Lesson 3:
Teamwork Makes the Dream Work

BIOL 1441

Cell & Molecular Biology

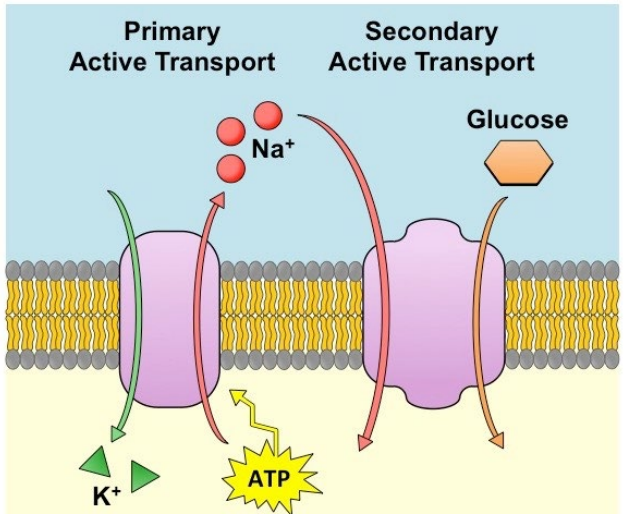
Learning Objectives (a.k.a. Study Guide)

By the end of this lesson, students will be able to:

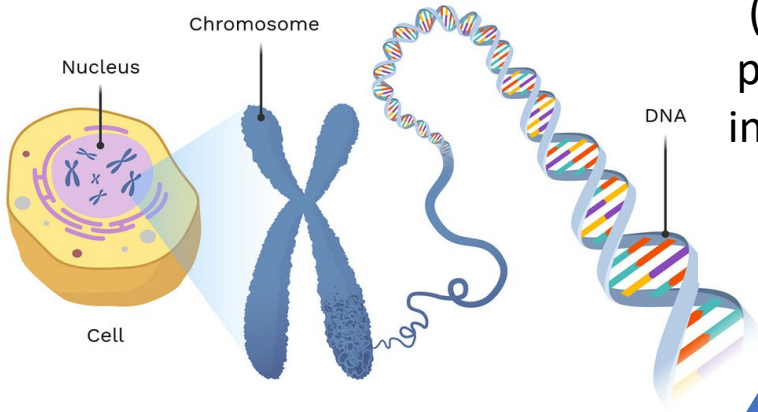
1. Describe the functions of each of the major organelles and structures in eukaryotic cells.
2. List the organelles involved in the endomembrane system, beginning with the organelle that stores DNA to the organelles that build, modify, & release proteins from the cell.
3. Identify the organelles that are found only in plant cells or only in animal cells.
4. Explain what makes a eukaryotic cell different from a prokaryotic cell.

Glucose transport requires transport proteins. Where do the proteins come from?

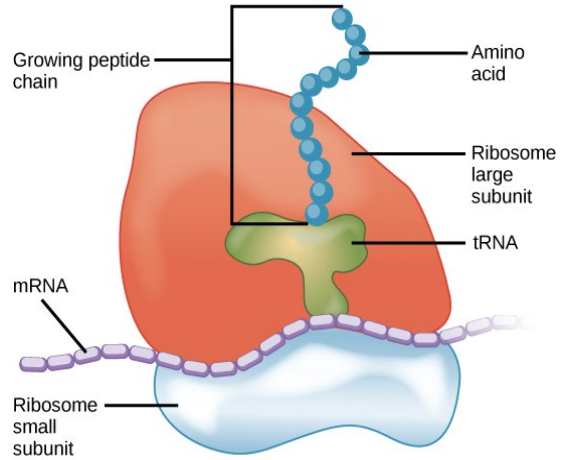
You eat a donut.



Your cells use <u>transport proteins</u> to move glucose into your cells.



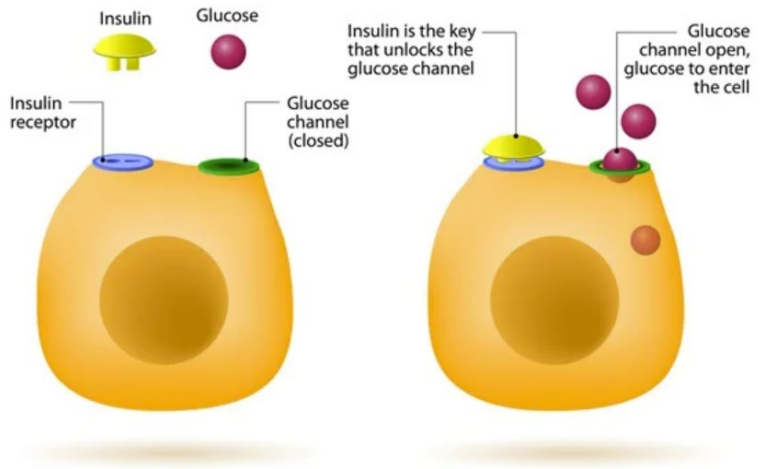
The instructions (DNA) for making proteins are found in the cell's nucleus (of a eukaryotic cell).



Those instructions are "read" by a ribosome, which assembles the protein.

The Life of a Cell

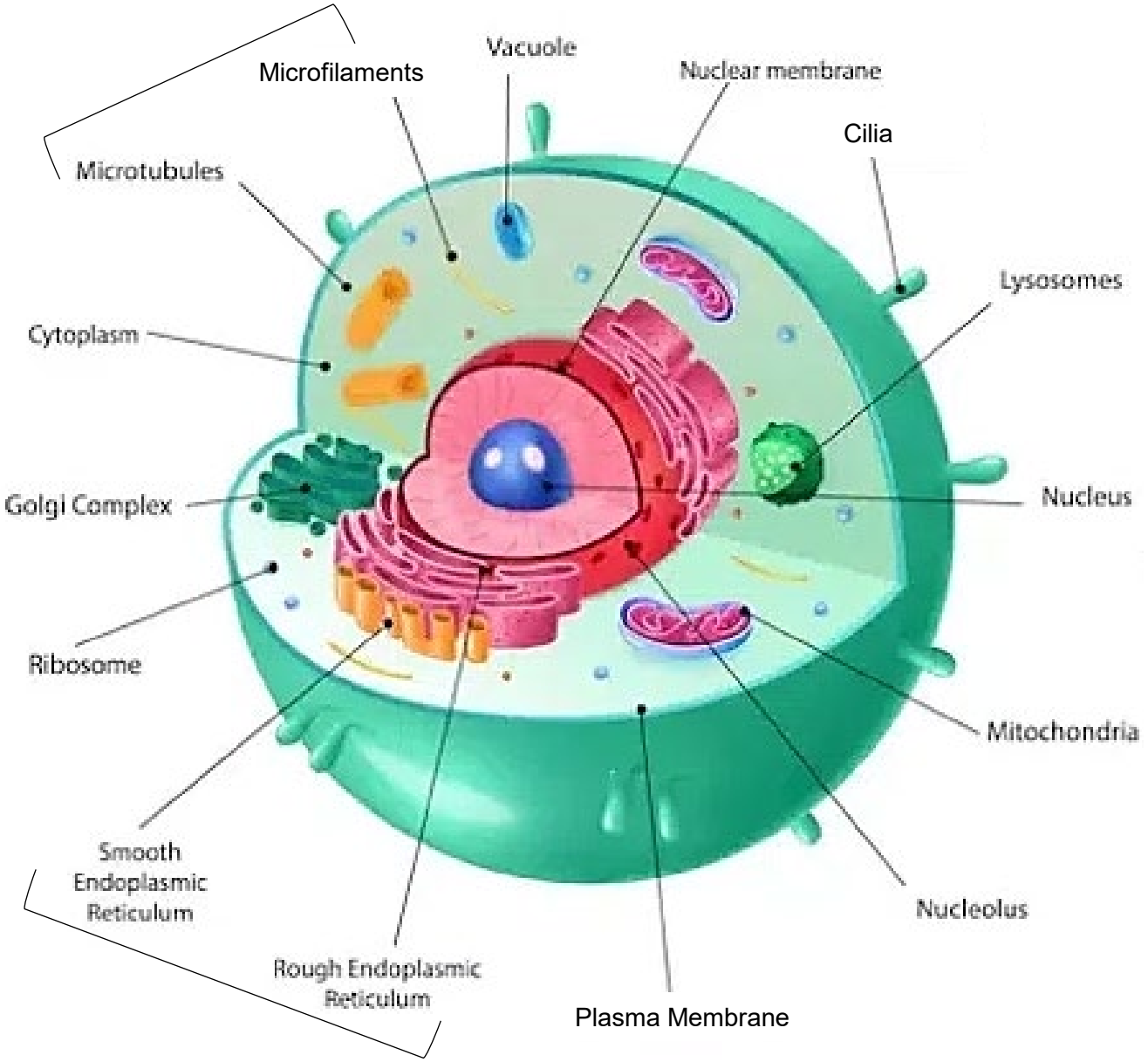
For cells to live and perform their many “jobs” they must be able to manufacture molecules and carry out processes, much like your body does to stay alive.



For example, a cell in your pancreas must be able to

- **manufacture** the protein insulin which is needed to unlock certain types of glucose transporters, and then
- **export** that insulin to the bloodstream

It takes a “dream team” of organelles and other special structures to keep a cell alive.

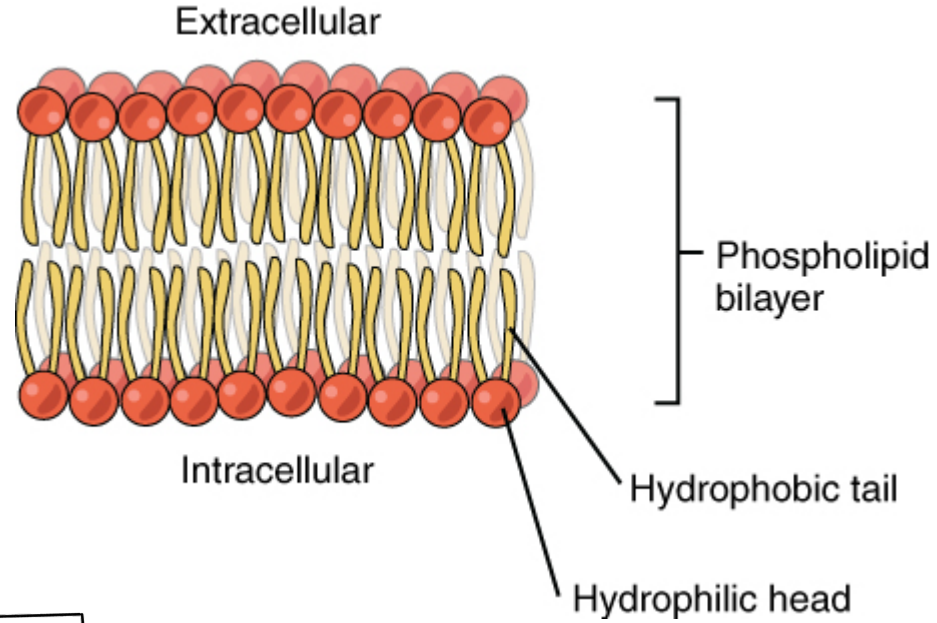


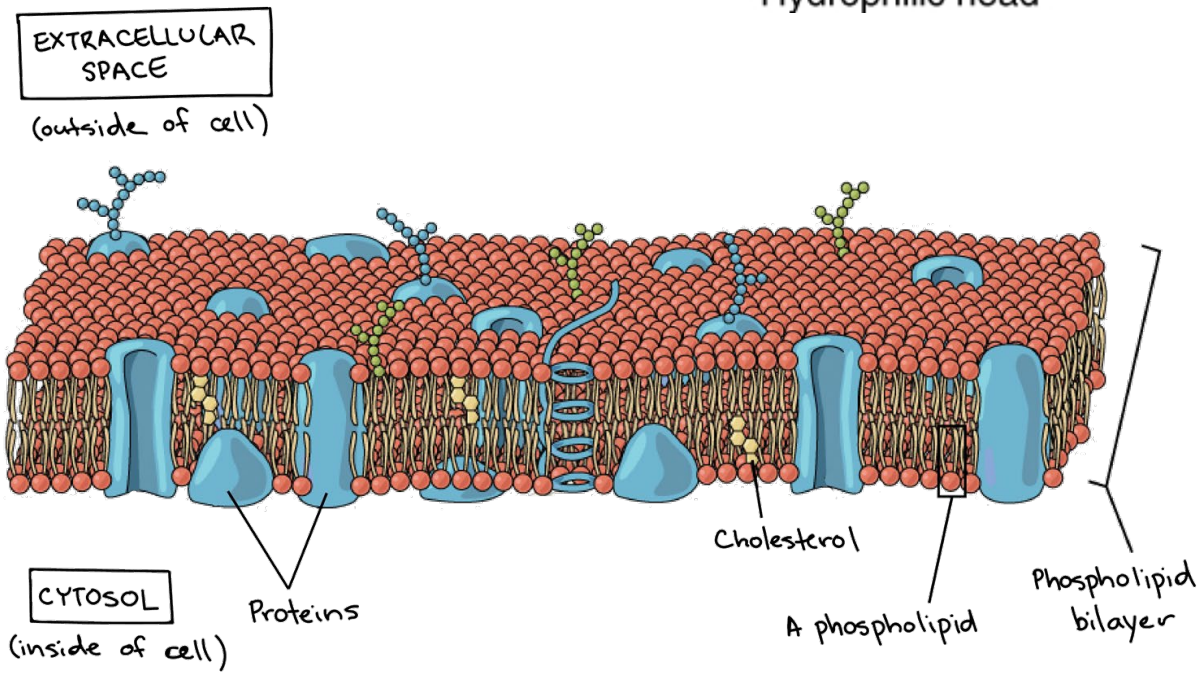
Plasma Membrane

The **plasma membrane** is the barrier between the inside & outside of a cell

The membrane is **semi-permeable**

- This means it only allows certain things to pass through it
- Hydrophobic & nonpolar molecules CAN pass straight through it
- Transport proteins must be used to move hydrophilic & polar molecules across





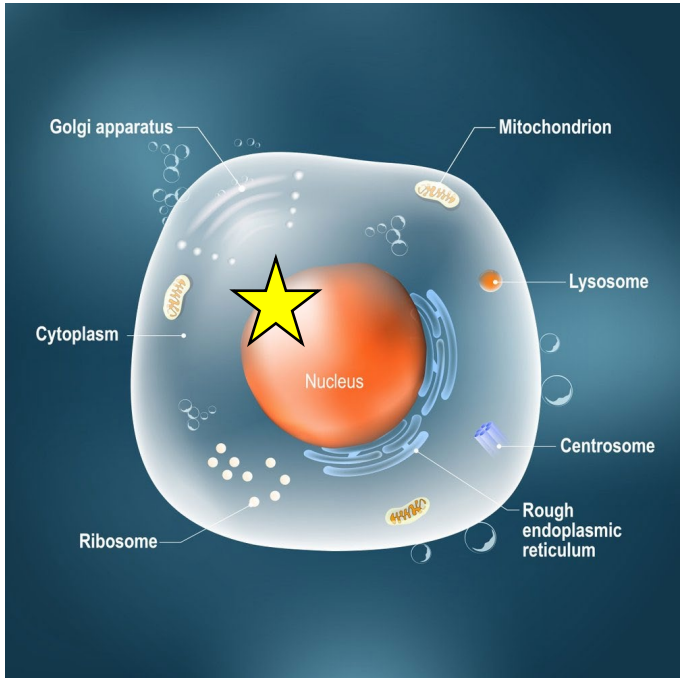
Nucleus

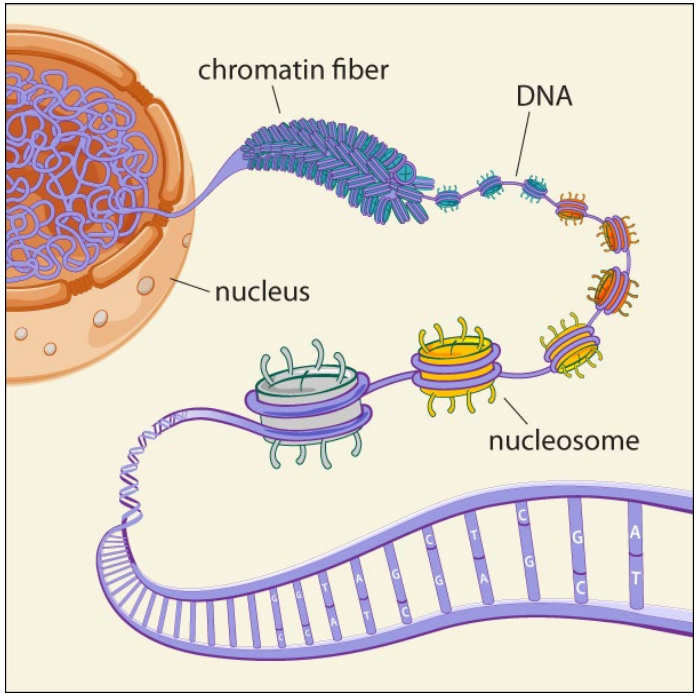
The **nucleus** is the location of a cell's DNA

- DNA stores the instructions for building every single protein that a cell could ever need
- These instructions are protected from the cytoplasm by the nuclear envelope

The DNA found in a cell's nucleus exists as **chromatin**

- This is a relaxed, stringy form of genetic information that is loosely wrapped around proteins
- It is only when a cell is preparing to divide that its DNA is found in the X-shaped **chromosome** arrangement





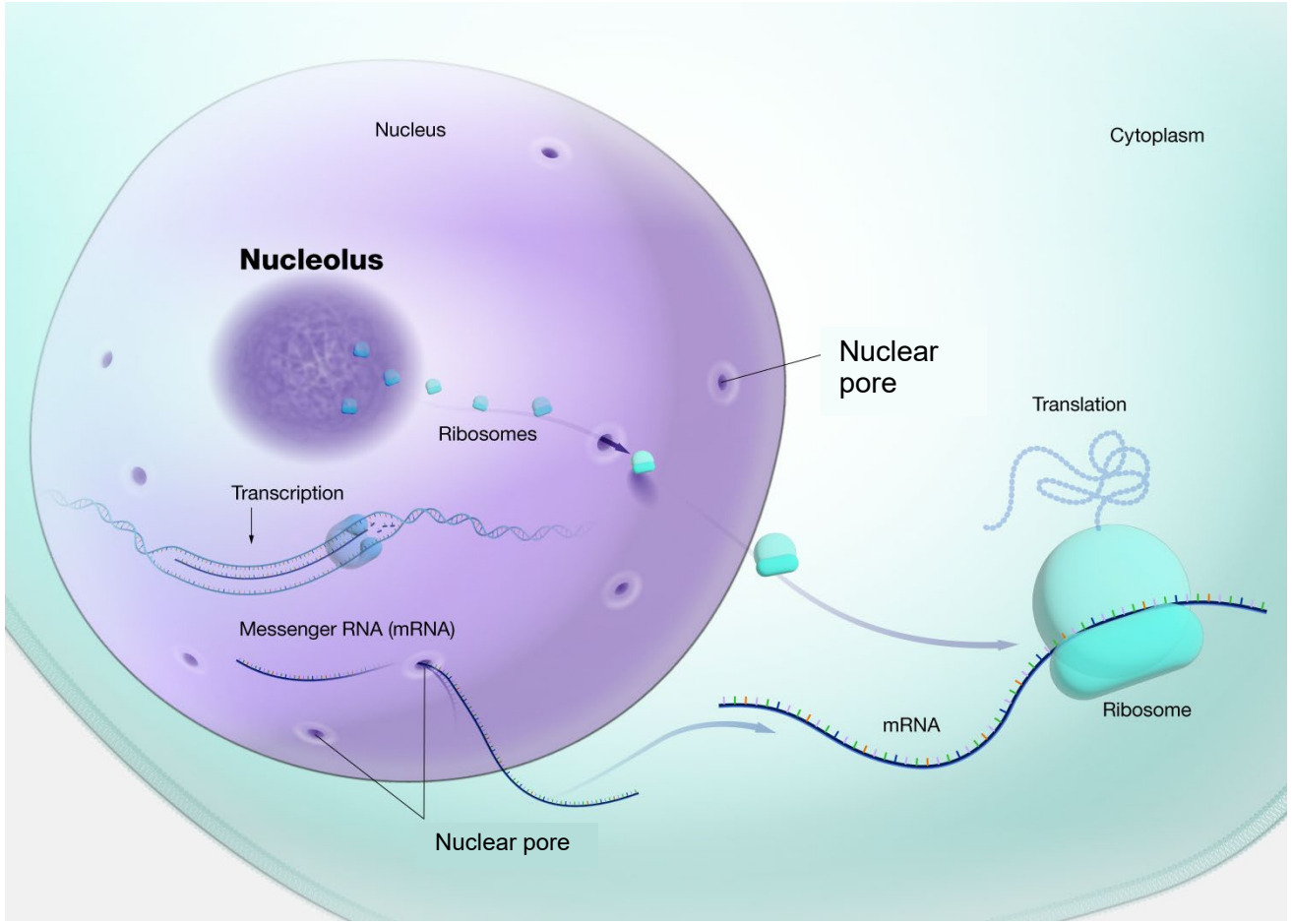
Nucleus and Nucleolus

When a cell needs a protein, it builds an mRNA copy of the directions for that protein

- This mRNA copy leaves the nucleus through a **nuclear pore**
- It is “read” by ribosomes in the cytoplasm

Ribosomes are also built in the **nucleolus** (found inside the nucleus)

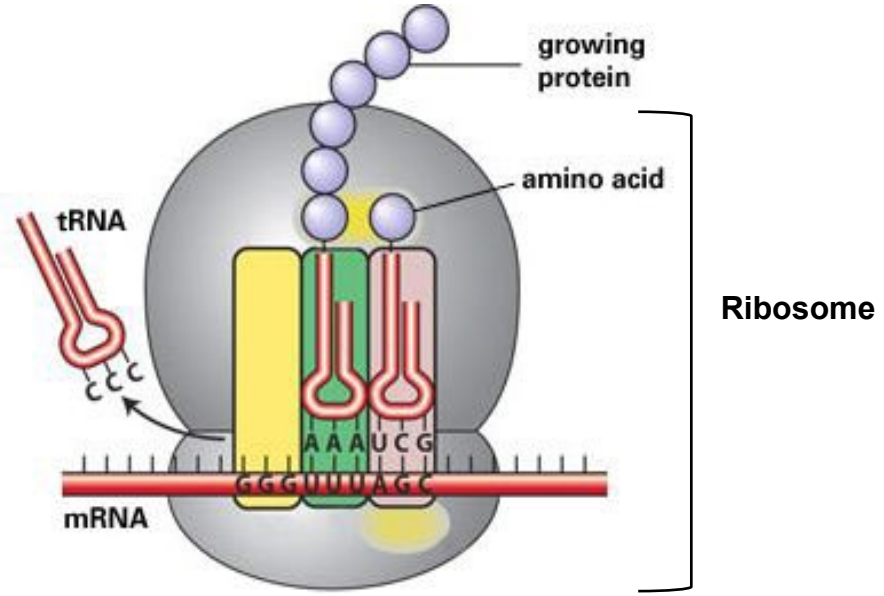
- Like mRNA messages, ribosomes leave the nucleus through the nuclear pores



Ribosomes

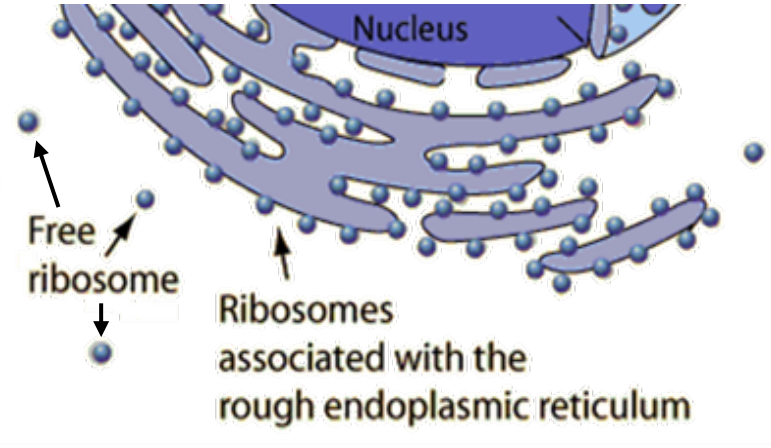
Ribosomes are the protein-building "machines" of a cell

- First, they "read" the information in mRNA
- Then, they connect amino acids (the monomer of proteins) together in the correct order



Some ribosomes are freely-floating in the cytosol of the cell

- These ribosomes release proteins directly into the cytosol



Some ribosomes are attached to the rough endoplasmic reticulum (rough ER)

- As proteins move through the rough ER, they fold into their correct 3D shape

Golgi Apparatus

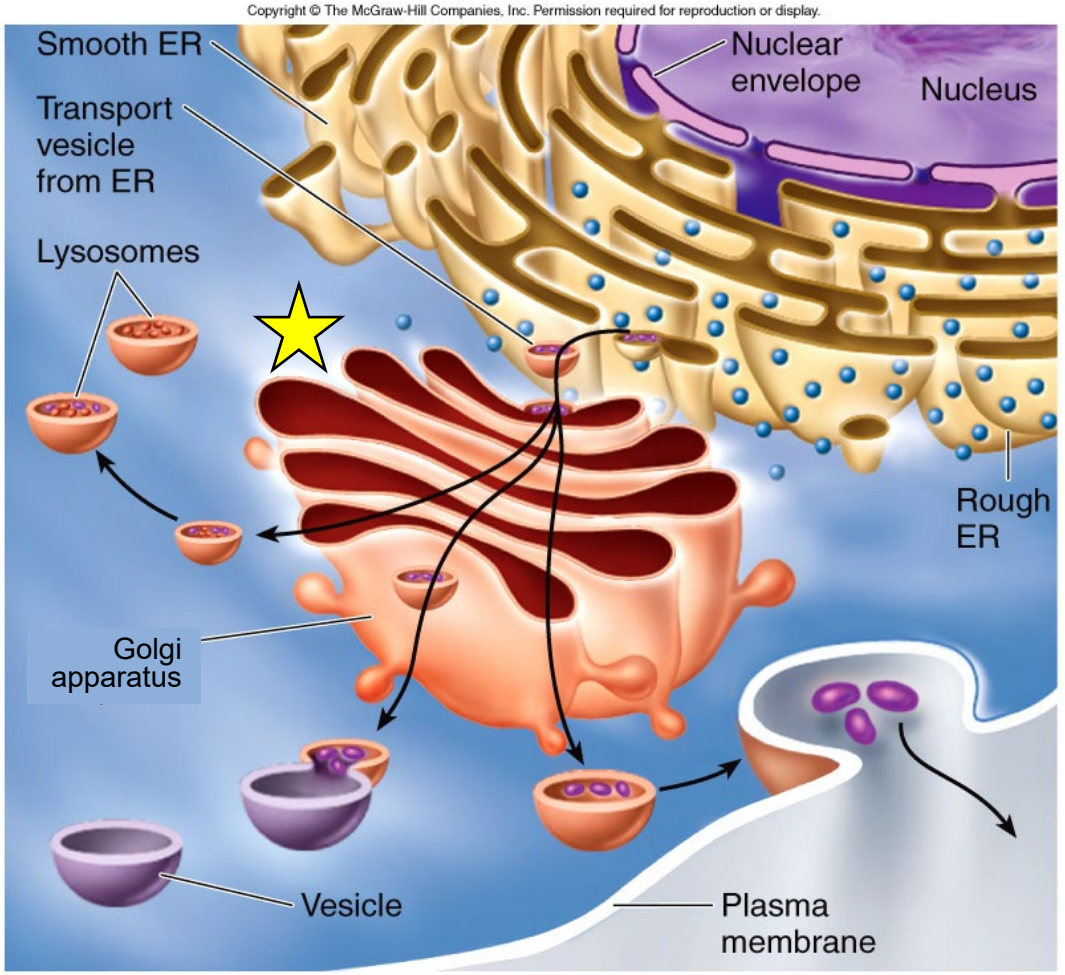
Proteins that leave the rough ER are sent to the **Golgi apparatus (Golgi body)**

The Golgi apparatus modifies the proteins

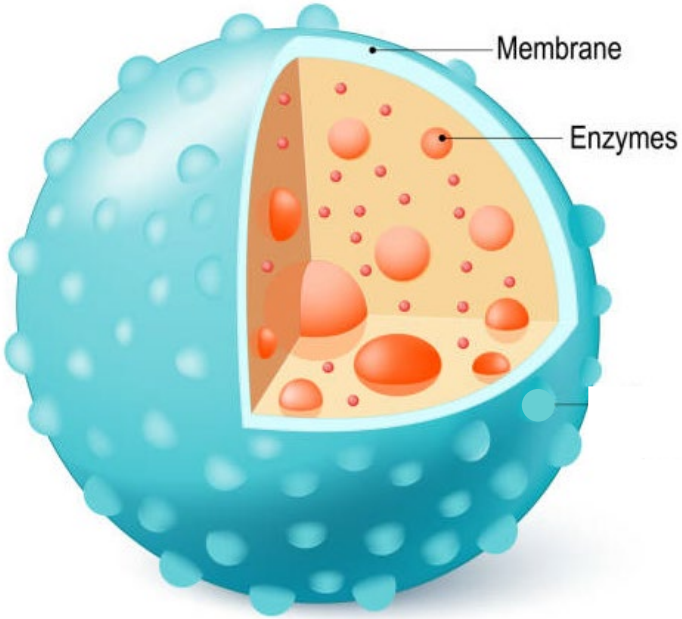
- It adds & removes chemical groups (like fatty acids, phosphates, and sugars)
- It activates digestive enzyme proteins

The Golgi apparatus then sorts the proteins & sends them where they are needed. For example:

- Some go into the plasma membrane (for example, transport proteins)
- Others, like insulin, get secreted out of the cell via vesicles
- Proteins such as digestive enzymes, are sent to lysosomes



Lysosomes

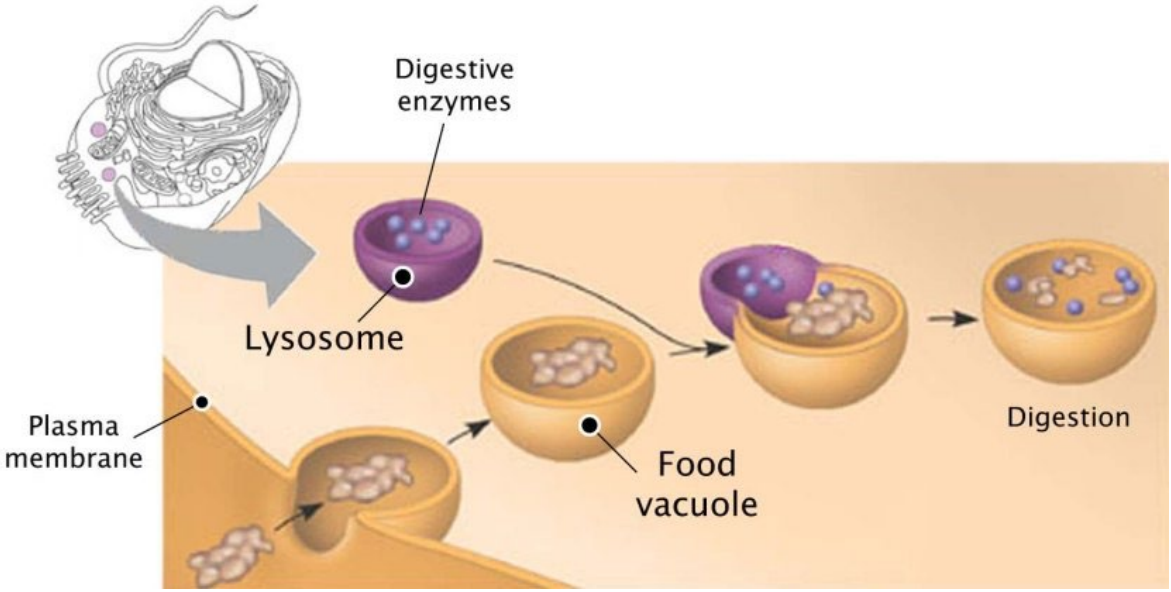


Lysosomes are organelles filled with digestive enzymes & acids and function like the cell's "stomach"

Lysosomes break large macromolecules into smaller, useable pieces

- Example: **glycogen**, which lysosomes break into glucose
- Example: proteins, which lysosomes break into amino acids

Lysosomes also break down worn-out organelles & misfolded proteins



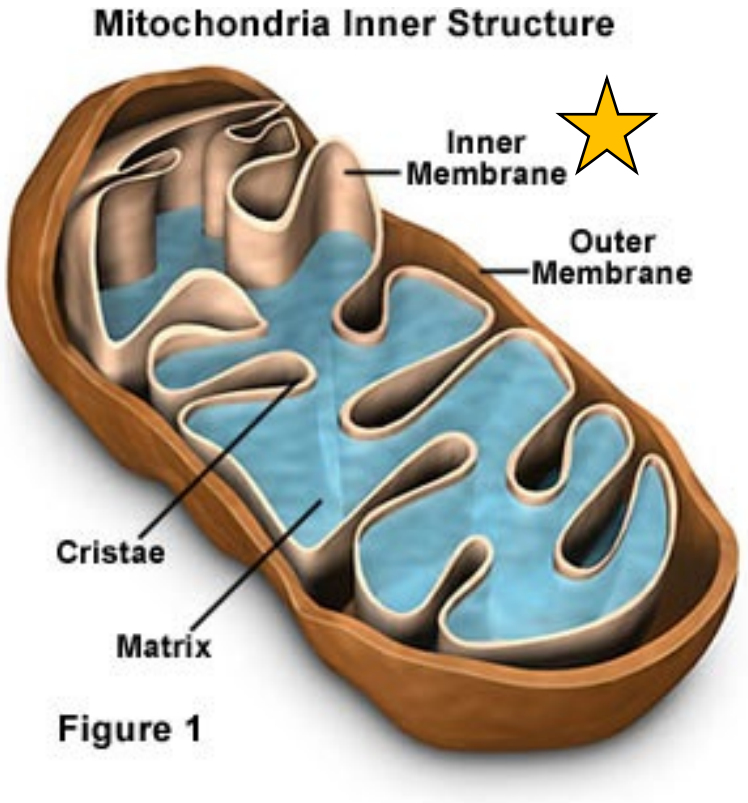
Mitochondria

Mitochondria are the organelles that convert glucose into ATP

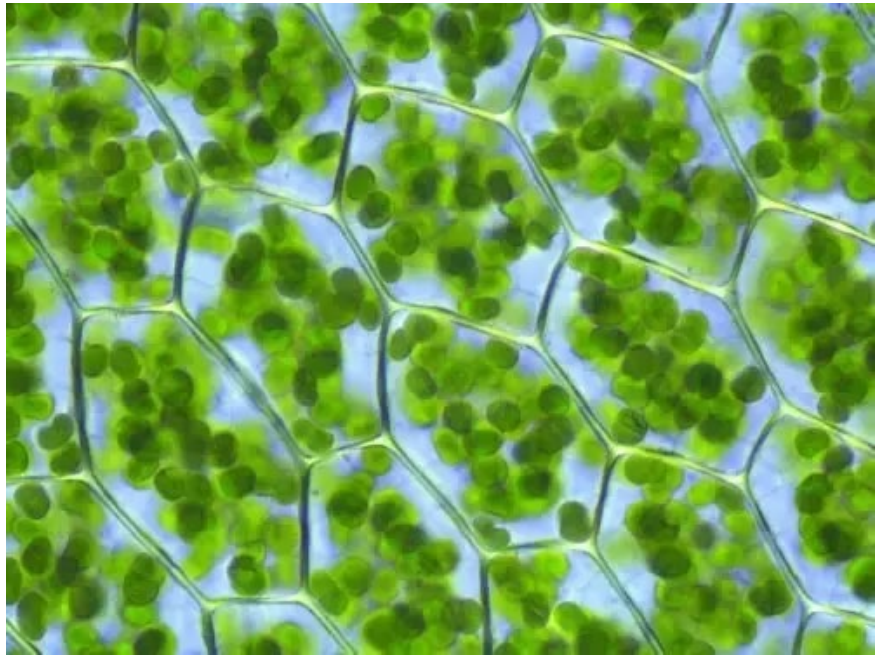
- Glucose's energy is stored in its chemical bonds
- **Catabolic** reactions break these bonds & release their energy
- **Anabolic** reactions then use this energy to form new chemical bonds (in ATP)

Mitochondria use the **Electron Transport Chain** to generate ATP

- The Electron Transport Chain proteins are found in the inner membrane of mitochondria
- To build ATP, the Electron Transport Chain <u>requires</u> oxygen



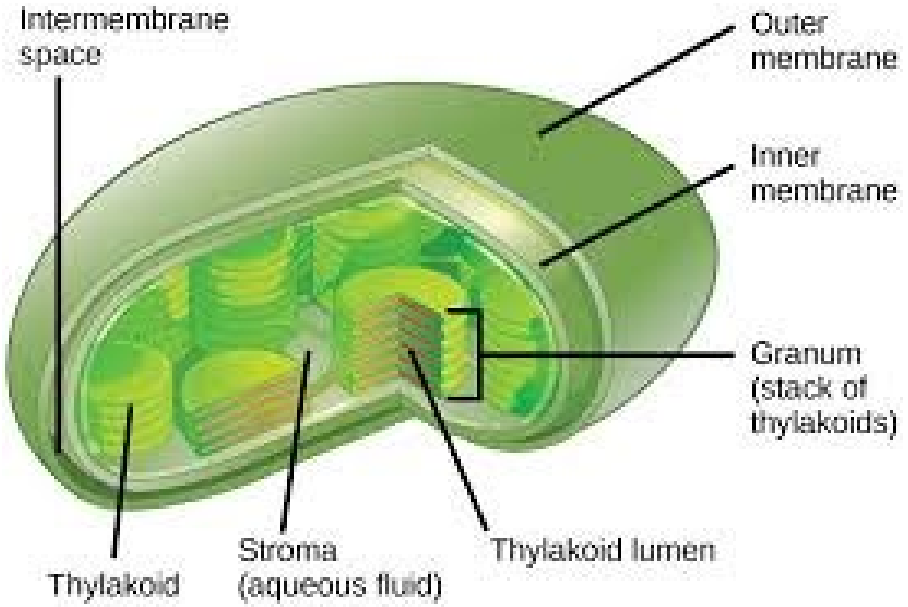
Chloroplasts



Chloroplasts are the organelle in **plant cells** that build glucose

To build glucose, chloroplasts use specialized proteins to capture the energy of sunlight

- This energy is then used to build the chemical bonds found in glucose
- This process is known as **photosynthesis**
- Oxygen is a by-product of photosynthesis



Vacuoles

Vacuoles are large vesicles (a.k.a. “bubbles”) that store materials inside cells

Vacuoles store different kinds of materials

- Plant cell vacuoles can store water & glucose
  - Water (in the central vacuole) maintains the shape of plant cells
  - Glucose (in smaller vacuoles) is an energy source for plant cells or the organisms that consume those plants
- The vacuoles in liver cells & muscles cell (in animals) store **glycogen**
  - Glycogen is the polysaccharide form of glucose
- Waste products can also be stored in vacuoles

Vacuoles in Animal Cells

Vacuoles in Plant Cells

Endoplasmic Reticulum

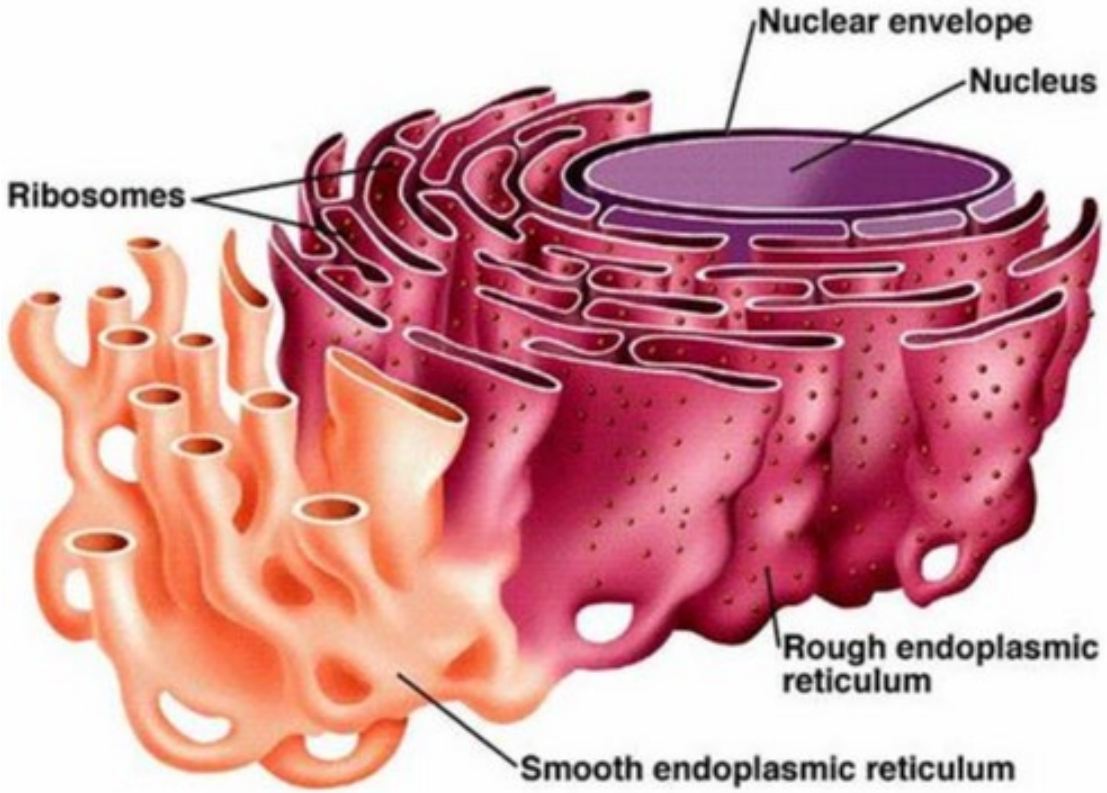
The **endoplasmic reticulum (ER)** has two parts: the smooth ER & the rough ER

The **smooth ER** detoxifies materials & builds lipids

- Waste products & toxins (like alcohol & drugs) are processed here

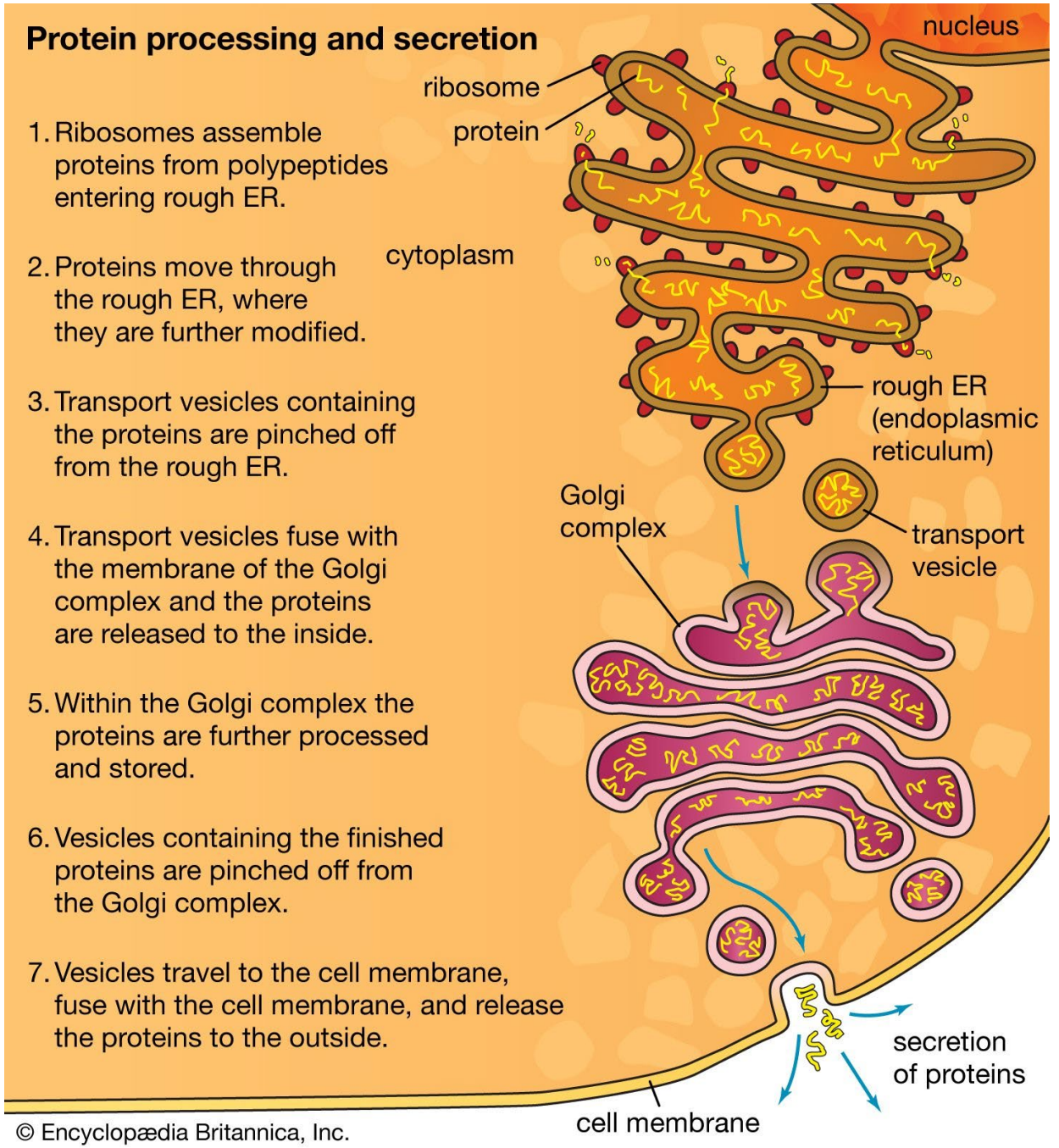
The **rough ER** builds proteins

- The rough ER is covered in ribosomes, the protein-building "machines"
- Proteins leave the rough ER & go to the Golgi apparatus



The Endomembrane System

- The transport “highway” of the cell
- Imagine a cell in the small intestine, the function of which is to produce digestive enzymes
- That cell must not only manufacture the enzymes, but also export them out into the bloodstream
- The endomembrane system is involved in the manufacture and transport of proteins and lipids



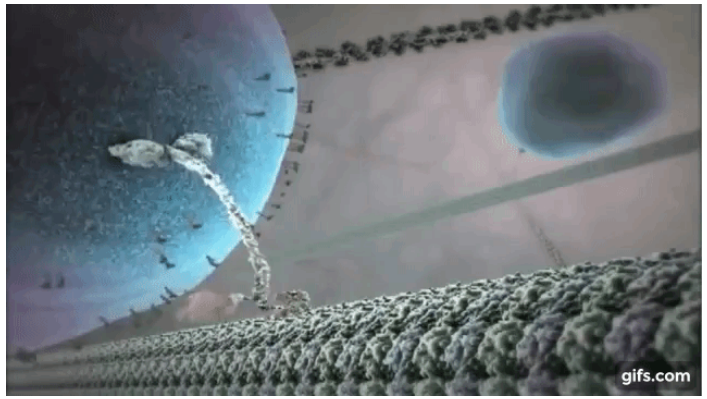
Let's Practice!

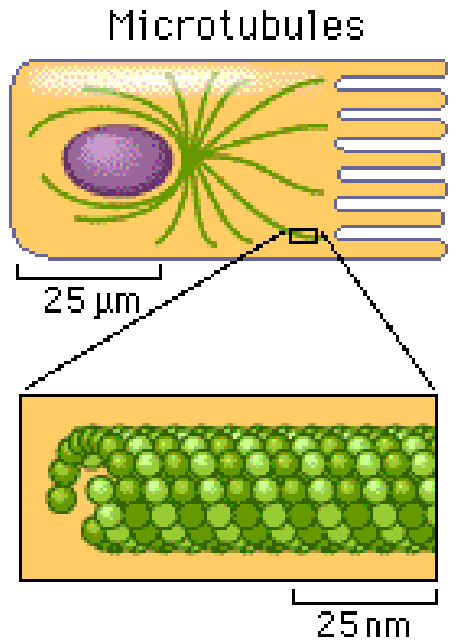
Use the vocabulary words below to make a diagram that follows the production of a glucose transport protein from start to finish. You should be able to explain what happens at each step.

Amino Acids
DNA
Golgi Body
Nucleus
Nuclear Membrane
Plasma Membrane
Ribosome
mRNA
Rough ER
Vesicle

Glucose transport requires transport proteins. Where do the proteins come from?

Cytoskeleton

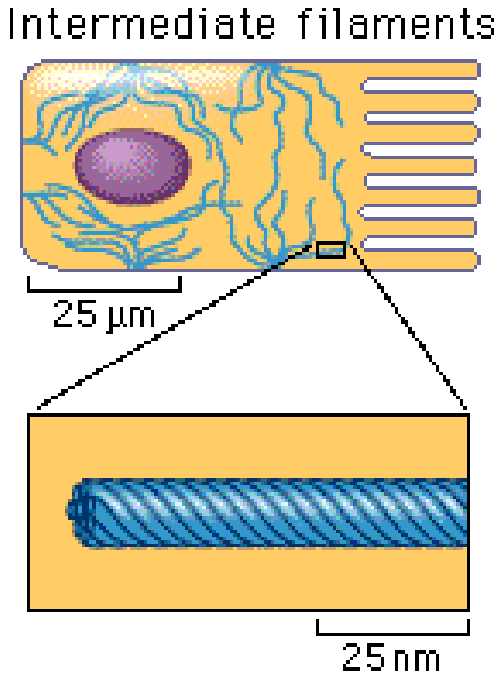


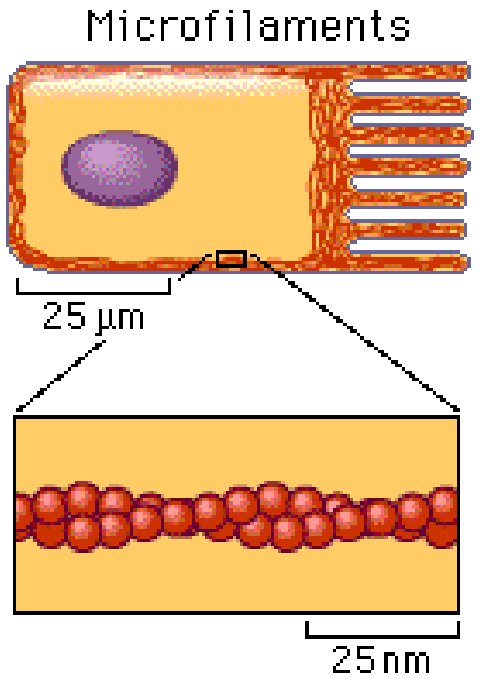


The **cytoskeleton** forms the internal framework of the cell

Types of cytoskeleton proteins:

- Microtubules, which provide pathways for vesicle movement
- Intermediate filaments, which hold organelles in place
- Microfilaments, which give flexibility to a cell's shape & enable muscle contraction





Cilia and Flagella

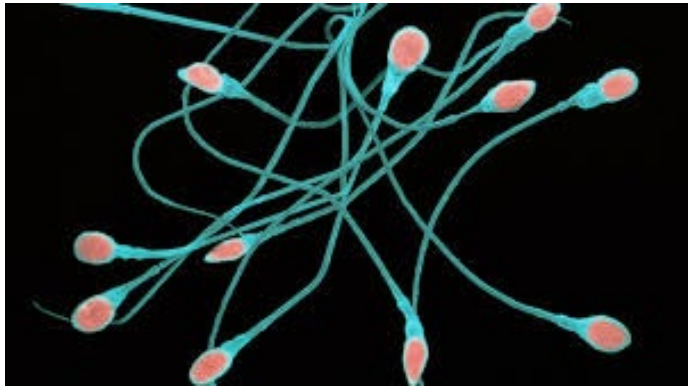
Cilia & **flagella** are structures involved in external movement

Cilia move fluids across the surface of cells

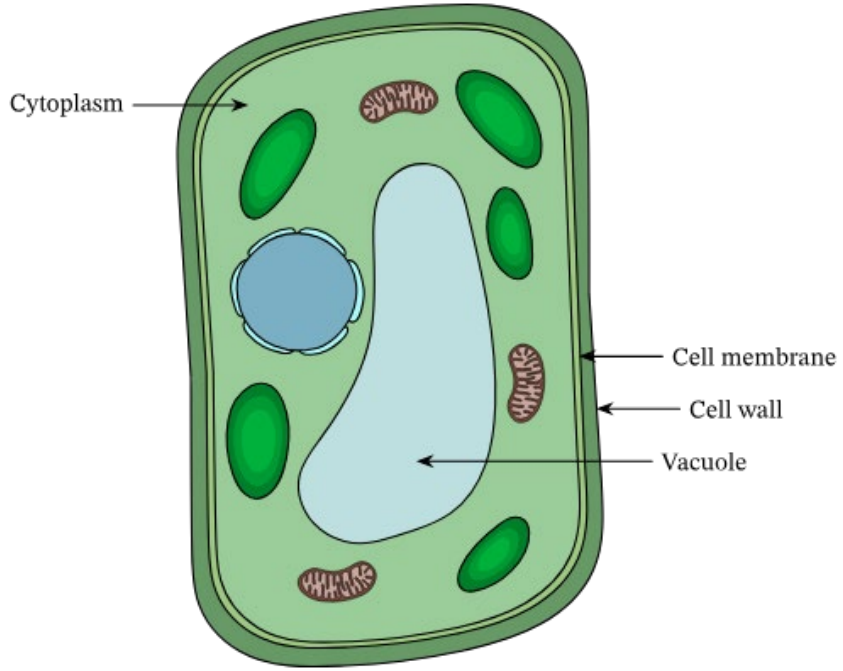
- This helps protists (like Paramecium) obtain food from their environment
- This helps cells in the human respiratory tract to move mucus out of the trachea
- Cilia are smaller & more numerous than flagella

Flagella move entire cells

- Example: flagella propel sperm cells toward eggs in the mammalian reproductive tract



Cell Wall

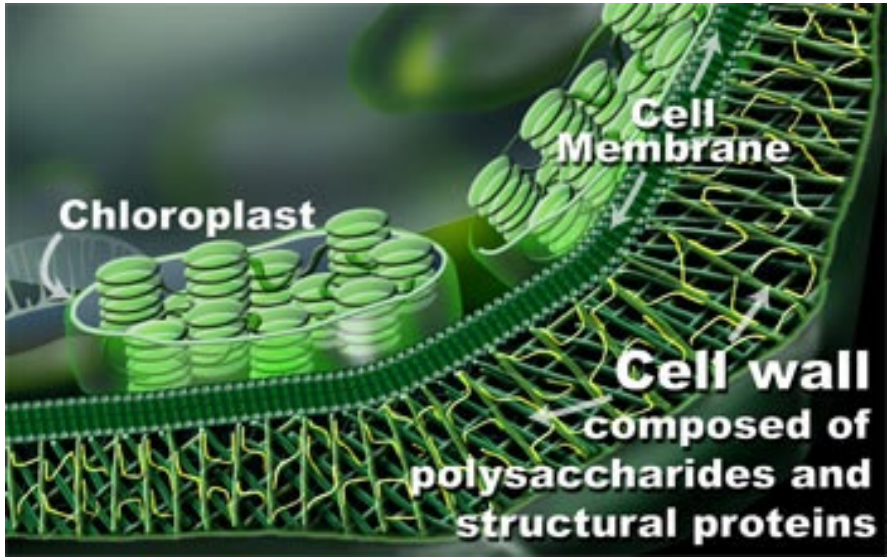


Plant cells have a strong external **cell wall**

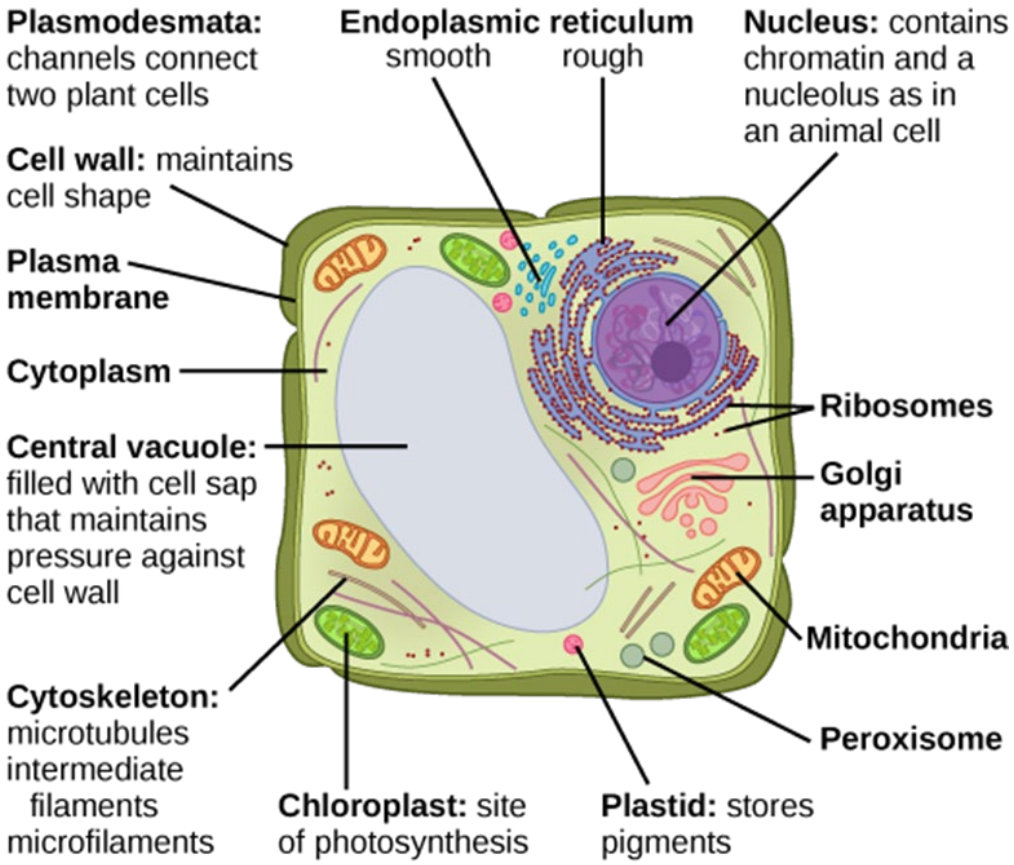
- This barrier is made out of cellulose, a <u>polysaccharide</u>

The plant cell wall is found outside of their plasma membrane

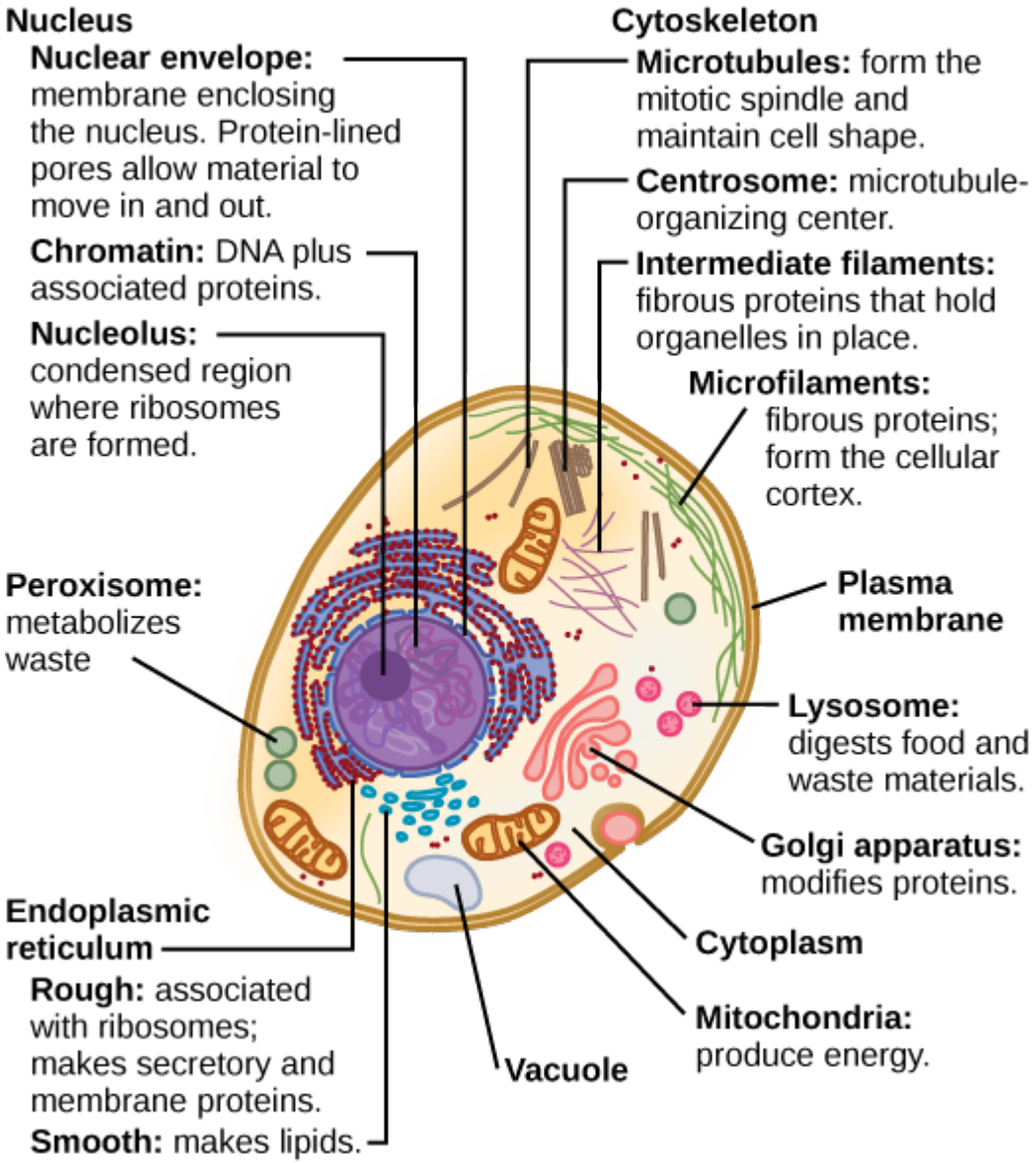
- The cell wall creates a rigid framework to support the plant
- It also creates a protective barrier around the cell



Review of Organelle Functions



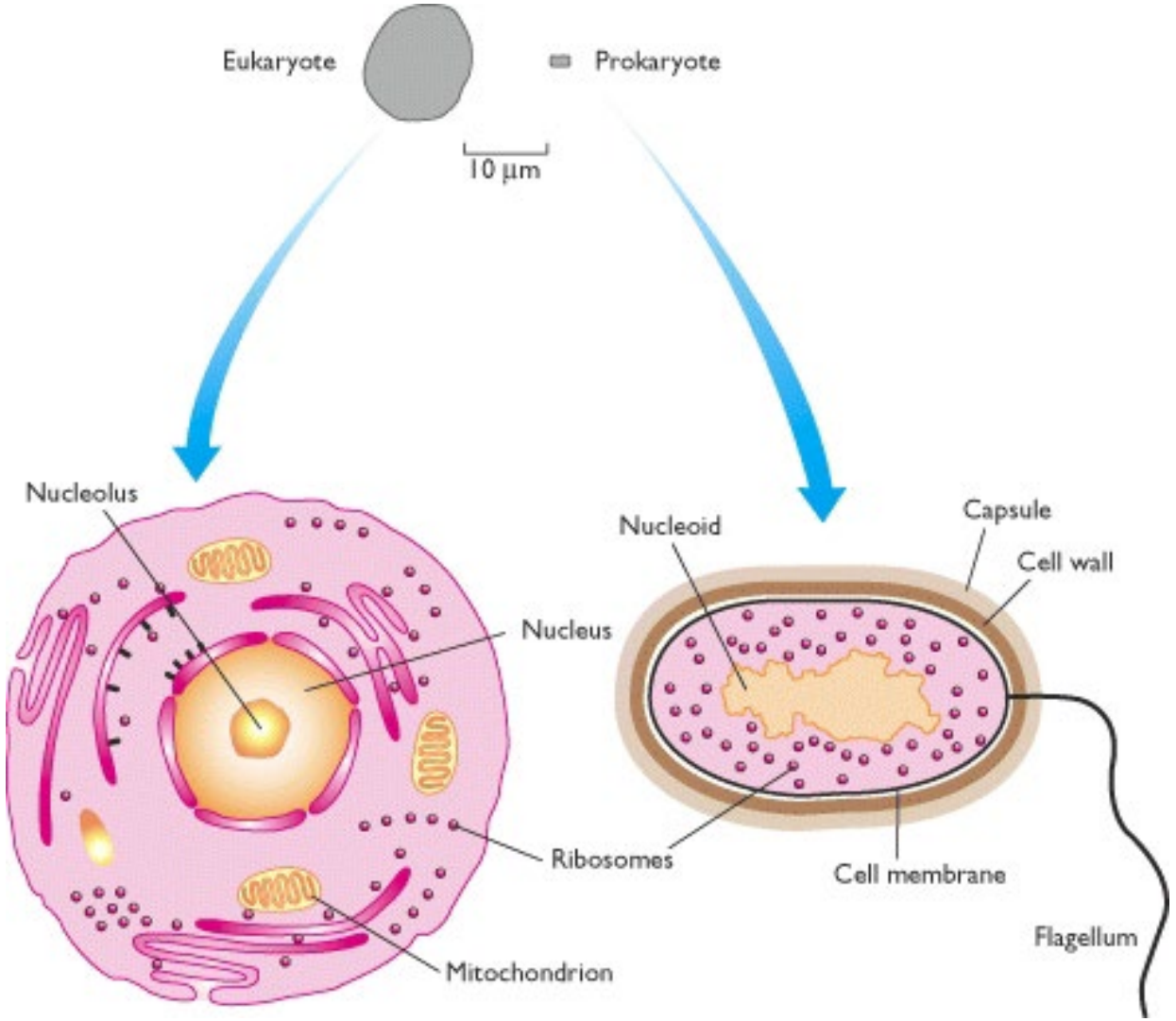
Plant Cell



Animal Cell

Organelle	Cell Type: Animal, Plant, or Both?	Function(s)
Plasma Membrane		
Nucleus		
Ribosomes		
Golgi apparatus		
Lysosomes		
Mitochondria		
Chloroplasts		

Organelle	Cell Type: Animal, Plant, or Both?	Function(s)
Vacuoles		
The rough endoplasmic reticulum (ER)		
The smooth endoplasmic reticulum (ER)		
The cytoskeleton		
Cilia		
Flagella		
Cell Wall		



And As a Friendly Reminder…

Not all cells have a nucleus!

Eukaryotic cells DO have a nucleus

- This includes animal and plant cells

Prokaryotic cells (bacteria) do NOT have a nucleus

- Their genetic information is found in the nucleoid region
- The only organelle prokaryotes have is **ribosomes**

To Prepare for Exam #1…

- ❑ Review your class notes
  - Use the eTextbook & Other Helpful Resources to supplement your lecture notes
- ❑ Complete the homework assignment
- ❑ Review your notes & assignments for Lessons #1 & #2… these will be on the exam!
- ❑ Install Respondus LockDown Browser on your laptop and make sure it is working prior to coming to class… you'll need it for the Practice Exam & Exam #1!
- ❑ Come to the Practice Exam with a fully charged laptop battery.