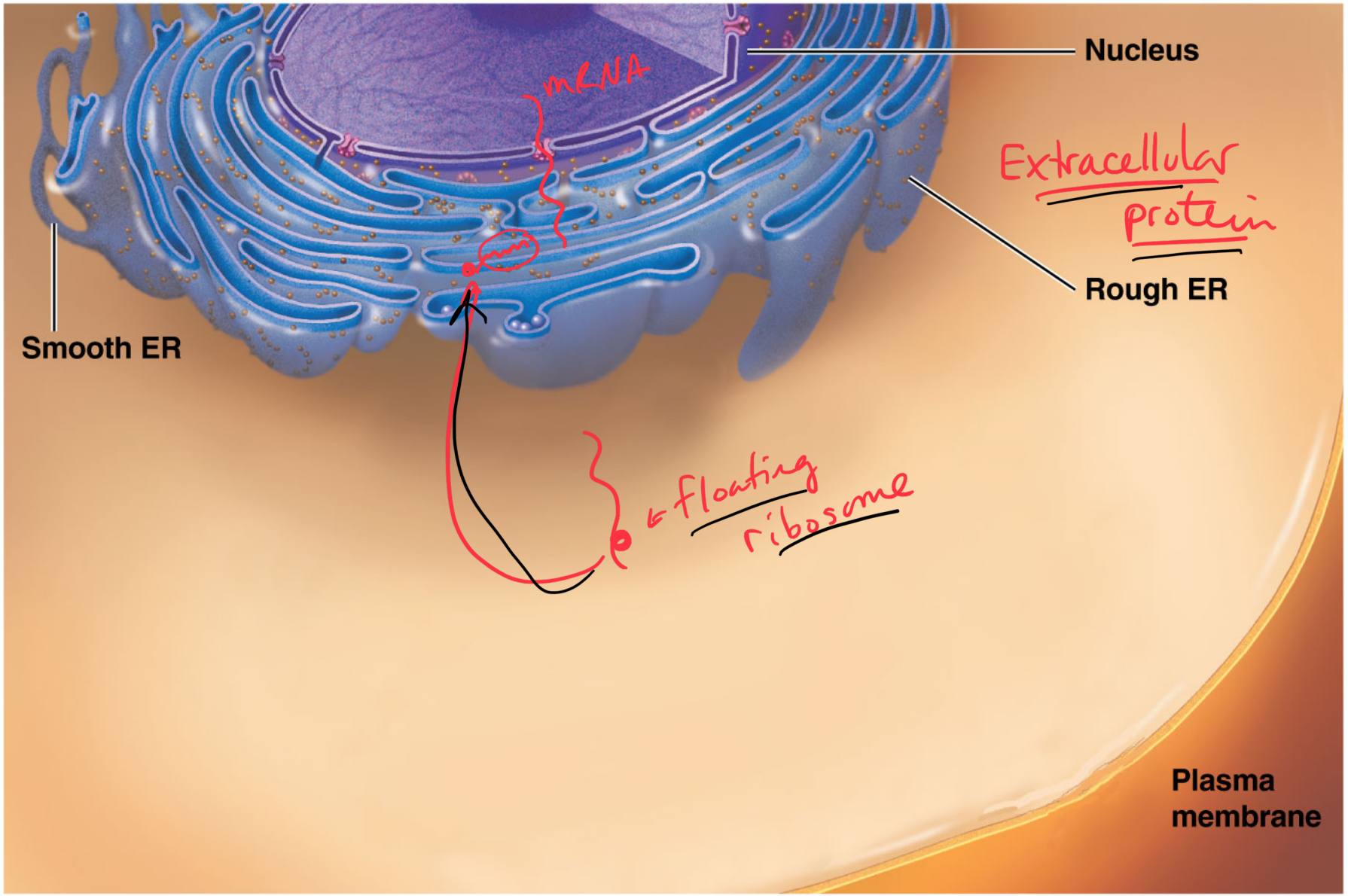

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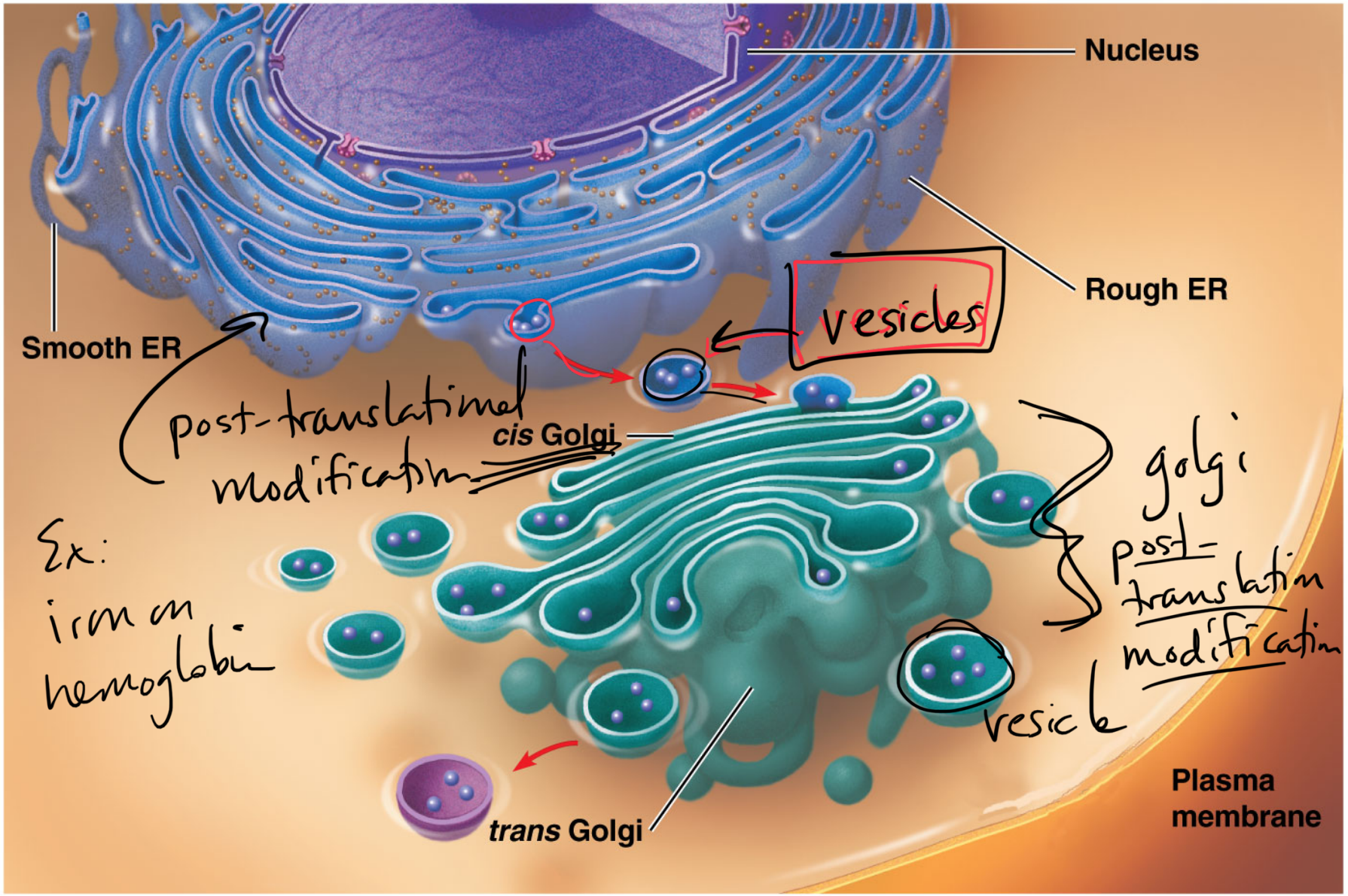

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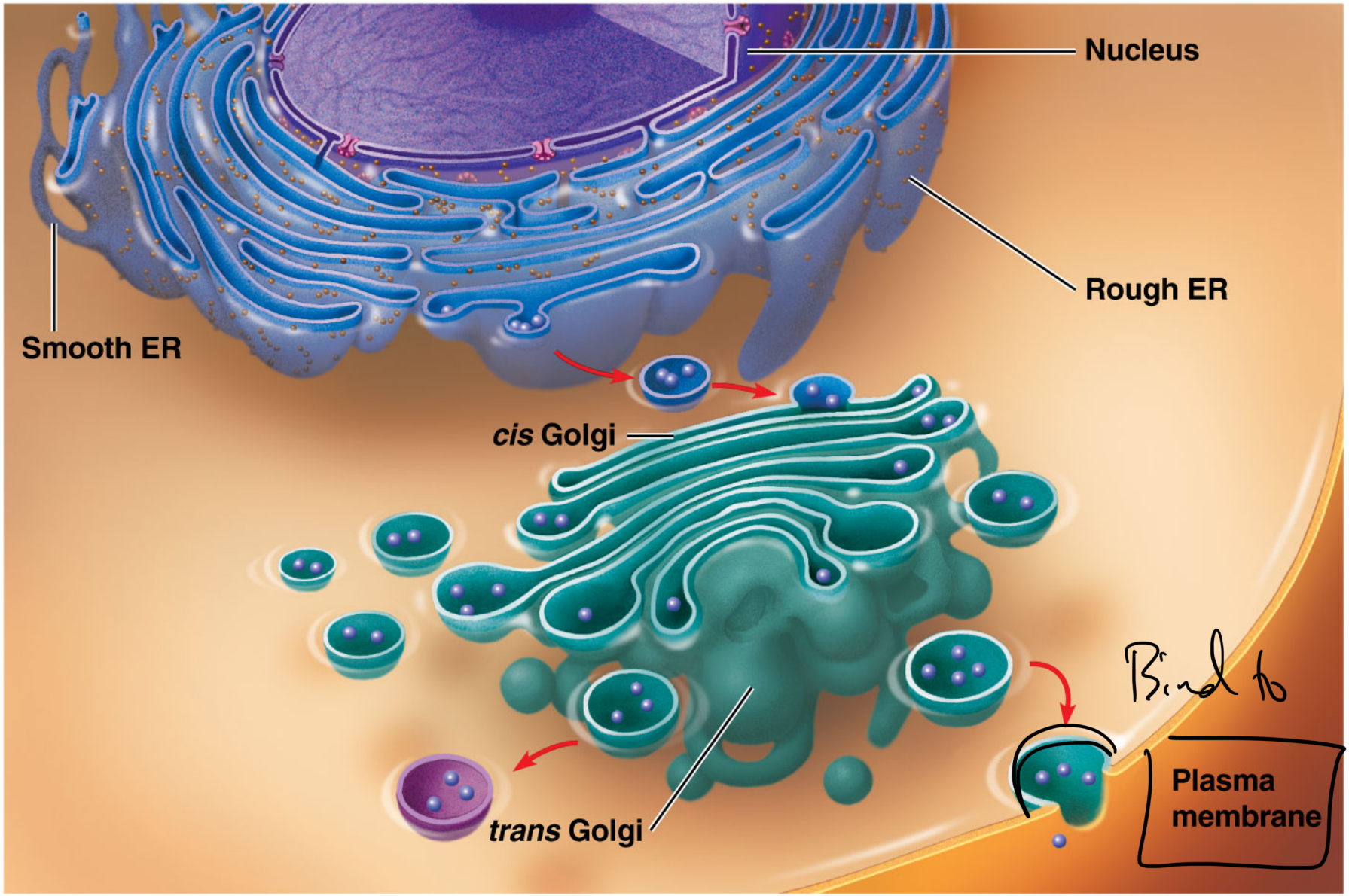

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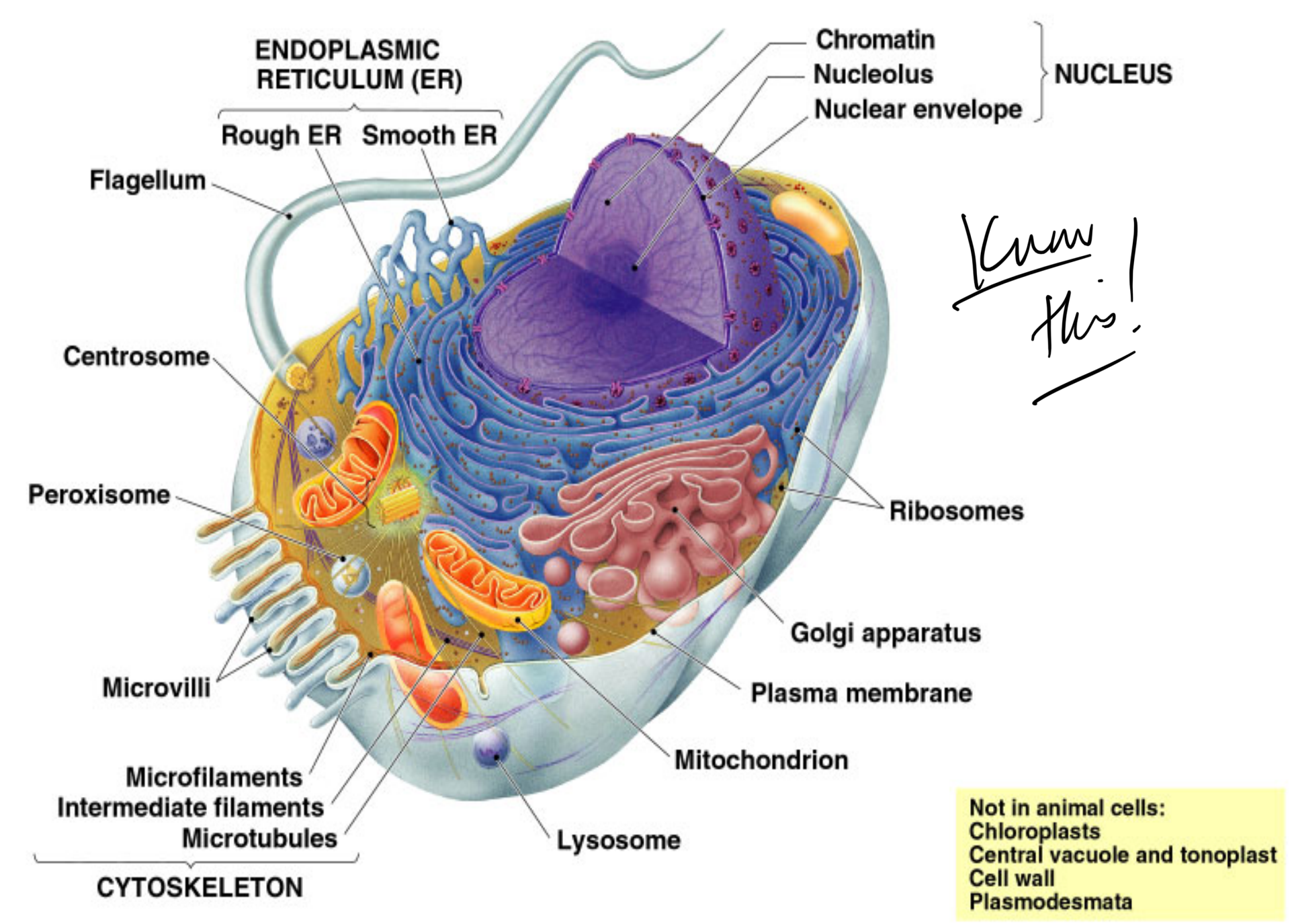

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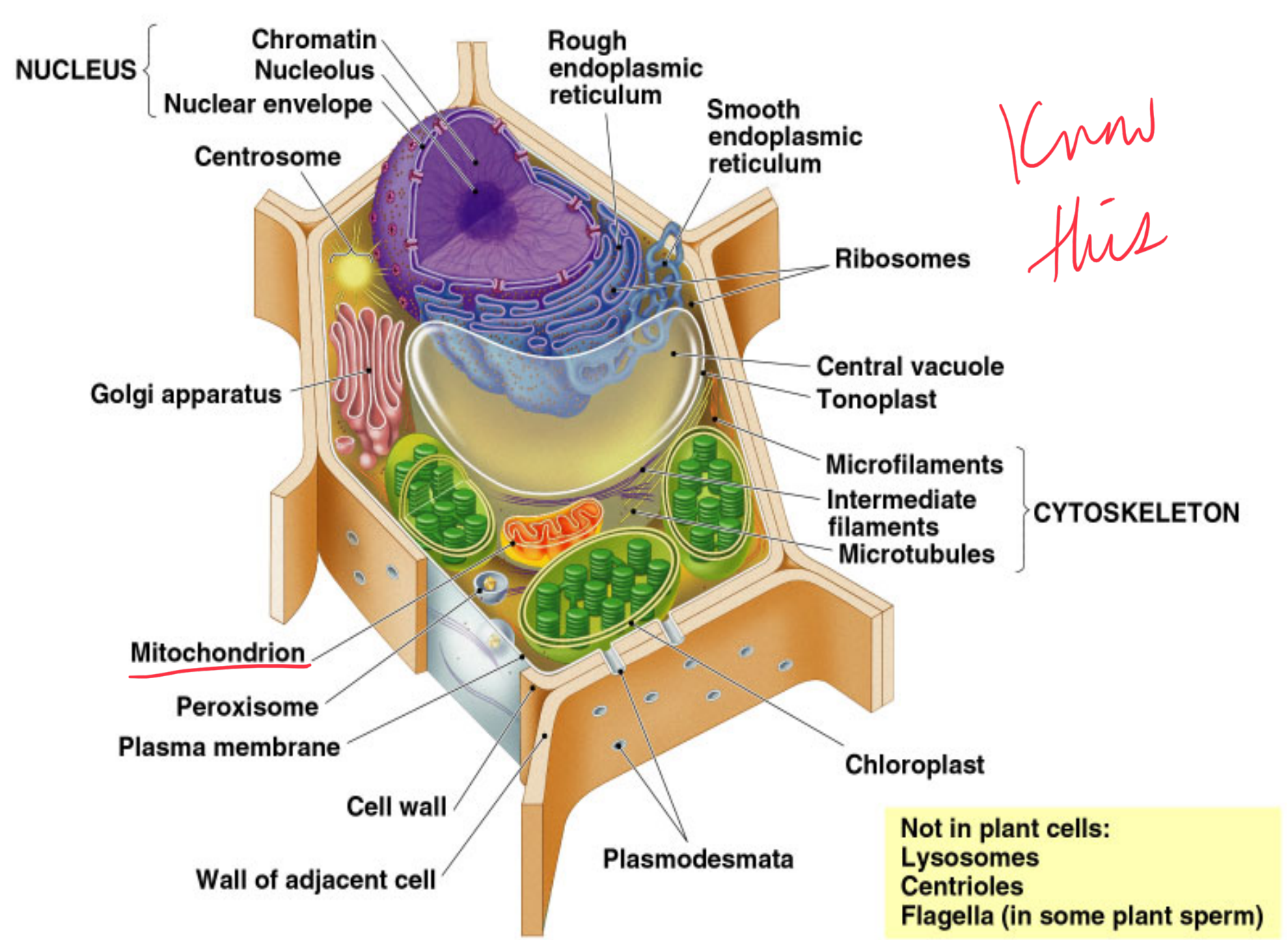

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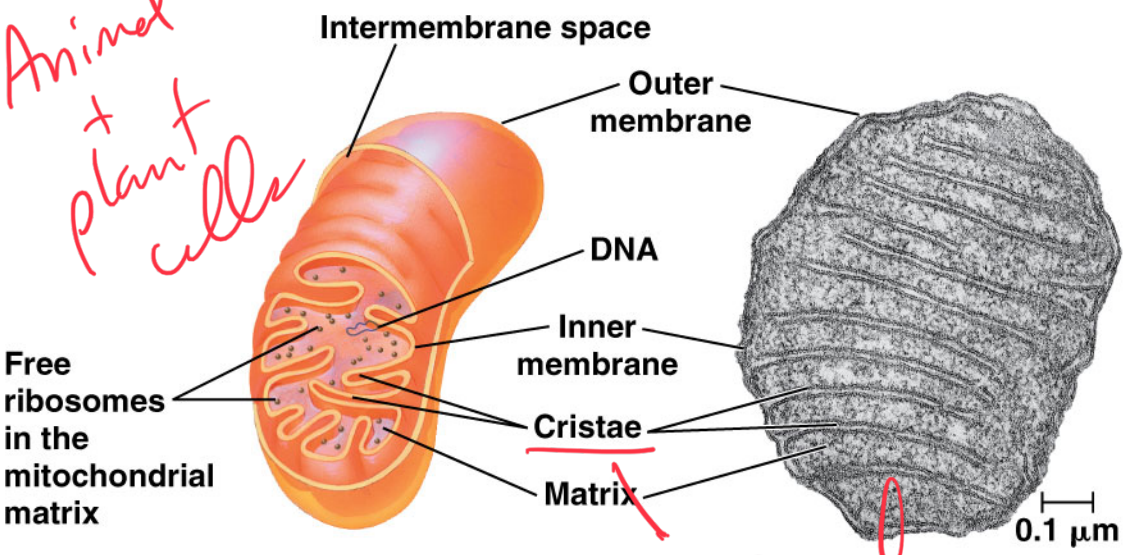
MITOCHONDRIA

ATP produced aerobic (needs oxygen)

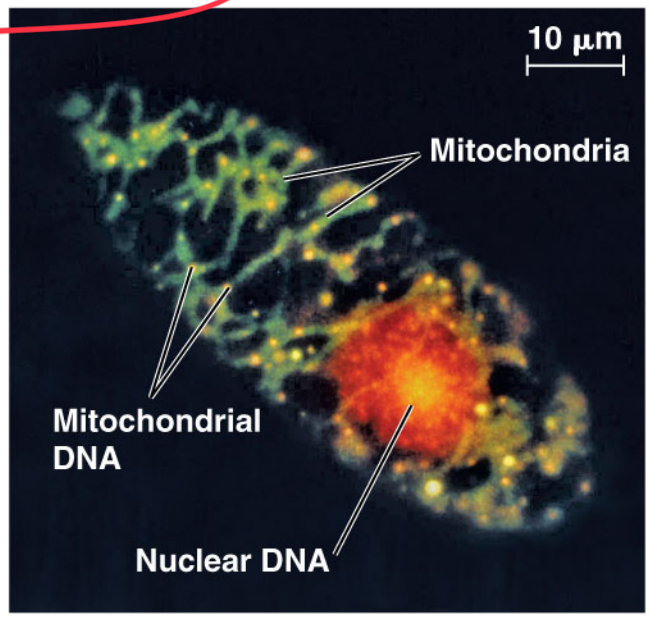
- Function: site of cellular respiration
- Double membrane: **outer** and **inner membrane**
- **Cristae**: folds of inner membrane; contains enzymes for ATP production; increased surface area to ↑ ATP made
- **Matrix**: fluid-filled inner compartment

Animal + plant cells



(a) Diagram and TEM of mitochondrion

increased surface area



(b) Network of mitochondria in a protist cell (LM)

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CHLOROPLASTS

only in plant cells

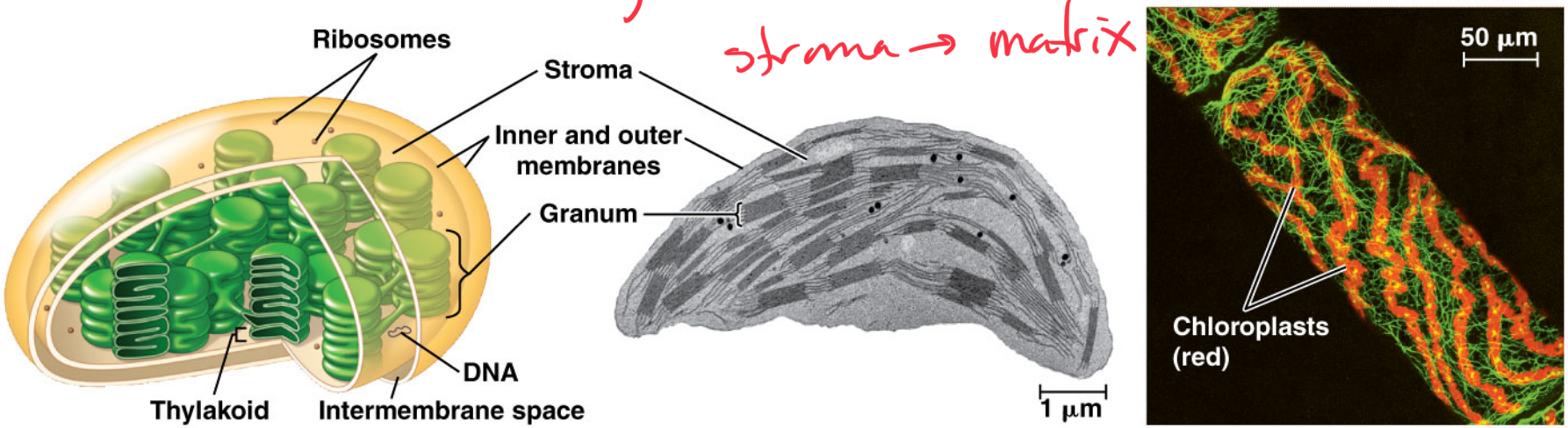
- Function: site of photosynthesis
- Double membrane
- Thylakoid disks in stacks (grana); stroma (fluid)
- Contains **chlorophylls** (pigments) for capturing sunlight energy

dark rxn → make sugar

light rxns → make energy

thylakoid → cristae

stroma → matrix



(a) Diagram and TEM of chloroplast

(b) Chloroplasts in an algal cell

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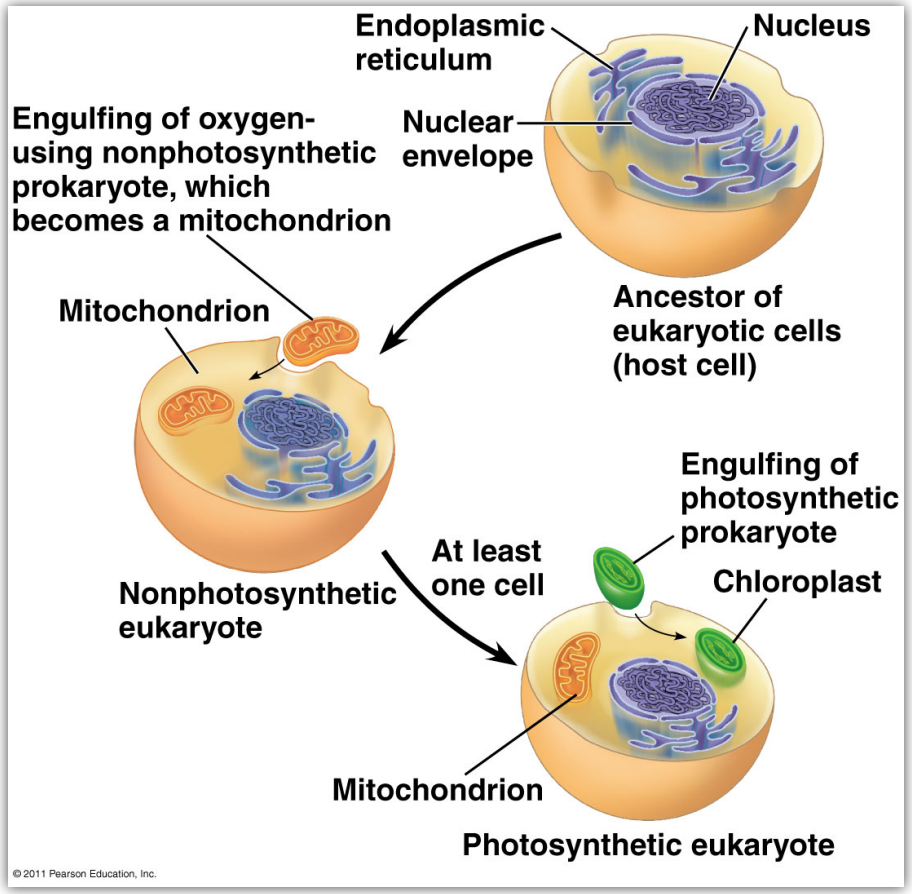
ENDOSYMBIONT THEORY



- Mitochondria & chloroplasts share similar origin
- Prokaryotic cells engulfed by ancestors of eukaryotic cells
- Evidence:
  - Double-membrane structure
  - Have own ribosomes & DNA
  - Reproduce independently within cell

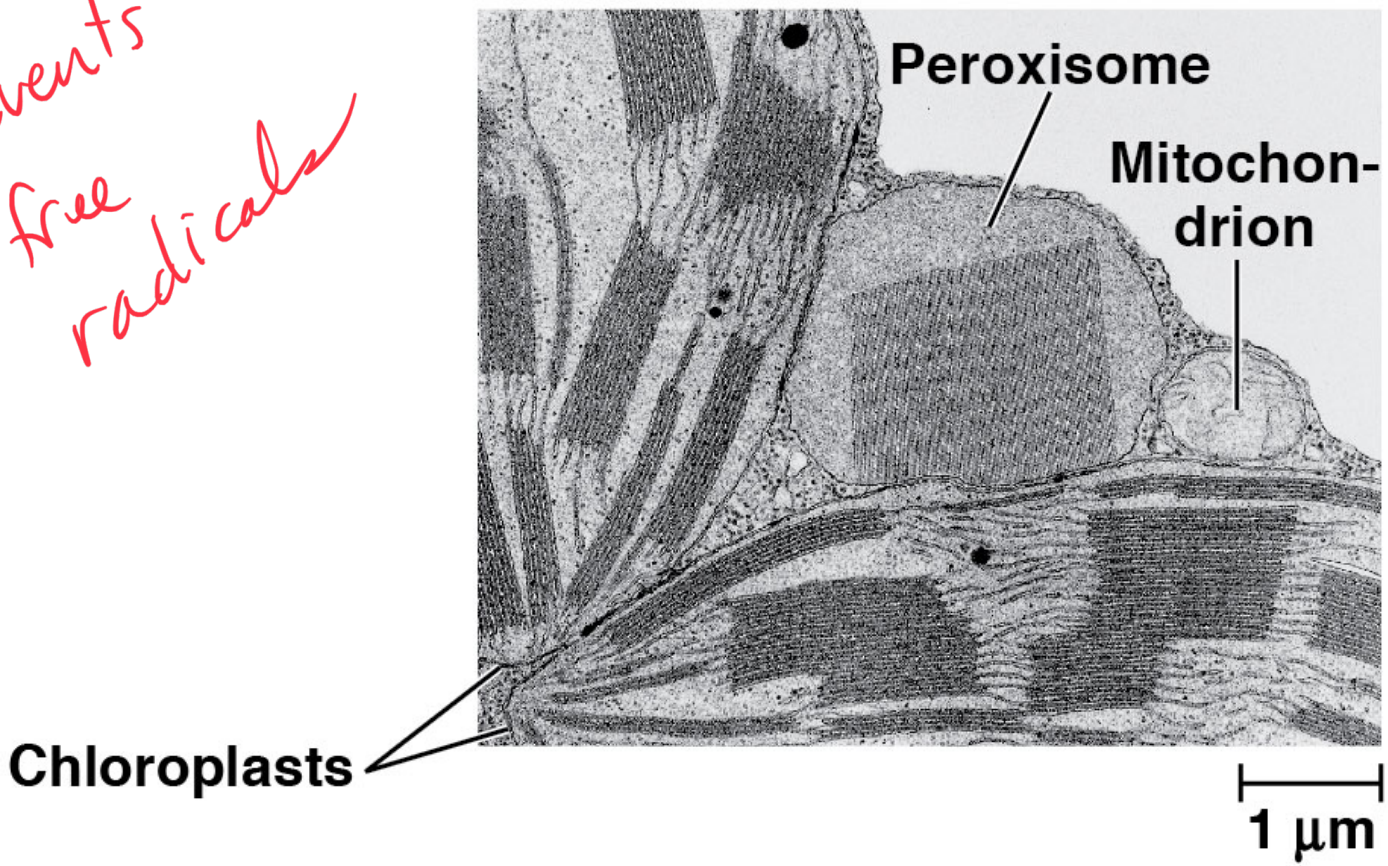
PEROXISOMES

catalase

- Functions: break down fatty acids; detox alcohol
- Involves production of hydrogen peroxide (H_2O_2)

breakdown

prevents free radicals



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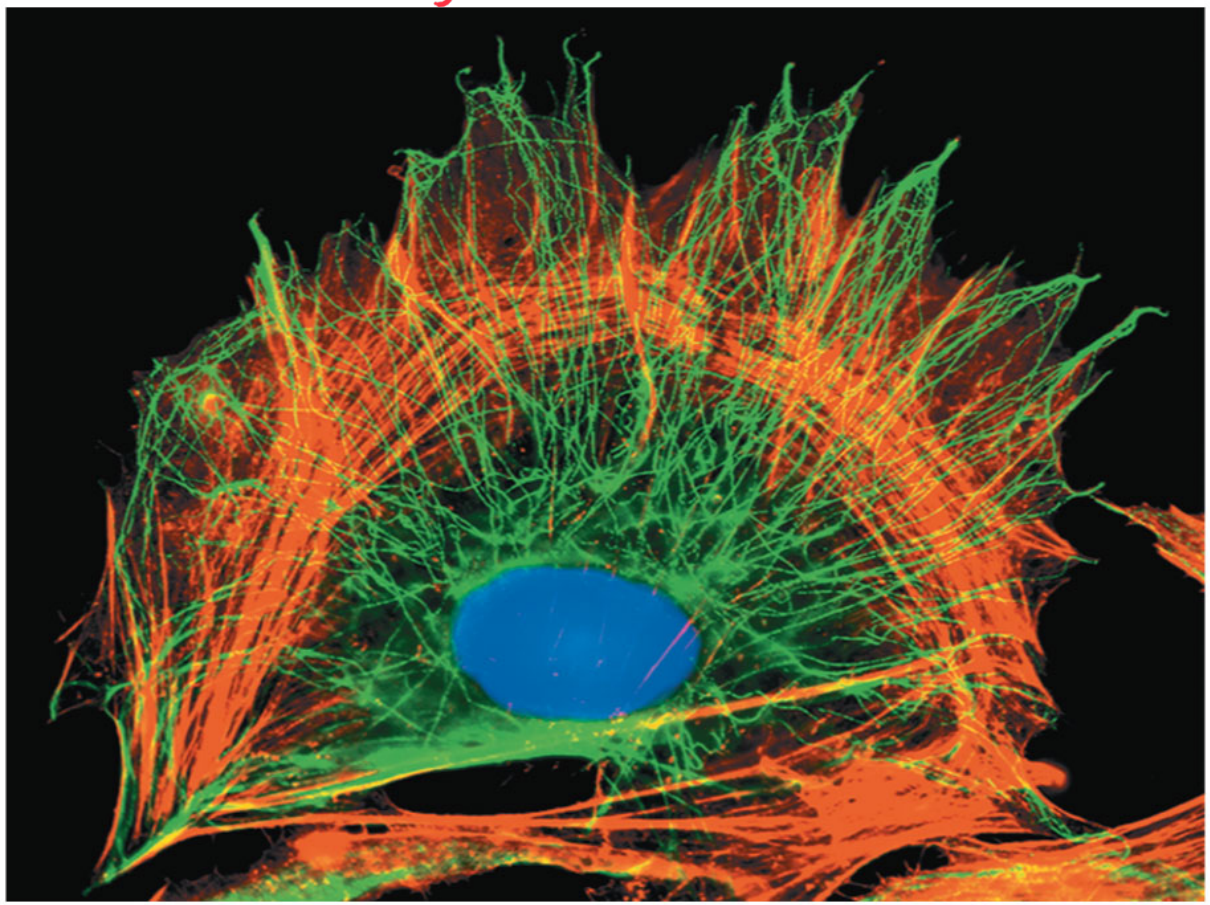
CYTOSKELETON: NETWORK OF PROTEIN FIBERS

- Function: support, motility, regulate biochemical activities

dynamic

made of protein



majority of cell is protein

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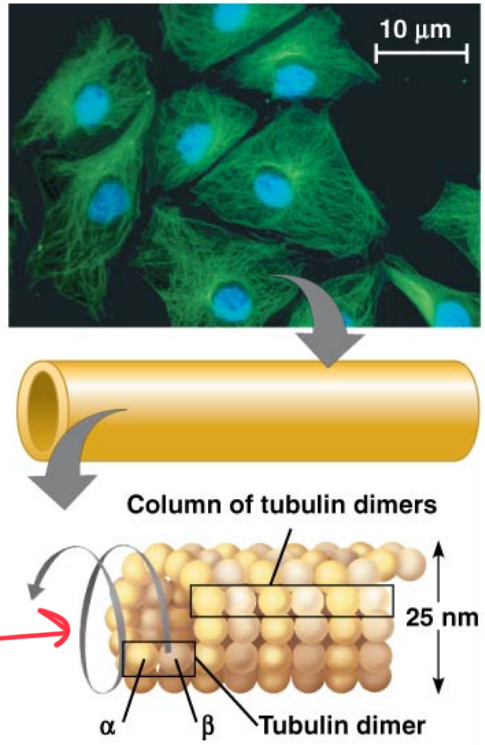
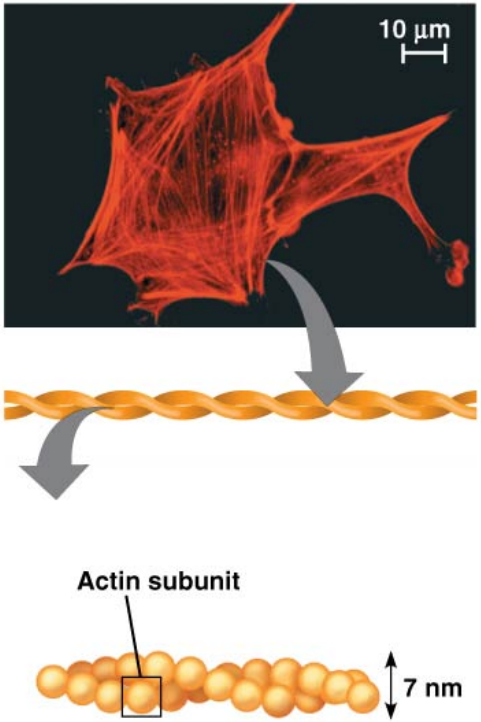
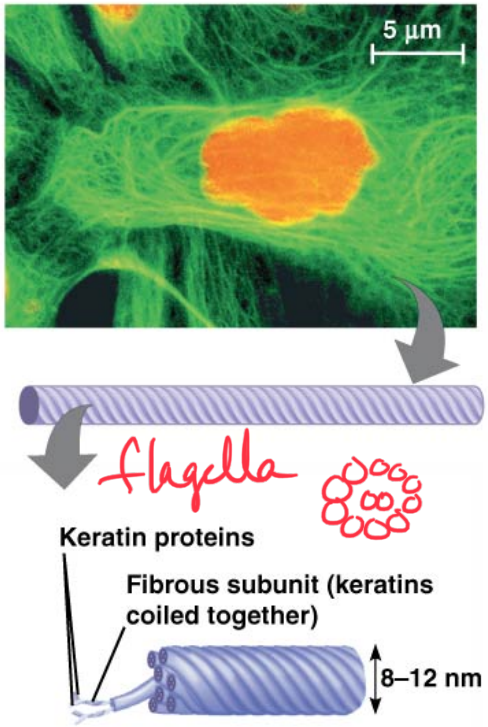
Table 4.1 The Structure and Function of the Cytoskeleton

Property	Microtubules (Tubulin Polymers)	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes	Two intertwined strands of actin	Fibrous proteins coiled into cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, a dimer consisting of α-tubulin and β-tubulin	Actin	One of several different proteins (such as keratins)
Main functions	Maintenance of cell shape; cell motility; chromosome movements in cell division; organelle movements	Maintenance of cell shape; changes in cell shape; muscle contraction; cytoplasmic streaming (plant cells); cell motility; cell division (animal cells)	Maintenance of cell shape; anchorage of nucleus and certain other organelles; formation of nuclear lamina
Fluorescence micrographs of fibroblasts. Fibroblasts are a favorite cell type for cell biology studies because they spread out flat and their internal structures are easy to see. In each, the structure of interest has been tagged with fluorescent molecules. The DNA in the nucleus has also been tagged in the first micrograph (blue) and third micrograph (orange).			

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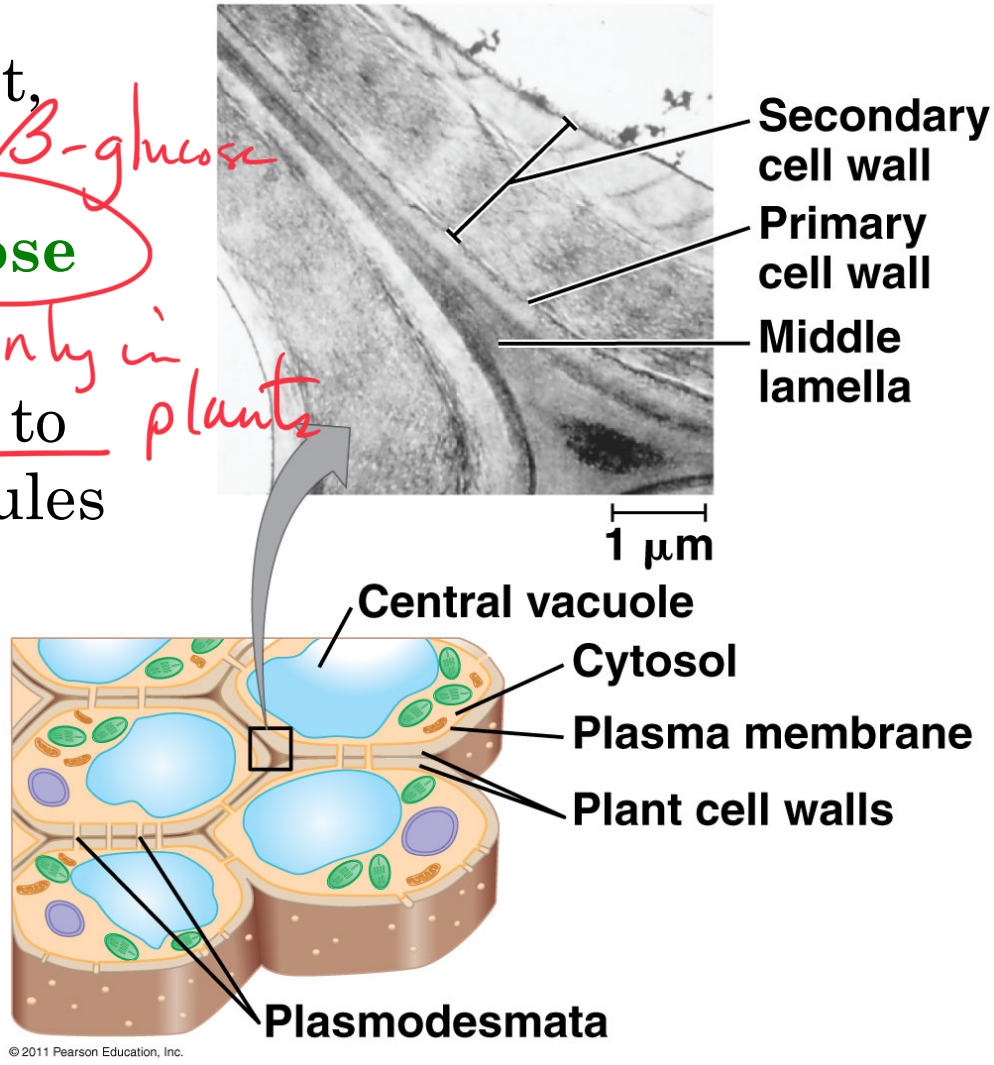
PLANT CELLS

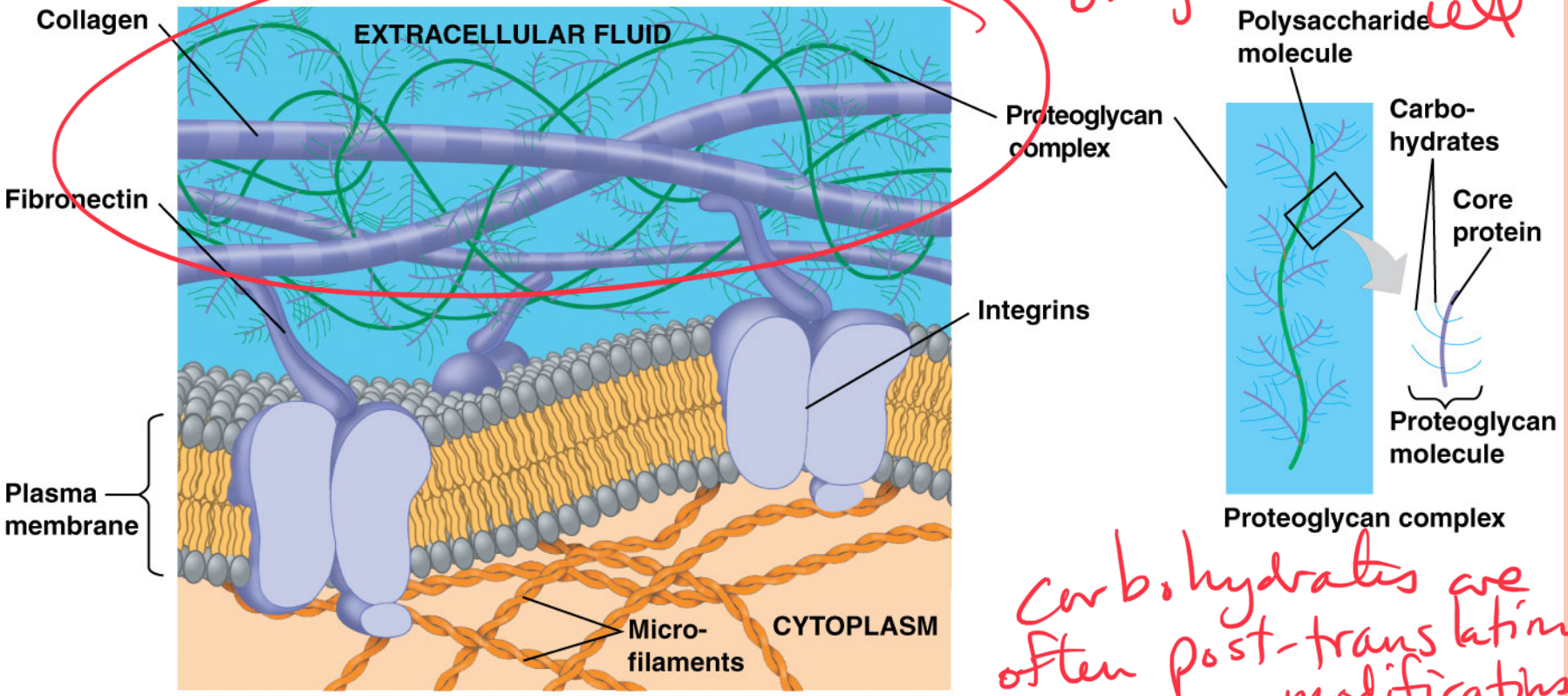
- **Cell wall**: protect plant, maintain shape
  - Composed of **cellulose**
- **Plasmodesmata**: channels between cells to allow passage of molecules from cell to cell



EXTRACELLULAR MATRIX (ECM)

- Outside plasma membrane of **animal cells**
- Composed of glycoproteins (ex. collagen)
- Function: Strengthens tissues and transmits external signals to cell

carbohydrates only on outside of cell



carbohydrates are often post-translational modifications

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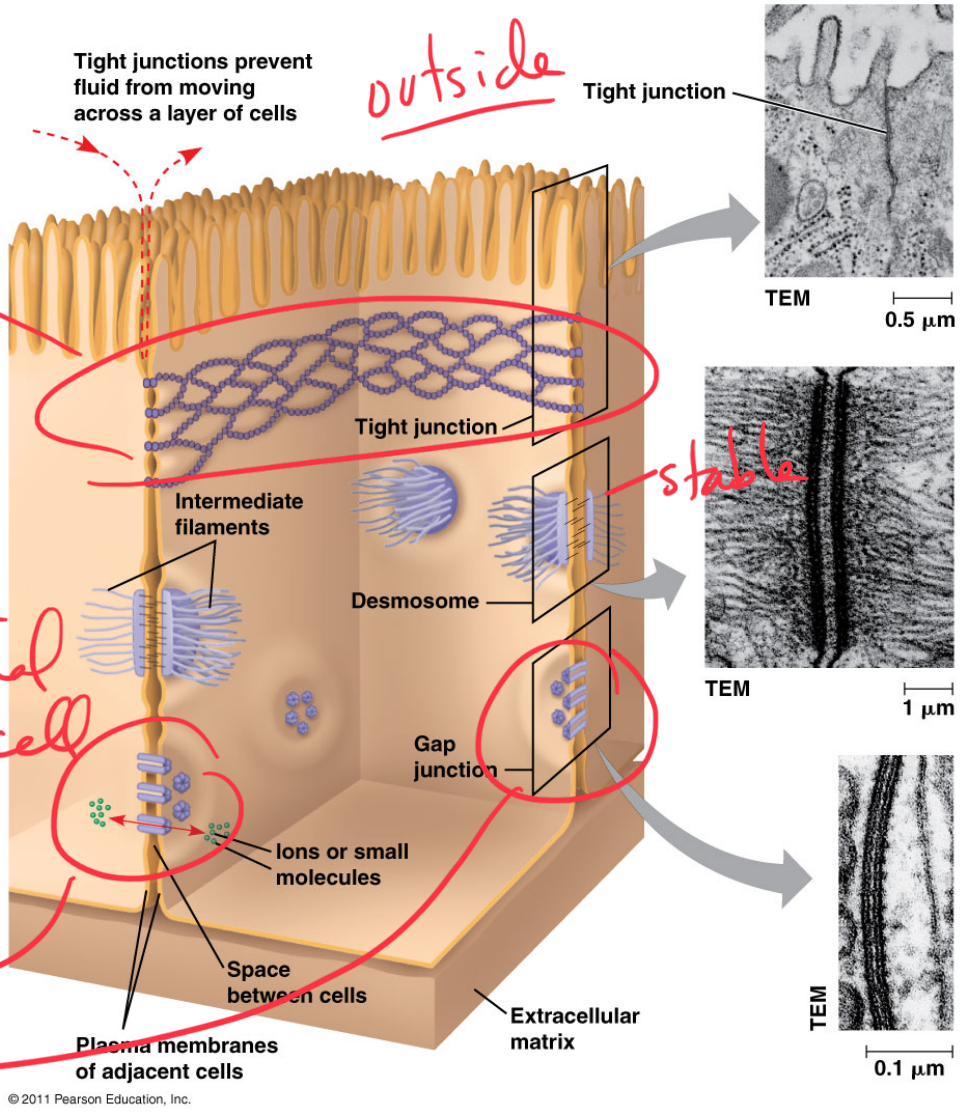
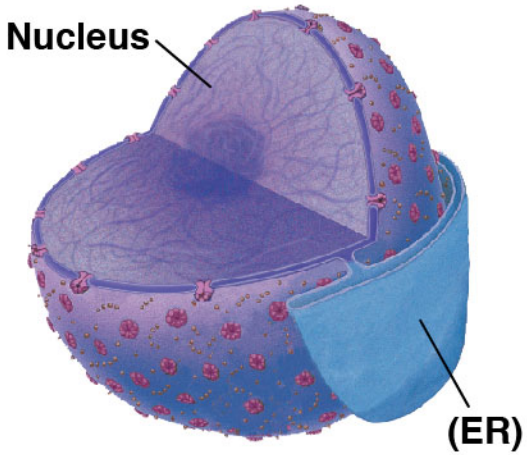
INTERCELLULAR JUNCTIONS (ANIMAL CELLS)

- **Tight junctions**: 2 cells are fused to form watertight seal
- **Desmosomes**: "rivets" that fasten adjacent cells into strong sheets
- **Gap junctions**: channels through which ions, sugar, small molecules can pass



Plant Cells Only	Animals Cells Only
Central vacuoles	Lysosomes
Chloroplasts	Centrioles
Cell wall of cellulose	Flagella, cilia
Plasmodesmata	Desmosomes, tight and gap junctions
	Extracellular matrix (ECM)

Cell Component	Structure	Function
	Surrounded by nuclear envelope (double membrane) perforated by nuclear pores; nuclear envelope continuous with endoplasmic reticulum (ER)	Houses chromosomes, which are made of chromatin (DNA and proteins); contains nucleoli, where ribosomal subunits are made; pores regulate entry and exit of materials
Ribosome	Two subunits made of ribosomal RNA and proteins; can be free in cytosol or bound to ER	Protein synthesis

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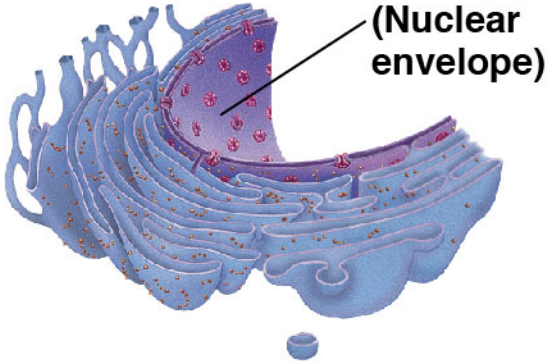
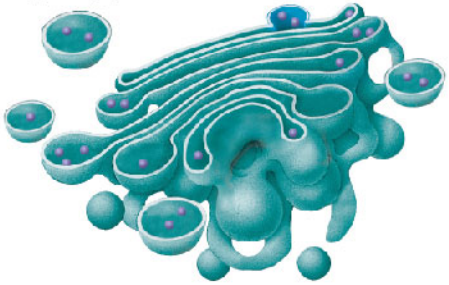
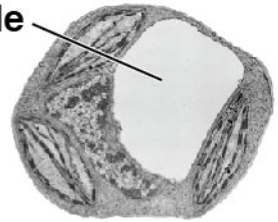
Cell Component	Structure	Function
Endoplasmic reticulum 	Extensive network of membrane-bounded tubules and sacs; membrane separates lumen from cytosol; continuous with nuclear envelope	Smooth ER: synthesis of lipids, metabolism of carbohydrates, Ca^{2+} storage, detoxification of drugs and poisons Rough ER: aids in synthesis of secretory and other proteins from bound ribosomes; adds carbohydrates to proteins to make glycoproteins; produces new membrane
Golgi apparatus 	Stacks of flattened membranous sacs; has polarity (*cis* and *trans* faces)	Modification of proteins, carbohydrates on proteins, and phospholipids; synthesis of many polysaccharides; sorting of Golgi products, which are then released in vesicles
Lysosome	Membranous sac of hydrolytic enzymes (in animal cells)	Breakdown of ingested substances, cell macromolecules, and damaged organelles for recycling
Vacuole 	Large membrane-bounded vesicle	Digestion, storage, waste disposal, water balance, plant cell growth and protection

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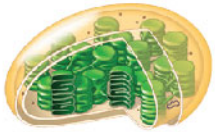
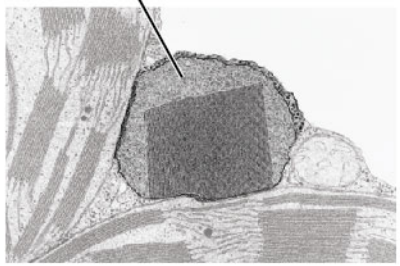
Cell Component	Structure	Function
Mitochondrion	Bounded by double membrane; inner membrane has infoldings (cristae)	Cellular respiration
Chloroplast 	Typically two membranes around fluid stroma, which contains thylakoids stacked into grana (in cells of photosynthetic eukaryotes, including plants)	Photosynthesis
Peroxisome 	Specialized metabolic compartment bounded by a single membrane	Contains enzymes that transfer hydrogen atoms from certain molecules to oxygen, producing hydrogen peroxide (H_2O_2) as a by-product; H_2O_2 is converted to water by another enzyme

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