General Biology 1
BIO1101
Syllabus & Textbook: http://goo.gl/rvgdrH

Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER

Lecture:https://openlab.citytech.cuny.edu/bio-oer/page/2/
Lab: https://openlab.citytech.cuny.edu/bio-oer/

Grade Breakdown:

Exams (4): 20% Each
Quizzes: 20% Average

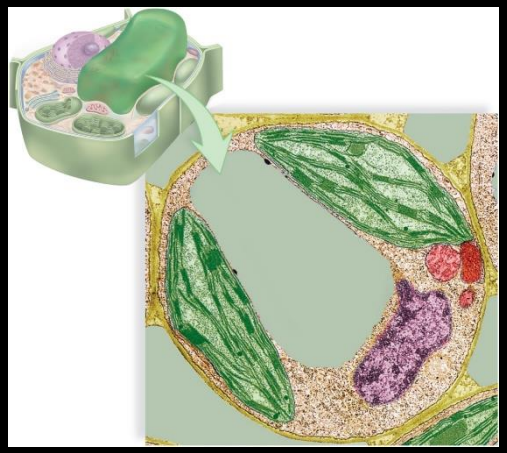
Recap: Meeting 11

A. Prokaryote vs Eukaryote:

1) Nucleus – double lipid bilayer (2 x PM)
2) Eukaryotes – Many Organelles

B. Important Organelles

1) Endoplasmic Reticulum (Rough vs Smooth)
    1) Ribosomes – Free (single or poly) vs attached to ER → RER
    2) Ribosomes are Non-membrane bound (mRNA → protein)
2) Golgi Apparatus
3) Vesicle & vesicle transport (exocytosis vs endocytosis)
4) Lysosomes and Peroxisomes
5) Vacuoles



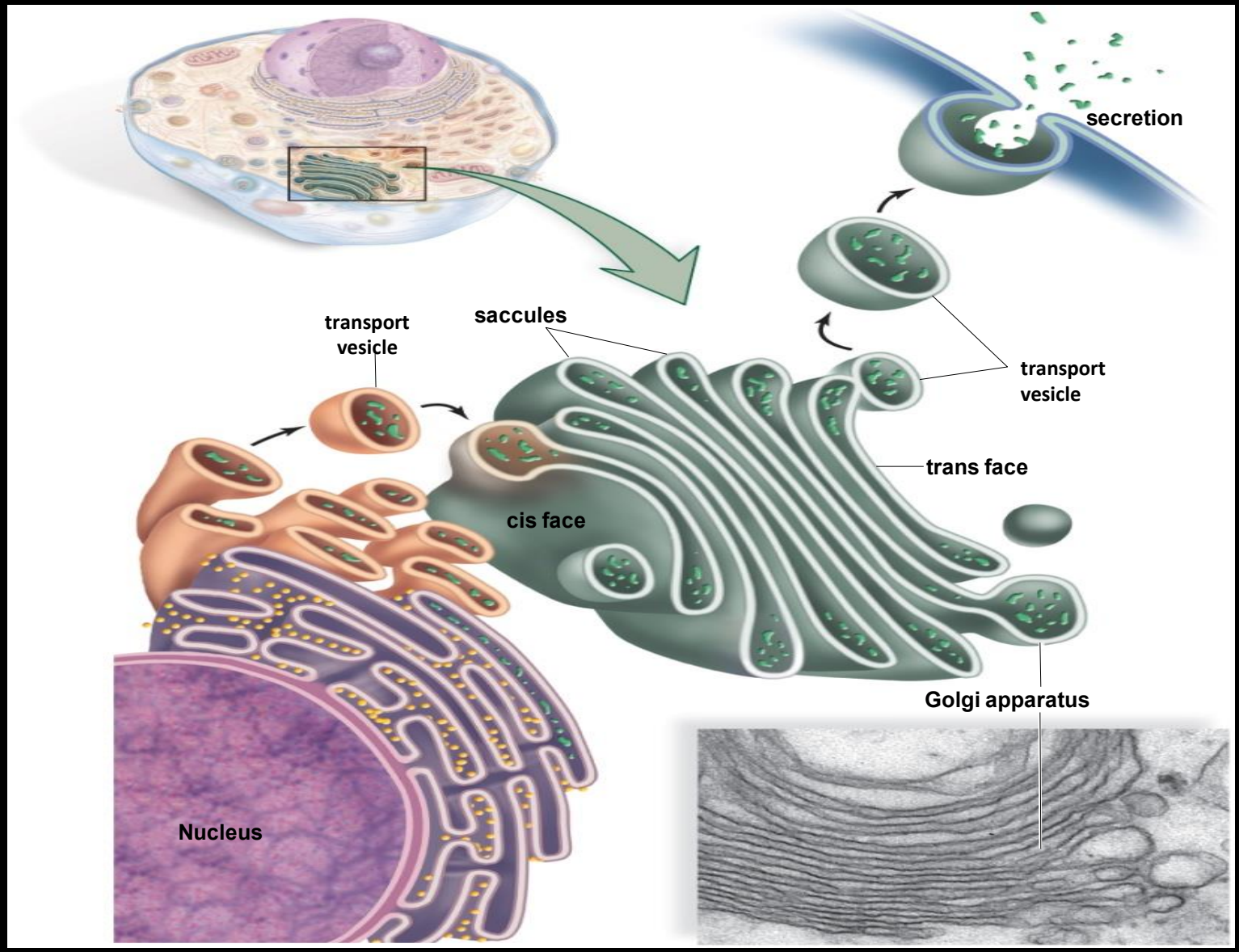
C. Endosymbionts

1) Mitochondria/Chloroplast

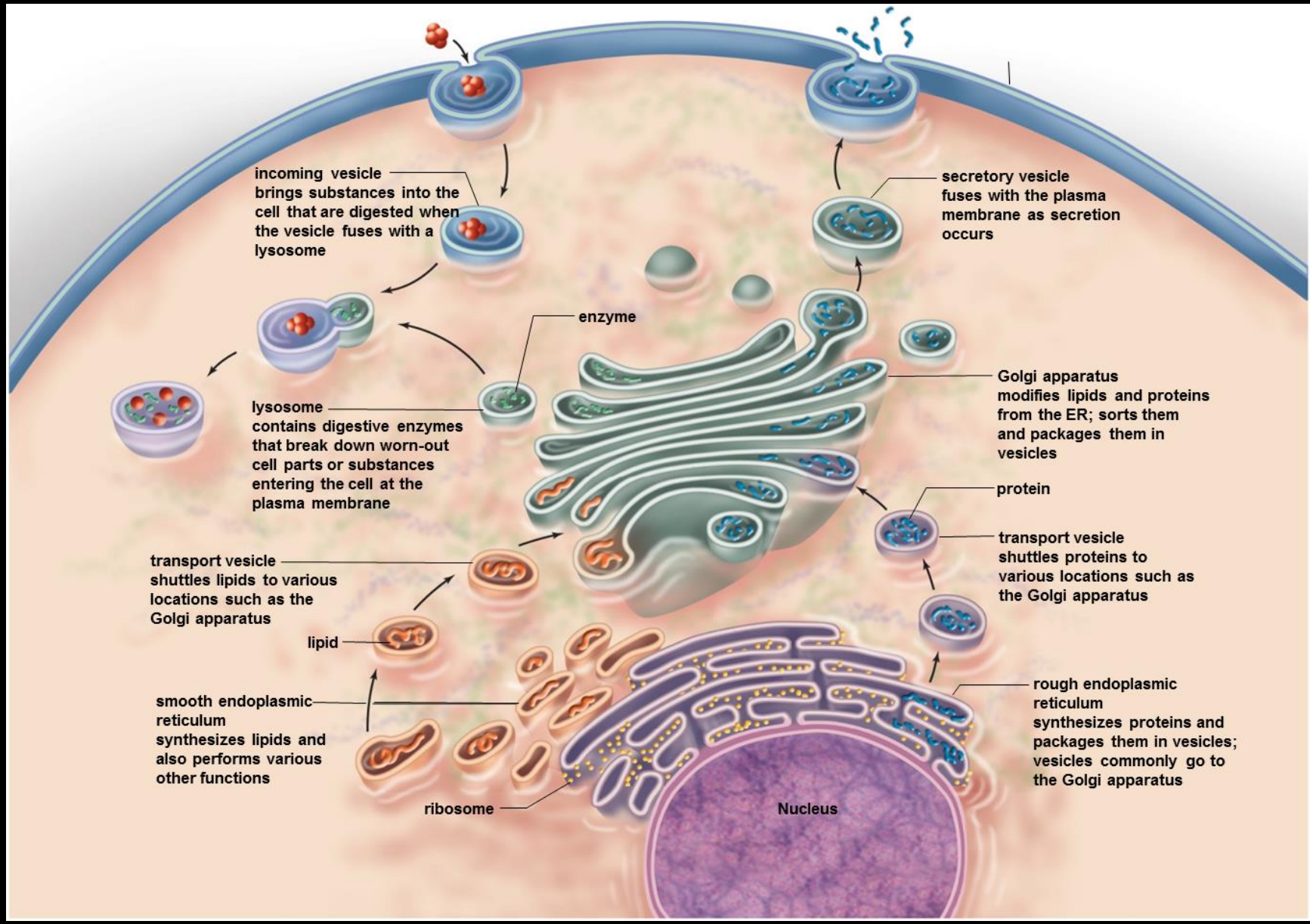
D. Cytoskeleton:

1) 3 filaments (Actin (thin), intermediate, Microtubule (thick))

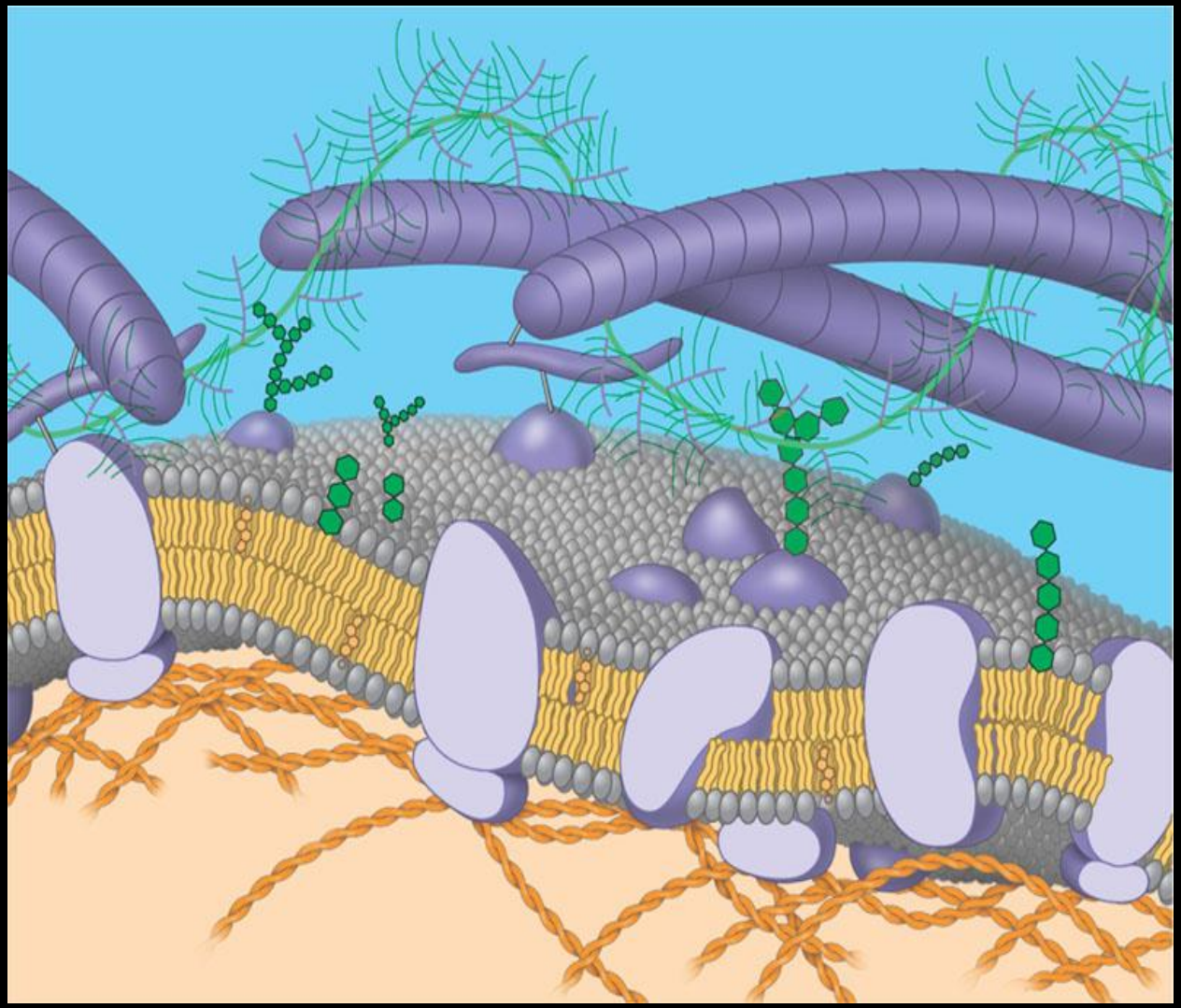
Important Organelles



Cellular Transport
Endocytosis -- Exocytosis



Membranes & Transport

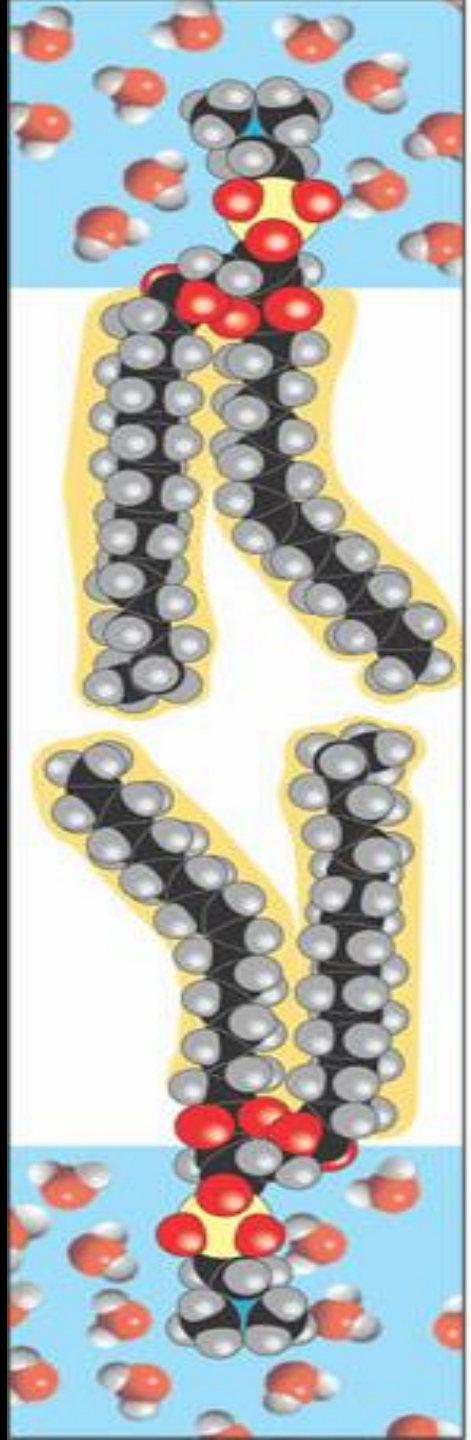


INTRODUCTION

- The plasma membrane is common to all cells
- The plasma membrane is the boundary that separates the living cell from its nonliving surroundings
- The plasma membrane exhibits **selective permeability**, allowing some substances to cross it more easily than others

Membranes are Lipid Bilayers

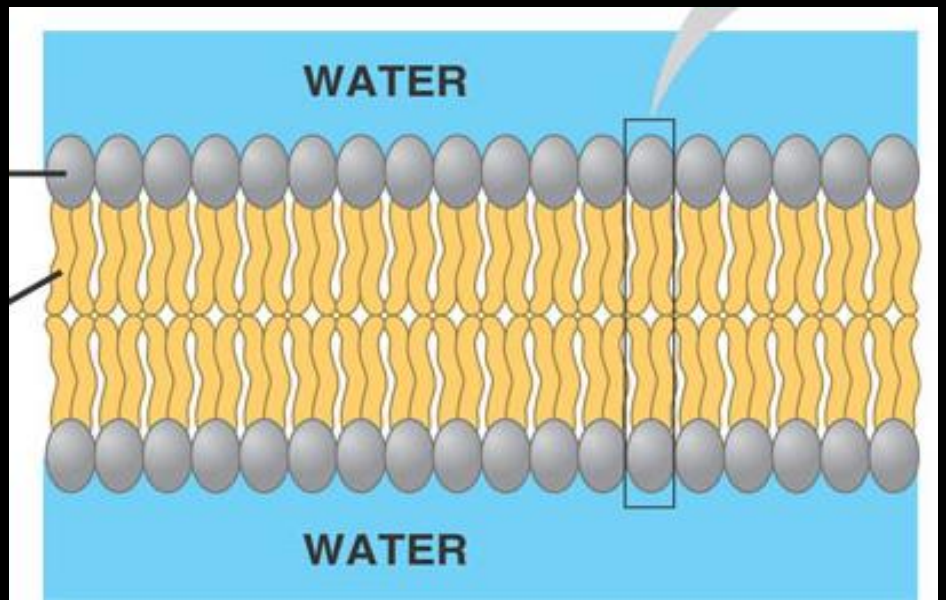
- Cell membranes are made mostly of **phospholipids**
  - PL's are **amphipathic/amphiphilic**
    - Hydrophilic head
    - Two Hydrophobic tails
- Phospholipids form **bilayers**
  - Tails face in, heads face out!



Hydrophilic

Hydrophobic

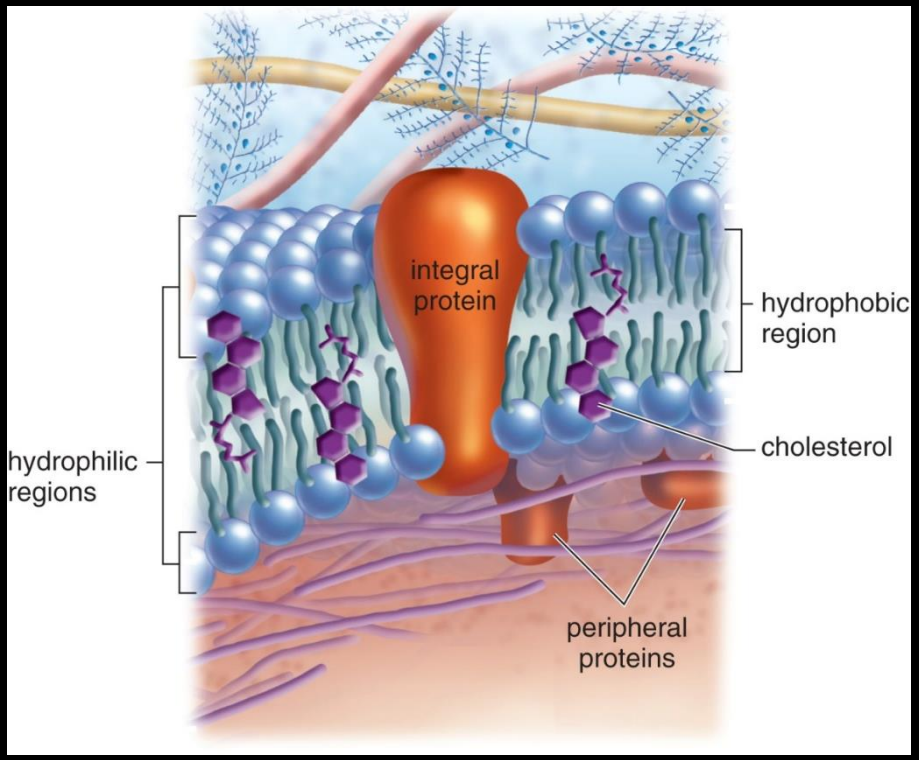
Hydrophilic



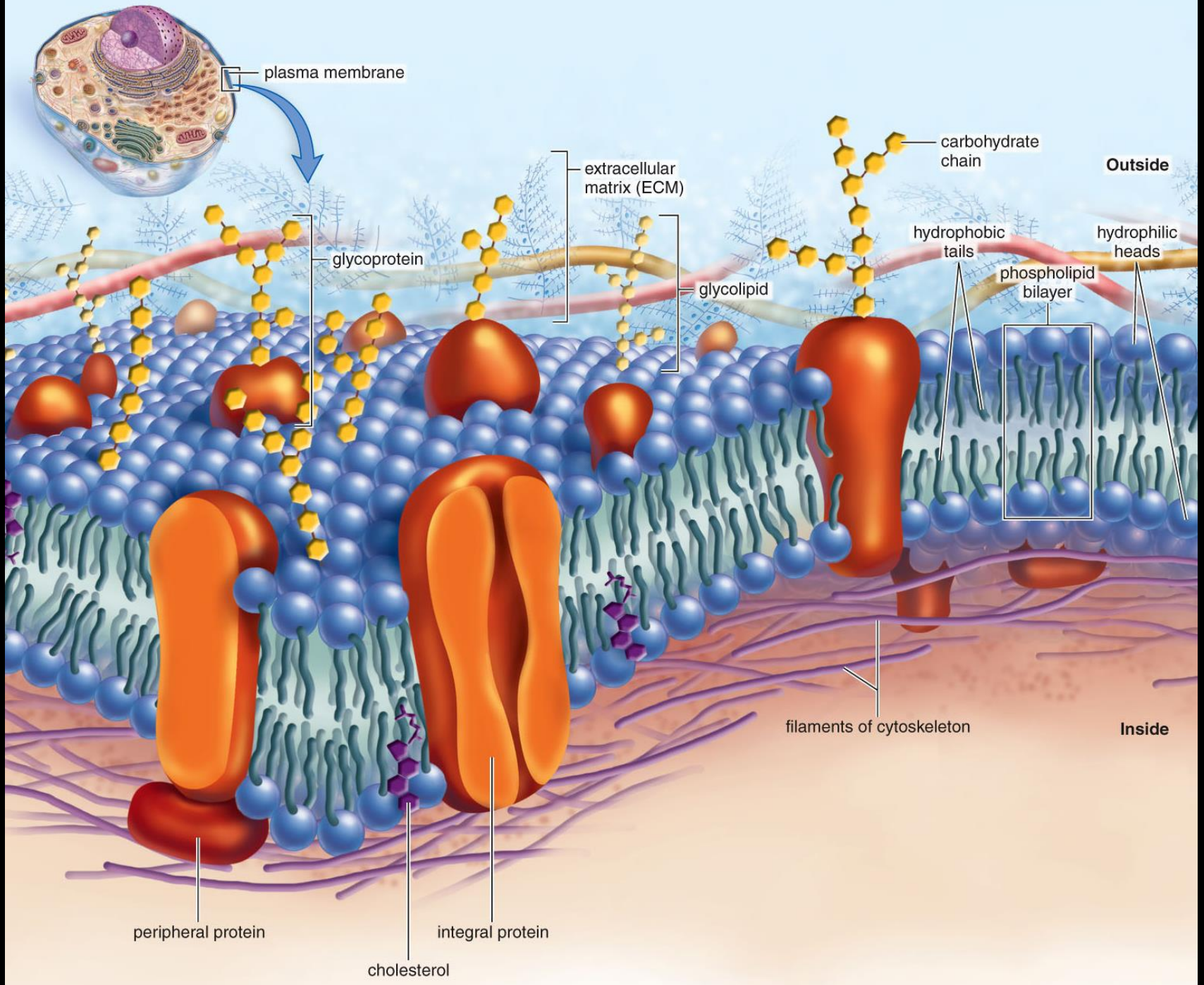
Fluid-Mosaic Model

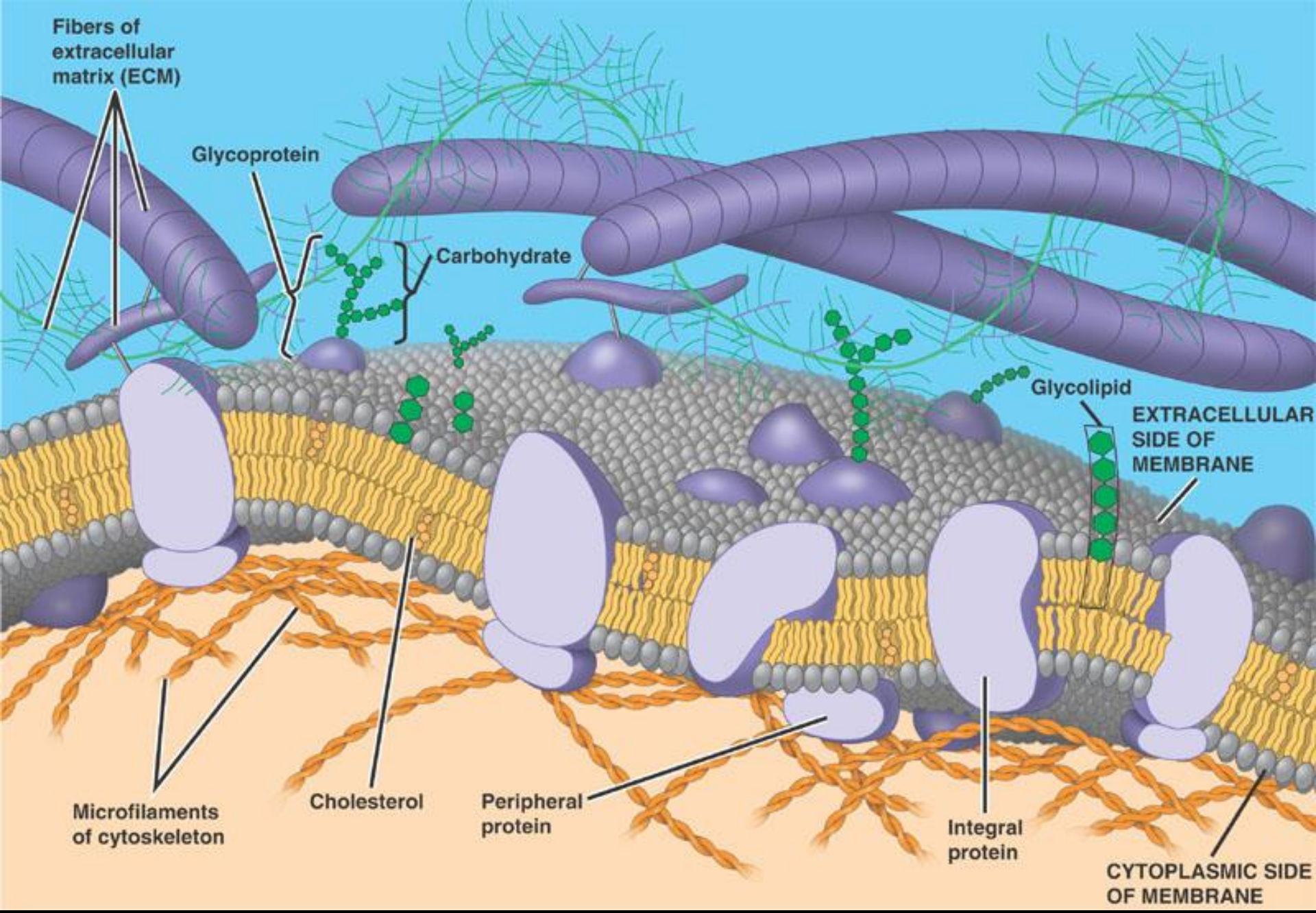
- The P.L. bilayer is very “fluid” and components float freely throughout
- Other components:
  - Cholesterol
  - Proteins,
  - glycoproteins
  - Glycolipids

“Glyco” refers to carbohydrate chains



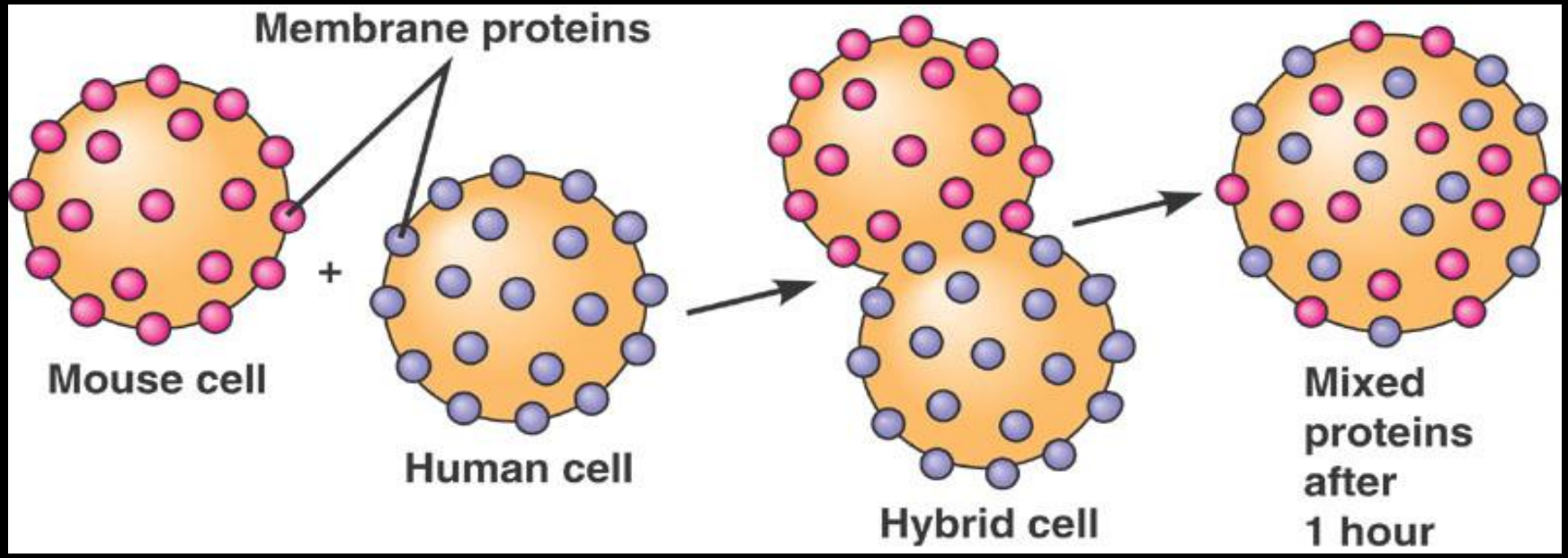
- Different membranes have different components
- Outer half different from inner half (asymmetrical)


plasma membrane
extracellular matrix (ECM)
carbohydrate chain
Outside
glycoprotein
glycolipid
hydrophobic tails
hydrophilic heads
phospholipid bilayer
filaments of cytoskeleton
Inside
peripheral protein
integral protein
cholesterol


Fibers of extracellular matrix (ECM)
Glycoprotein
Carbohydrate
Glycolipid
EXTRACELLULAR SIDE OF MEMBRANE
Microfilaments of cytoskeleton
Cholesterol
Peripheral protein
Integral protein
CYTOPLASMIC SIDE OF MEMBRANE

Fluid-Mosaic Model

- Some proteins in the plasma membrane can drift within the bilayer
- Proteins are much larger than lipids and move more slowly
- To investigate whether membrane proteins move, researchers fused a mouse cell and a human cell

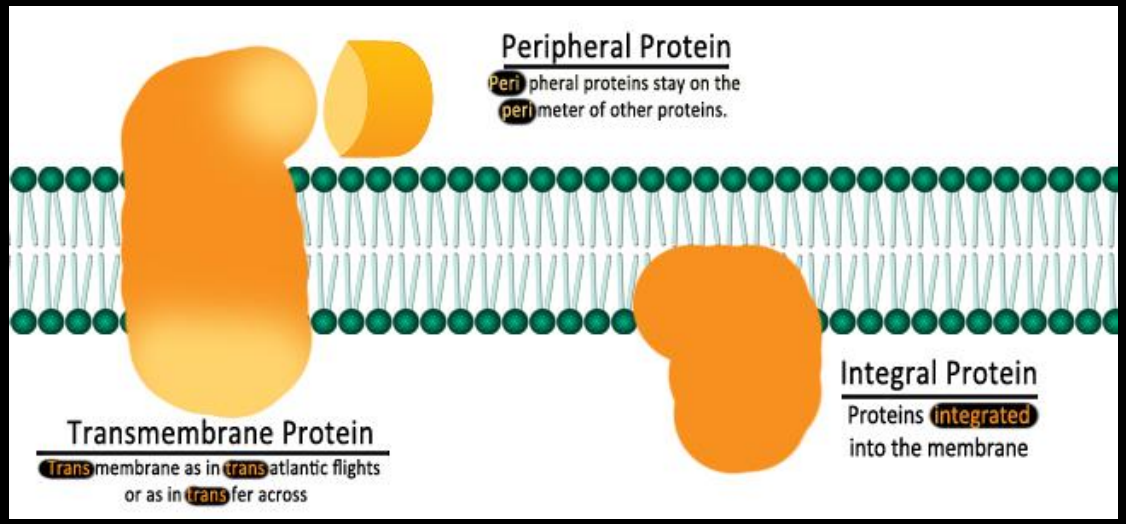


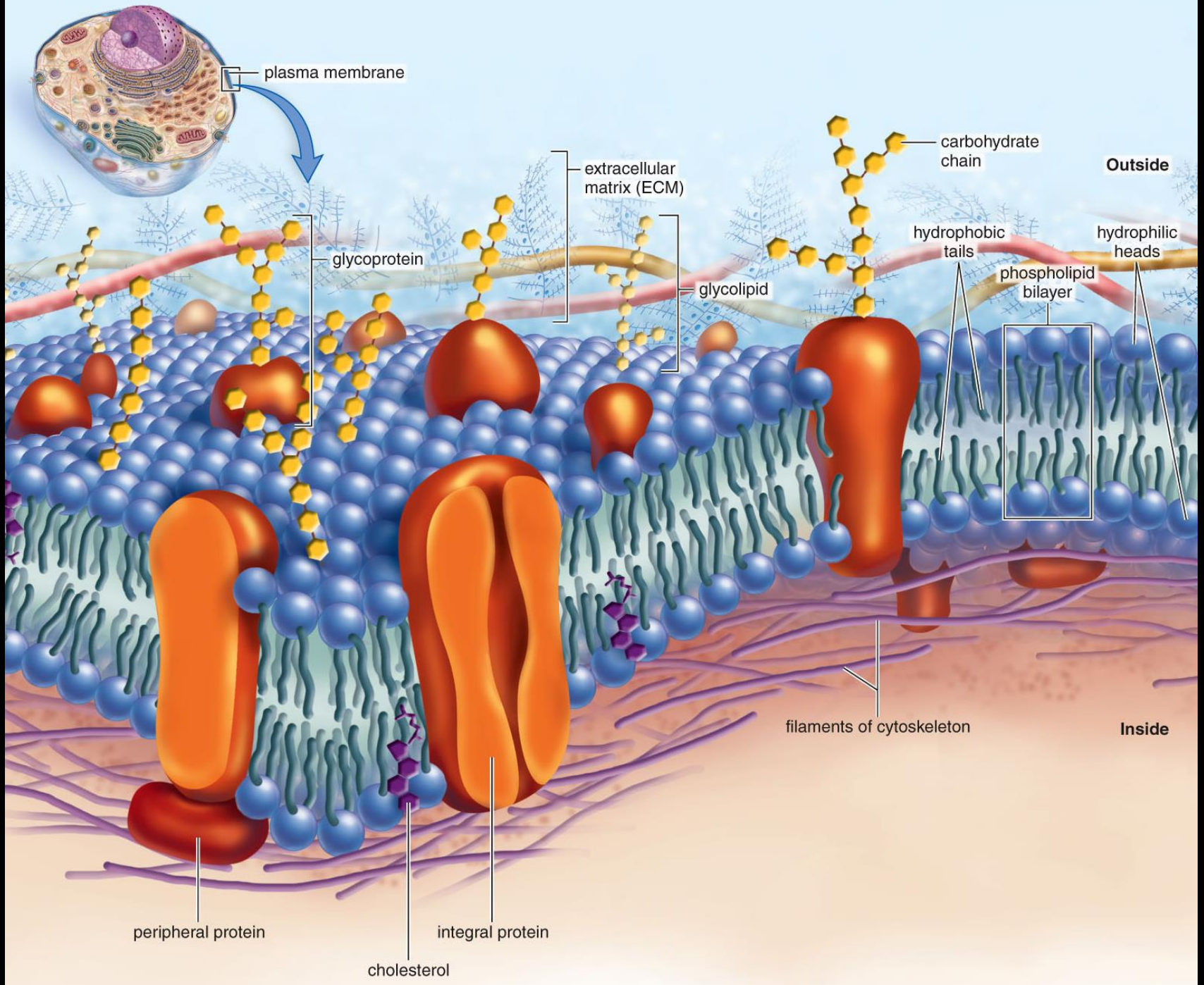
Proteins in the membrane

- **Integral Membrane Proteins**
  - Some are "**transmembrane proteins**"
  - Firmly embedded into membrane through hydrophobic regions

Peripheral Membrane Proteins

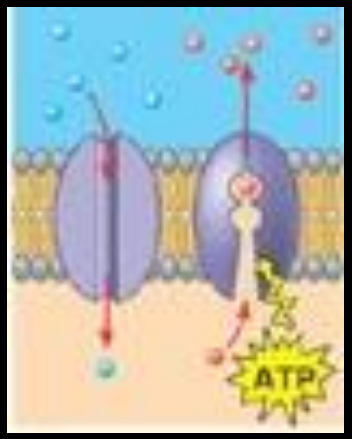
  - Closely associated, but not embedded
  - often bound through a transmembrane protein
- Proteins in the inner half may be anchored to cytoskeleton
- Proteins in the outer half may be anchored to ExtraCellularMatrix

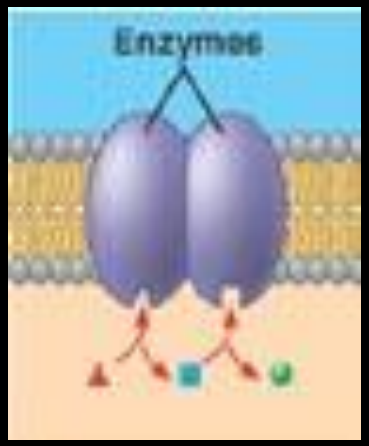


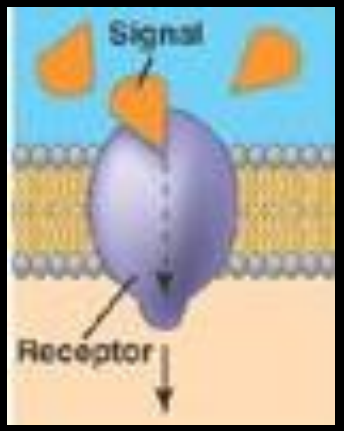

plasma membrane
extracellular matrix (ECM)
carbohydrate chain
Outside
glycoprotein
glycolipid
hydrophobic tails
hydrophilic heads
phospholipid bilayer
filaments of cytoskeleton
Inside
peripheral protein
integral protein
cholesterol

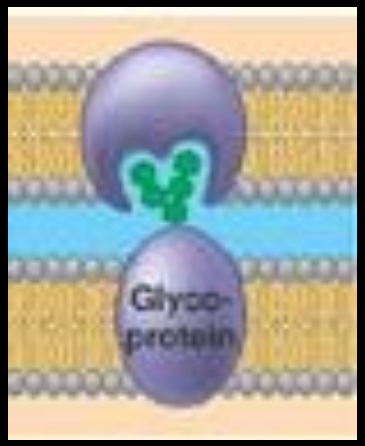
Functions of membrane proteins

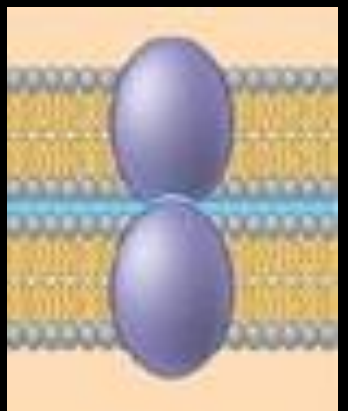
- **Transport**
  - Channels and Pumps/carrier
  - Allow a particular molecule/ion to cross the membrane
- **Enzymes**
  - Catalyse a specific reaction
- **Signal Transduction**
  - Receptors bind to a specific molecule
- **Cell-cell Recognition**
  - Provides unique chemical ID for cells
- **Cell-cell attachment**
  - Junctions
  - Join cells so that a tissue can fullfil a function
- **Attachment to ExtraCellularMatrix**

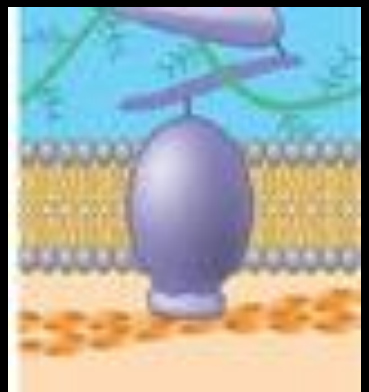






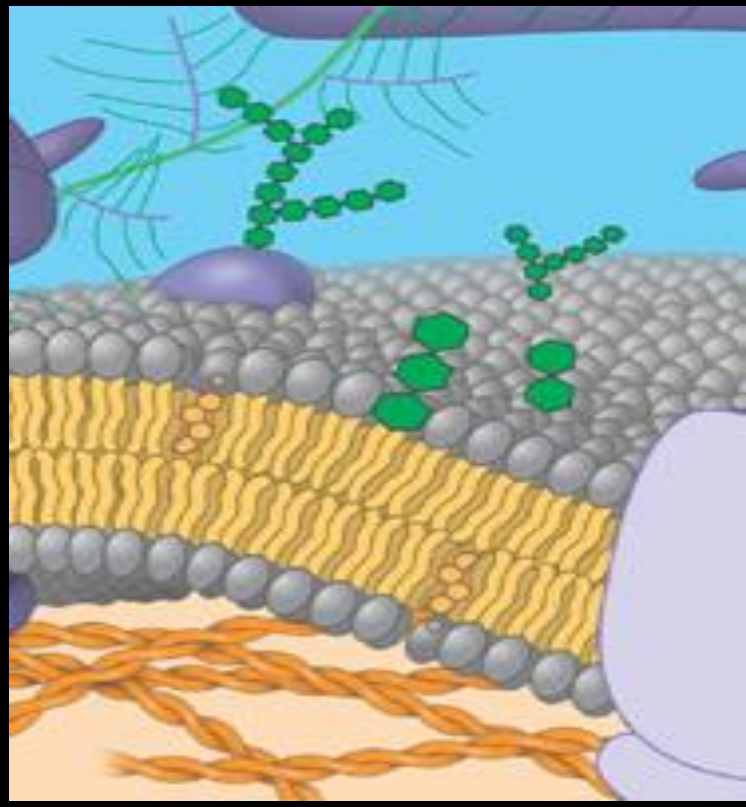






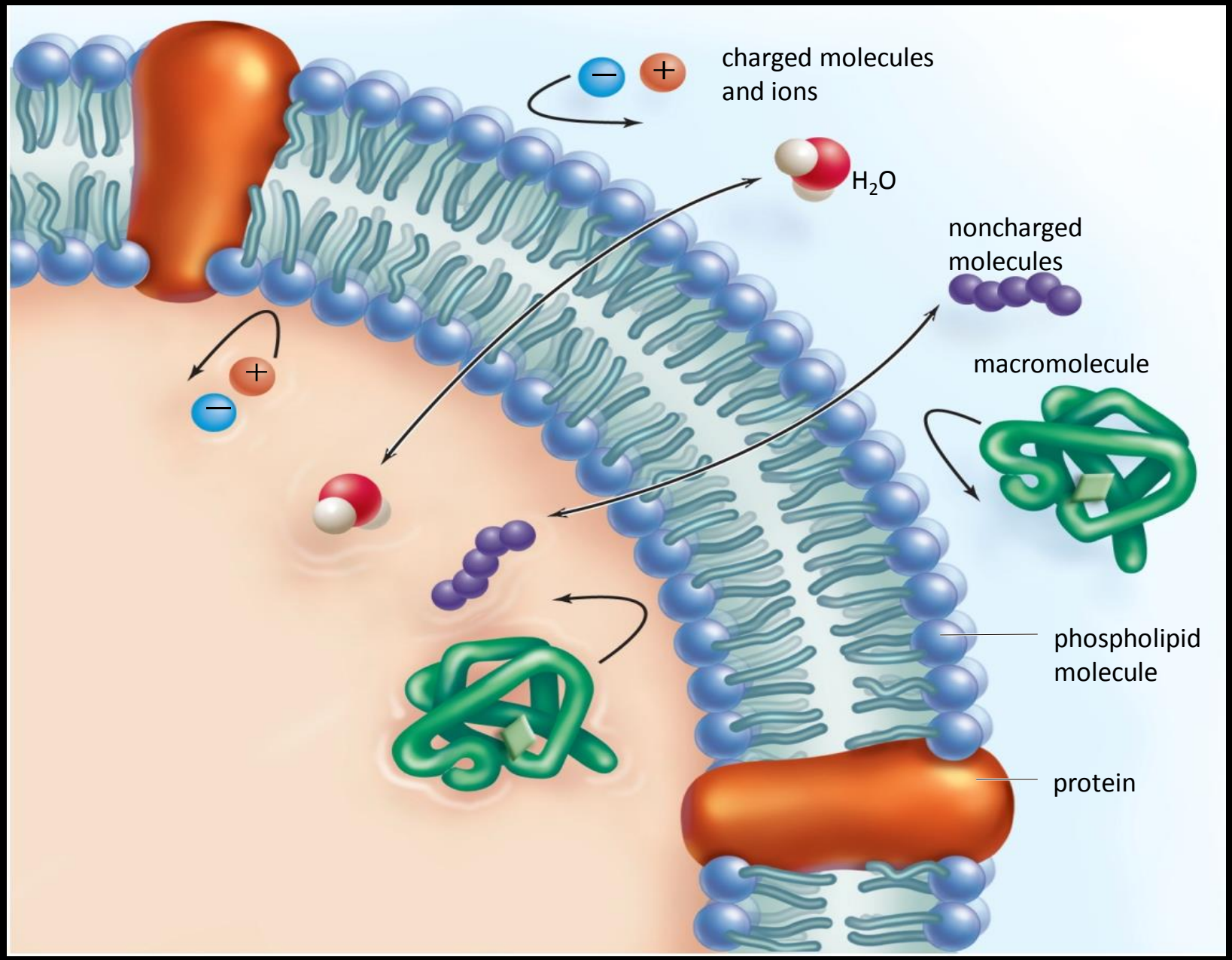
Carbohydrates in the membrane

- Carbohydrates are **always outside** of the cell and bound to:
  - Proteins (glyco-protein) Or…
  - Lipid (glyco-lipids)
- Used to “mark” the cell
  - Can vary by species, individual, and cell type
- Example – A,B,O blood type on RBC’s



Permeability of the Plasma Membrane

- Membranes have **Selective Permeability**
- Non-polar can easily pass right through!
  - Hydrocarbons, Lipids, steroid hormones
  - O_2, CO_2
- Ions and polar molecules cannot pass through: they require **Transport Proteins**
  - Even tiny water requires water channels called "**aquaporins**"
- Although Lipid Bilayers are NOT permeable to ions and water, biological membranes ARE permeable because of transport proteins!
- Two kinds: (both very specific!)
  - Channels – used for **Passive Transport**
  - Pumps – used for **Active Transport**



How molecules cross the Plasma Membrane

(What's wrong with this figure?)

Transport Proteins

- Although Lipid Bilayers are NOT permeable to ions and water, biological membranes ARE permeable because of transport proteins!
- Two kinds:
  - Channels – used for **Passive Transport**
  - Pumps – used for **Active Transport**

Diffusion

- **Diffusion** – *passive* movement of molecules to spread out evenly. (aka **Passive Transport**)
  - Requires no energy!
  - Molecule will flow DOWN a **concentration gradient**
- Nonpolar molecules can freely diffuse across biological membranes
- Polar and charged molecules require a **CHANNEL** to diffuse across membranes
  - Called… **Facilitated Diffusion**
    - **EX: Aquaporin**

<u>Diffusion</u> – *passive* movement of molecules to spread out evenly.

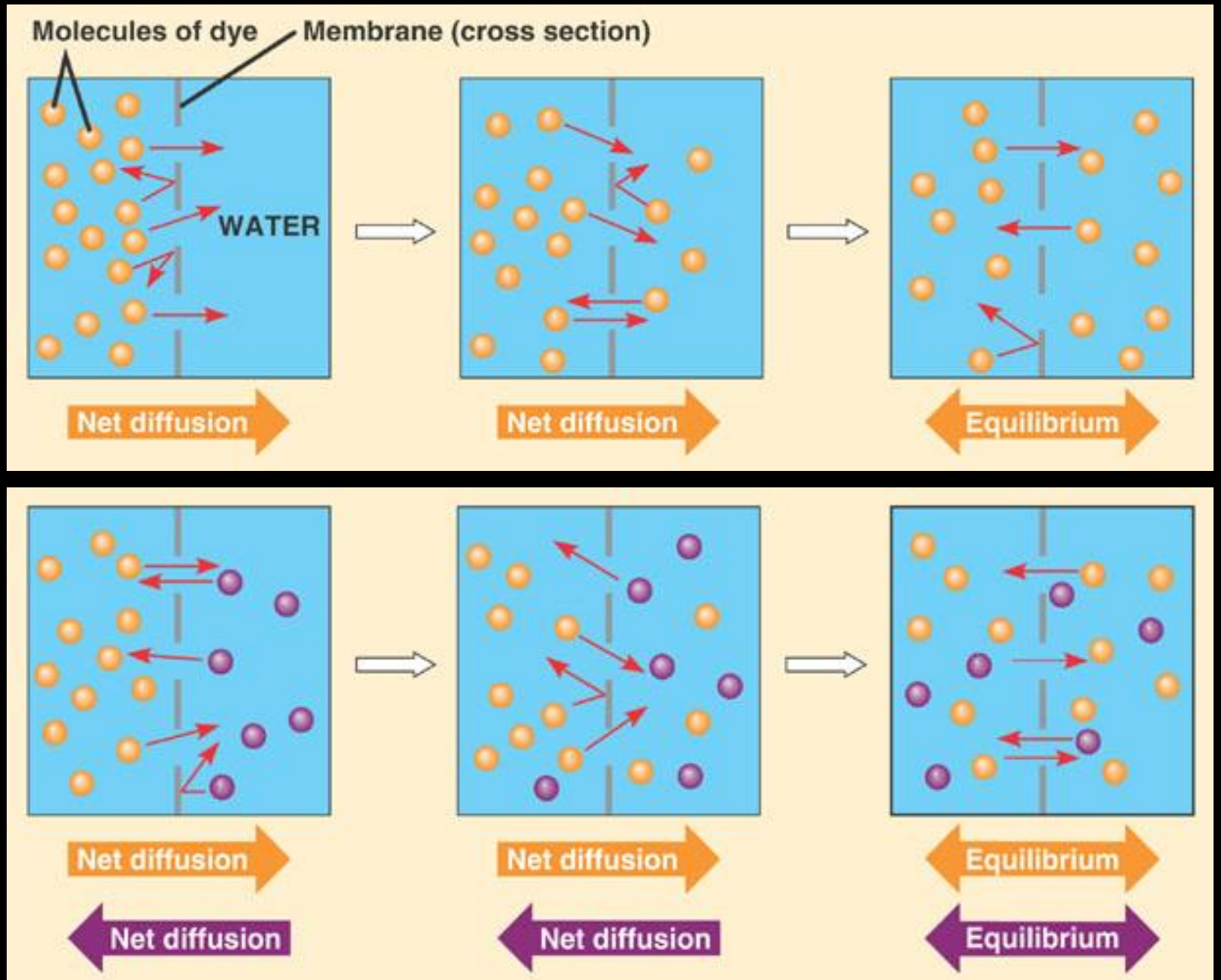
Active Transport

- This is the *active* movement of molecules UP (or “against”) their concentration gradient
  - Requires **energy** (ATP-dependent)
  - Must be performed by a “Pump”
    - EX: Na^+/K^+ pump

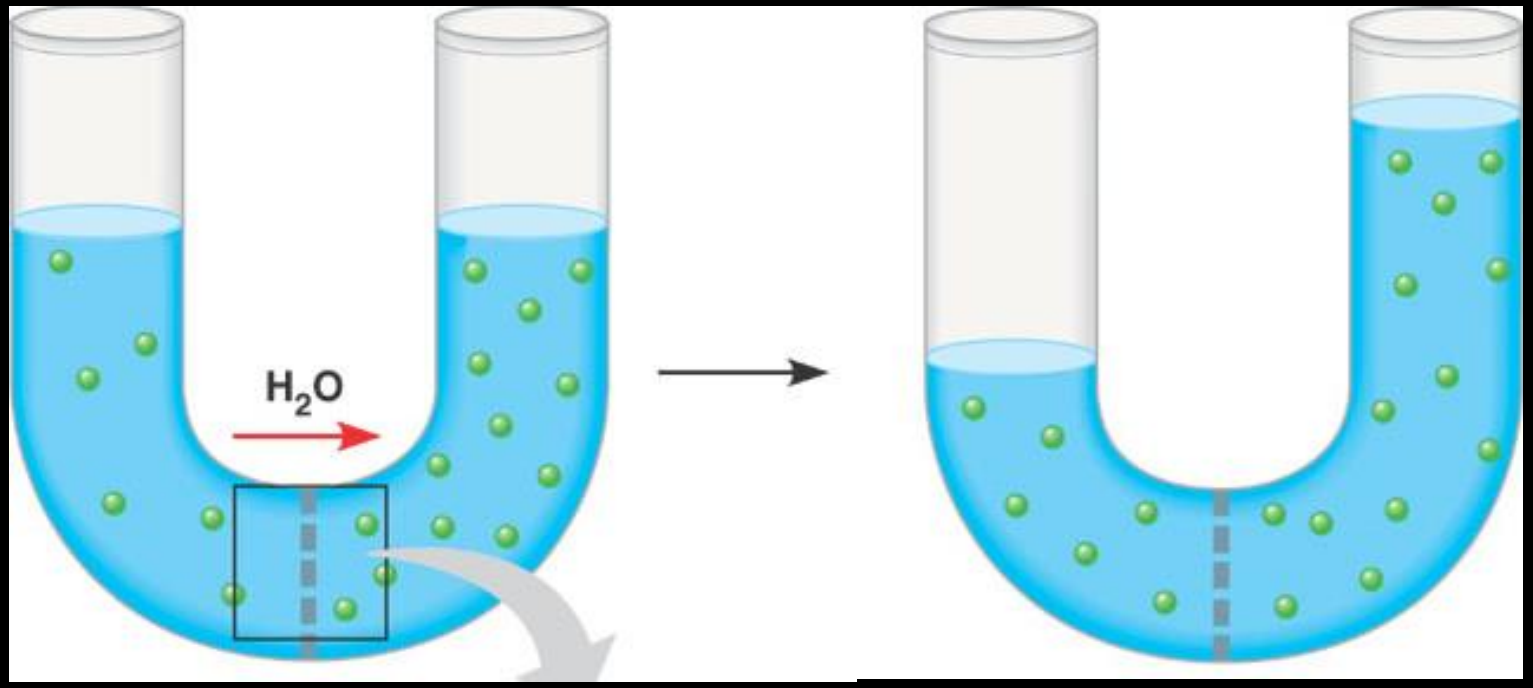
Osmosis and Gradients

- **Osmosis** – the **diffusion** of **water** across membranes
- Molecules are always in random motion, this leads to diffusion
- If one type of molecule accumulates more on one side of a barrier (e.g. membrane) there is a **CONCENTRATION GRADIENT**
- Diffusion (or osmosis) tends to REDUCE gradients to achieve Equilibrium (passive)
- Active Transport – BUILDS gradients

Diffusion


Molecules of dye
Membrane (cross section)
WATER
Net diffusion
Net diffusion
Equilibrium
Net diffusion
Net diffusion
Equilibrium
Net diffusion
Net diffusion
Equilibrium

Osmosis: diffusion but for water



Osmoregulation

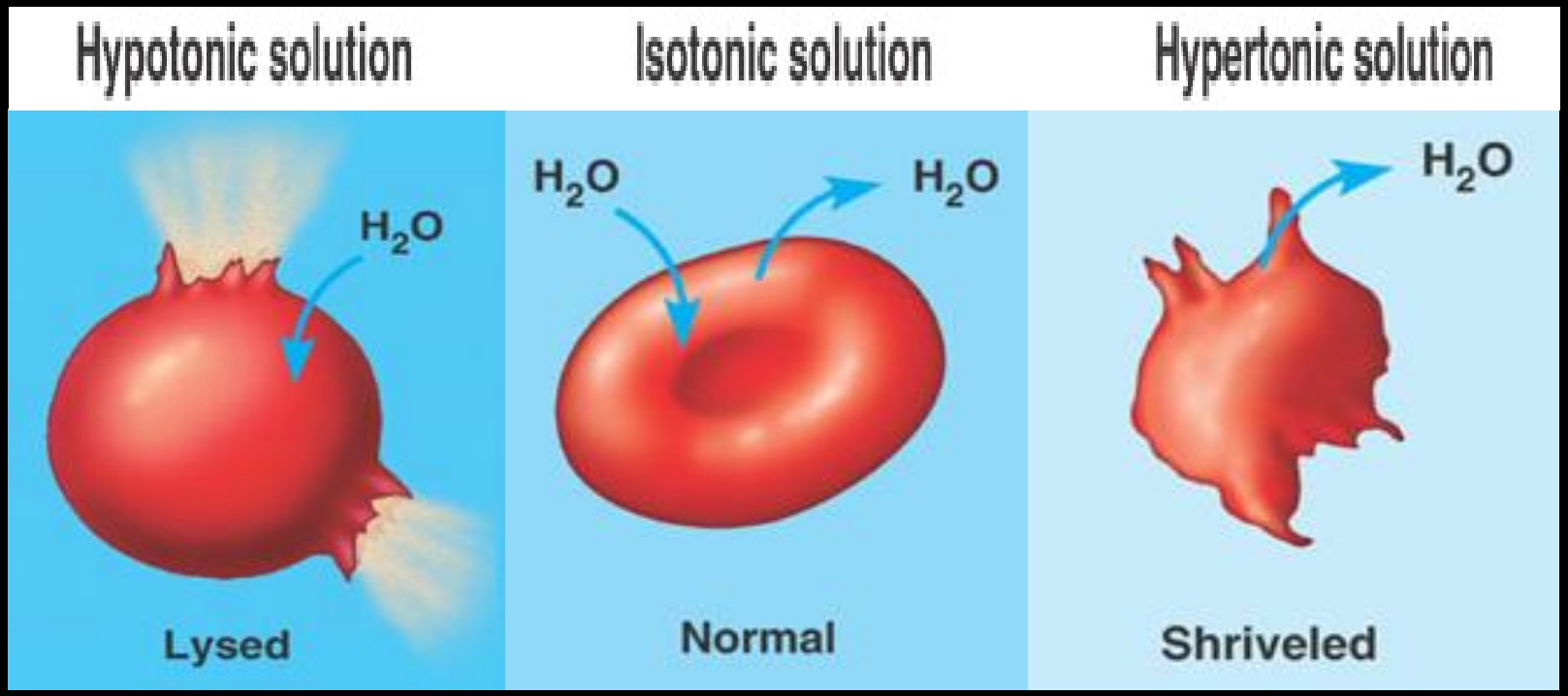
- … is the control of water balance

- **Hypotonic** – a solution with LOWER [solute] → Lower solute concentration
- **Isotonic** – a solution with EQUAL [solute]
- **Hypertonic** – sol'n w/ HIGHER [solute]

- Water can rush in or out of a cell, if it is not in isotonic solution!
  - Through aquaporins!
  - Fate of the Cell depends on cell wall!

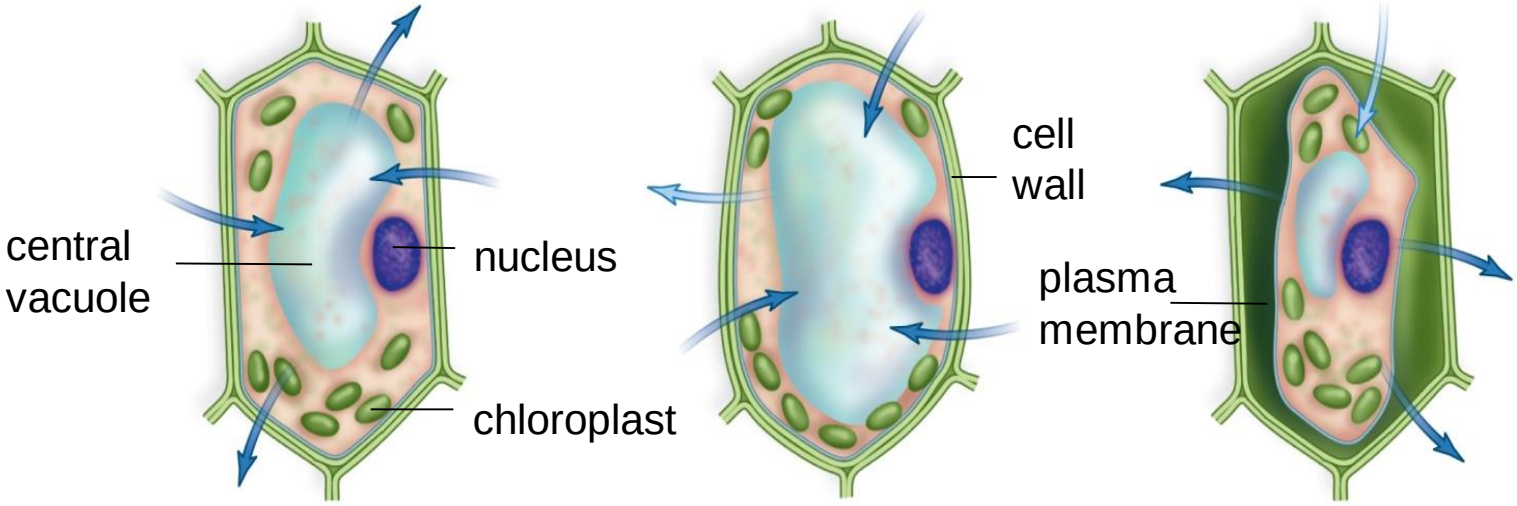
Osmosis in Animal Cells

1. Hypotonic: Less [solute] in solution than cell
2. Isotonic: Equal [solute] in solution and cell
3. Hypertonic: More [solute] in solution than cell



Osmosis in Plant Cells

Isotonic Solution	Hypotonic solution	Hypertonic solution



In an isotonic solution, there is no net movement of water.

In a hypotonic solution, vacuoles fill with water, **turgor pressure** develops, and chloroplasts are seen next to the cell wall.

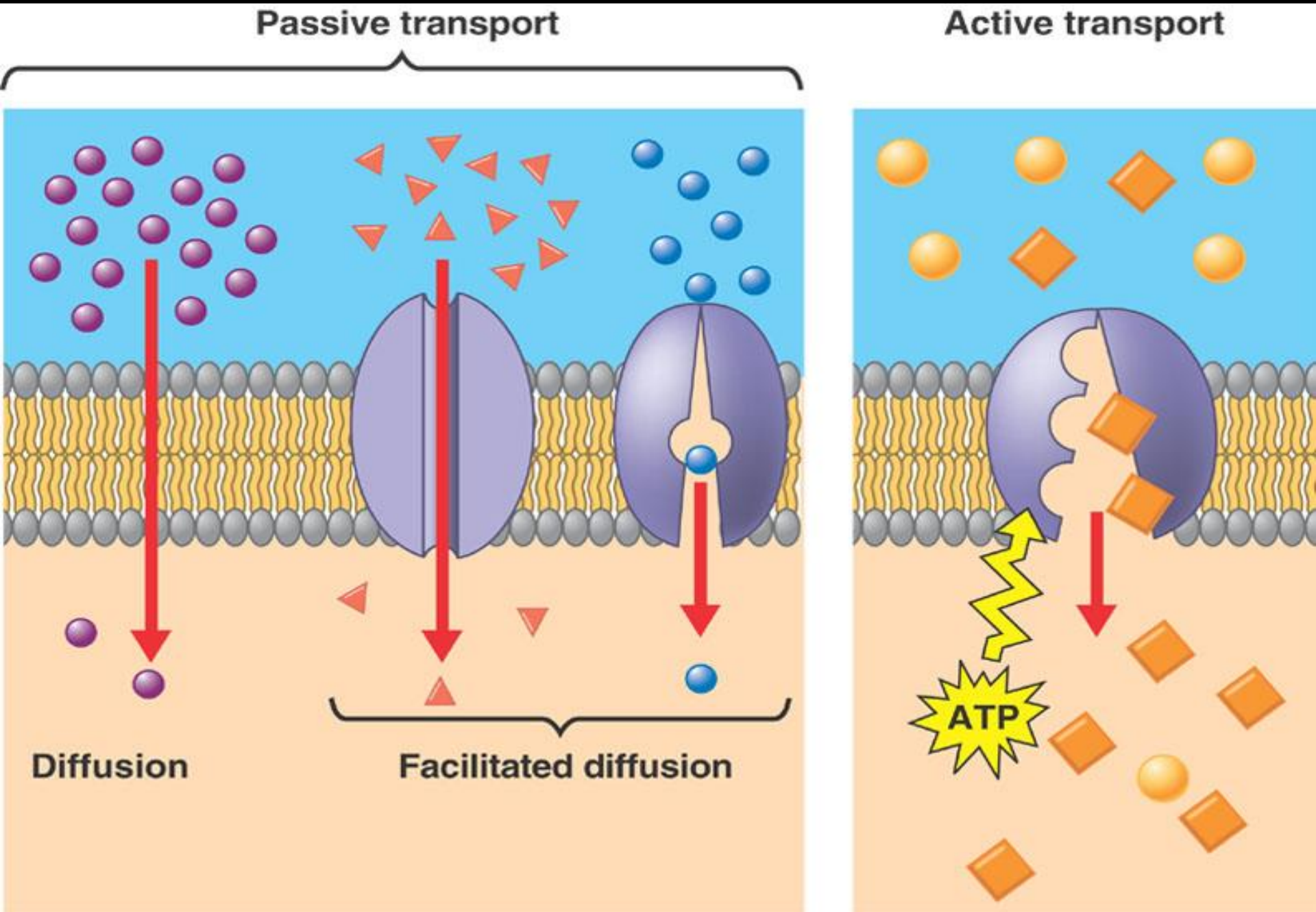
In a hypertonic solution, vacuoles lose water, the cytoplasm shrinks (plasmolysis), and chloroplasts are seen in the center of the cell.

1. **Isotonic: Equal [solute] in solution and cell**
2. **Hypotonic: Less [solute] in solution than cell → water influx**
3. **Hypertonic: More [solute] in solution than cell → H_2O outflux**

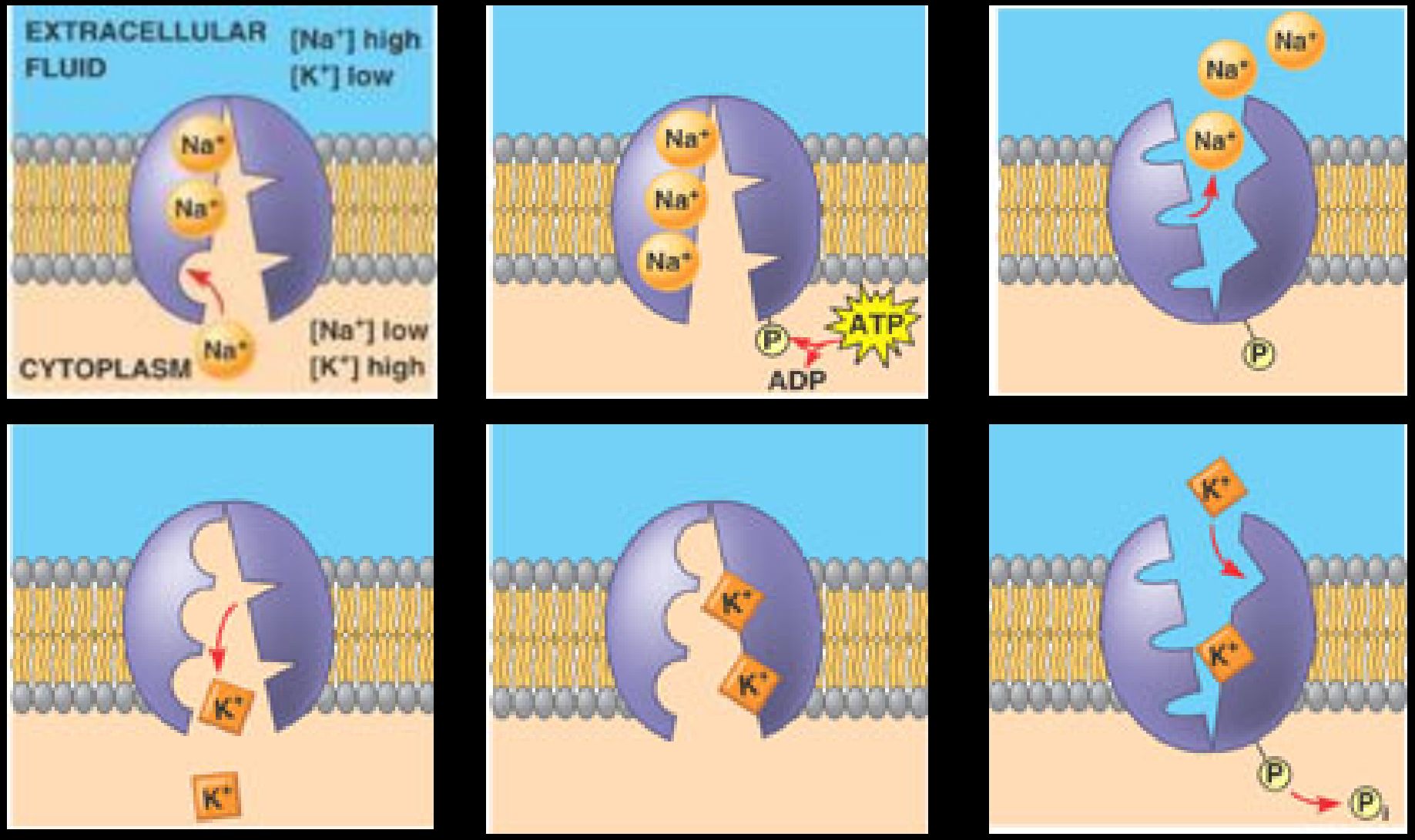
Transport Proteins

- Can be used for **Passive Transport**
  - Also called "facilitated diffusion"
  - Requires no energy
  - Channels and Carriers (some very specific, others not)
  - Can often be "**gated**" – requires a stimulus to open and/or close

- …Or can be used for **Active Transport**
  - This requires energy and BUILDS gradient
  - Energy comes from ATP
  - Very specific, but some pump two things at a time!
  - Know this Example: Na^+/K^+ pump


Passive transport
Active transport
Diffusion
Facilitated diffusion
ATP

Na^+/K^+ Pump, know this figure… also in your textbook p95



An example of Active transport across the membrane: the sodium-potassium pump

Gradients

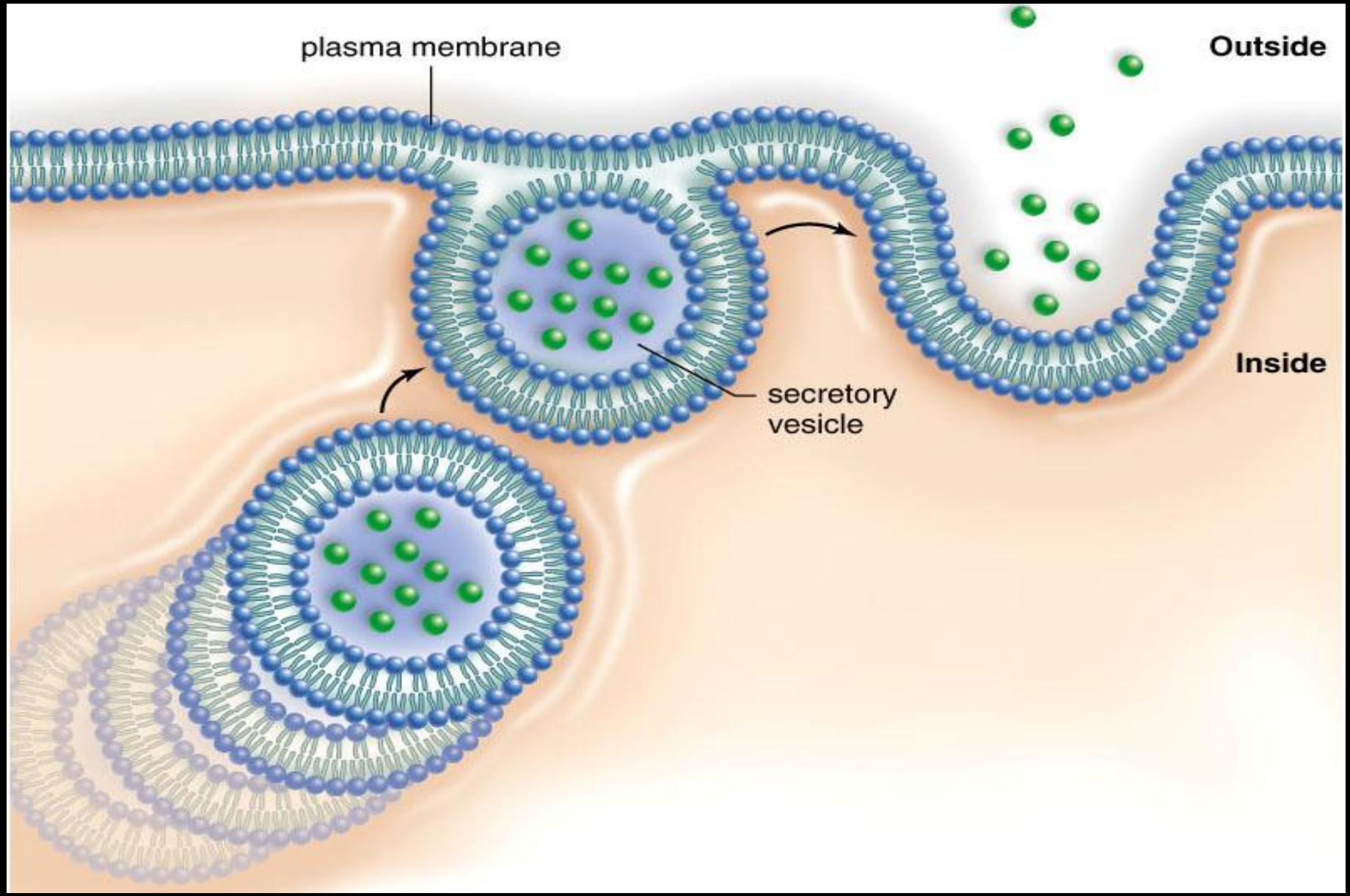
- When pumps create a gradient, it can be used for energy
- When it's a gradient of IONS, it's called an "**electrochemical**" gradient.

- http://www.youtube.com/watch?v=owEgqrq51zY

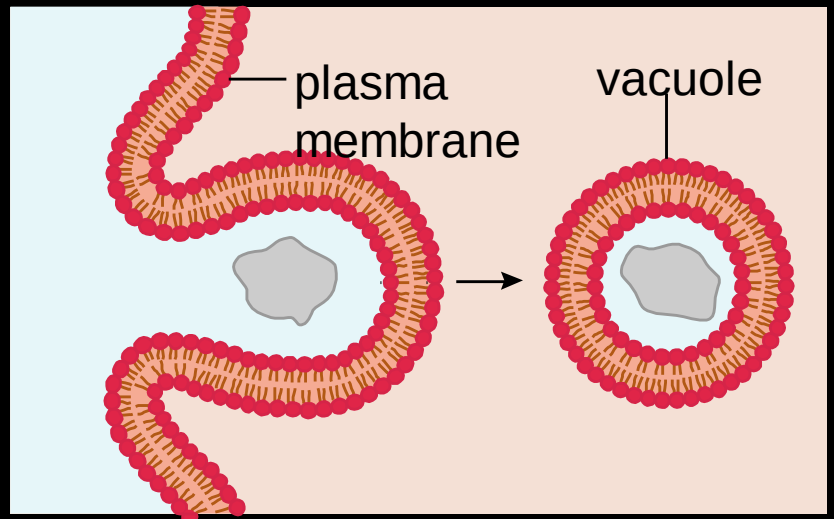
Bulk Transport (large molecules)

- **Exocytosis** – *secretion* of large molecules by vesicle fusion
- **Endocytosis** – formation of vesicles from the P.M. (brings outside matter in)
  - Phagocytosis (cell eating)
    - Brings in LARGE things (bacteria, even other cells!)
    - Forms a vacuole, fuses with lysosome for digestion
  - Pinocytosis (cell drinking)
    - Brings in small droplets
  - Receptor-mediated Endocytosis
    - Brings in large amounts of a SPECIFIC THING

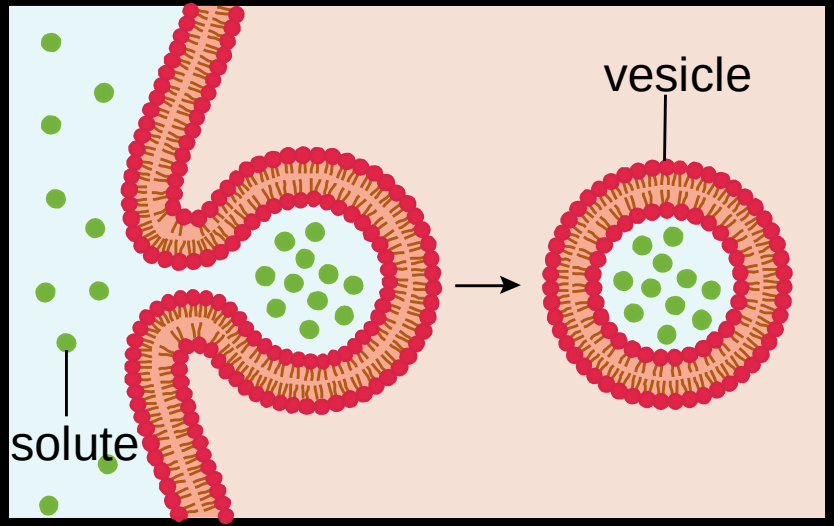
Bulk Transport: **Exocytosis**



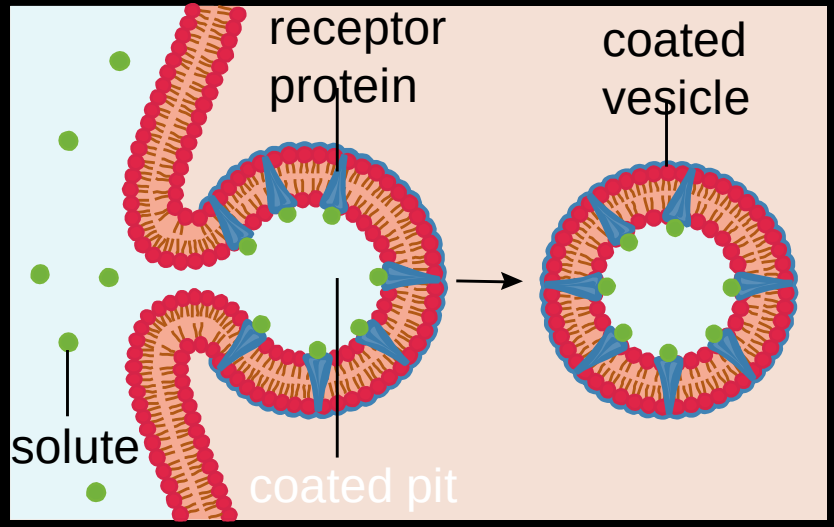
Bulk transport: **Three methods of endocytosis**



a. Phagocytosis – larger molecules



b. Pinocytosis – smaller molecules

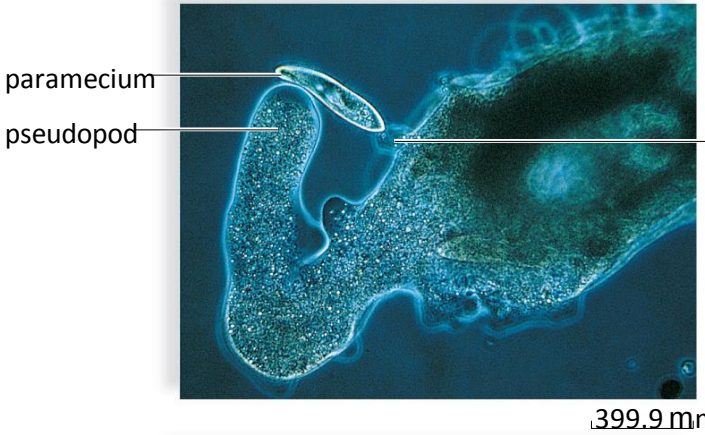


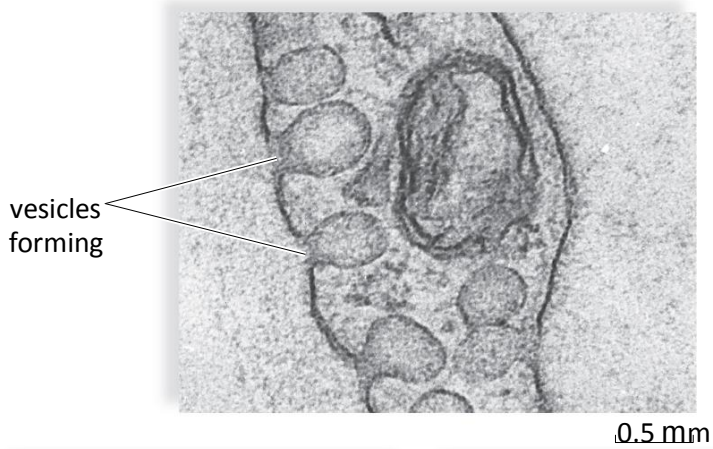
c. Receptor mediated endocytosis – special proteins recognize molecules

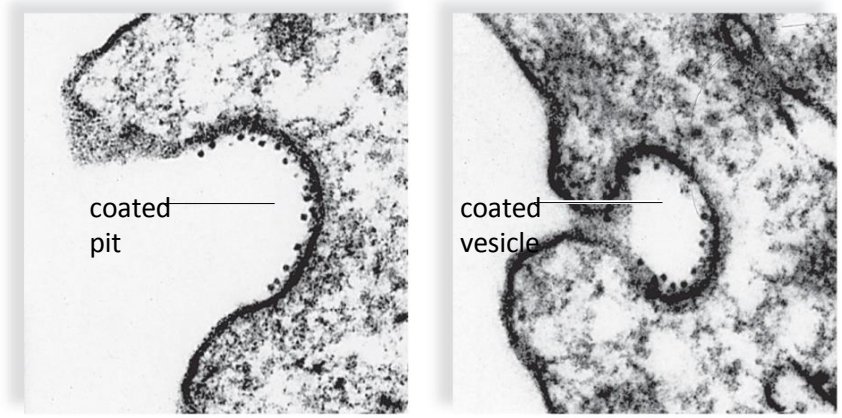
Phagocytosis – larger molecules

Bulk Transport: **Endocytosis**

Receptor mediated endocytosis







Cell-Surface Modifications: **Junctions**

Adhesion Junctions (Cardiac muscle)

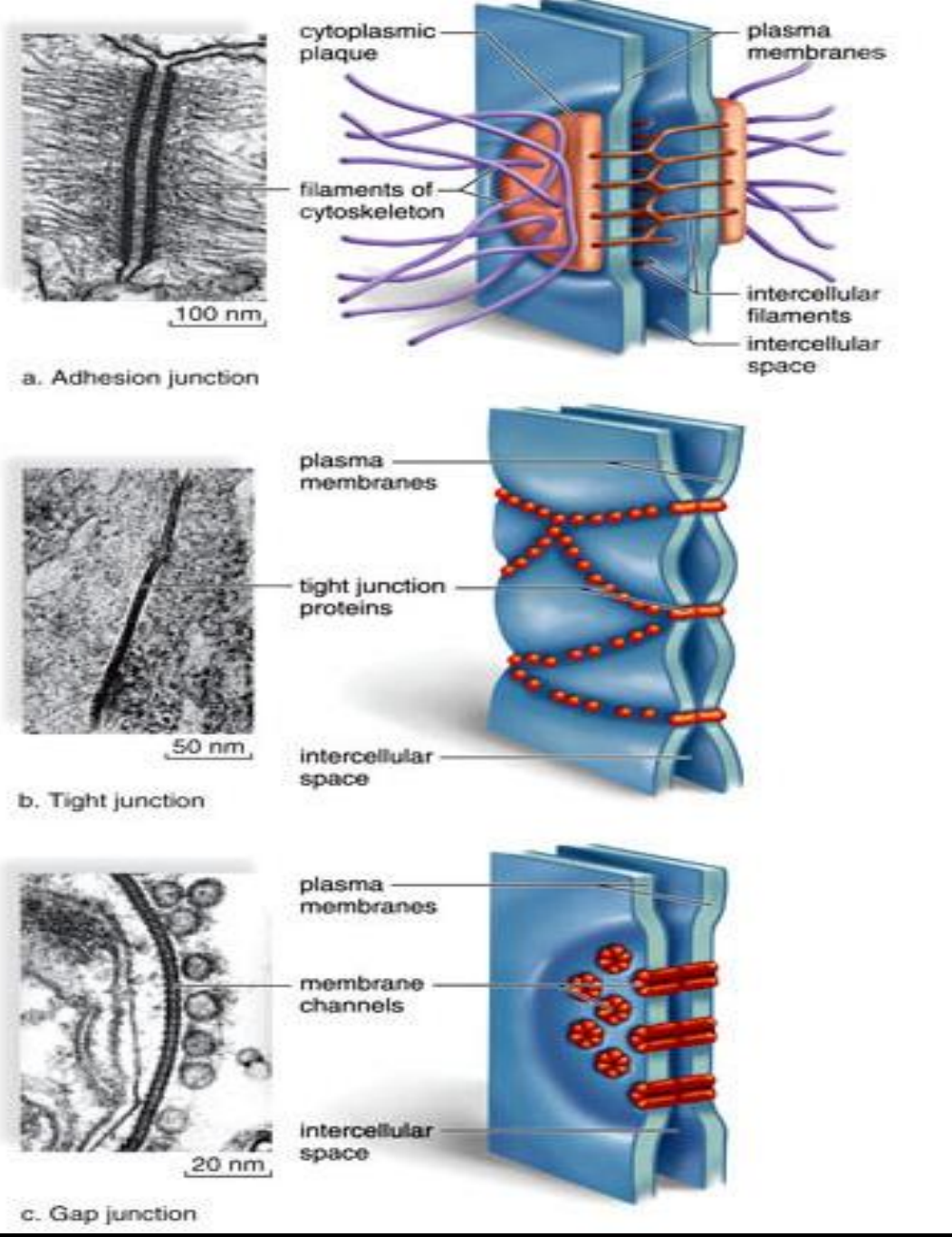
- Intercellular filaments between cells
- VERY STRONG attachment between cells (intermediate filaments, keratins)

Tight Junctions (Lung Tissue)

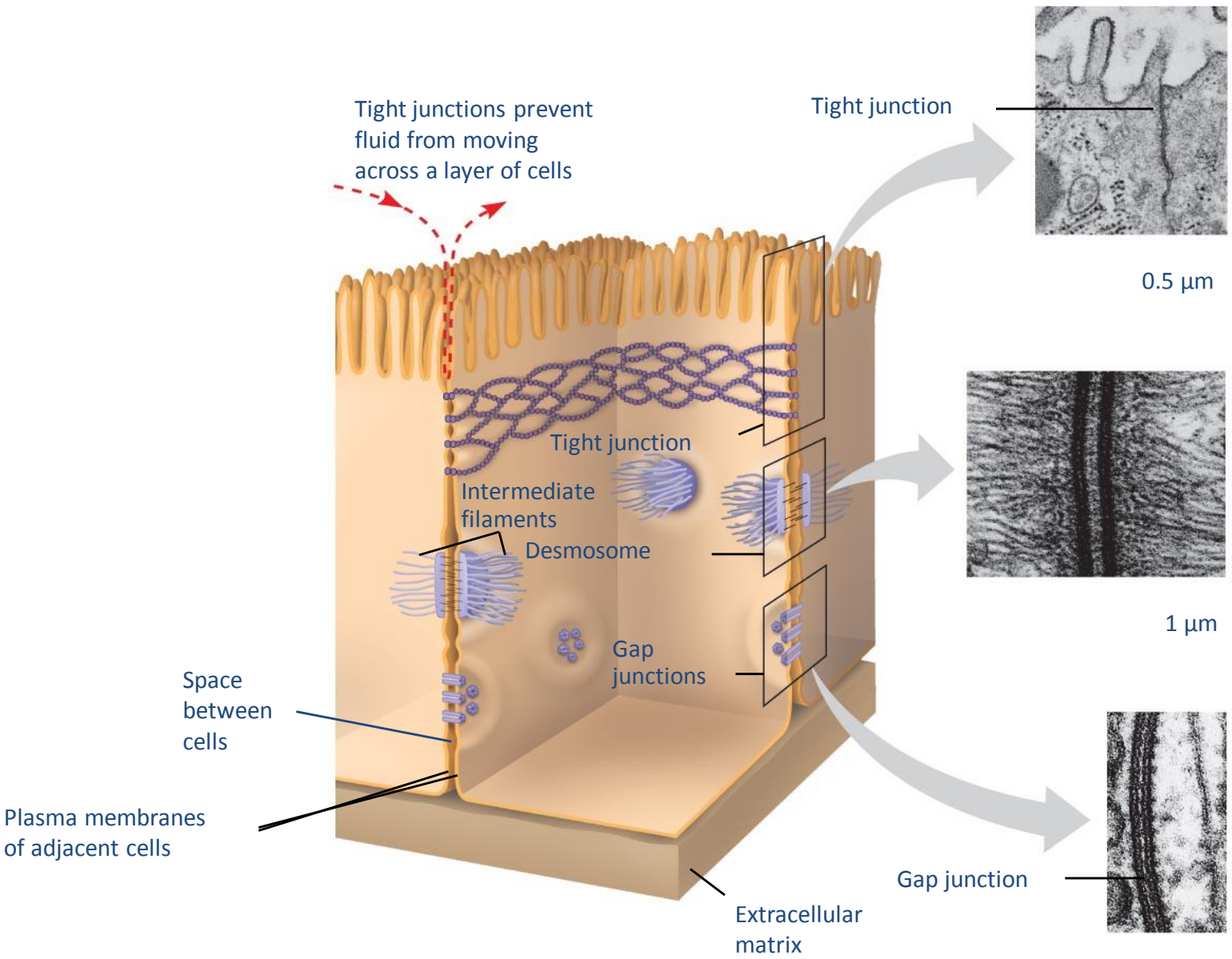
- Form impermeable barriers: the PM of neighboring cells form a "seal" to separate two compartments

Gap Junctions (Nerve Cells)

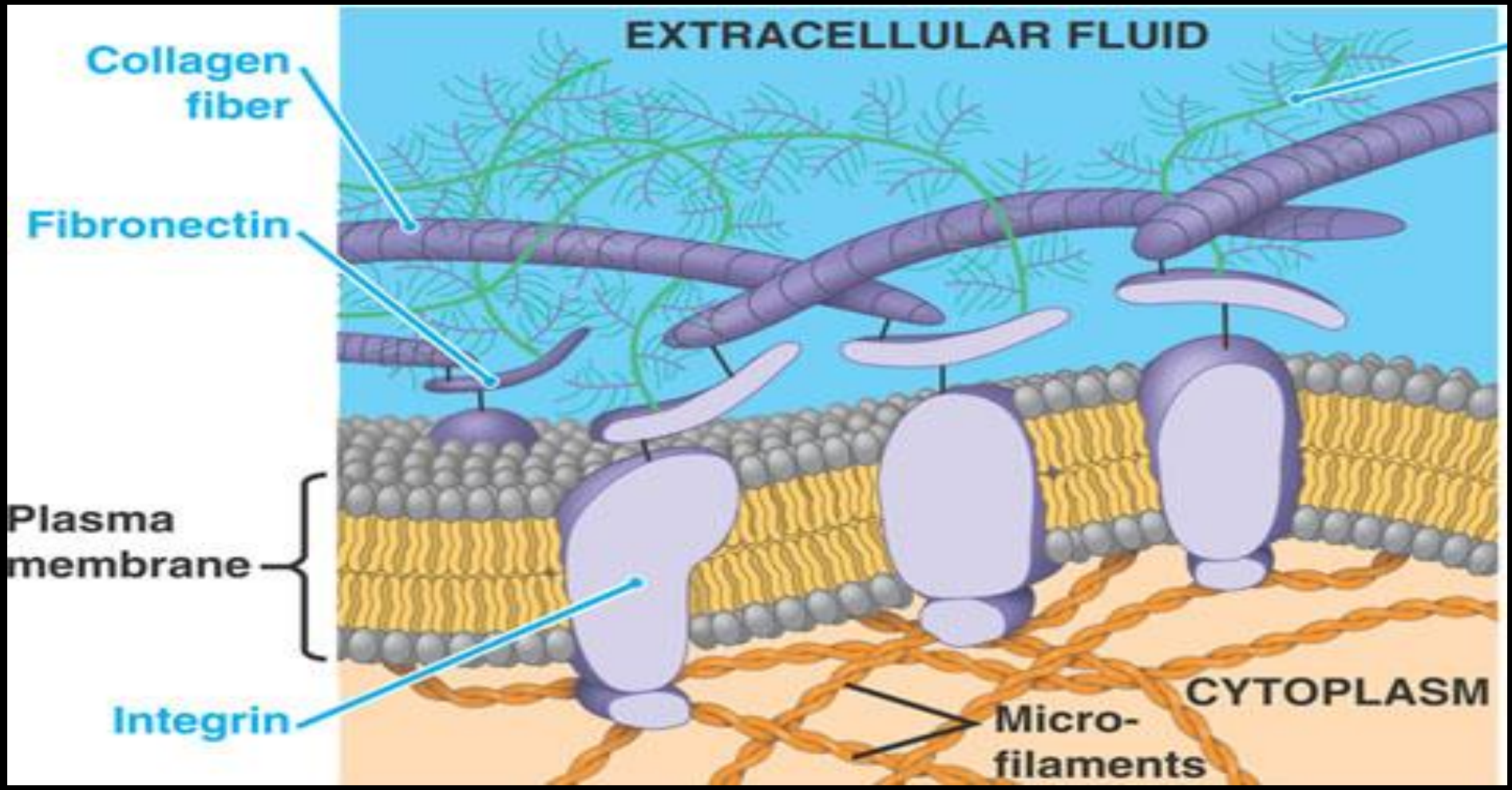
- Plasma membrane channels are joined (allows communication)
- channels that allow cells to share cytoplasm



Cell Attachments



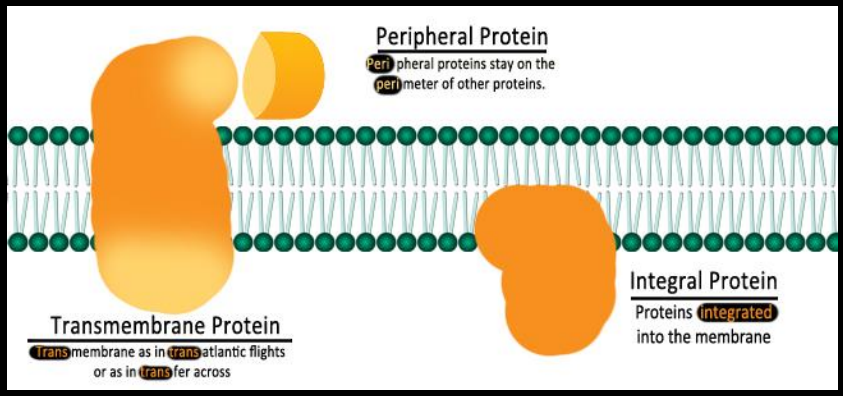
Cell Surface Modifications:
ECM



Recap: Meeting 12

A. Plasma Membrane

1) Common to all cells
2) Made of phospholipid bilayer
   1)– hydrophobic/hydrophilic -- amphipathic
3) Also has cholesterol/lipids and protein
4) Fluid Mosaic model

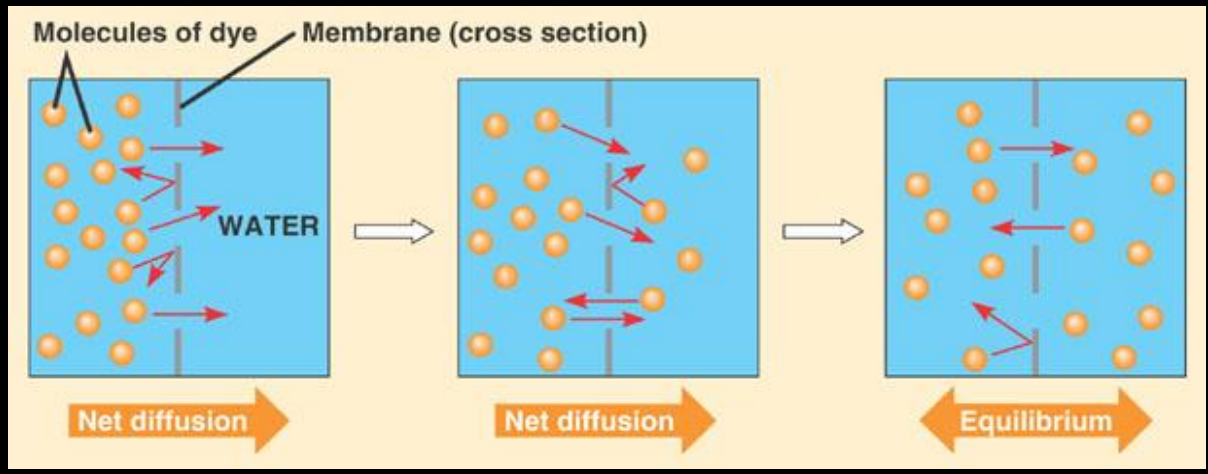


B. Proteins around cell membrane

Integral sometimes transmembrane
Peripheral
function of proteins in membrane?

C. Movement:

Diffusion
Osmosis
Passive Transport
Active Transport
Concentration Gradient



Review Questions

- What are Aquaporins?
- Which organelle has a lumen with low pH?
- What organelle performs cellular respiration?
- Circle the organelles that WOULD be found in a prokaryote:
  - Nucleus, Golgi, ribosome, Chloroplast, Plasma membrane
- What organelles performs detox. of drugs/poisons?
- Circle the organelles that are part of the Endomembrane system:
  - Lysosome, chloroplast, Golgi apparatus, vacuole, Endoplasmic Reticulum, Mitochondria
- What organelles synthesize proteins?
- What are the building block proteins of:
  - Microtubules, actin filaments, intermediate filaments
- Where is most collagen found:
  - ER, ECM, nucleus, mitochondria, lysosome, chloroplast, Golgi

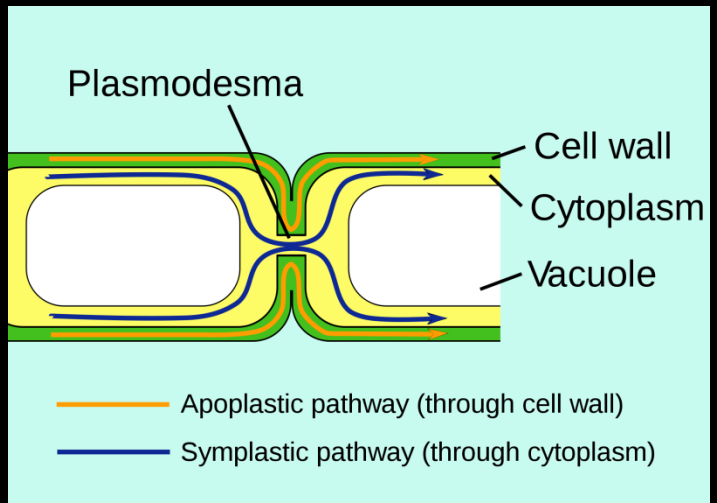
Review Questions

- What macromolecule are the main component of membranes?
- What does “lipid bilayer” mean?
- What kinds of molecules can directly pass through a lipid bilayer?
- What kinds of molecules CANNOT pass directly through a lipid bilayer?
- So, how do ions and water get in and out of the cell?
- Is diffusion passive or active transport?
- When a molecules flows from HIGH concentration to LOW concentration is this passive or active?
- If a cell is in HYPERTONIC solution, what does that mean?
- What is a concentration gradient?
- What does the Na+/K+ pump do?
- What is it called when a cell brings in a small droplet of extracellular fluid and digests it?

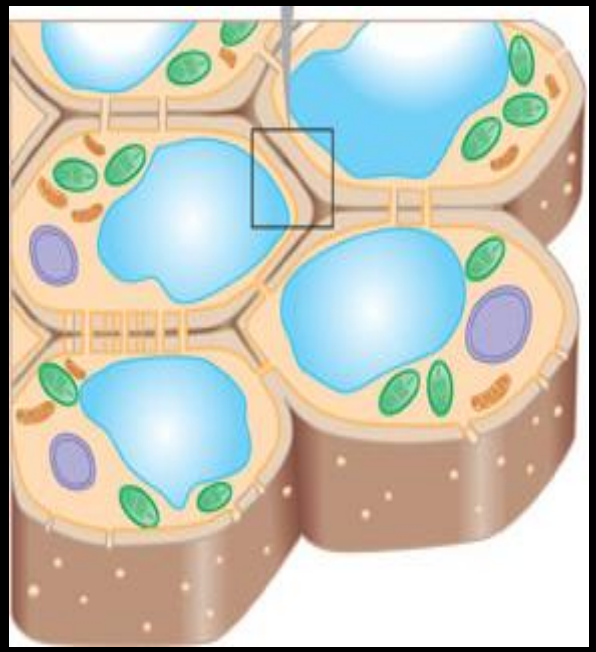
Cell Surface Modifications: **Cell Walls**

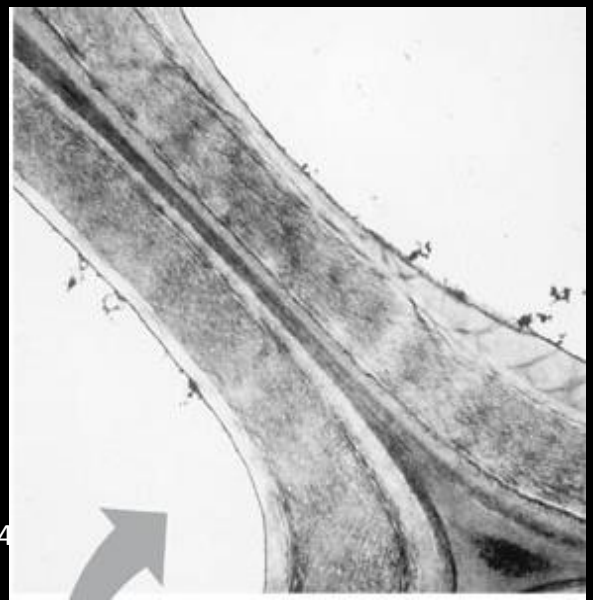
Cell Surfaces in **Plants**

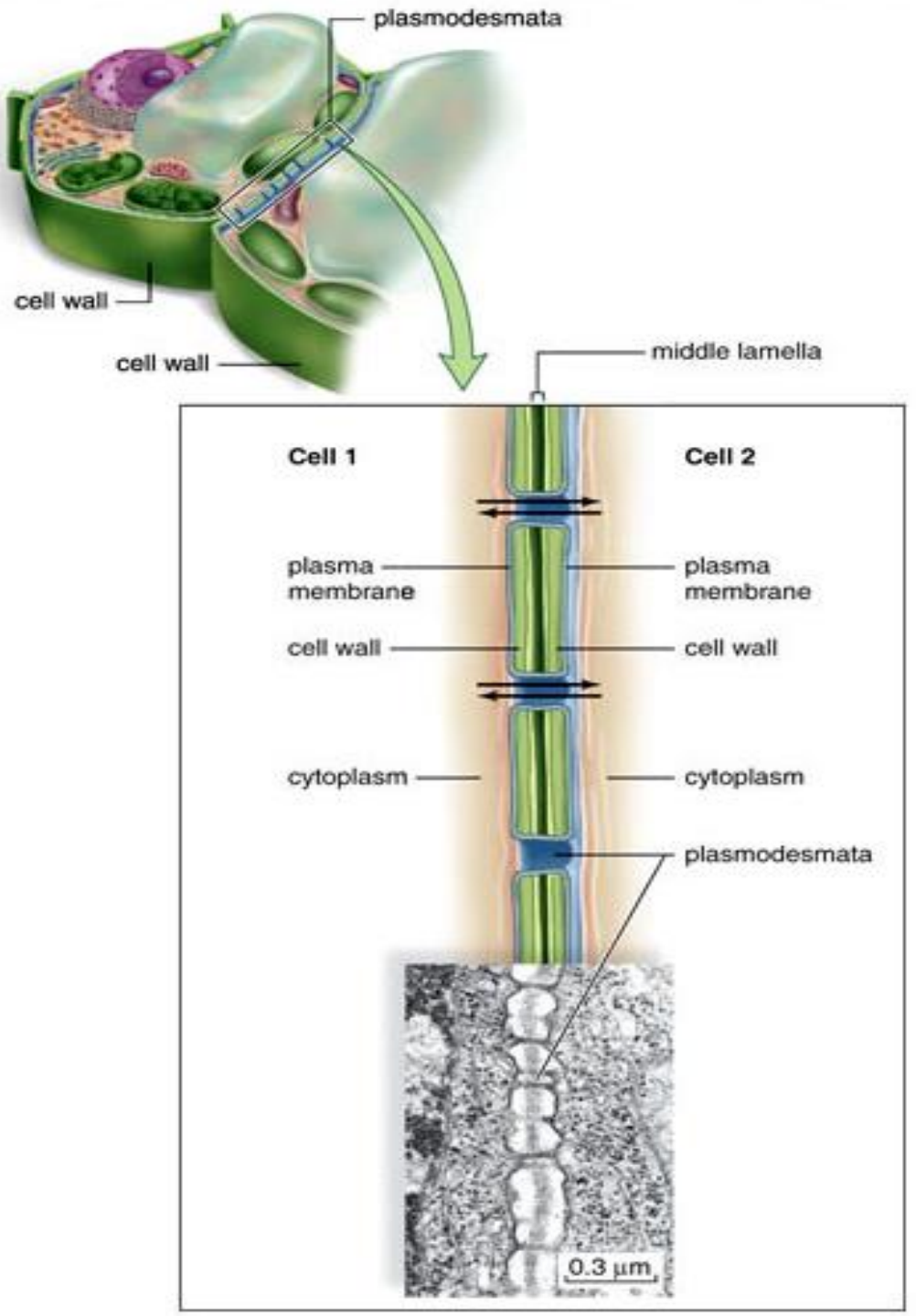
- Plant Cell Walls
  - Plants have freely permeable cell wall, with cellulose as the main component
    - **Plasmodesmata** penetrate cell wall
    - Each contains a strand of cytoplasm
    - Allow passage of material between cells



Cell Walls






plasmodesmata
cell wall
cell wall
middle lamella
Cell 1
Cell 2
plasma membrane
plasma membrane
cell wall
cell wall
cytoplasm
cytoplasm
plasmodesmata
0.3 µm

Cell Surface Modifications: **ECM**

Cell Surfaces in **Animals**

- Extracellular Matrix
  - Animal cells do not have cell wall, but they make extensive **extracellular matrix** (ECM)
  - External meshwork of polysaccharides and proteins
    - **Collagen** (~50% of total protein in the human body!)
    - A protein called **fibronectin** attaches to cells to hold them in the ECM
    - **Fibronectin** attaches to "**Integrins**" (proteins embedded in PM) on the cell surface.
  - Found in close association with the cell that produced them