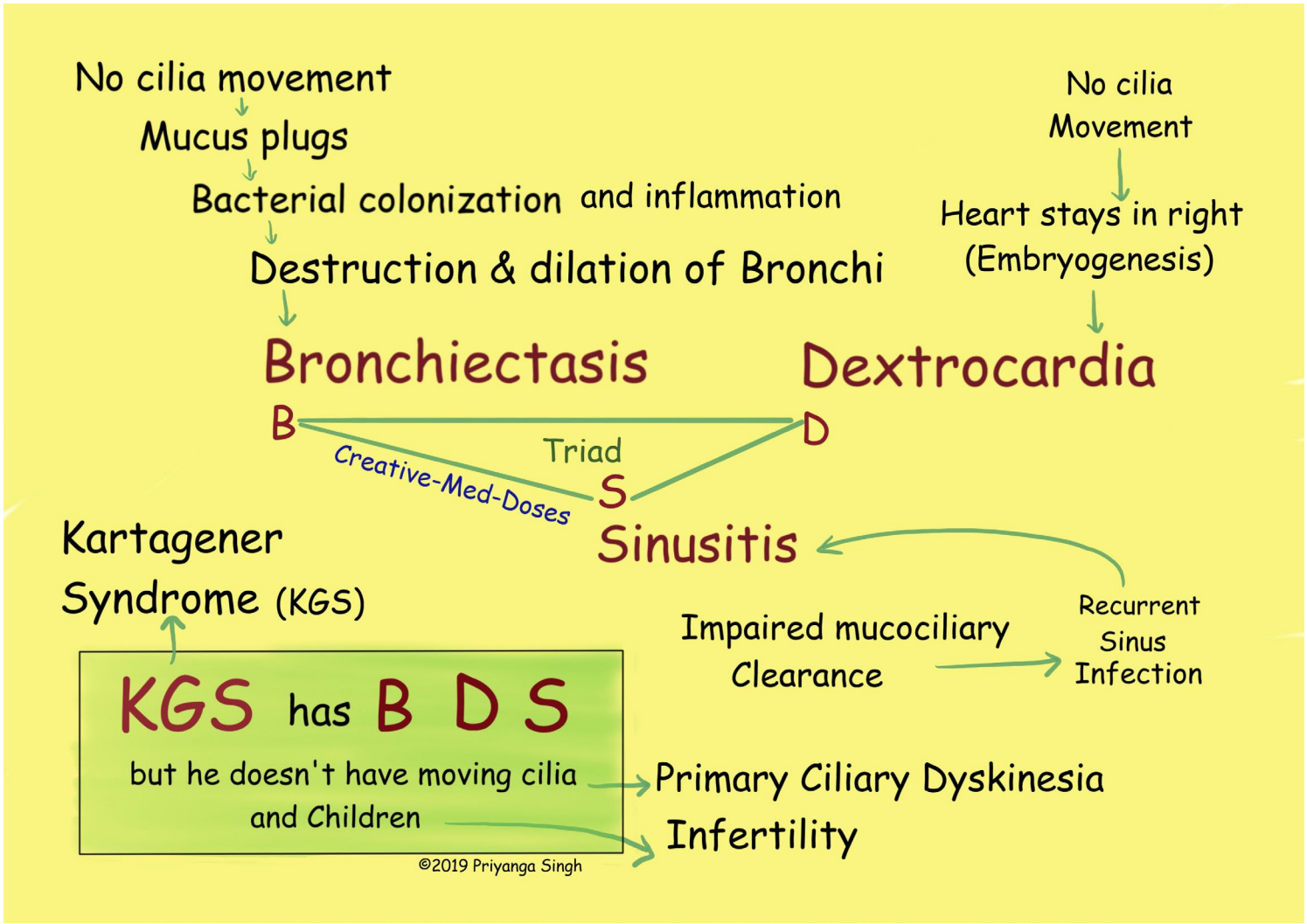
4. Mitotic spindle
Transport chromosomes into daughter cells during cell division. Will discuss further in Cell Division class.

Many anti-cancer drugs target microtubules.



Kartagener Syndrome

Defective dynein in cilia: slow, uncoordinated movement

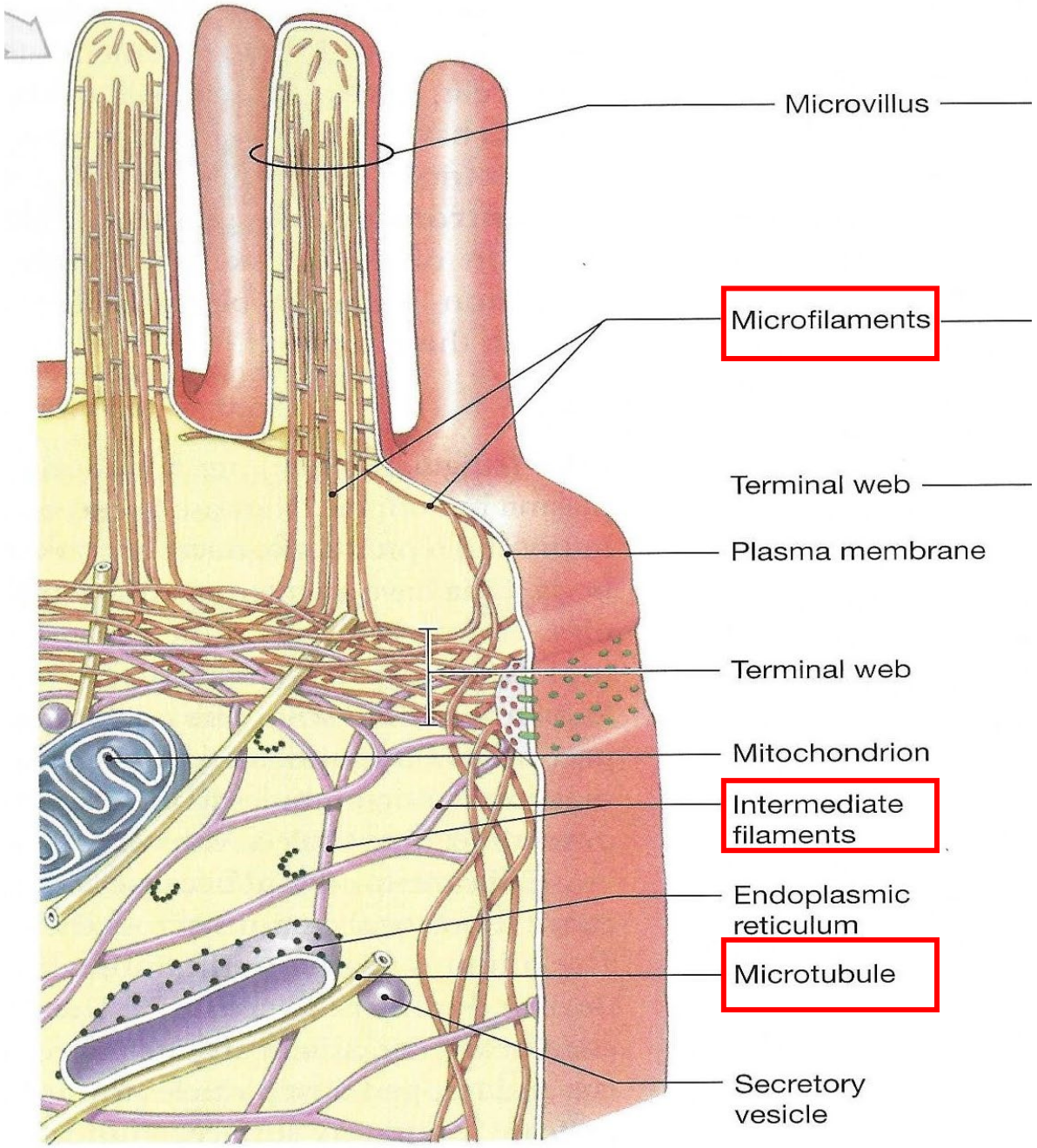


3 types:

Microtubules: movement of organelles, cilia, cells

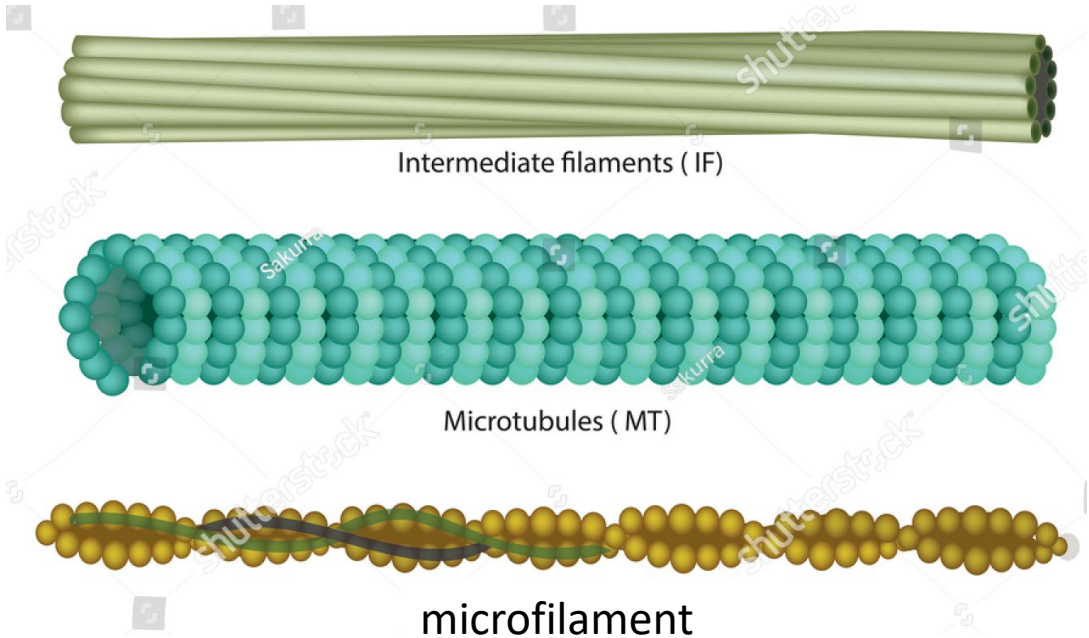
Intermediate filaments: stability

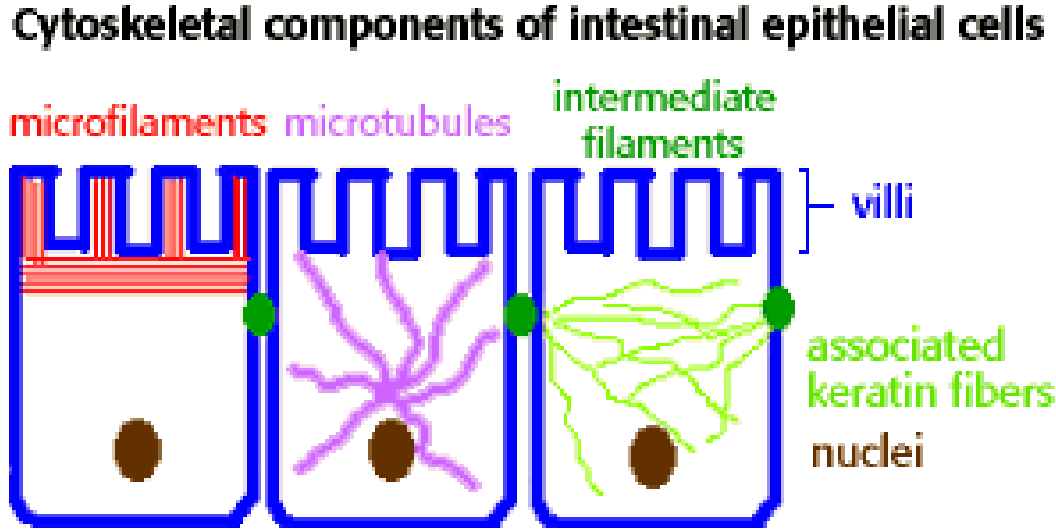
Microfilaments: Movement, shape and anchoring of cells

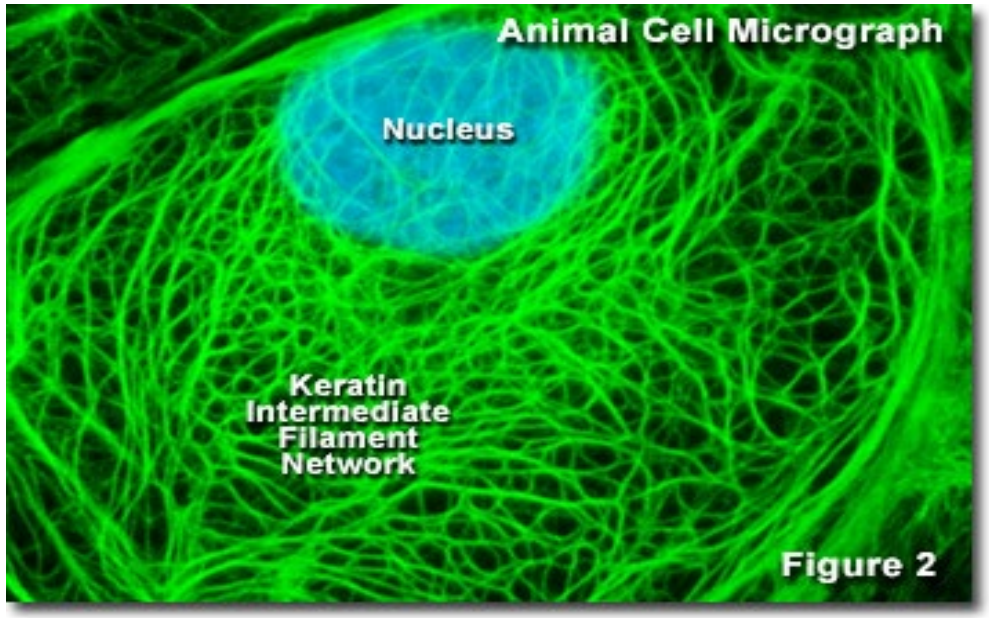


2. Intermediate Filaments

Exceptionally *strong* rope-like structures to resist mechanical stress, hold cells together, stabilize cell walls.

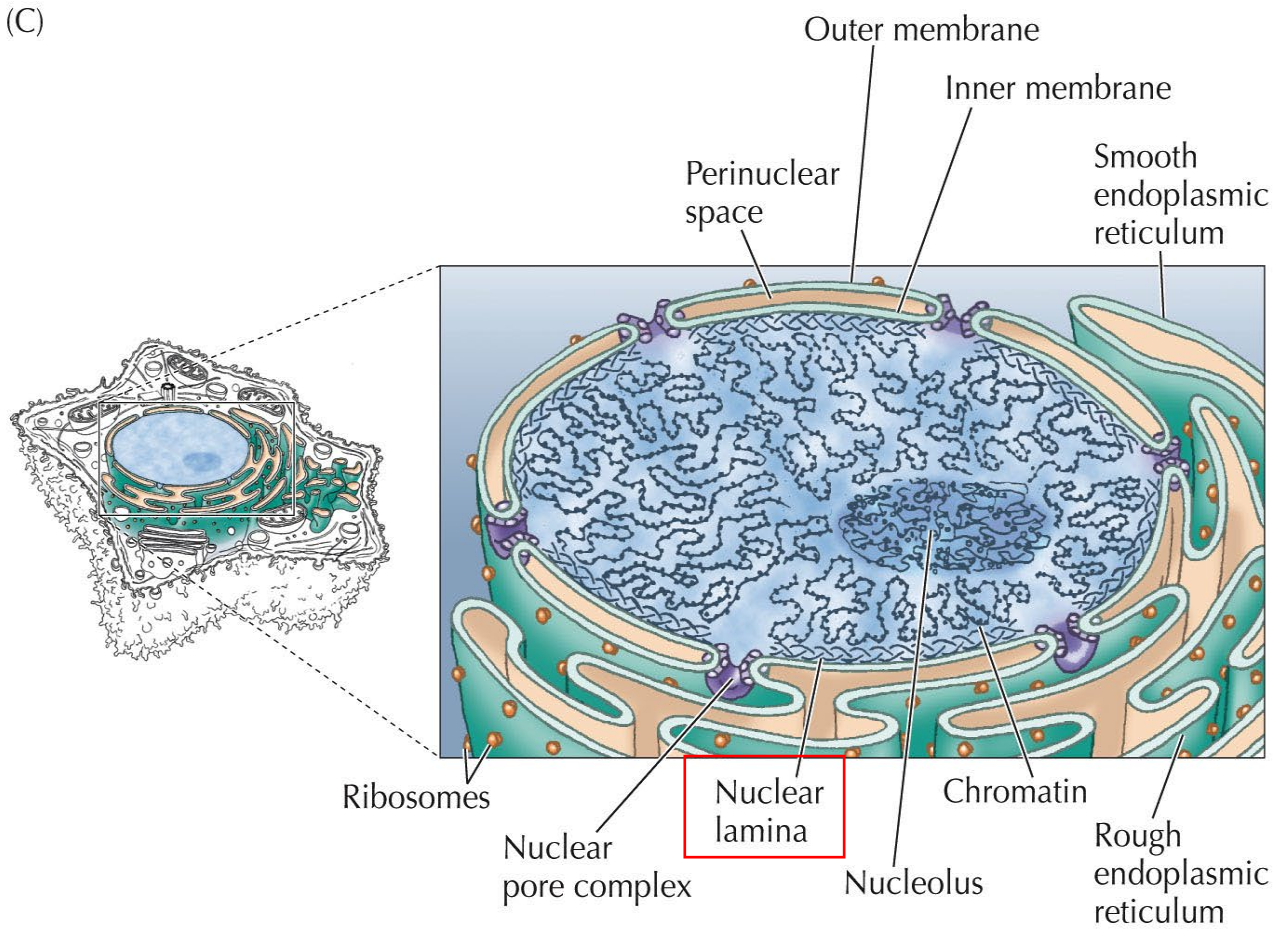


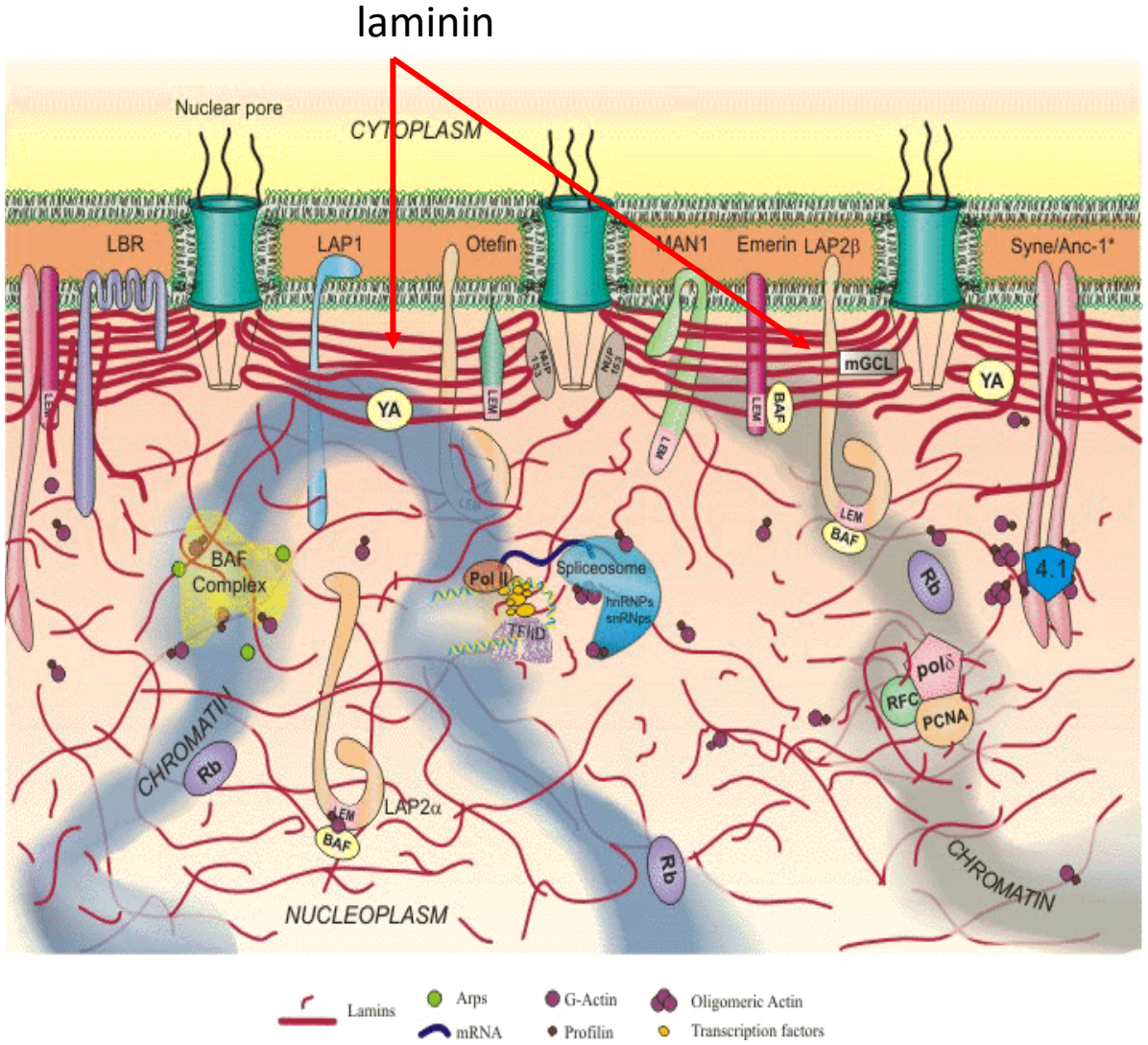




Nuclear laminins

Reinforce nuclear envelope and organize the locations of the chromosomes.

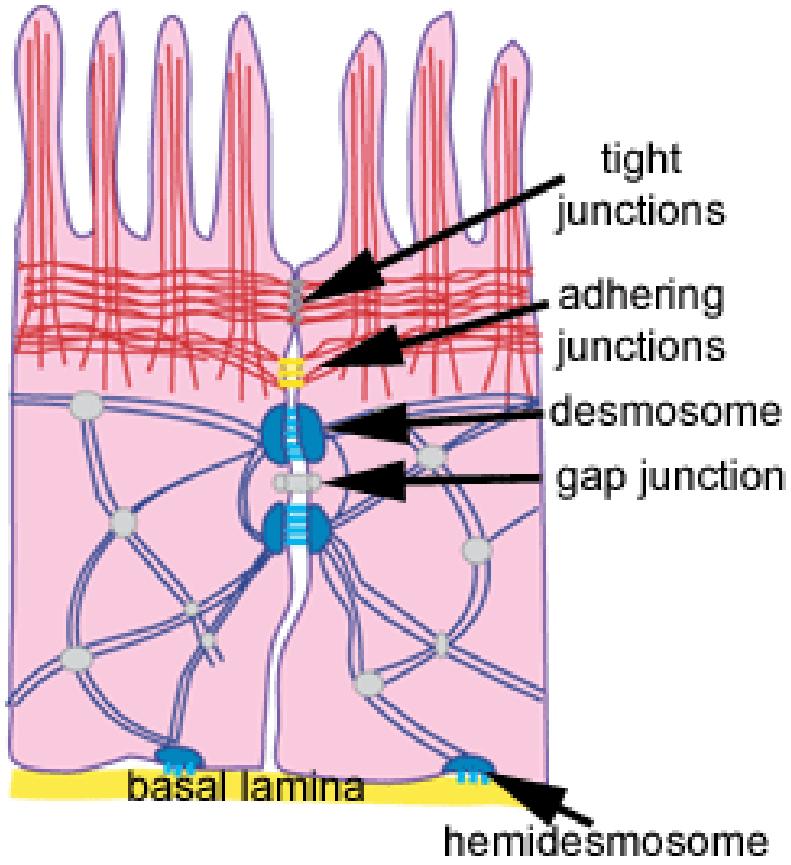


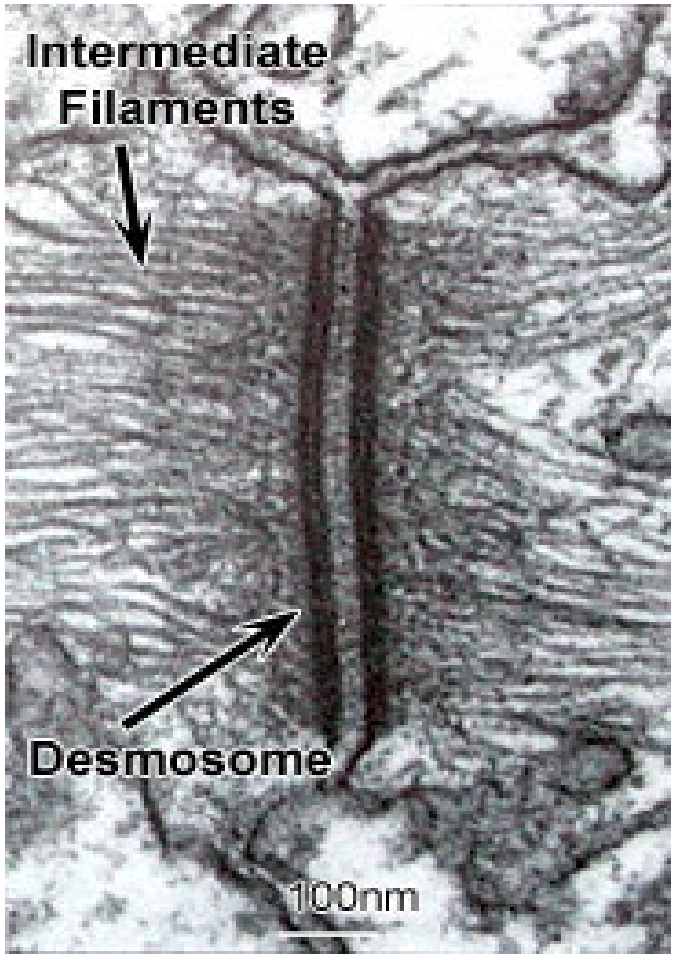


Connect cells: to each other and to substrate

Especially important to withstand mechanical stress.
Epithelial cells: ***keratin*** IF; give strength to skin (hair, nails).
Muscle cells: ***desmin*** IF
Nerve cells: ***neurofilaments***
Connective tissue: ***vimentin***
Glial cells: ***glial filaments***

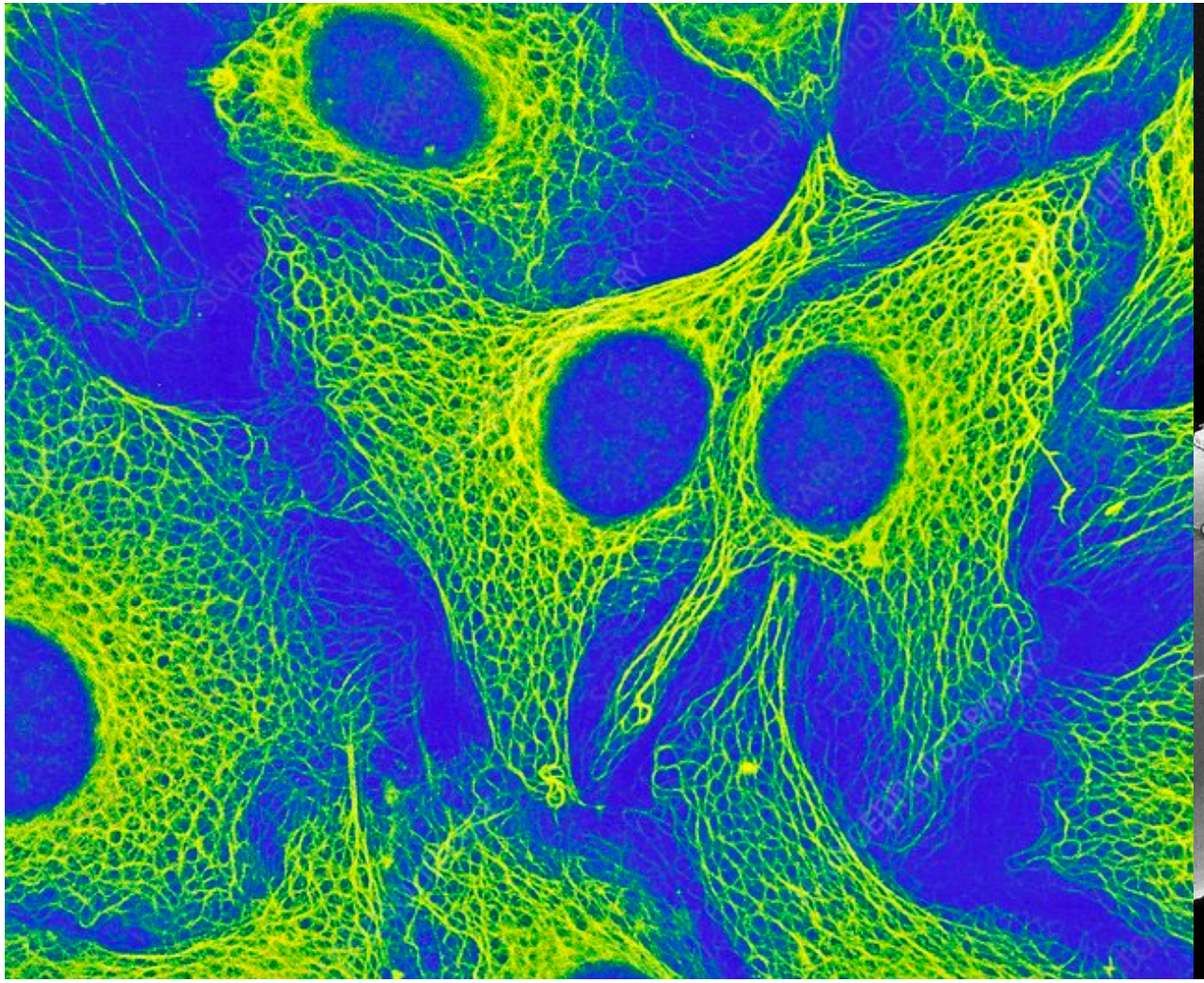
Immunocytochemical (colored antibody labels) testing of cancer cells helps determine their origin.

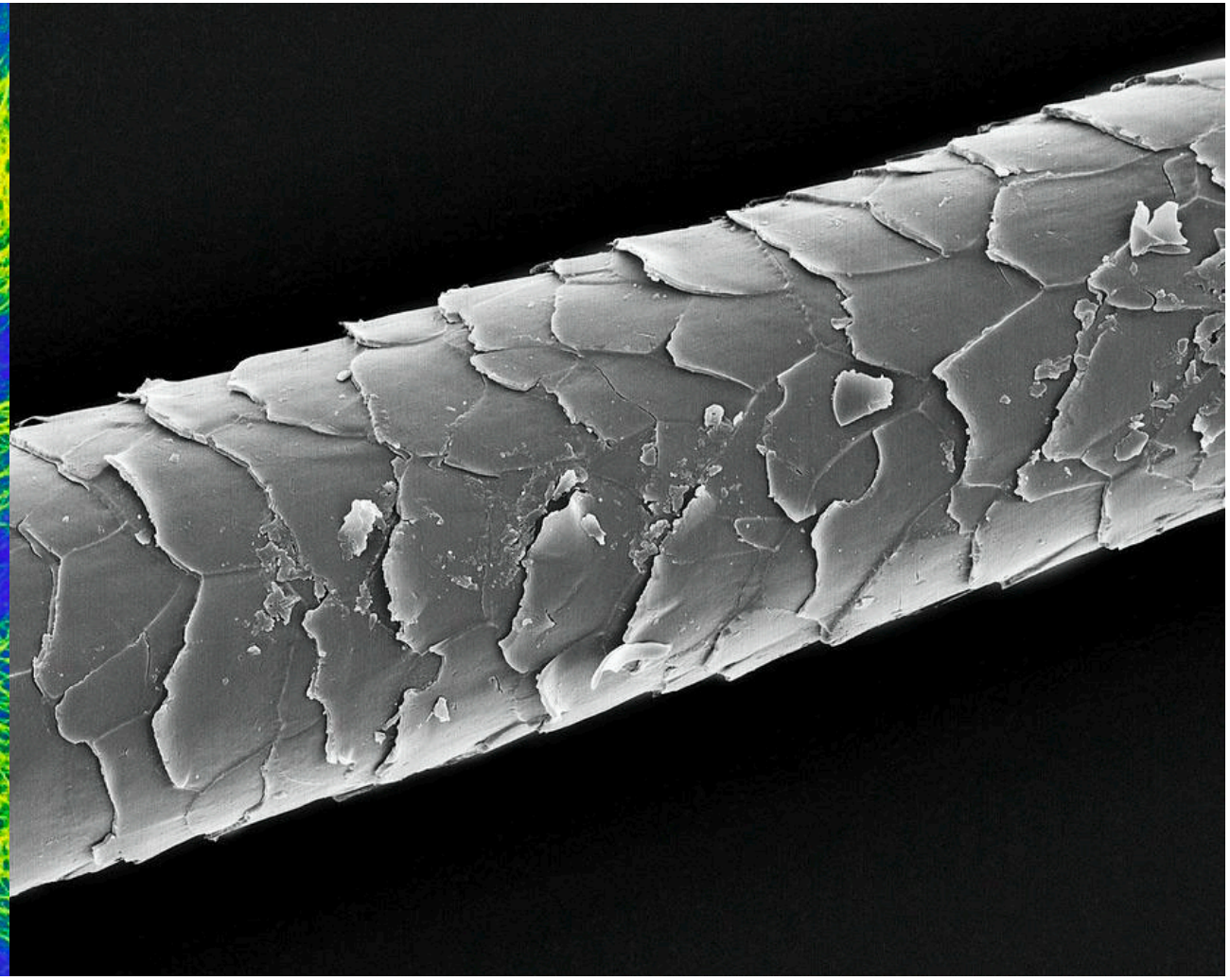




Red: microfilaments
Blue: intermediate filaments

Keratin in skin cells and hair



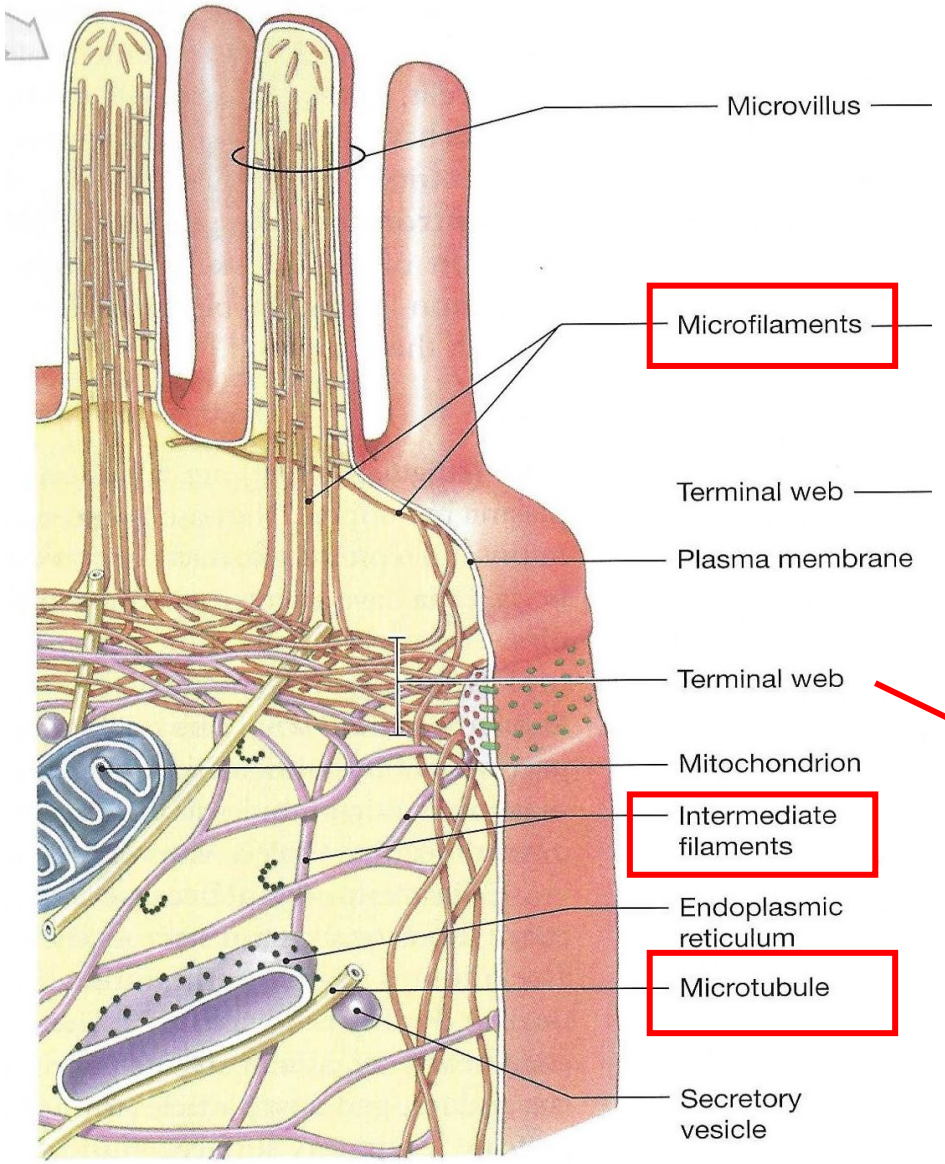


3 types:

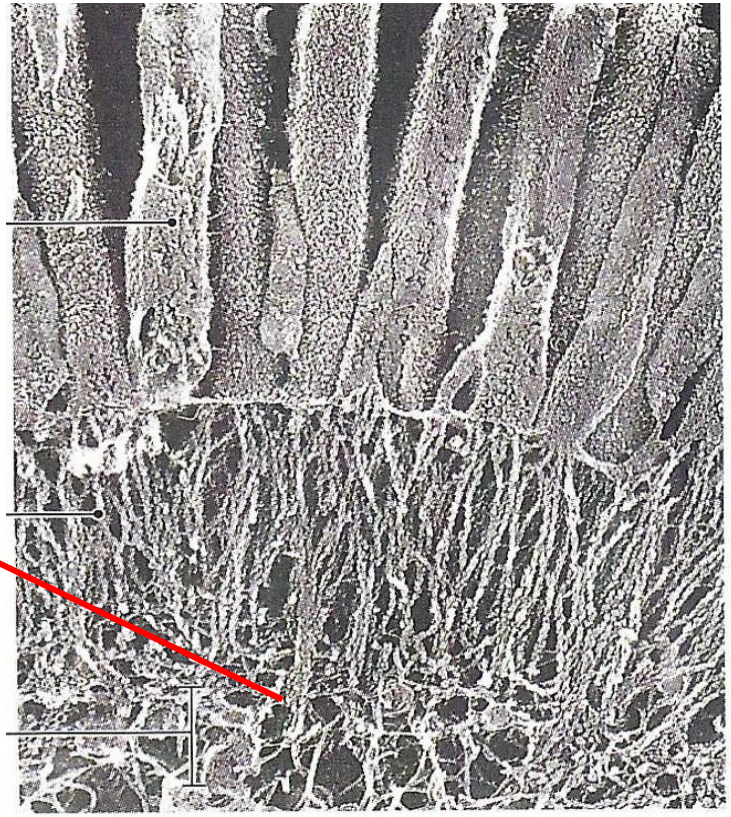
Microtubules: movement of organelles, cells

Intermediate filaments: stability

Microfilaments: movement and anchoring of cells and cell membrane



a The cytoskeleton provides strength and structural support for the cell and its organelles. Interactions between cytoskeletal components are also important in moving organelles and in changing the shape of the cell.



b The microfilaments and microvilli of an intestinal cell. Such an image, produced by a scanning electron microscope, is called a scanning electron micrograph (SEM) (SEM × 30,000).

3. Microfilaments

Composed of 2 strands of **actin**. Flexible but strong. Stabilize membranes (attach membrane to cytoplasmic structures), shape cell.

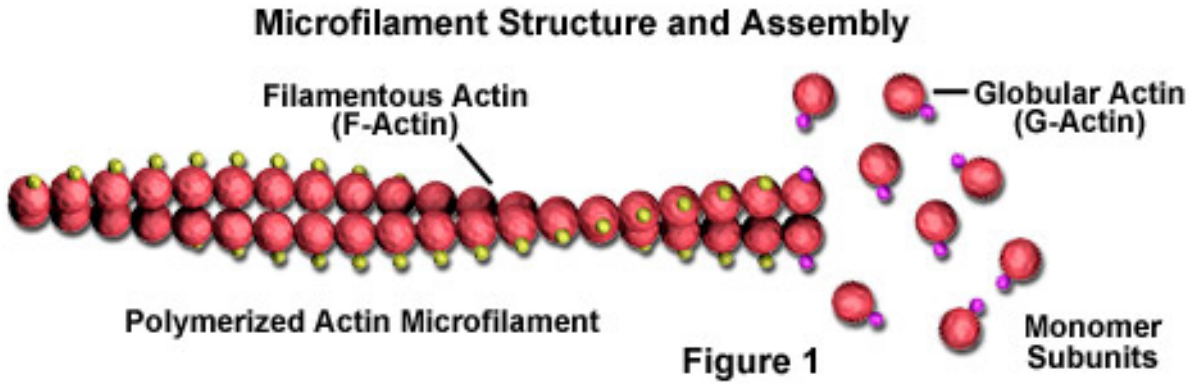
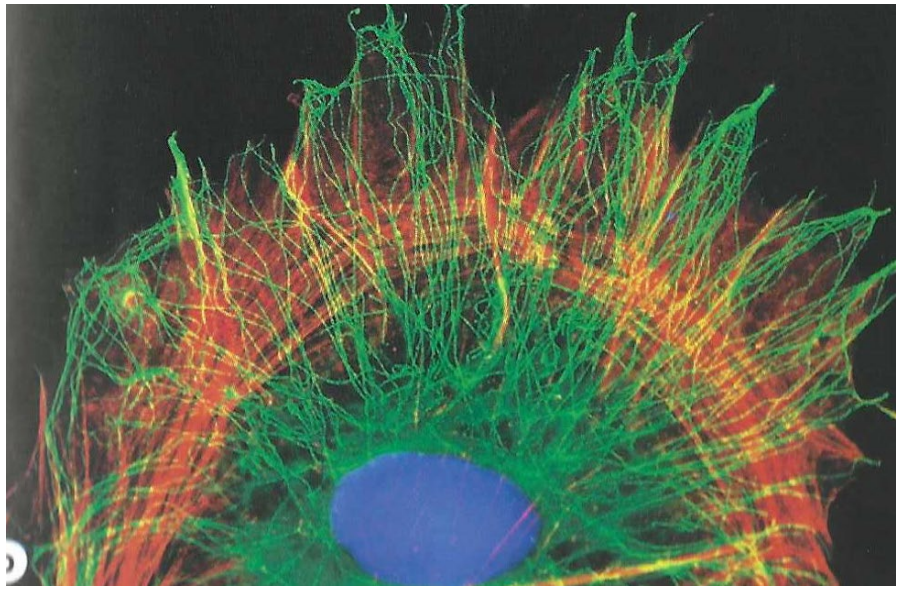
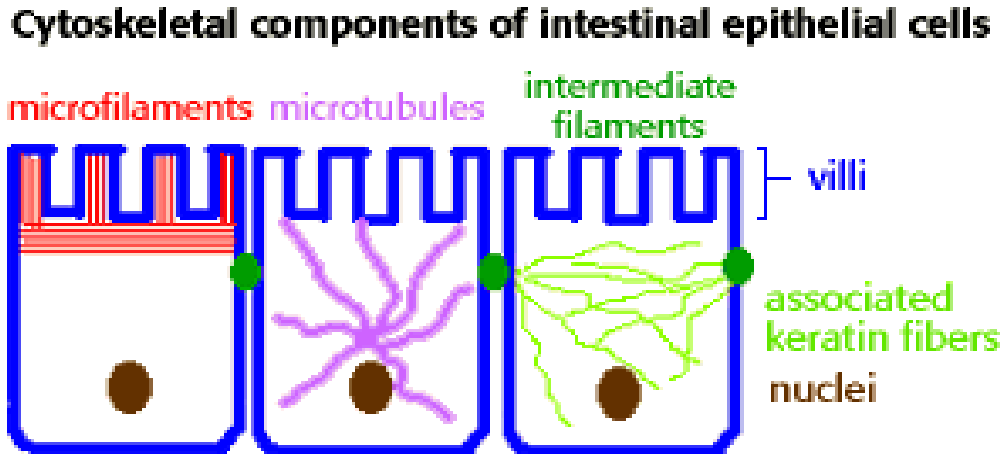


Figure 1

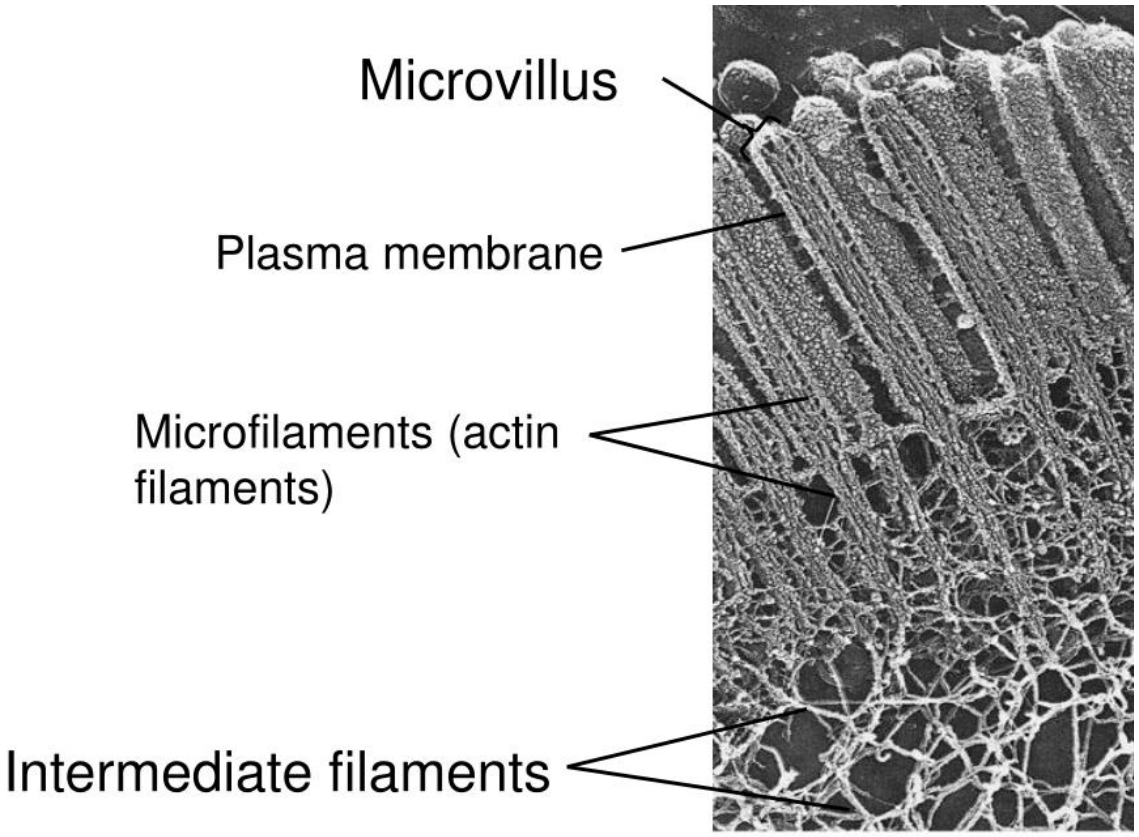


Green: microtubules
Red: microfilaments

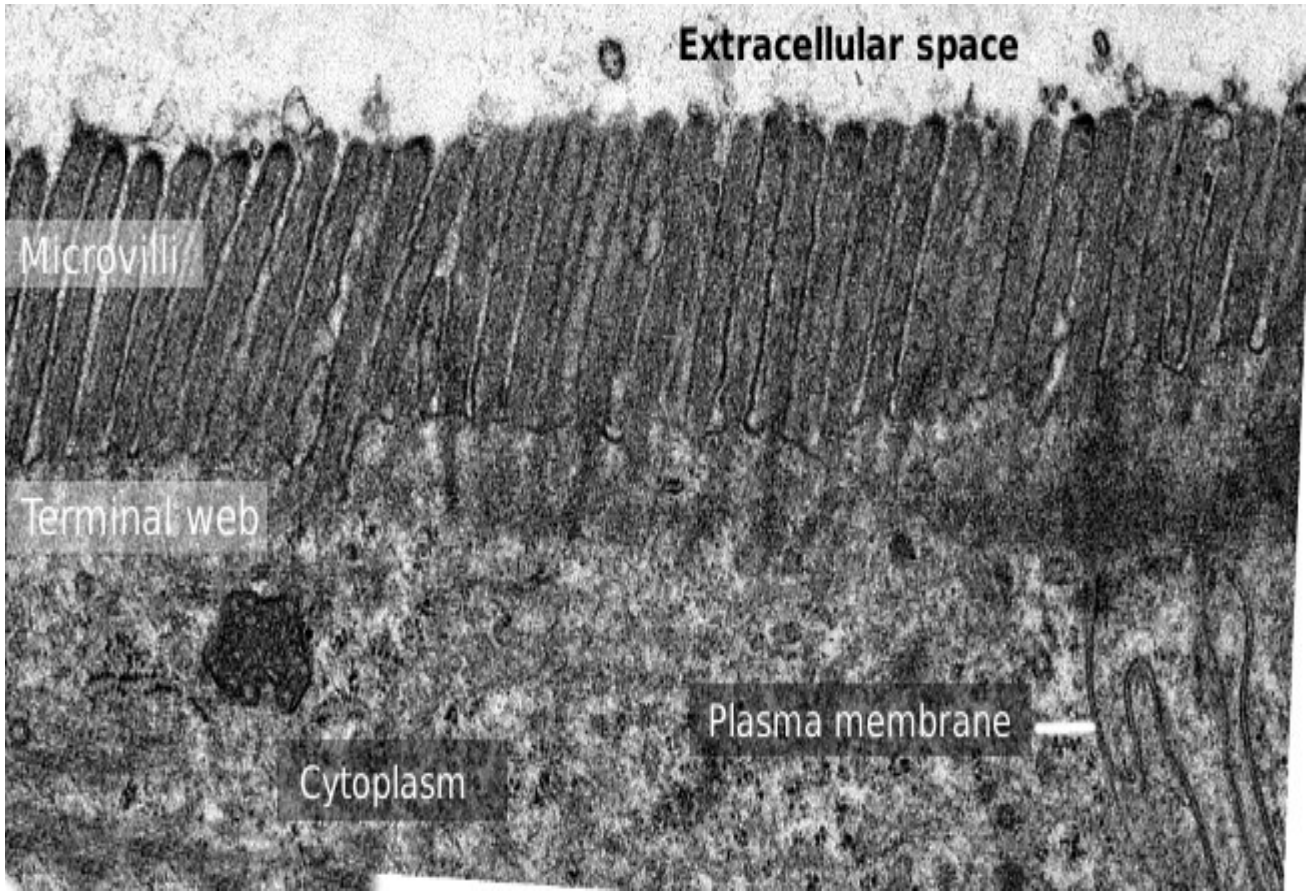


Core of microvilli

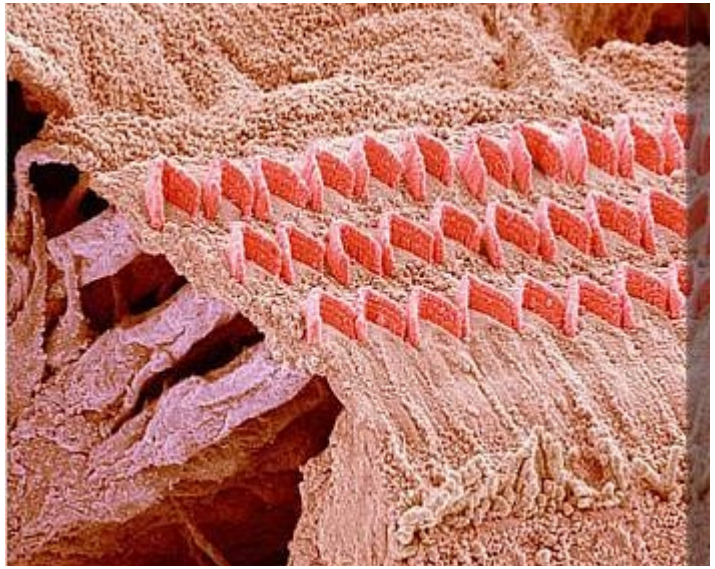
Provide stiffness for microvilli



Stabilize membranes

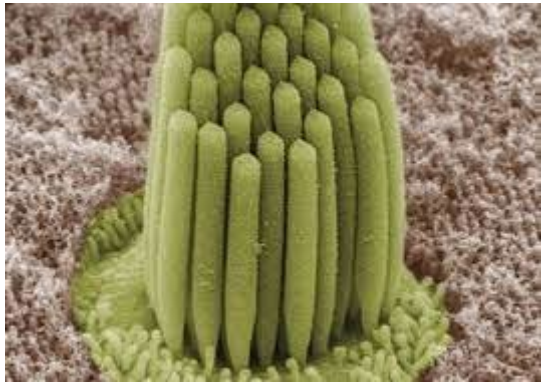


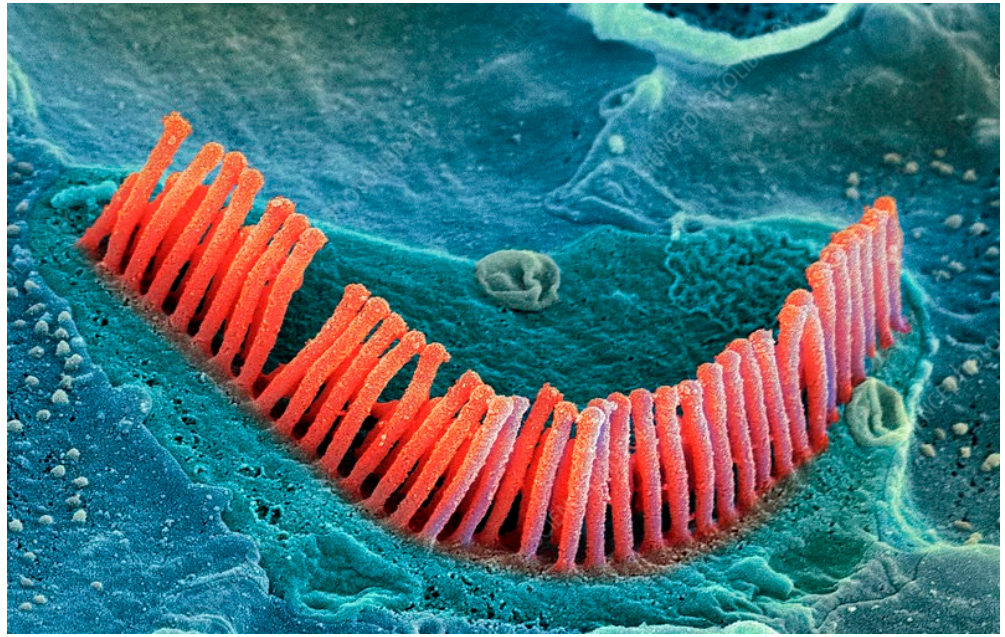
Stereocilia



Hair cells of inner ear

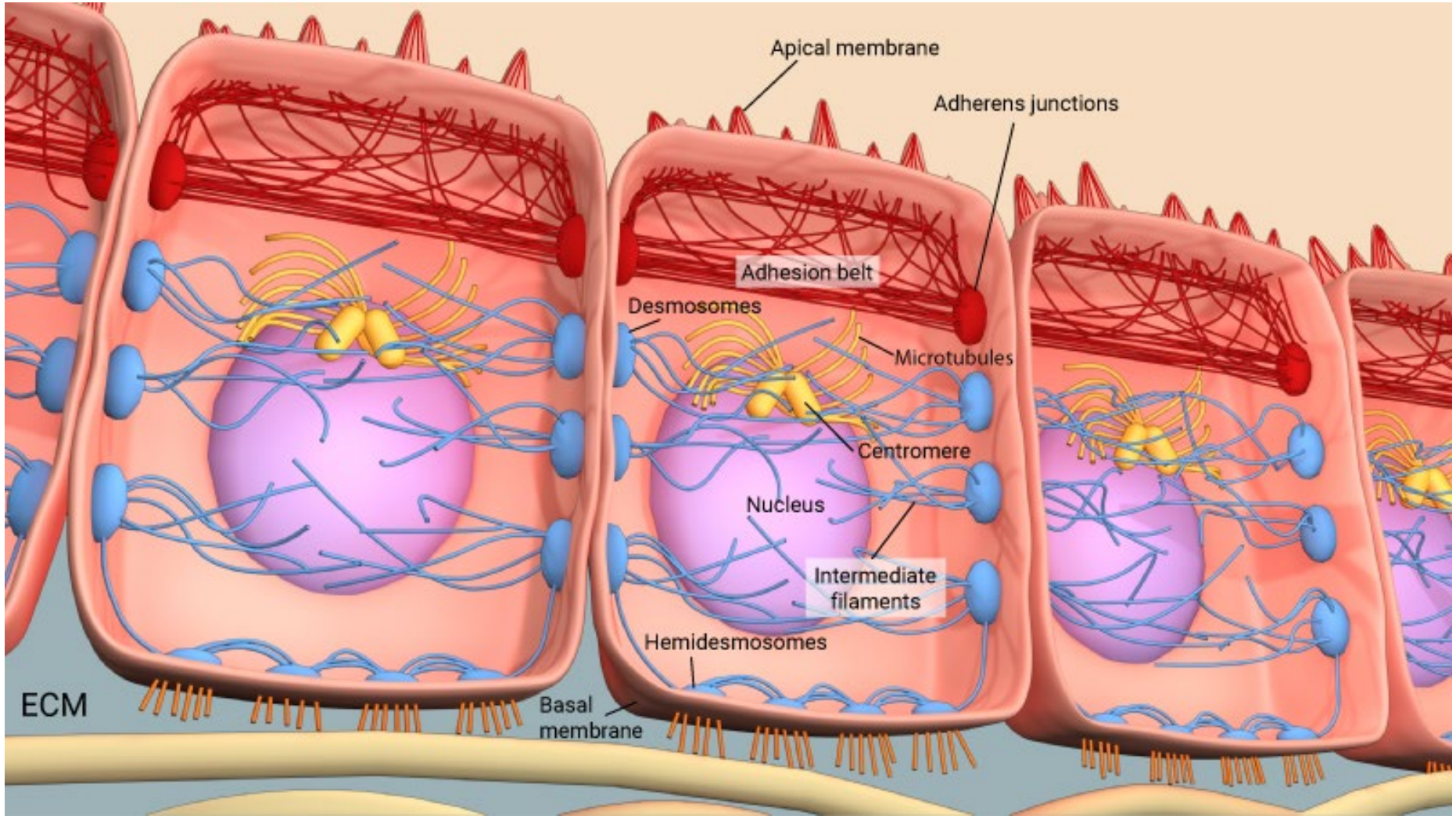
Structurally, they are actually large **microvilli**, filled with actin. Sensitive to mechanical disruption (tension-gated channels); hair cells of inner ear.





Cell adhesion

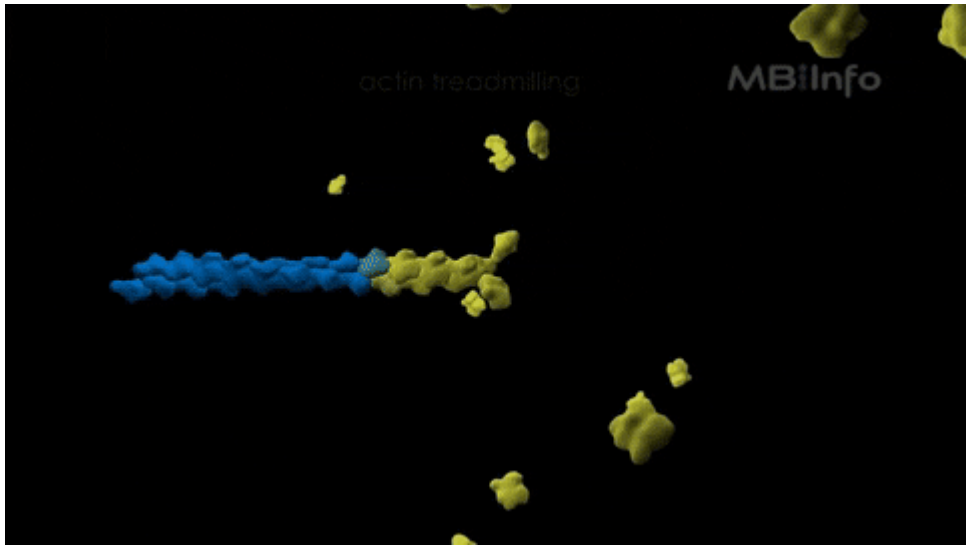
Forms a *cell cortex* that gives the cell mechanical strength and attaches to other cells.

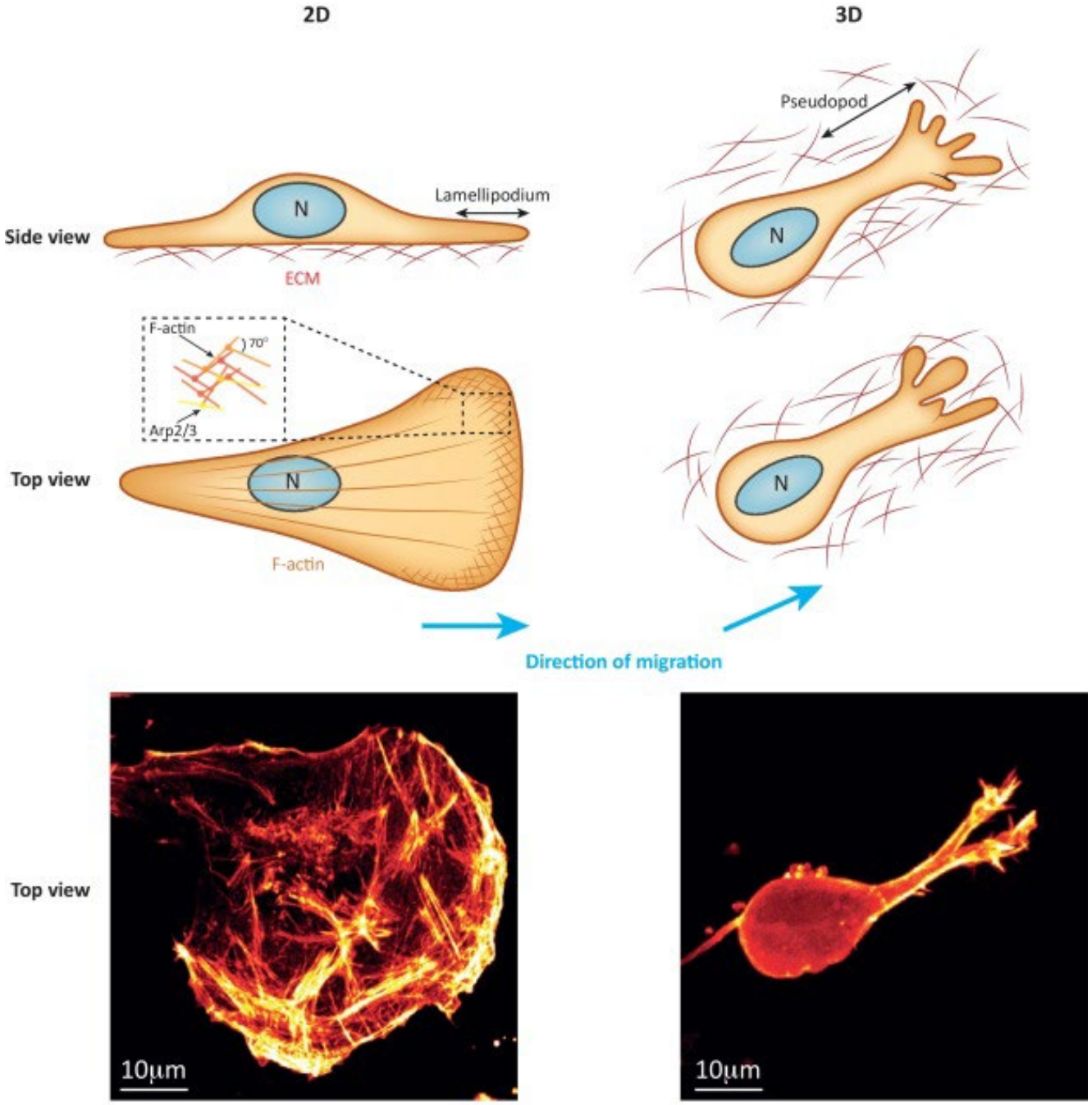


Red: actin microfilaments
Blue: intermediate filaments
Yellow: microtubules

Cell migration

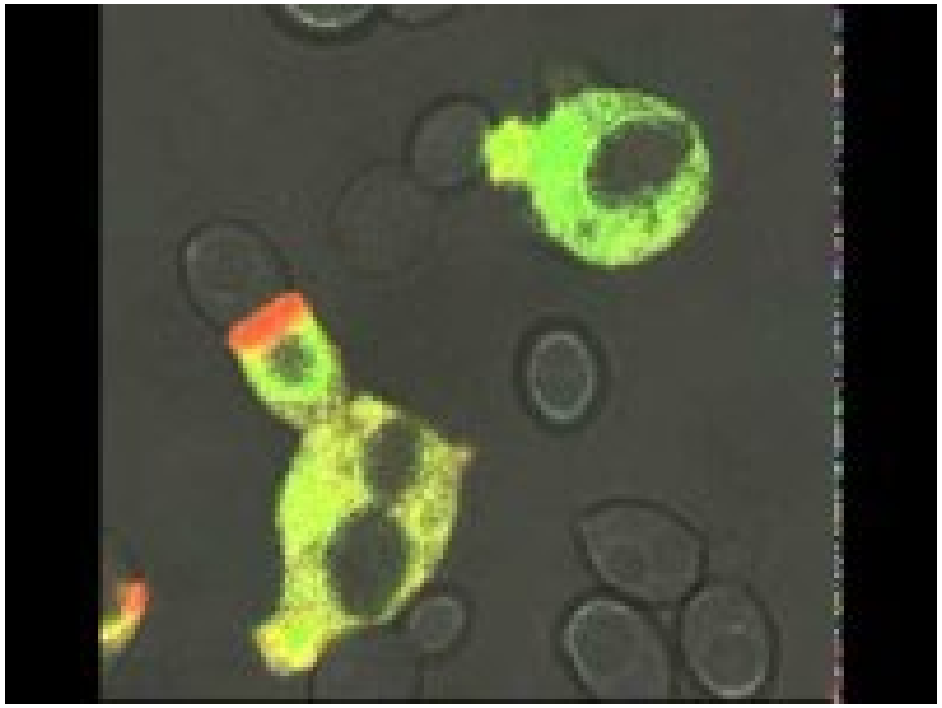
Attachment to substrate re-organizes actin network to produce movement in that direction by sticking to ECM



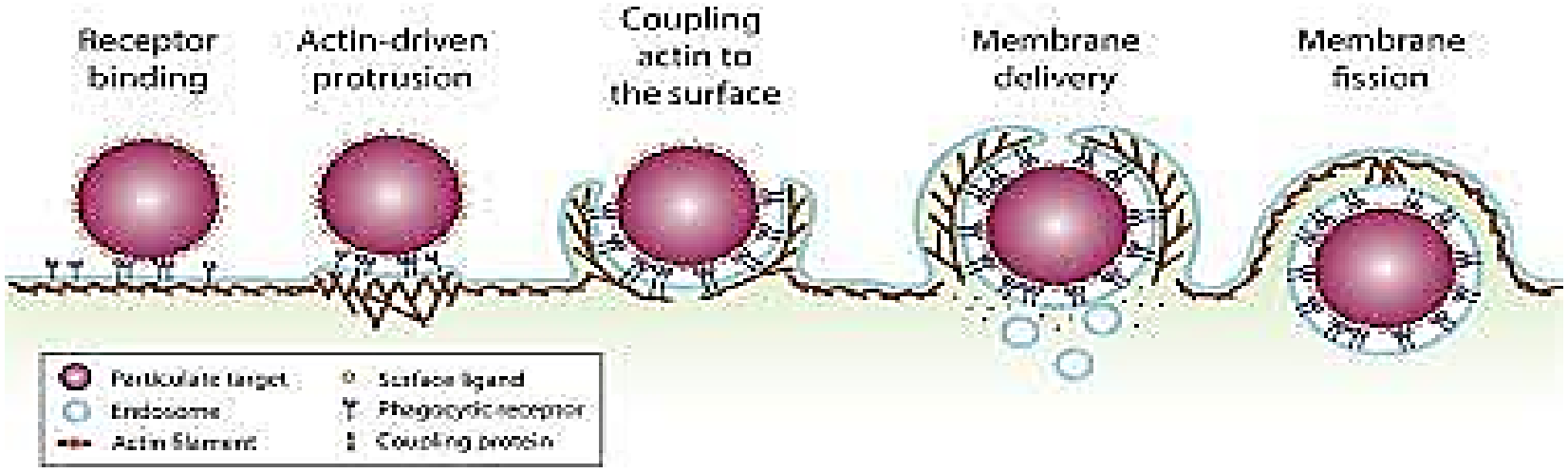


Phagocytosis

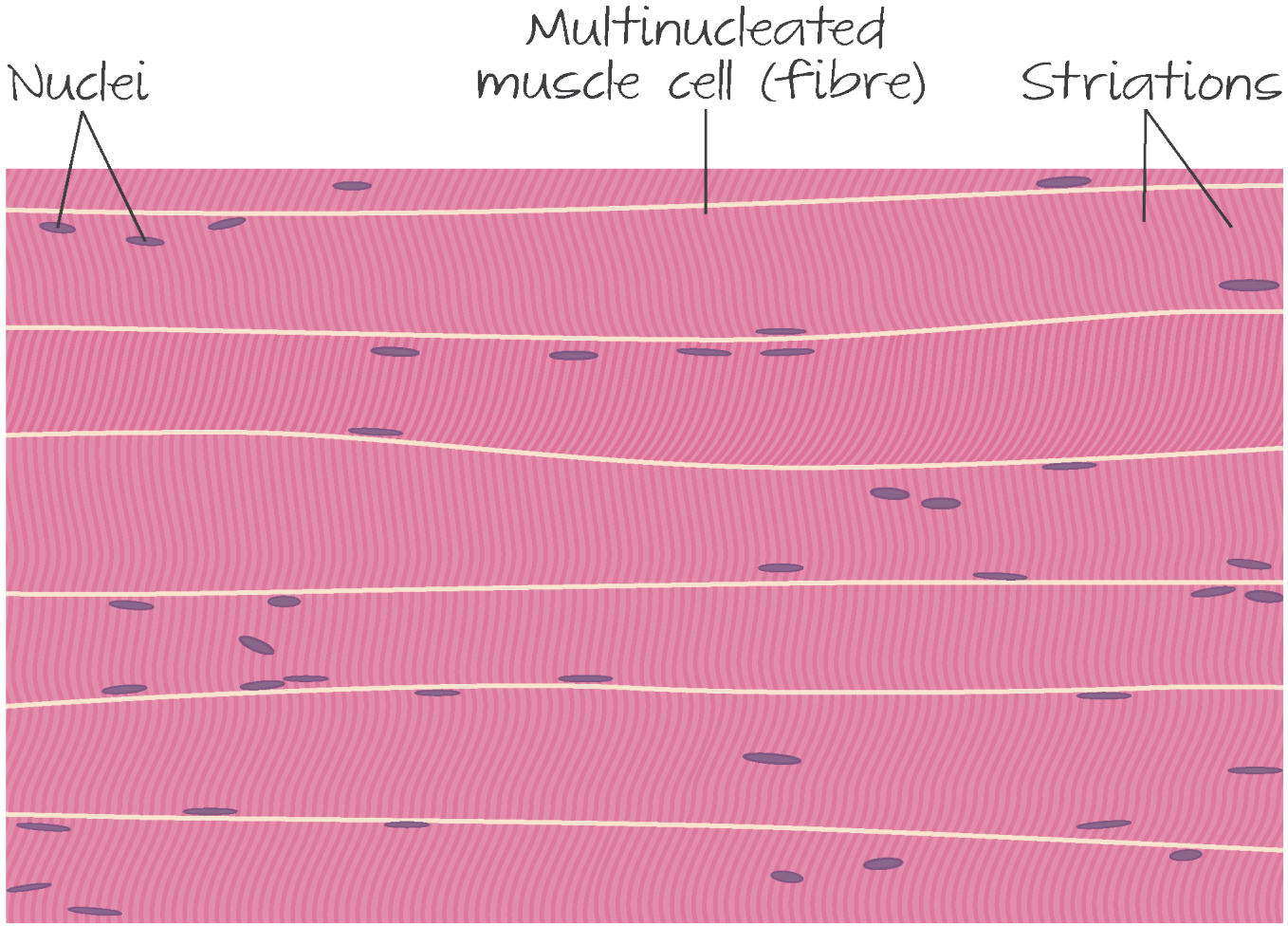
Used by neutrophils to engulf foreign particles. Actin shapes the pseudopods.

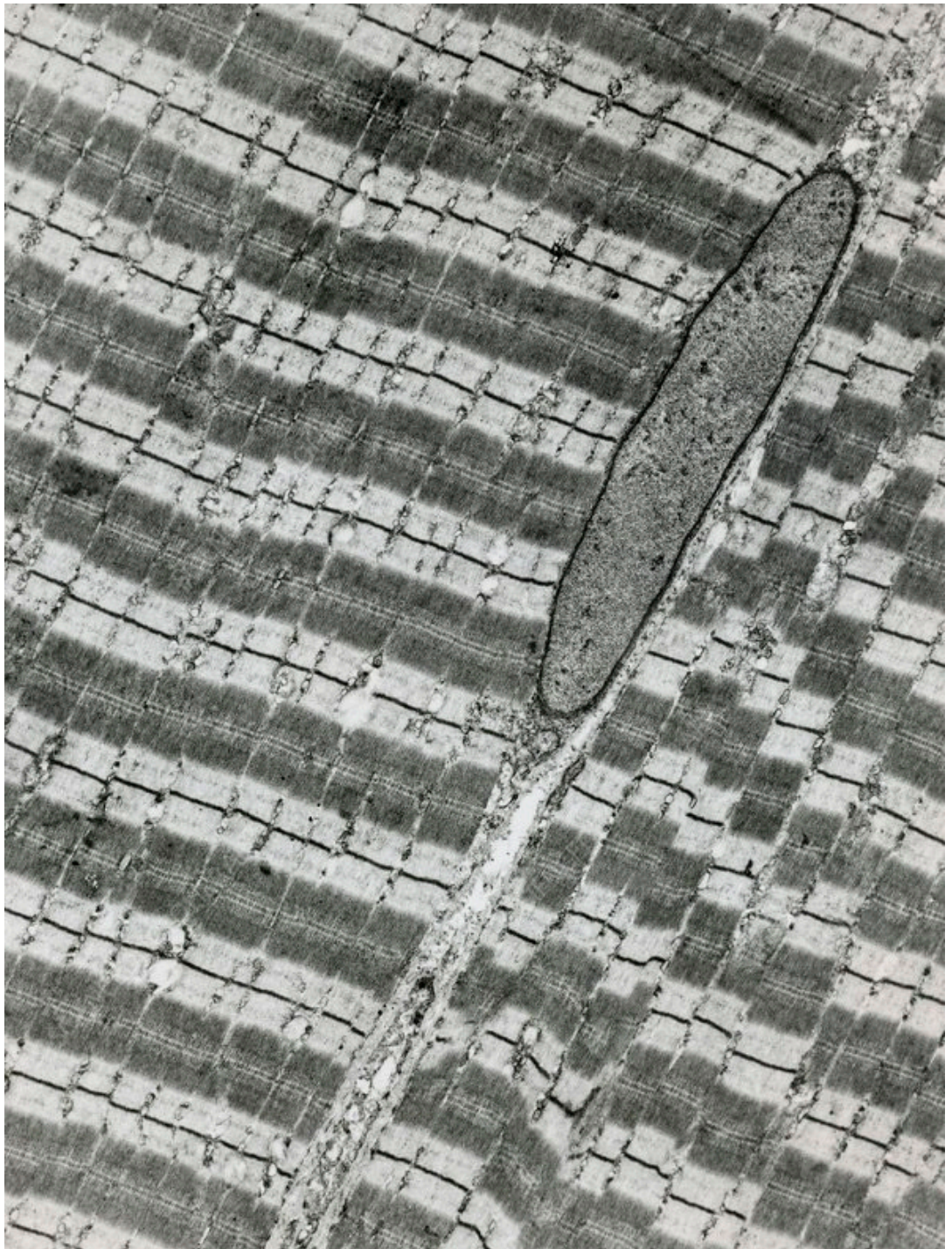


Yeast engulfing particle



Skeletal Muscle

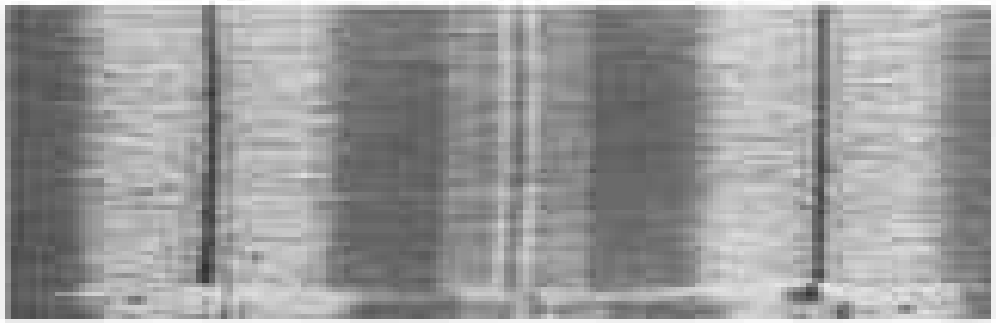




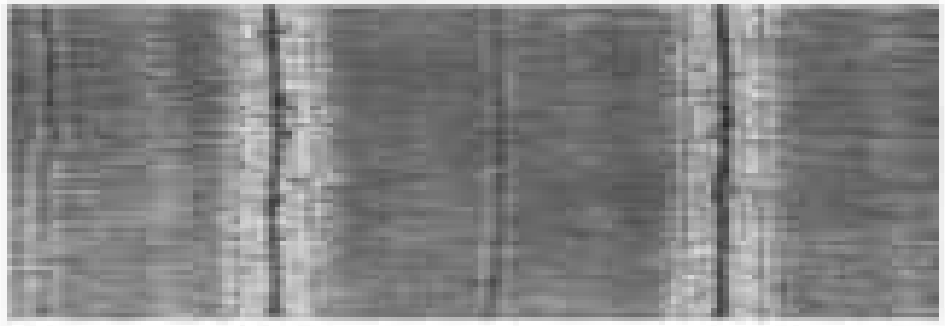
Muscle contraction

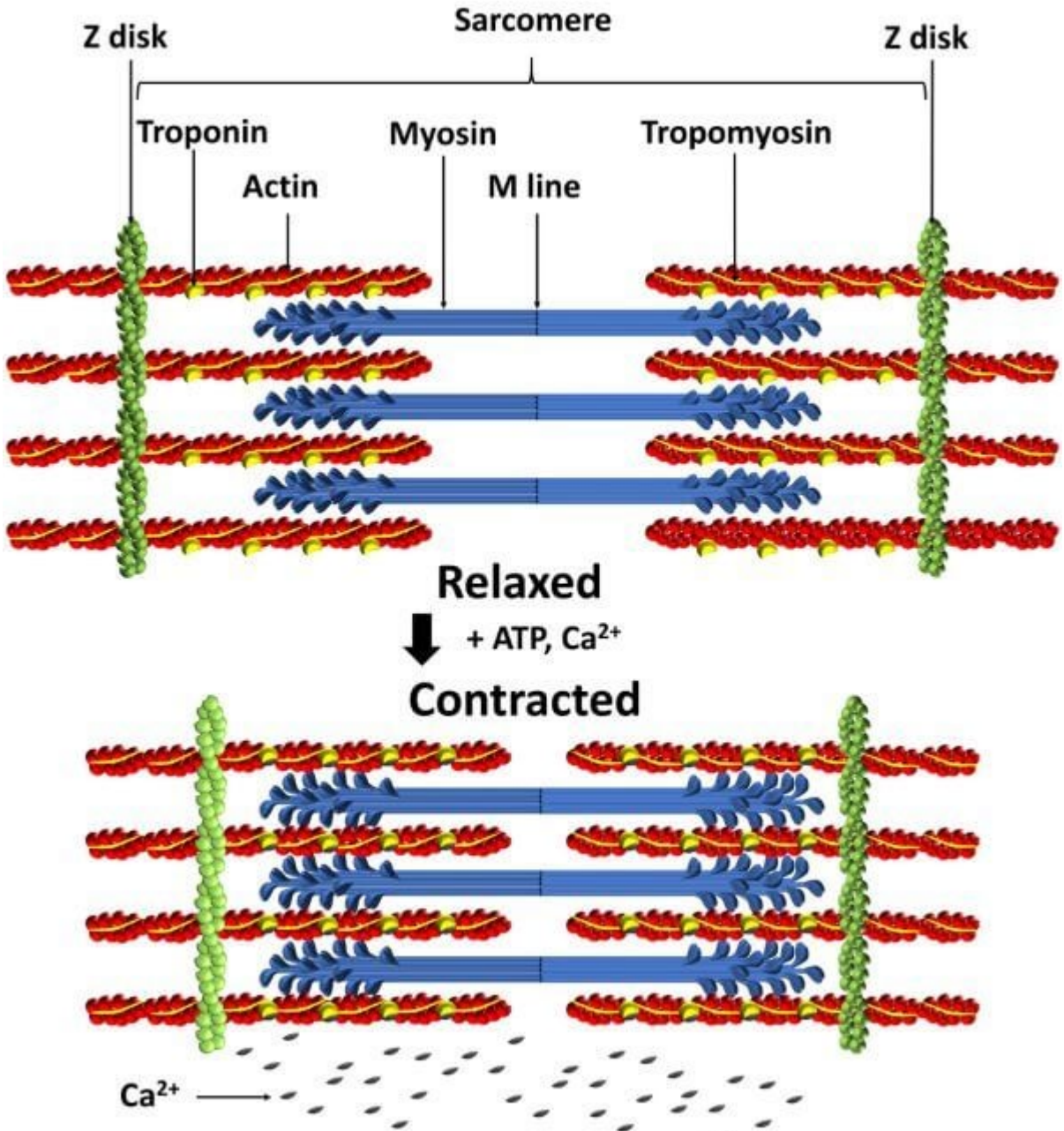
Actin interacts with other, thick, **myosin** fibers to produce muscle contraction or to change shape of cell.

relaxed



contracted





Cytokinesis

Contractile ring squeezes the cells apart. Will discuss in Cell Division.