# Cell Structure and Function

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# Essential Question

**How are cell structures adapted to their functions?**

# Light Microscopes

- **Most microscopes use lenses to magnify the image of an object by focusing light or electrons.**
- A typical light microscope allows light to pass through a specimen and uses two lenses to form an image.
  - The first set of lenses, located just above the specimen, produces an enlarged image of the specimen.
  - The second set of lenses magnifies this image still further.
  - Because light waves are diffracted, or scattered, as they pass through matter, light microscopes can produce clear images of objects only to a magnification of about 1000 times.
  - Another problem with light microscopy is that most living cells are nearly transparent, making it difficult to see the structures within them. Using chemical stains or dyes can usually solve this problem.

# Electron Microscopes

- Light microscopes  can be used to see cells and cell structures as small as 1 millionth of a meter. To study something smaller than that, scientists need to use electron microscopes.
- Electron microscopes use beams of electrons, not light, that are focused by magnetic fields.
- Electron microscopes offer much higher resolution than light microscopes.
- Researchers chemically preserve their samples first and then carefully remove all of the water before placing them in the microscope.
- This means that electron microscopy can be used to examine **only** nonliving cells and tissues.
- There are two major types of electron microscopes: transmission  and scanning
- Because electrons are easily scattered by molecules in the air, samples examined in both types of electron microscopes must be placed in a vacuum in order to be studied.

# Transmission Electron Microscopes

- Transmission electron microscopes produce flat, two-dimensional images.
  - Transmission electron microscopes make it possible to explore cell structures and large protein molecules.
  - Because beams of electrons can only pass through thin samples, cells and tissues must be cut first into ultra thin slices before they can be examined under a transmission electron microscope.
- Because electrons are easily scattered by molecules in the air, samples examined in both types of electron microscopes must be placed in a vacuum in order to be studied.
- Researchers chemically preserve their samples first and then carefully remove all of the water before placing them in the microscope.
- This means that electron microscopy can be used to examine **only** nonliving cells and tissues.

# Scanning Electron Microscopes

- In scanning electron microscopes, a pencil-like beam of electrons is scanned over the surface of a specimen.
  - Because the image is of the surface, specimens viewed under a scanning electron microscope do not have to be cut into thin slices to be seen.
  - Scanning electron microscopes produce three-dimensional images of the specimen's surface.

# How are prokaryotic and eukaryotic cells different?

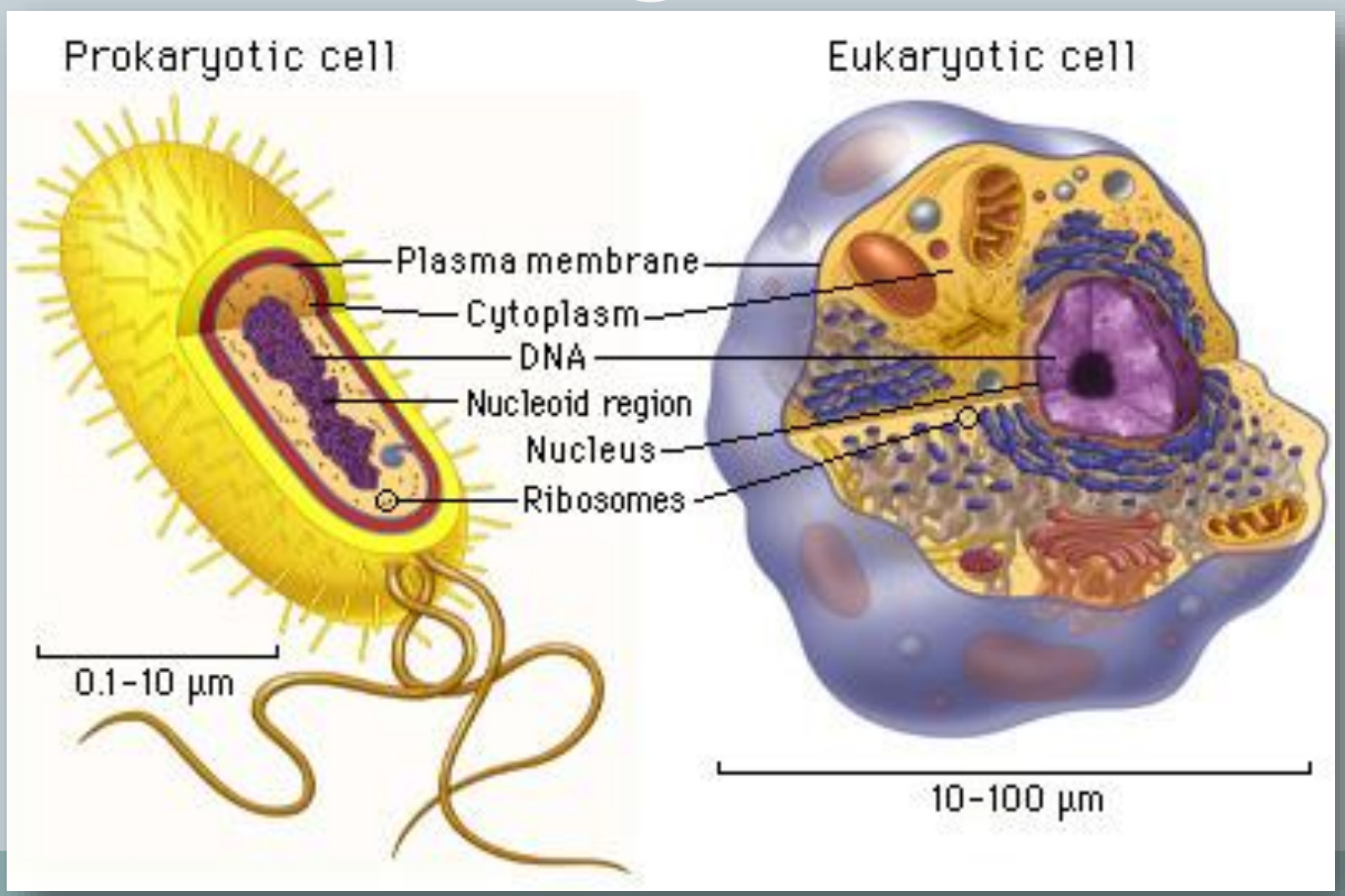
# Cell Theory

- A **Theory** is a well-tested explanation that unifies a broad range of observations and hypotheses, and enables scientists to make accurate predictions about new situations.
- The cell theory states:
  - 1. All living things are composed of cells
    - There are 2 types of cells
      - 1. prokaryote (Domain Archae- Kingdom Archaebacteria and Domain Bacteria- Kingdom Eubacteria) and
      - 2. eukaryote (Domain Eukarya- Kingdoms Plantae, Animalia, Fungi, Protista)
  - 2. Cells are the basic units of structure and function in living things
  - 3. New cells are produced from existing cells

# Prokaryotes v. Eukaryotes

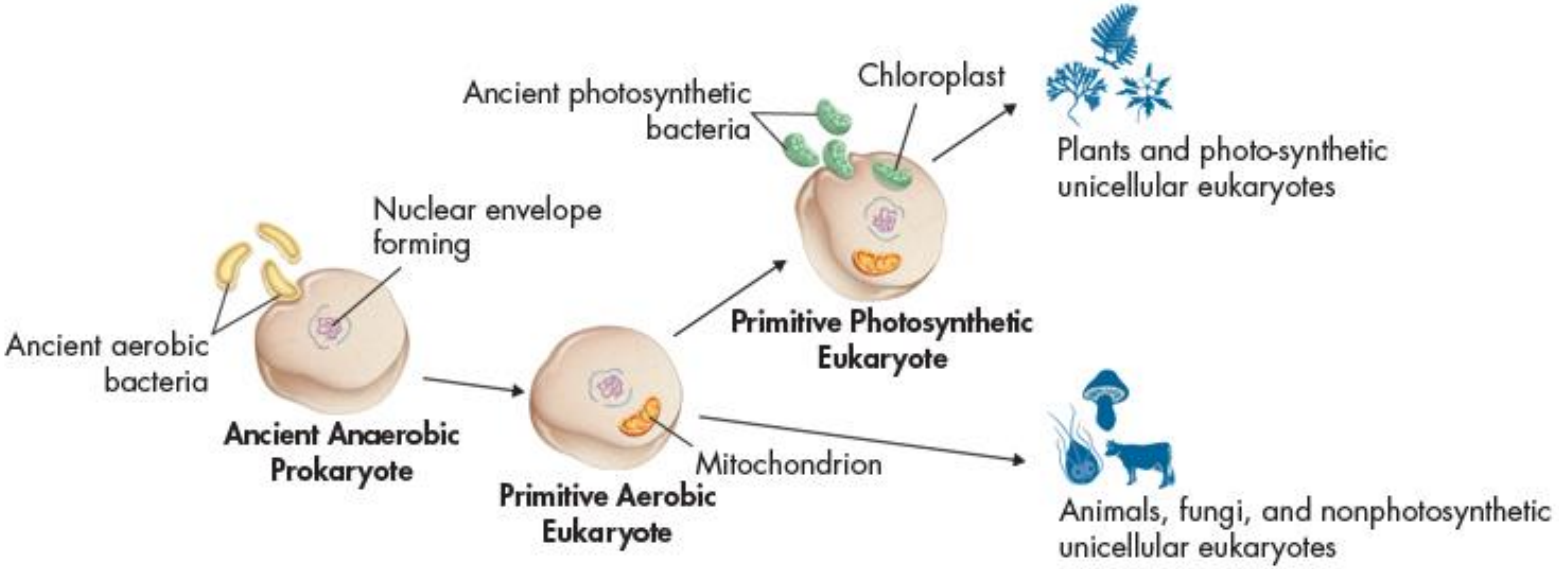
| | Prokaryotes | Eukaryotes |
|---|---|---|
| **Nucleus?** | No- genetic material is not contained in the nucleus but freely floating in the cytoplasm | Yes- contains genetic material |
| **Size** | smaller | small |
| **Complexity** | Simple as it lacks most membrane-bound structures/organelles except ribosomes | Complex as it has many membrane-bound structures/organelles |
| **Example(s)** | Bacteria | Plant, fungi, protist, and animal cells |

# Prokaryotes v. Eukaryotes



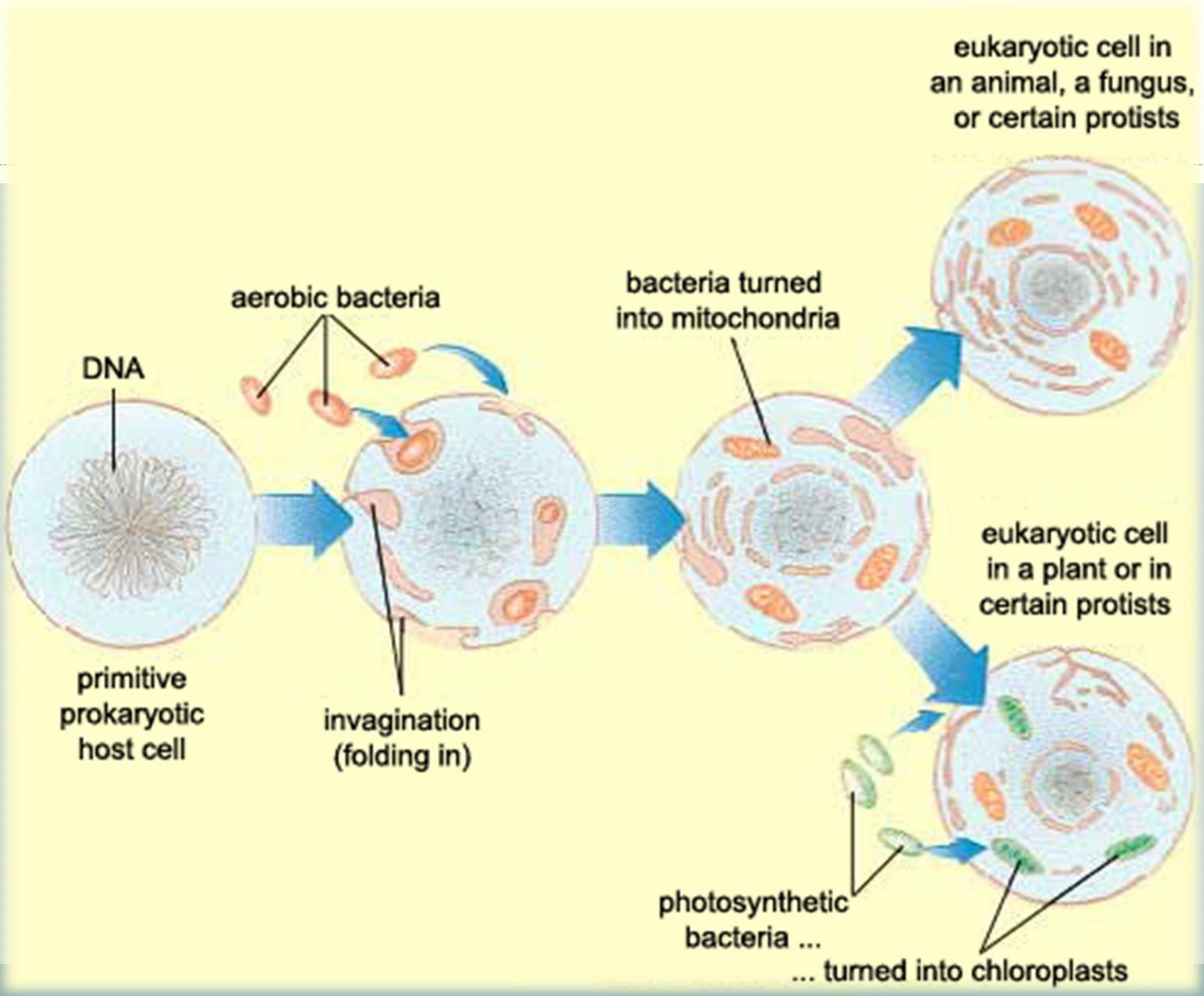
# Origin of Eukaryotic cells

- **The endosymbiotic theory** is a theory that eukaryotic cells formed from a symbiosis among several different prokaryotic organisms
  - The endosymbiotic theory proposes that eukaryotic cells arose from living communities formed by prokaryotic organisms



# The Endosymbiotic Theory

- Mitochondria and chloroplasts were once primitive bacterial cells that lived alongside some of the oldest cells on Earth that were single-celled prokaryotes in Domain Archae.
- The organelles were engulfed through endocytosis by bacterial cells and both the bacteria and organelles developed a mutualistic symbiotic relationship.
  - The bacteria benefited from the chloroplasts as they provided crucial nutrients such as carbohydrates (through photosynthesis), the mitochondria was able to extract energy from these carbohydrates (through cellular respiration), and the organelles benefited from the bacteria as they received protection and a steady environment in which to live.


eukaryotic cell in
an animal, a fungus,
or certain protists
aerobic bacteria
bacteria turned
into mitochondria
DNA
eukaryotic cell
in a plant or in
certain protists
primitive
prokaryotic
host cell
invagination
(folding in)
photosynthetic
bacteria ...
... turned into chloroplasts

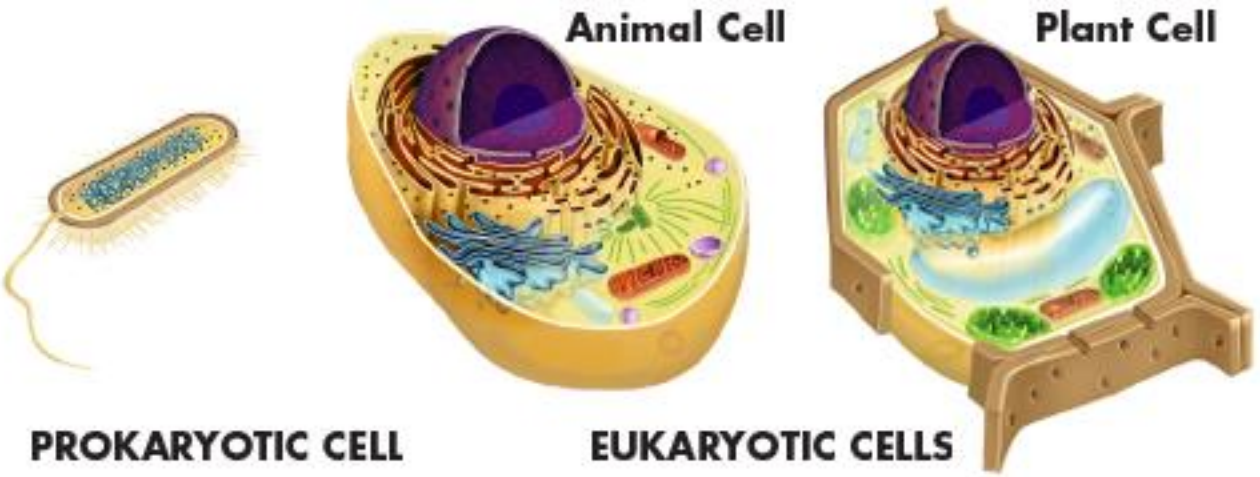
# The Endosymbiotic Theory

- Evidence to support it:
  1. Mitochondria and chloroplasts have many similarities with bacterial cells, such as their own DNA (which is separate from the DNA found in the nucleus of the cell)
  2. Both organelles use their DNA to produce many proteins
  3. Both organelles have a double membrane which suggests they were ingested by a primitive host
  4. The organelles reproduce similar to bacteria by replicating their own DNA and directing their own division

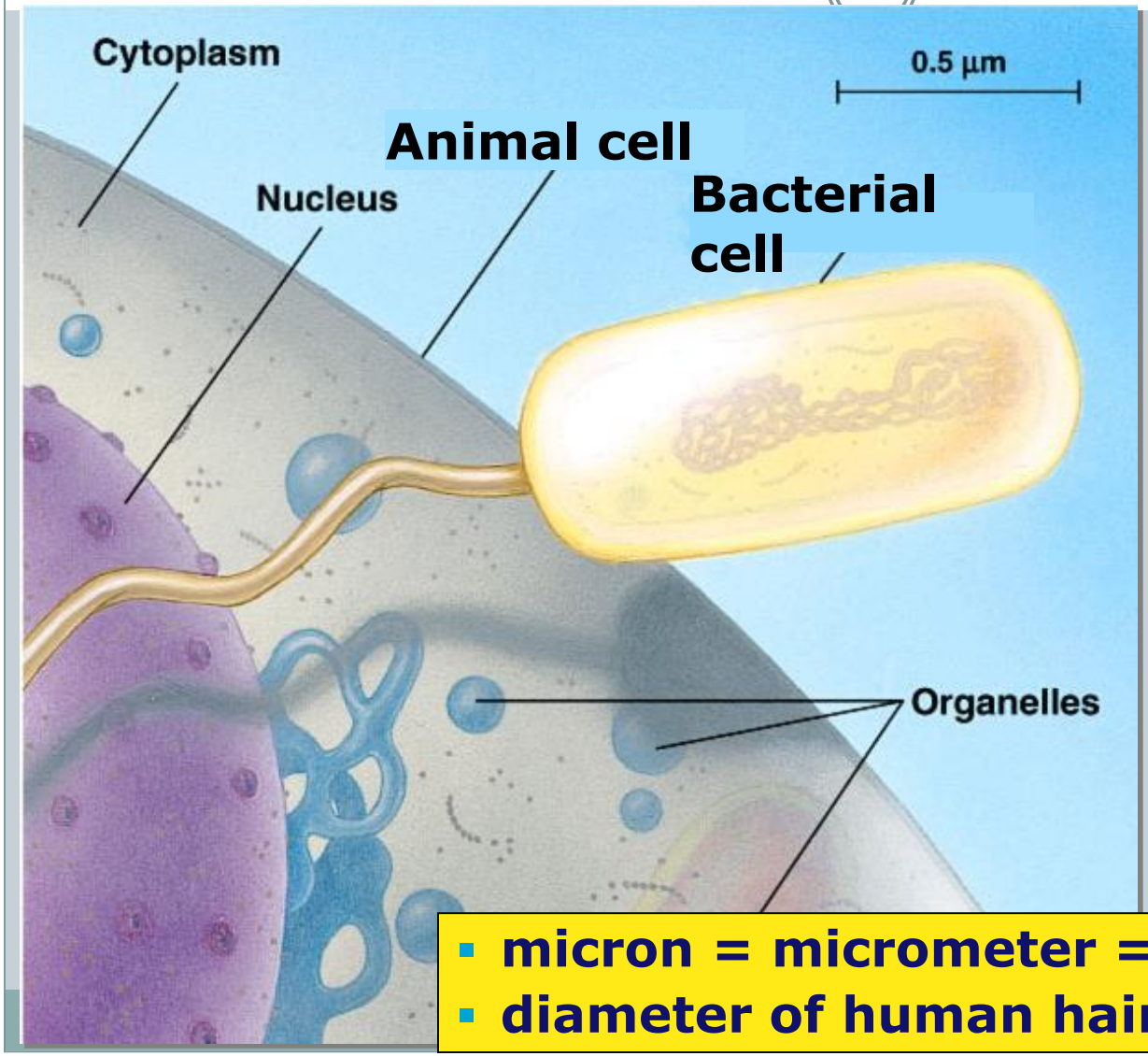
# Prokaryotes and Eukaryotes

**Eukaryotes** are cells that enclose their DNA in nuclei.

**Prokaryotes** are cells that do not enclose DNA in nuclei (no nucleus present).



# Cell size comparison




**most bacteria**

- 1-10 microns

**eukaryotic cells**

- 10-100 microns

- micron = micrometer = 1/1,000,000 meter
- diameter of human hair = ~20 microns

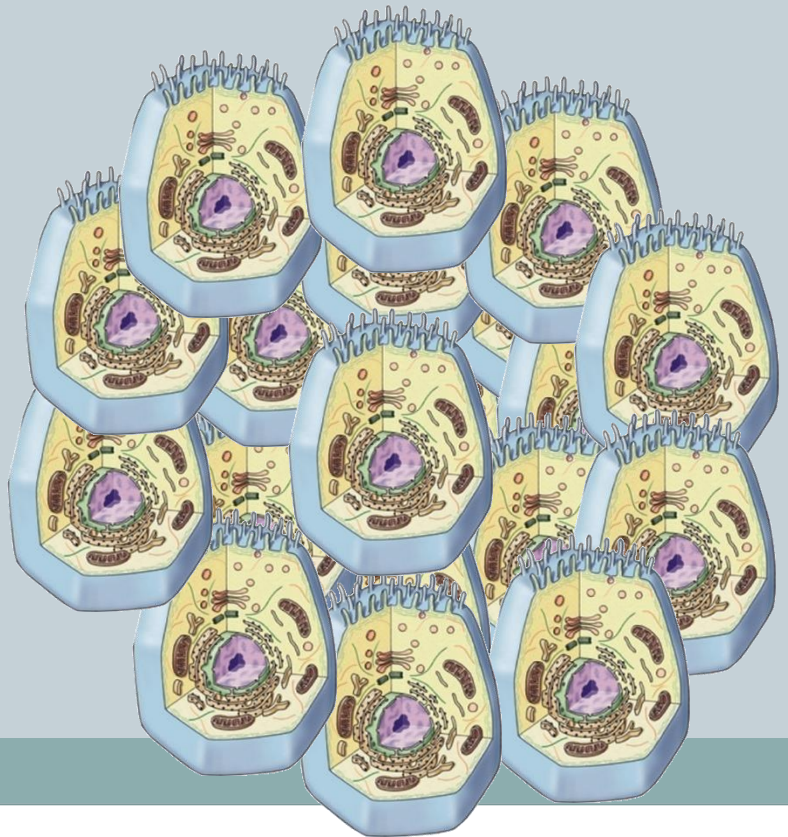
# QUESTION AND ANSWER

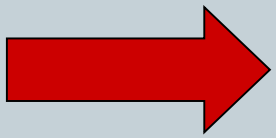
**How are prokaryotic and eukaryotic cells different?**

# What are the roles of organelles in the cell?

# Why study cells?

- Cells → Tissues → Organs → Organ systems → Bodies
  - bodies are made up of cells
  - cells do all the work of life!



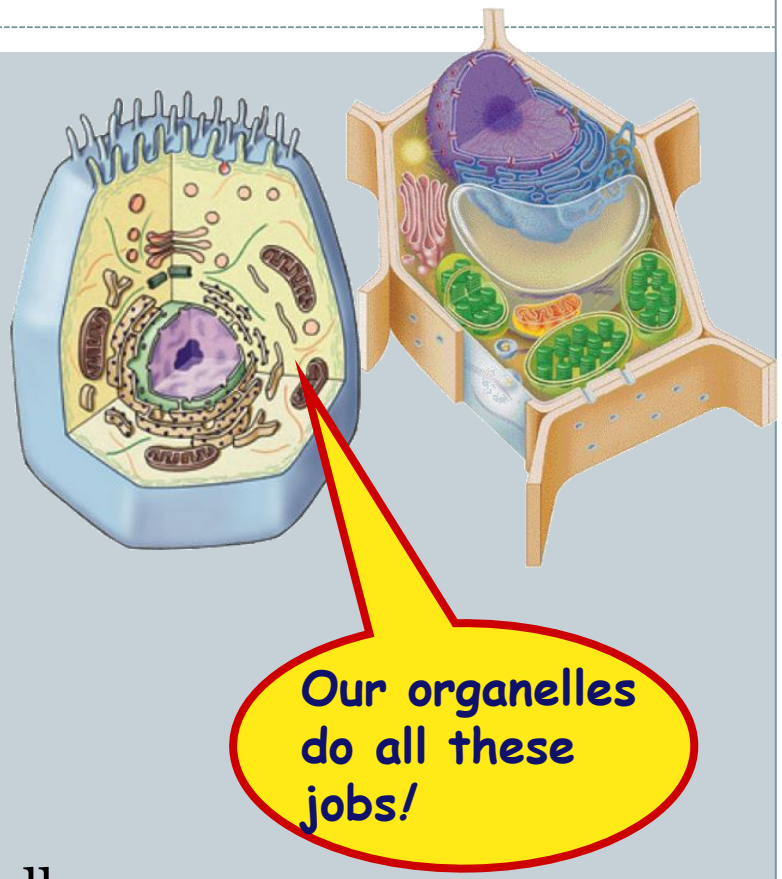


# The Work of Life

- What jobs do cells have to do for an organism to live…
  - "breathe"
    - gas exchange: $O_2$ in vs. $CO_2$ out
  - eat
    - take in & digest food
  - make energy
    - ATP
  - build molecules
    - proteins, carbohydrates, fats, nucleic acids
  - remove wastes
  - control internal conditions
    - homeostasis
  - respond to external environment
  - build more cells
    - growth, repair, reproduction & development

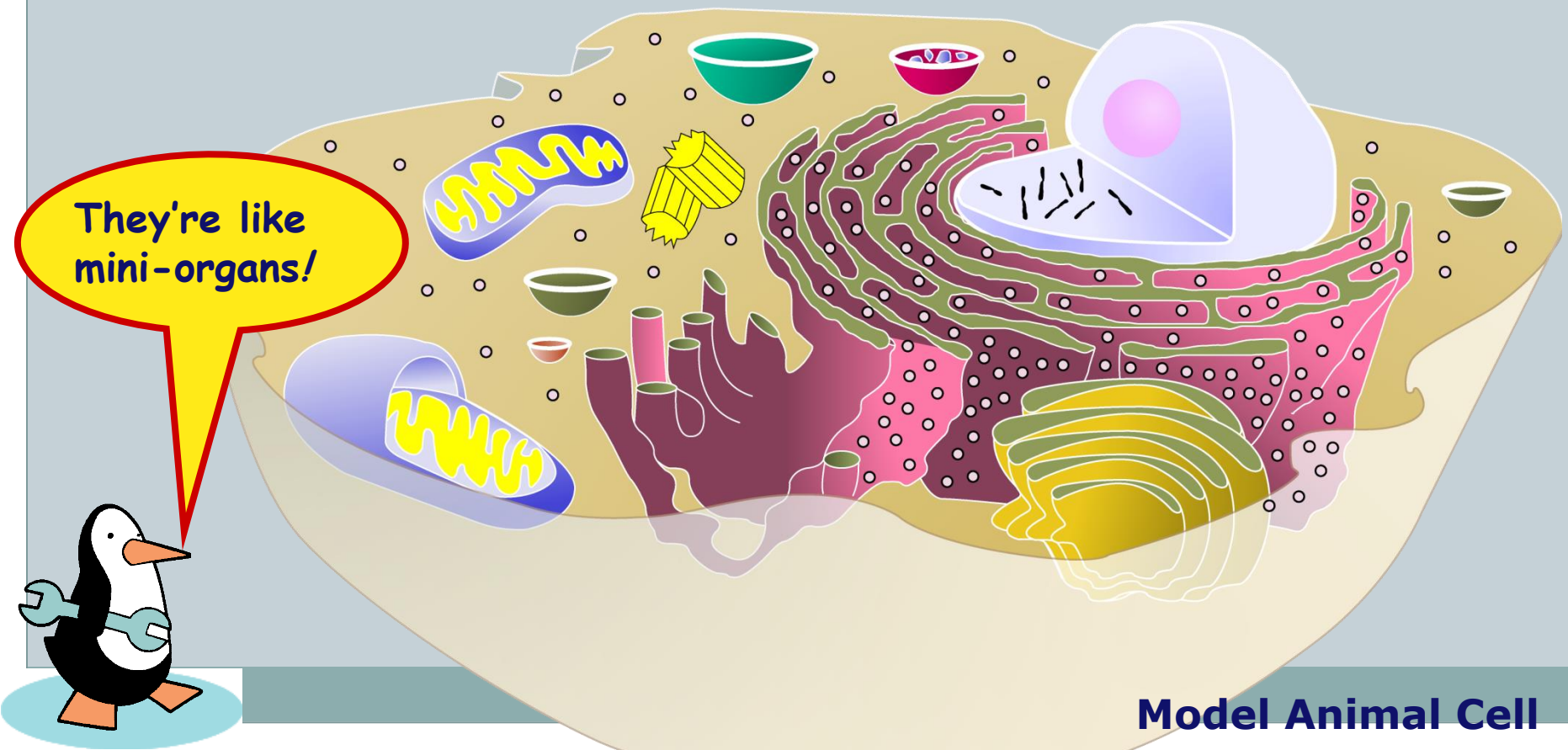

# The Jobs of Cells

- Cells have 3 main jobs
  - 1. make energy
    - need energy for all activities
    - need to clean up waste produced while making energy
  - 2. make proteins
    - proteins do all the work in a cell, so we need lots of them
  - 3. make more cells
    - for growth
    - to replace damaged or diseased cells



# Organelles

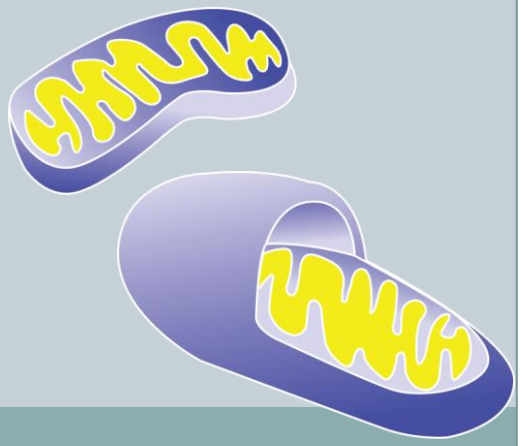
- Organelles do the work of cells
  - each structure has a job to do
    - keeps the cell alive; keeps you alive



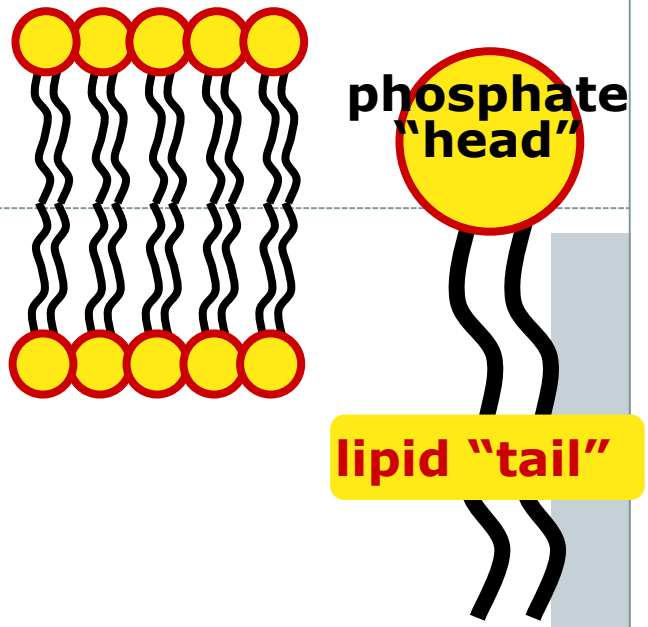

Model Animal Cell

# 1. Cells need power!

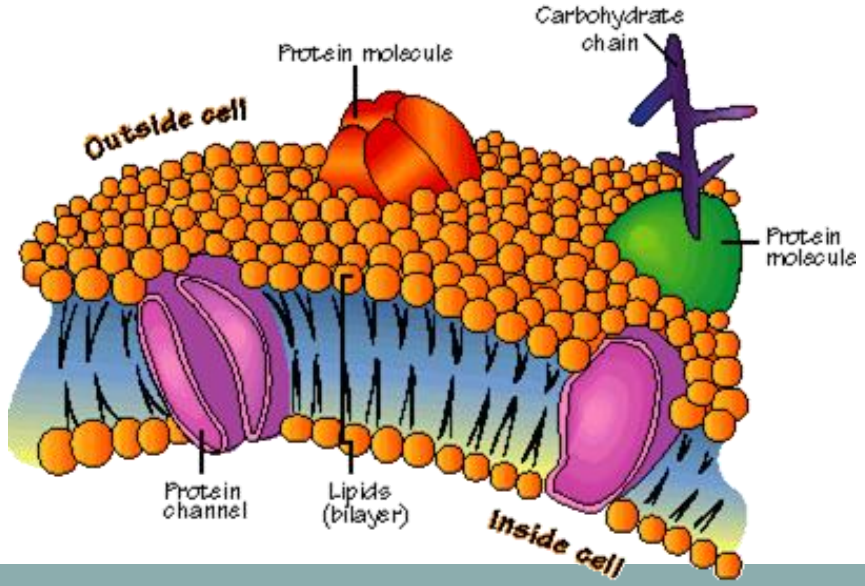
- Making energy
  - to fuel daily life & growth, the cell must…
    - take in food & digest it
    - take in oxygen ($O_2$)
    - make ATP
    - remove waste
  - organelles that do this work…
    - cell membrane
    - lysosomes
    - vacuoles & vesicles
    - mitochondria

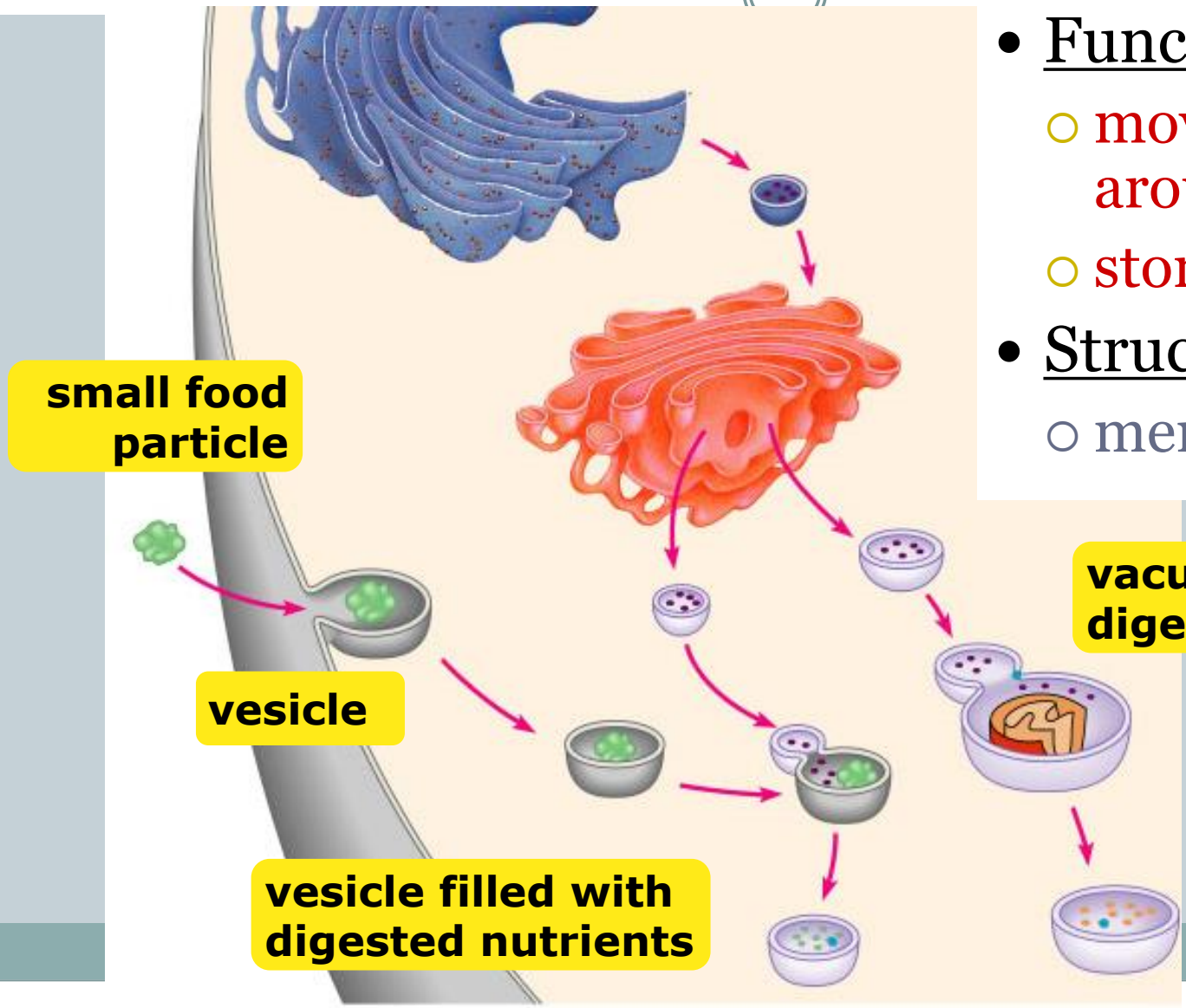
# Cell membrane




- Function
  - separates cell from outside
  - controls what enters or leaves the cell
    - $O_2$, $CO_2$, food, $H_2O$, nutrients, waste
  - recognizes signals from other cells
    - allows communication between cells
- Structure
  - double layer of lipid (fat)
    - phospholipid bilayer
  - receptor molecules
    - proteins



# Vacuoles & vesicles

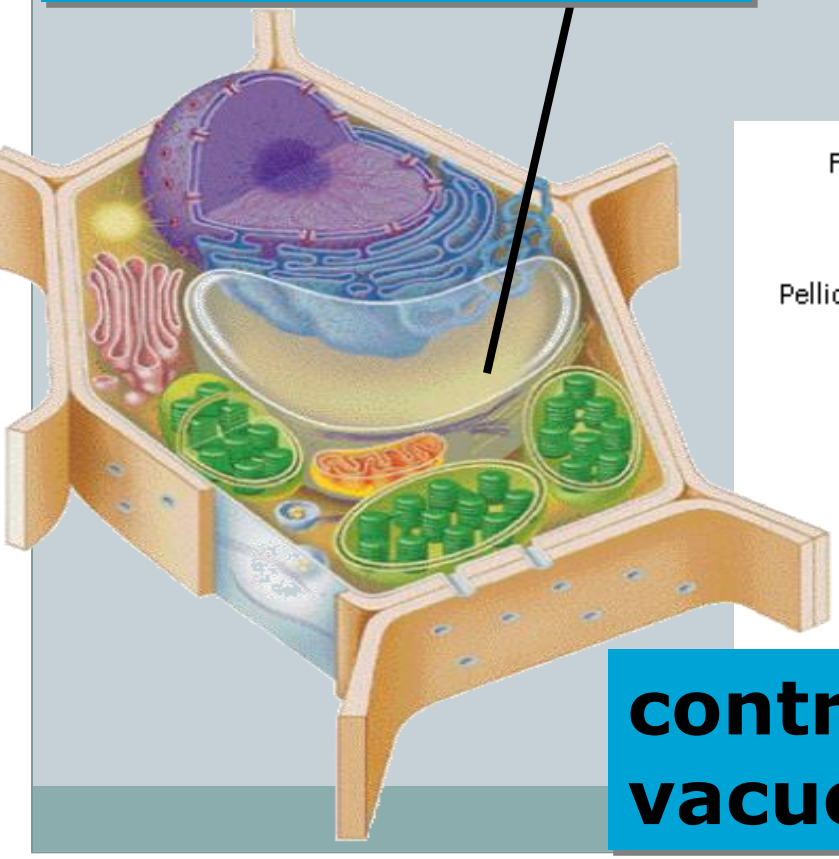


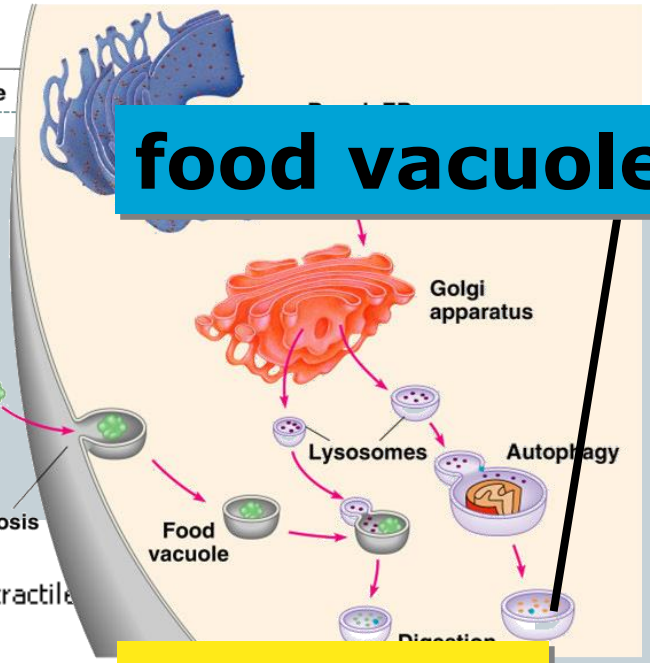

- Function
  - moving material around cell
  - storage
- Structure
  - membrane sac

# Food & water storage

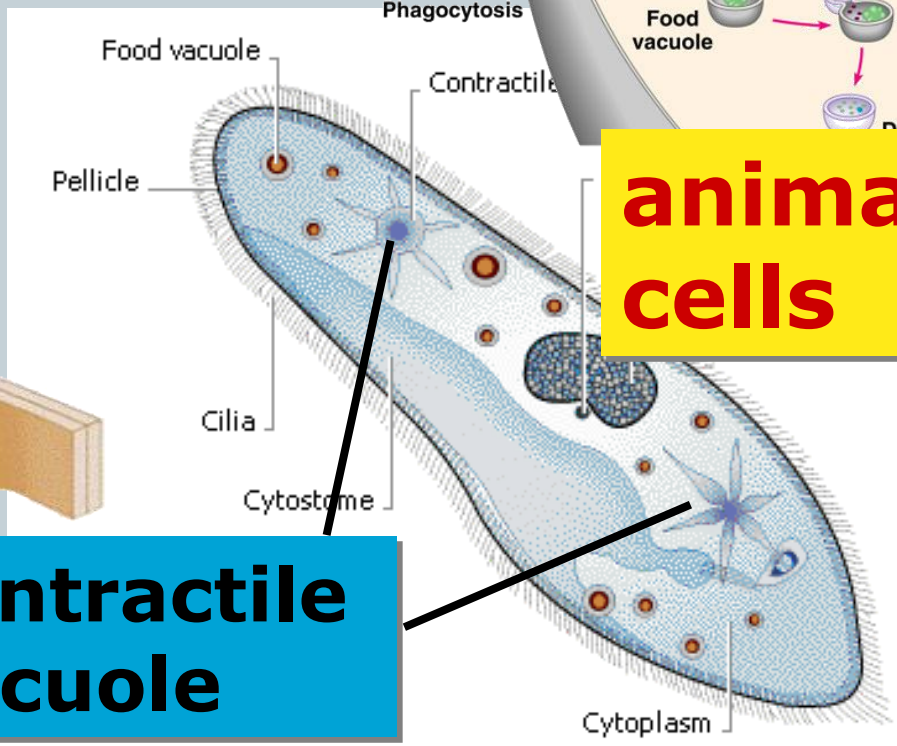
**plant cells**

**central vacuole**






**food vacuole**

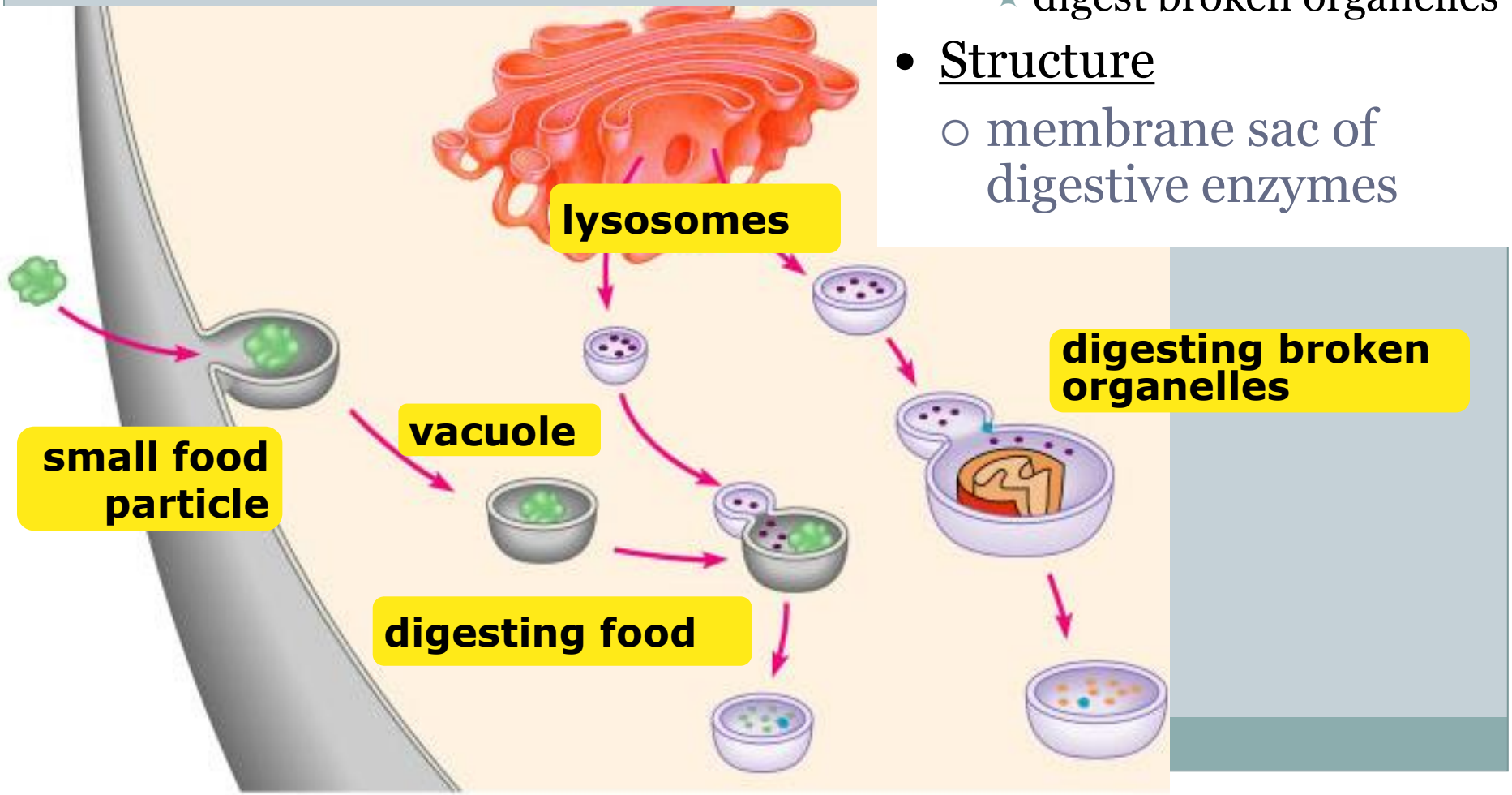



**animal cells**

**contractile vacuole**

# Lysosomes

- Function
  - digest food
    - used to make energy
  - clean up & recycle
    - digest broken organelles
- Structure
  - membrane sac of digestive enzymes

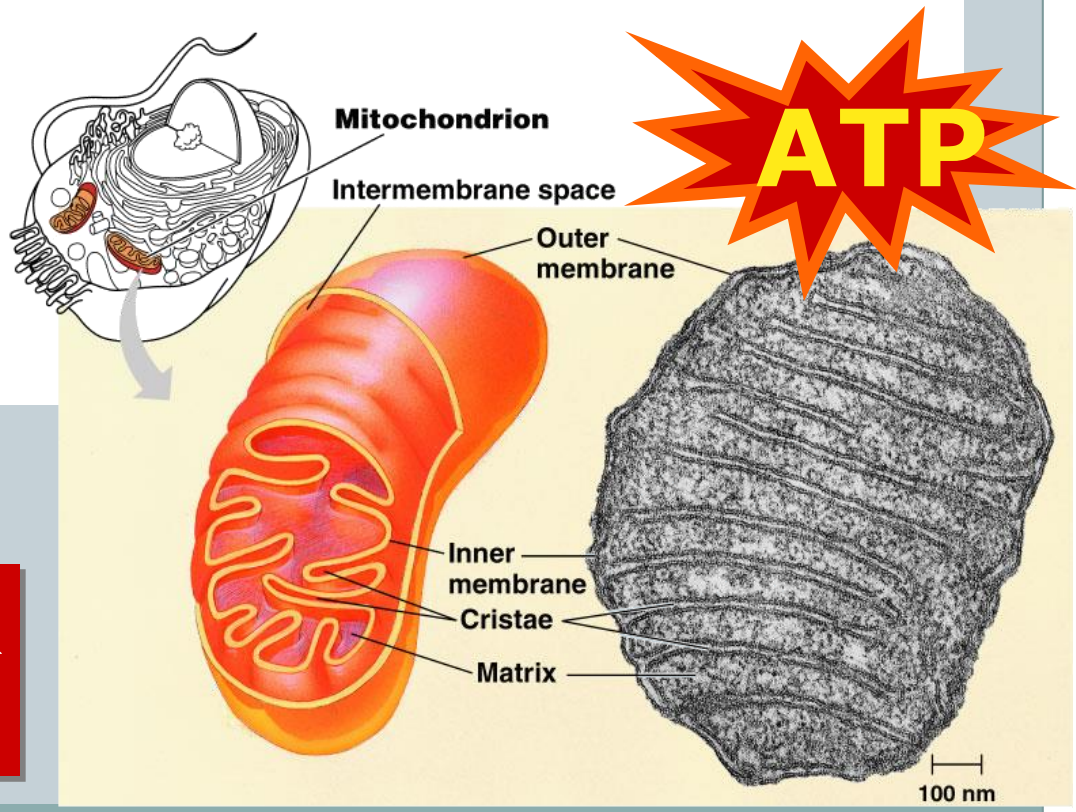


# A Job for Lysosomes




# Mitochondria

- Function
  - make ATP energy from cellular respiration
    - sugar + $O_2$ → ATP
    - fuels the work of life
- Structure
  - double membrane
  - has its own DNA

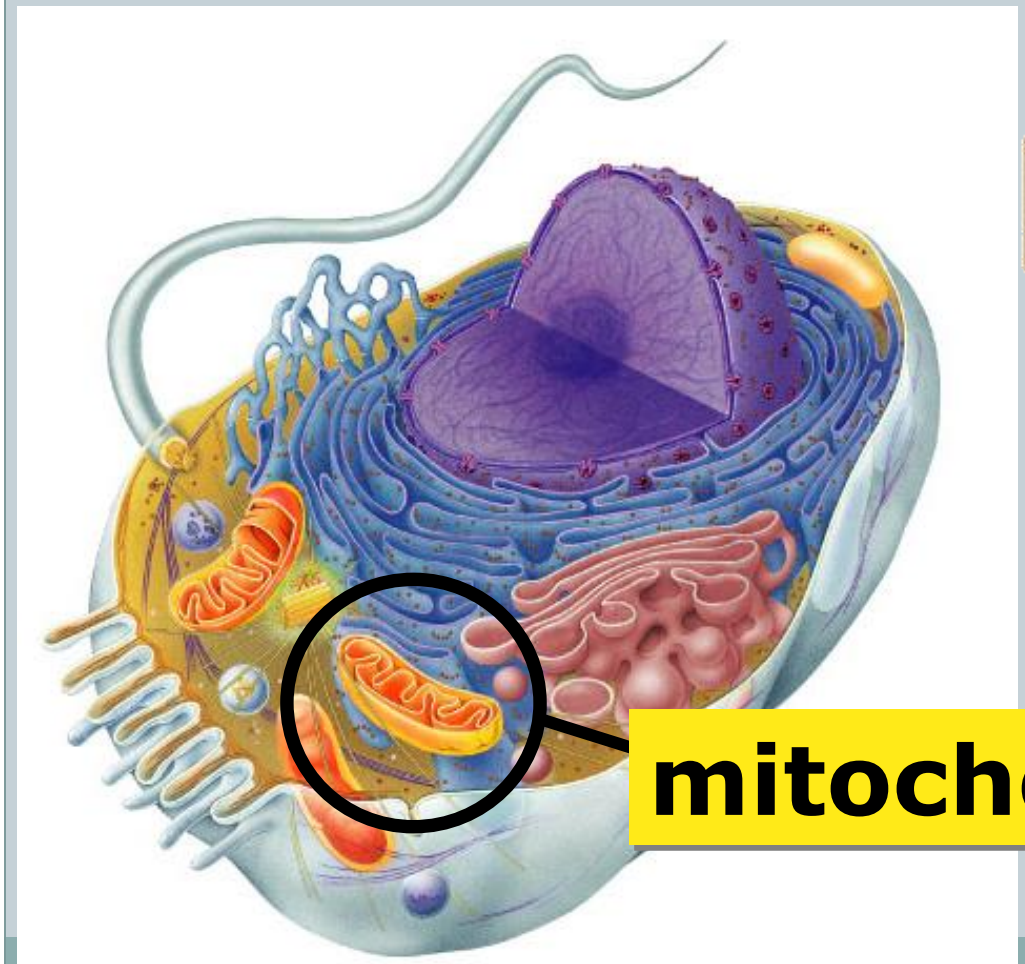


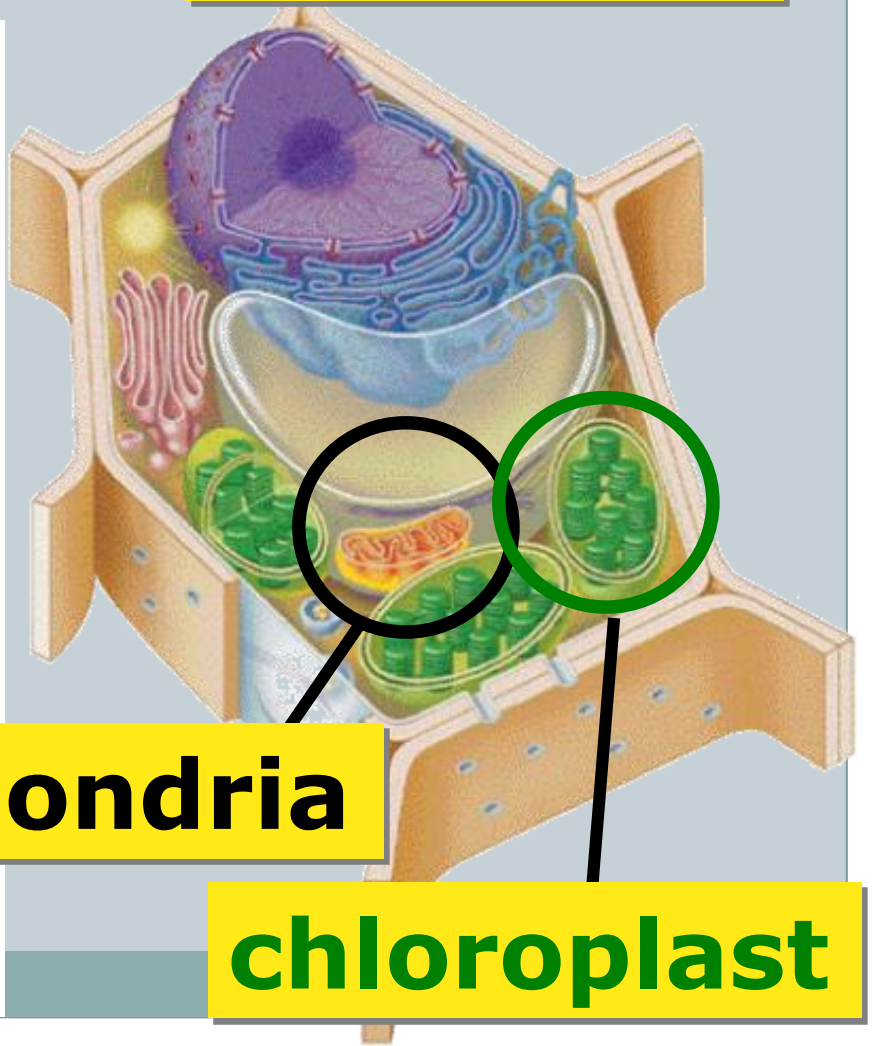

**in both animal & plant cells**

# Mitochondria are in both cells!!

**animal cells**

**plant cells**



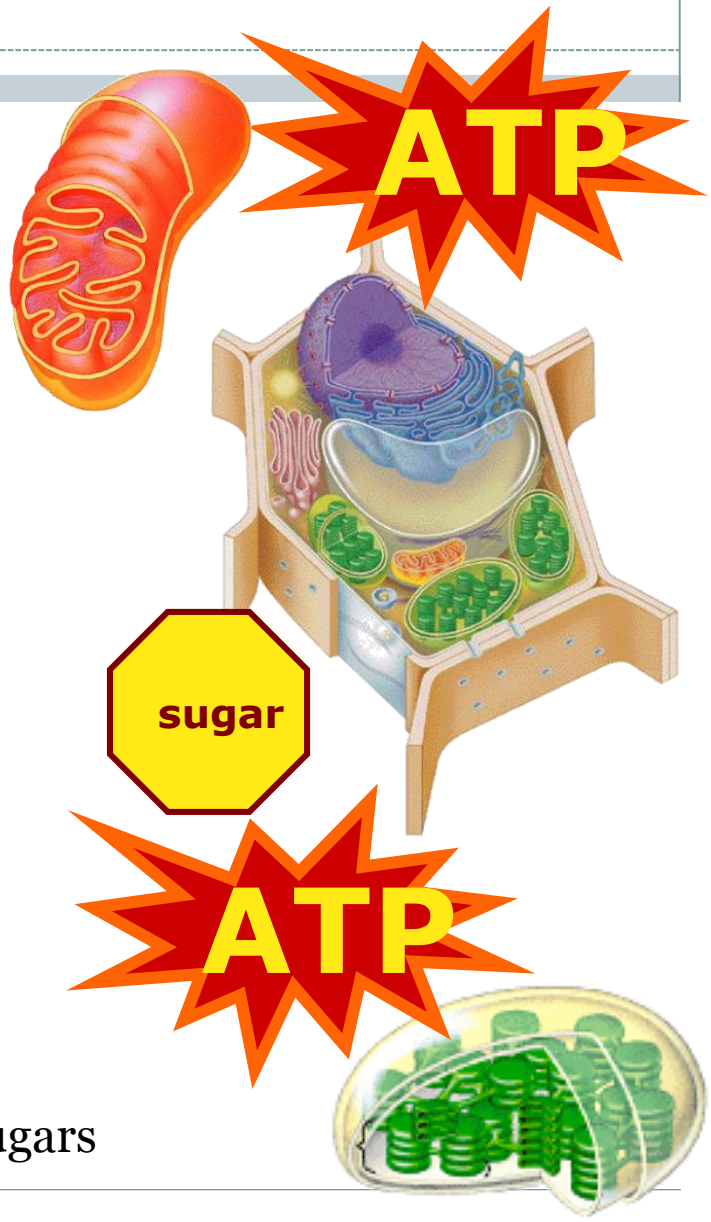


**mitochondria**

**chloroplast**

# Plants make energy two ways!

- **Mitochondria**
  - make energy from sugar + $O_2$
    - cellular respiration
    - sugar + $O_2 \rightarrow$ ATP
- **Chloroplasts**
  - make energy + sugar from sunlight
  - has its own DNA
    - photosynthesis
    - sunlight + $CO_2 \rightarrow$ ATP & sugar
      - ATP = active energy
      - sugar = stored energy
        - build leaves & roots & fruit out of the sugars



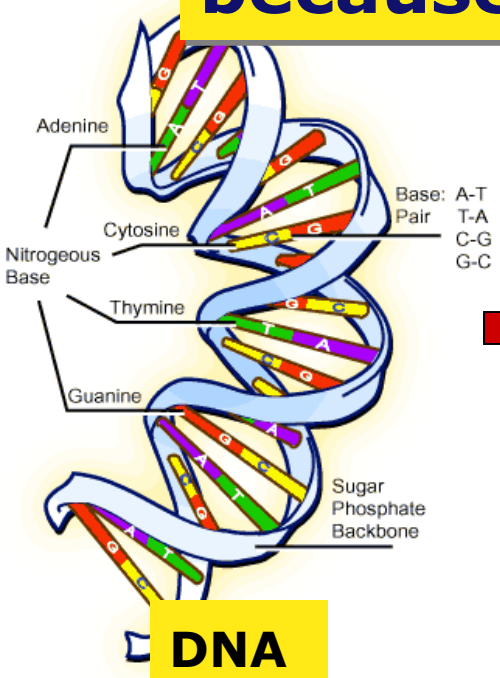
# 2. Cells need workers = proteins!

- Making proteins
  - to run daily life & growth, the cell must…
    - read genes (DNA)
    - build proteins
      - structural proteins (muscle fibers, hair, skin, claws)
      - enzymes (speed up chemical reactions)
      - signals (hormones) & receptors
  - organelles that do this work…
    - nucleus
    - ribosomes
    - endoplasmic reticulum (ER)
    - Golgi apparatus

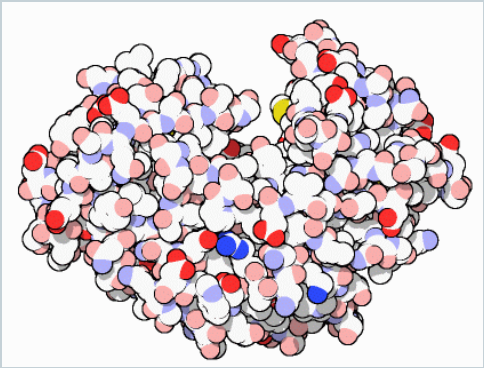
# Proteins do all the work!

**one of the major job of cells is to make proteins, because…**

**proteins do all the work!**




**DNA**



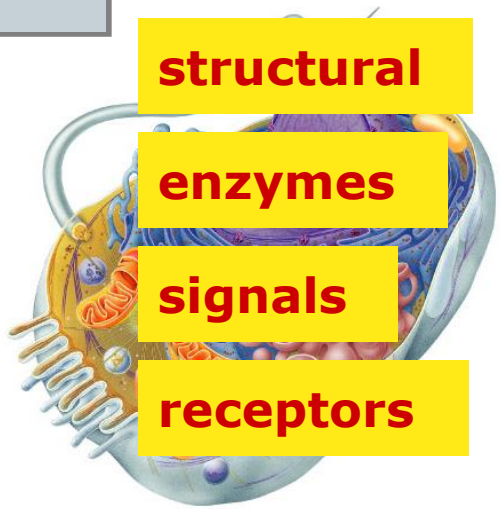
**proteins**

**structural**

**enzymes**

**signals**

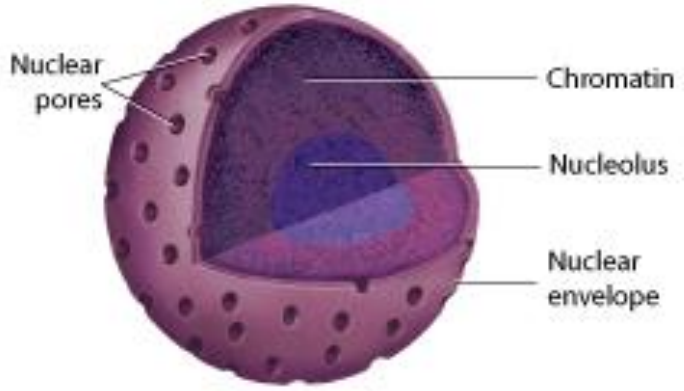
**receptors**



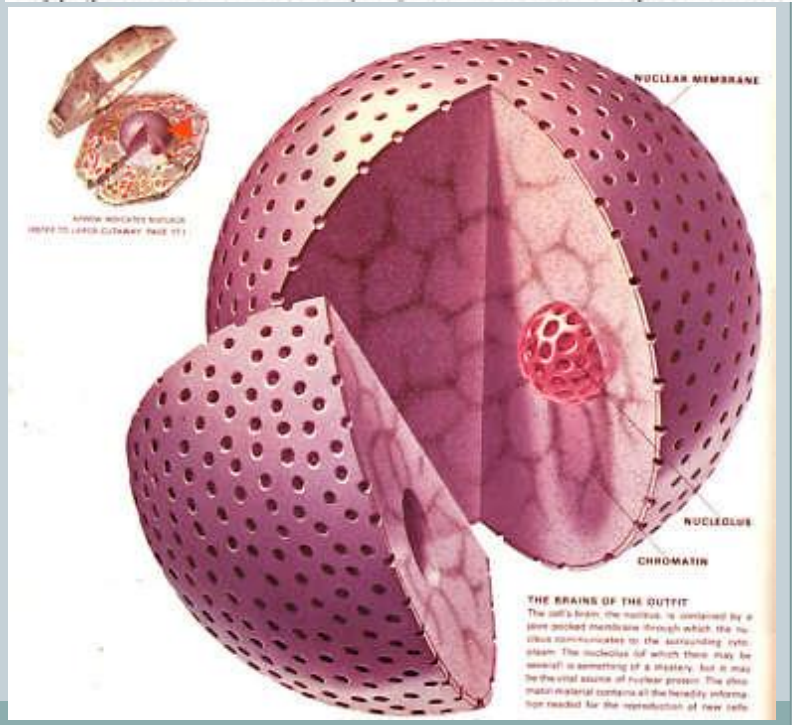
**cells**

# Nucleus

- Missing in prokaryotic cells
- Function
  - control center of cell
  - protects DNA
    - instructions for building proteins
- Structure
  - nuclear membrane
  - nucleolus
    - ribosome factory
  - chromosomes
    - DNA

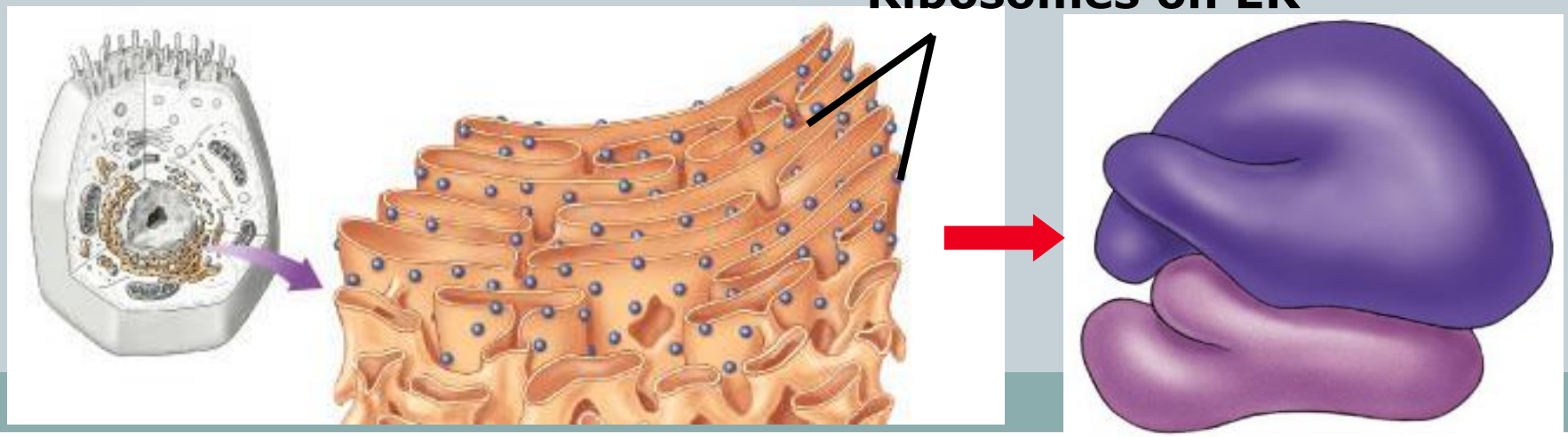




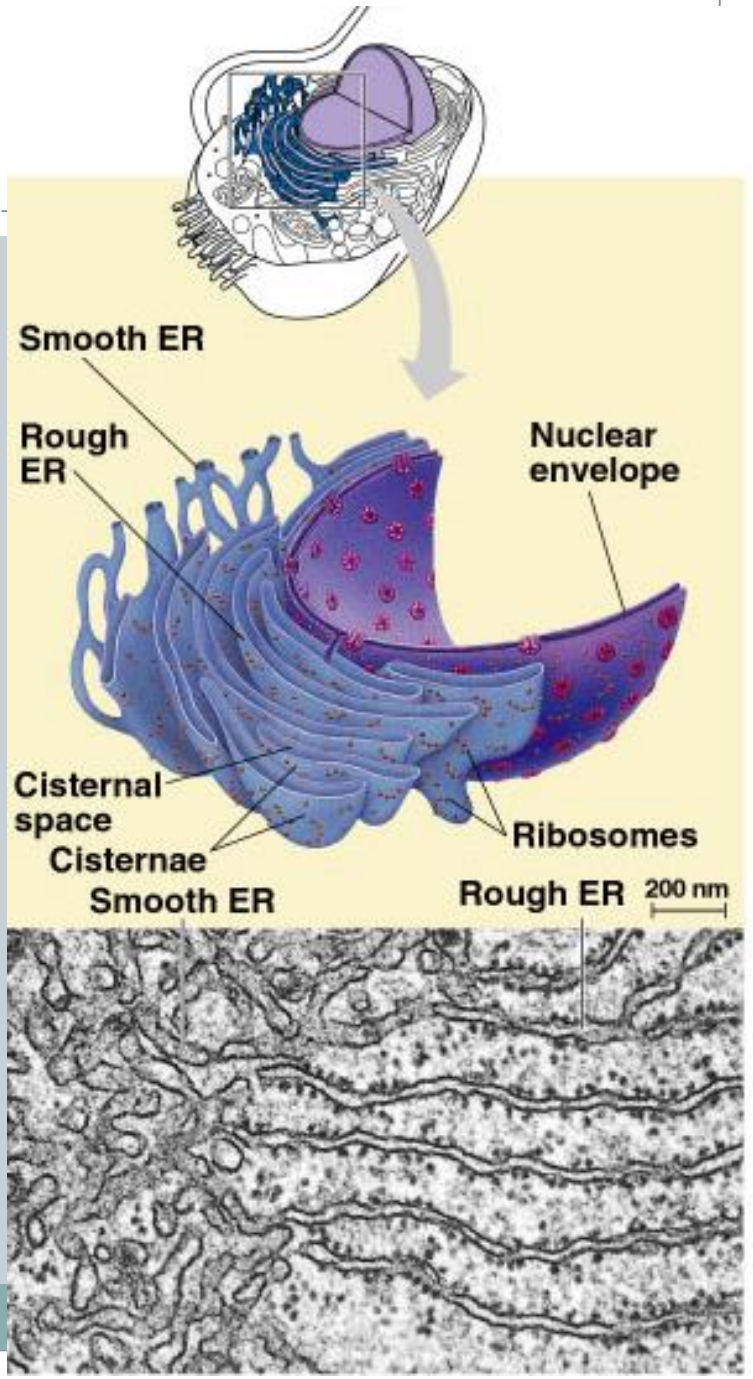
# Ribosomes

- Function
  - protein factories
  - read instructions to build proteins from DNA
- Structure
  - some free in cytoplasm
  - some attached to ER



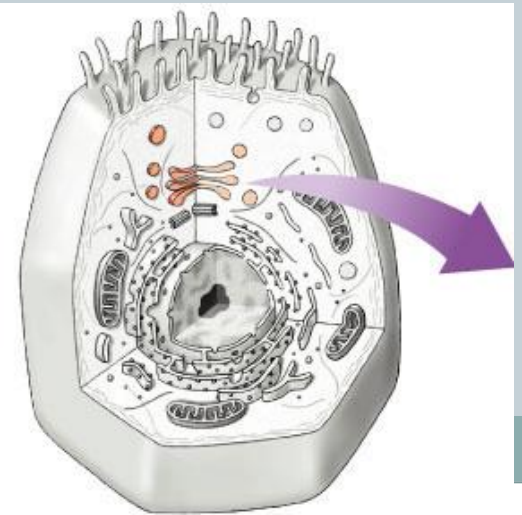
# Endoplasmic Reticulum

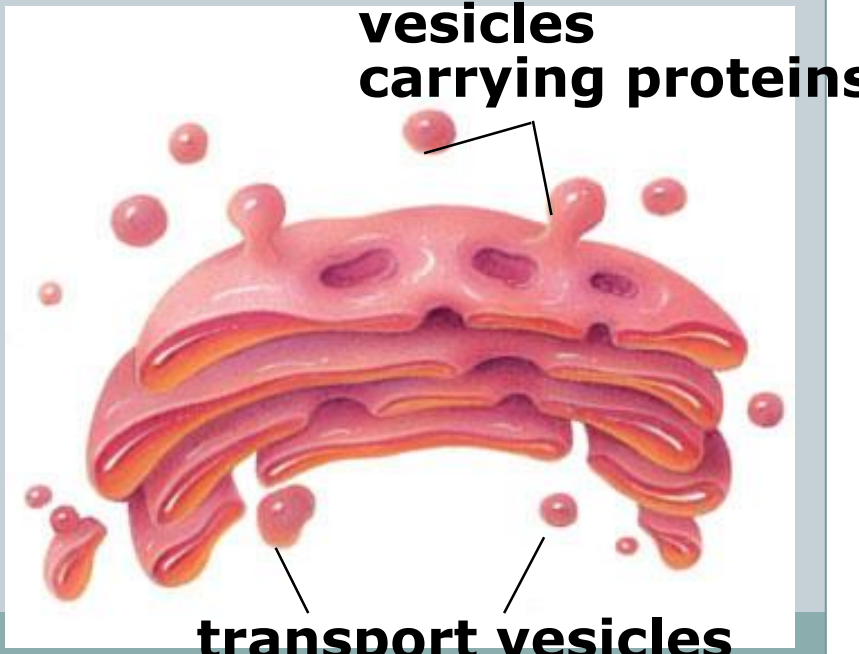
- Function
  - works on proteins
    - helps complete the proteins after ribosome builds them
  - makes membranes
- Structure
  - rough ER
    - ribosomes attached
    - Modifies the structure of proteins
  - smooth ER
    - makes membranes

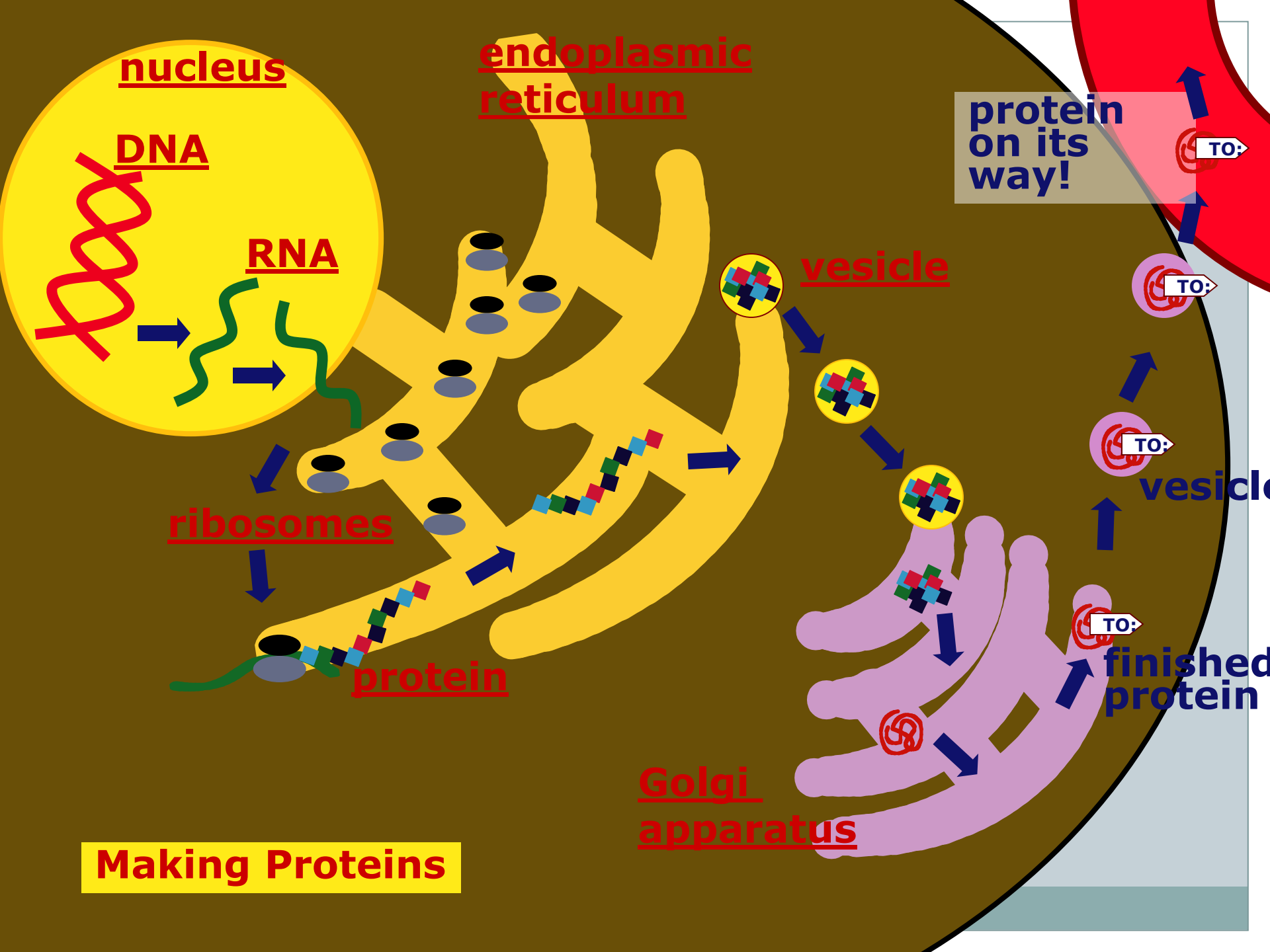


# Golgi Apparatus

- Function
  - finishes, sorts, labels & ships proteins
    - like UPS headquarters
      - shipping & receiving department
  - ships proteins in vesicles
    - "UPS trucks"
- Structure
  - membrane sacs

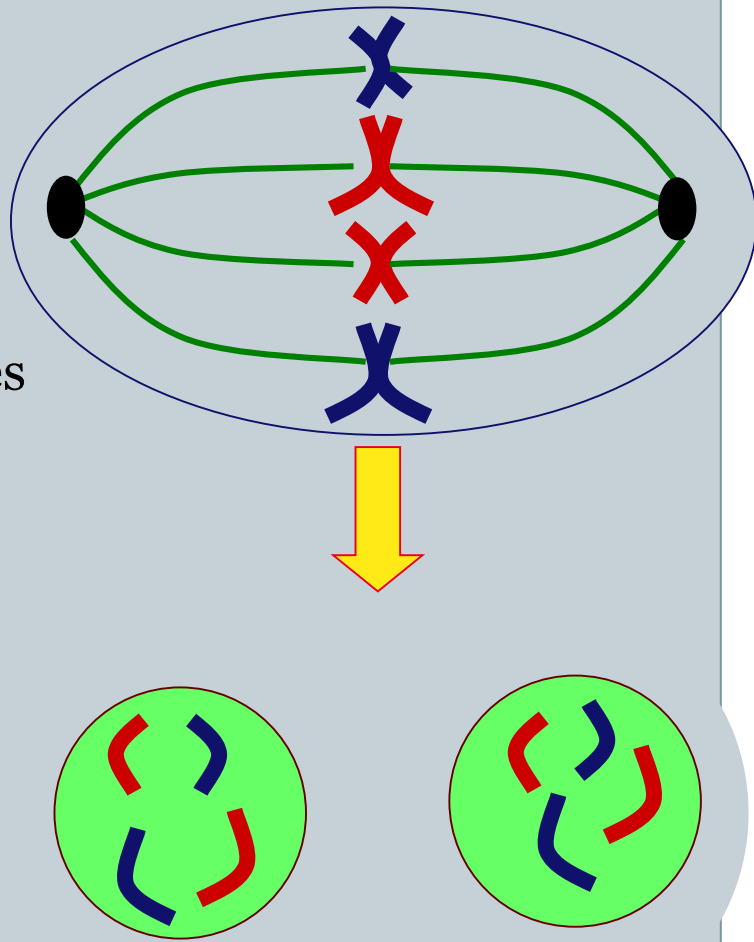





nucleus
DNA
RNA
endoplasmic reticulum
ribosomes
protein
vesicle
protein on its way!
TO:
TO:
TO:
TO:
vesicle
finished protein
Golgi apparatus
Making Proteins

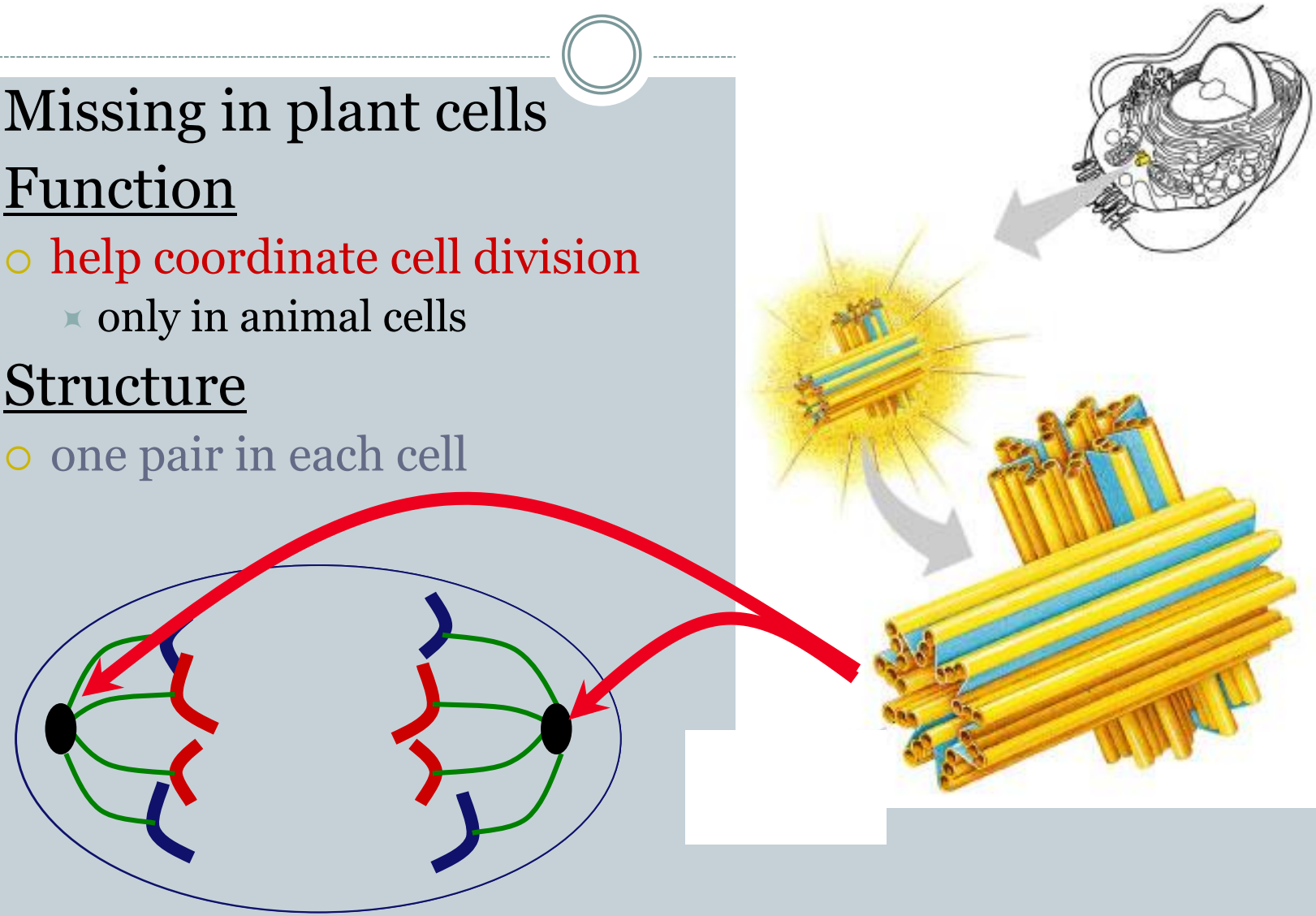
# 3. Cells need to make more cells!

- Making more cells
  - to replace, repair & grow, the cell must…
    - copy their DNA
    - make extra organelles
    - divide the new DNA & new organelles between 2 new "daughter" cells
  - organelles that do this work…
    - nucleus
    - centrioles



# Centrioles

- Missing in plant cells
- Function
  - help coordinate cell division
    - only in animal cells
- Structure
  - one pair in each cell

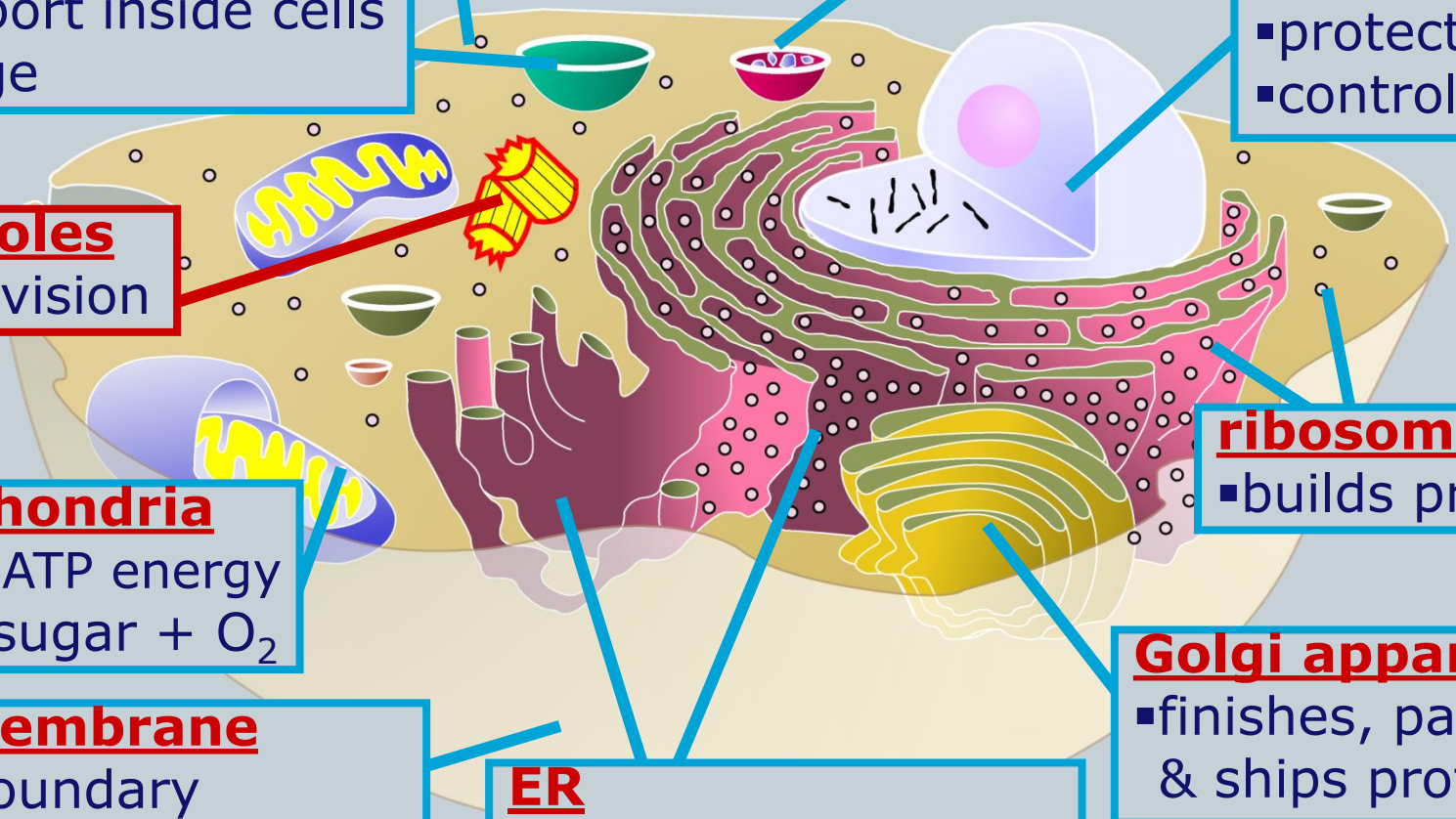


# Organelle Functions

| Organelle | Function |
|---|---|
| Nucleus | Contains DNA - “control center” of the cell |
| Ribosomes | The assembly of proteins occurs here |
| Endoplasmic Reticulum | The assembly of lipid components of the cell membrane occurs here along with proteins and other materials that are exported from the cell |
| Chloroplasts | Capture energy from the sunlight and convert it to chemical energy during the process of photosynthesis |
| Mitochondria | Provides energy to the cell. Location of cellular respiration |
| Cilia | any of the short thread-like projections on the surface of a cell or organism, whose rhythmic beating causes movement of the organism or of the surrounding fluid |
| Flagella | Hair-like structure that acts primarily as an organelle of locomotion in the cells of many living organisms |

| | |
|---|---|
| Cytoskeleton | Helps cell maintain its shape and movement |
| Microtubules | Microtubules are fibrous, hollow rods, that function primarily to help support and shape the cell. They also function as routes along which organelles can move. They are typically found in all eukaryotic cells and are a component of the cytoskeleton, as well as cilia and flagella. Composed of subunits of protein tubulin. |
| Microfilaments | Microfilaments are fine, thread-like protein fibers and makes up the cytoskeleton. Predominantly composed of contractile protein called actin. |
| Vacuoles | Store materials such as water, salts |
| Lysosomes | Digests and breaks down lipids, carbohydrates, and proteins |
| Golgi apparatus | Modify, sort, and package proteins |

# Animal cell



**cytoplasm**
- jelly-like material holding organelles in place

**lysosome**
- food digestion
- garbage disposal & recycling

**vacuole & vesicles**
- transport inside cells
- storage

**nucleus**
- protects DNA
- controls cell

**centrioles**
- cell division

**ribosomes**
- builds proteins

**mitochondria**
- make ATP energy from sugar + $O_2$

**Golgi apparatus**
- finishes, packages & ships proteins

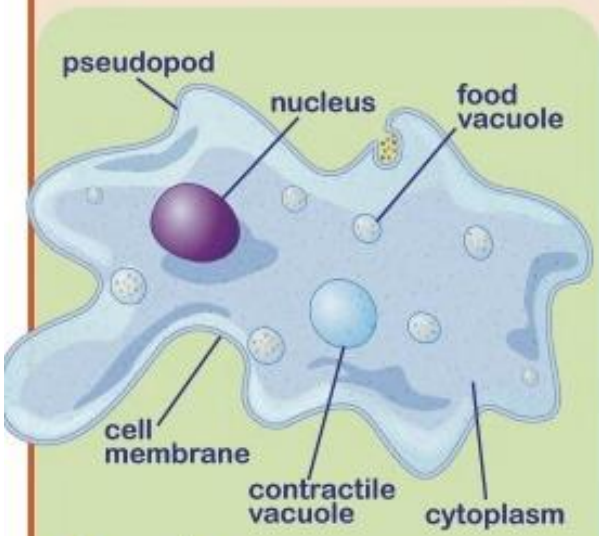
**cell membrane**
- cell boundary
- controls movement of materials in & out
- recognizes signals

**ER**
- helps finish proteins
- makes membranes

# Other Eukaryotic Cells- Kingdom Protista

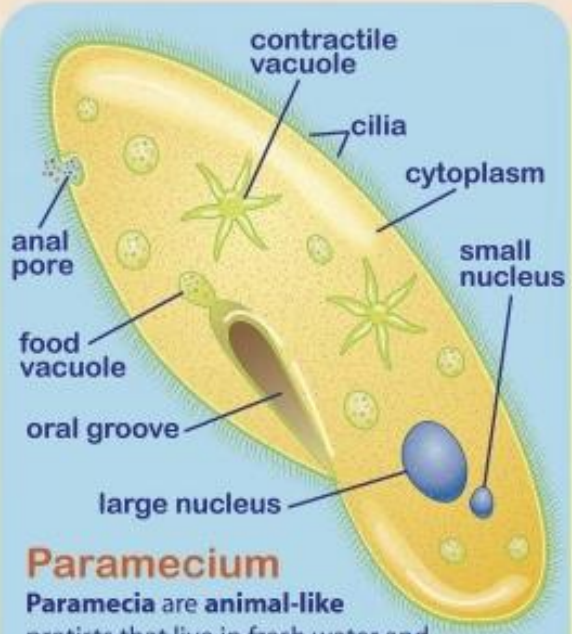
## Protists

The protist kingdom is the most diverse. Some protists are **unicellular** while others **multicellular**. The wide variety of characteristics of the numerous protist species makes it difficult to categorize them, but scientists developed a method that places each species into three separate categories: **animal-like**, **plant-like (algae)**, and **fungus-like**.



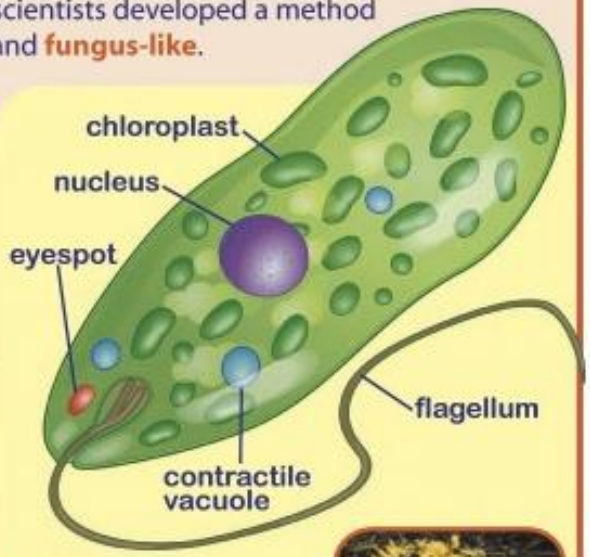

### Amoeba

**Amoebas** are **animal-like** and feed on bacteria and smaller protists.




### Paramecium

**Paramecia** are **animal-like** protists that live in fresh water and feed on bacteria and smaller protists.




### Euglena

**Euglenoids** are unicellular algae that live in fresh water and can make their own food in the presence of sunlight.

**Fungus-like** protists, like fungi, are **heterotrophs** and use spores to reproduce.

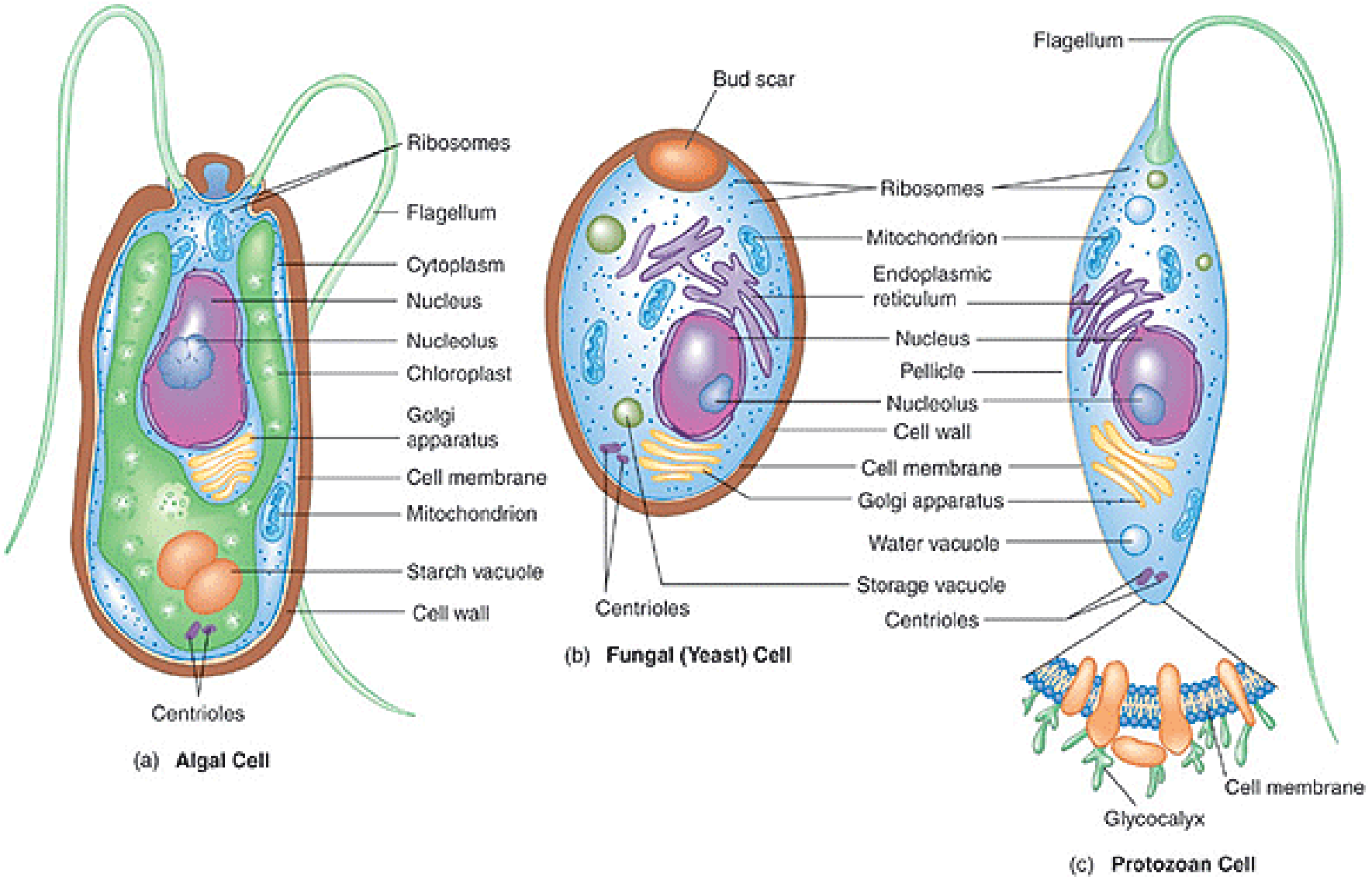
slime mold

Some photos courtesy of CDC and USDA.

NewPath Learning

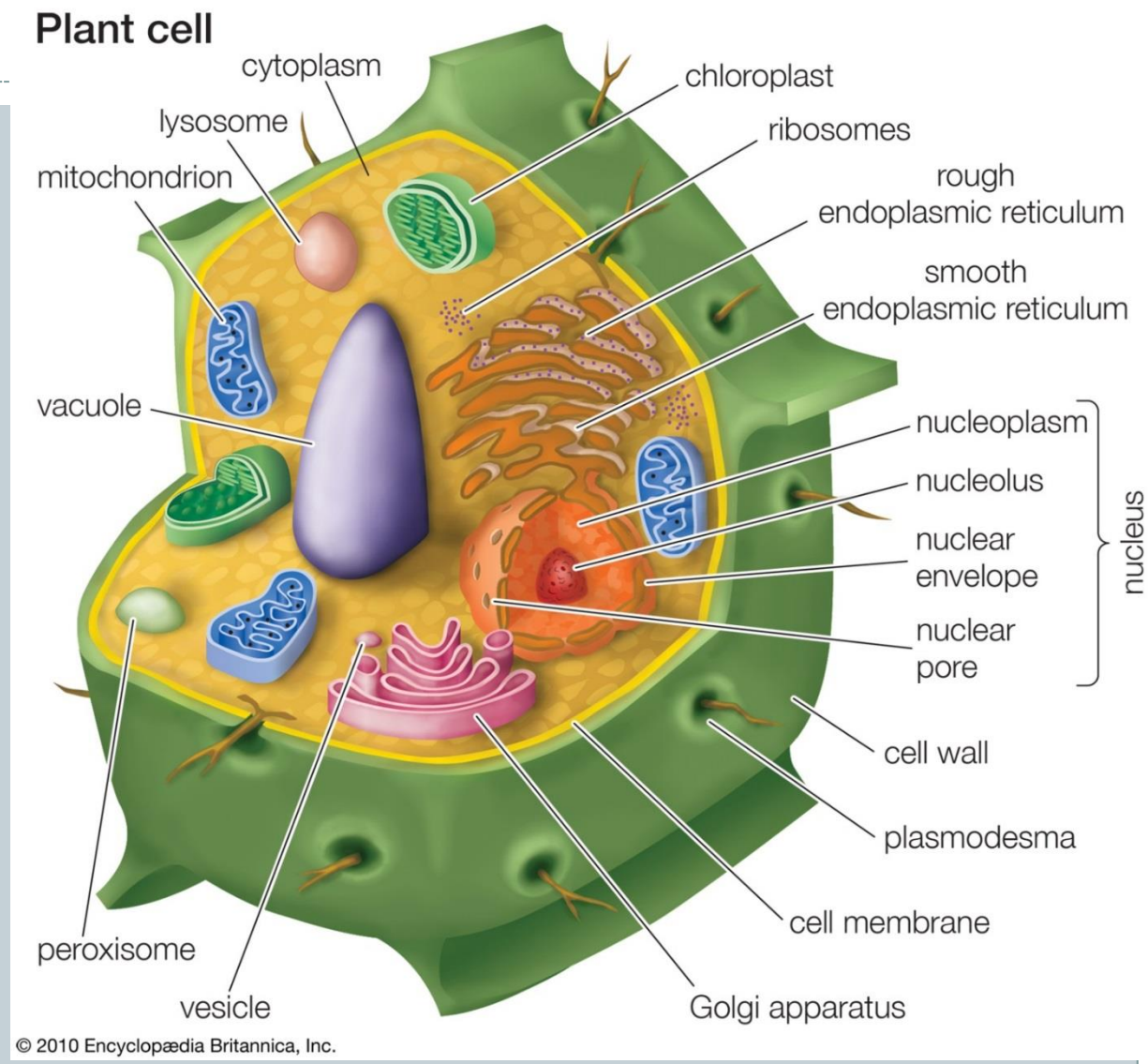
# Other Eukaryotic Cells





# Plant cell

- Possesses a:
  - cell wall (made of cellulose) that provides structural support
  - chloroplasts (location of photosynthesis)
  - a large central vacuole (storage)
  - and lacks centrioles



# Prokaryotic cell

- Lacks a nucleus- DNA floats freely in the cytoplasm
- Contains a cell wall, cell membrane, ribosomes, DNA, and some possess a flagella

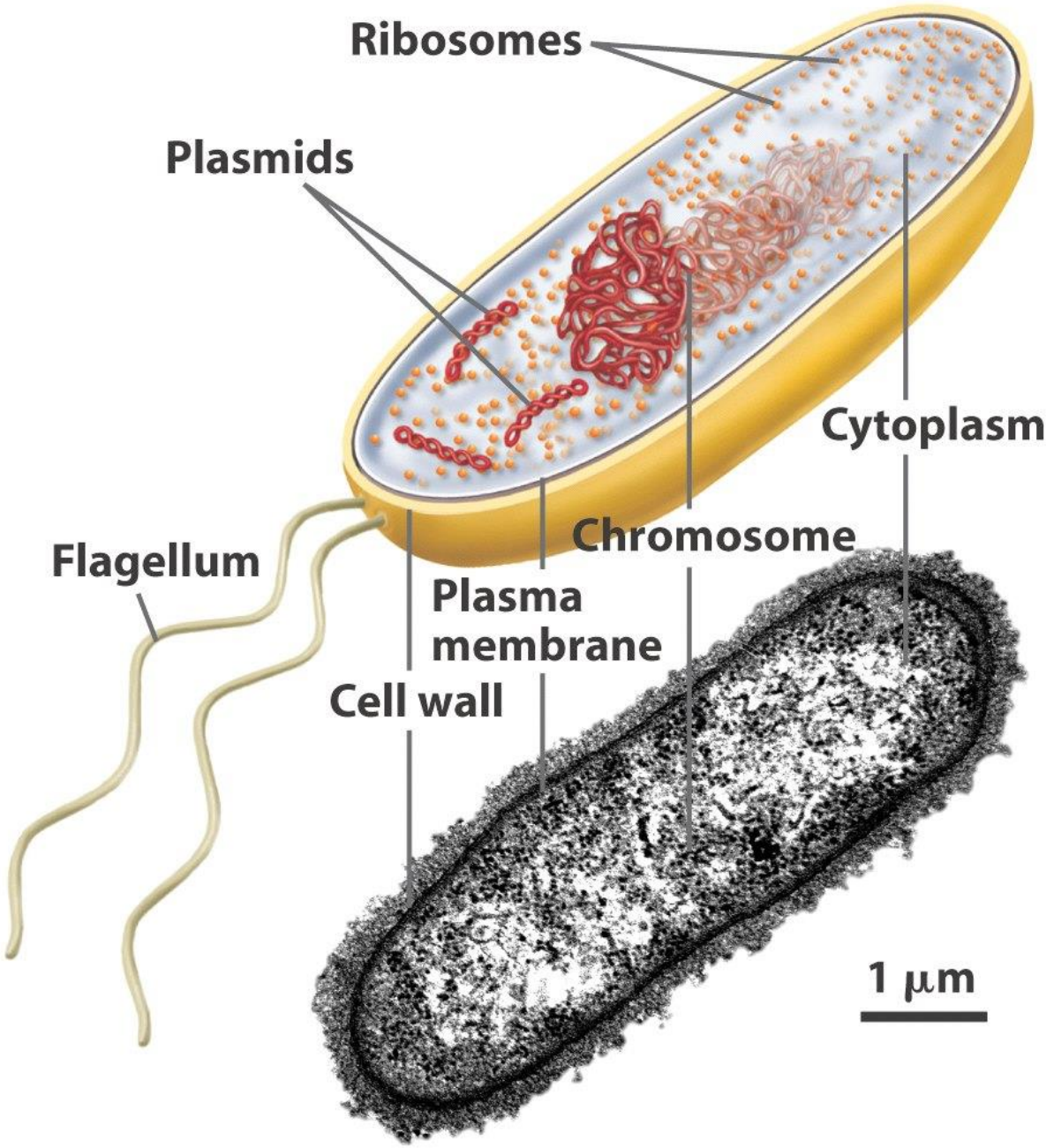
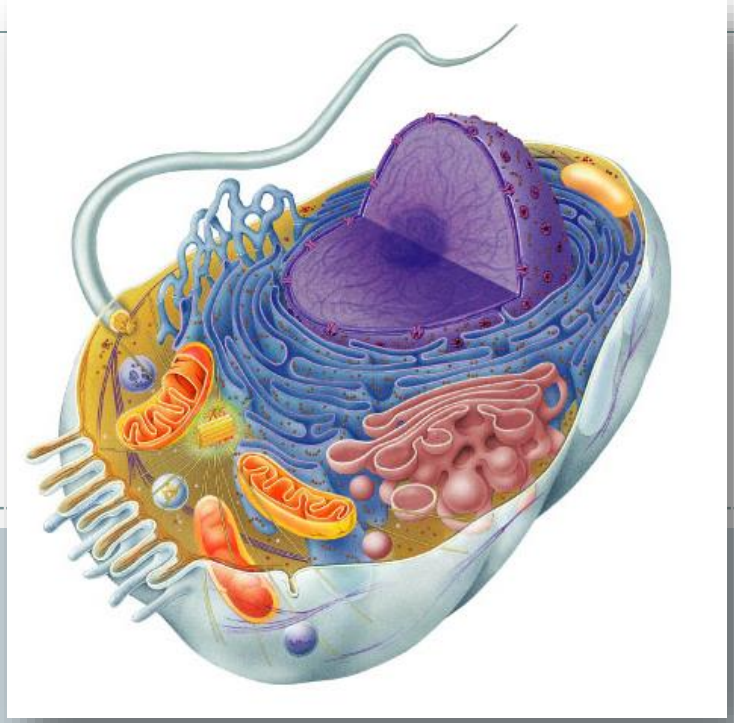


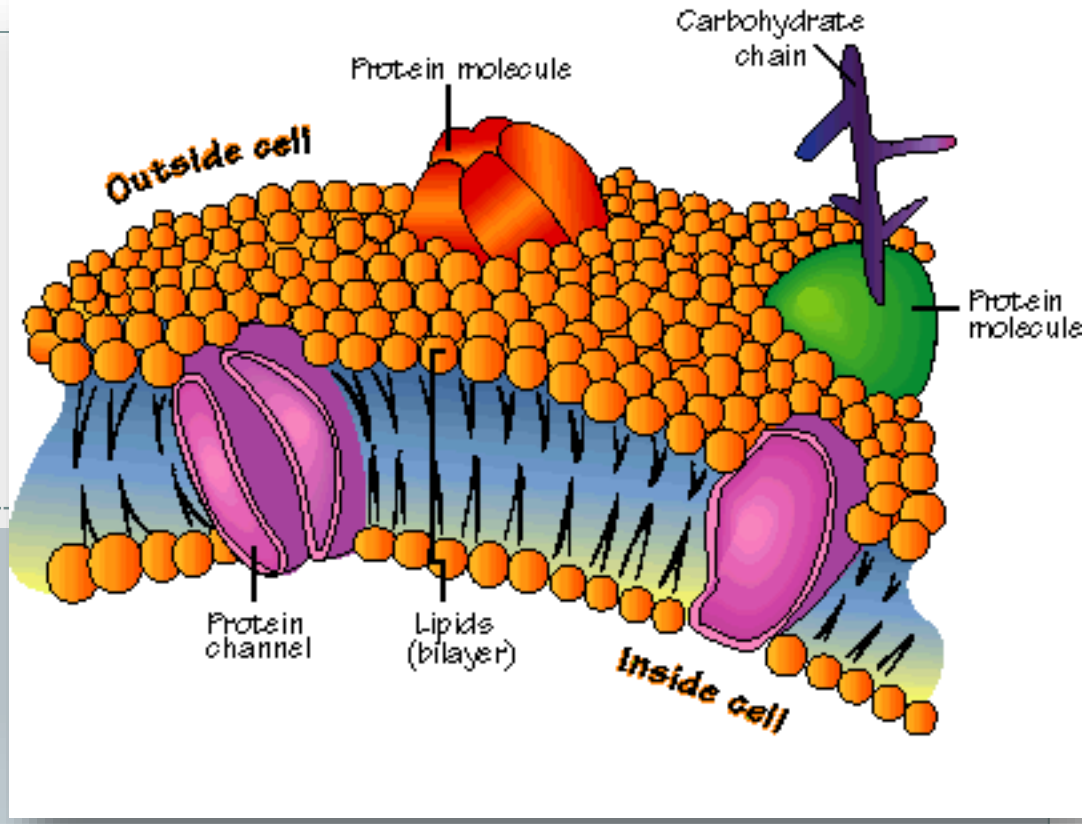

Figure 7-1 Biological Science, 2/e

# QUESTION AND ANSWER

**What are the roles of organelles in the cell?**

# How do molecules move into and out of the cell?

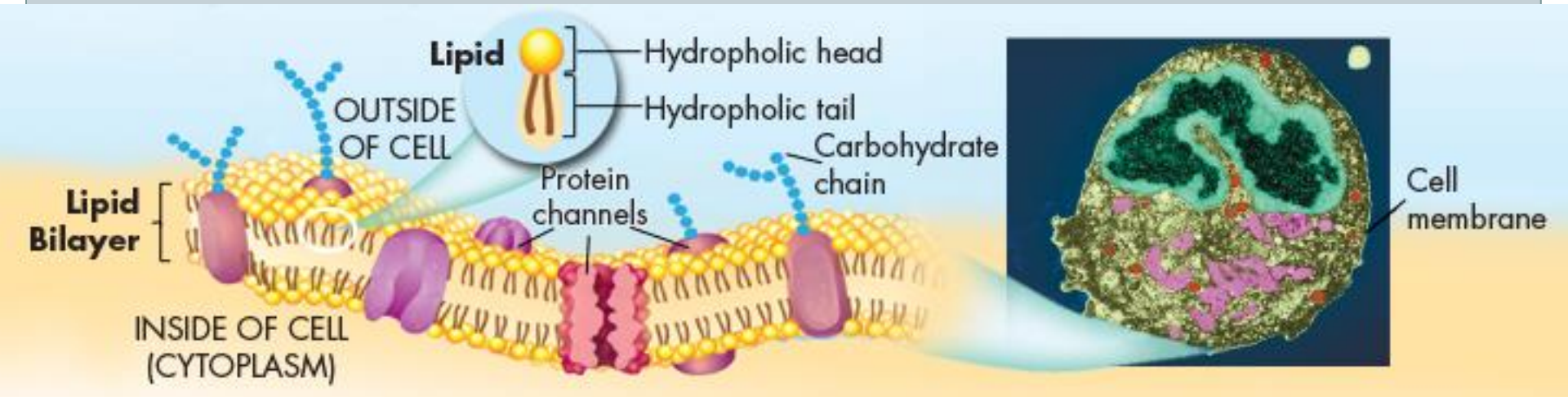





# Cell Membranes & Movement Across Them

# 7-3 Cell Boundaries

- The cell membrane regulates what enters and leaves the cell and provides support and protection
  - Composed of a phospholipid bilayer that contains carbohydrates, proteins, and lipids
- In plant, fungi, and bacterial cells, the cell wall provides support and protection

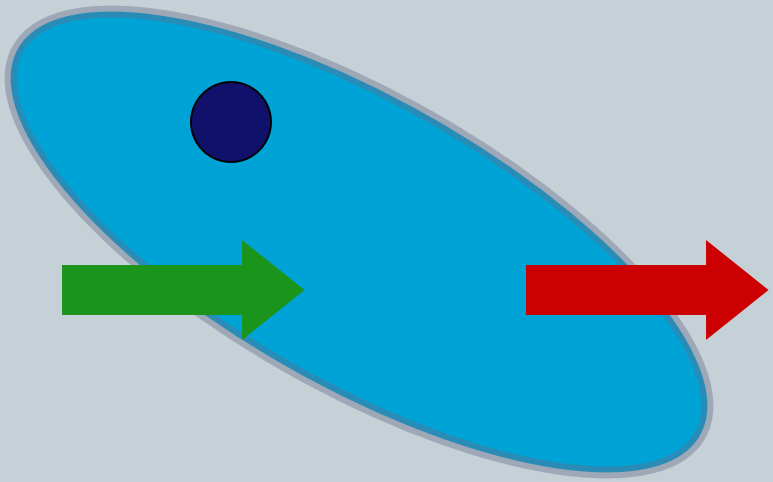


# Cell (plasma) membrane

- Cells need an inside & an outside…
  - separate cell from its environment
  - cell membrane is the boundary

**IN**
**food**
- **sugars**
- **proteins**
- **fats**

**salts**
**$O_2$**
**$H_2O$**



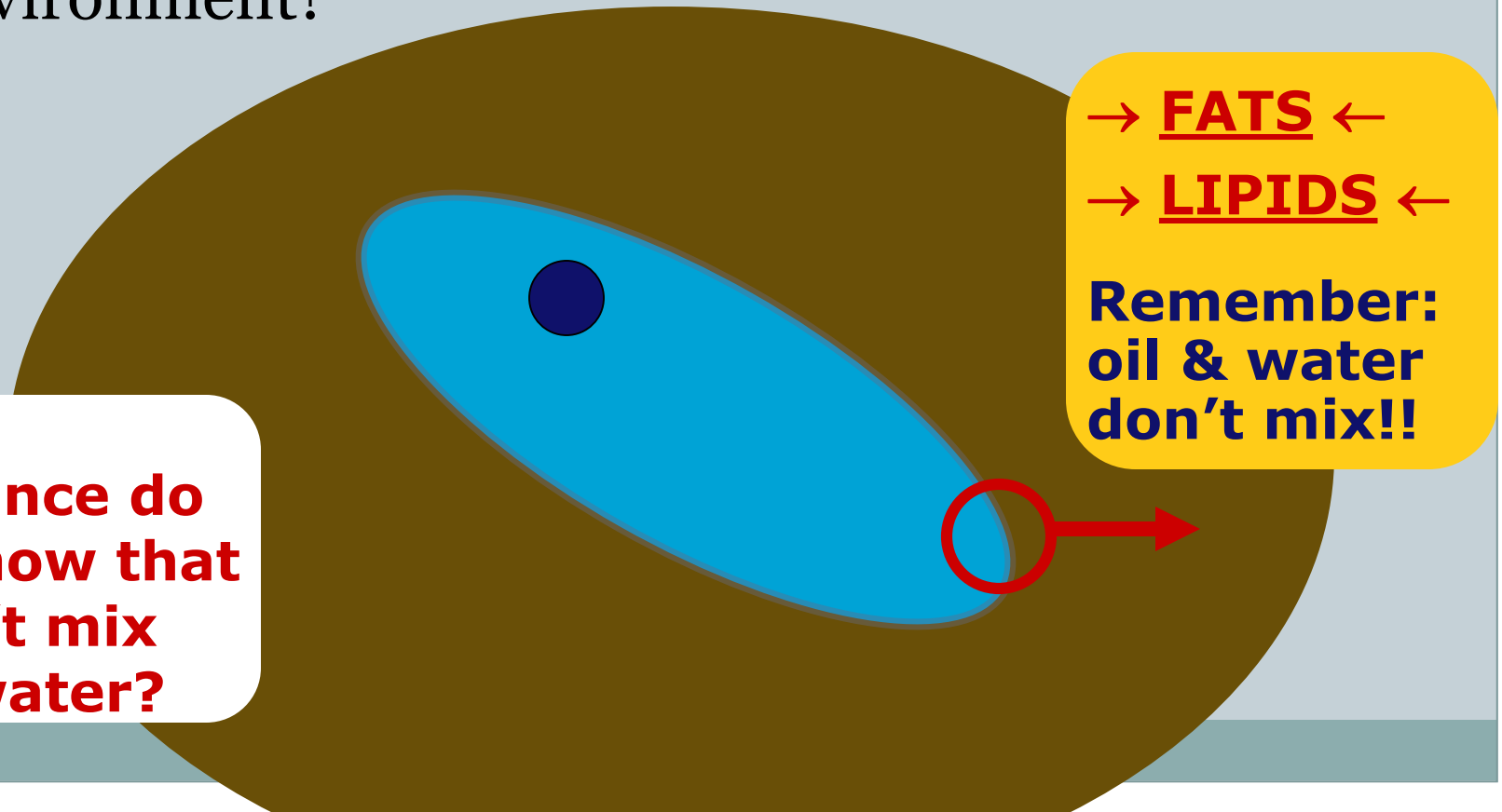
**OUT**
**waste**
- **ammonia**
- **salts**
- **$CO_2$**
- **$H_2O$**

**products**
- **proteins**

**cell needs materials in & products or waste out**

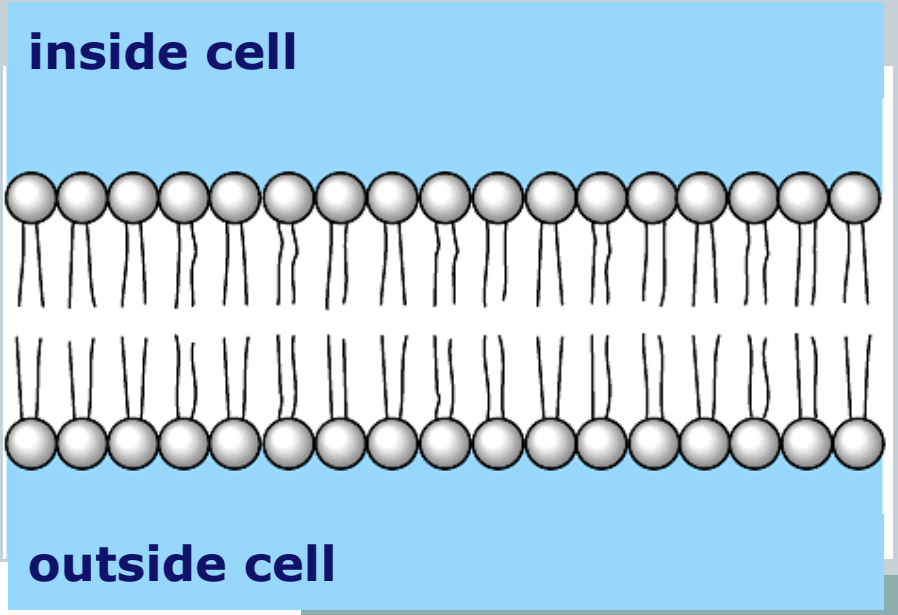
# Building a membrane

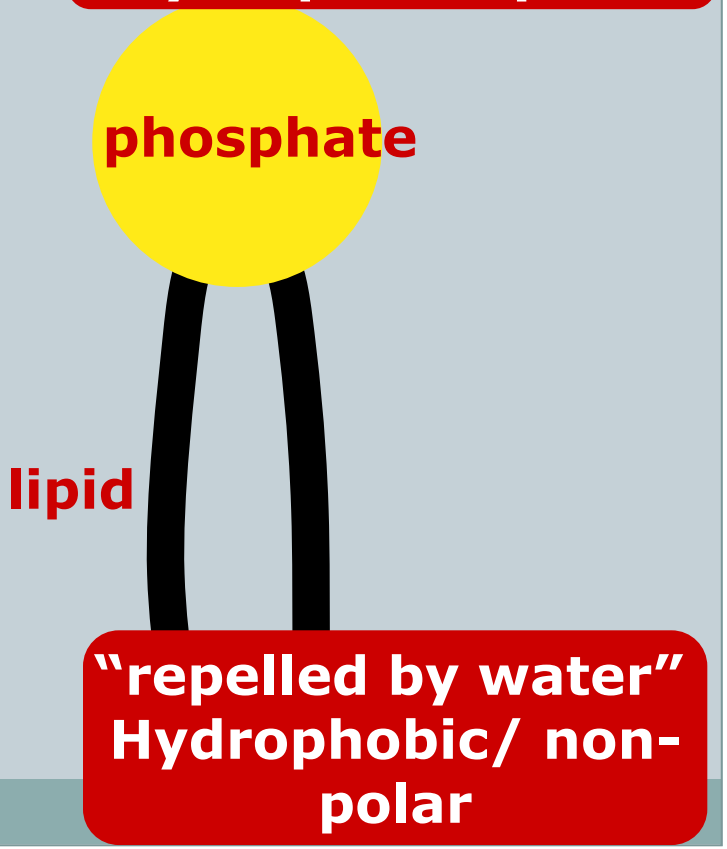
- How do you build a barrier that keeps the watery contents of the cell separate from the watery environment?

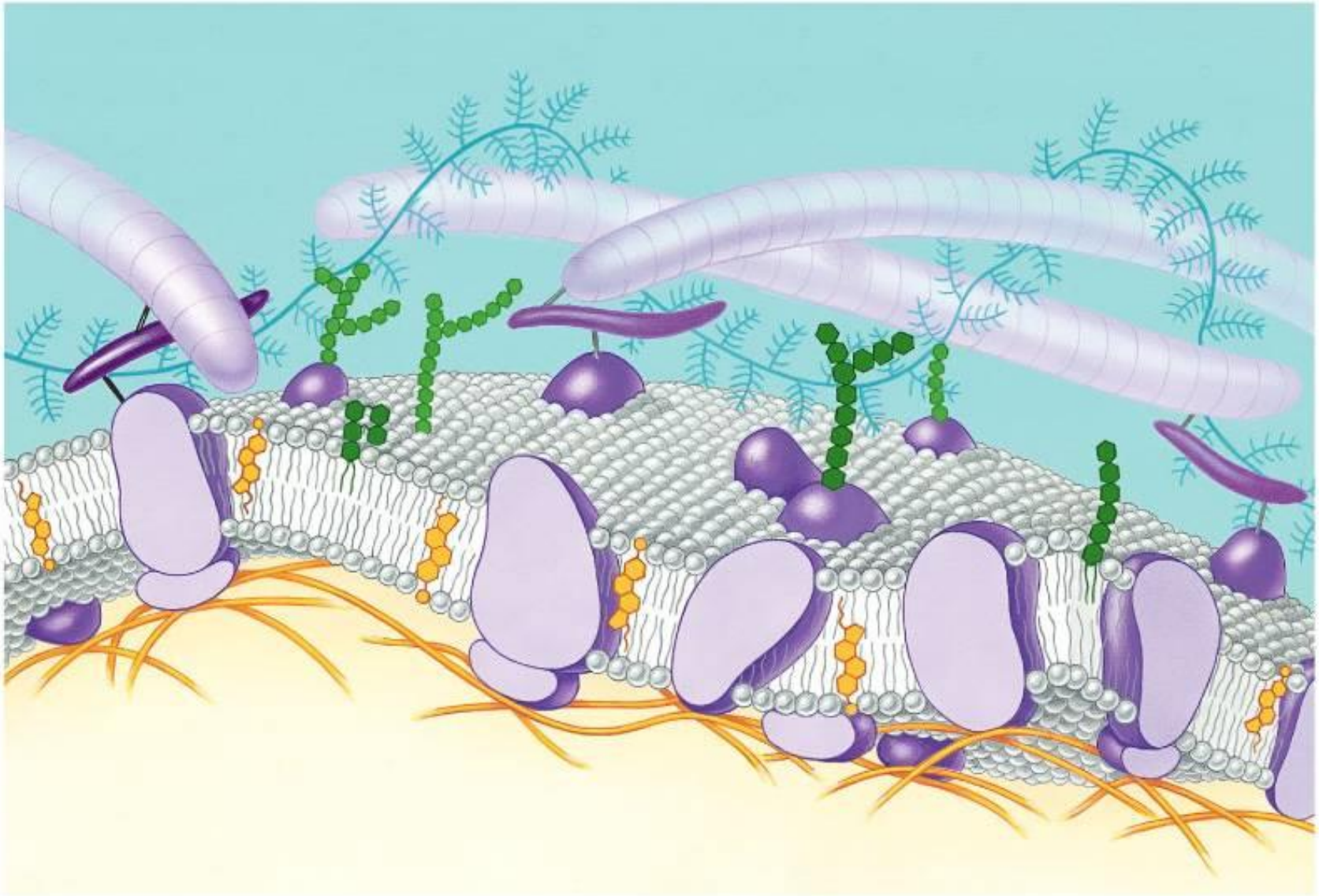


# Lipids of cell membrane

- Membrane is made of special kind of lipid
  - phospholipids
  - "split personality"
- Membrane is a double layer
  - phospholipid bilayer

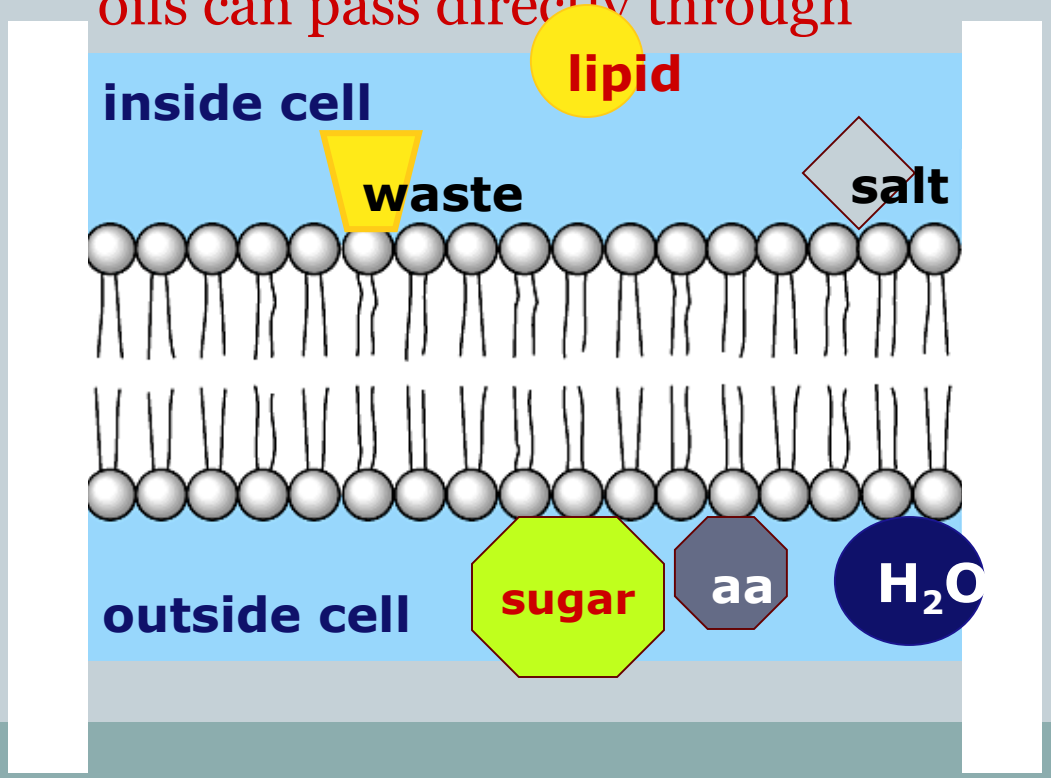




# Crossing the cell membrane

- What molecules can get through the cell membrane directly?
  - Fats, nonpolar (hydrophobic), gases, small molecules, and oils can pass directly through

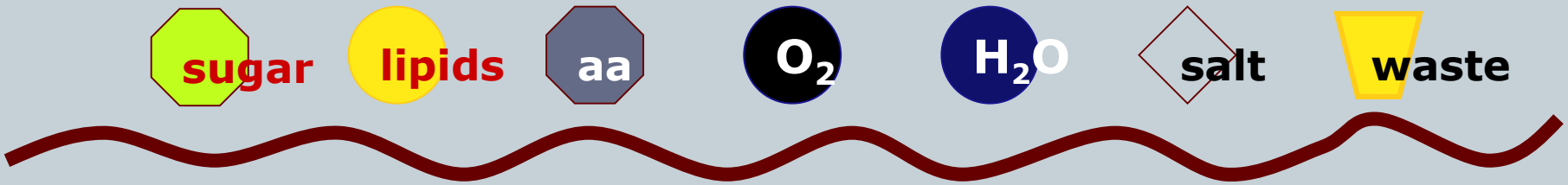



**but… what about other stuff?**

# Semi-permeable membrane

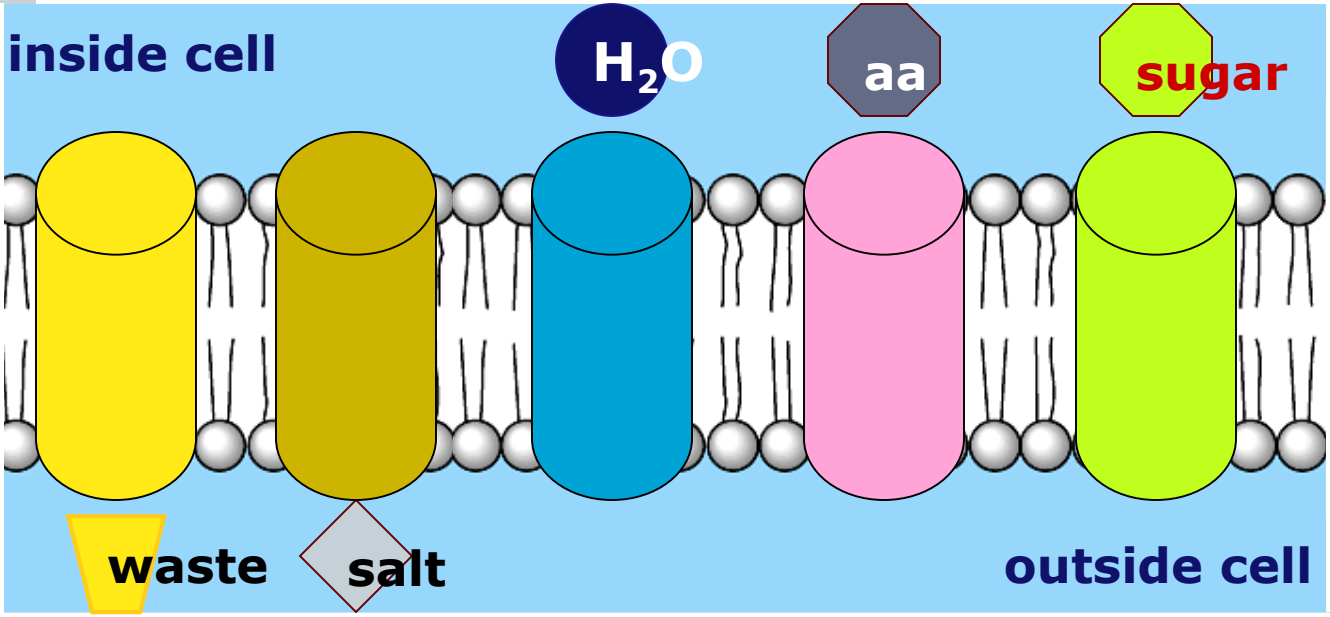
- Cell membrane controls what gets in or out
- Need to allow some materials — but not all — to pass through the membrane
  - semi-permeable or selectively permeable
    - only some material can get in or out

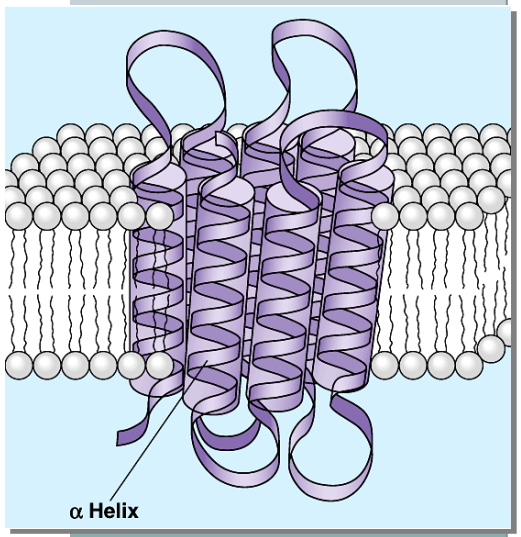
**So what needs to get across the membrane?**



# Cell membrane channels

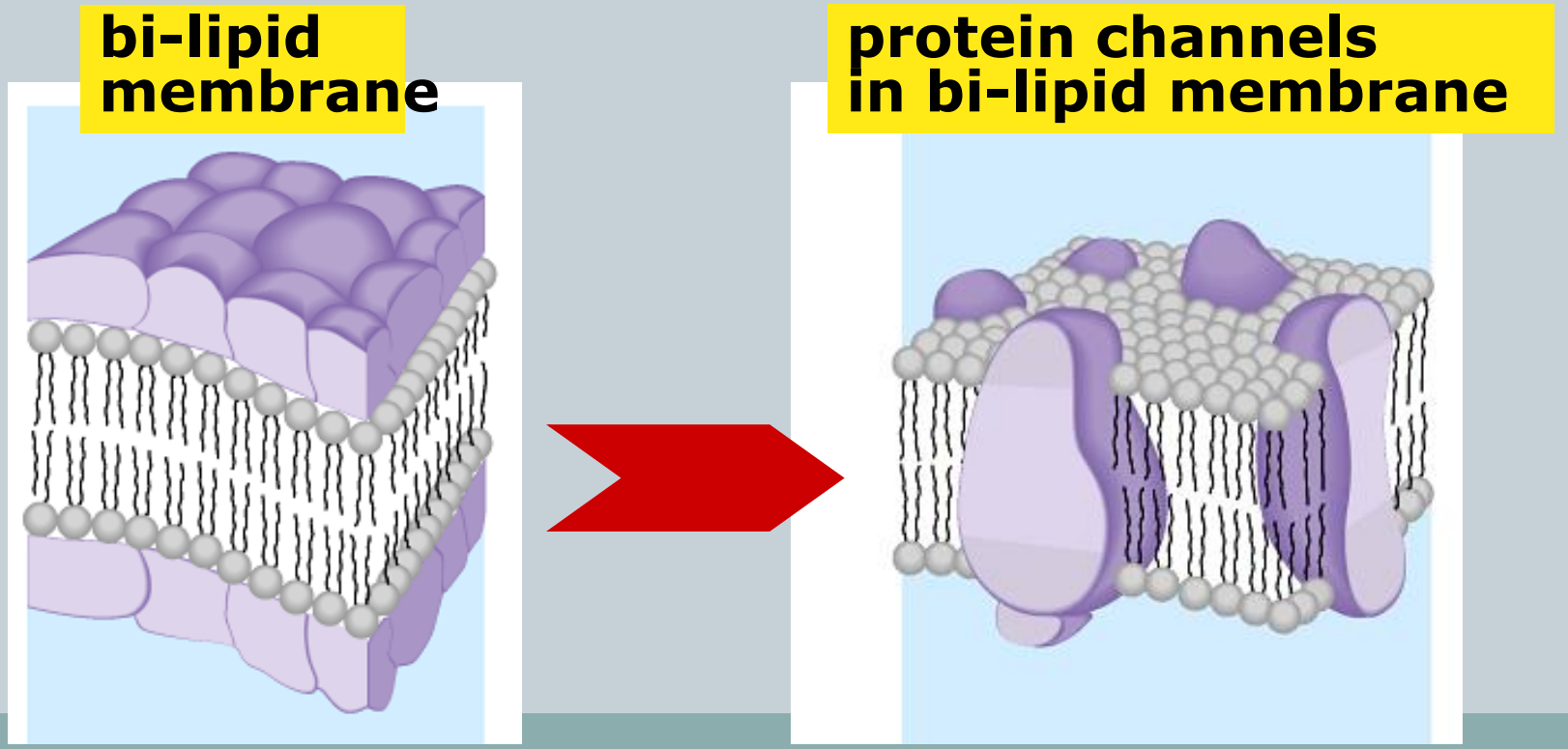
- Need to make “doors” through membrane
  - protein channels allow substances in & out
    - specific channels allow specific material in & out
    - $H_2O$ channel, salt channel, sugar channel, etc.
    - A transmembrane protein is a type of membrane protein spanning the entirety of the biological membrane to which it is permanently attached



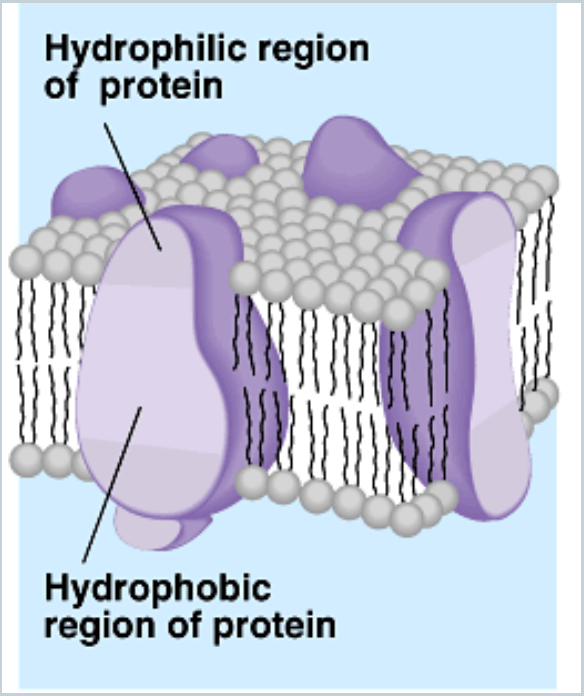
# How do you build a semi-permeable cell membrane?

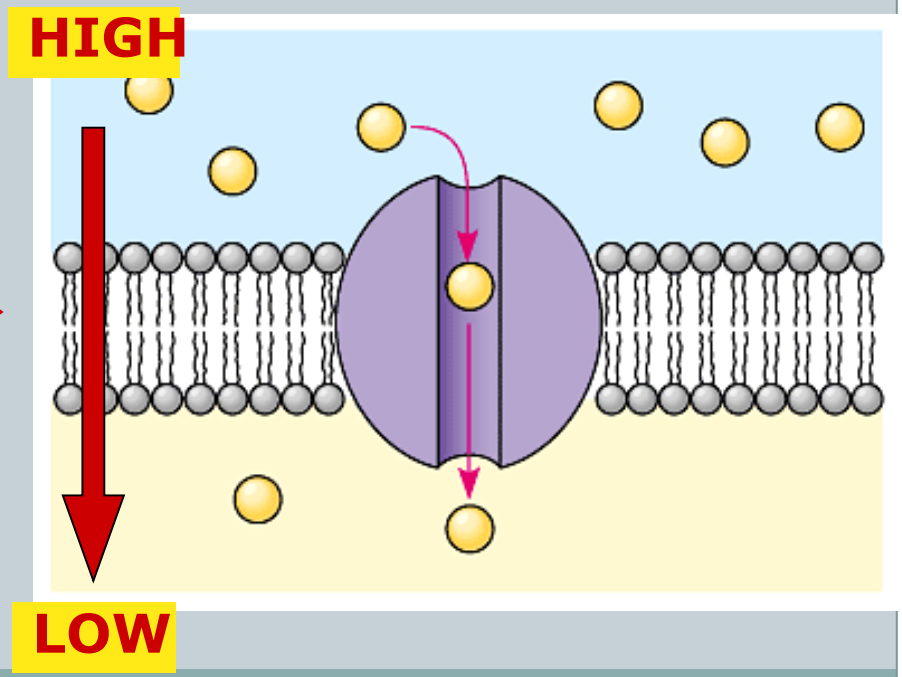
- Channels are made of proteins
  - proteins both “like” water & “like” lipids



# Protein channels

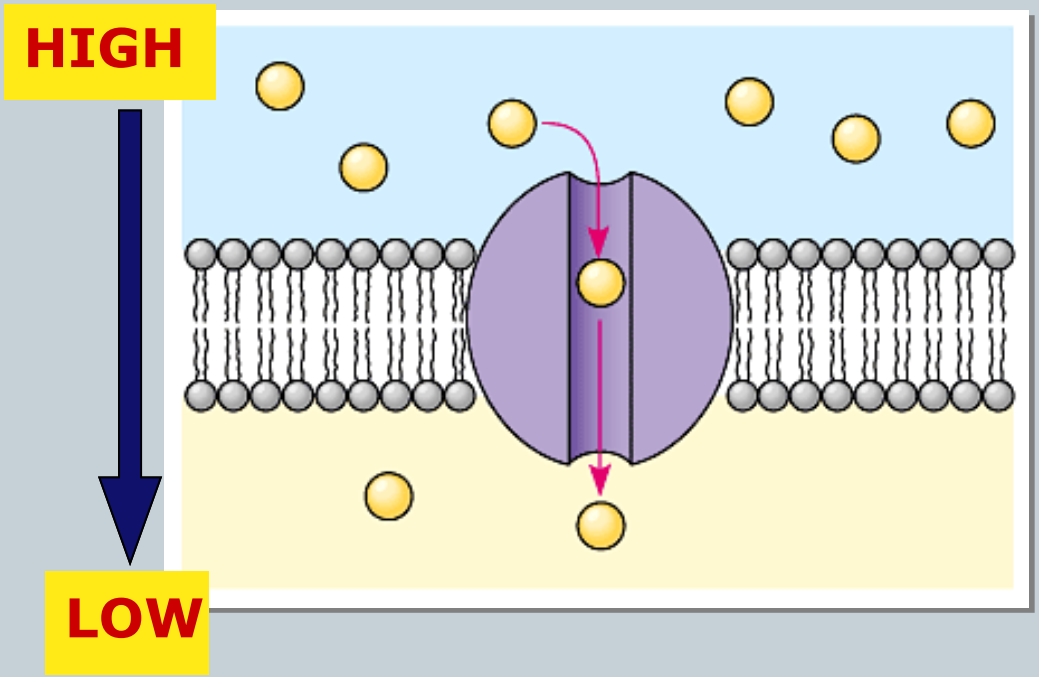
- Proteins act as doors in the membrane
  - channels to move specific molecules through cell membrane



# Movement through the channel

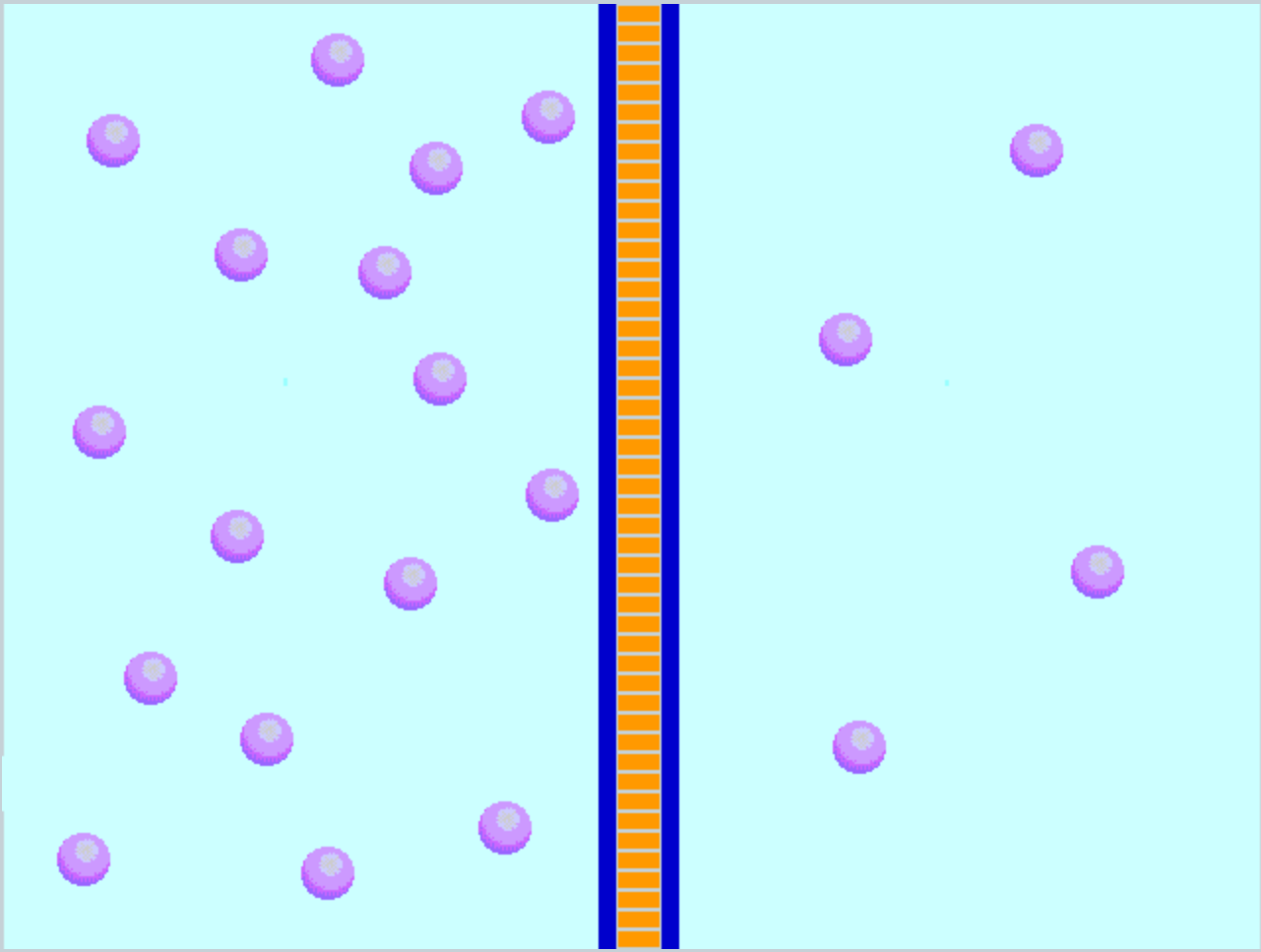
- Why do molecules move through membrane if you give them a channel?

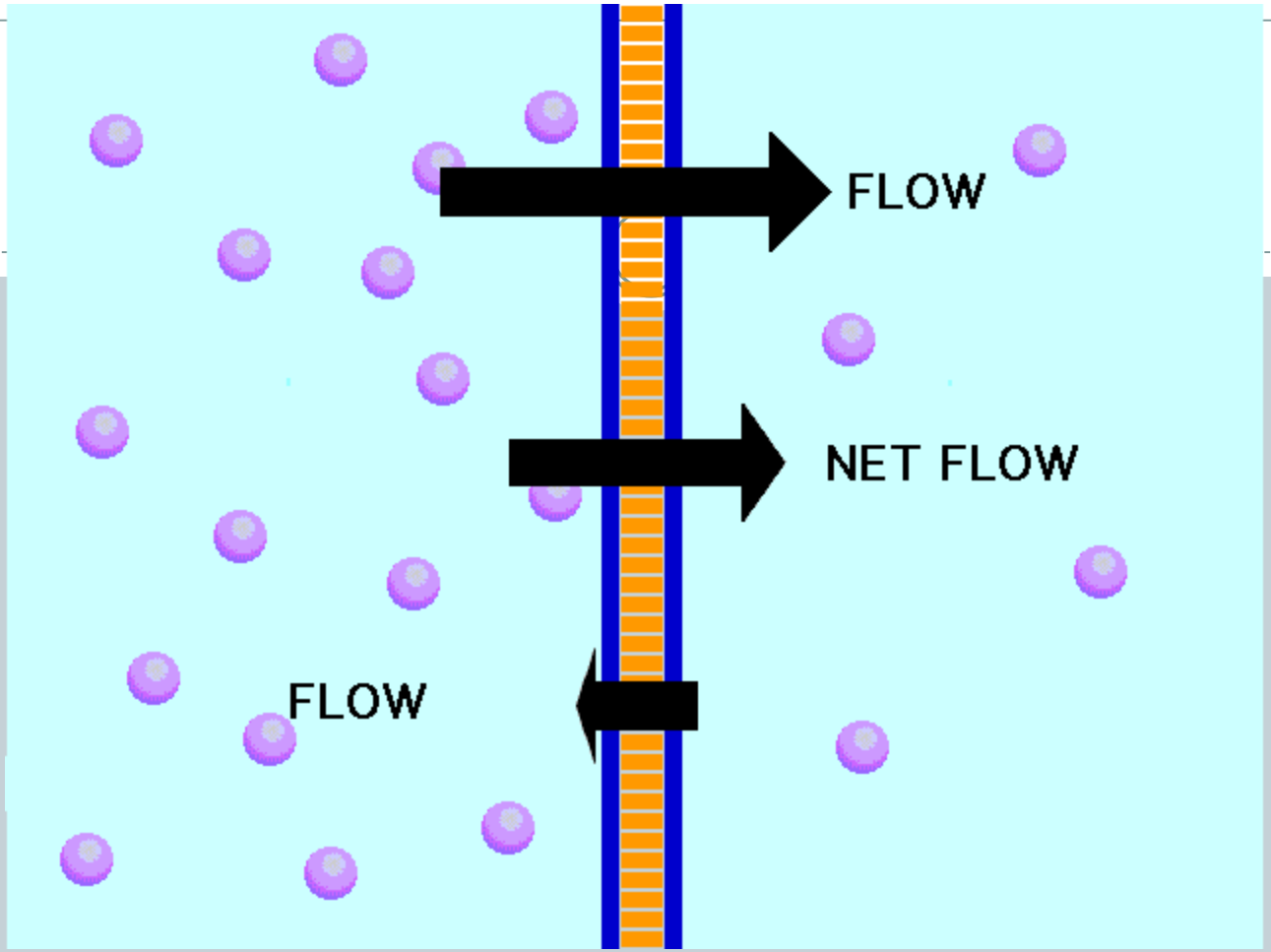


# Diffusion

- **Concentration:** the mass of solute in a given solution
- Particles move from an area of high concentration to an area of low concentration in a process called **diffusion**
- When the concentration of the solute is same throughout a system, the system has reached **equilibrium**

# Diffusion

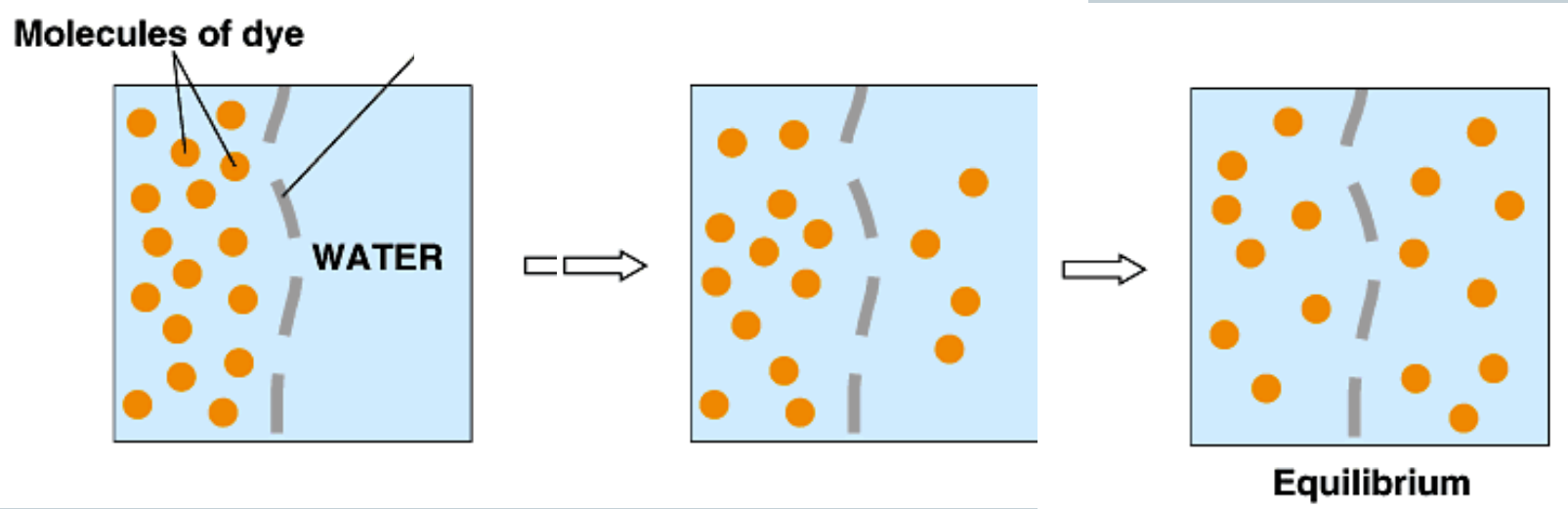




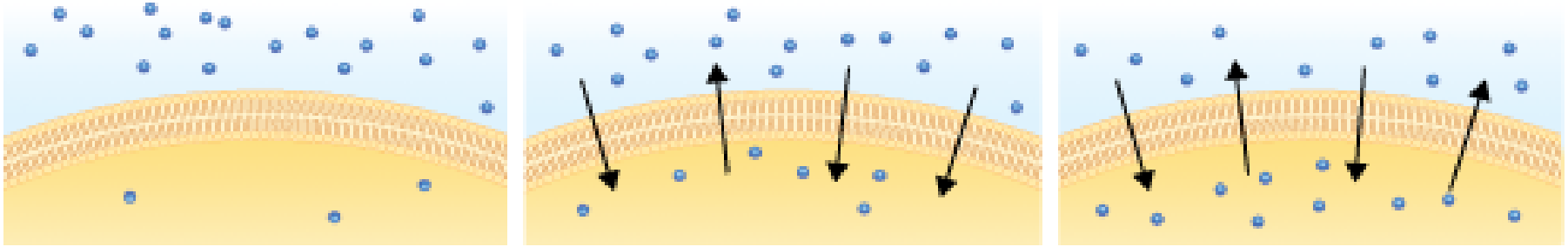

Because diffusion depends upon random particle movements, substances diffuse across membranes without requiring the cell to use energy

# Molecules move from high to low

- Diffusion
  - move from HIGH to LOW concentration (down a concentration gradient)
  - Molecules that do so are: small, gases, non-polar



# Diffusion



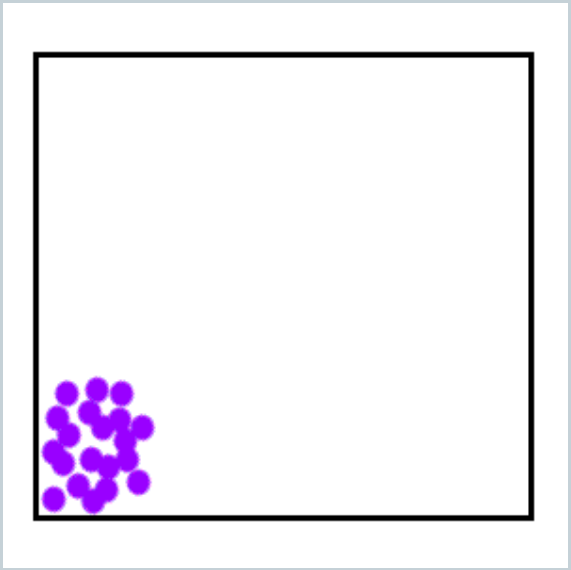
There is a higher concentration of solute on one side of the membrane than on the other.

Diffusion causes a net movement of solute particles from the side of the membrane with the higher solute concentration to the side with the lower solute concentration.

Once equilibrium is reached, solute particles continue to diffuse across the membrane in both directions but at approximately equal rates, so there is no net change in solute concentration.

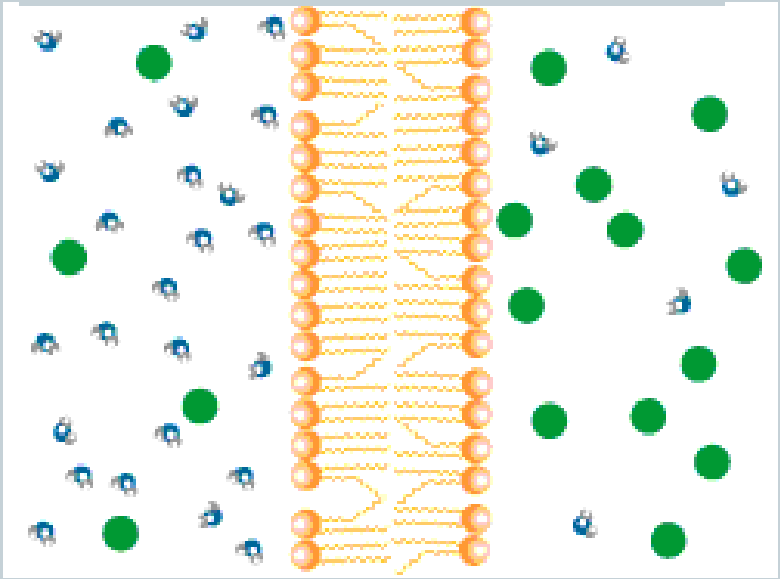
# Diffusion

- Move from HIGH to LOW concentration
  - passive transport
  - no energy needed



diffusion

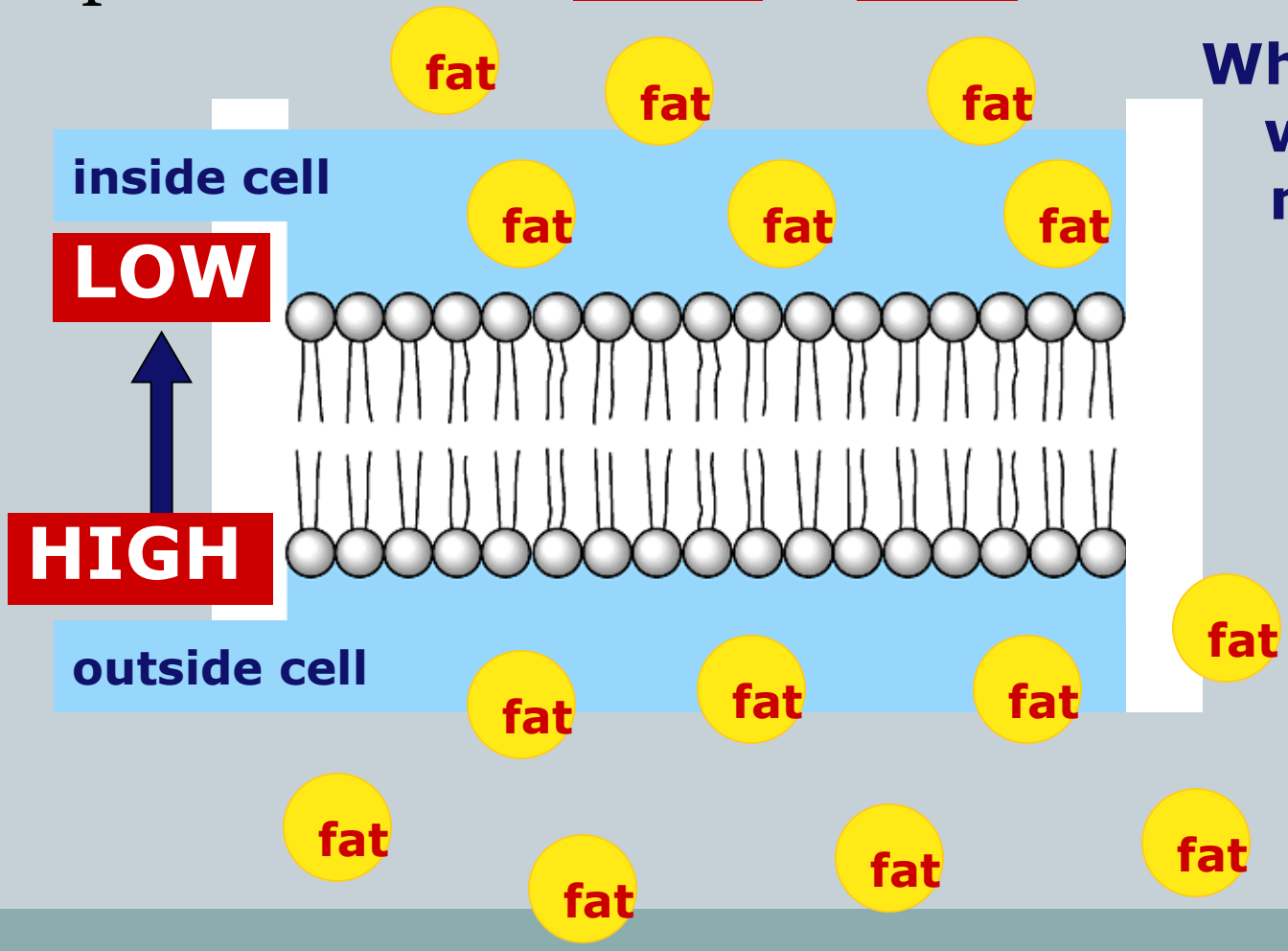
diffusion of water



osmosis

# Simple Diffusion

- Lipids move from HIGH to LOW

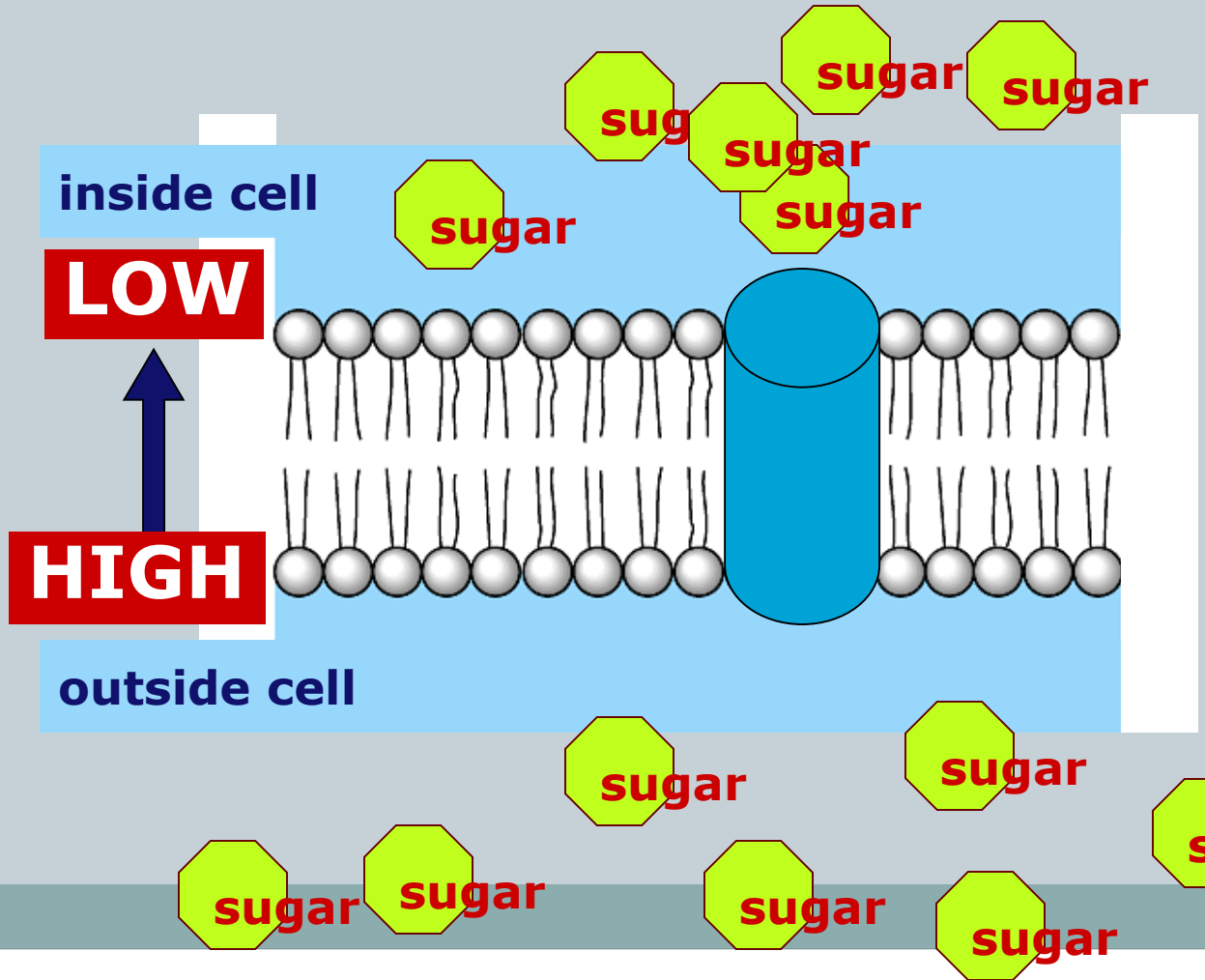


# Facilitated Diffusion

- **Facilitated diffusion:** movement of specific molecules ex. glucose, across cell membranes through protein channels
  - Molecules that cannot diffuse across the cell's lipid bilayer on their own instead resort to this process
    - These molecules include:
      - Polar (hydrophilic)
      - Water
      - Large molecules, ex. glucose, proteins
      - Ions (positively or negatively charged atoms), ex. $Cl^-$

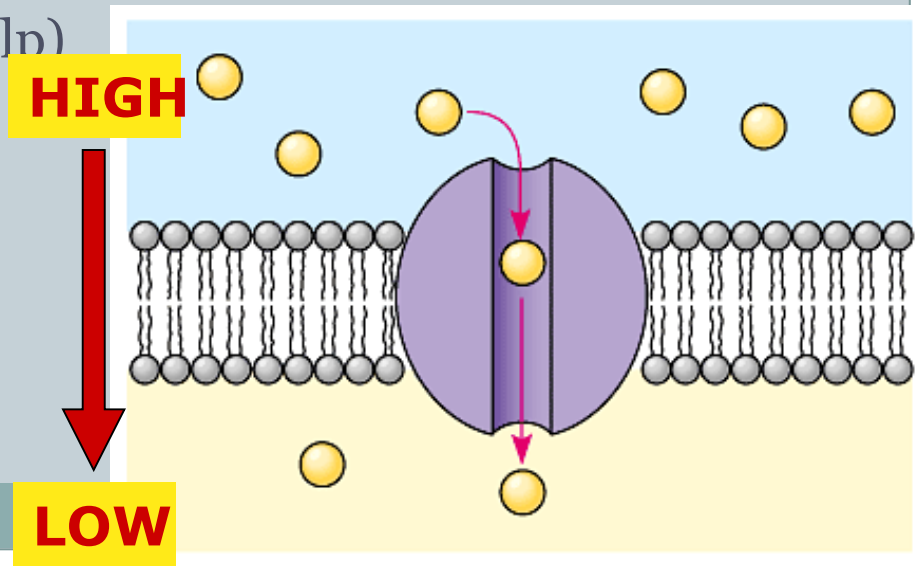
# Facilitated Diffusion

- Move from HIGH to LOW through a channel



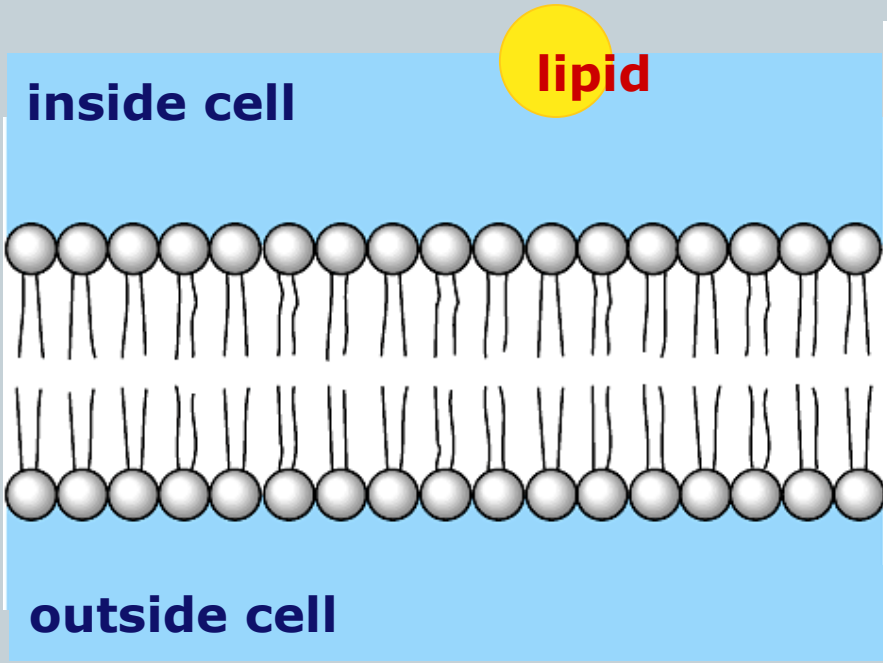
# Diffusion

- Move from HIGH to LOW concentration (down a concentration gradient)
  - directly through membrane
    - simple diffusion
    - no energy needed
  - help through a protein channel
    - facilitated diffusion (with help)
    - no energy needed

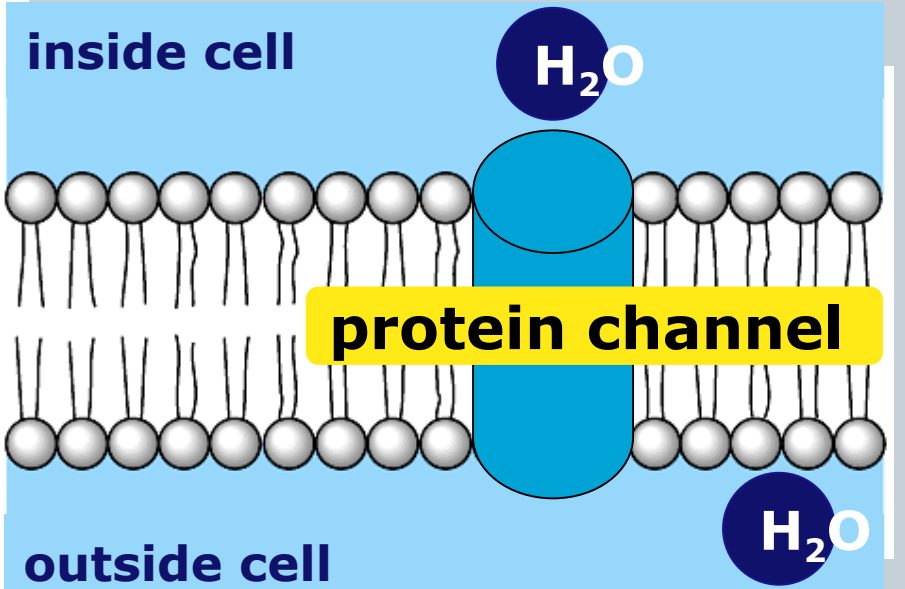


# Simple vs. facilitated diffusion

**simple diffusion**




**facilitated diffusion**

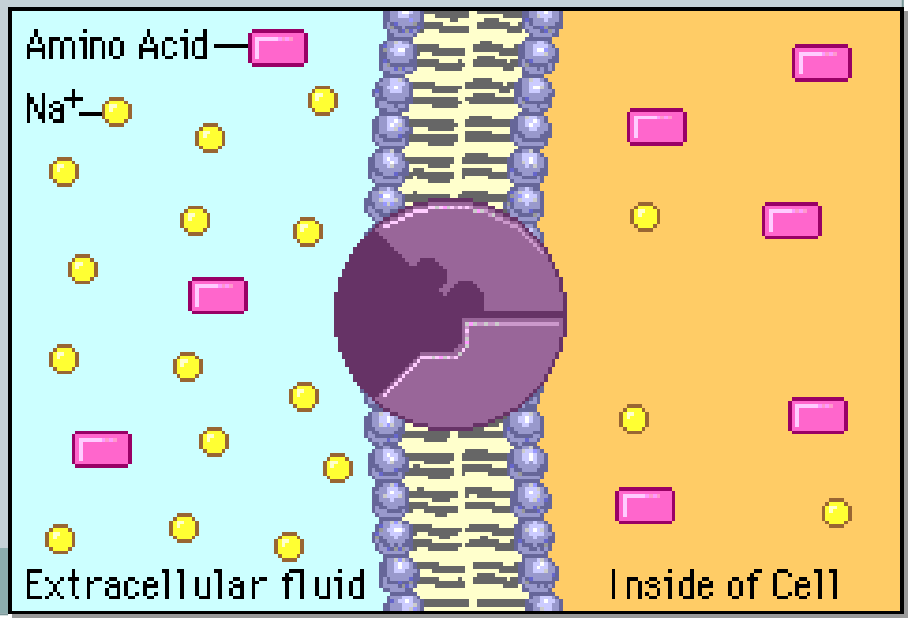


# Active Transport

- **Active transport:** energy-requiring process that moves material across a cell membrane against a concentration gradient
  - Small molecules and ions are transported against/down a concentration gradient (molecules move from low to high instead of high to low)
  - Energy provided from ATP
  - Example: sodium-potassium pump ($Na^+/K^+$)
    - 3 $Na^+$ are pumped outside the cell and 2 $K^+$ are pumped into the cell

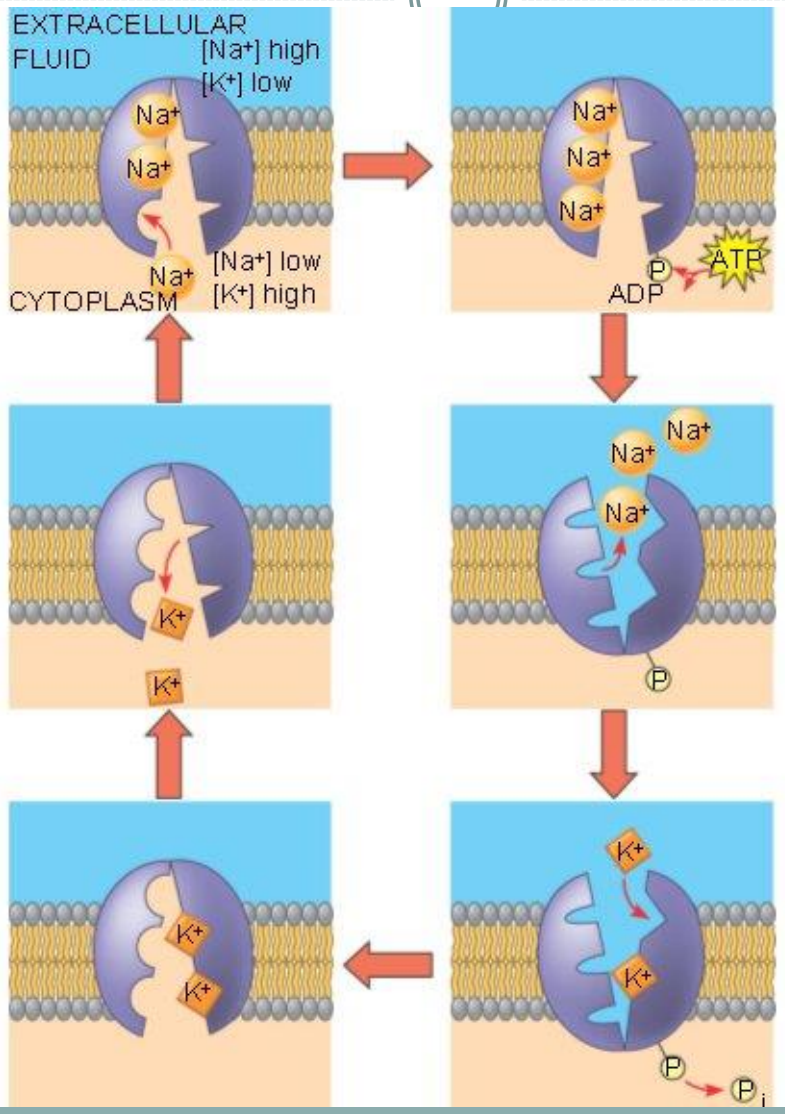
# Active transport

- Cells may need molecules to move *against* concentration "hill"
  - need to pump "uphill"
    - from LOW to HIGH using energy
  - protein pump
  - requires energy
    - ATP

# Sodium-Potassium Pump

1. Cytoplasmic $Na^+$ binds to the sodium-potassium pump.



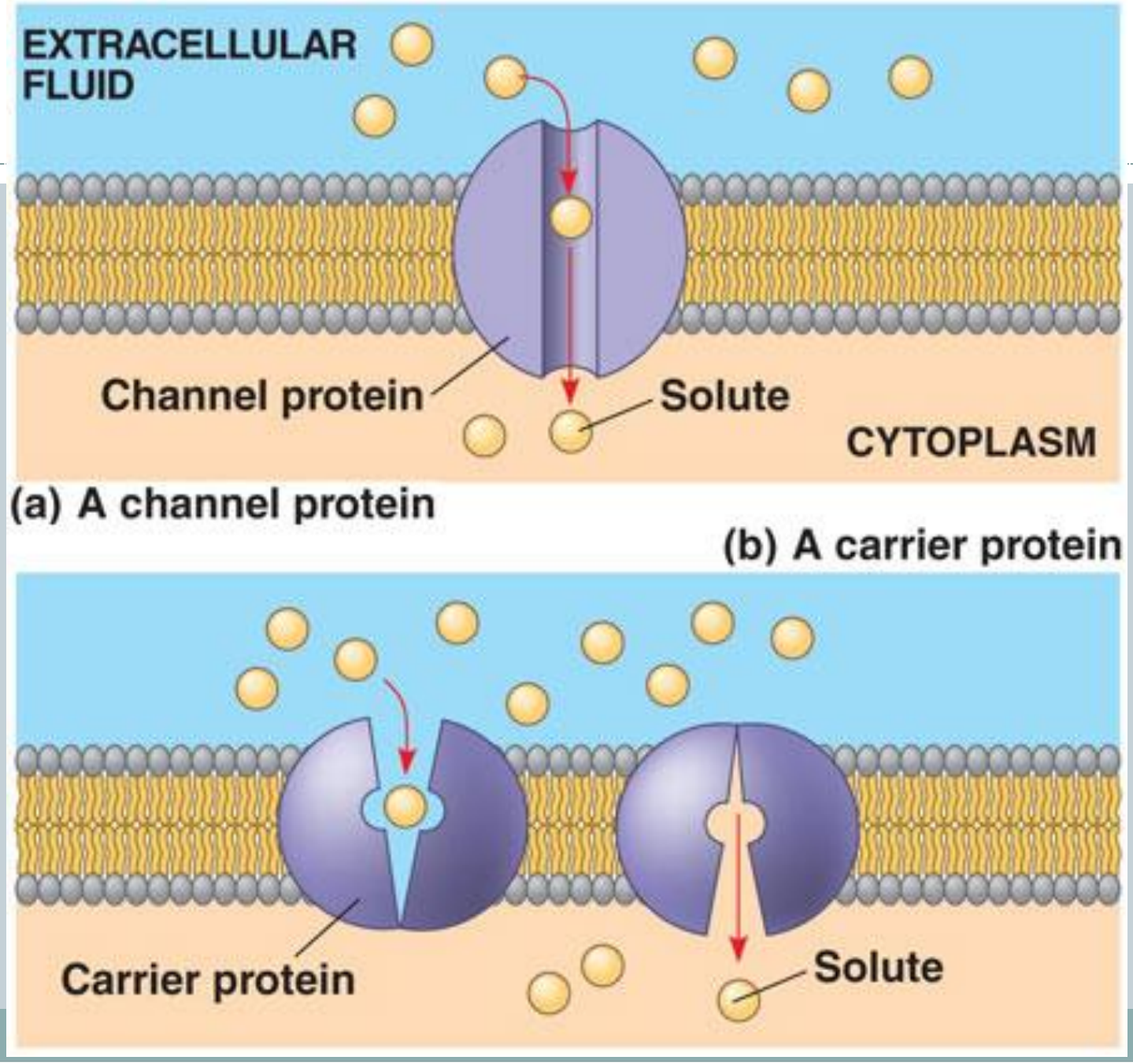

2. $Na^+$ binding stimulates phosphorylation by ATP.

3. $K^+$ is released and $Na^+$ sites are receptive again; The cycle repeats.

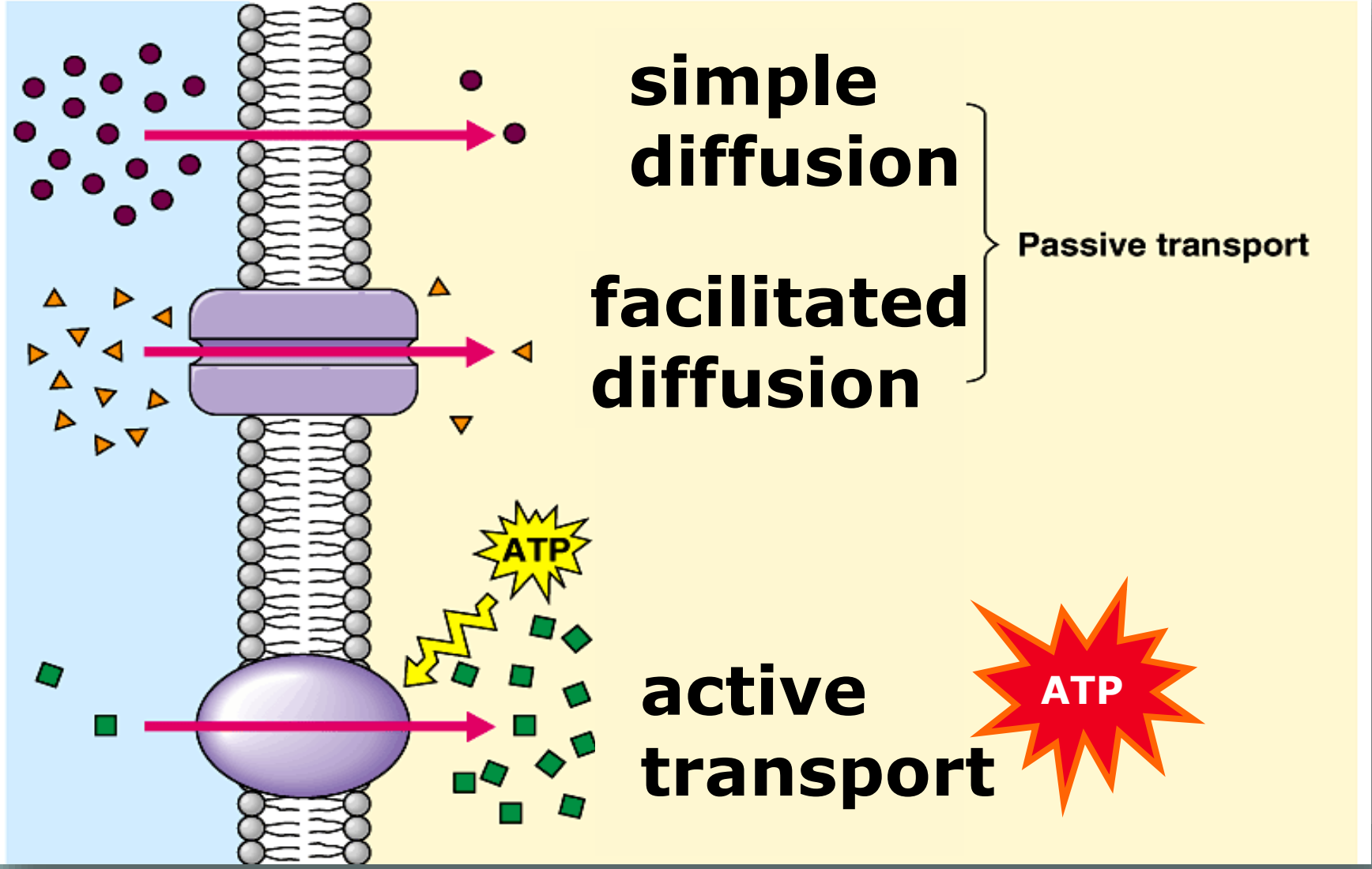
4. Phosphorylation causes the protein to change its conformation, expelling $Na^+$ to the outside.

5. Loss of the phosphate restores the protein's original conformation.

6. Extracellular $K^+$ binds to the protein, triggering release of the Phosphate group.

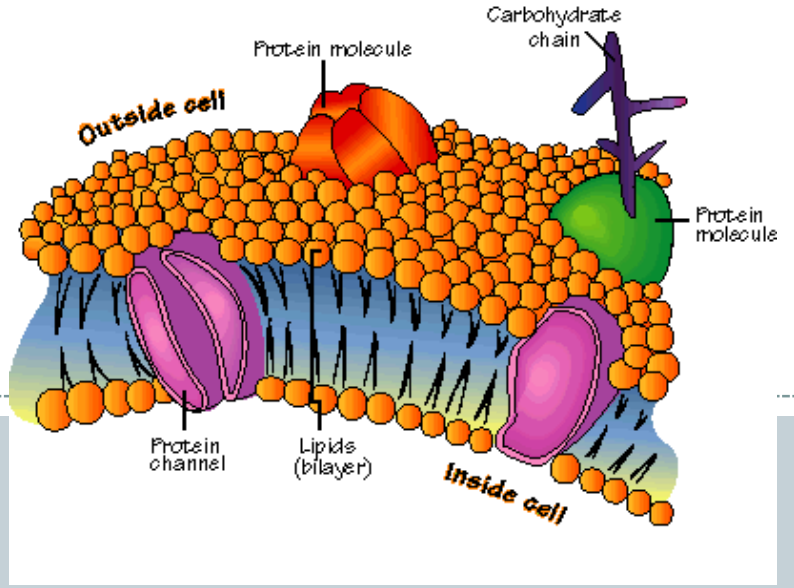

EXTRACELLULAR FLUID
Channel protein
Solute
CYTOPLASM
(a) A channel protein
(b) A carrier protein
Carrier protein
Solute

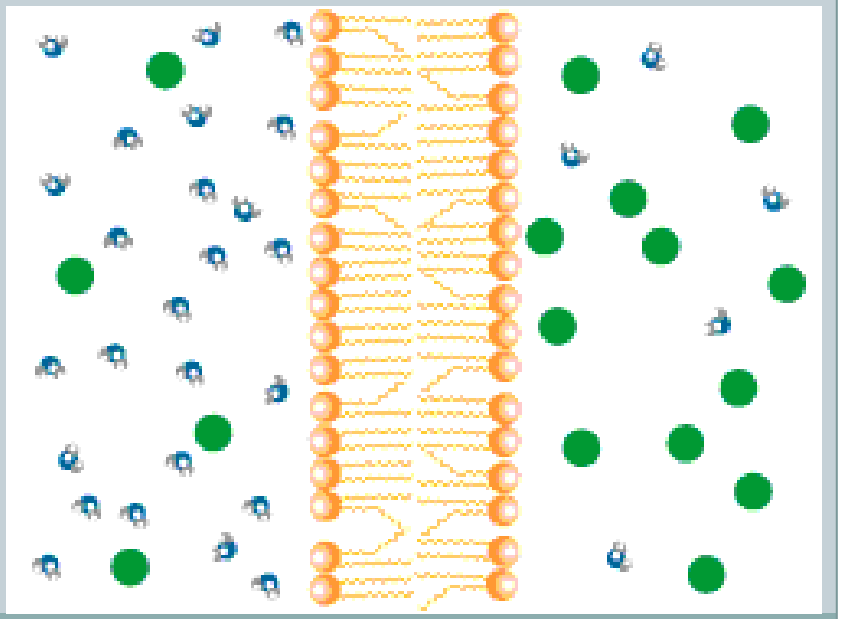
# Transport of molecules summary



# Osmosis

## Movement of Water Across Cell Membrane



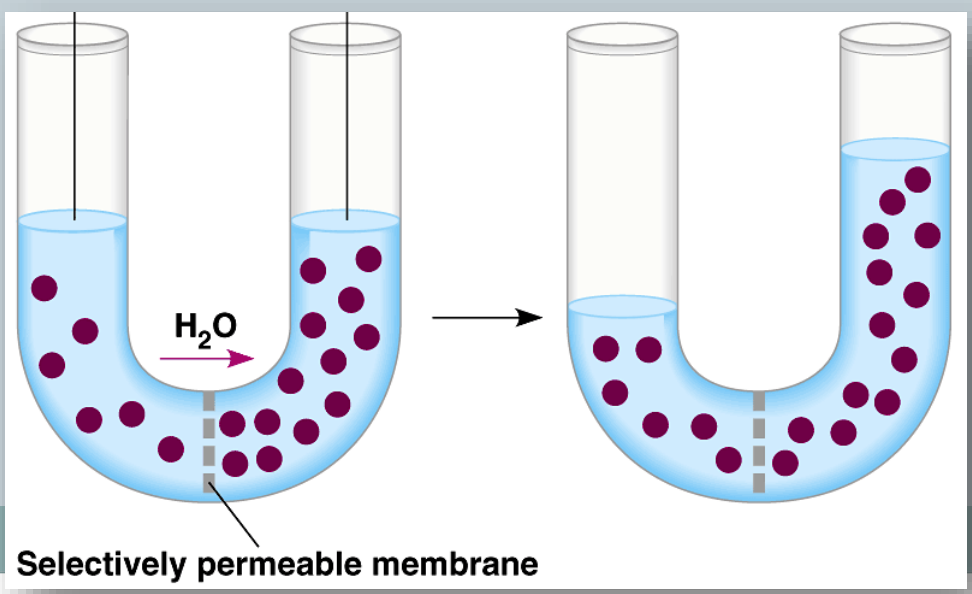



# Osmosis Terms

- If a substance is able to diffuse across a membrane, the membrane is said to be **permeable** to it
- A membrane is **impermeable** to substances that cannot pass across it
- Most biological membranes are **selectively permeable**, meaning that some substances can pass across them and others cannot
- **Osmosis:** the diffusion of water through a selectively permeable membrane down a concentration gradient
  - **Isotonic:** "same strength" or when the concentrations of 2 solutions is the same
  - **Hypertonic:** when comparing 2 solutions, the solution with the greater concentration of solutes
  - **Hypotonic:** when comparing 2 solutions, the solution with the lesser concentration of solutes
- **Water moves from hypotonic to hypertonic solutions until isotonic**

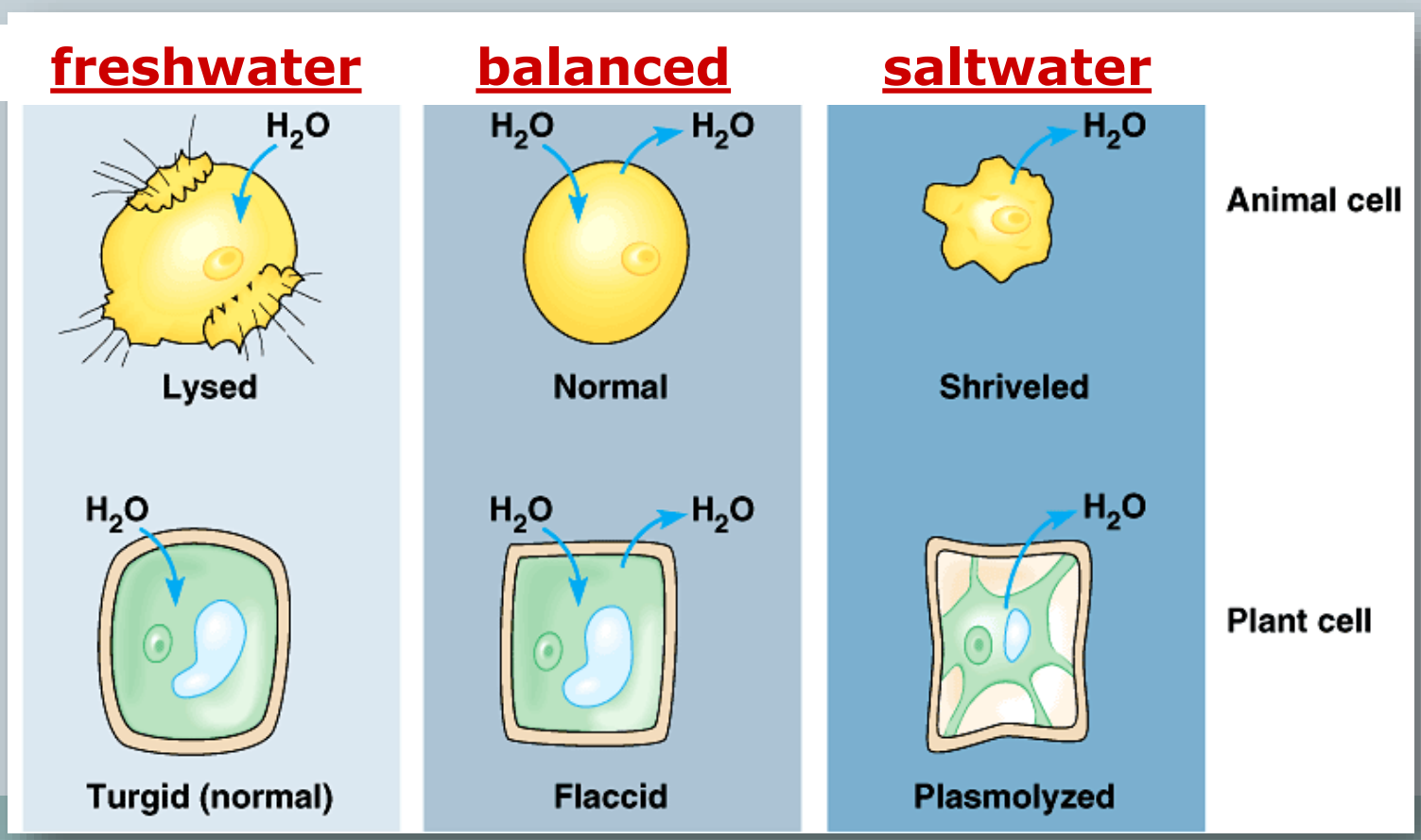
# Osmosis

- Water movement is very important, so we chose to talk about water separately
- Osmosis
  - diffusion of water from HIGH concentration of water to LOW concentration of water
    - across a semi-permeable membrane



# Keeping water balance

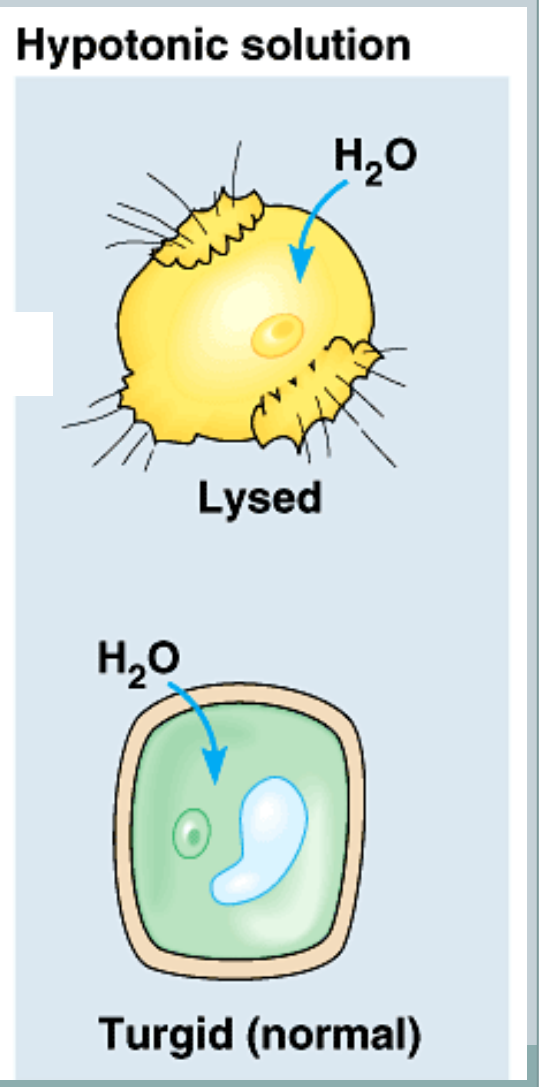
- Cell survival depends on balancing water uptake & water loss



# 1 Keeping the right amount of water in the cell

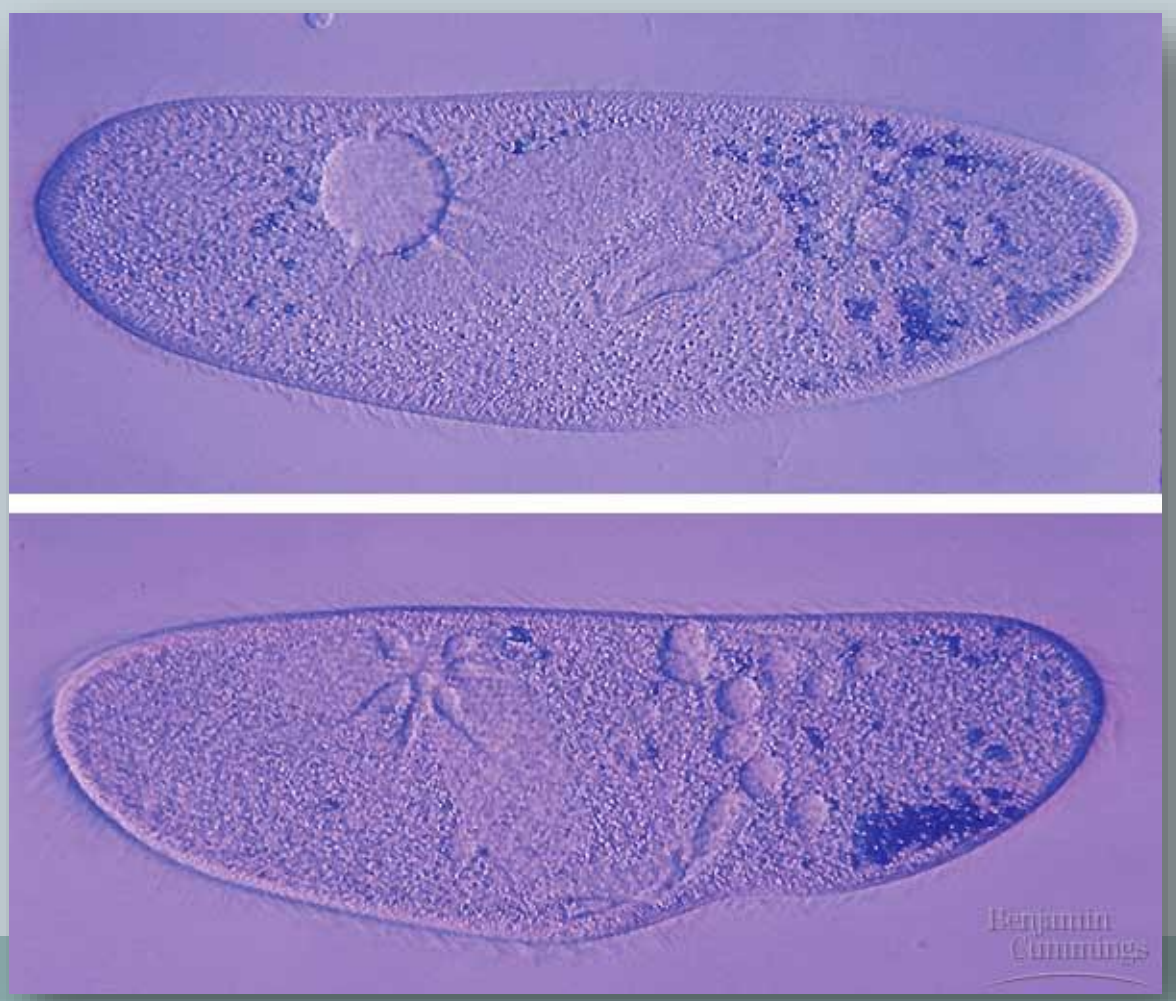
- Freshwater
  - a cell in fresh water
  - high concentration of water around cell
    - cell gains water
    - example: *Paramecium*
    - problem: cells gain water, swell & can burst
    - **Cytolysis or lysis** occurs when a cell bursts due to an osmotic imbalance that has caused excess water to move into the cell
      - water continually enters *Paramecium* cell
    - solution: contractile vacuole
      - pumps water out of cell

**freshwater**



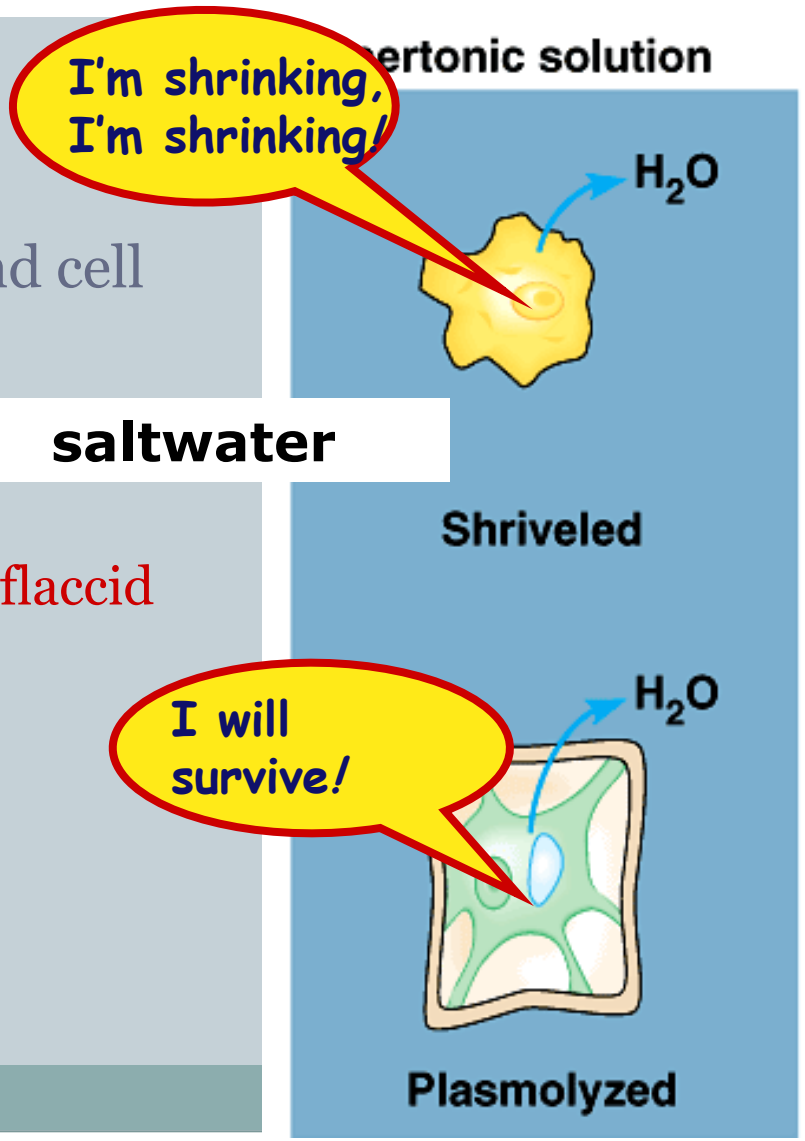
# Controlling water concentrations

- Contractile vacuole in *Paramecium*



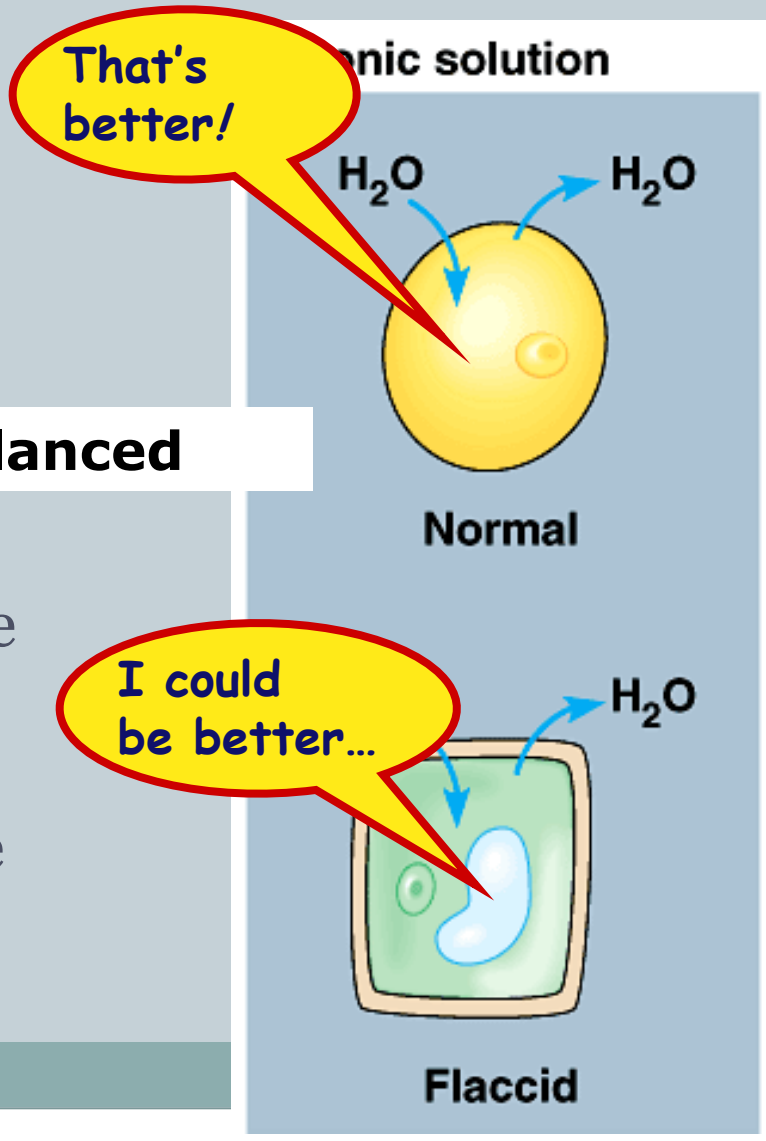
# 2 Keeping the right amount of water in the cell

- Saltwater
  - a cell in salt water
  - low concentration of water around cell
    - cell loses water
  - example: shellfish
  - problem: cell loses water
    - in plants: plasmolysis, or wilting, flaccid
    - in animals: shrinking cell
  - solution: take up water

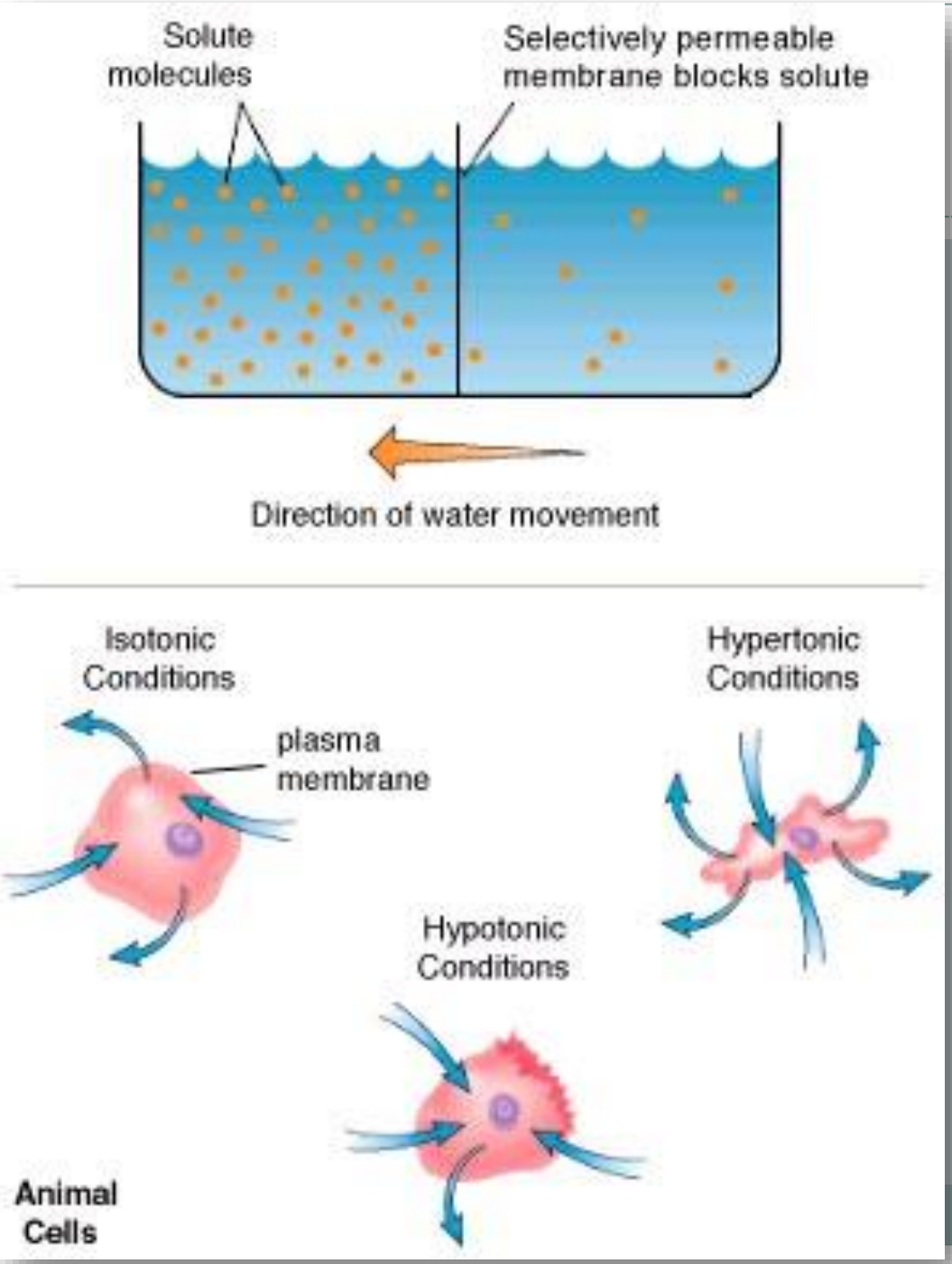


# 3 Keeping the right amount of water in the cell

- Balanced conditions
  - no difference in concentration of water between cell & environment
    - cell in equilibrium
    - example: blood
    - problem: none
      - water flows across membrane equally, in both directions
      - volume of cell doesn't change




**balanced**


Solute molecules
Selectively permeable membrane blocks solute
Direction of water movement
Isotonic Conditions
plasma membrane
Hypertonic Conditions
Hypotonic Conditions
Animal Cells

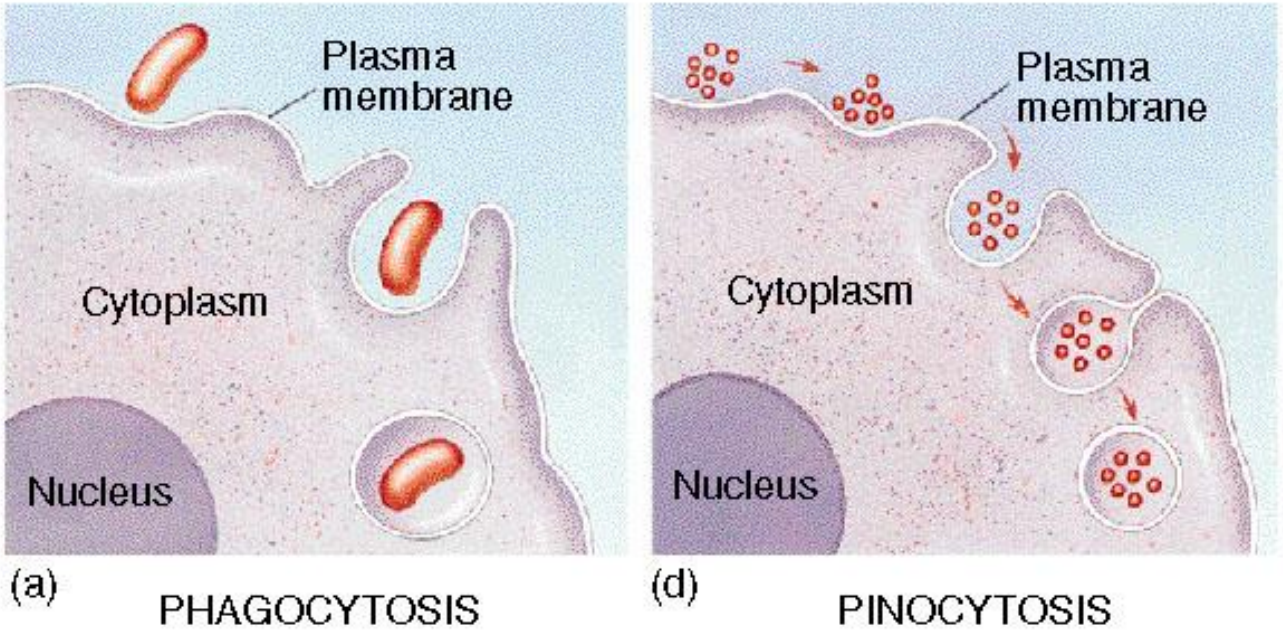
# Bulk Transport

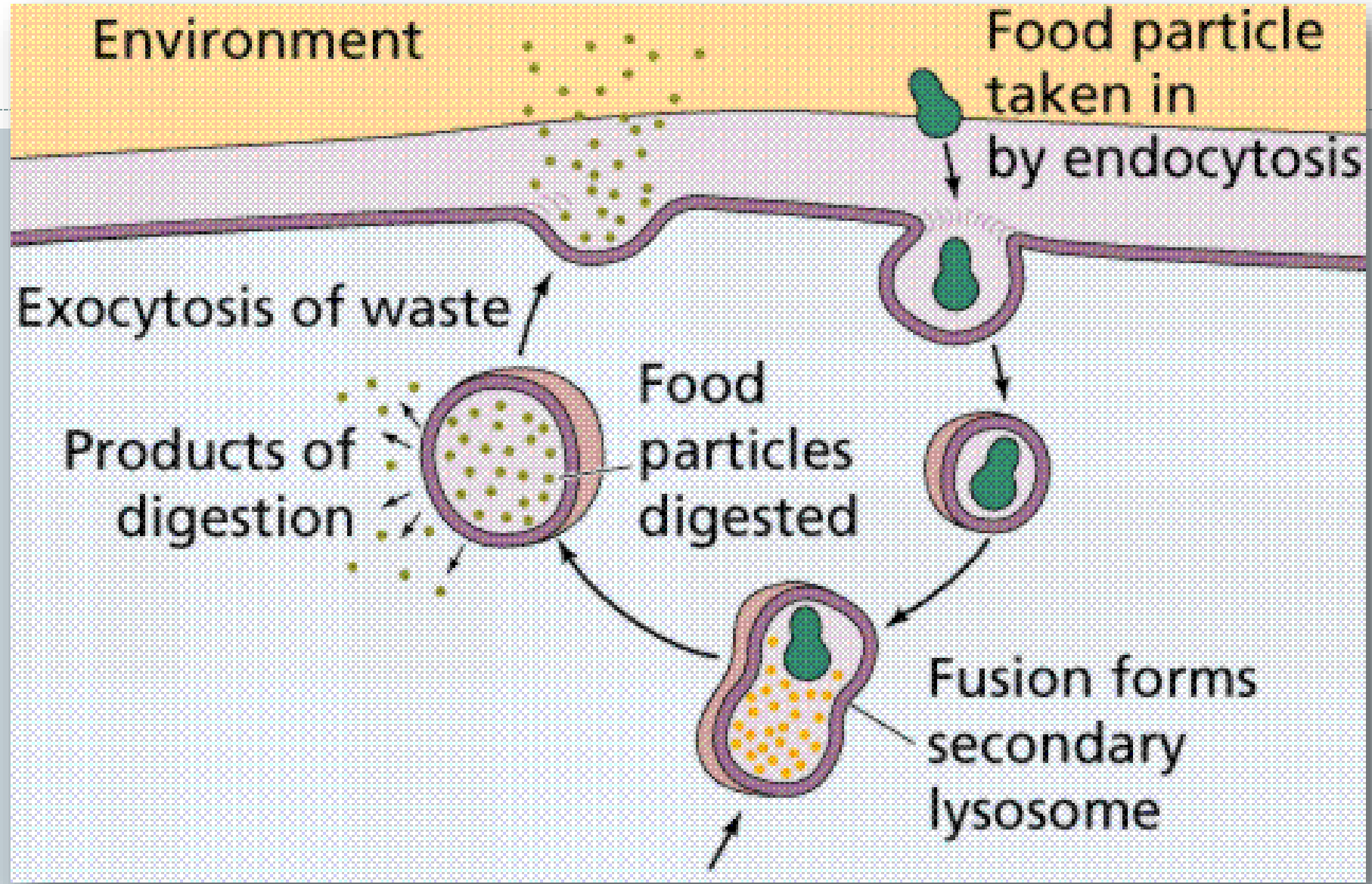
- **1. Endocytosis:** the process of taking material into the cell by means of infoldings, or pockets, of the cell membrane
  - Example of phagocytosis and pinocytosis
    - **Phagocytosis:** process in which extensions of cytoplasm surround and engulf large particles and take them into the cell
      - Used by amoebas
    - **Pinocytosis:** process by which a cell takes in liquid from the surrounding environment
- **2. Exocytosis:** process by which a cell releases large amounts of material
  - Example, the removal of water by a contractile vacuole

# Endocytosis

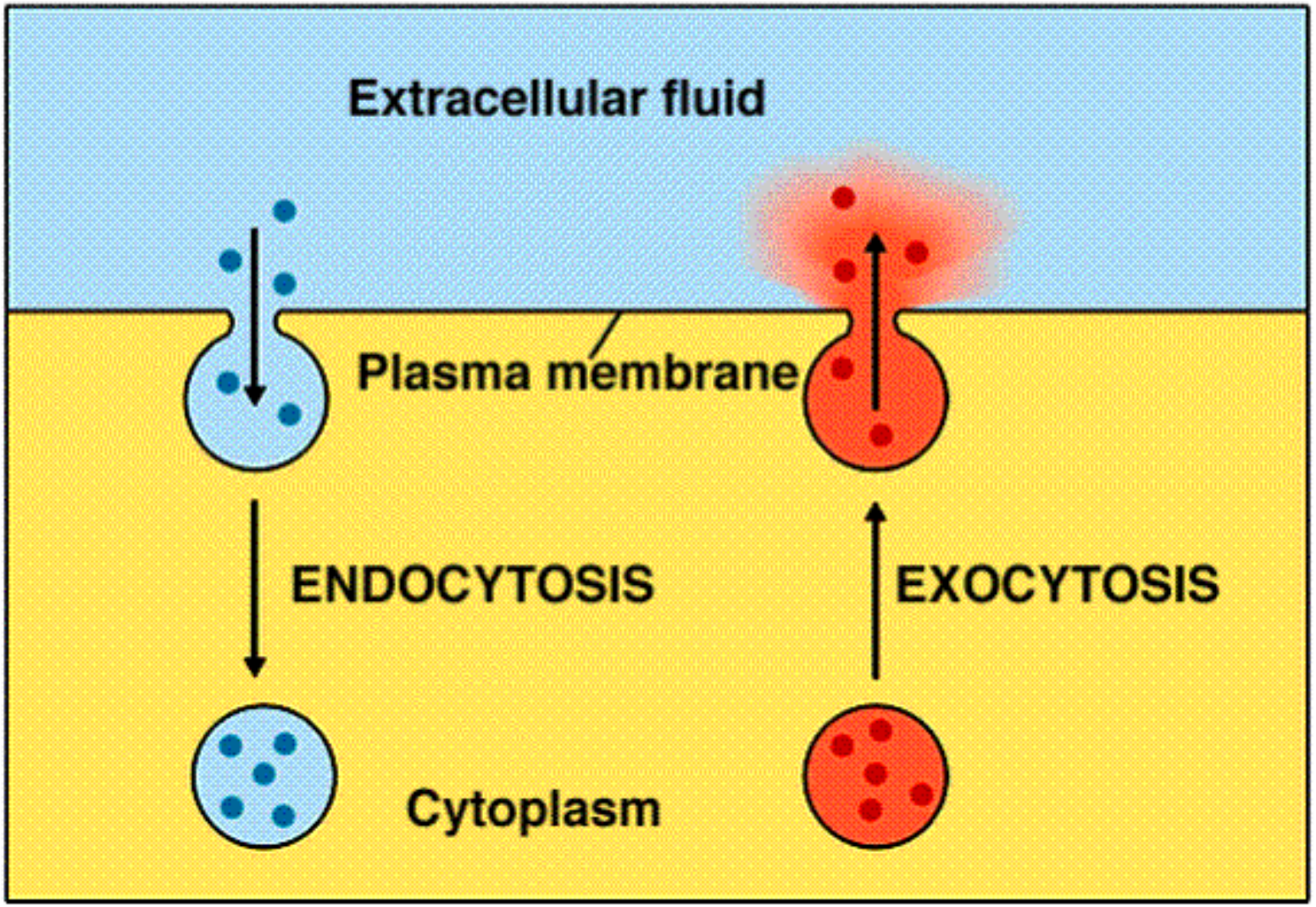


Endocytosis. Figure 5.11a, d




Environment
Food particle taken in by endocytosis
Exocytosis of waste
Products of digestion
Food particles digested
Fusion forms secondary lysosome

# Endocytosis and Exocytosis



# QUESTION AND ANSWER

**How do molecules move into and out of the cell?**

# How do the cells of multi-cellular organisms work together to maintain homeostasis?

# Diversity of Cellular Life

- Organisms are either
  - Unicellular, ex. Amoeba, Paramecium, Bacteria
  - Multi-cellular, ex. Humans
    - most multi-cellular organisms contain specialized cells that have very specific functions, ex. neurons, red blood cells
    - cells develop in different ways and perform different tasks is a process called **cell specialization**
      - each cell (excluding sex cells) contains identical DNA.
      - in cell specialization, stem cells that produce specialized cells contain genes that are expressed differently- some are activated (expressed) and others are deactivated (not expressed) due to internal and external environmental conditions

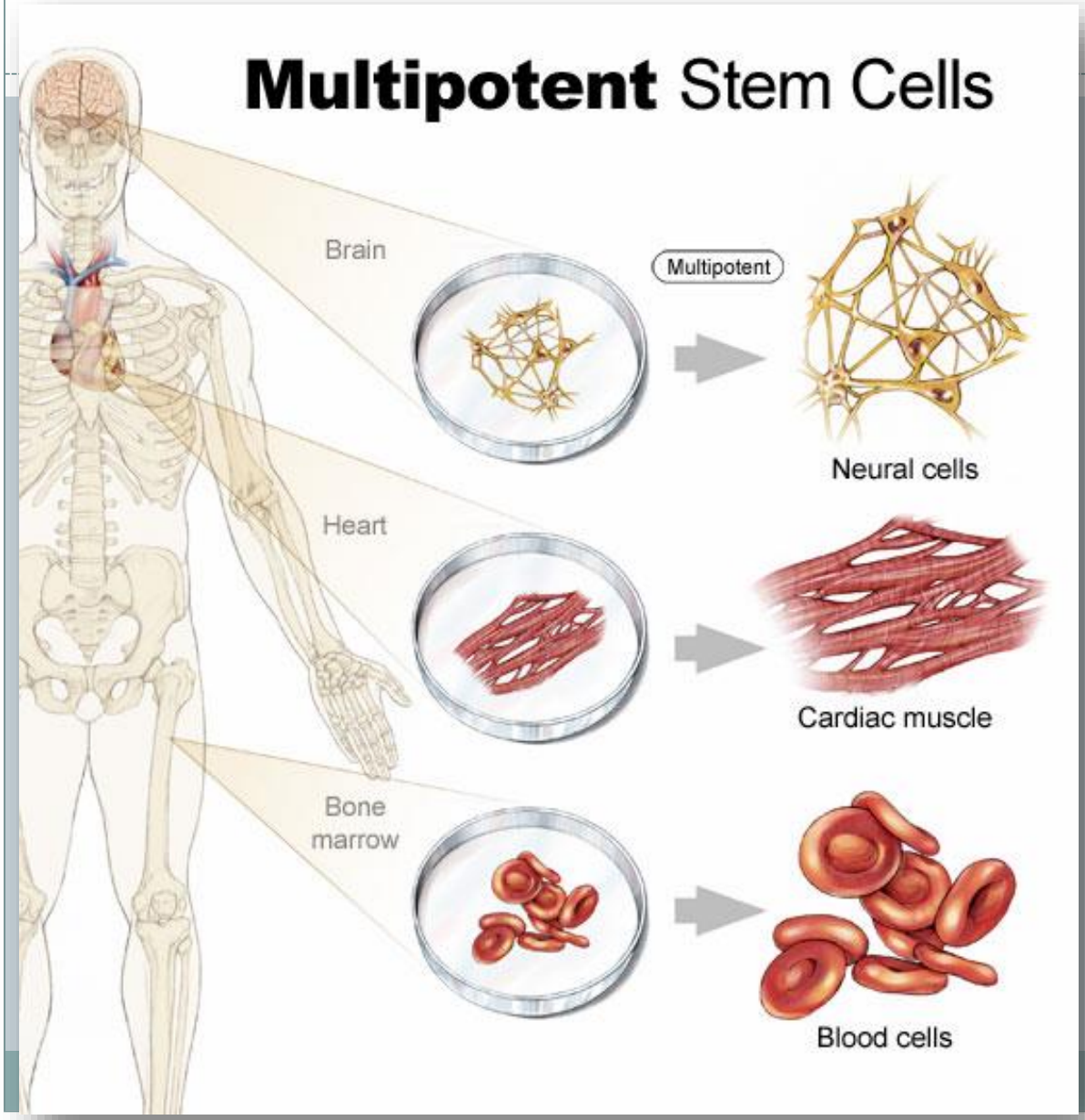
# The cell as an organism

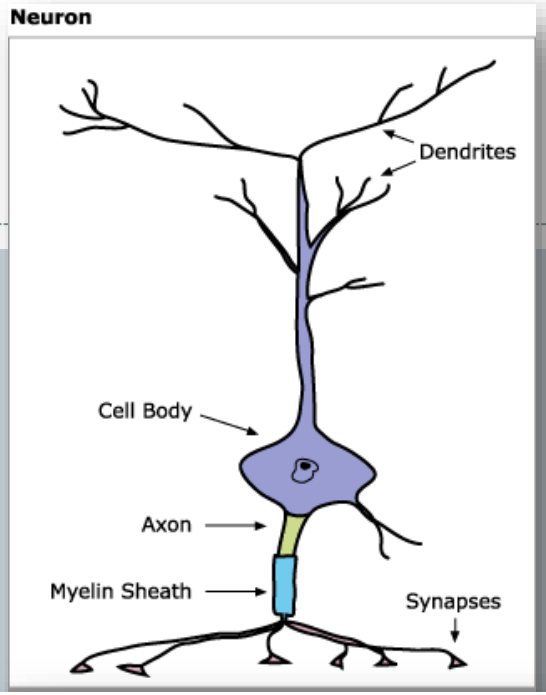
- The cells of multi-cellular organisms become specialized for particular tasks and communicate with one another to maintain homeostasis
  - **Homeostasis** relatively constant internal physical and chemical conditions that organisms maintain
  - **Dynamic equilibrium** refers to the optimal conditions for survival
- To maintain homeostasis, unicellular organisms grow, respond to the environment, transform energy, and reproduce
- Cells communicate by the means of chemical signals that are passed from one cell to another. These signals can speed up or slow down the activities of the cells that receive them and can even result in the cell to change what it is doing.
  - To respond to the signals from another cell, a cell must have a receptor to which the signaling molecule can bind

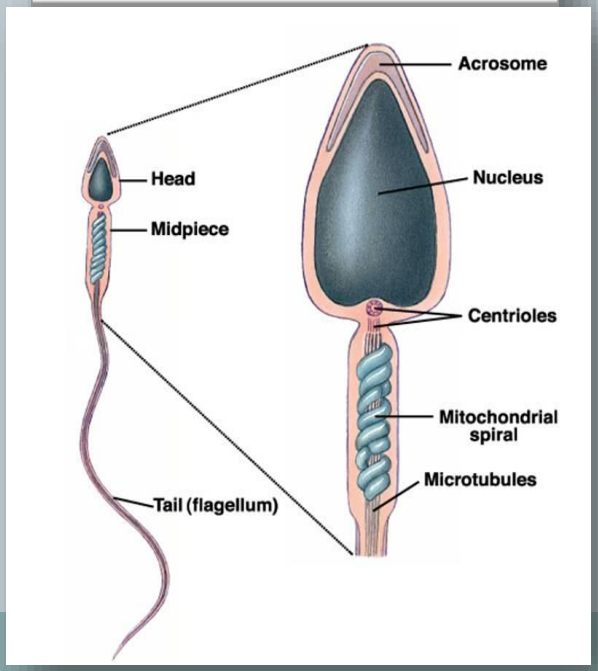
# Levels of organization in multi-cellular organisms

- The levels of organization from simple to complex are: individual cells, tissues, organs, organ systems, organism
  - **Tissues:** a group of similar cells that perform a particular function
  - **Organ:** many tissues working together
  - **Organ system:** a group of organs that work together and perform a specific function

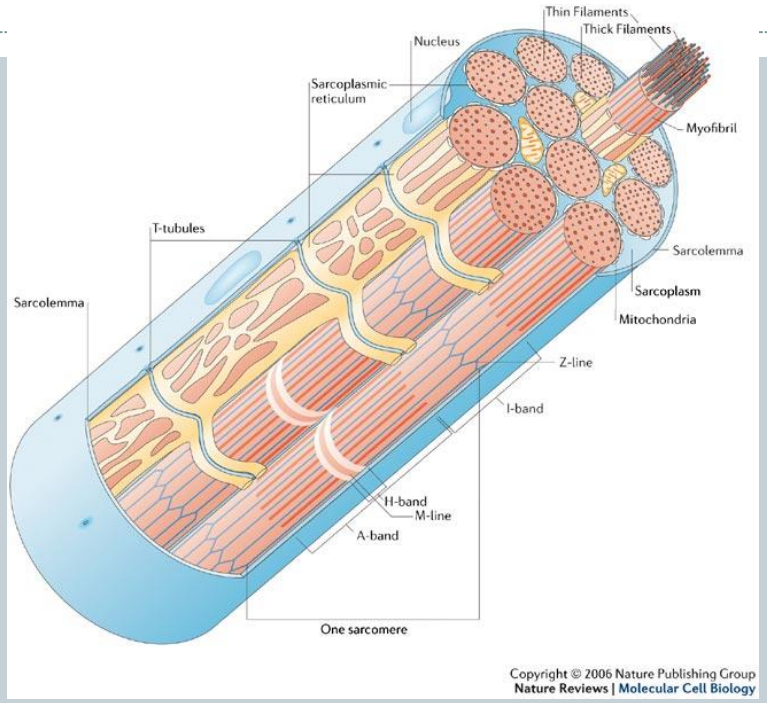
# Specialized Cells

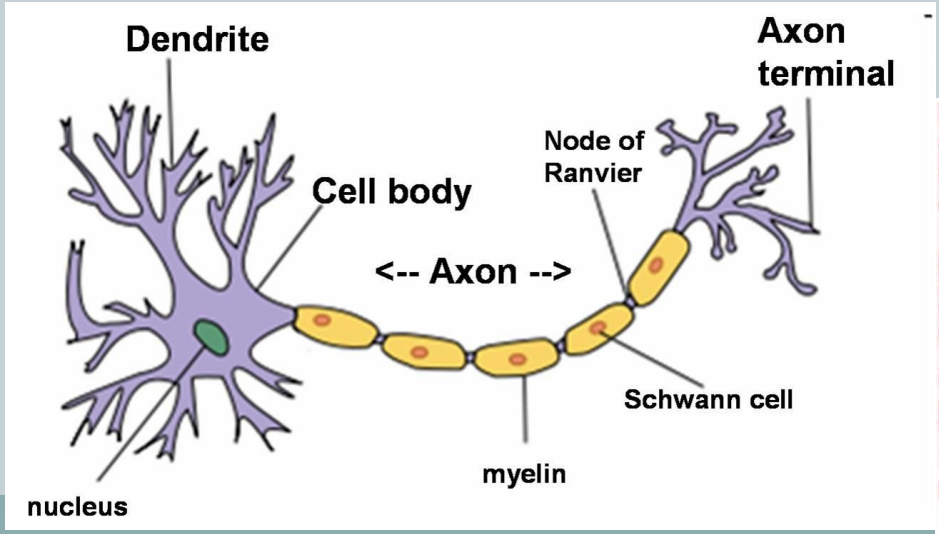


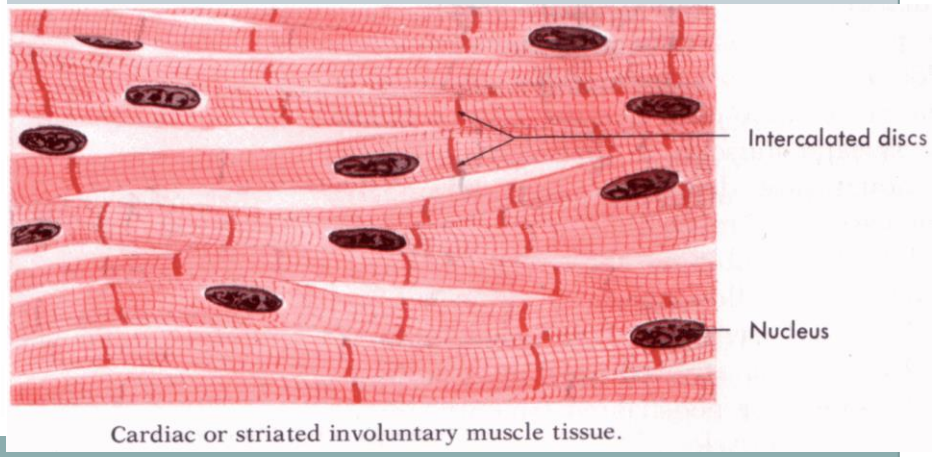



# Cell specialization


Cardiac or striated involuntary muscle tissue.

Human Body

CELLS

TISSUES

ORGANS

SYSTEMS

MeridianLife

# QUESTION AND ANSWER

**How do the cells of multi-cellular organisms work together to maintain homeostasis?**

# Essential Question

**How are cell structures adapted to their functions?**