

# Cells

Structure, Function and  
Homeostasis

# Cell Functions

- Protection and support (bones, keratin, mucus)
- Movement (muscle cells contract)
- Communication (produce hormones, propagate sensory information)
- Harness & use Energy (body heat, enzyme production)
- Inheritance (maintains and copies blueprint for life)

# Types of Eukaryotic cells



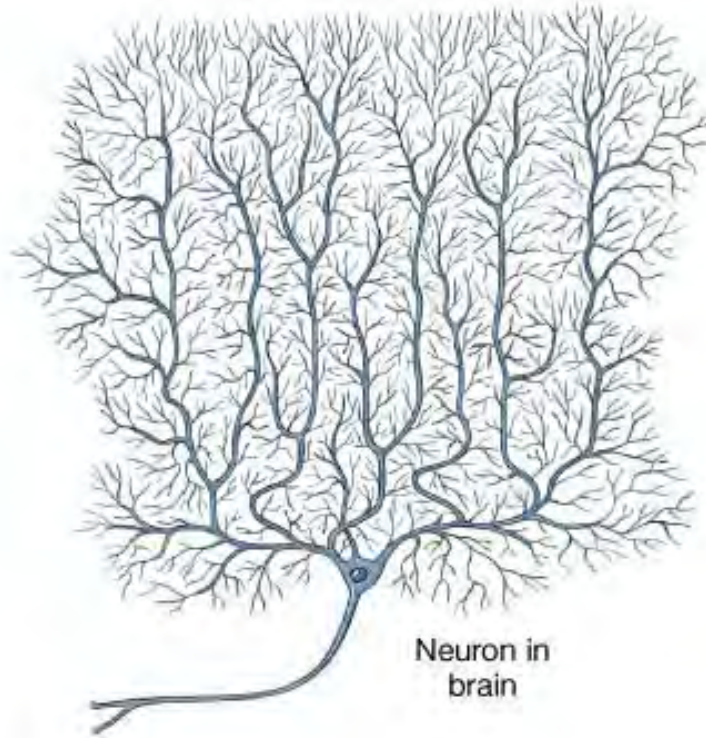
Smooth muscle cell



Blood cells



Bone cell



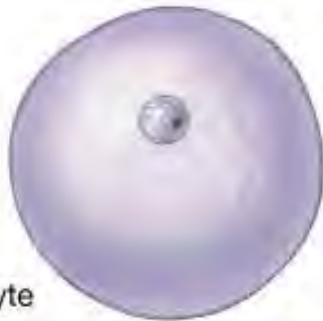
Neuron in brain



Cells lining intestinal tract



Fat cell



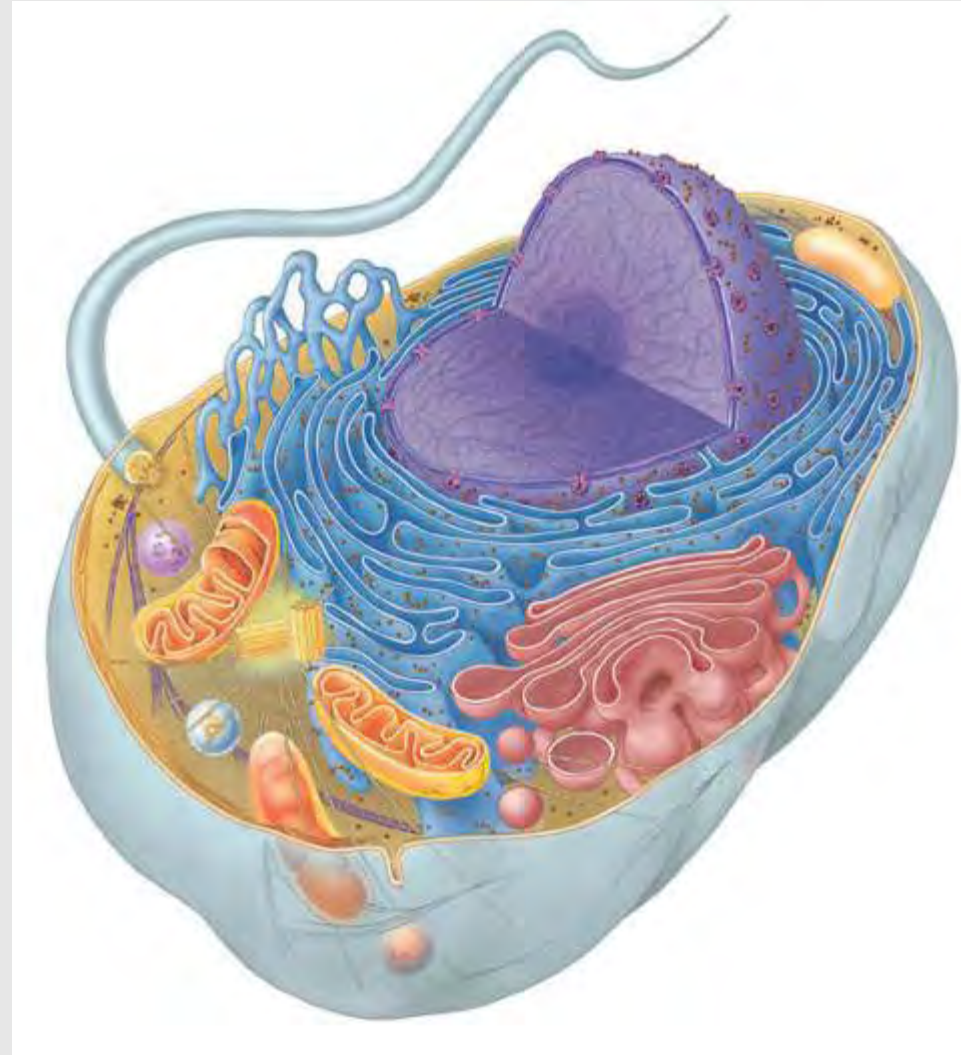
Oocyte



Sperm

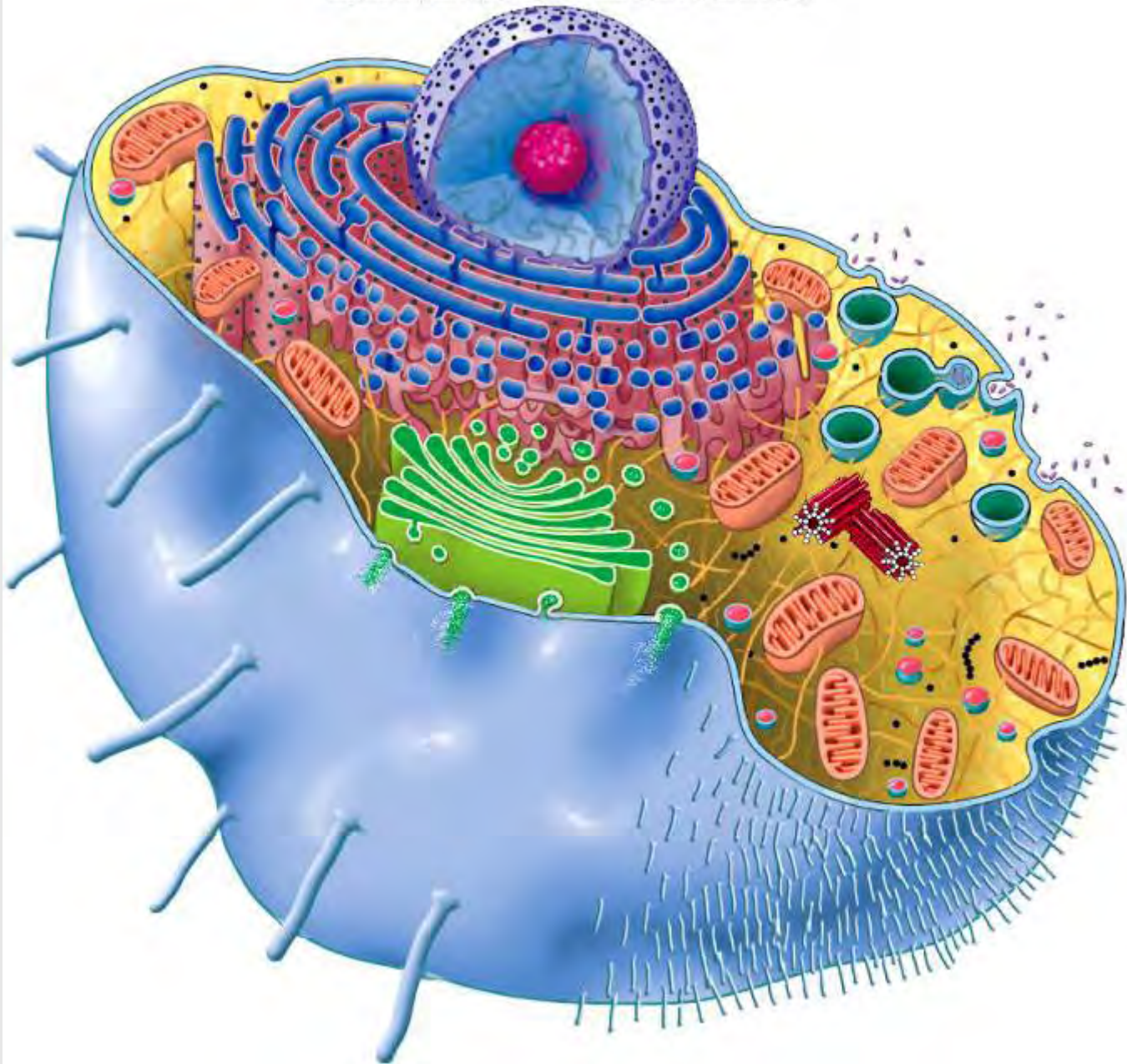
# Human cell anatomy

- Nucleus
- Smooth & Rough Endoplasmic Reticulum
- Golgi Apparatus
- Lysosomes
- Peroxisomes
- Plasma membrane
- Mitochondria
- Cytoskeleton
- Centrioles \*\*
- Flagellum \*\*



# Three Major Parts

1. **Cell (plasma) membrane** - barrier between inside and outside (*skin*)
2. **Cytoplasm** - organelles, free proteins, ions (*guts*)
3. **Nucleus** - Control center for decision-making, responding to environment and replicating genetic material (*nervous system*)

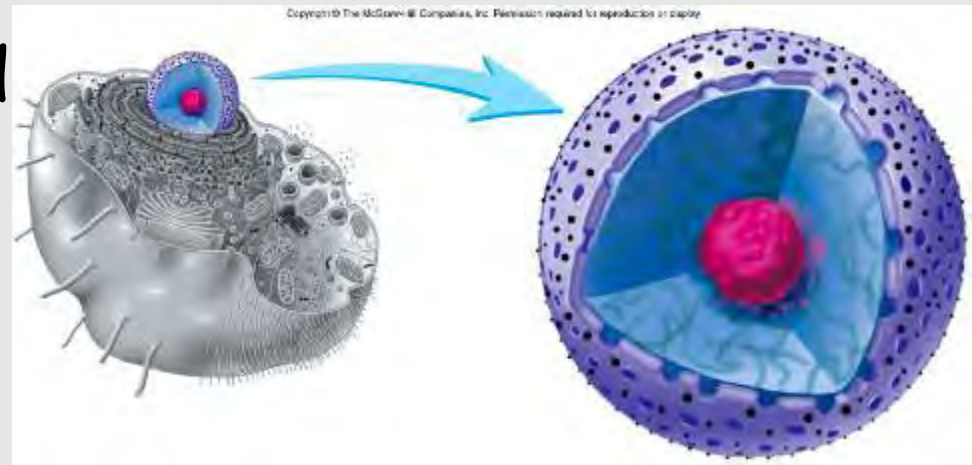


# Questions for the cell

- What structure controls which proteins, lipids & RNA are produced and when?
- Where do cells get Energy? Which structures harness is?
- What structures move stuff around the cell?
- Where are proteins and lipids built?
- How does the cell move stuff in and out?
- How does it eat, drink and defend itself?

# Nucleus: Integrator (Control center)

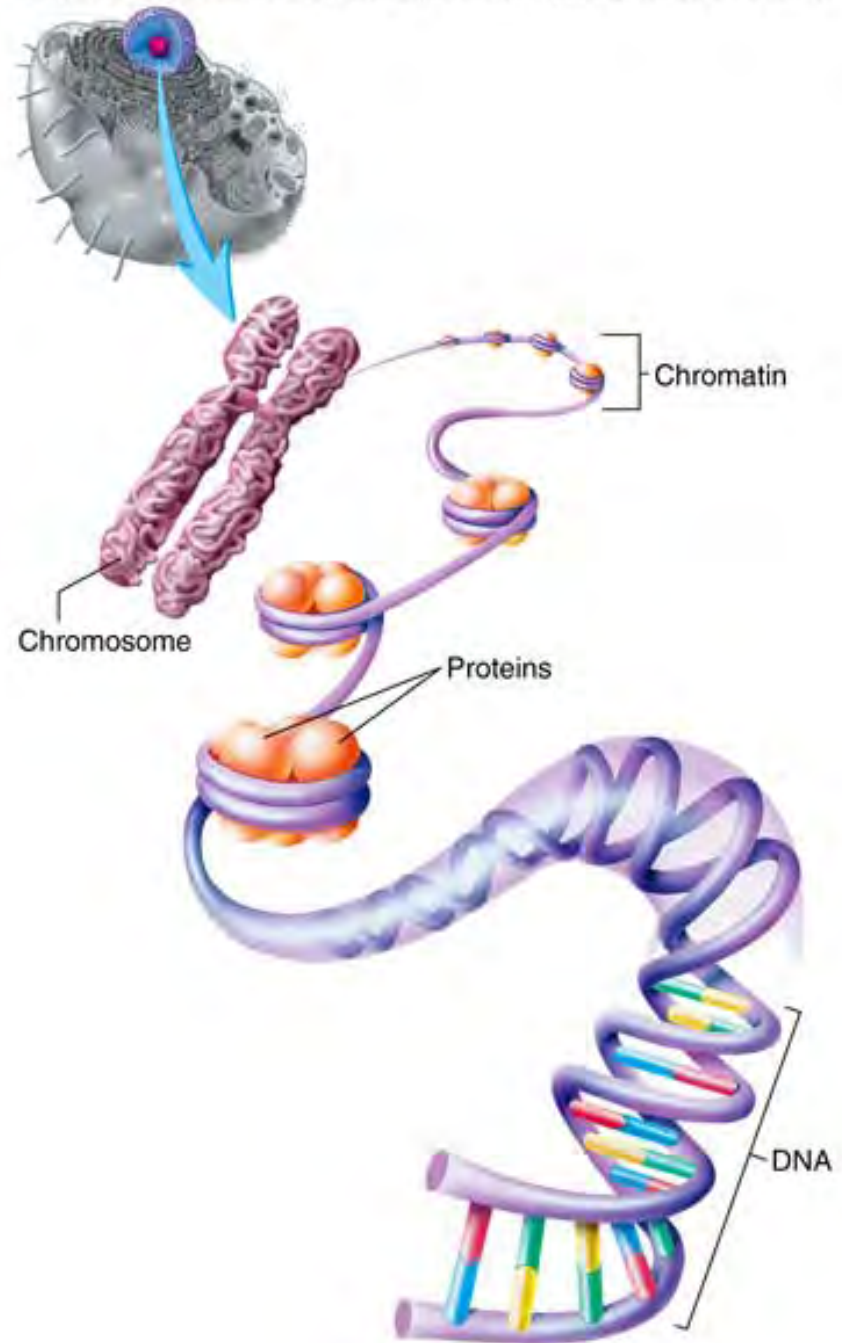
- Holds genetic code and "machinery" for replication and transcription
- Bounded by **nuclear envelope** (inner and outer membrane)
- Present in every cell at some life-stage



- Nuclear pores
- Chromatin
- Chromosomes



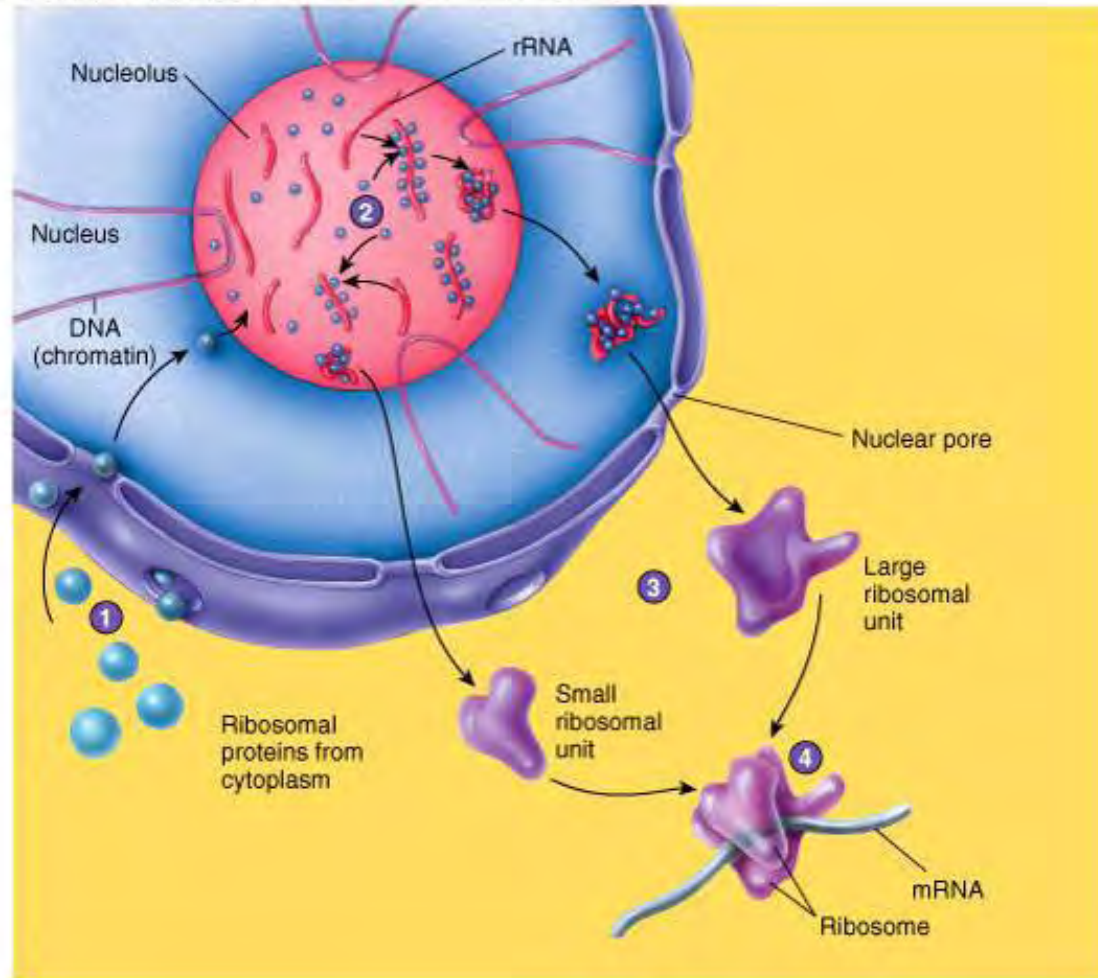
- **Chromosomes?**
  - Hypercoiled DNA
- **Chromatin?**
  - Histone coiled DNA



# Nucleoli

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- 1 - 4 per nucleus
- Produce ribosomal RNA (**rRNA**)
- Site of ribosome construction (attaches **rRNA** to ribosomal proteins)

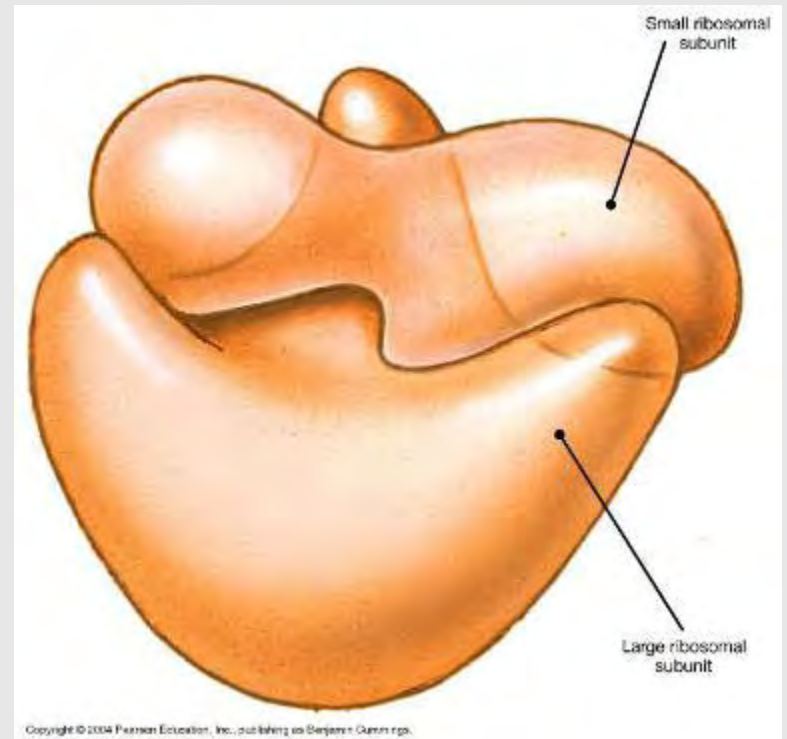


# Where is the **cytoplasm**?

- Between cell membrane & nuclear membrane
- Consists of:
  - **Cytosol**: intracellular fluid (mostly H<sub>2</sub>O, ions & buffering proteins)
  - **Organelles**: structures with specific functions; suspended in cytosol
  - **Inclusions**: Insoluble materials (lipids)

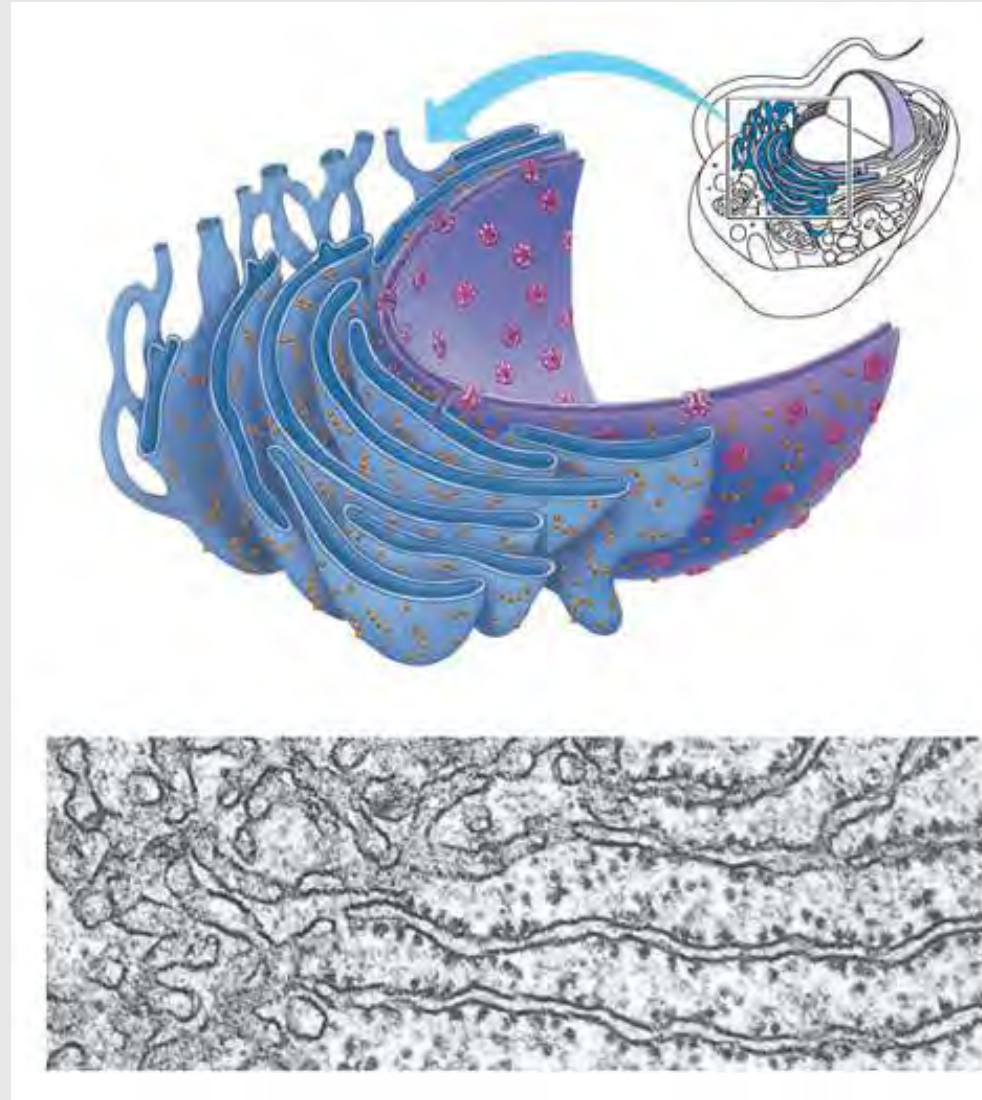
# Ribosomes

- Site of protein synthesis
- Consist of 2 subunits, each made of rRNA + protein
- Two varieties
  - **Free** ribosomes: produce proteins that travel to nucleus
  - **Fixed** ribosomes: produce proteins for export to Endoplasmic Reticulum (ER)



# Endoplasmic Reticulum (ER)

- Network of membranes connected to nuclear envelope
- 4 major functions
  1. Synthesis (pro, carbs, lipids)
  2. Storage
  3. Transport
  4. Detoxification
- Two types
  1. Smooth
  2. Rough

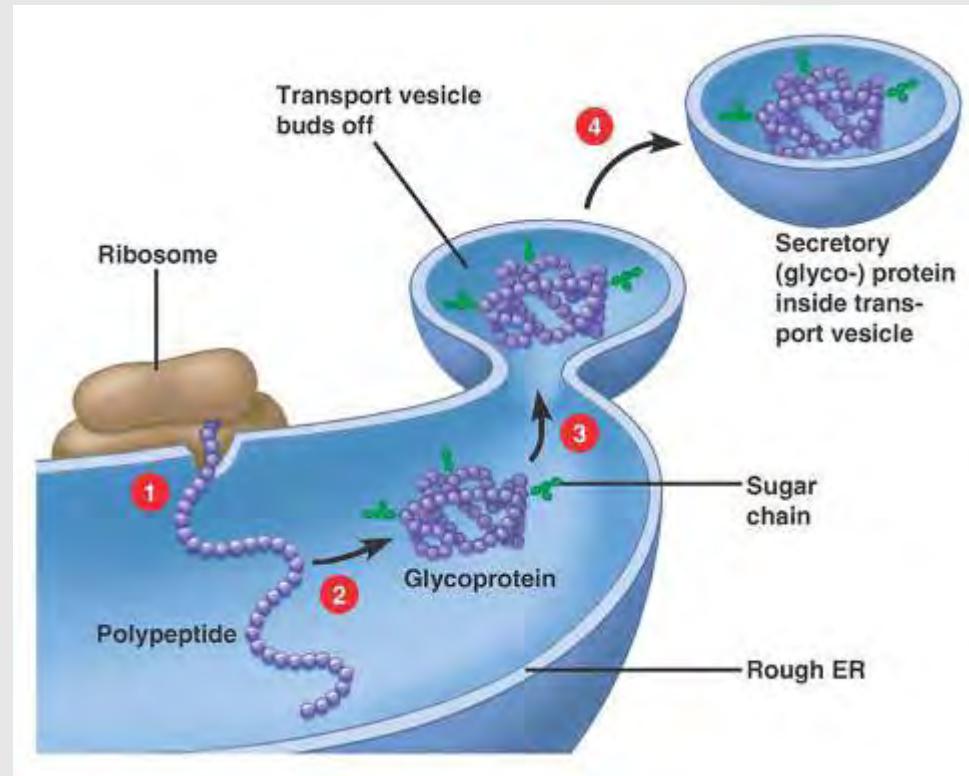


# Smooth ER (SER)

- Why is it called smooth?
- Responsible for the **synthesis and storage** of:
  - Phospholipids and cholesterol 4 maintenance and growth of membranes of cell, ER, nucleus, Golgi apparatus (GA) What type of molecules?
  - Steroid hormones: estrogens and androgens
  - Glycerides in liver and fat cells
  - Glycogen in skeletal muscle and liver cells  
What type of molecules?

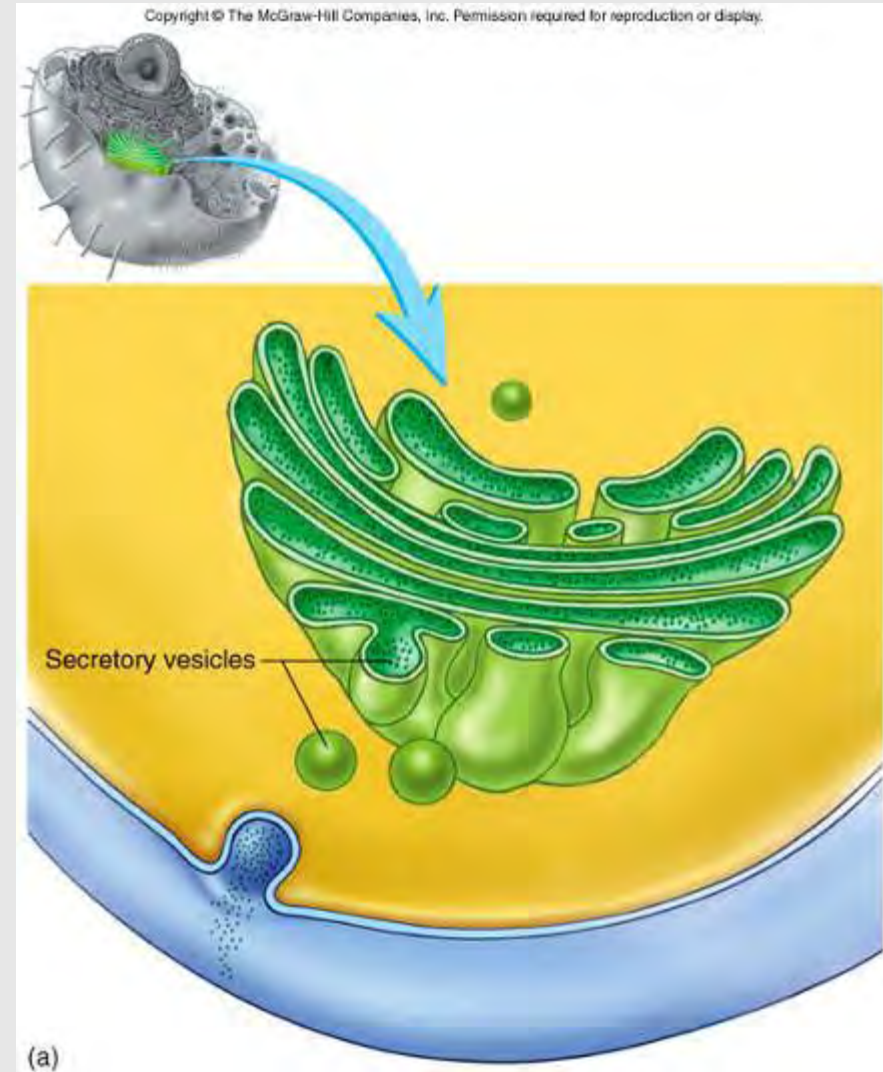
# Rough ER (RER)

- Workshop
- Synthesizes & chemically modifies *proteins* (fixed ribosomes!!).
  - Polypeptide chains migrate into **cisternae**, assume tertiary structure + additional modification
- Ships proteins to GA via **transport vesicles**



# Golgi Apparatus

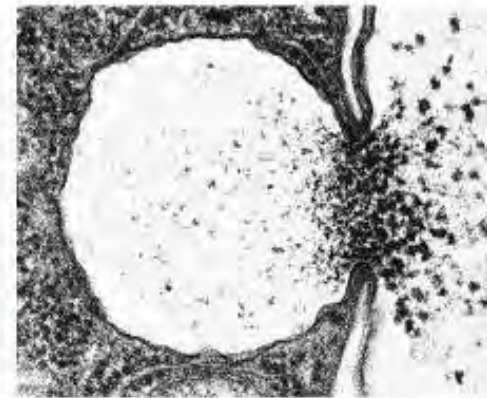
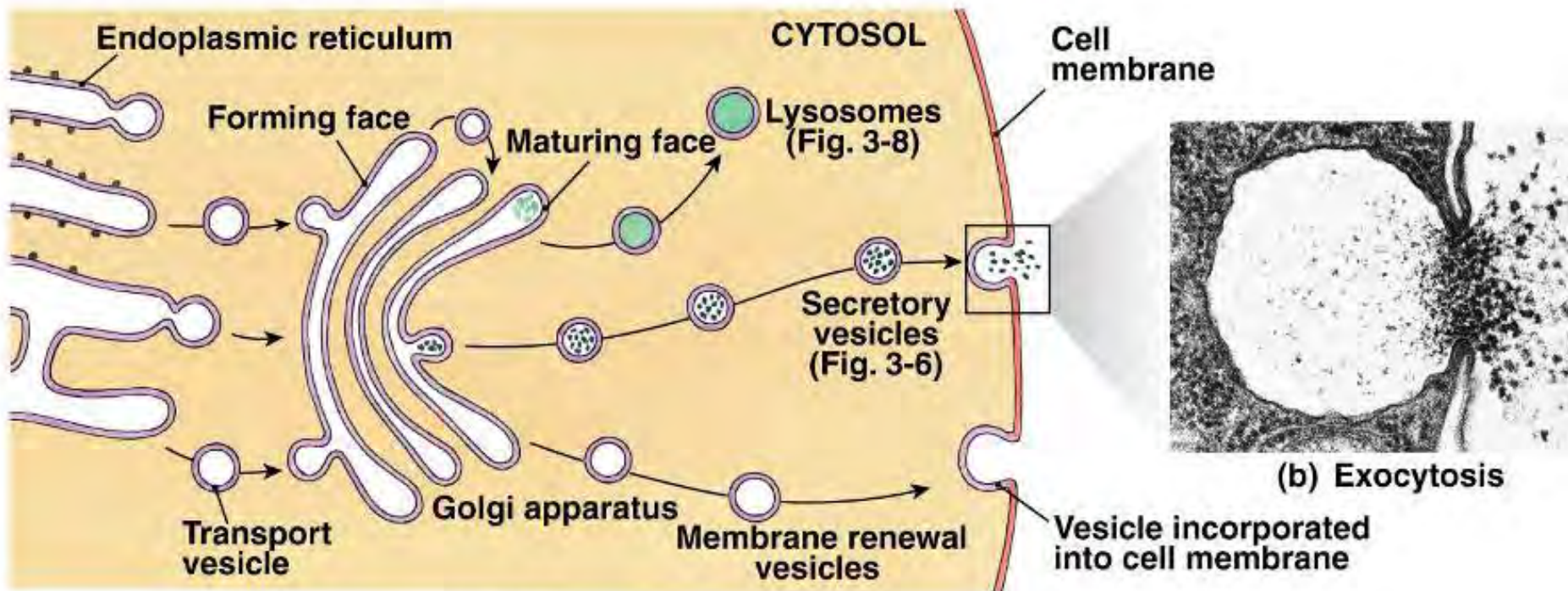
- Packing & shipping depot
- Consists of 5-6 flattened membranous disks (**cisternae**)
- Functions
  - Modifies (adds parts) & packages secretions
  - Renews cell membrane
  - Packages special enzymes





# Functions of GA

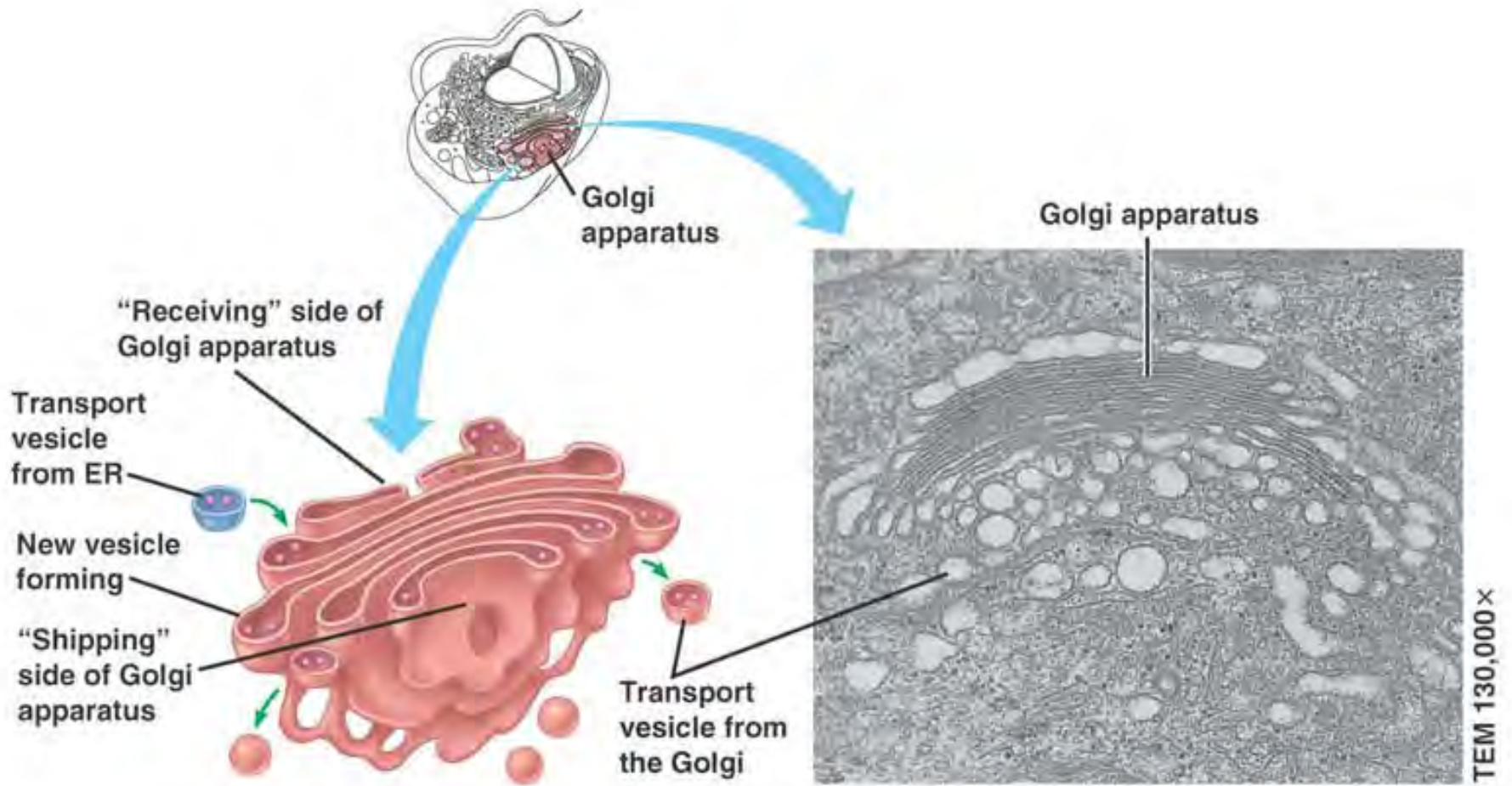
- Produces 3 export vesicles:
  1. Secretory - **exocytosis**
  2. Membrane renewal - *replacement & remodeling*
  3. **Lysosomes** - "Primary" contain inactive digestive enzymes



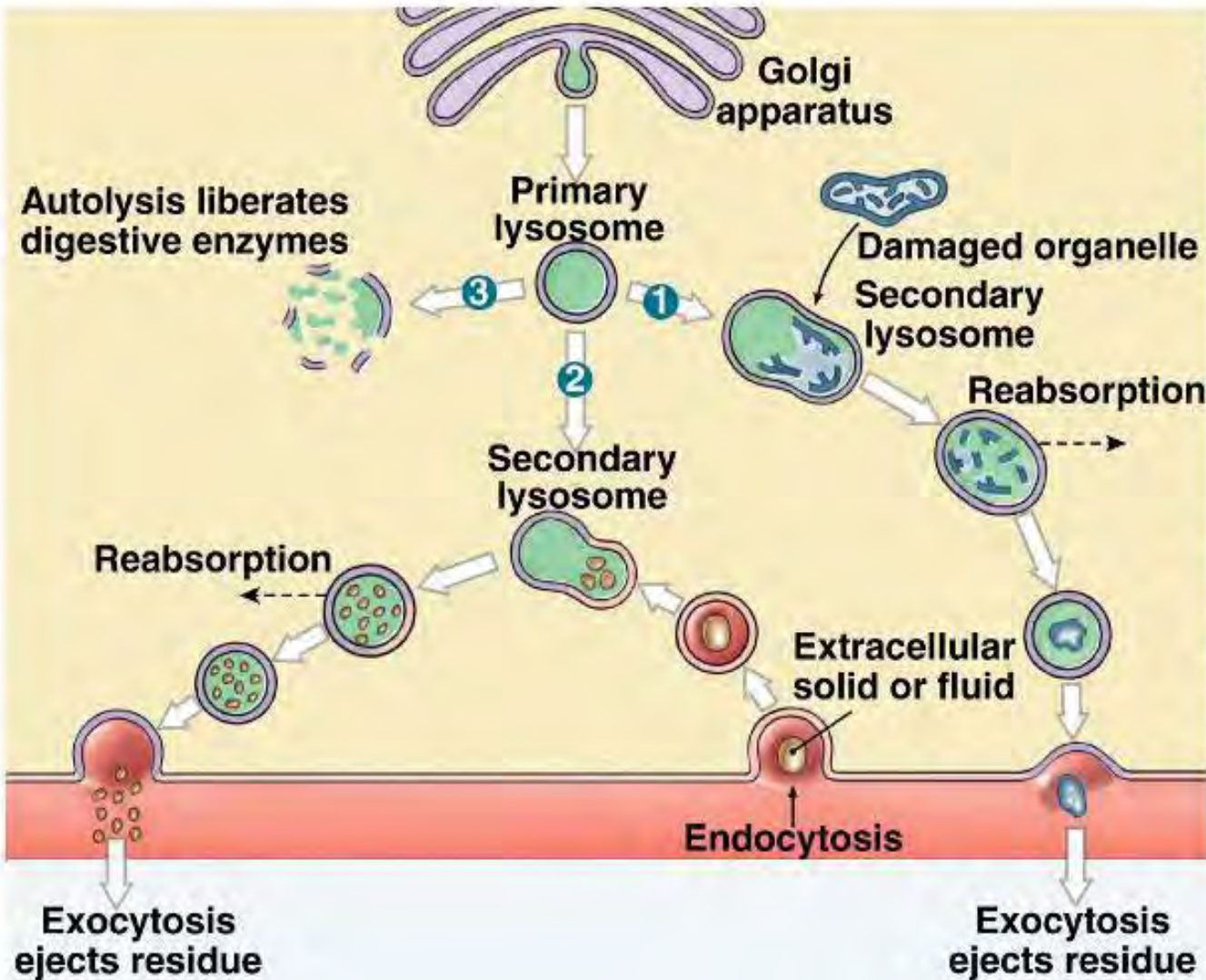
(b) Exocytosis

Vesicle incorporated into cell membrane

# GA



# Lysosome Functions



Activation of lysosomes occurs when:

- 1** Primary lysosome fuses with the membrane of another organelle, such as a mitochondrion
- 2** Primary lysosome fuses with an endosome containing fluid or solid materials from outside the cell
- 3** The lysosomal membrane breaks down during autolysis following injury to, or death of, the cell

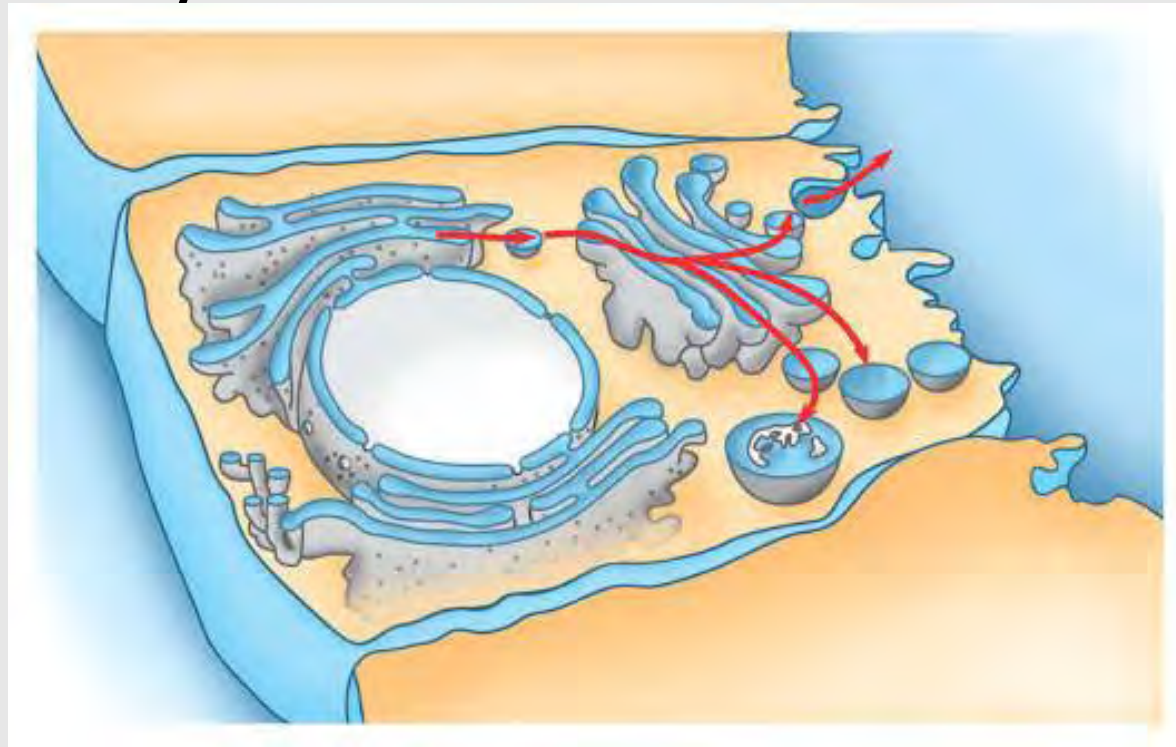
Show "Lysosomes"

# Abnormal lysosomes

- Lack, or have malfunctioning enzymes
  - Normal cell products accumulate & stifle (suffocate) cells
- Tay-Sachs disease
  - Lysosomes lack enzymes that break down lipids in nerve cells
- Pompe's disease
  - Lysosomes lack hydrolytic enzyme that splits glycogen

# The endomembrane system allows membrane flow

- Phospholipid bilayer is maintained!
- Nuclear envelope ⇨ continuous network of SER & RER ⇨ transport vesicles ⇨ Golgi Apparatus ⇨ secretory vesicles ⇨ cell membrane



# Peroxisomes

- Functions:
  - Absorb and breakdown fatty acids and nucleic acids - produces  $H_2O_2$  (danger!)
  - Convert free radicals to  $H_2O_2$
  - Converts  $H_2O_2$  to harmless  $H_2O$  and  $O_2$ , using **catalase**
- Contain digestive enzymes; produced @ free ribosomes

# Concept Check



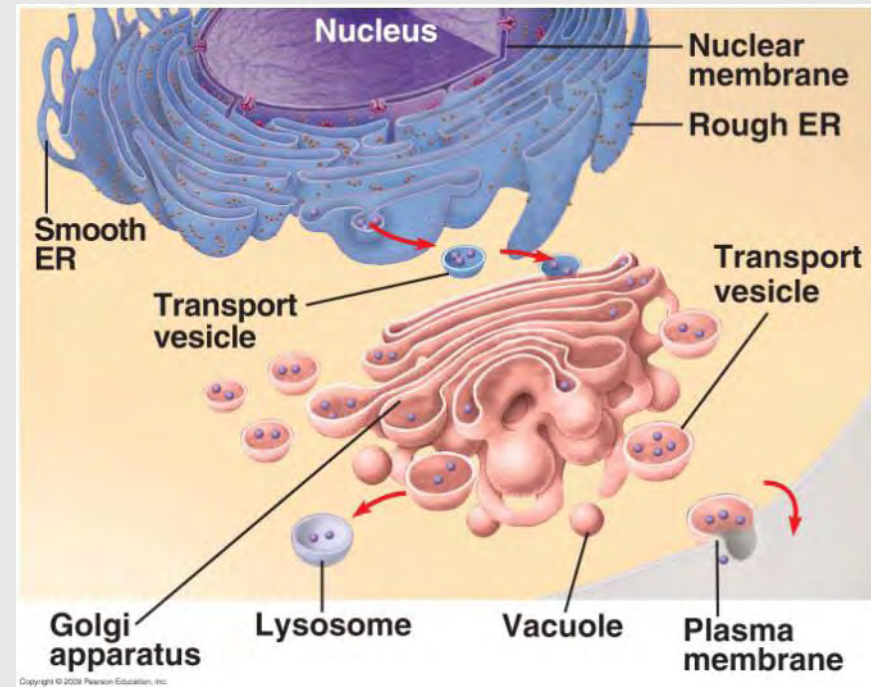
•The cell is sometimes described as a protein factory. Using the cell-as-factory analogy, which of the following accurately describes the functions of the endomembrane system?

The ribosomes on the rough endoplasmic reticulum are analogous to a production line in a factory.

The golgi apparatus is analogous to the packaging and shipping department.

The nucleus is analogous to management offices.

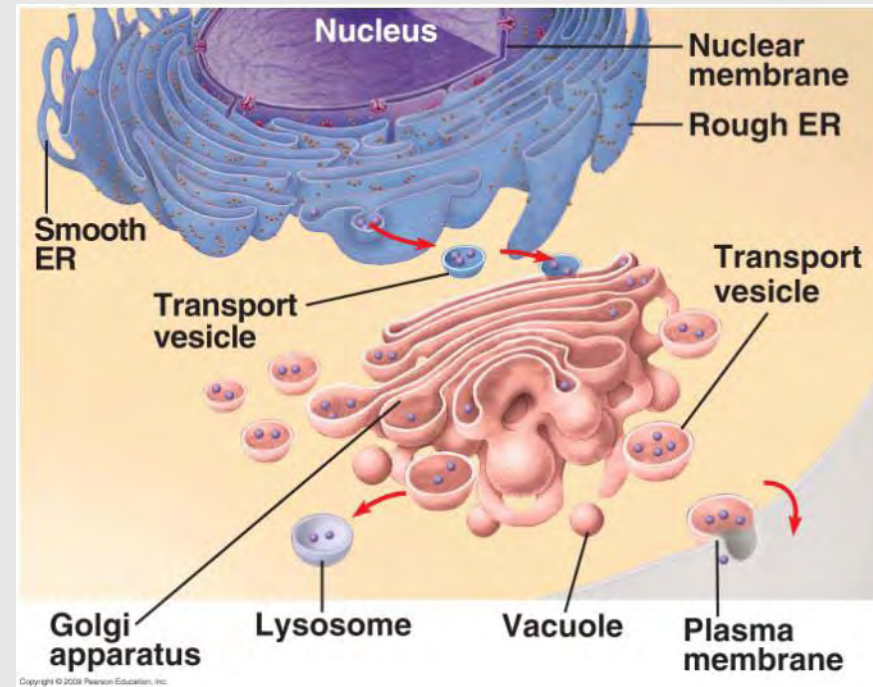
All of the above.





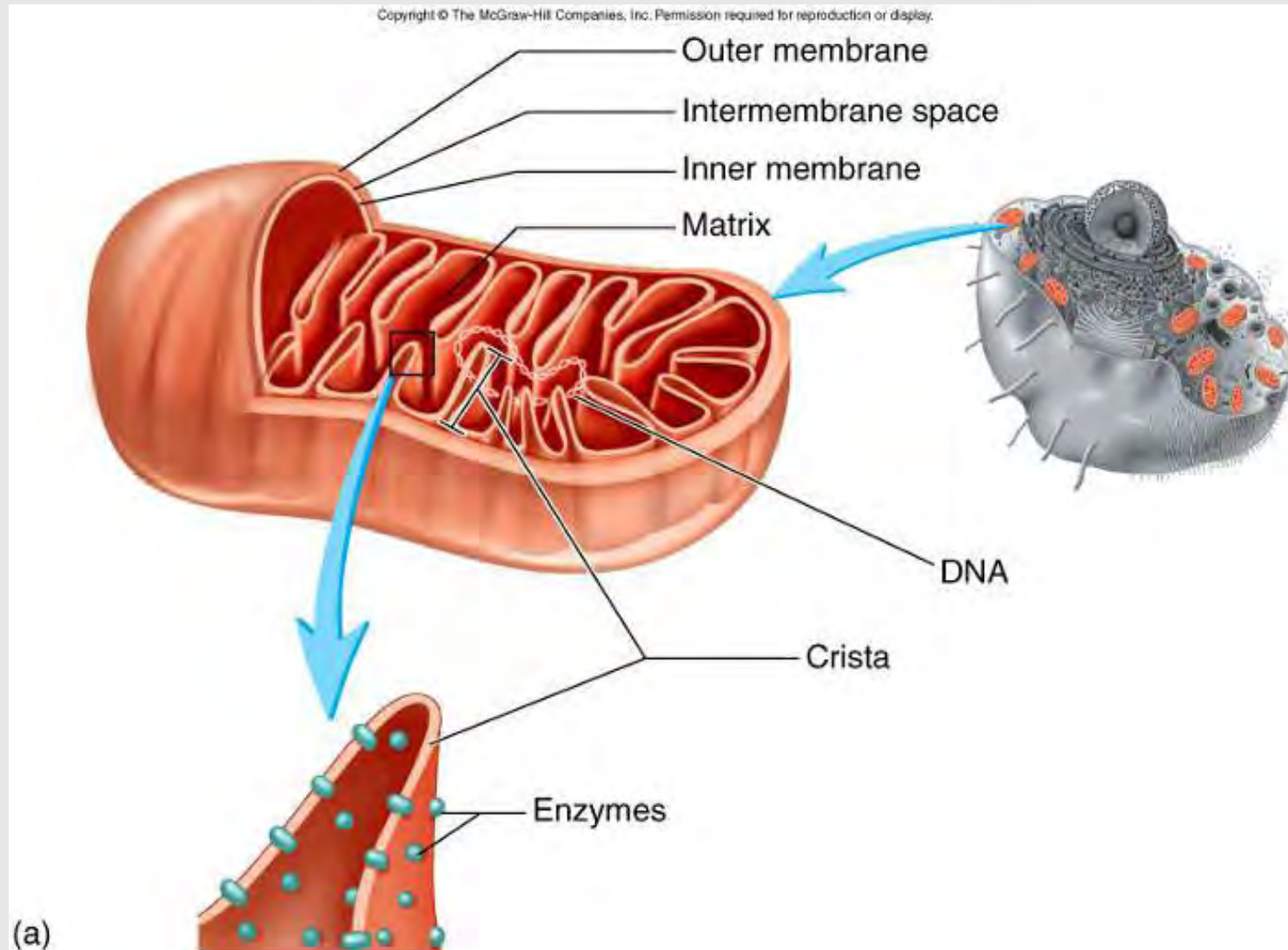
# Answer

- The cell is sometimes described as a protein factory. Using the cell-as-factory analogy, which of the following accurately describes the functions of the endomembrane system?



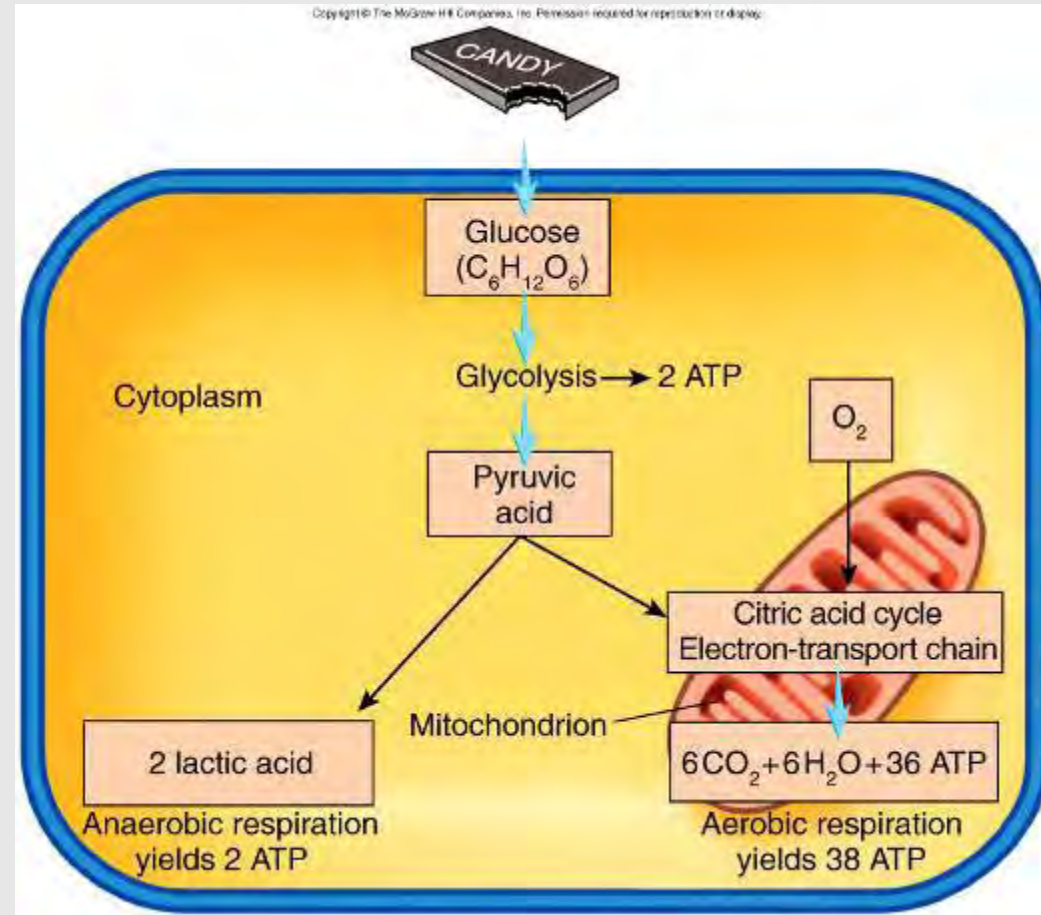
d) All of the above.

# Mitochondria = Powerhouse



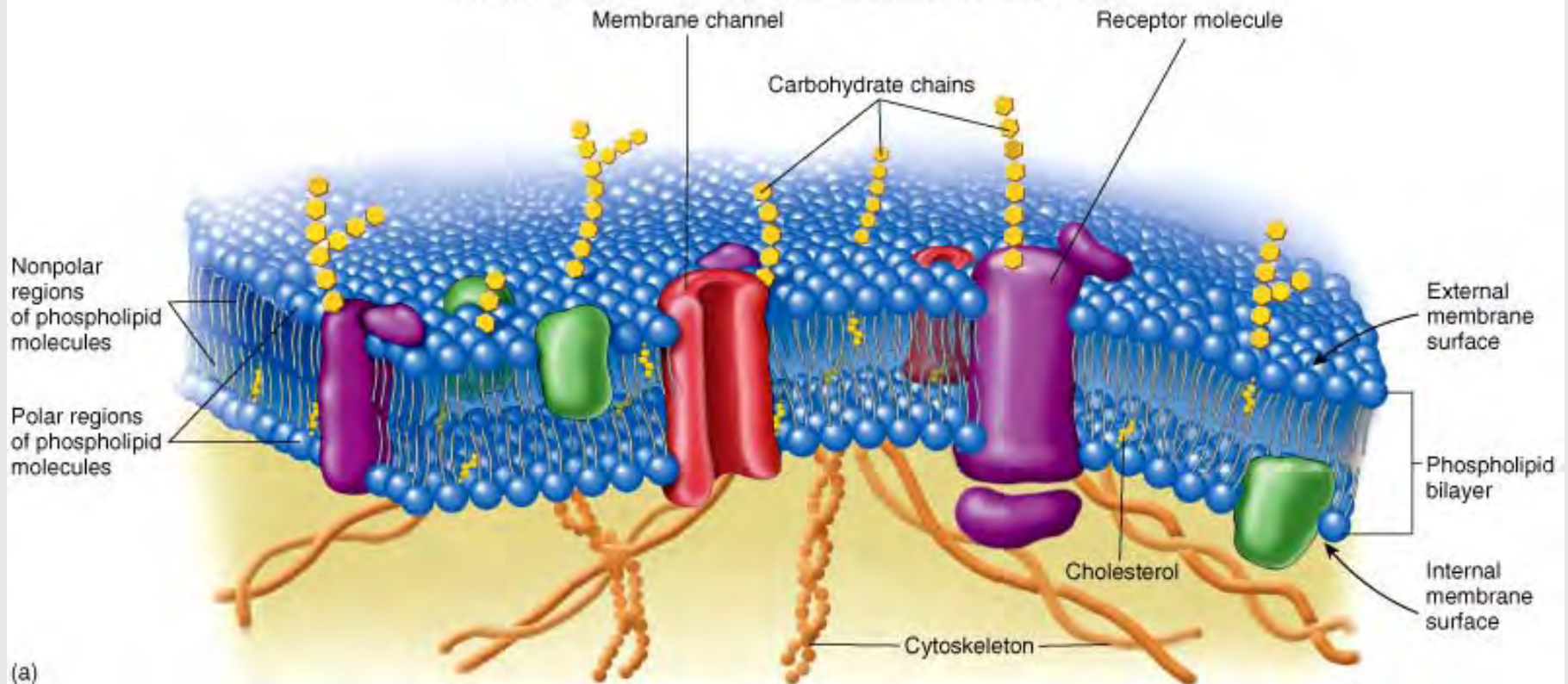
# Mitochondria harness energy!

- “powerhouse” of the cell...makes **ATP**
- Double membrane
- Number per cell varies with metabolic activity (0% volume of RBC, 20% volume of liver cell)



# Cell Membrane = Fluid Mosaic

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# Structure of cell membrane

- 6-10 nm thick
- Contains lipids, proteins and carbohydrates
  - Lipids
    - Phospholipids; Cholesterol; Glycolipids
  - Proteins
    - Integral; Peripheral
  - Carbohydrates
    - Form glycocalyx (identity)

# Cell Membrane Functions

- *Physical isolation* - separates inner and outer environments
- *Sensory receptor* - receptor proteins sense changes in external environment (encrusted with peripheral nerves)
- *Regulates exchange with the environment* - membrane channel proteins + carrier proteins
- *Structural support* - intercellular protein attachment