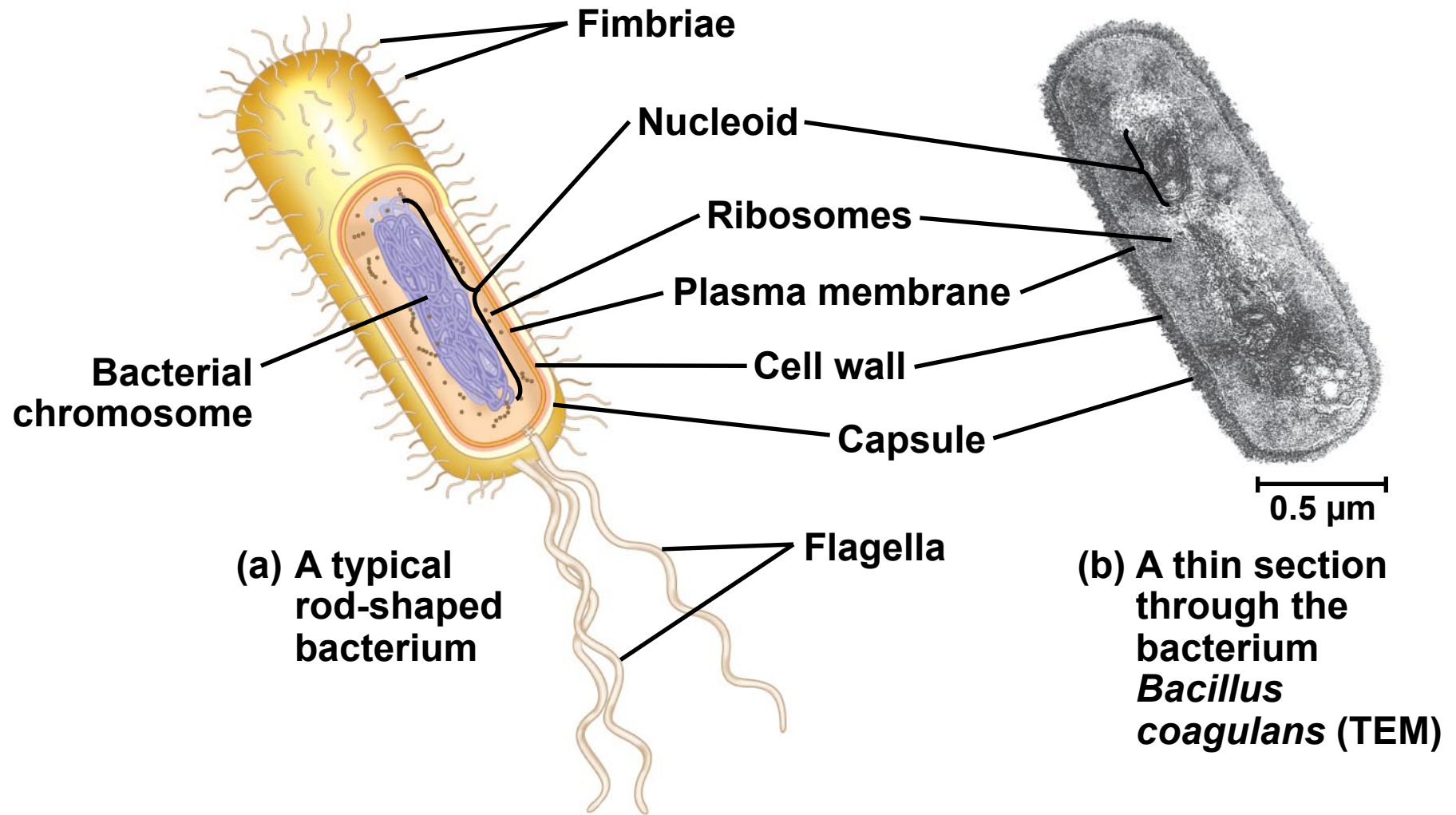
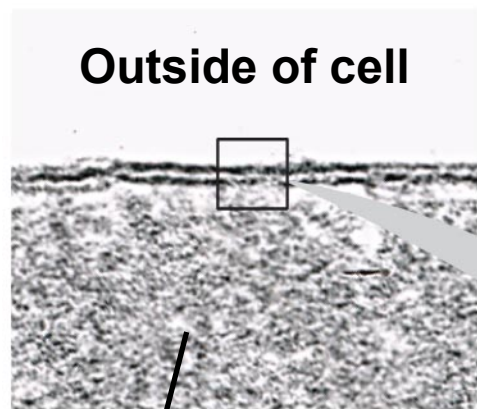


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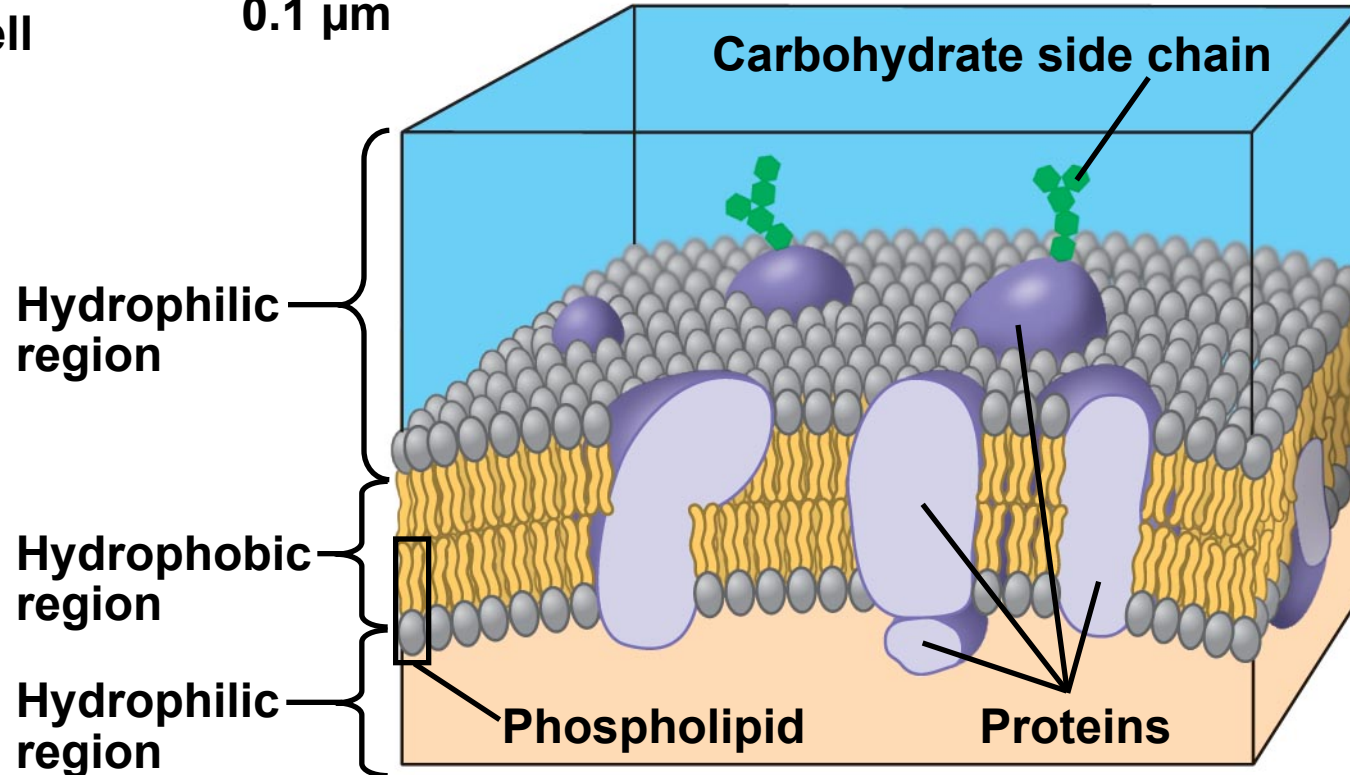


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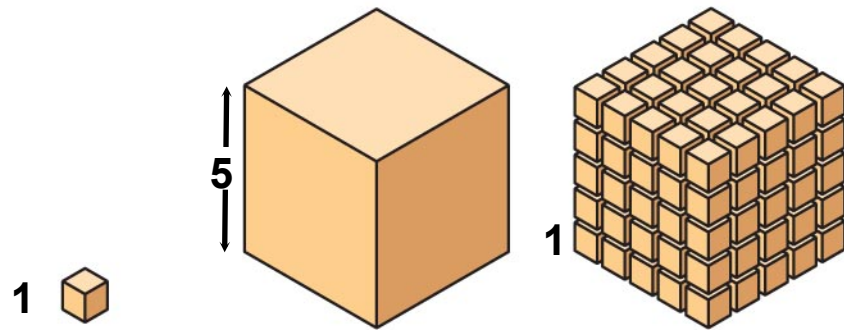
Inside of cell  
0.1  $\mu\text{m}$

(a) TEM of a plasma membrane

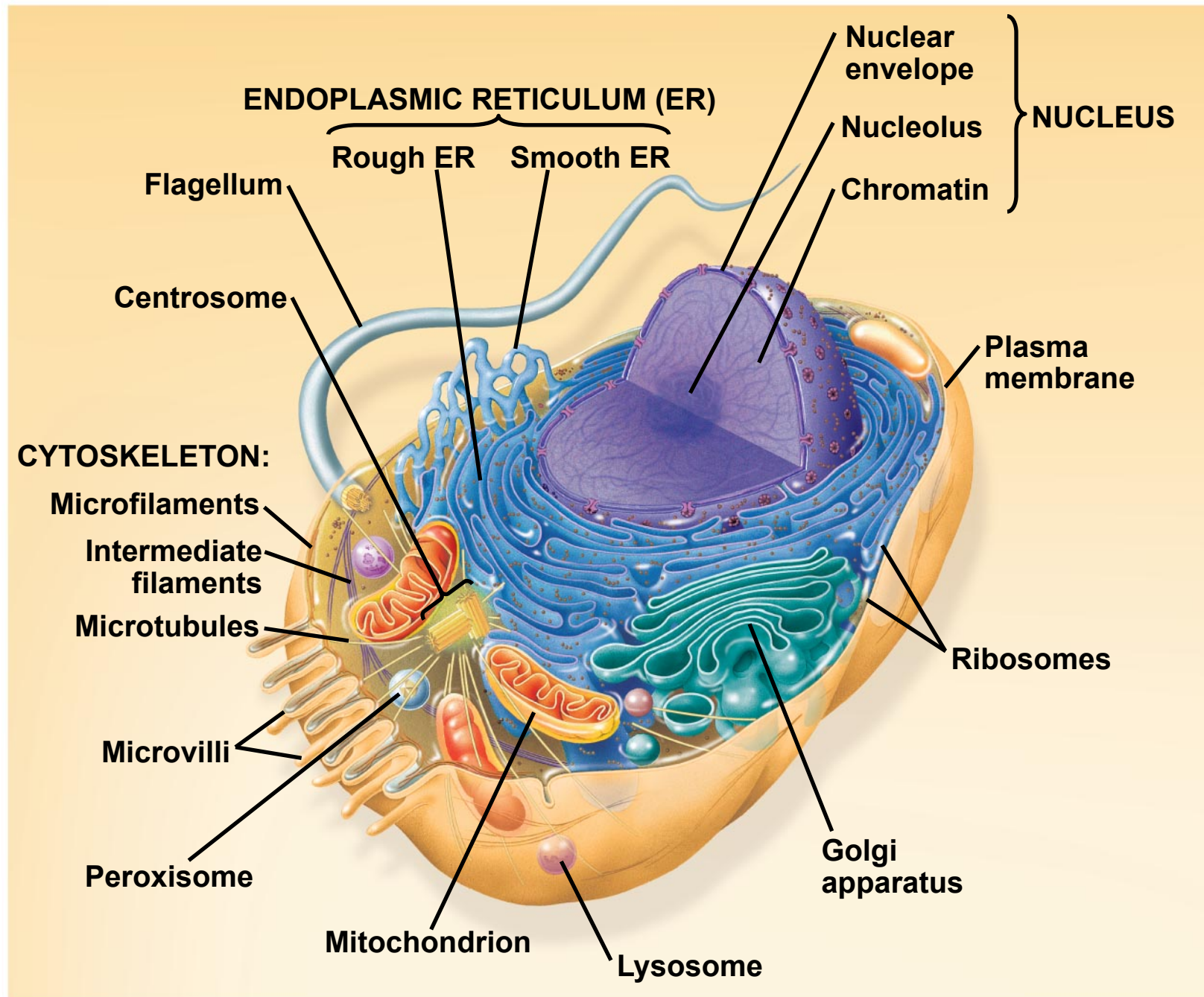


(b) Structure of the plasma membrane

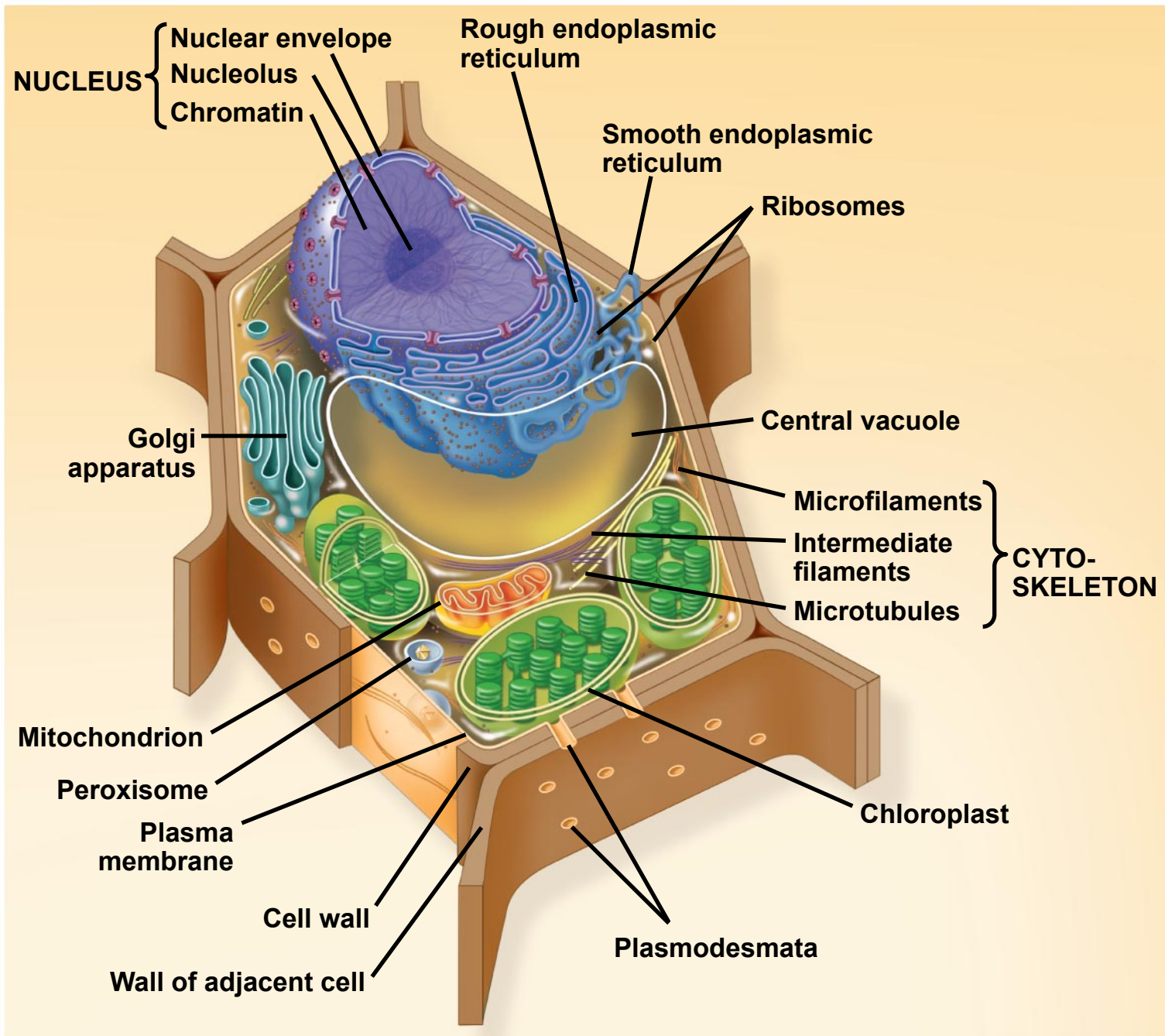
Surface area increases while  
total volume remains constant

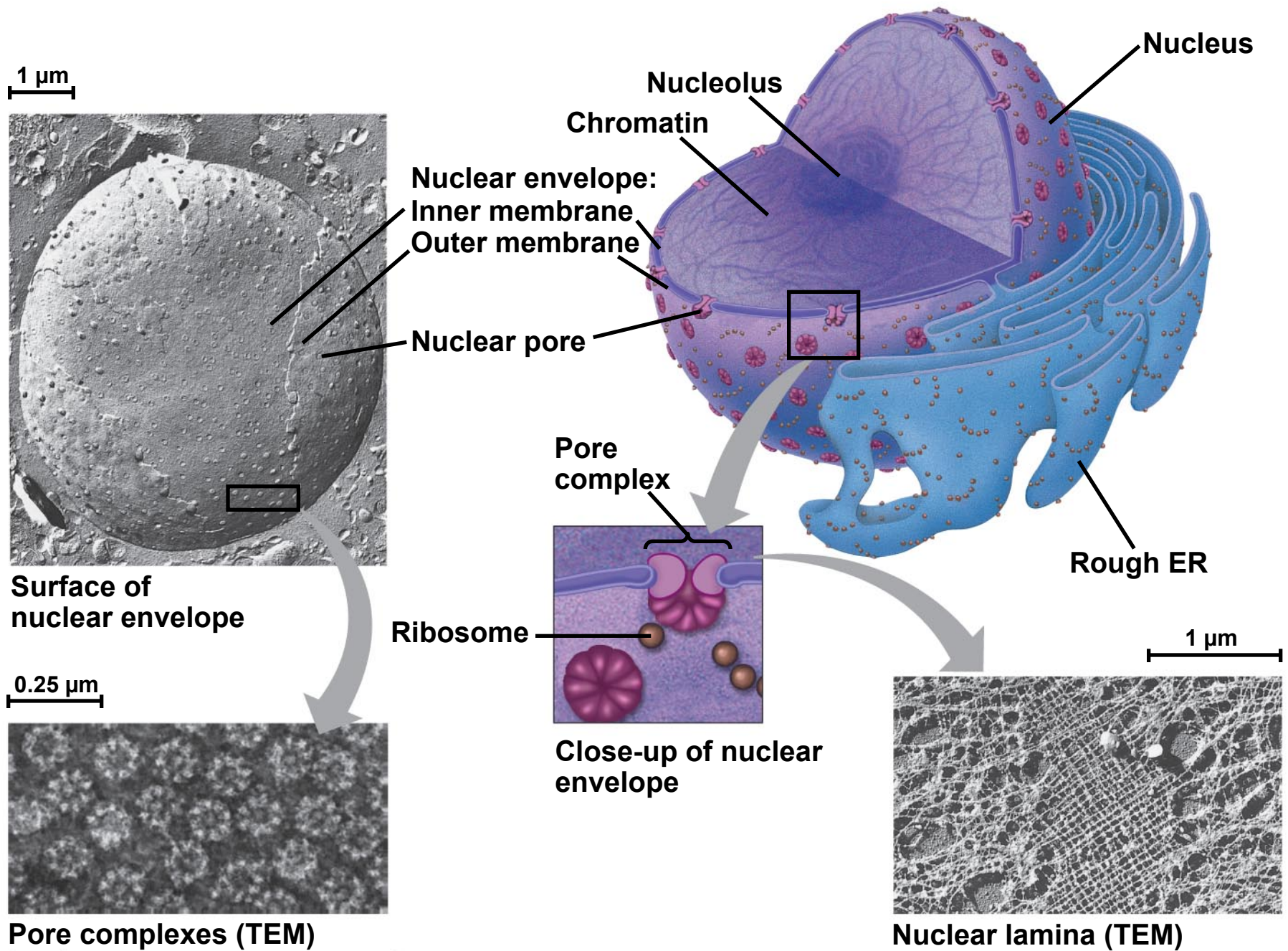


<b>Total surface area</b> [Sum of the surface areas (height × width) of all boxes sides × number of boxes]	6	150	750
<b>Total volume</b> [height × width × length × number of boxes]	1	125	125
<b>Surface-to-volume</b> (S-to-V) ratio [surface area ÷ volume]	6	1.2	6



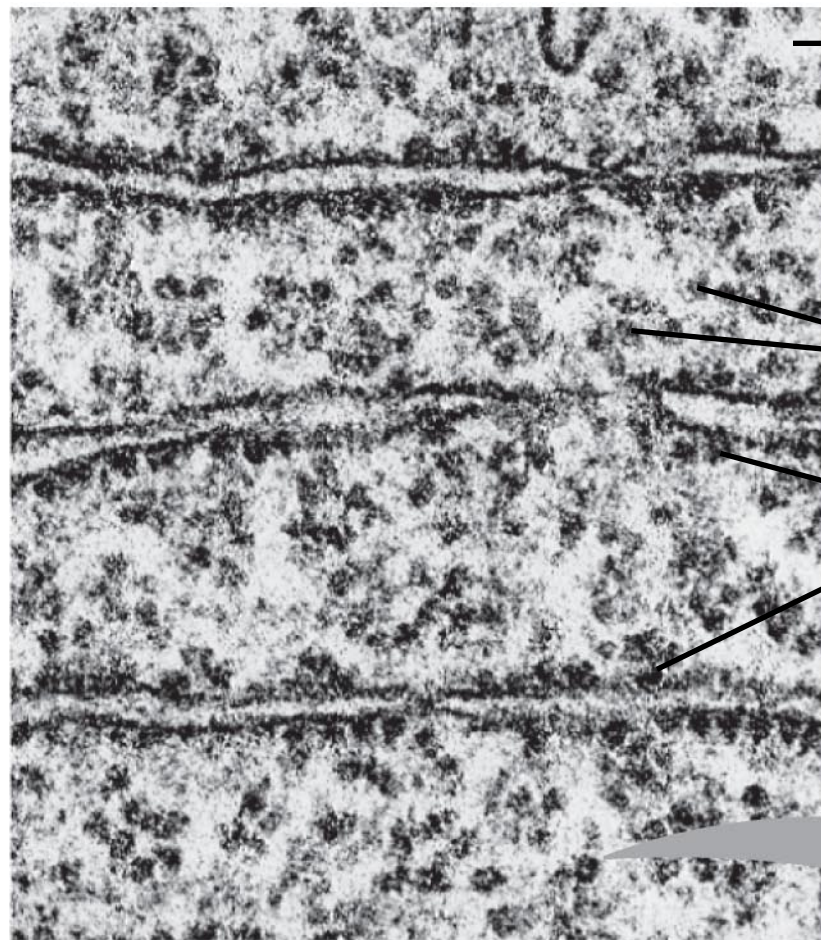






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**Cytosol**

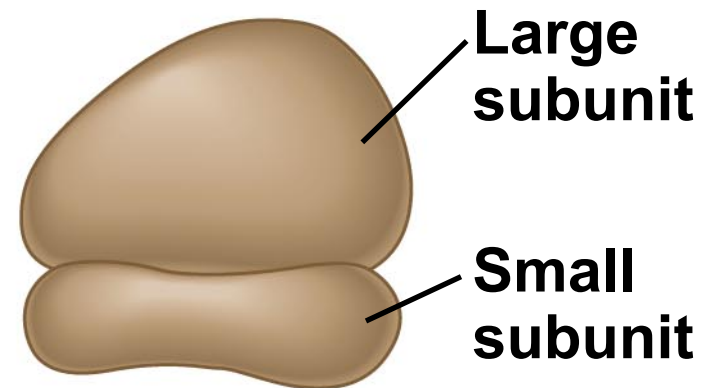
**Endoplasmic reticulum (ER)**

**Free ribosomes**

**Bound ribosomes**

**0.5 μm**

**TEM showing ER and ribosomes**



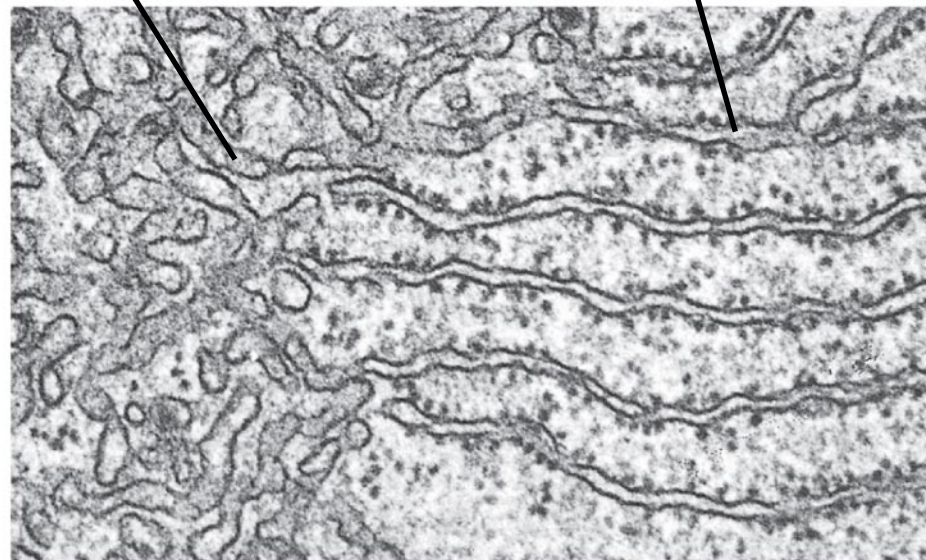
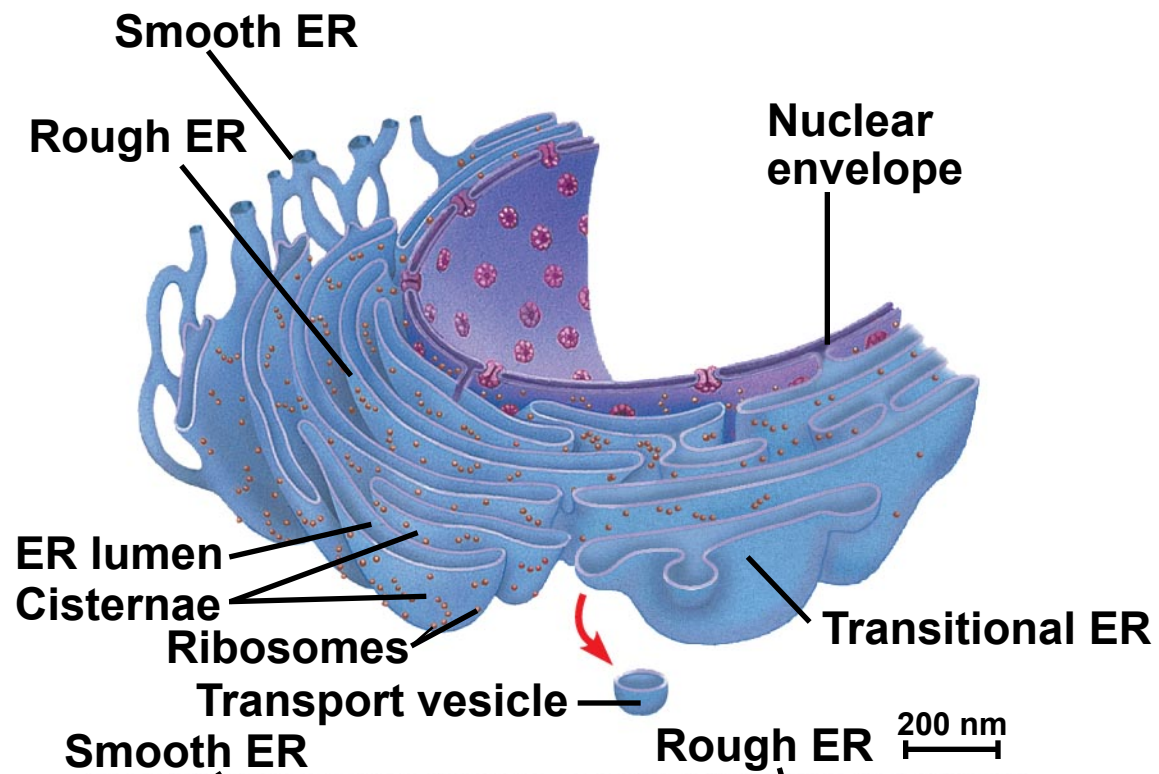
**Large subunit**

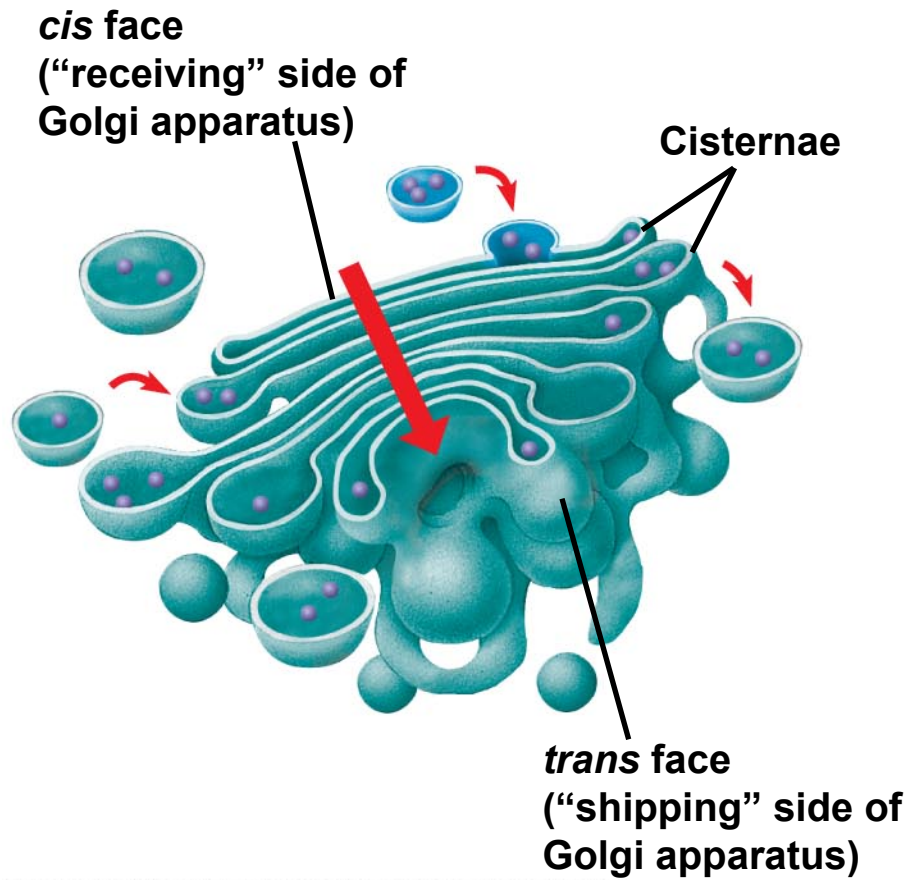
**Small subunit**

**Diagram of a ribosome**

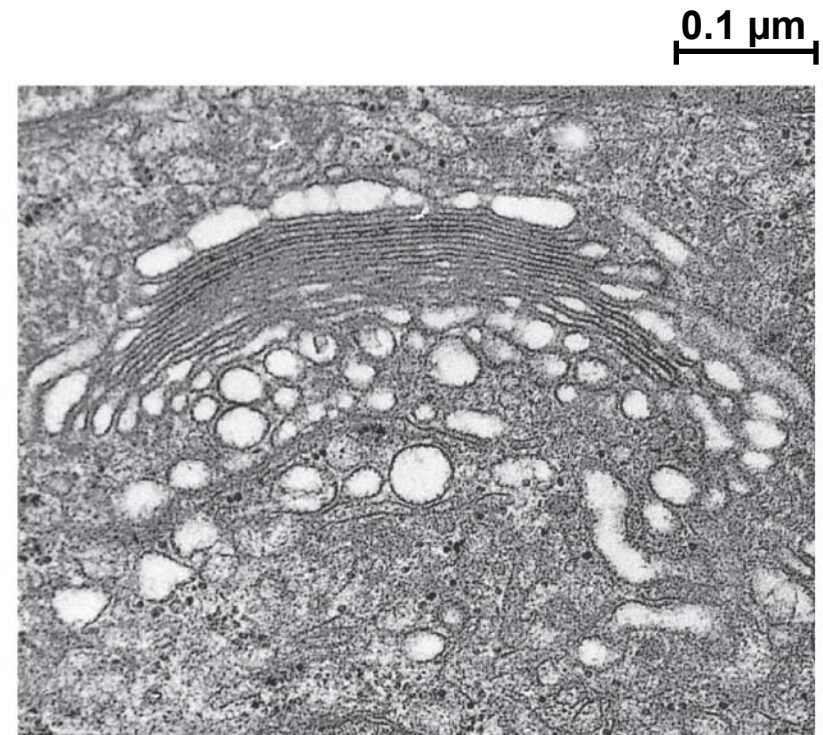
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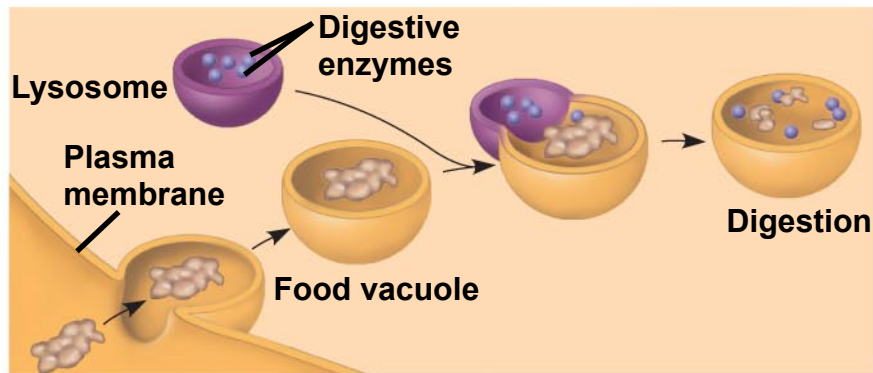
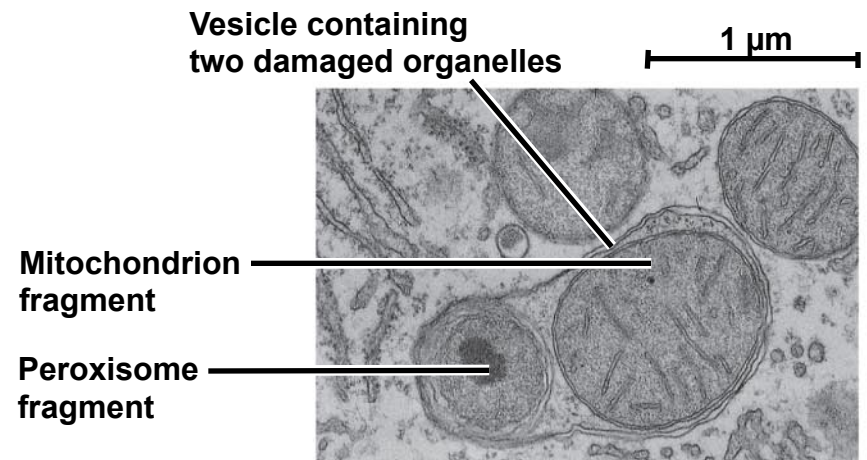
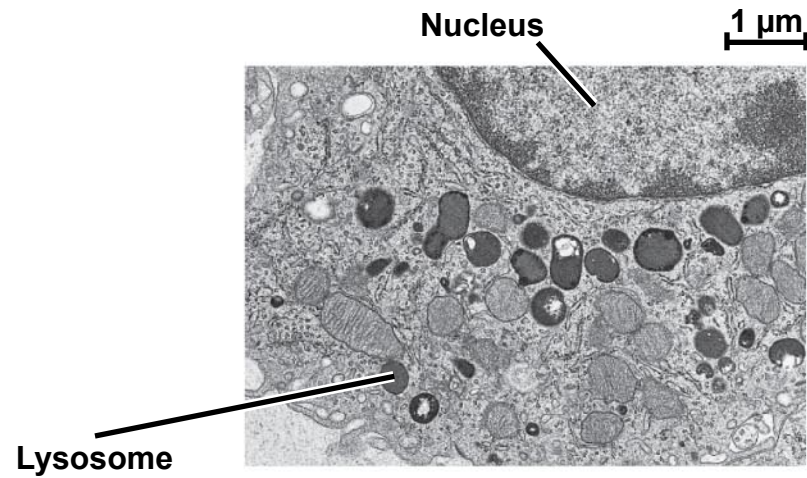




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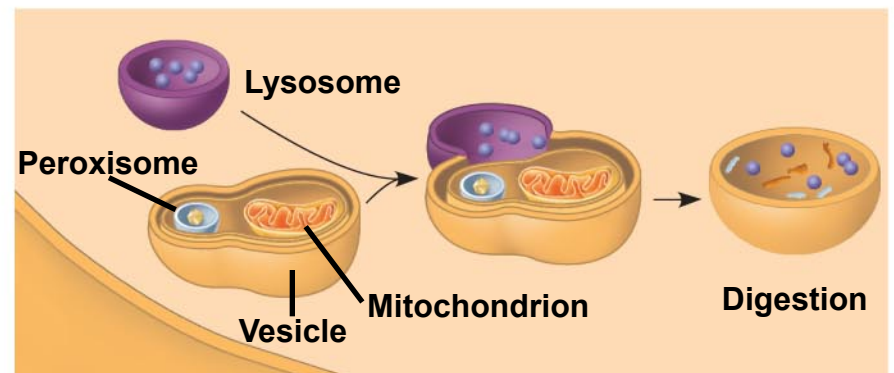


**TEM of Golgi apparatus**



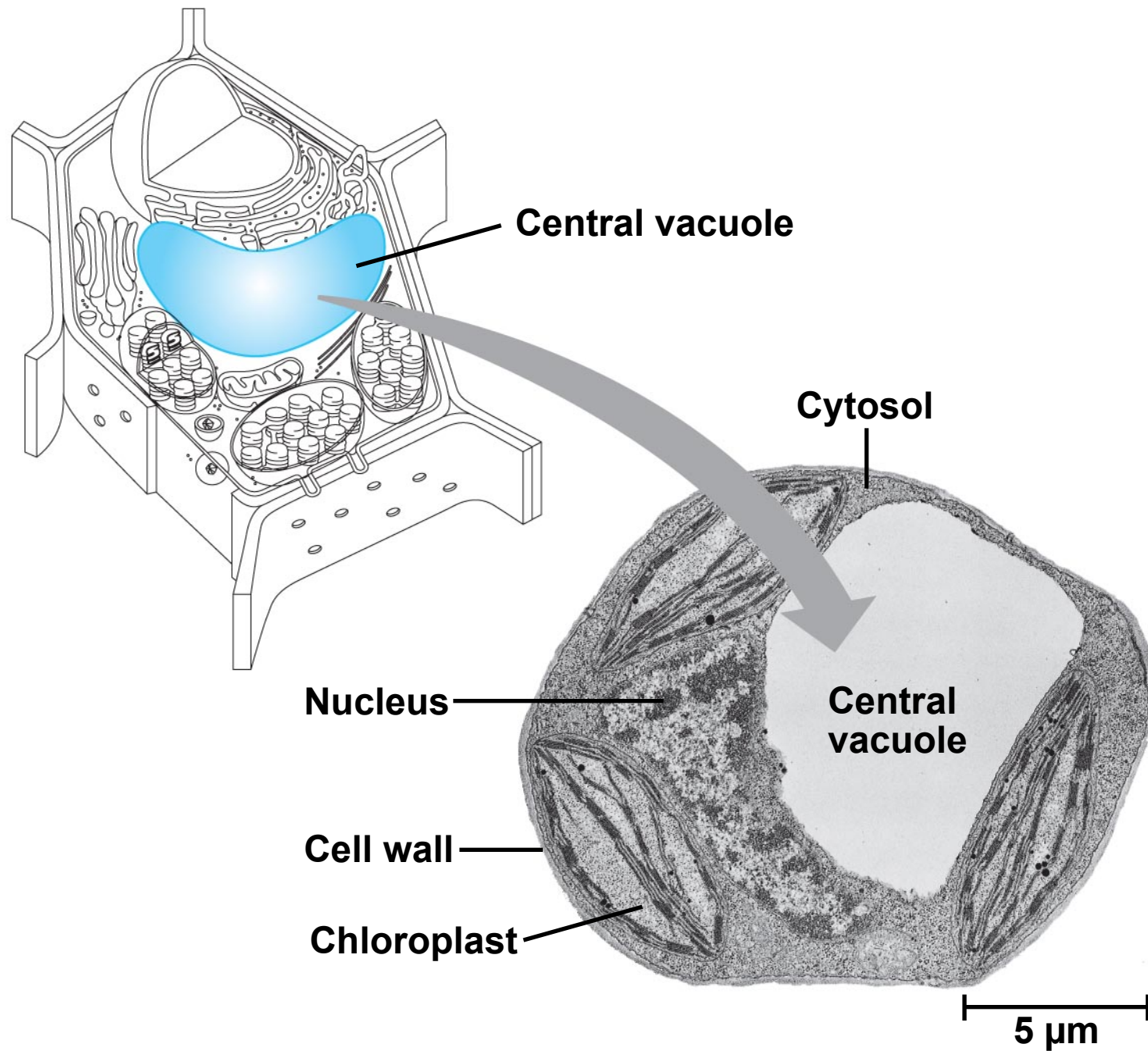
**(a) Phagocytosis**

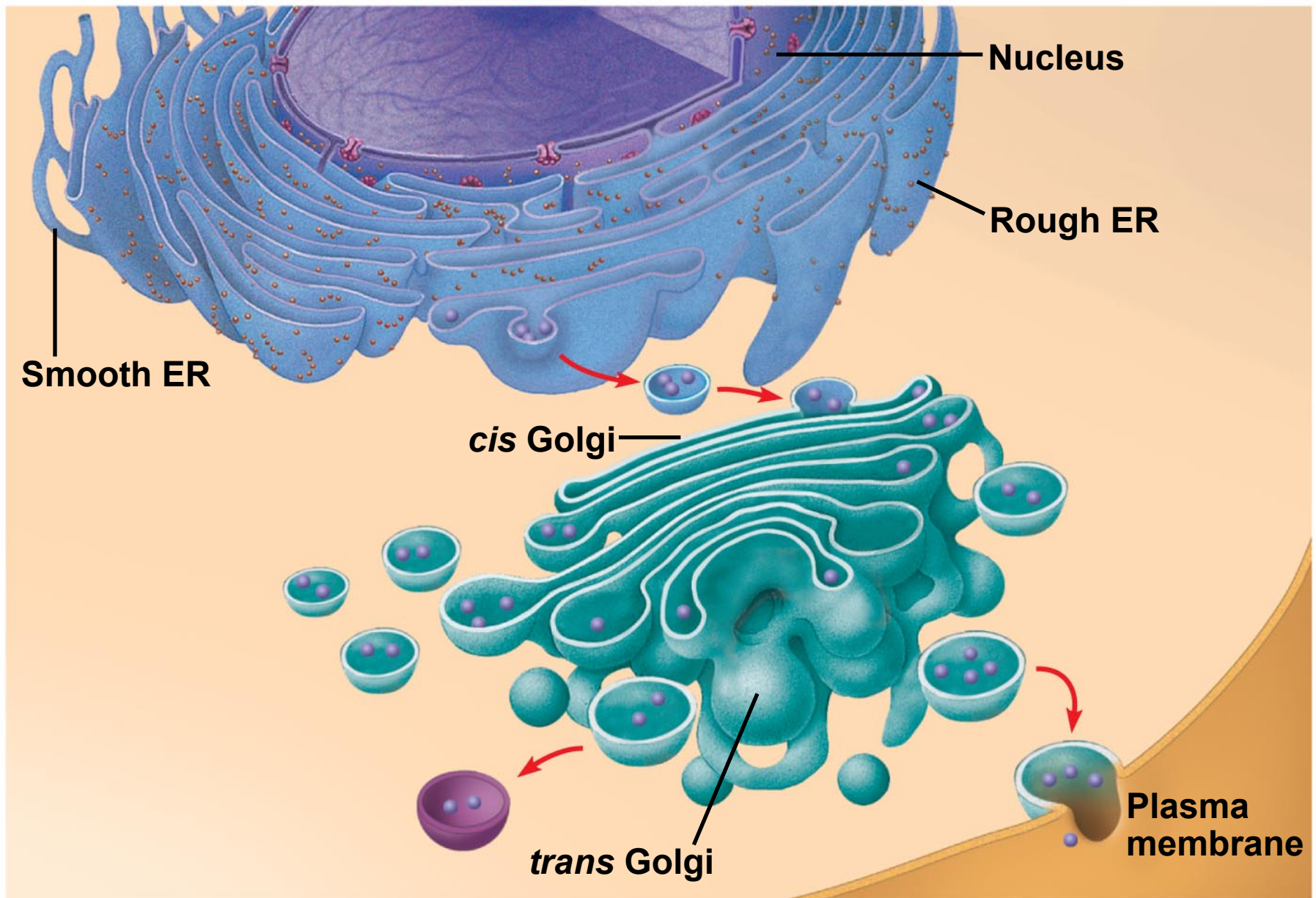
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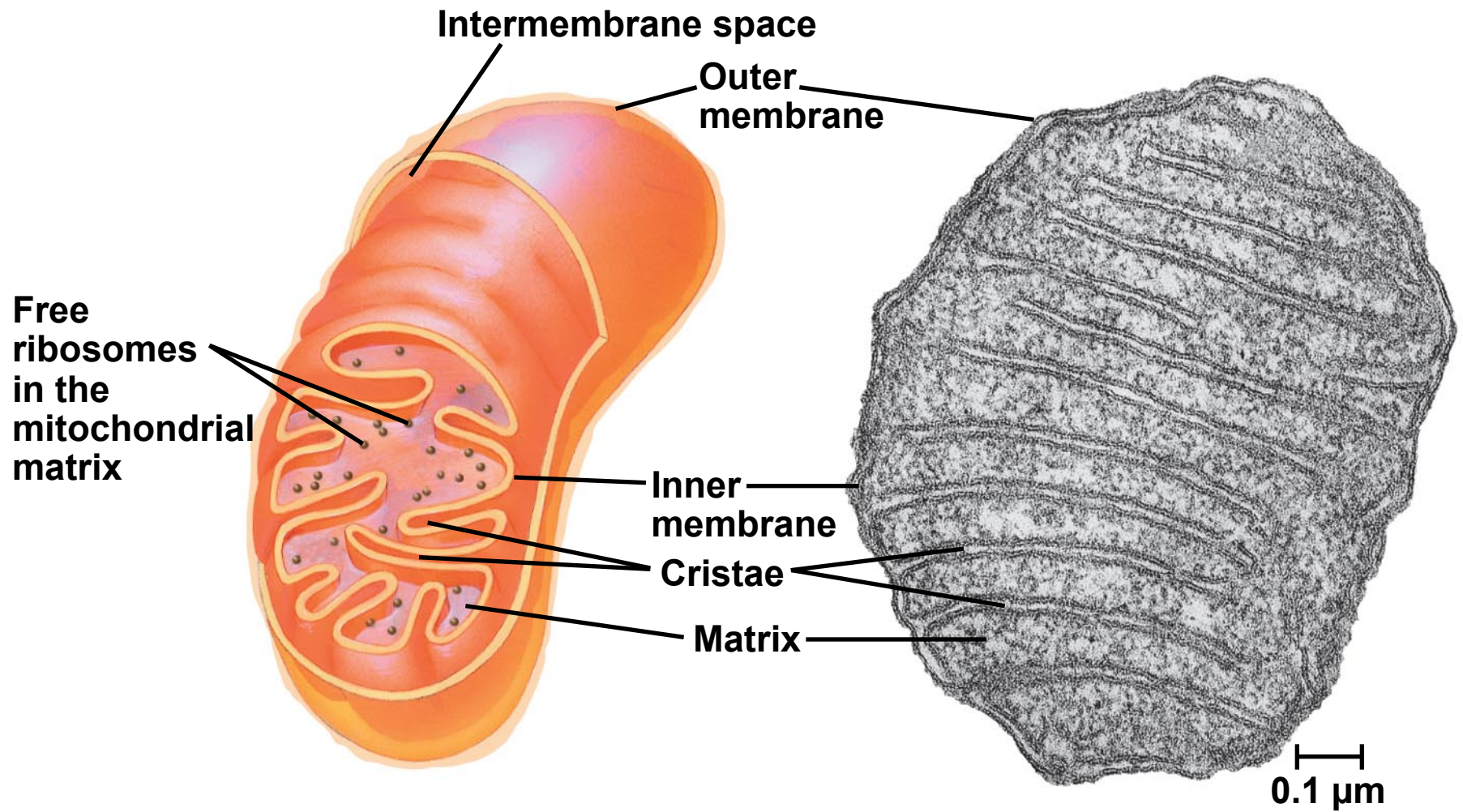
**(b) Autophagy**





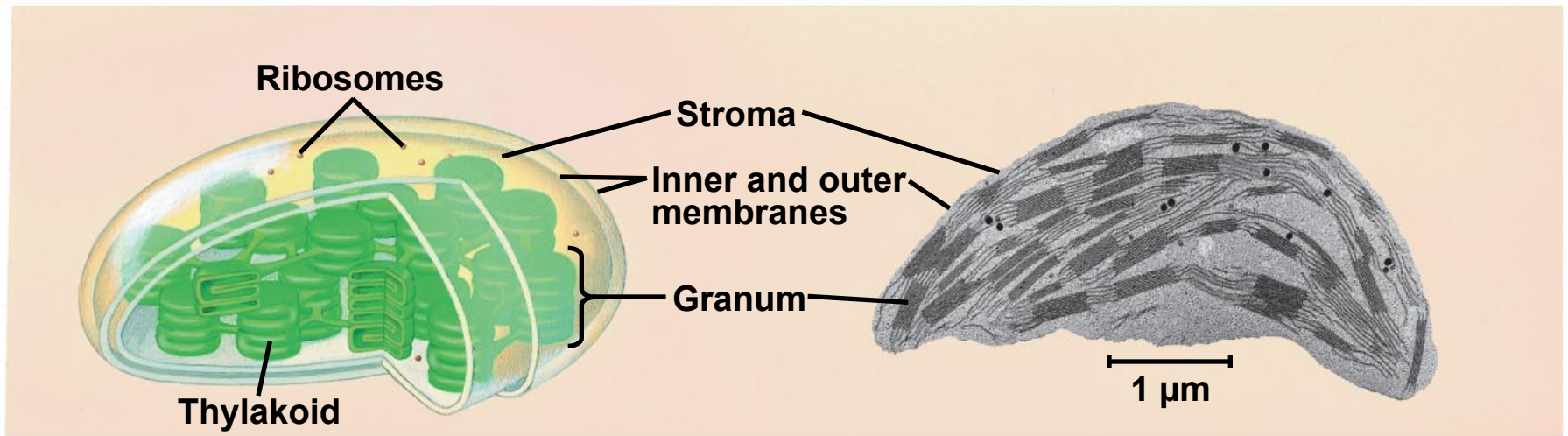




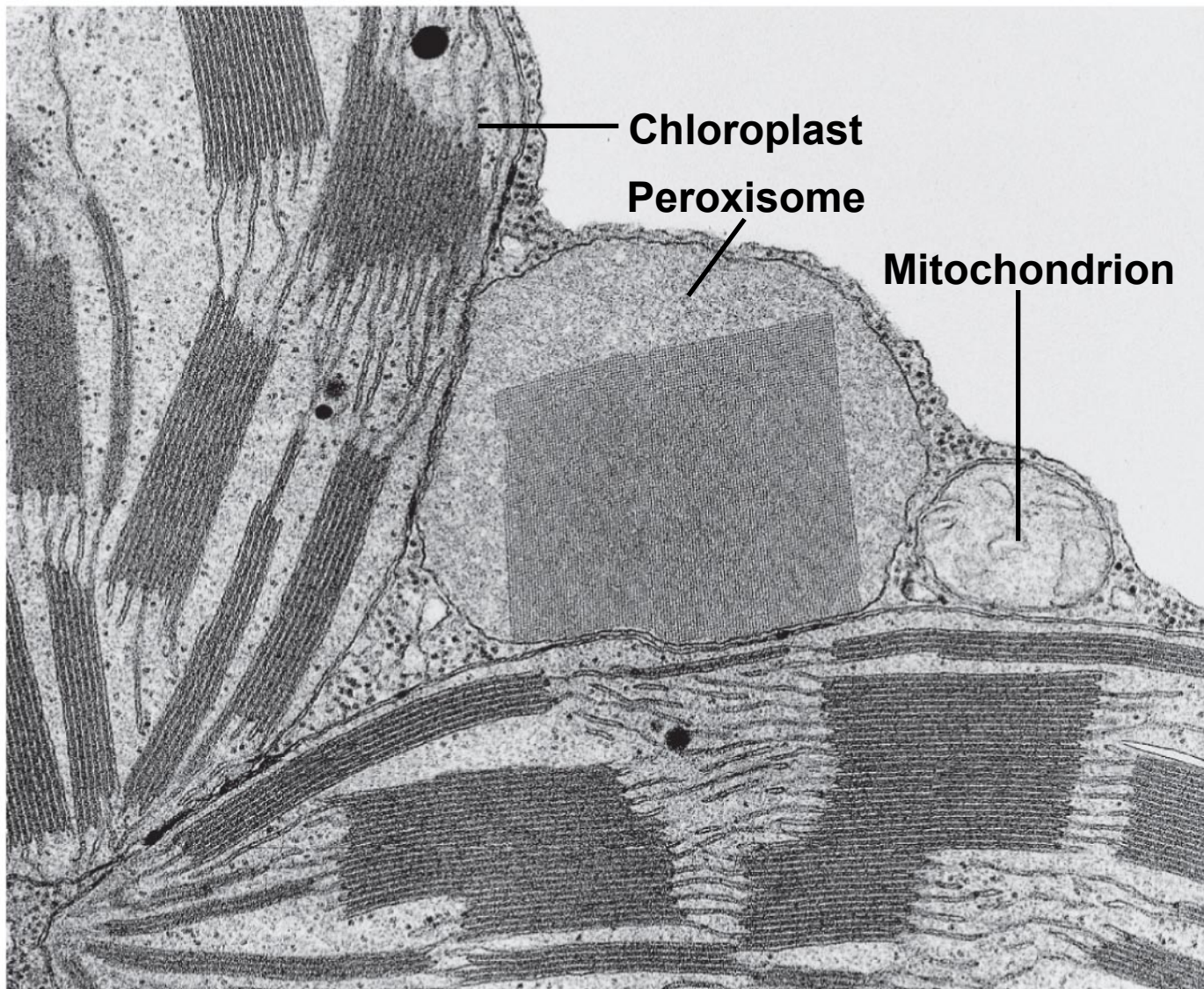


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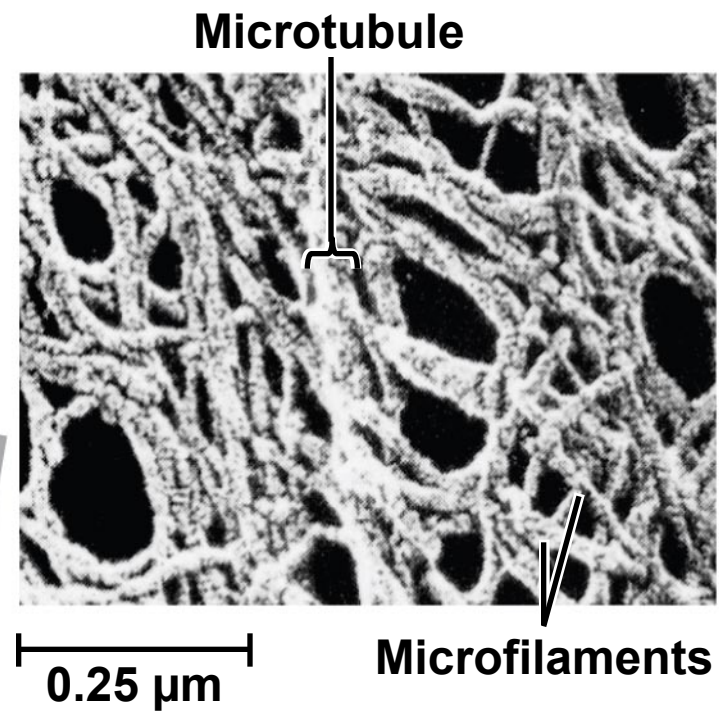
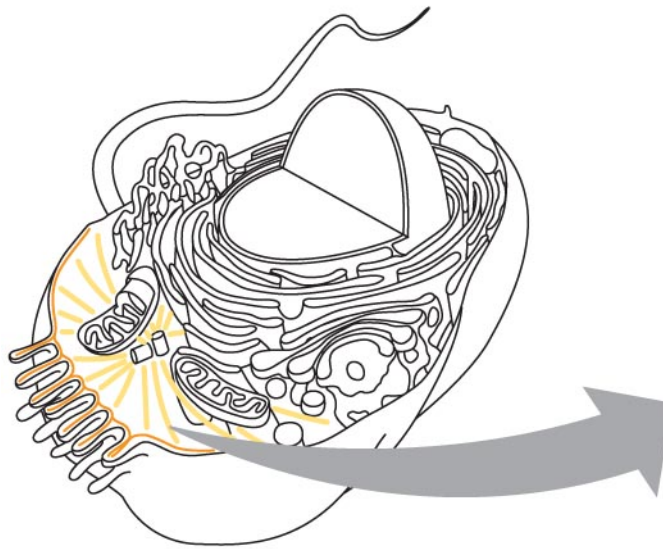




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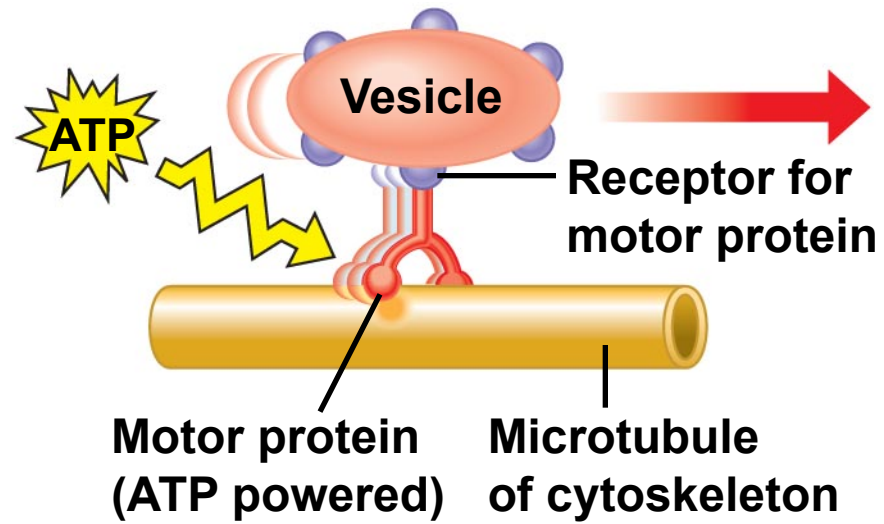


1  $\mu$ m

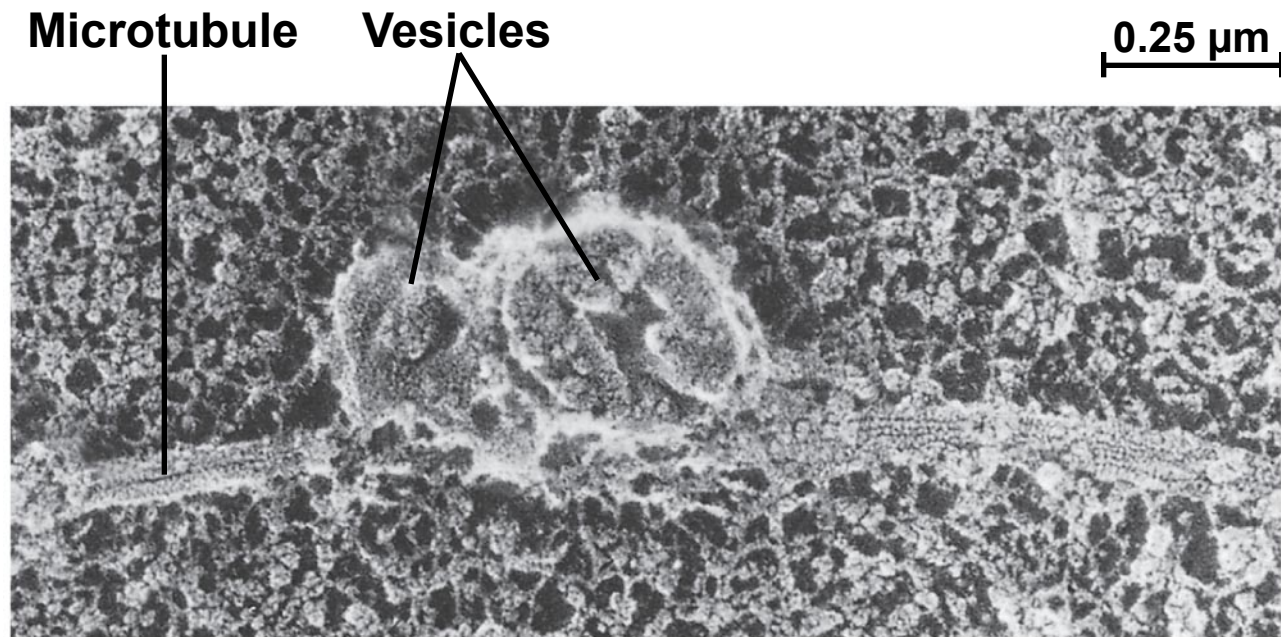


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(a)



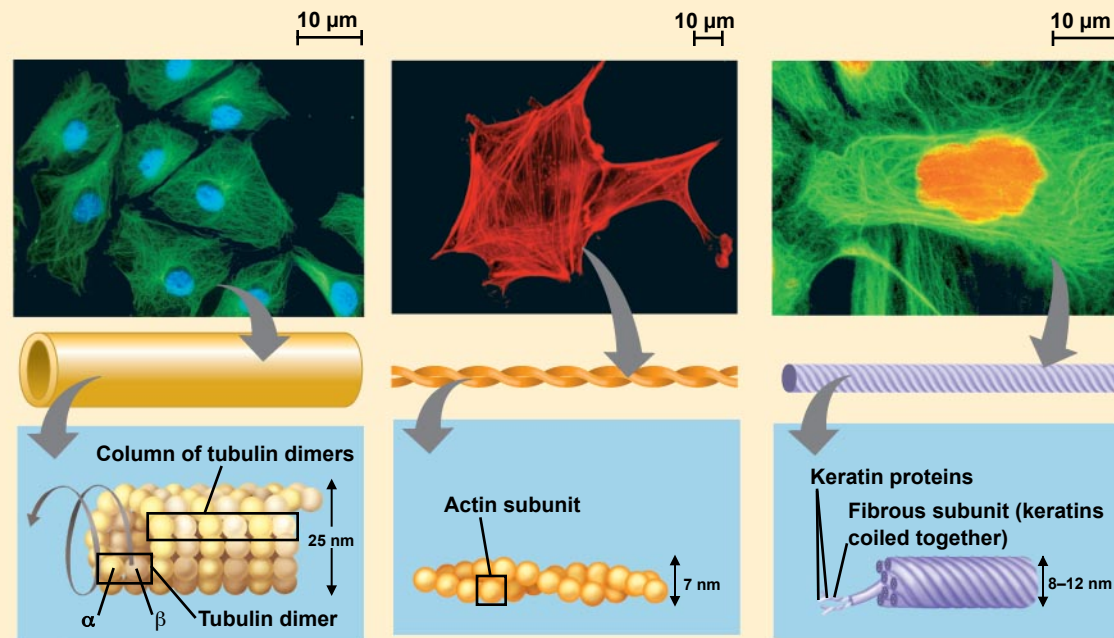
(b)

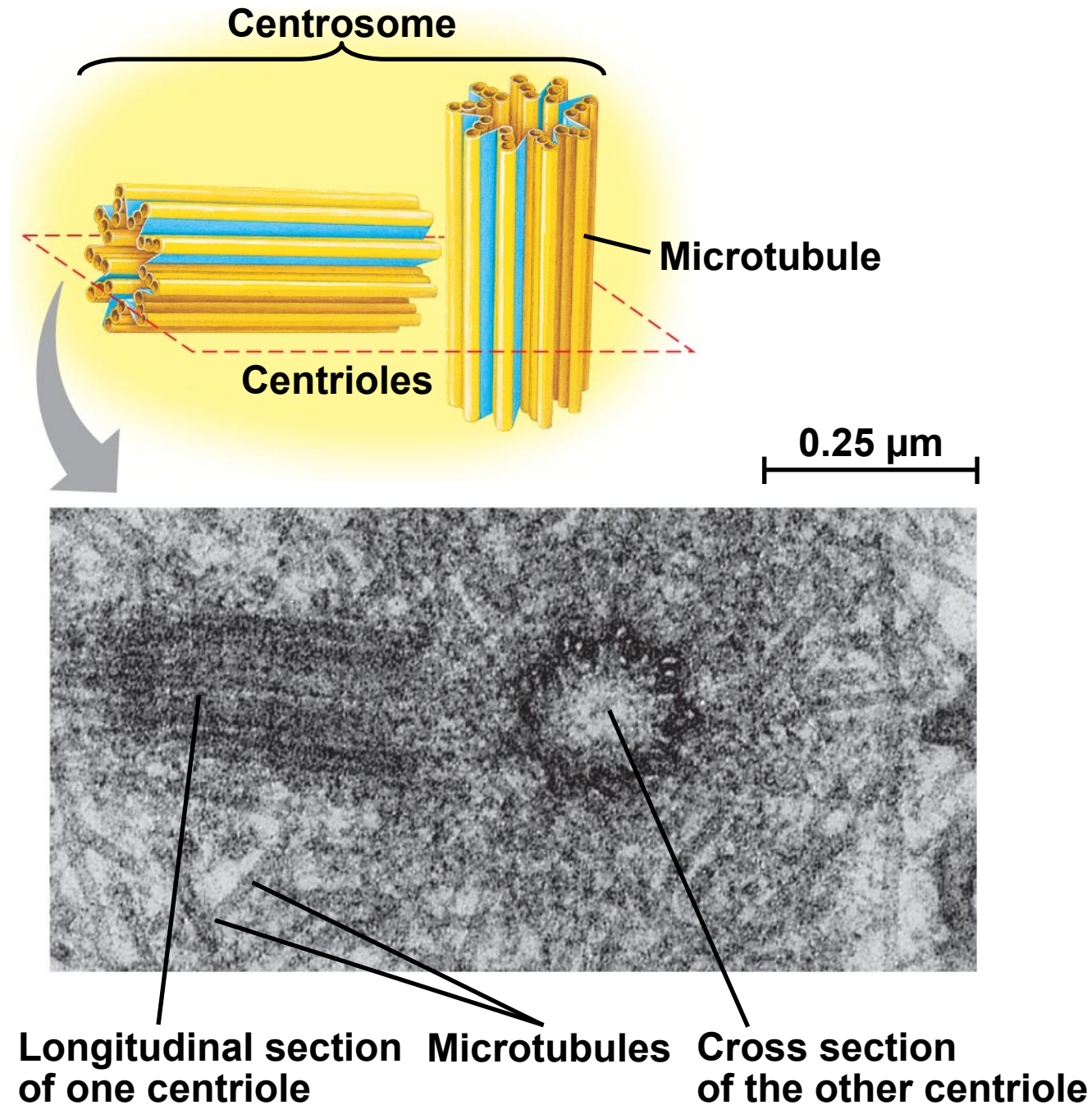
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**Table 6.1 The Structure and Function of the Cytoskeleton**

Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin, each a polymer of actin subunits	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of $\alpha$ -tubulin and $\beta$ -tubulin	Actin	One of several different proteins of the keratin family, depending on cell type
Main functions	Maintenance of cell shape (compression-resisting “girders”) Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina

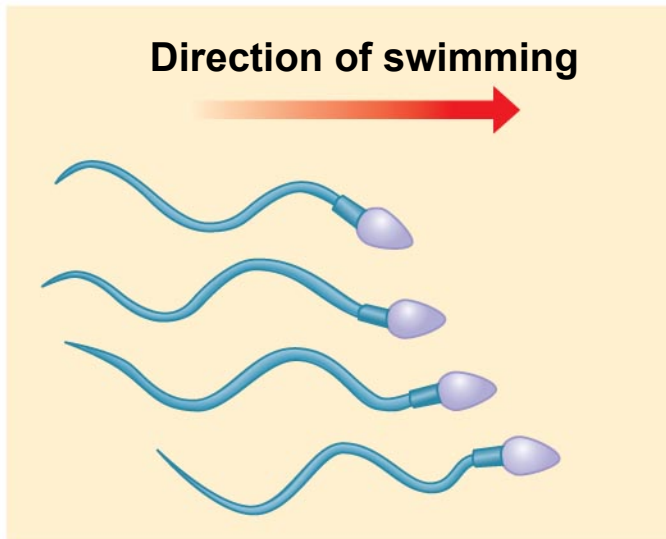
Micrographs of fibroblasts, a favorite cell type for cell biology studies. Each has been experimentally treated to fluorescently tag the structure of interest.





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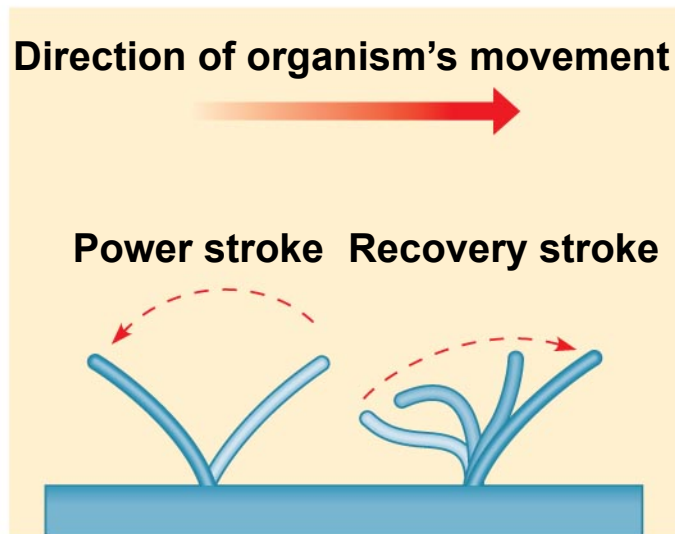




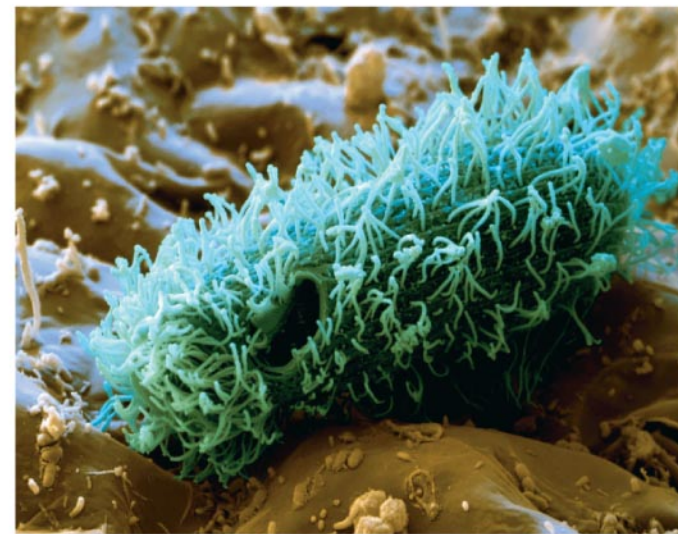
(a) Motion of flagella



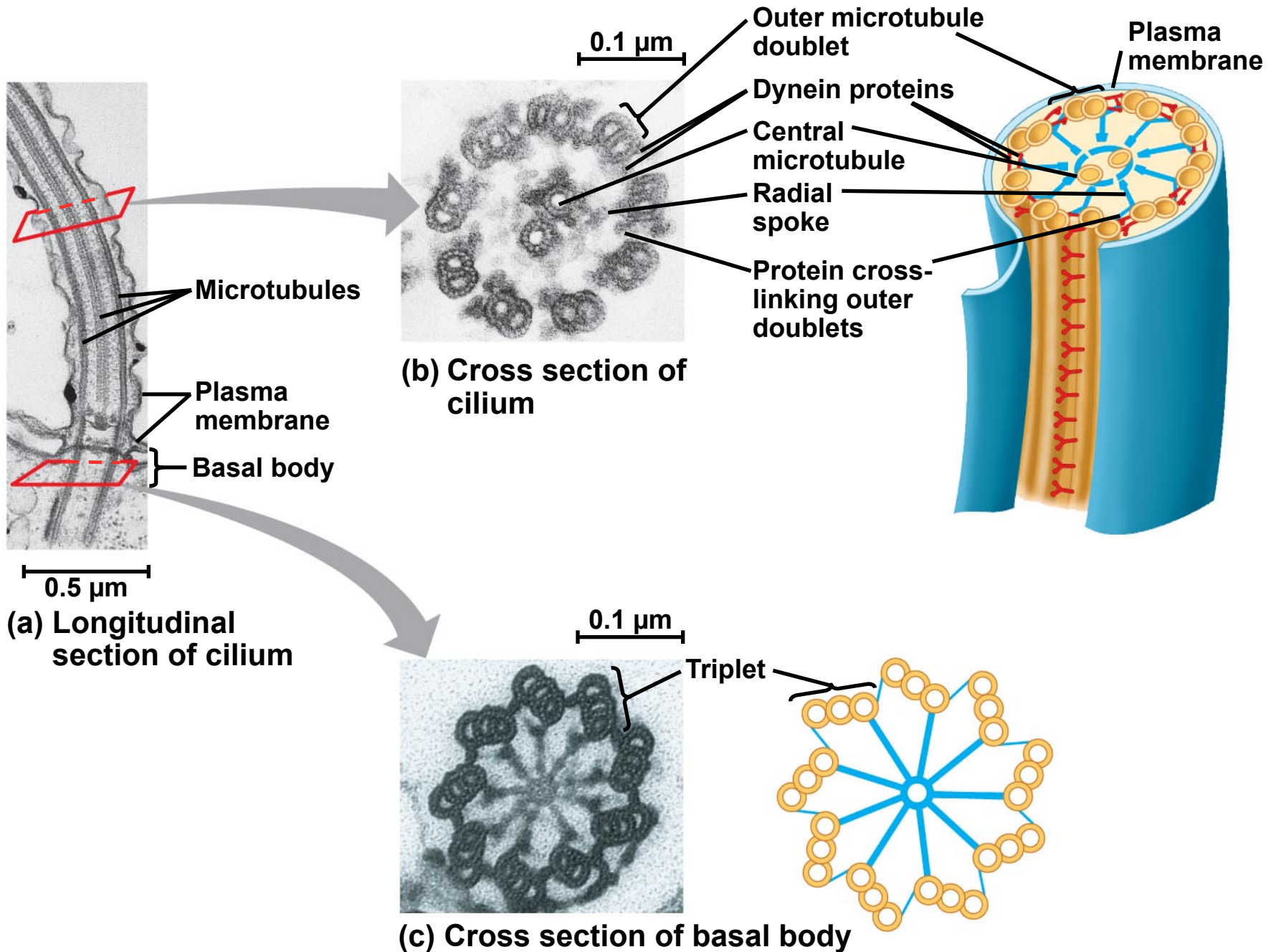
5 μm

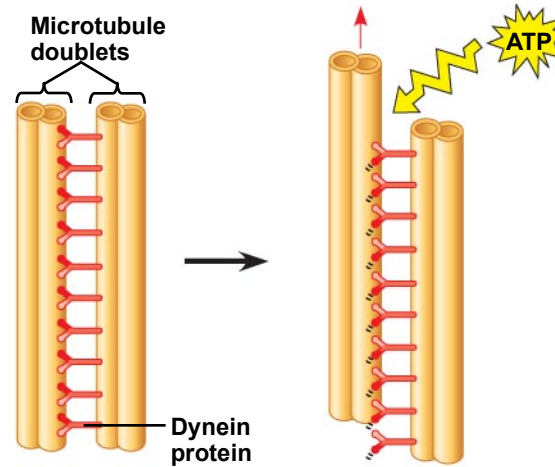


(b) Motion of cilia

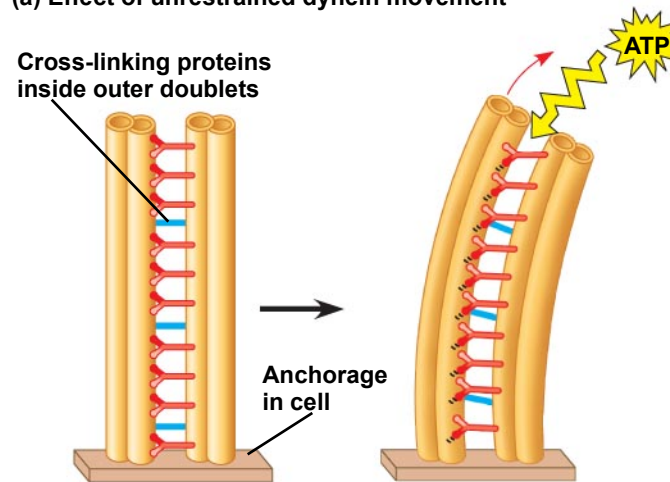


15 μm

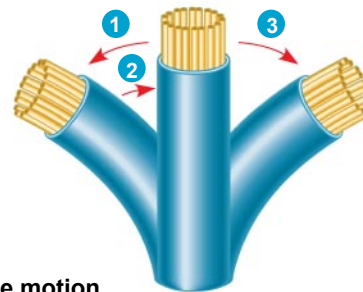




(a) Effect of unrestrained dynein movement



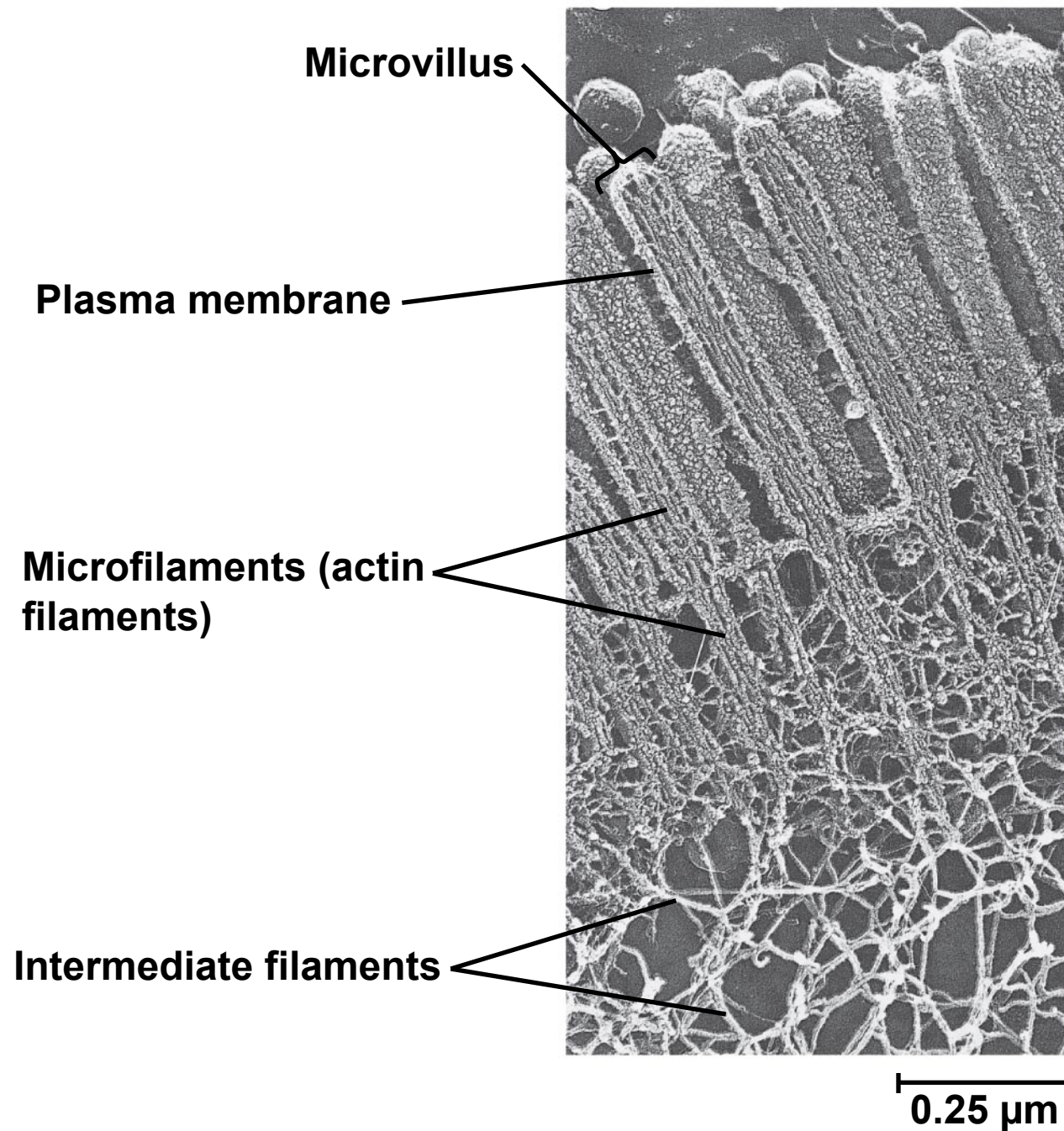
(b) Effect of cross-linking proteins

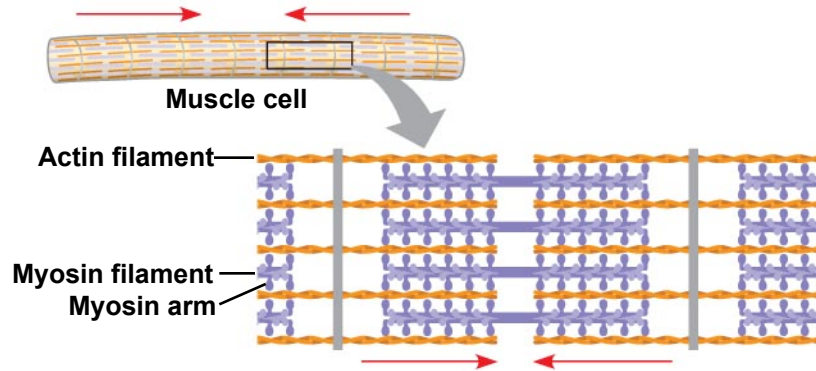


(c) Wavelike motion

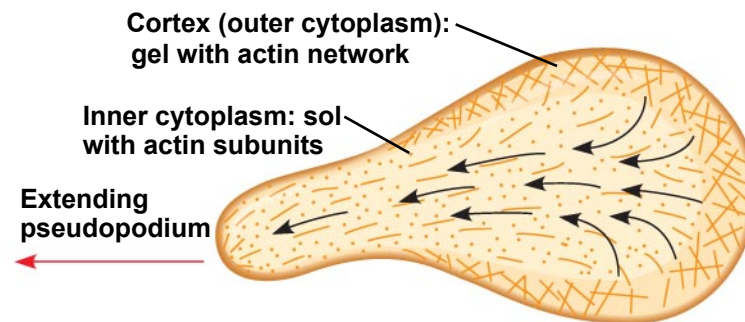
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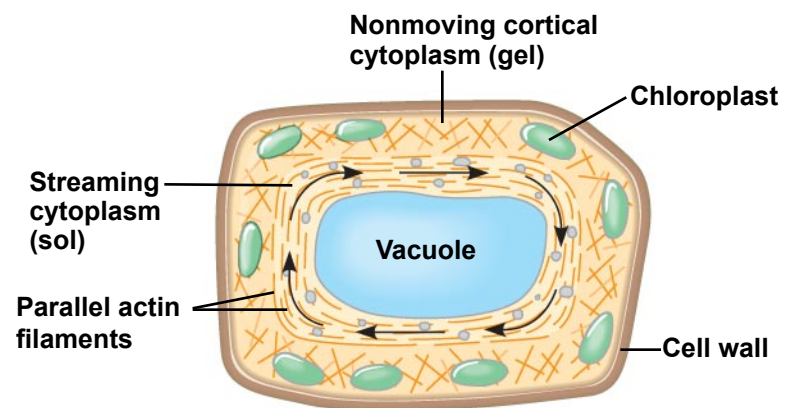




(a) Myosin motors in muscle cell contraction

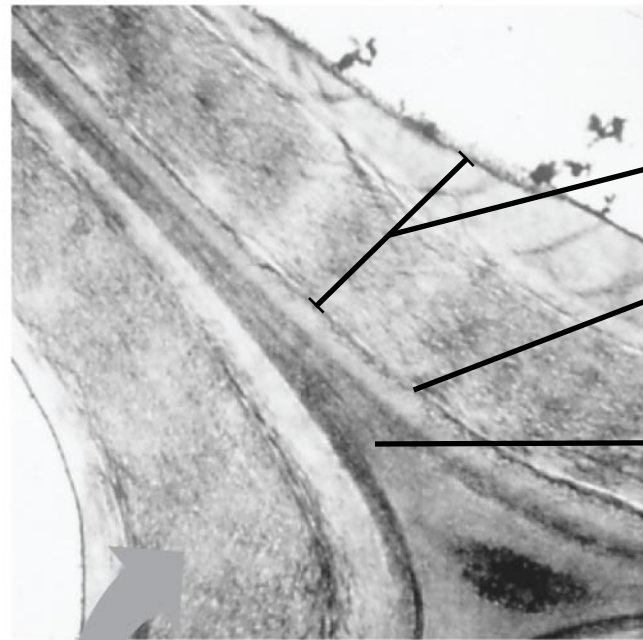


(b) Amoeboid movement



(c) Cytoplasmic streaming in plant cells

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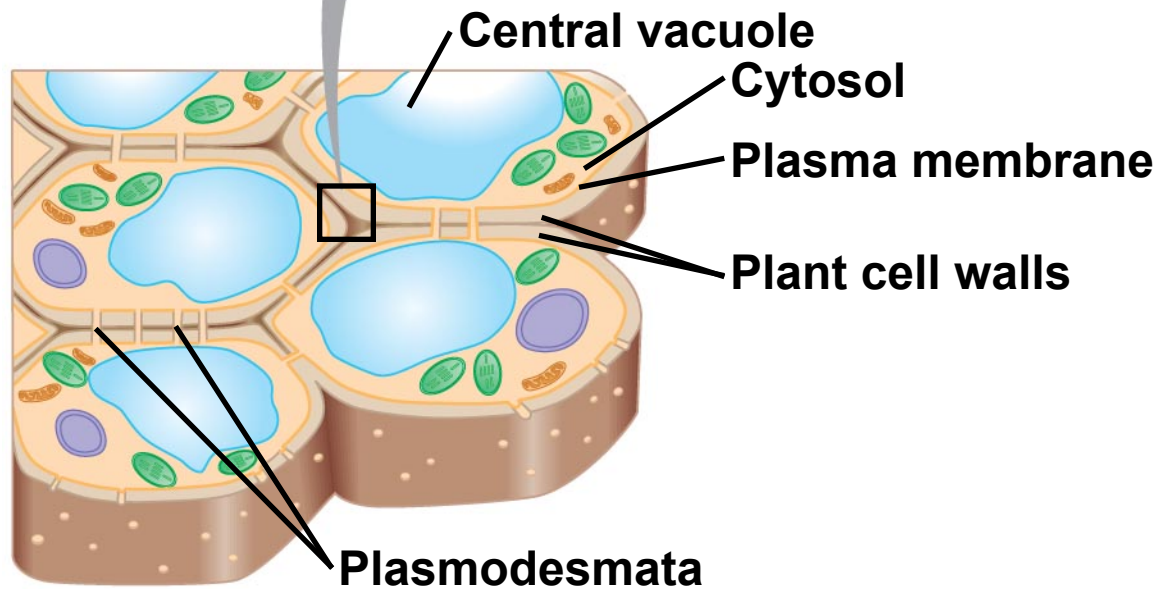


**Secondary  
cell wall**

**Primary  
cell wall**

**Middle  
lamella**

1 μm



**Central vacuole**

**Cytosol**

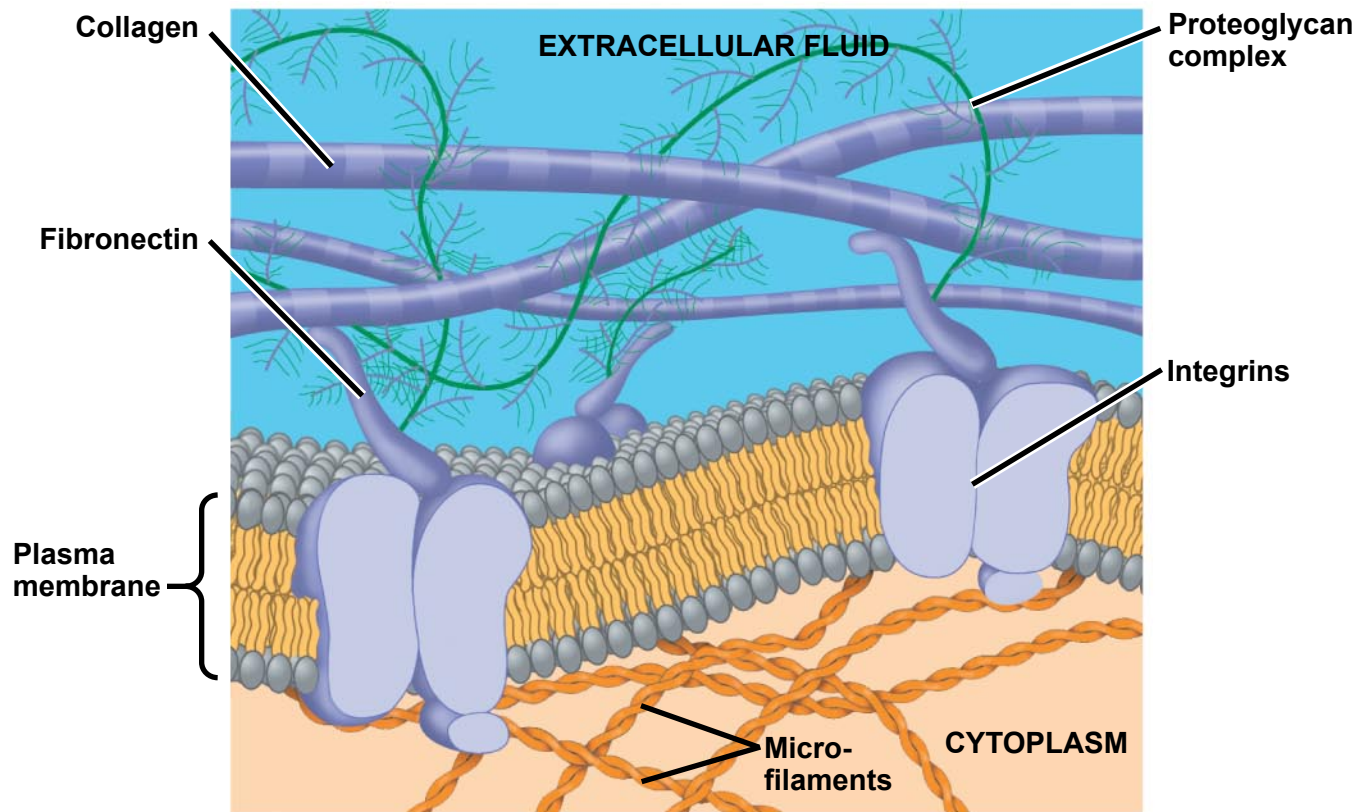
**Plasma membrane**

**Plant cell walls**

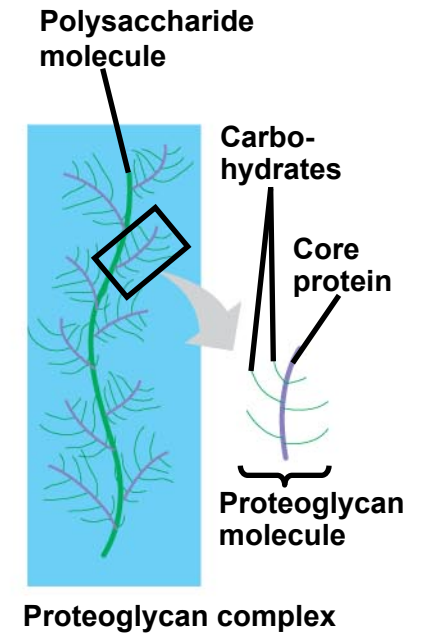
**Plasmodesmata**

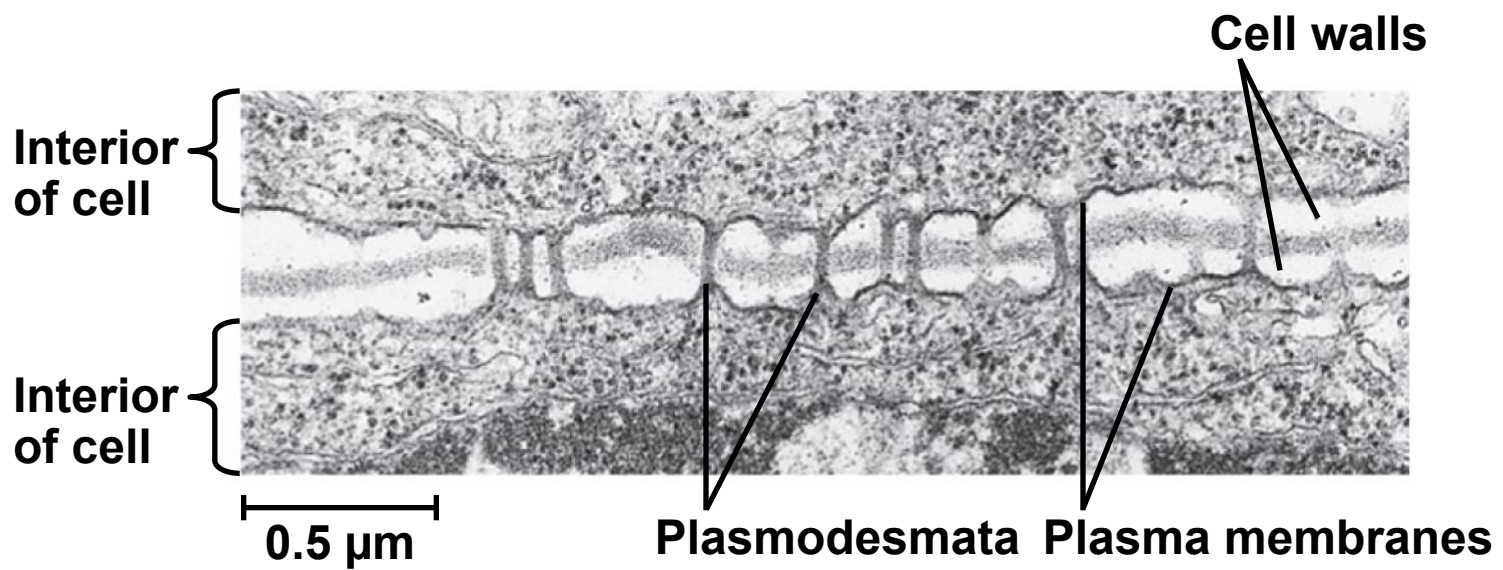
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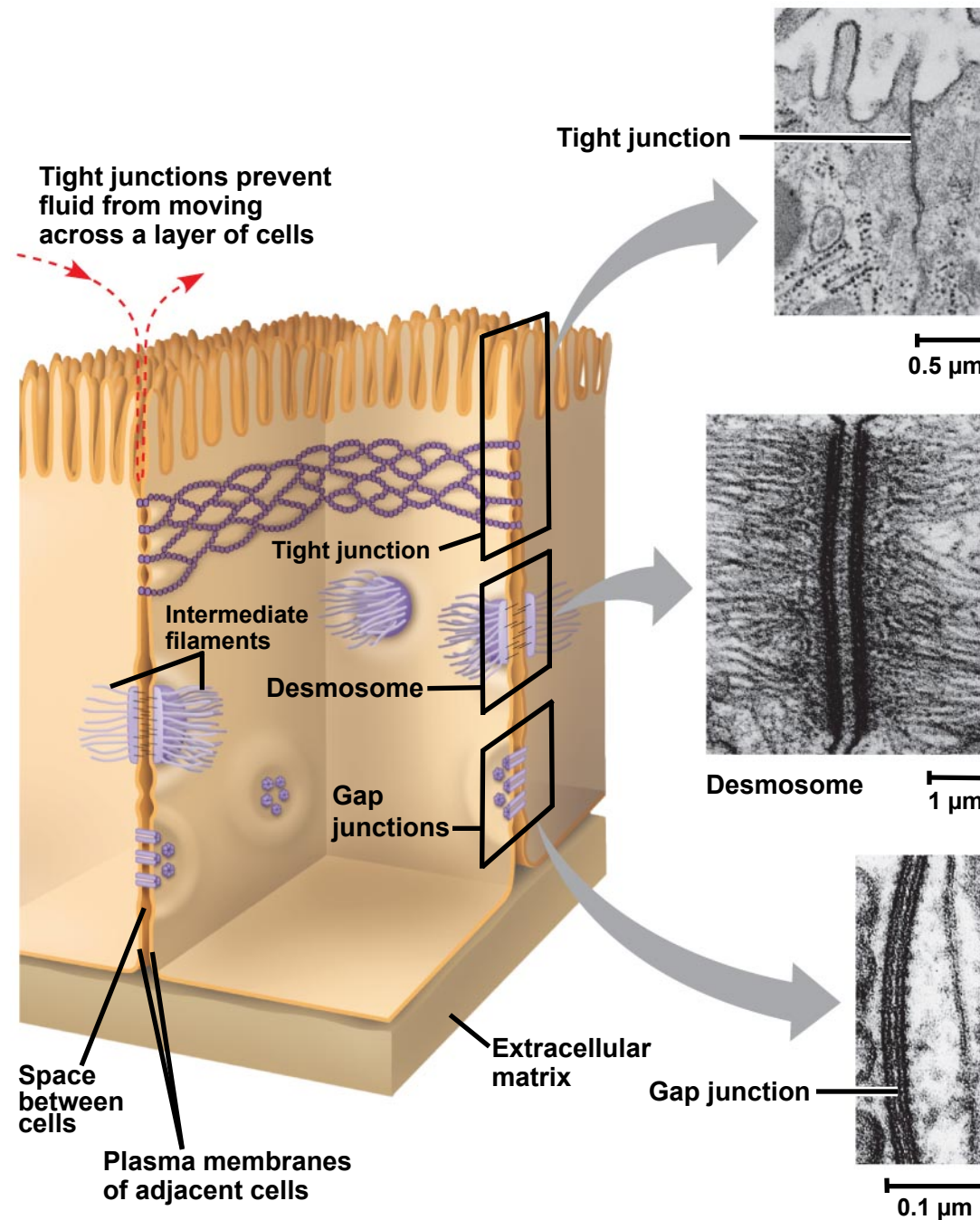


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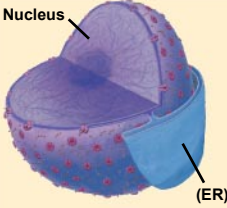

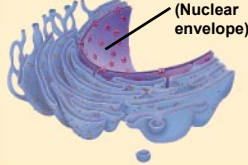


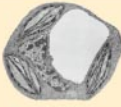





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	Cell Component	Structure	Function
<b>Concept 6.3</b> The eukaryotic cell's genetic instructions are housed in the nucleus and carried out by the ribosomes	<b>Nucleus</b> 	Surrounded by nuclear envelope (double membrane) perforated by nuclear pores. The nuclear envelope is continuous with the endoplasmic reticulum (ER).	Houses chromosomes, made of chromatin (DNA, the genetic material, and proteins); contains nucleoli, where ribosomal subunits are made. Pores regulate entry and exit of materials.
	<b>Ribosome</b> 	Two subunits made of ribosomal RNA and proteins; can be free in cytosol or bound to ER	Protein synthesis
<b>Concept 6.4</b> The endomembrane system regulates protein traffic and performs metabolic functions in the cell	<b>Endoplasmic reticulum</b> 	Extensive network of membrane-bound tubules and sacs; membrane separates lumen from cytosol; continuous with the nuclear envelope.	Smooth ER: synthesis of lipids, metabolism of carbohydrates, $\text{Ca}^{2+}$ storage, detoxification of drugs and poisons  Rough ER: Aids in synthesis of secretory and other proteins from bound ribosomes; adds carbohydrates to glycoproteins; produces new membrane
	<b>Golgi apparatus</b> 	Stacks of flattened membranous sacs; has polarity ( <i>cis</i> and <i>trans</i> faces)	Modification of proteins, carbohydrates on proteins, and phospholipids; synthesis of many polysaccharides; sorting of Golgi products, which are then released in vesicles.
	<b>Lysosome</b> 	Membranous sac of hydrolytic enzymes (in animal cells)	Breakdown of ingested substances, cell macromolecules, and damaged organelles for recycling
	<b>Vacuole</b> 	Large membrane-bounded vesicle in plants	Digestion, storage, waste disposal, water balance, cell growth, and protection
<b>Concept 6.5</b> Mitochondria and chloroplasts change energy from one form to another	<b>Mitochondrion</b> 	Bounded by double membrane; inner membrane has infoldings (cristae)	Cellular respiration
	<b>Chloroplast</b> 	Typically two membranes around fluid stroma, which contains membranous thylakoids stacked into grana (in plants)	Photosynthesis
	<b>Peroxisome</b> 	Specialized metabolic compartment bounded by a single membrane	Contains enzymes that transfer hydrogen to water, producing hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) as a by-product, which is converted to water by other enzymes in the peroxisome