Eukaryotic cell

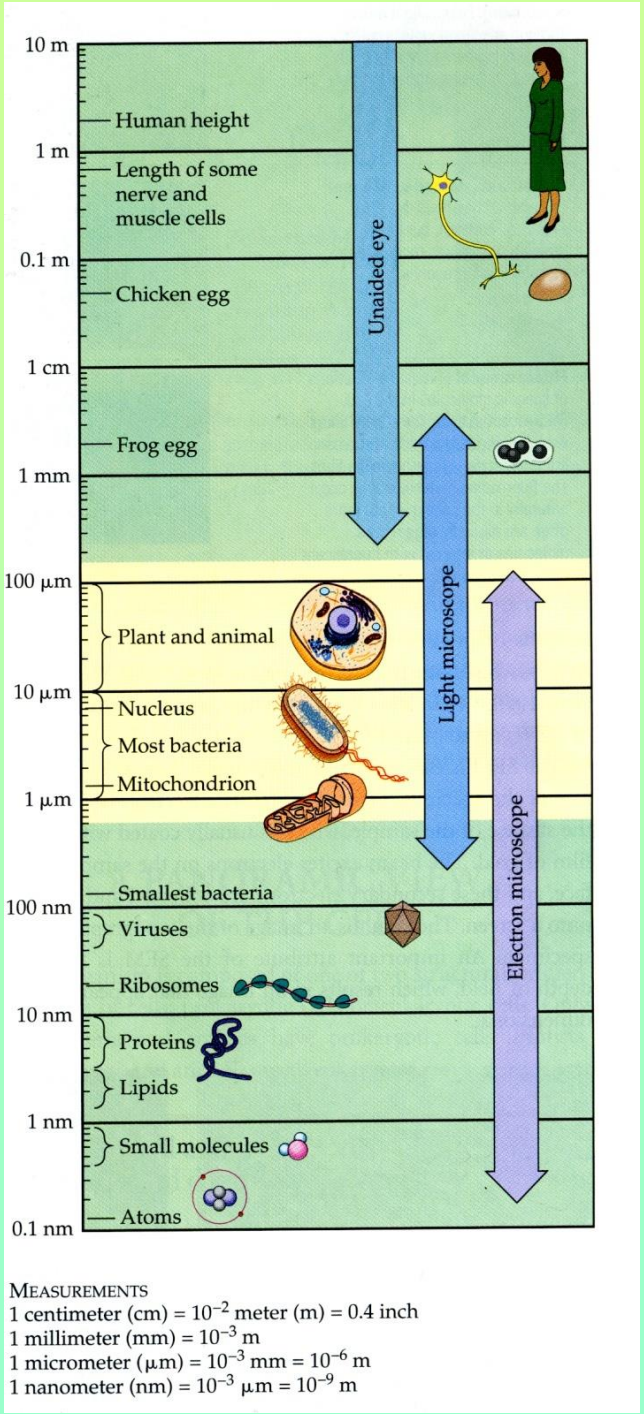
Premedical IV Biology

The size range of organisms

Light microscopes

- visible light is passed through the specimen and glass lenses
- the resolution is limited by the wavelength of the visible light
- magnification up to **1000x** the size of the actual specimen

Resolving power - the minimum distance of two points, which can be distiquished.



Electron microscope

– focused a beam of **electrons**, having the wavelength much shorter than the visible light, **1 nm (0.1nm)**

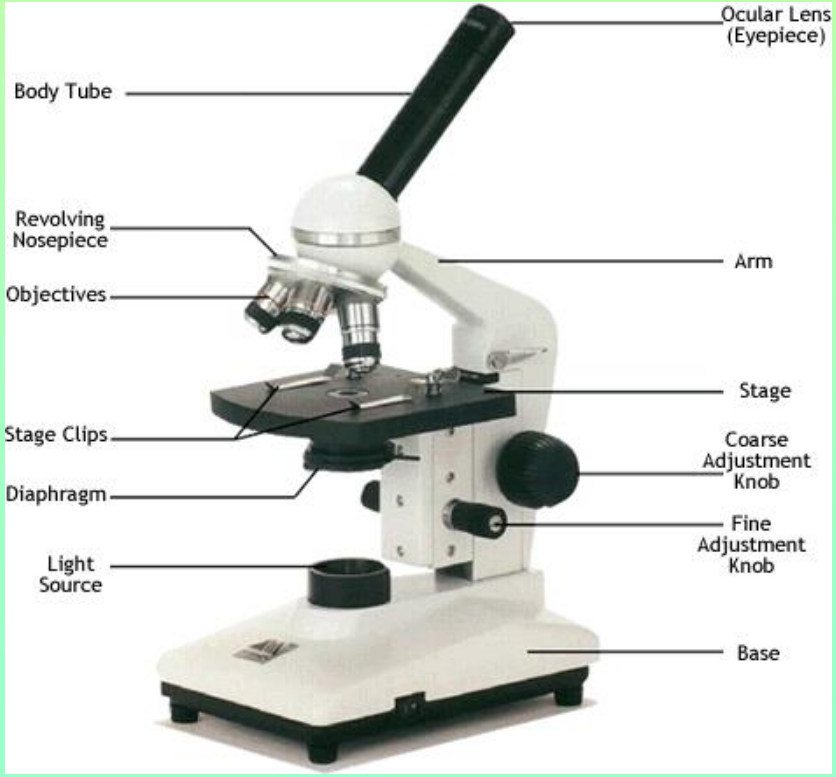
• usage the electromagnets instead of glass lenses

TEM transmission: the beam go through a thin specimen - ultrastructure

SEM scanning: the electron beam scans the surface of the sample

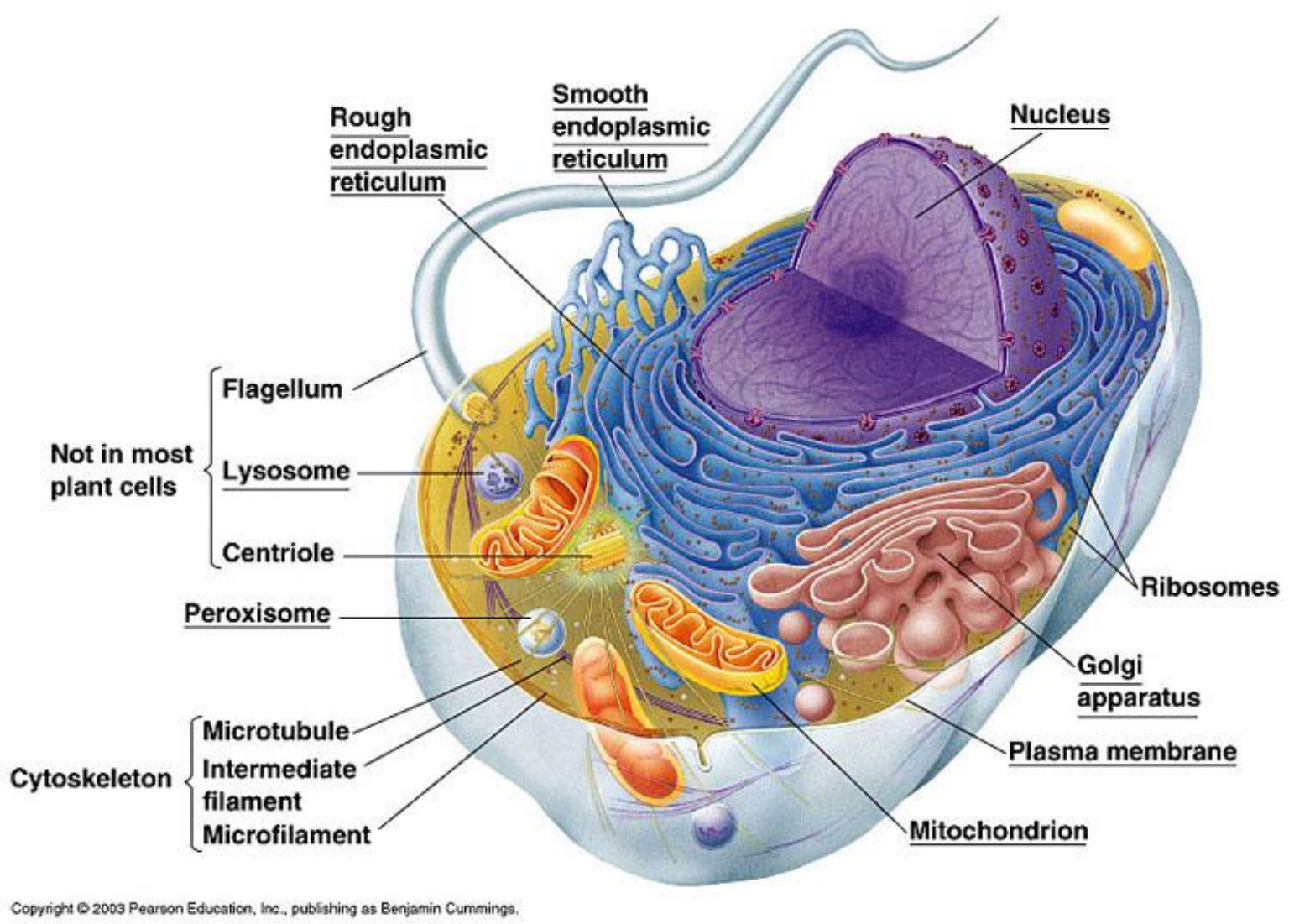
* TEM

SEM



Light microscope

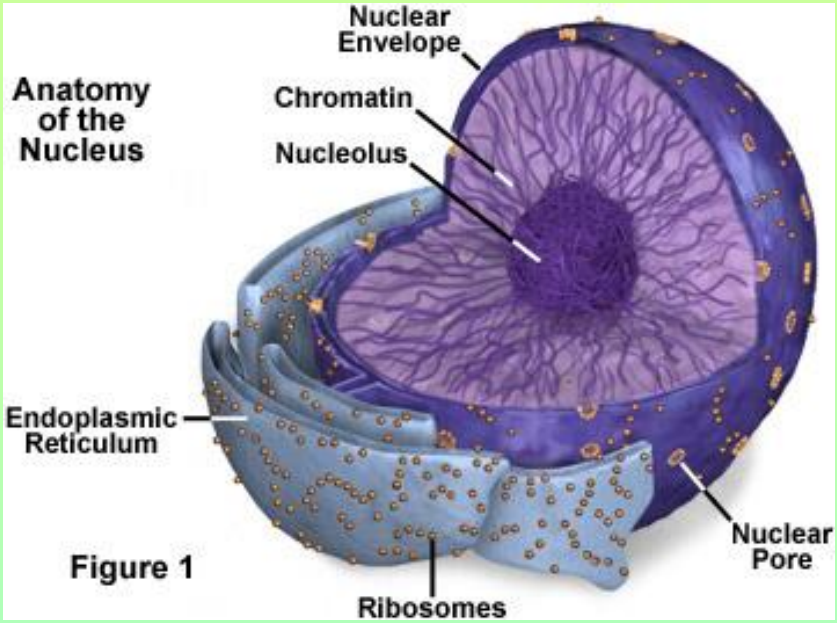
Eukaryotic cell



Cytoplasm = cytosol + organelles

The nucleus

Nuclear envelope is a **double** envelope, each membrane is **phospholipid bilayer** with proteins, between them is **perinuclear space**

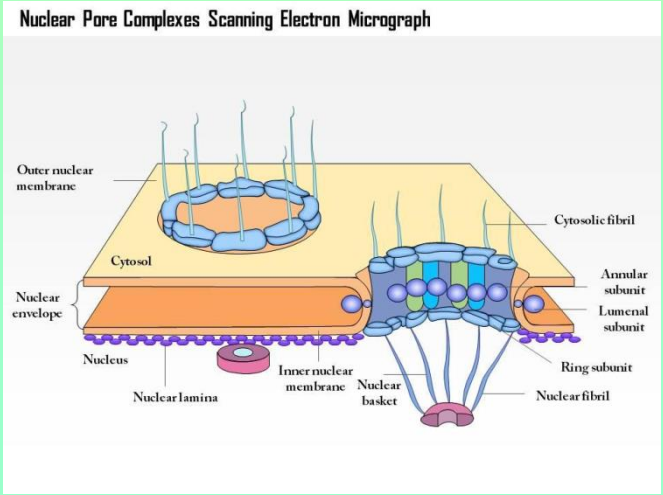


N. envelope is perforated by **pores.**

Chromatin consists of DNA, histons and non-histon proteins.

Nucleolus (one or more) represents place of synthesis of ribosomal DNA, rRNA

During cell division = mitosis, chromatin condensates to chromosomes



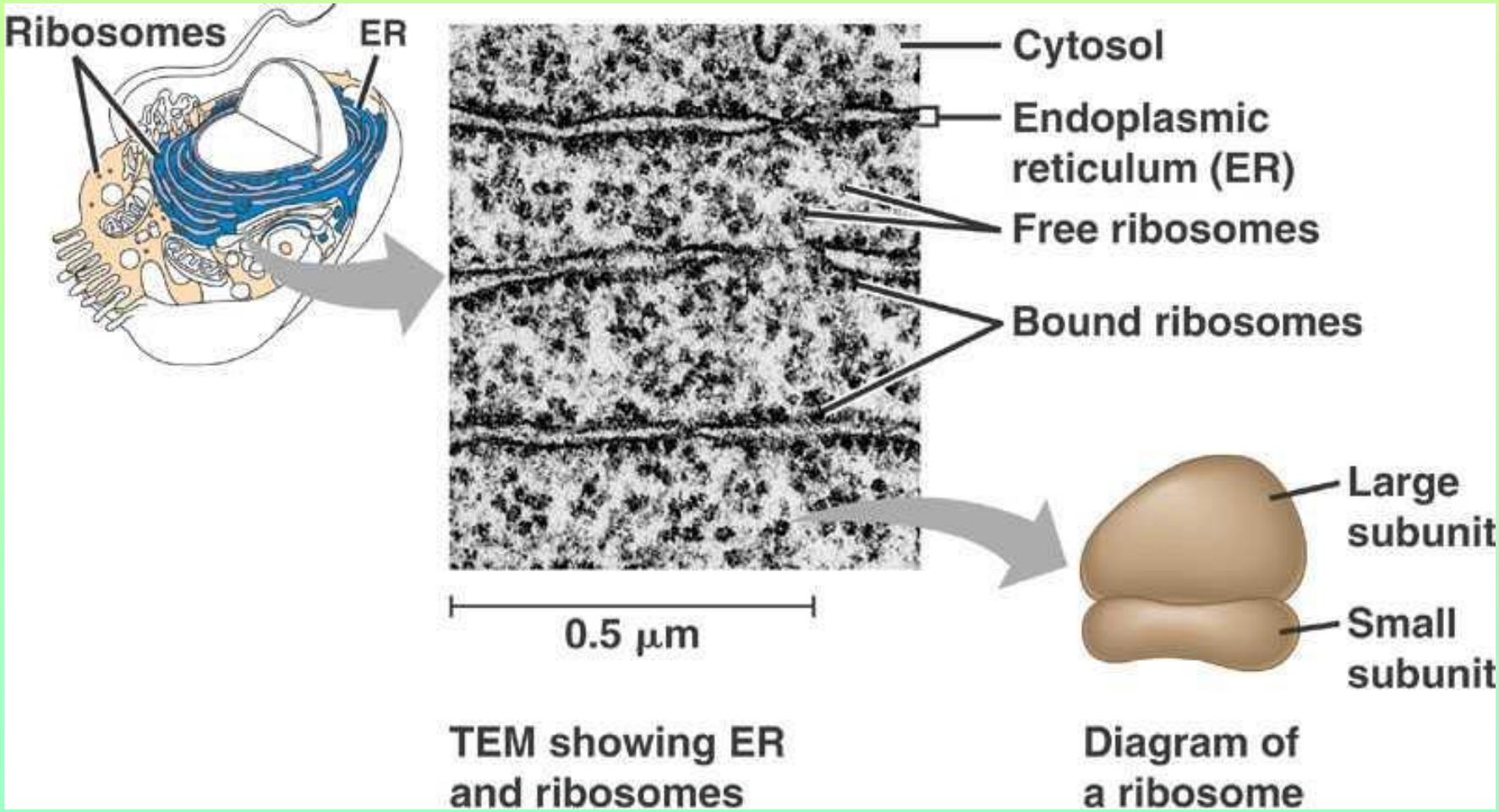
Nucleus controls a protein synthesis by sending molecular messengers in the form of RNA = hnRNA, then **mRNA - messenger** - **TRANSCRIPTION.**

mRNA is synthesized in nucleus according to sequences of DNA.

In ribosomes mRNA = genetic information is translated into the primary structure of a specific peptide - **TRANSLATION**

- **free ribosomes –** occurred in the cytosol - translation of proteins with function in cytosol
- **bound ribosomes** are attached to membrane network called the endoplasmatic reticulum (the rough one); translation of proteins intended to be in the membrane and for export from the cell = **secretory proteins**

Ribosomes


Ribosomes
ER
Cytosol
Endoplasmic reticulum (ER)
Free ribosomes
Bound ribosomes
0.5 μm
Large subunit
Small subunit
TEM showing ER and ribosomes
Diagram of a ribosome

The endomembrane system

Nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosoms, various kinds of vesicles and plasma membrane

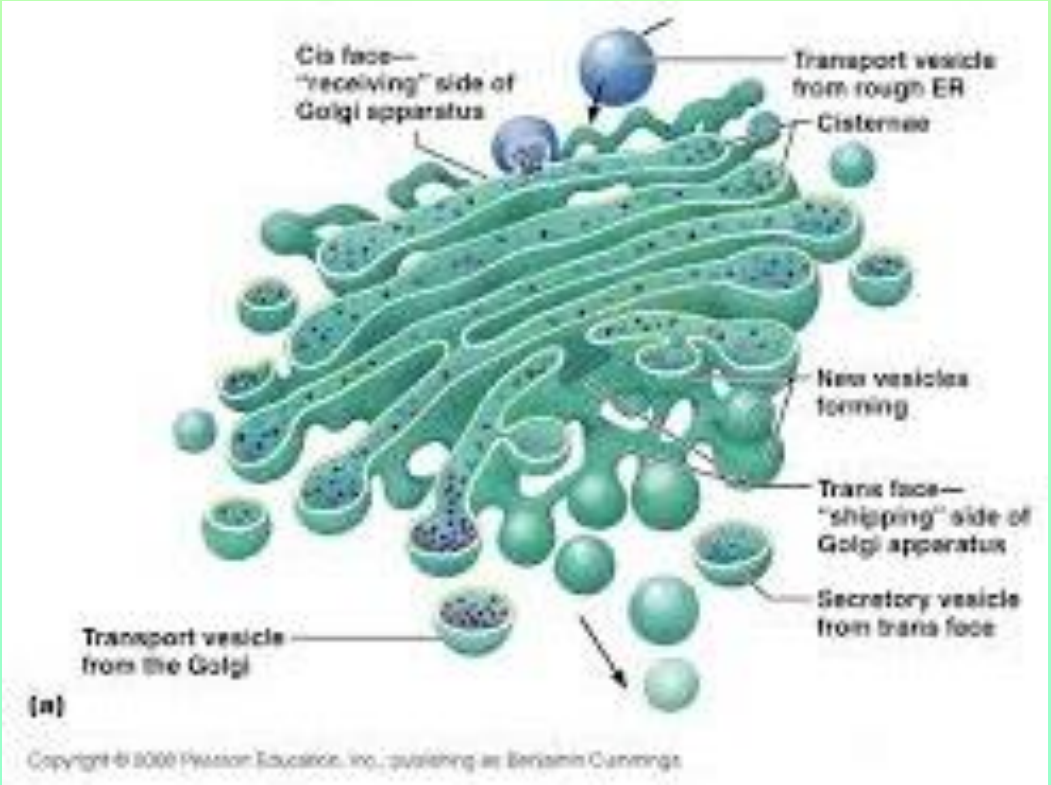
- **ER** consist of a network of membranous tubules and sacs called cisternae, ER passes into nuclear envelope
- **Smooth ER -** cytoplasmic surface lacks ribosomes
- **Rough ER** – ribosomes are attached to the cytoplasmic side

Golgi apparatus – function is sorting of cell products, also modification and storage (removes sugar monomers and product diverse oligosaccharides). Two poles are referred to as the ***cis*** face ad ***trans*** face

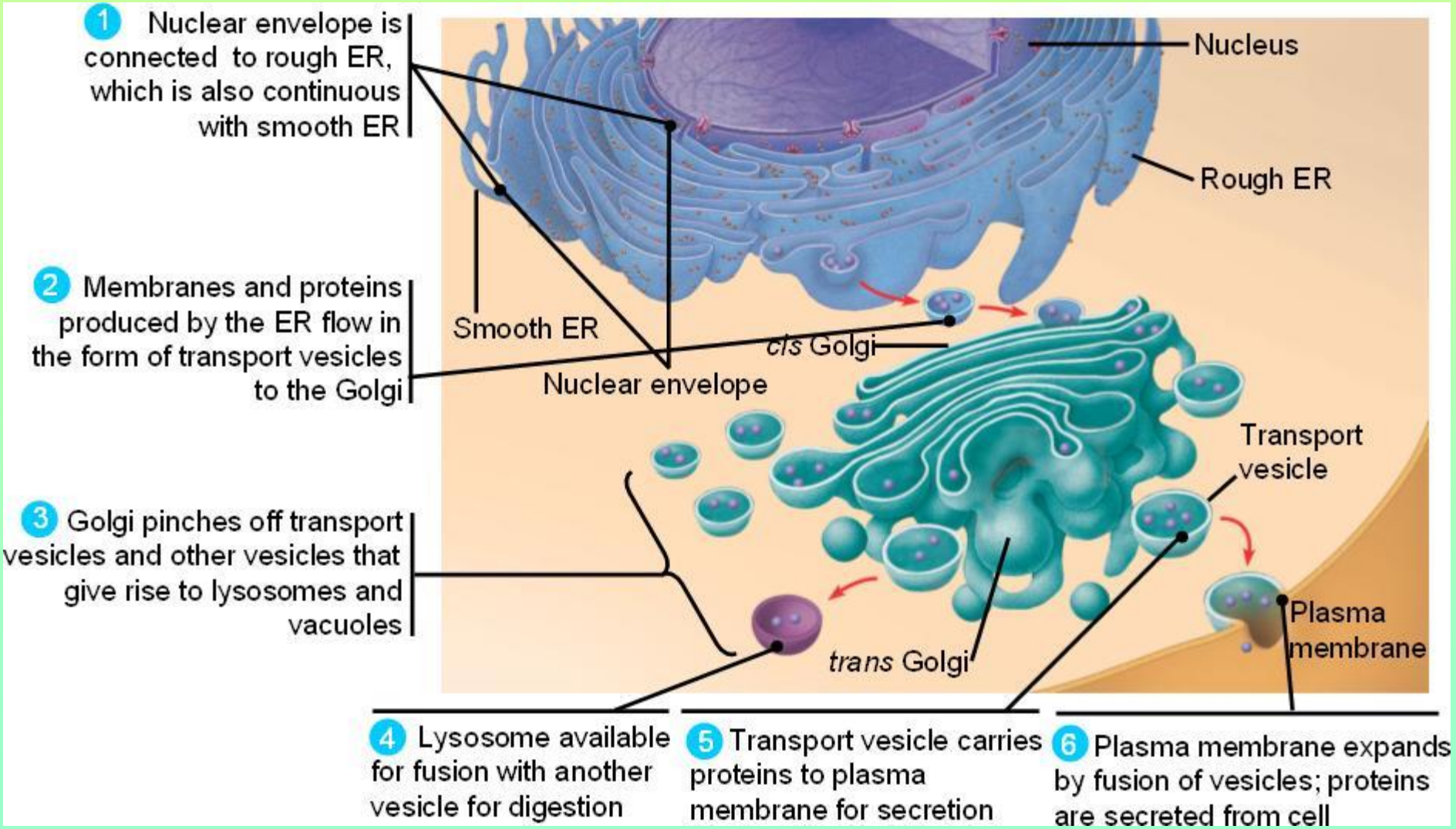
Function of the smooth ER – synthesis of lipids (phospholipids, steroids), metabolism of carbohydrates (glycogen) and detoxification of drugs (barbiturates) and poisons

Function of the rough ER – secretion of proteins, glycoproteins; formation of transport vesicles to other components of endomembrane system

Golgi apparatus



Organelles of the endomembrane system



Exocytosis and Endocytosis

= transport of large molecules

Cell secretes macromolecules by a fusion of vesicles (of Golgi ap.) with plasma membrane = **Exocytosis.**

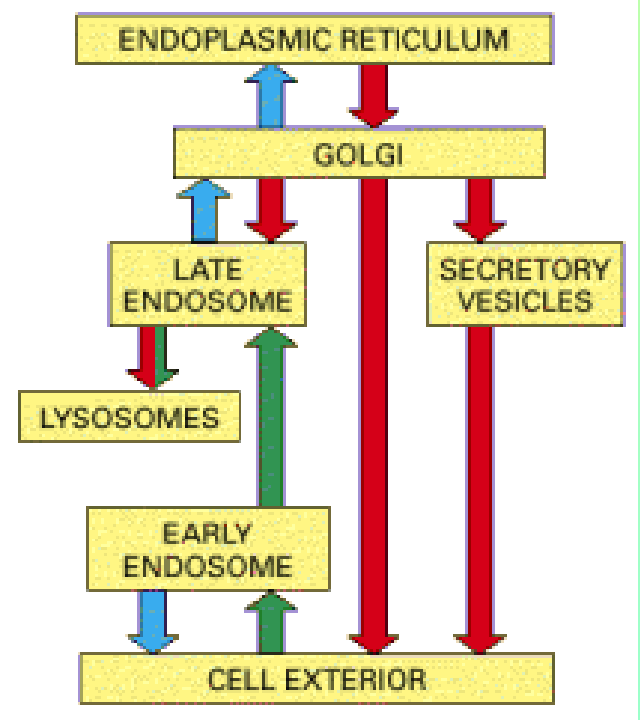
Endocytosis – cell intakes macromolecules by forming new vesicles from plasma membrane

three types of endocytosis :

Phagocytosis – cell intakes a particle

Pinocytosis – cell intakes droplets of extracellular fluid

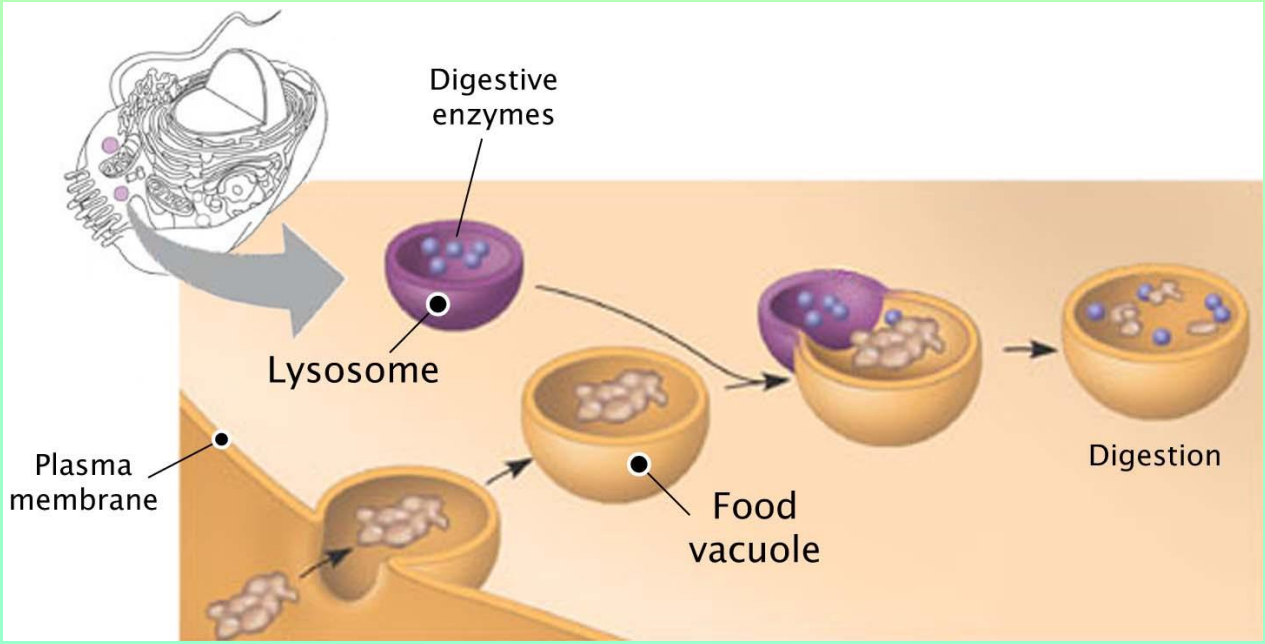
Receptor-mediated endocytosis is very specific – receptor and ligand



Lysosomes are digestive compartments

It is membrane bounded sac of **hydrolytic enzymes.** Enzymes **hydrolyze** in acidic environment (pH 5) proteins, polysaccharides, fats and nucleic acids.

Function is **intracellular digestion** of food particles, smaller organisms and organic components intaken by **phagocytosis** and own organic old material by **autophagy.**



Vacuoles, vesicles

- membrane–bounded sacs
- vacuoles have various functions: food vacuoles
  contractile vacuoles
  tonoplast

Mitochondria and chloroplasts

are semiautonomous organelles,

that grow and reproduce in the cell.

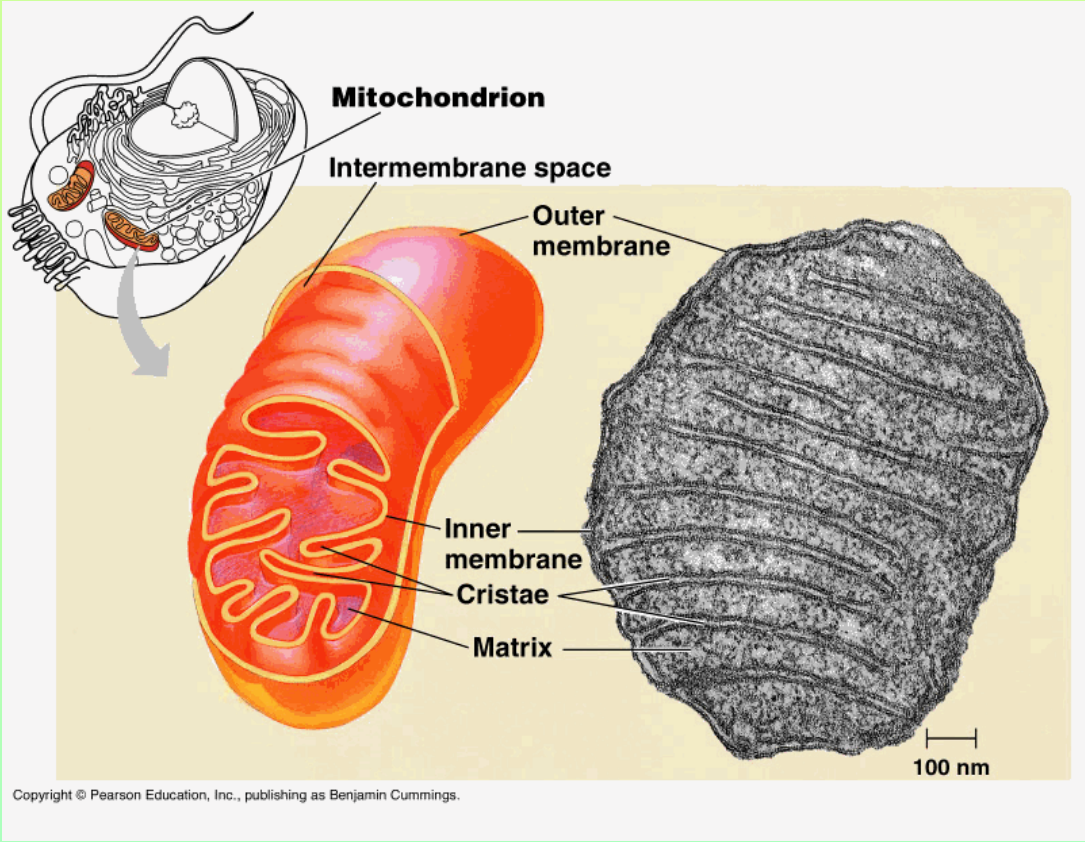
Mitochondria are places of cellular respiration.

Chloroplasts are the places of photosynthesis

They contain their own DNA (prokaryotic type), produce or convert energy (ATP) that cells use for work, all processes.

Mitochondria

are in all eukaryotic cells (hundreds or thousands). They have two membranes, each is phospholipid bilayer with a unique collection of embedded proteins



The outer membrane is smooth, the inner membrane is convoluted with infoldings called **cristae**

Intermembrane space between membranes

Mitochondrial matrix – Citric acid cycle

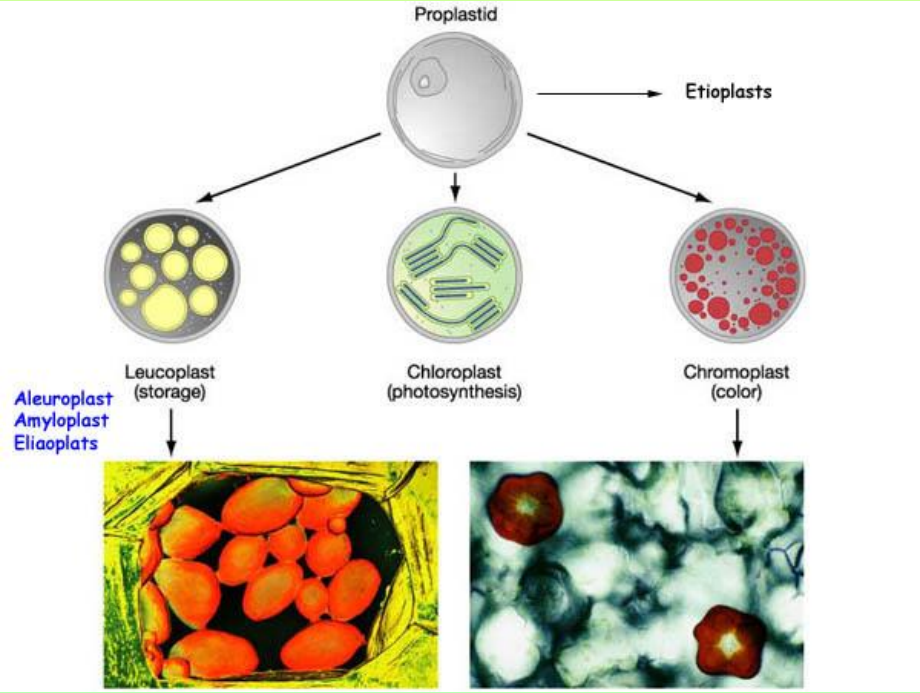
Chloroplast

A member of plant organelles family called **plastids:**

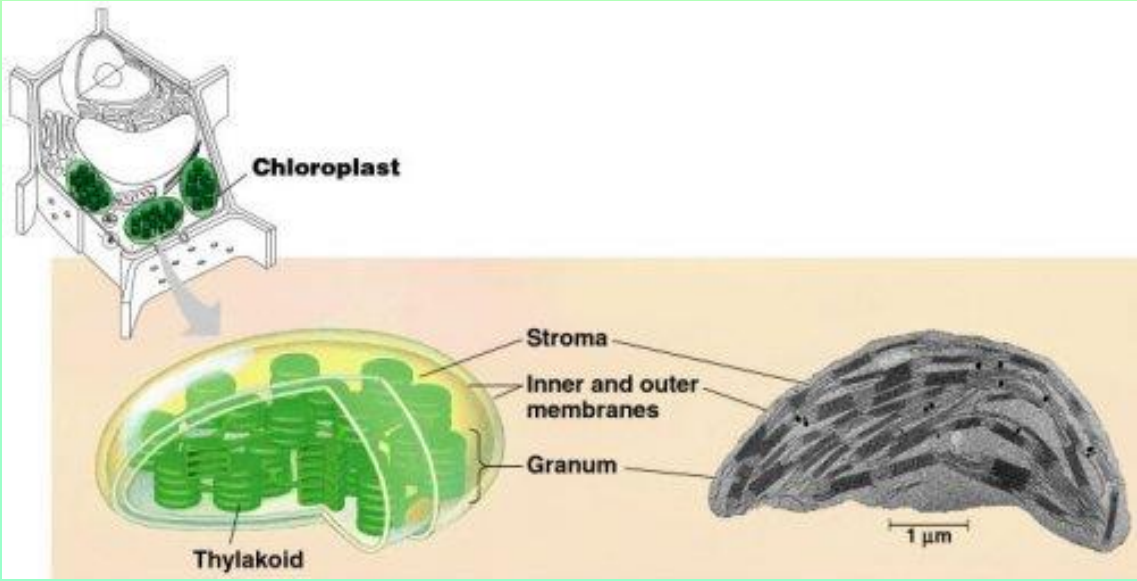
leukoplast - starch

Chromoplasts - pigment

chloroplasts **- photosynthesis**



Inside is inner membranous system with **thylakoids,** outside of it is **stroma.**



The cytoskelet

Is the dynamic networks of protein fibers throughout the cytoplasm

Function is support, motility, regulation

microtubules microfilaments

intermediate filaments

SUMMARY TABLE 7.3 **Cytoskeletal Filaments**

The three types of filaments found in the cytoskeleton are distinguished by their si

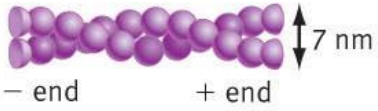
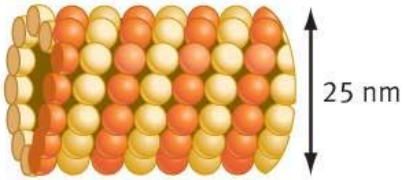
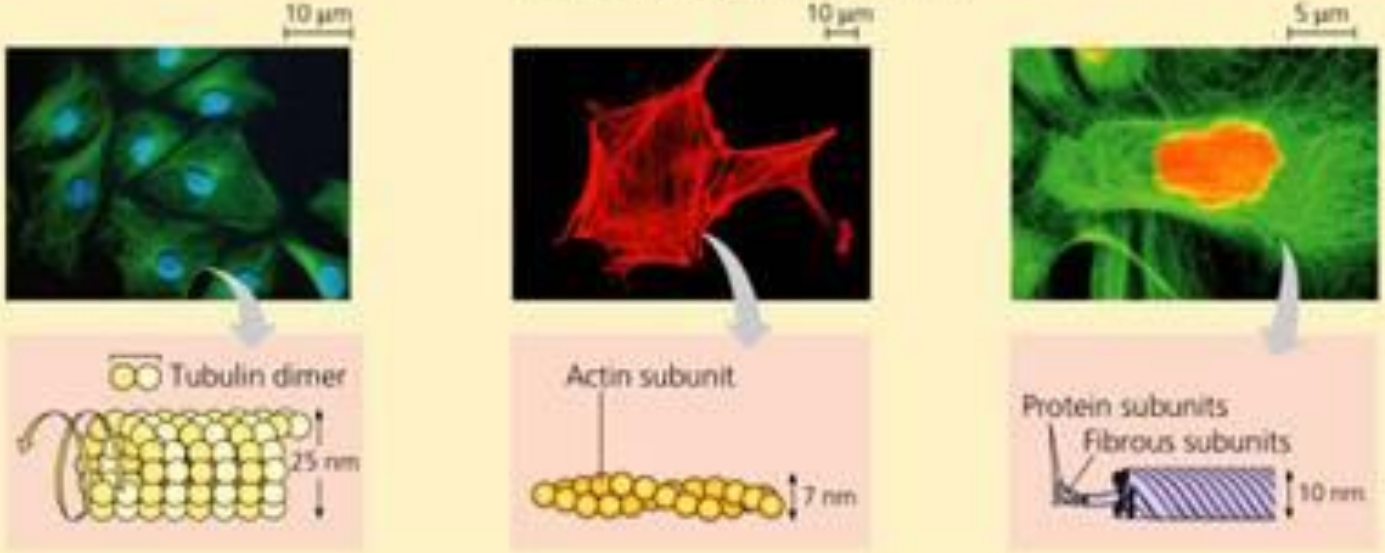
	Structure	Subunits
Actin filaments (microfilaments)	Strands in double helix 	Actin 
Intermediate filaments	Fibers wound into thicker cables 	Keratin or vimentin or lamin or others 
Microtubules	Hollow tube 	α- and β-tubulin dimers 

Table 7.2 The Structure and Function of the Cytoskeleton

Property	Microtubules	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, consisting of α-tubulin and β-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



SOURCE: Adapted from W. M. Becker, L. J. Kleinsmith, and J. Hardin, *The World of the Cell*, 4th ed. (San Francisco, CA: Benjamin Cummings, 2000), p. 753.

1. **Compression-resisting function**, **the axoneme of cilia and flagella, the mitotic spindle during mitosis,** intracellular transport (associated with dyneins and kinesins), transport organelles like mitochondria or vesicles

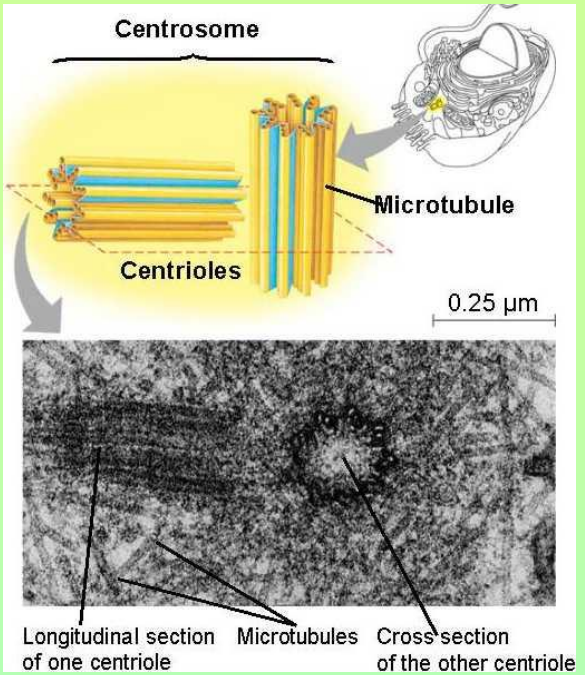
Dynamic behavior: polymerization (GTP), depolymerization.

2. The thinnest filaments consist of twisted two chains of actin subunits. Function is cell-shape, cell organization, **function in muscle**, **amoeboid movement of pseudopodia**

3. Function is cell-shape, **mechanical support**. They provide anchorage for many organelles and cytosolic enzymes.

Centrosomes and Centrioles

is an organelle that serves as the main **microtubule organizing center** (MTOC)
Microtubules grow from a centrosome,
inside is a pair of **centrioles** (in animal cells)
- **set of 9 triplets of microtubules**.
Subunits are α, β tubulin. Function is also cell shape, cell motility, cell division, organelle movementS.



Flagella and Cilia

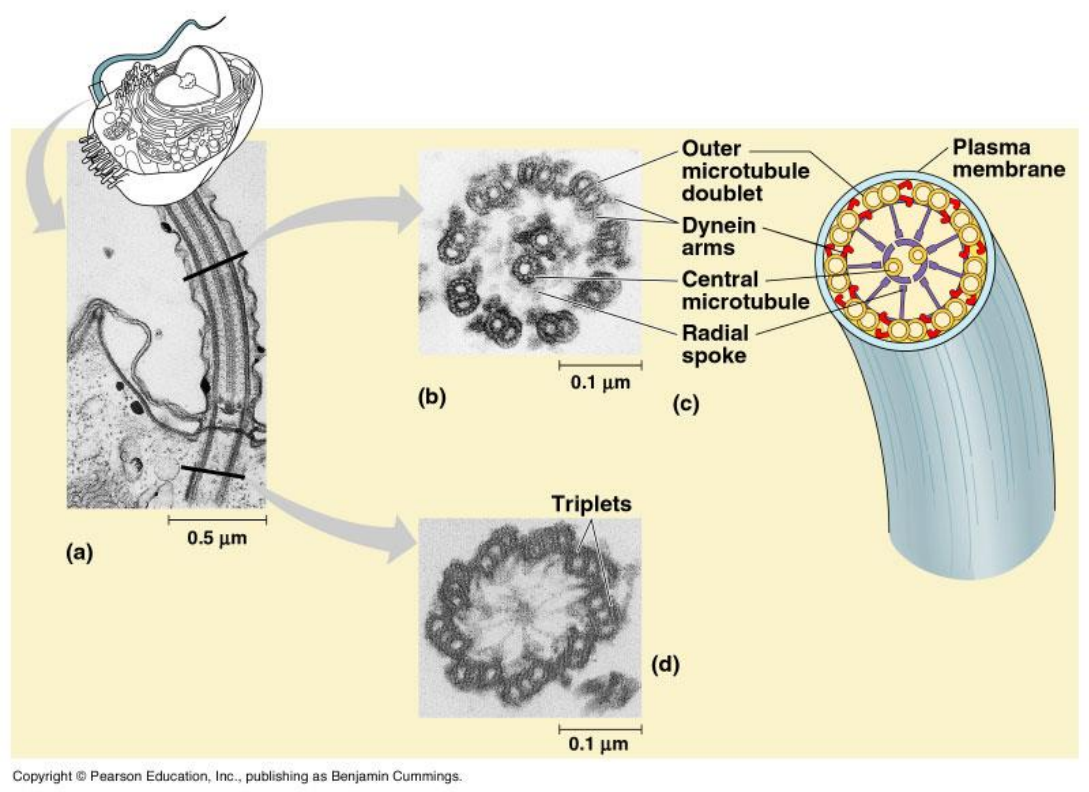
are in unicellular eukaryotic organisms, sperm of animals, algae and some plants
Cilia occur in large numbers on the cell surface.
Cilia work like oars:

Flagellum

Flagella are longer and their number is usually limited to just one or few. They do not work without the **motor molecule called dynein.**

Basal body of flagellum is identical to centriole.

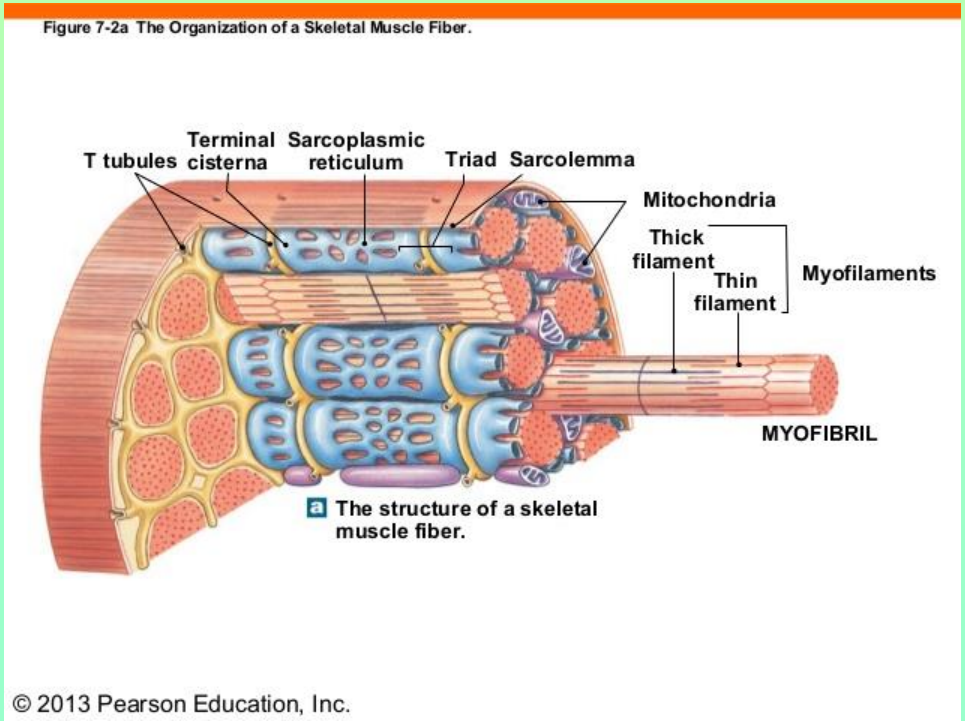
The core of flagellum and cilia is **Axoneme - 9 doublets of outer microtubules and one doublet of inner microtubule**



Microfilaments - Actin filaments

Molecules of **G actin** = a globular protein polymerizes into **F** fibrilar actin protein, which is a twisted double chain of actin subunits. Function is to bear tension (pulling forces) and

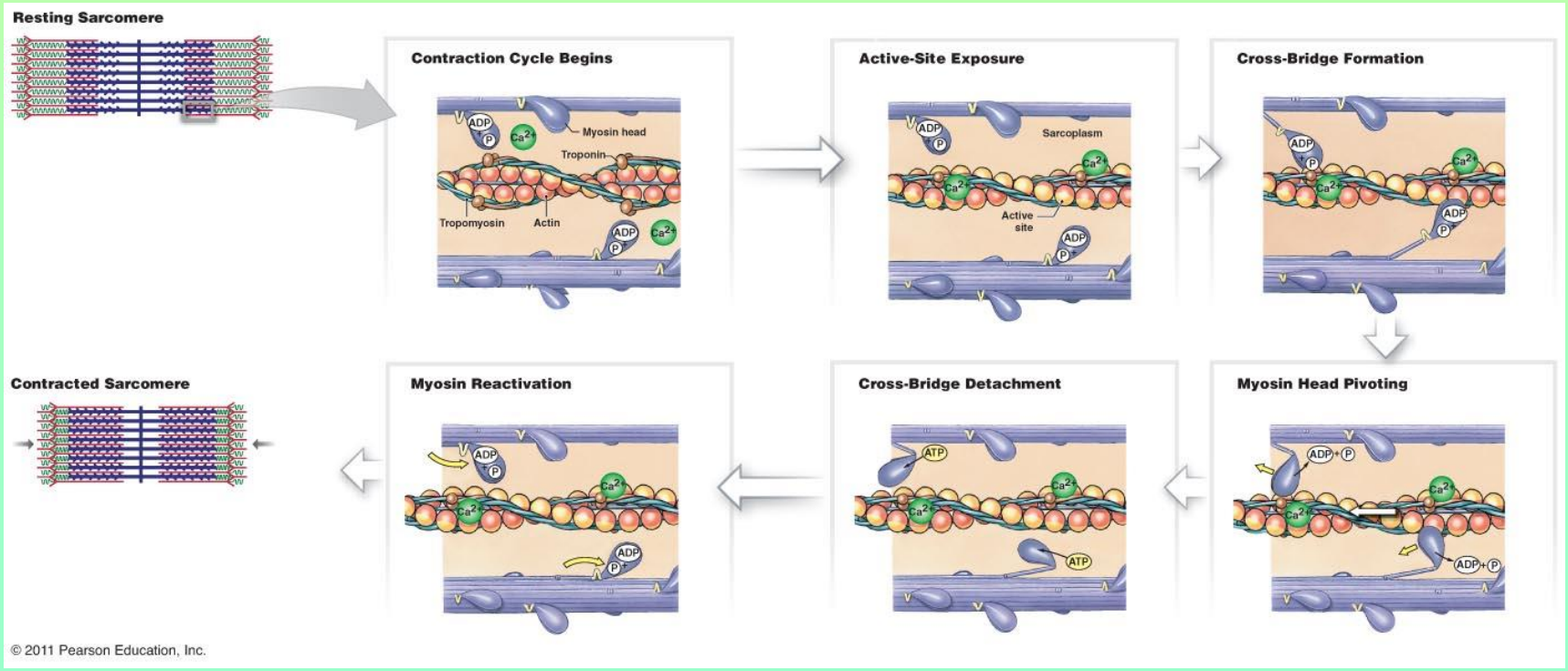
ameboid movement (Protists). They provide extension and contraction of **pseudopodia,** also actin provides maintenance of shape and changes of shape.



Function of actin **in Muscles**

Protein **myosin is** arranged parallelly to actin. **Actin and myosin interact.** As the heads of myosin slide (walk), the muscle get shorted and contracts.

Essential is presence of ATP and Ca^{+}



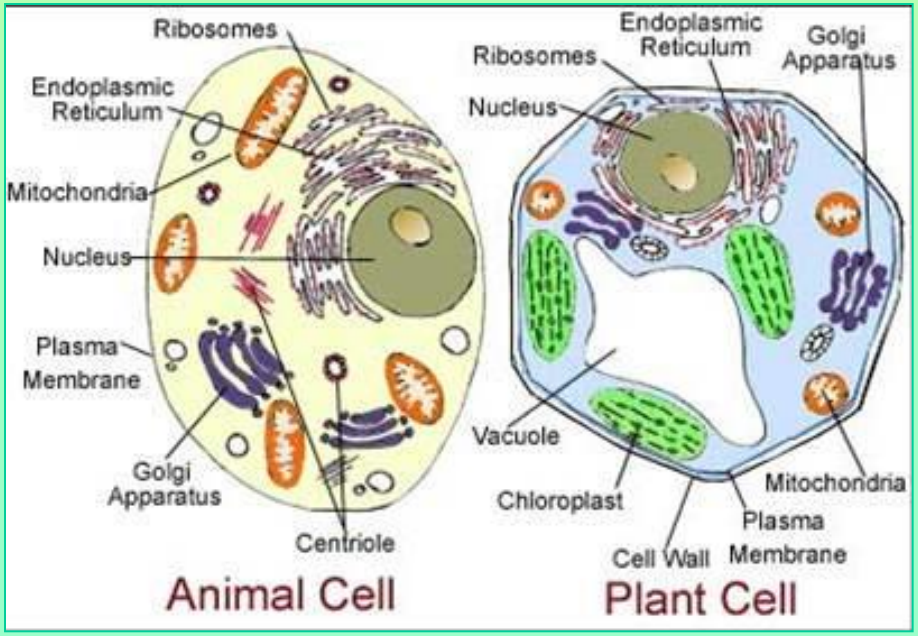
Plant Cells:

have chloroplast
run photosynthesis
have cell wall
one large vacuole
are rectangular

Animal Cells:

don't have chloroplast
don't have cell wall
one or more small vacuoles
either circular or have irregular shape

Cellulose of plant cell walls helps to plant cells to allow high pressure to build inside of it, without bursting. A plant cell has to be able to accept large amounts of liquid through osmosis, without being destroyed. An animal cell does not have this cell wall. If you start to fill the animal cell with too much distilled water or other fluid, it will eventually burst.



Campbell, Neil A., Reece, Jane B., Cain Michael L., Jackson, Robert B., Minorsky, Peter V.**, Biology**, Benjamin-Cummings Publishing Company, 1996 –2010.