Cell Membranes

Marjorie D. Shaw, Ph.D.

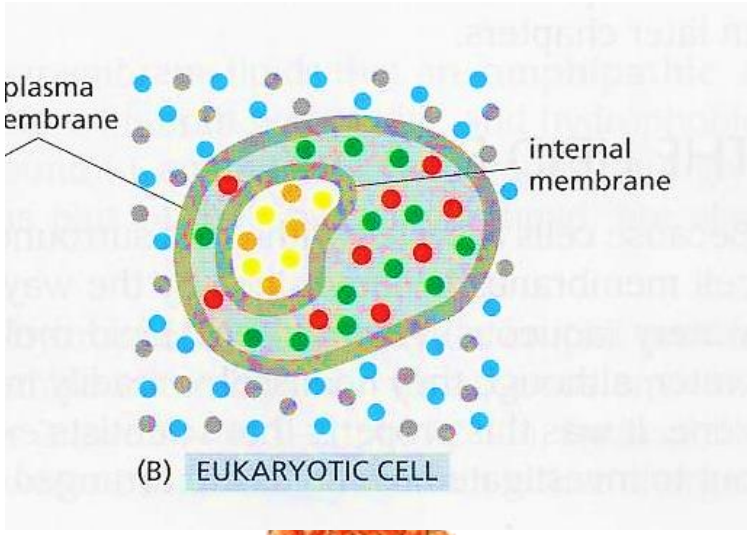
OLLI Fall 2023

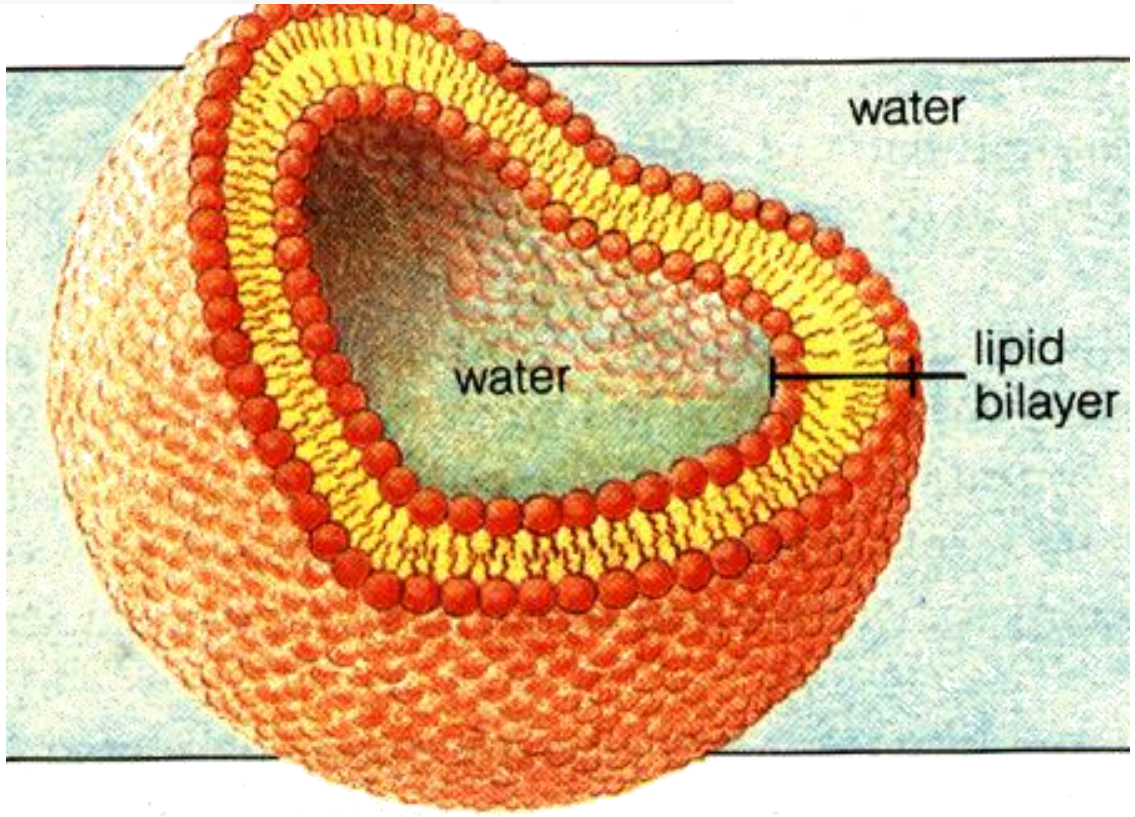
Study Group : 426

Cell Membrane

Defining barrier, separating inside and outside environments of all cells (ie concentrations, voltages). But can't be totally sealed; need to get nutrients in , waste out, receive and transmit signals.

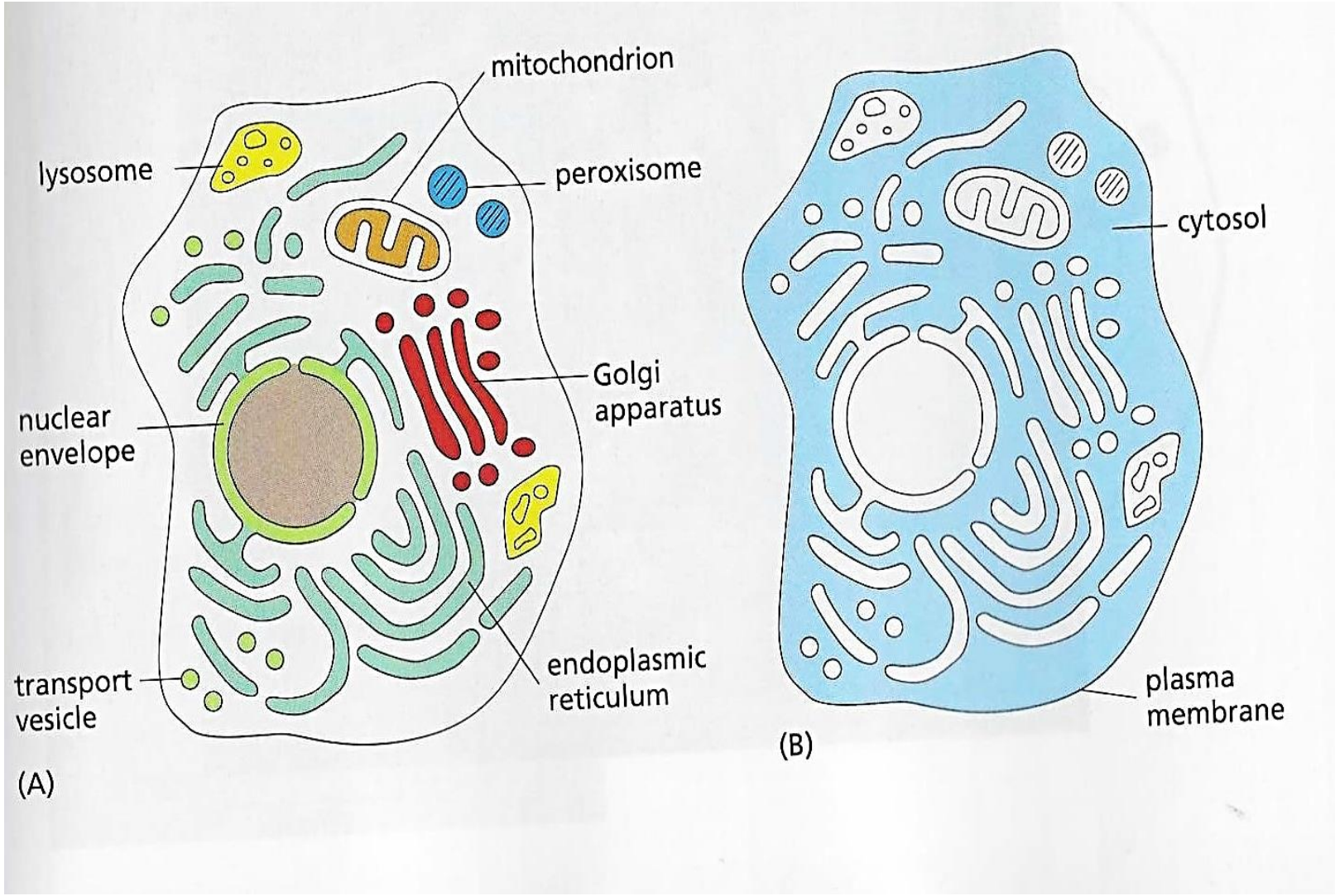
Semi-permeable



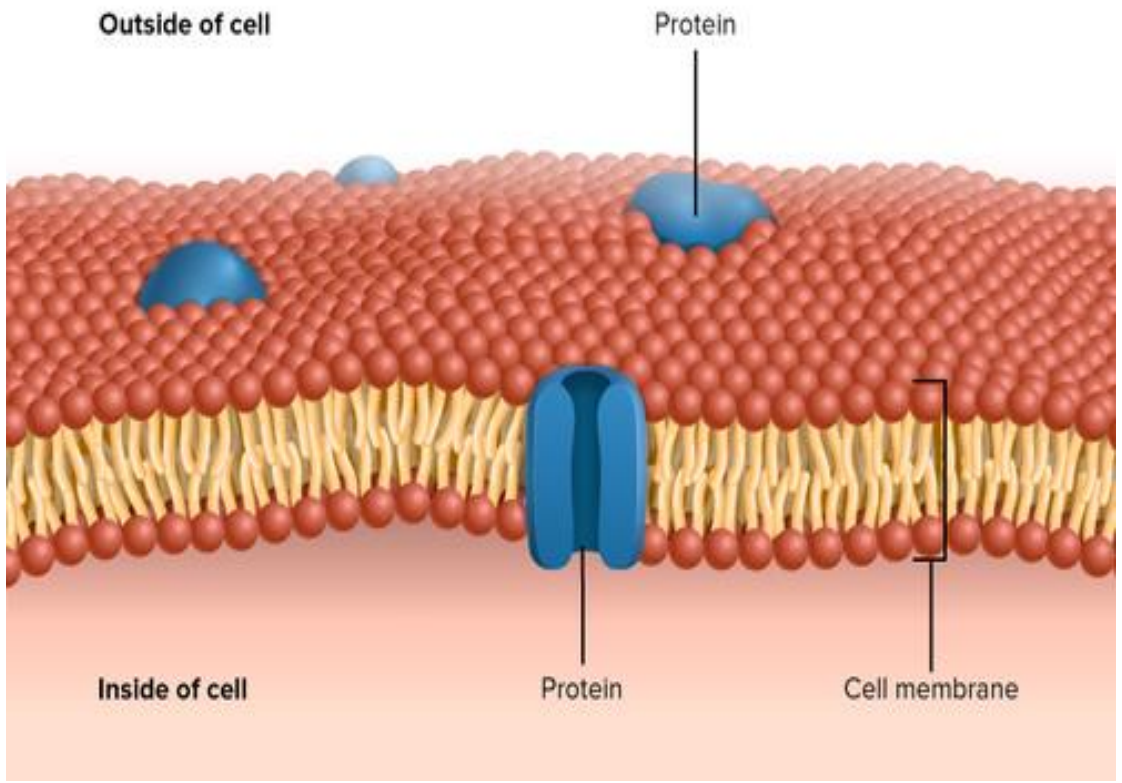


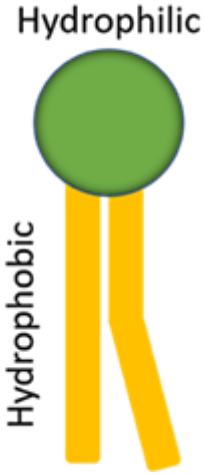
Membrane-enclosed Organelles

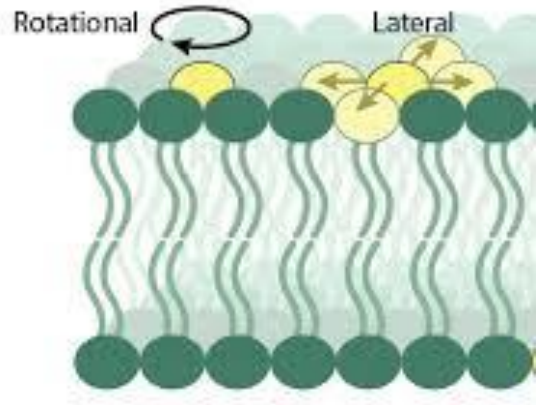
Eucaryotic cells also contain membrane-enclosed organelles: nucleus, ER, mitochondria, Golgi, vesicles. These segregate neighborhoods where chemical processes can proceed more efficiently because all the molecules involved are concentrated and arranged in the organelle.



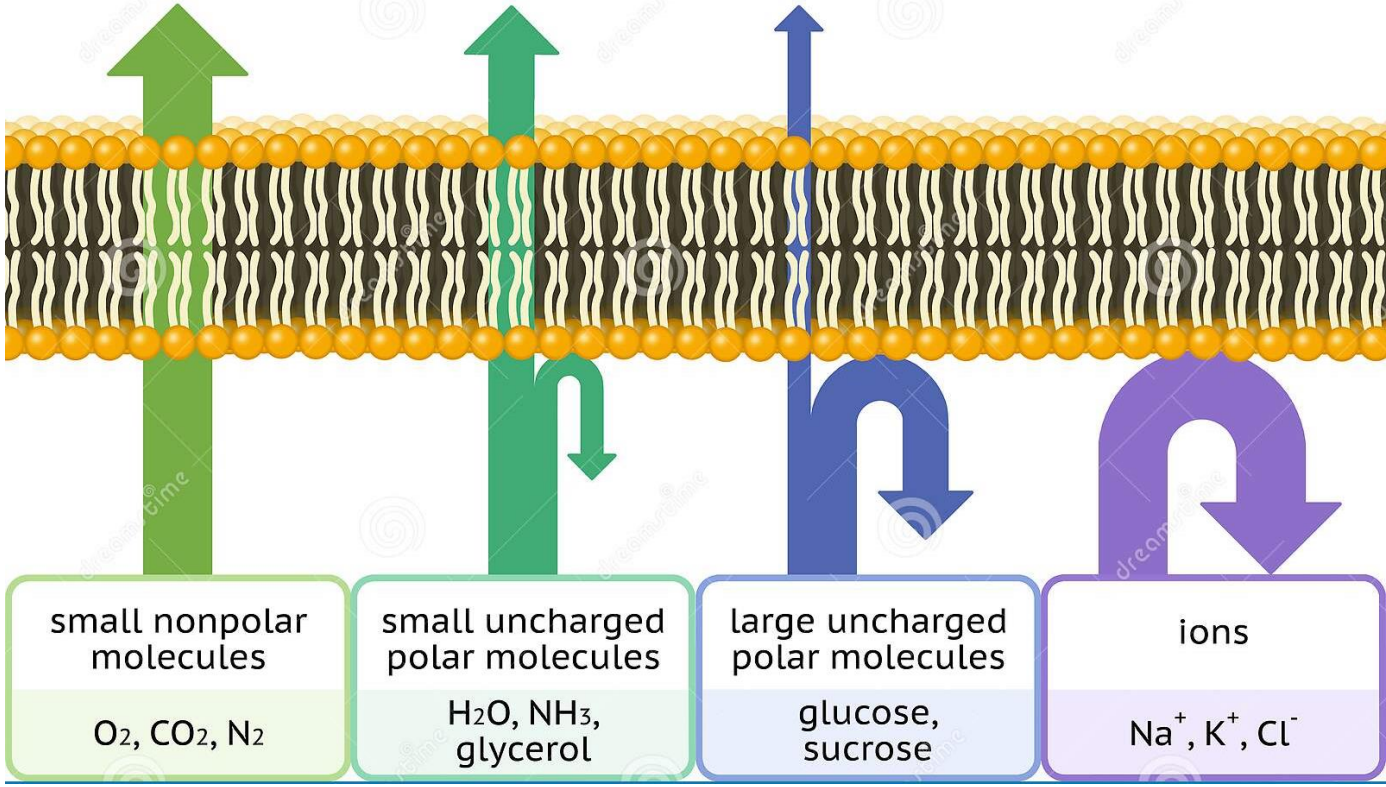
Phospholipid bilayer: semi-permeable







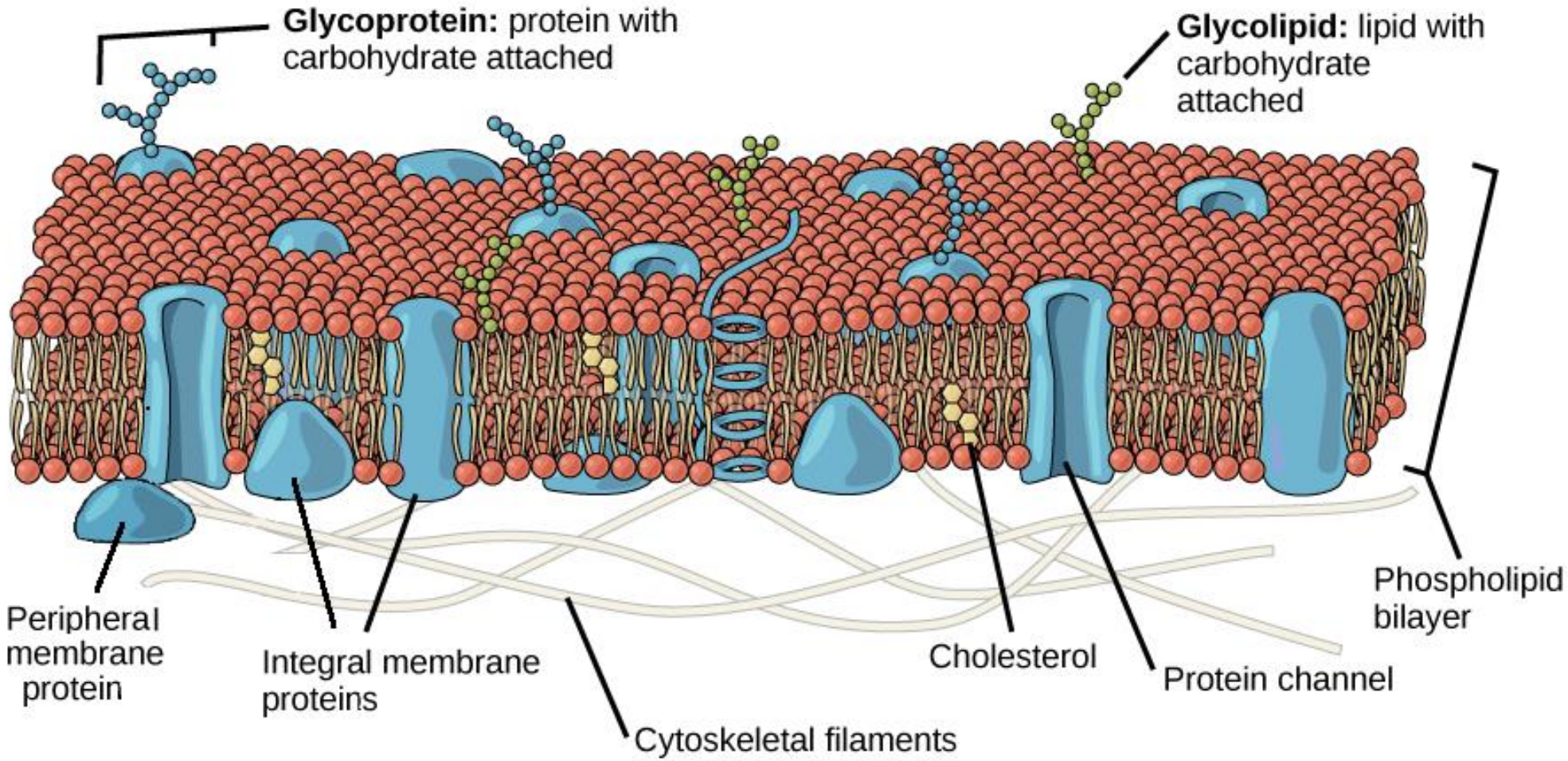
SELECTIVE PERMEABILITY OF LIPID BILAYER



Oil and water don't mix!

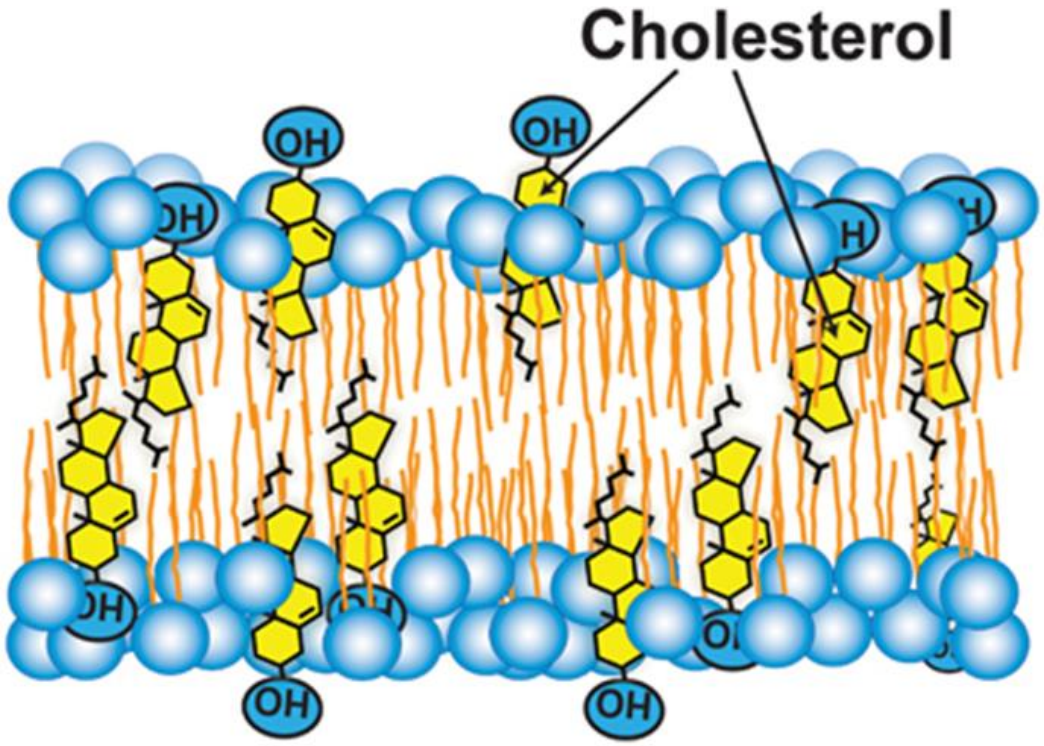
Fluid Mosaic

Some proteins float freely like icebergs in a lipid sea; others are tethered together like rafts or confined to specific surfaces . Can change shape, grow, move, self-seal.

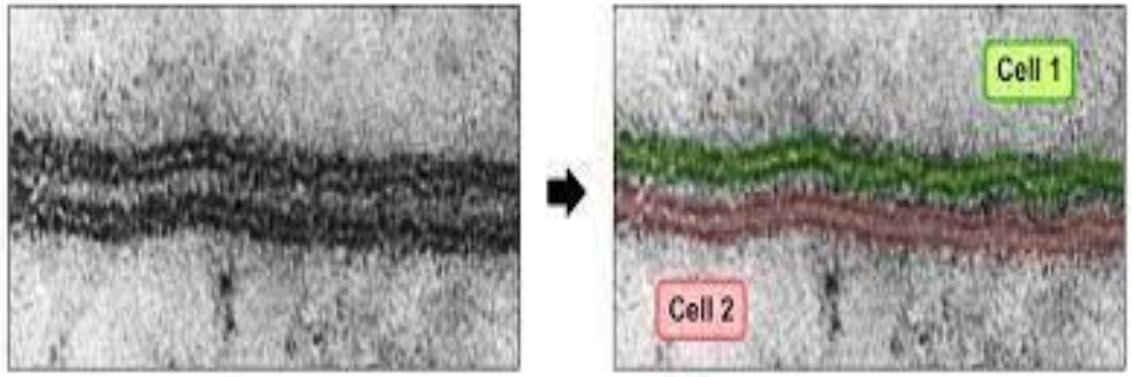


Cholesterol

Cholesterol molecules are 20% of the membrane and increase the ***stability and rigidity***. Also have polar head and non-polar tails.

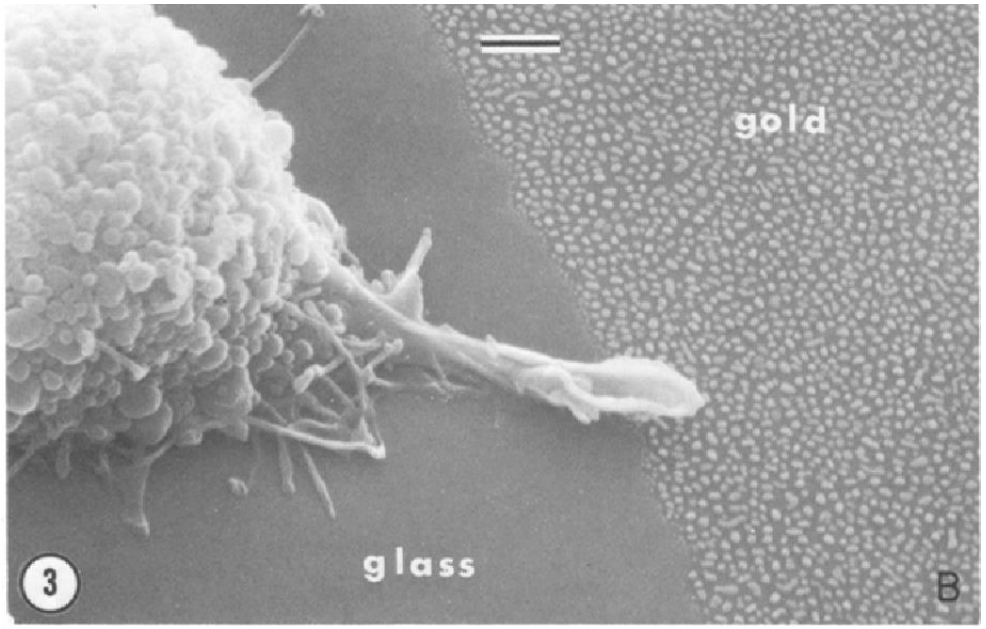


Flexible bilayer

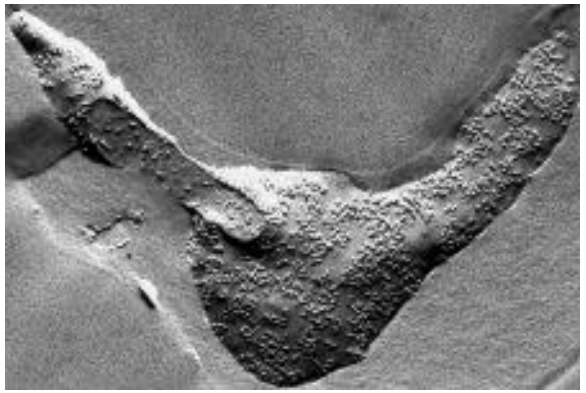


Membrane of two adjoining cells

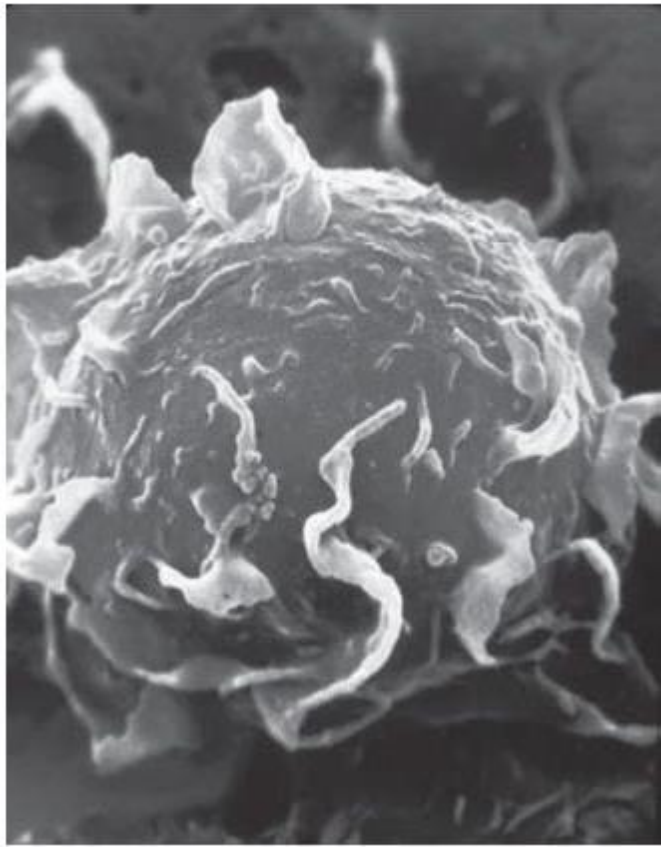
'Trilaminar' appearance highlighted



Exploring filopodia

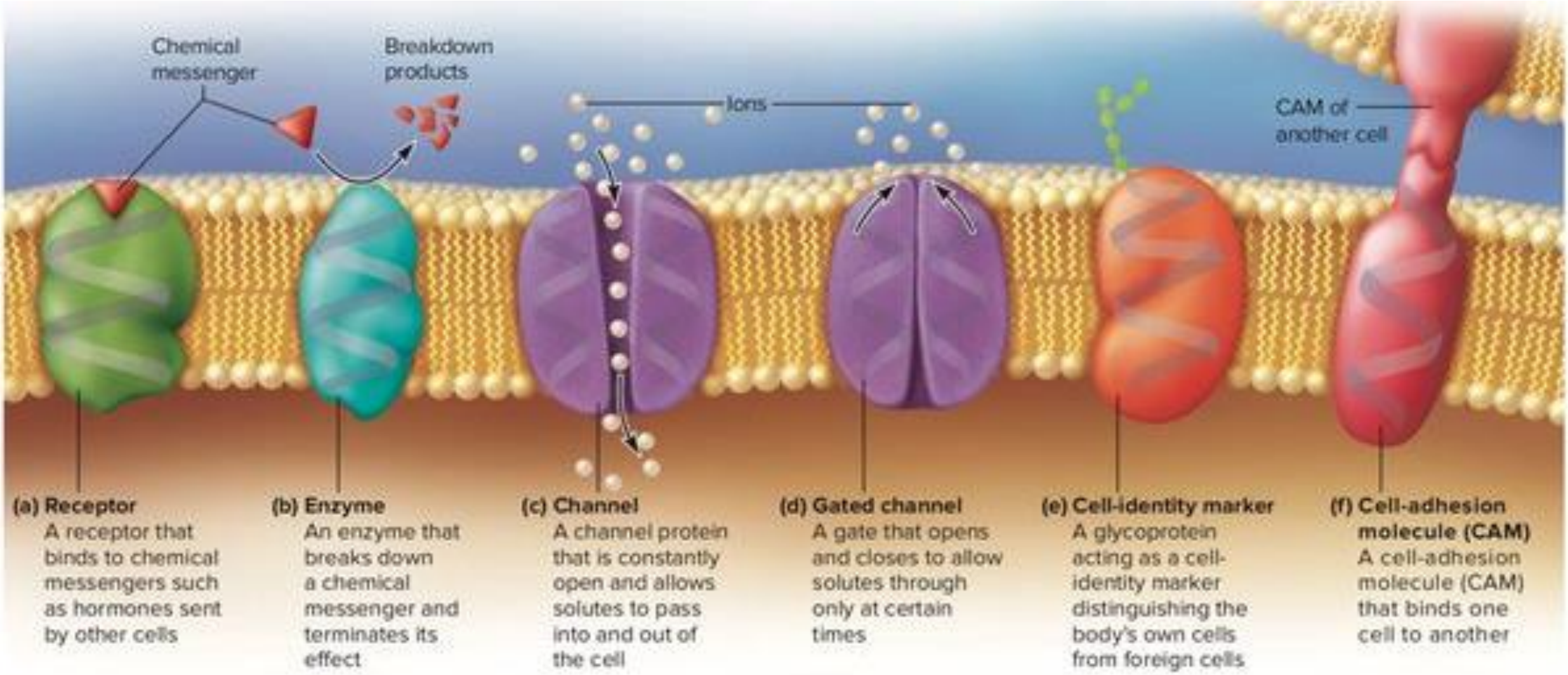


Proteins embedded in RBC



macrophage

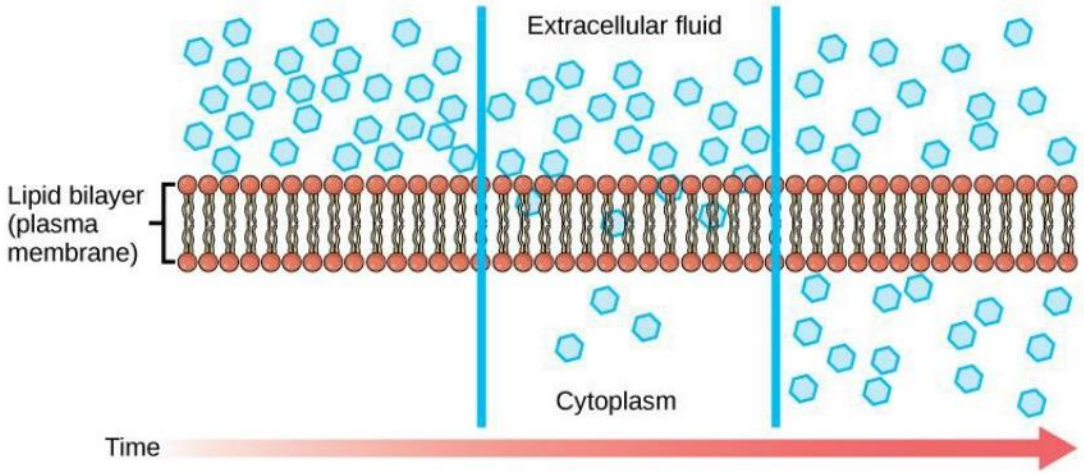
Functions of membrane proteins (50% mass)



Gradients

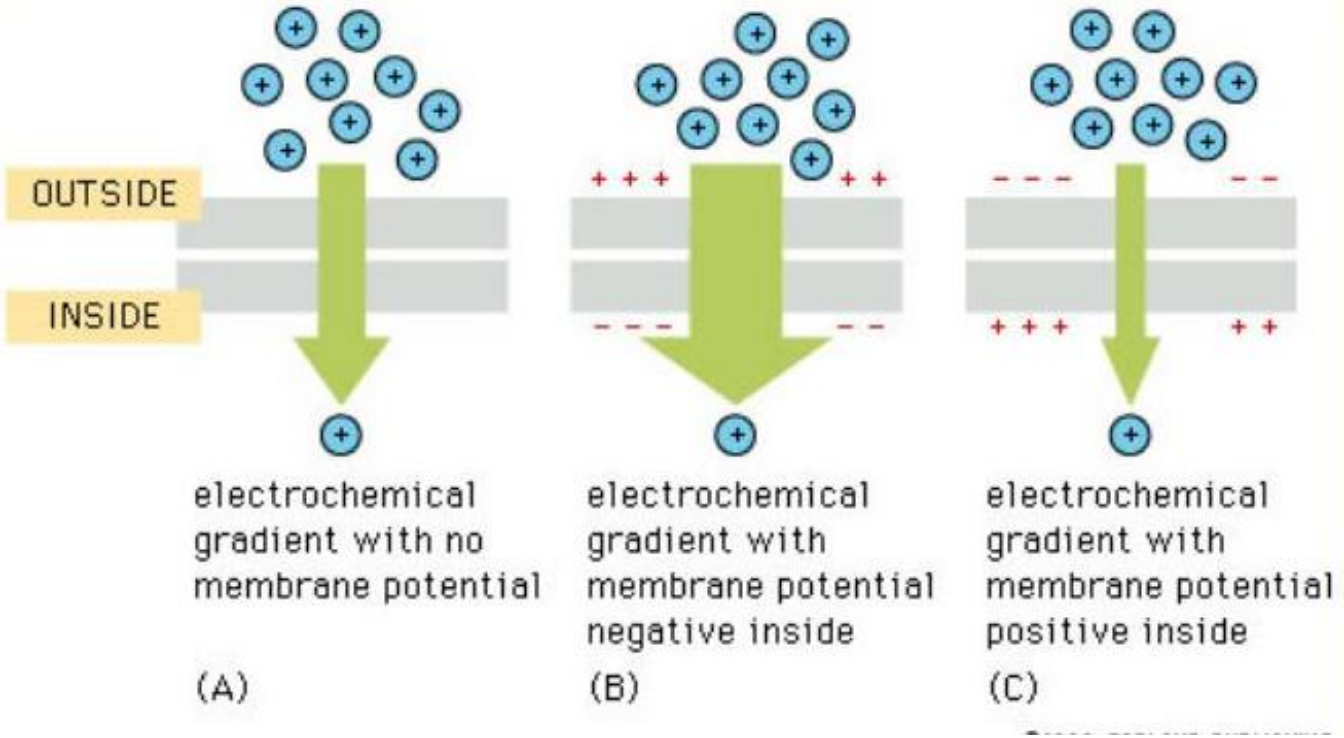
Concentration Gradient

- The difference between the concentration of solutes in solutions.
- **Natural flow** is from **high** to **low**.
  (**with** the concentration gradient)



Electrochemical Gradient

Can counter chemical gradient



Electrical Gradients

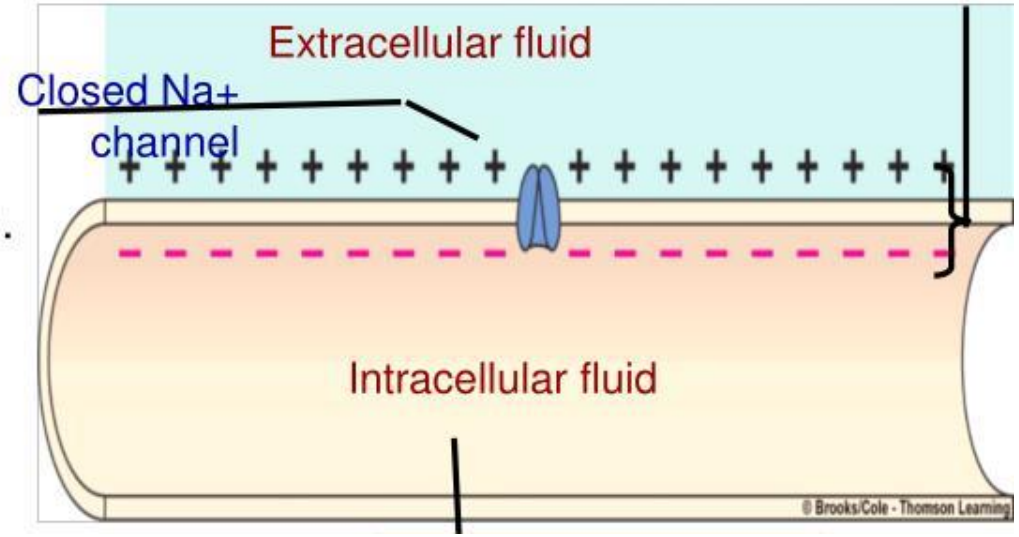
Concentrations of charged ions next to the membrane produce voltage differences across the membrane = **membrane potential**.

Resting membrane potential (RMP)

It is the difference in electrical potential between the inside &the outside membrane surface under resting conditions.

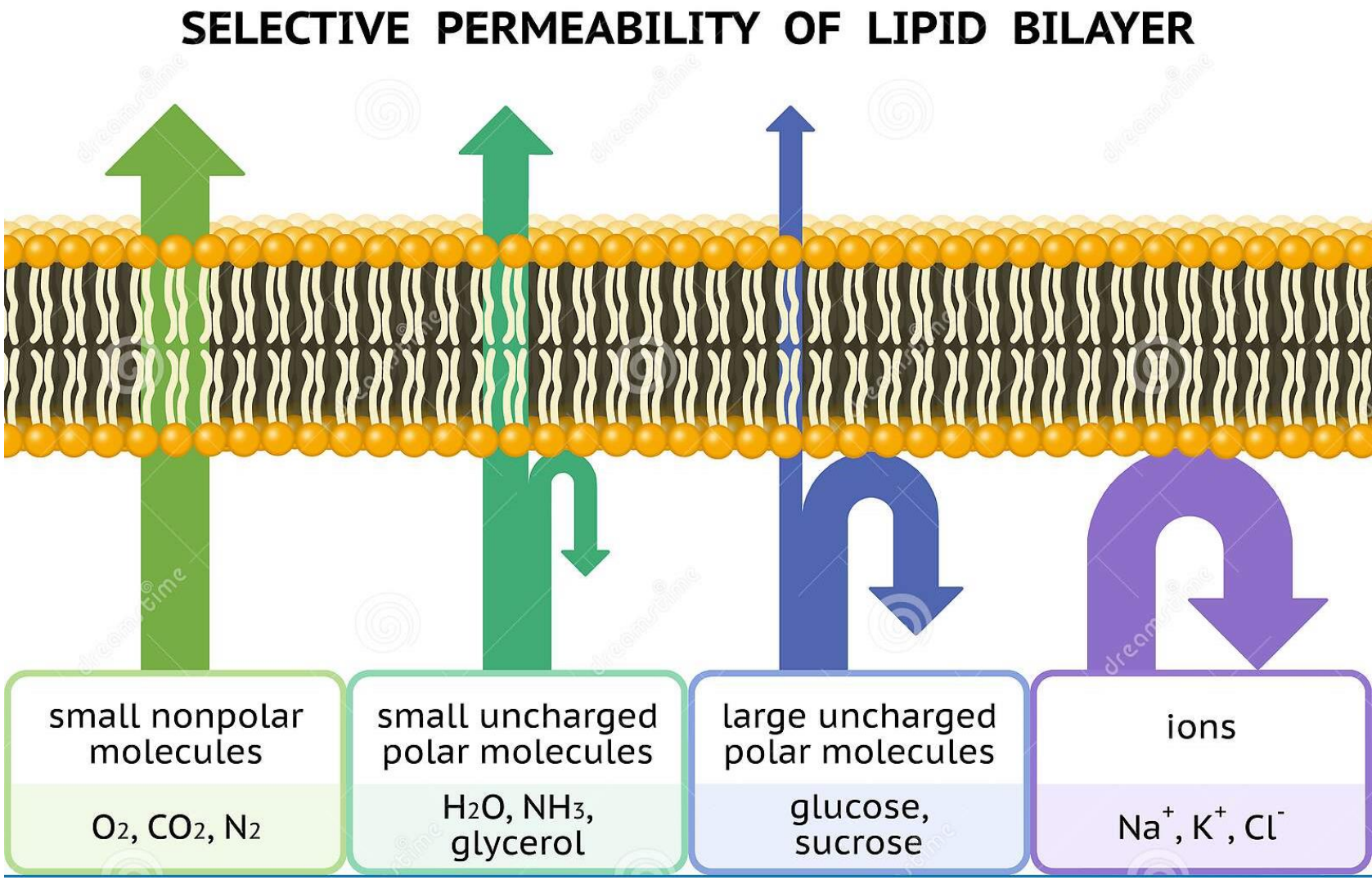
The inside is negative relative to the outside of the membrane (polarized state).

Unbalanced charges distributed across the plasma membrane that are responsible for membrane potential



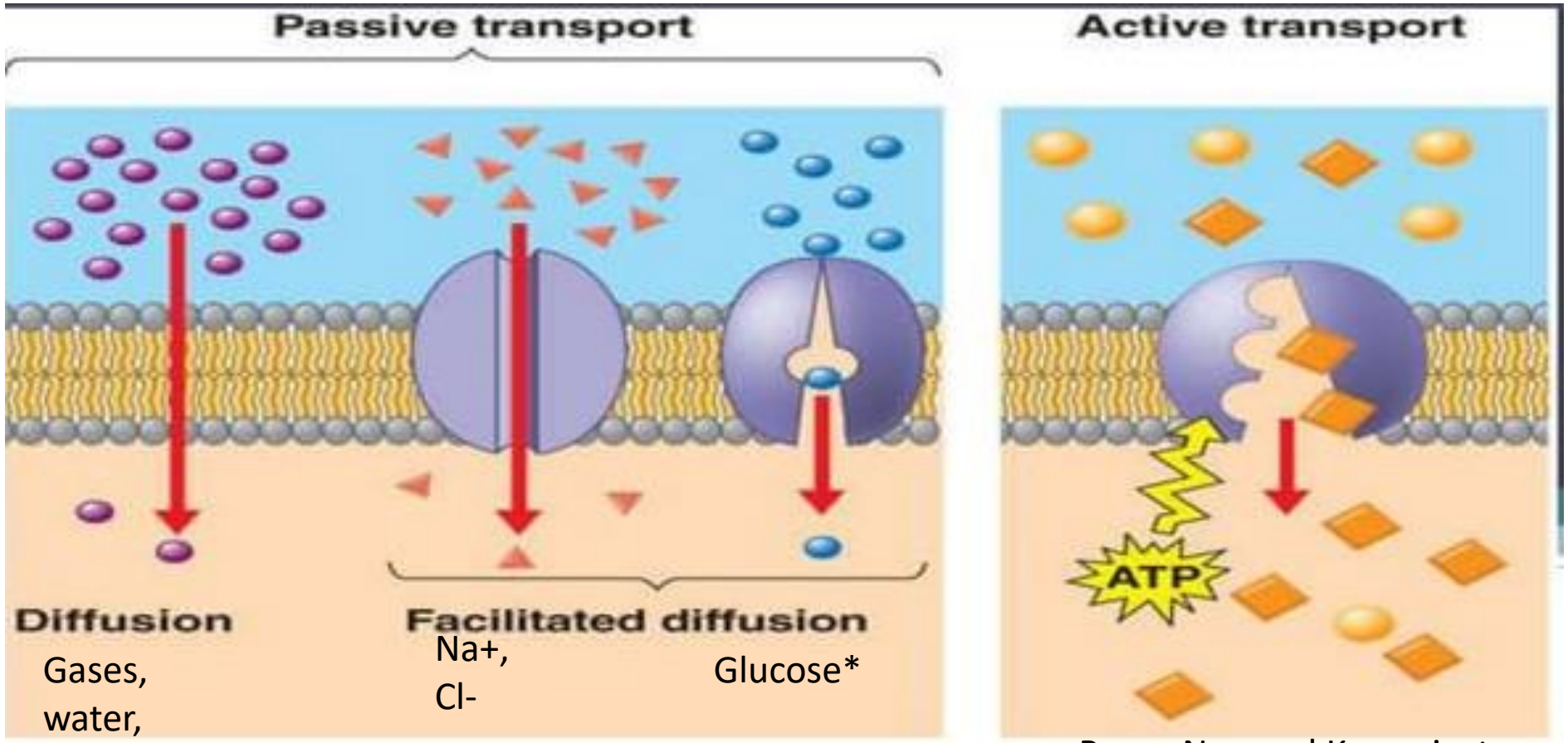
Membrane Permeability

Without protein transporters, many important molecules cannot cross a lipid bilayer.



Transporter proteins and channels

Private passageways for select substances.



Gases, water, urea

Na+, Cl-

Glucose*

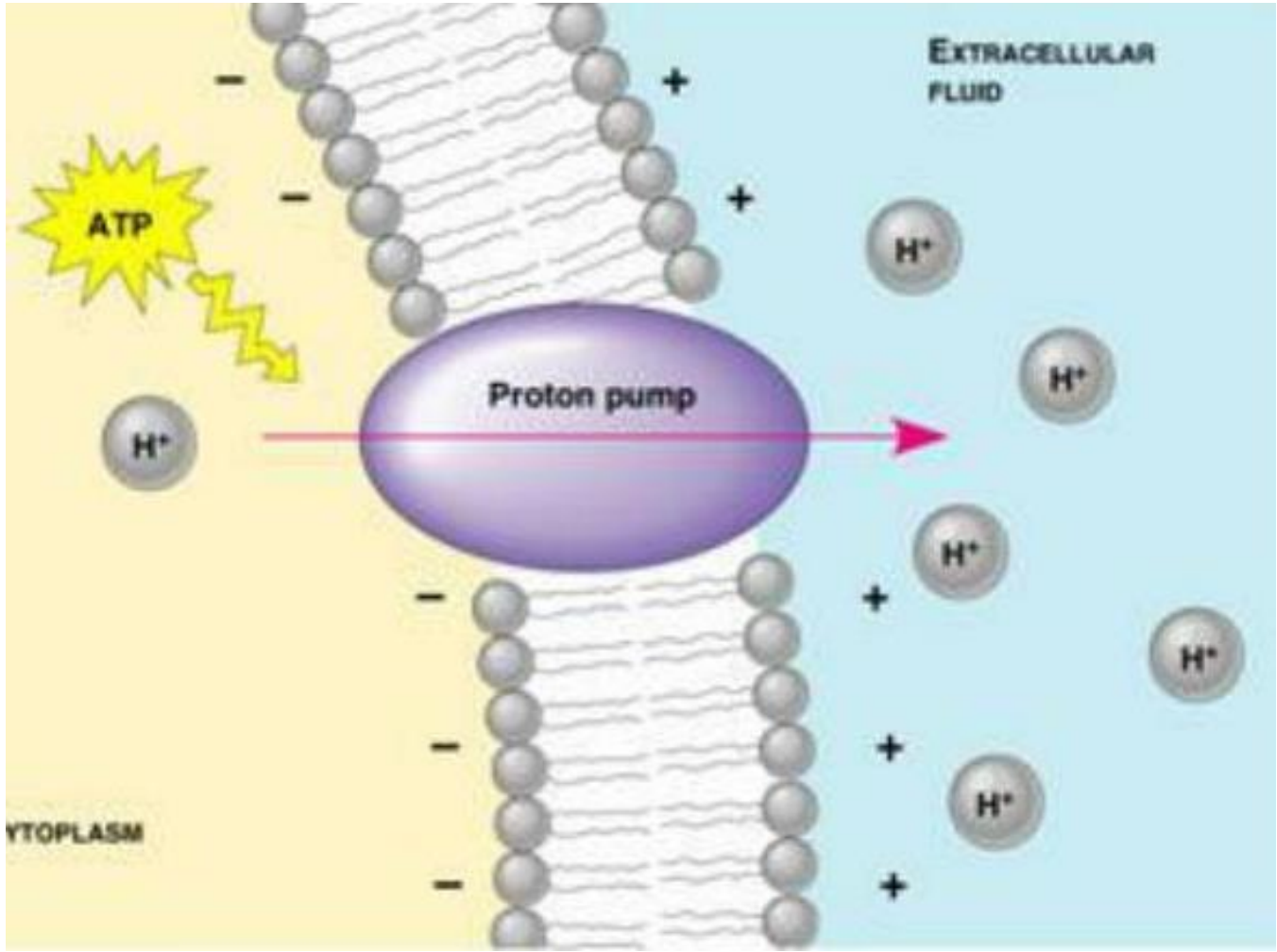
*Insulin increases # of glucose carriers of muscle cells

Pump Na+ and K+ against concentration gradients: establish voltages. 40% of ATP

Active Transport: pumps

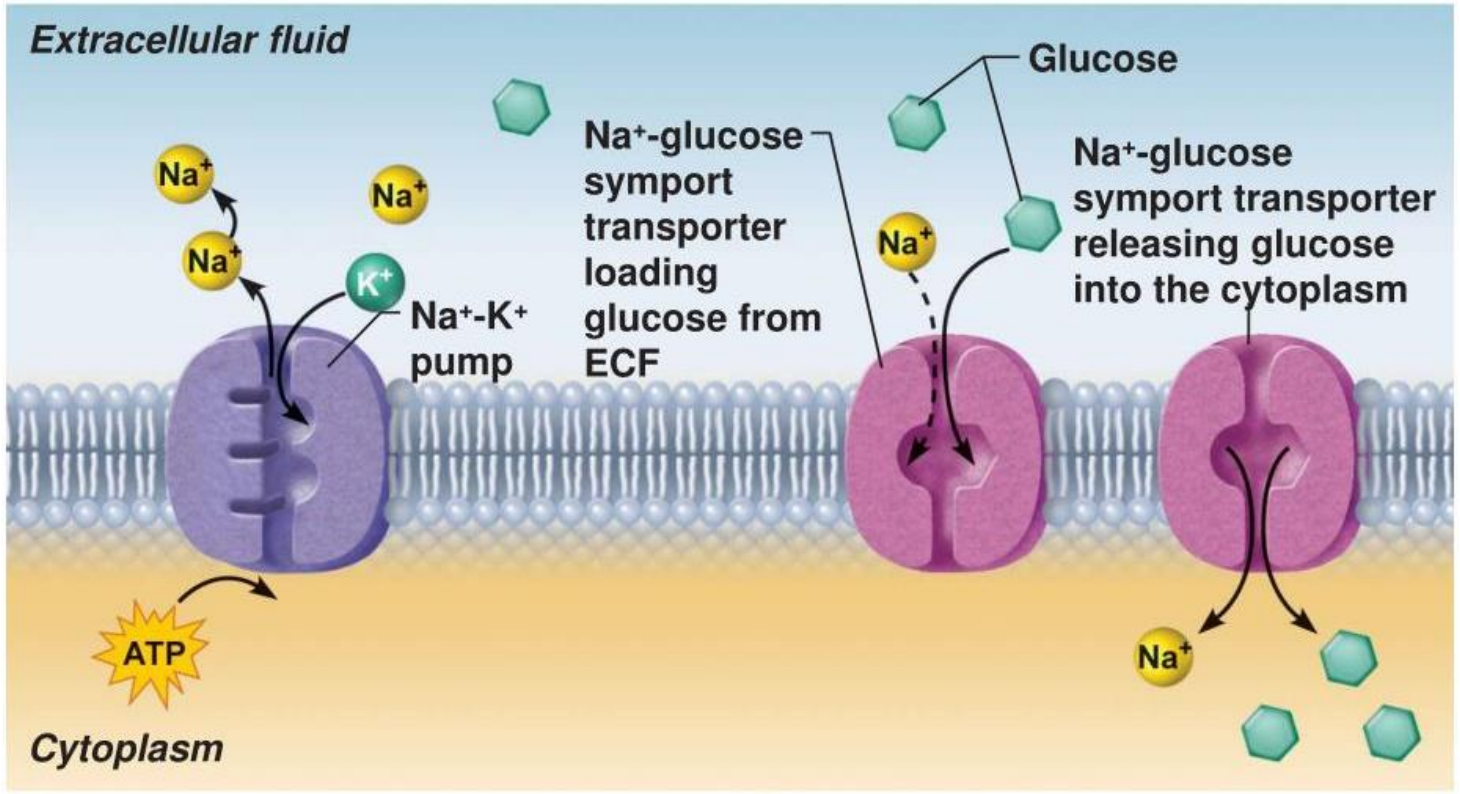
Move substances from low to high concentration, creating a **concentration gradient or electrical gradient**. Must use **ATP** for energy to do so.

Gradients are like water behind a dam; it's flow can fuel transport of other substances against their chemical gradients. Especially important for Na^+.



Gradient-Driven Pumps

Some glucose enters via passive transporters, down their gradient. But in gut need to transport glucose against gradient. Uses sodium gradient to facilitate transport of glucose into the cell.



① The ATP-driven Na^+-K^+ pump stores energy by creating a steep concentration gradient for Na^+ entry into the cell.

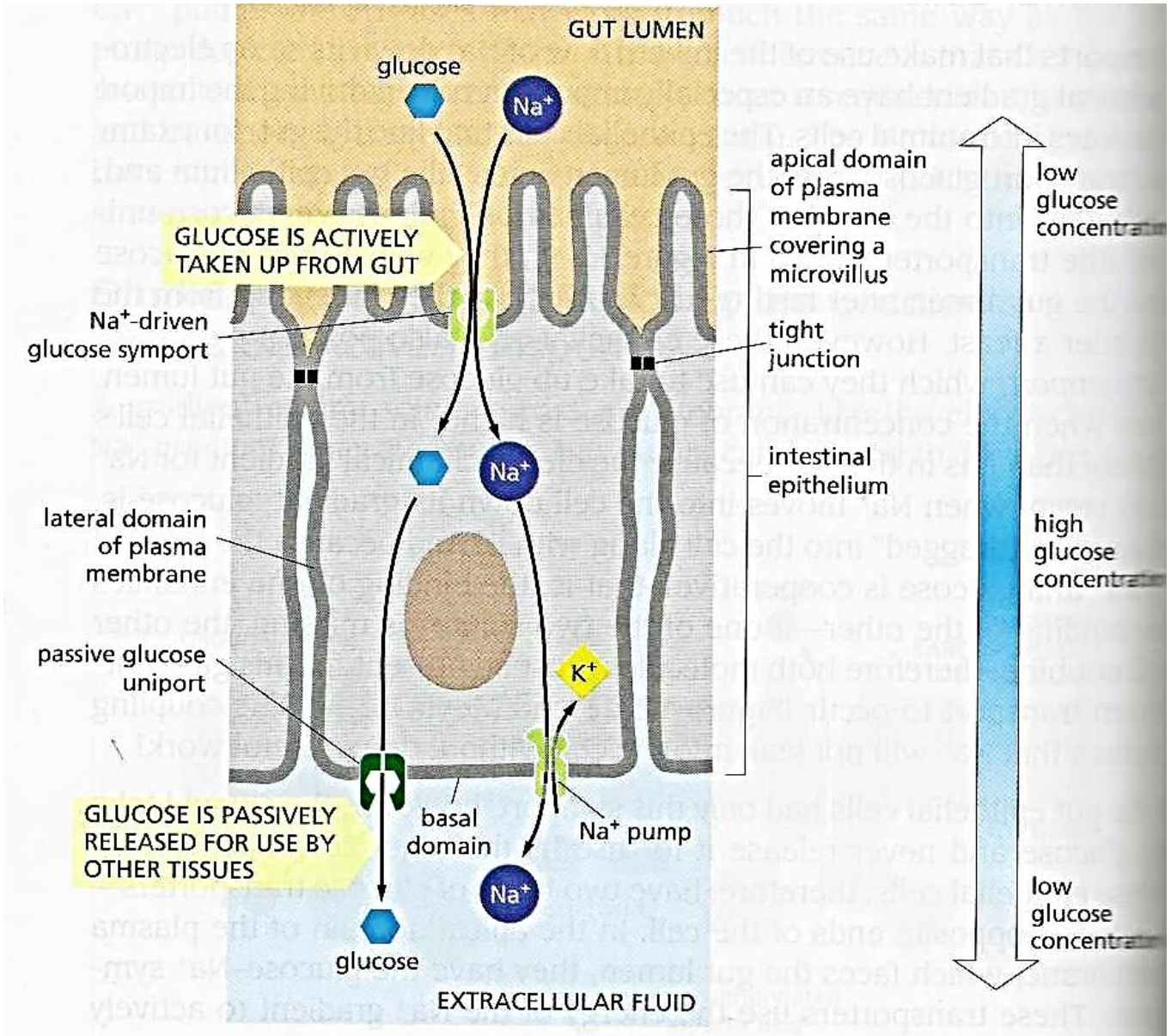
② As Na^+ diffuses back across the membrane through a membrane cotransporter protein, it drives glucose against its concentration gradient into the cell. (ECF = extracellular fluid)

Intestinal Transport

Gut epithelial cells have 2 types of glucose transporters.

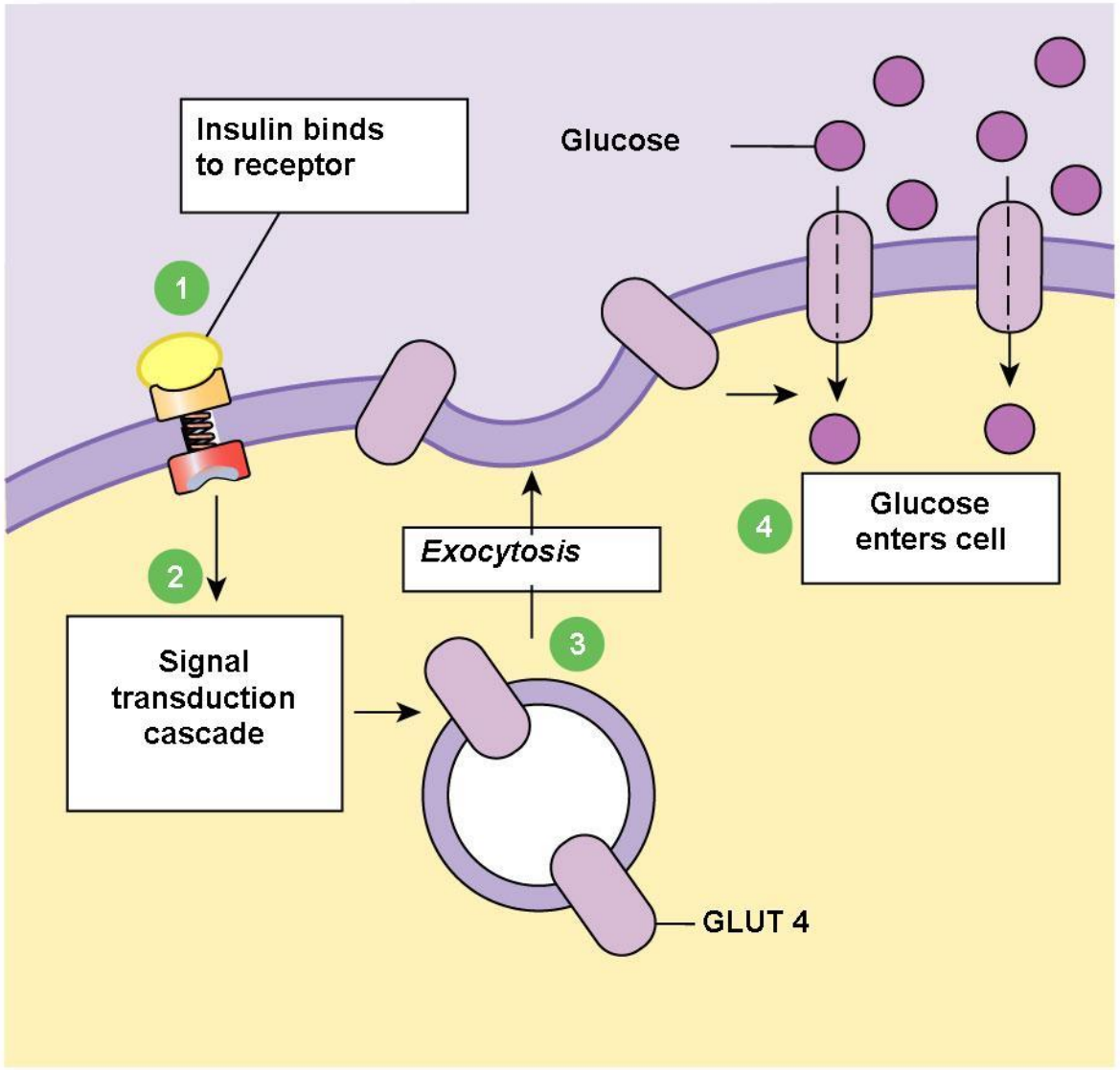
Sodium-driven transport at lumen creates high concentration inside.

Drives passive transport across basal membrane into blood system.



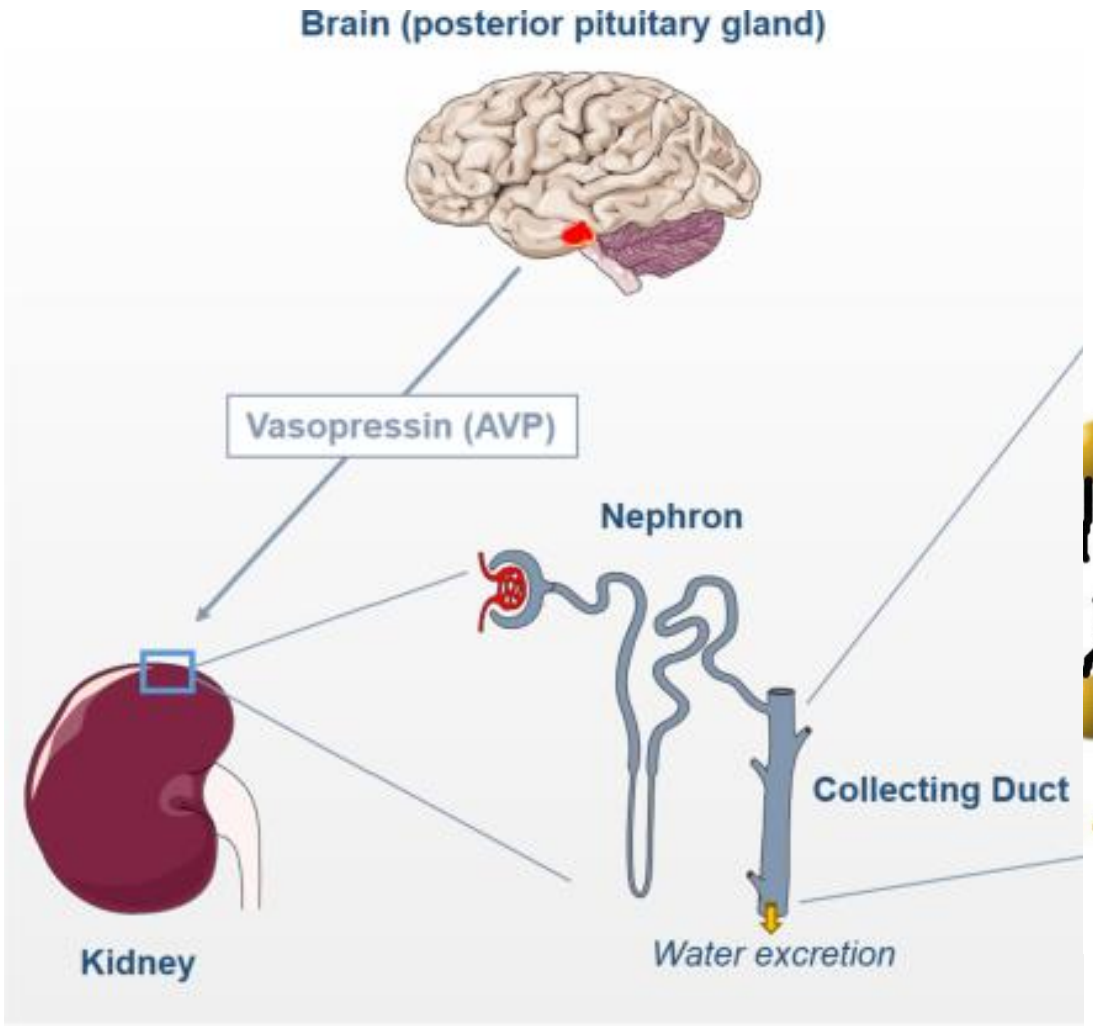
Regulation

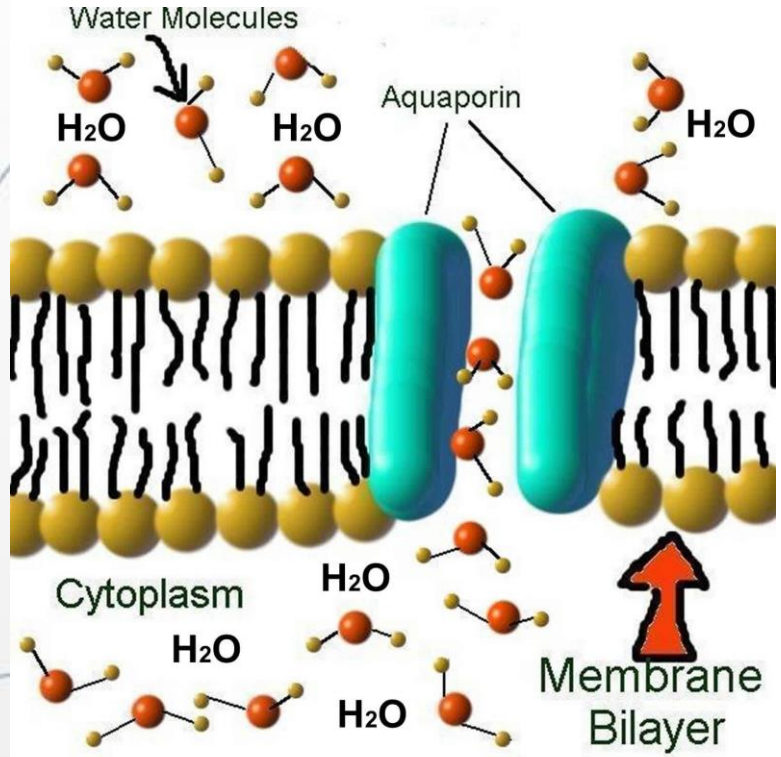
Muscles need to import more glucose when active or after meals. Both exercise and release of **hormone** insulin can cause insertion of **more transporters** in the cell membrane, so more glucose can enter.



Regulation

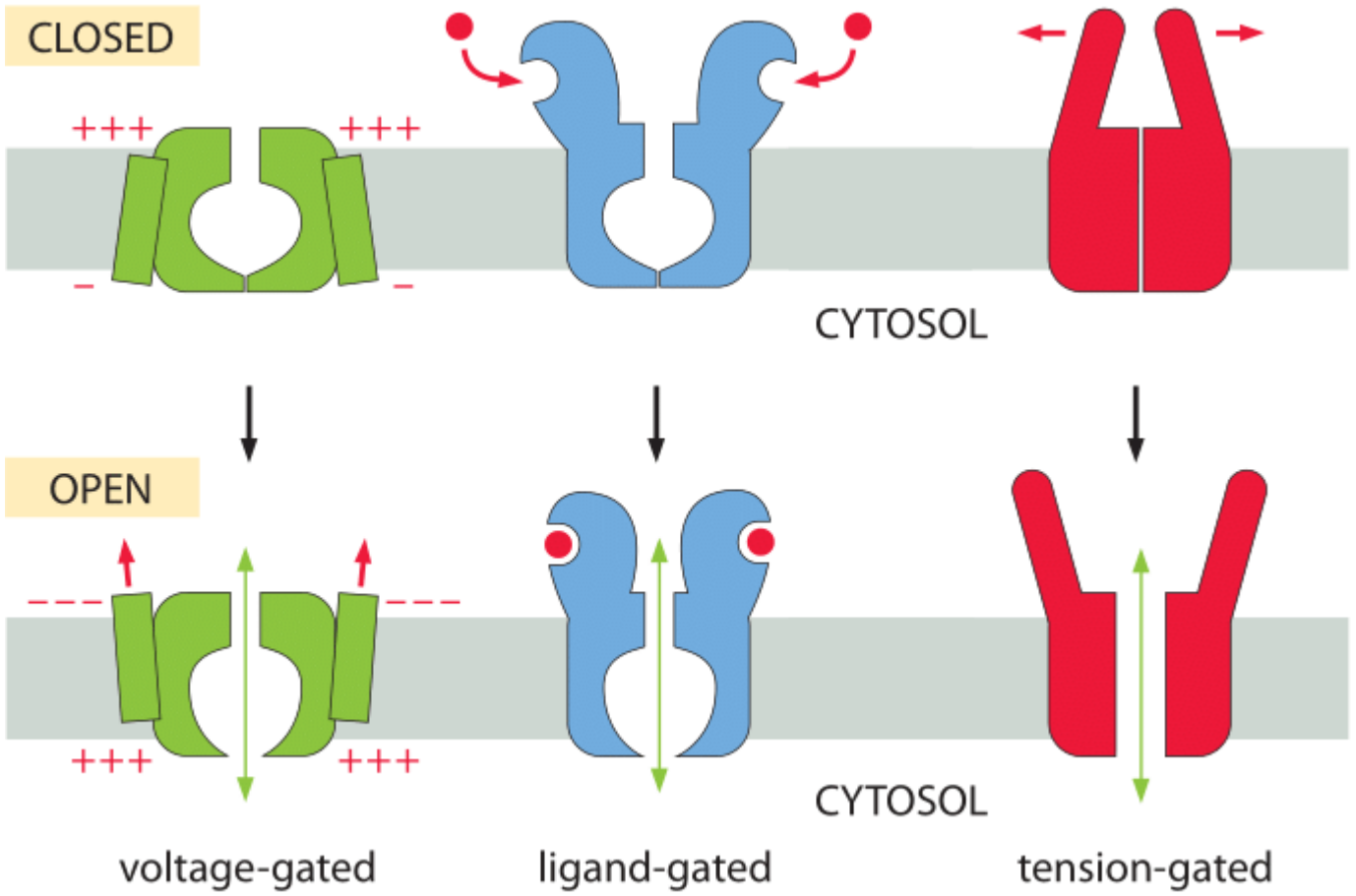
When brain senses blood is too thick, it release **hormone** vasopressin that causes cells in the collecting ducts of the kidney to insert **aquaporin channels** to transport more water back into the body.



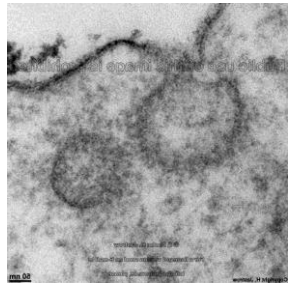


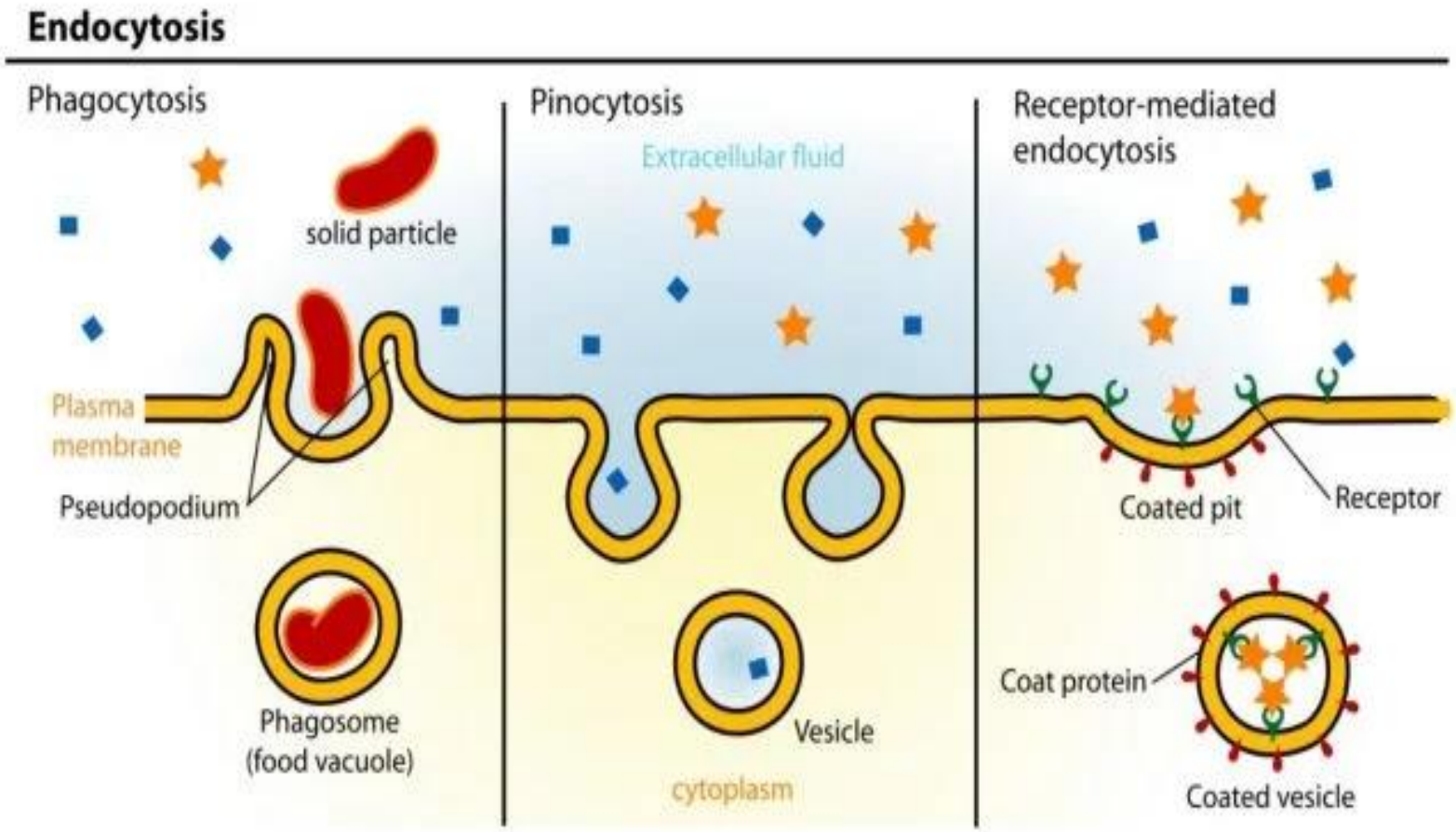
Regulation: Gated Channels

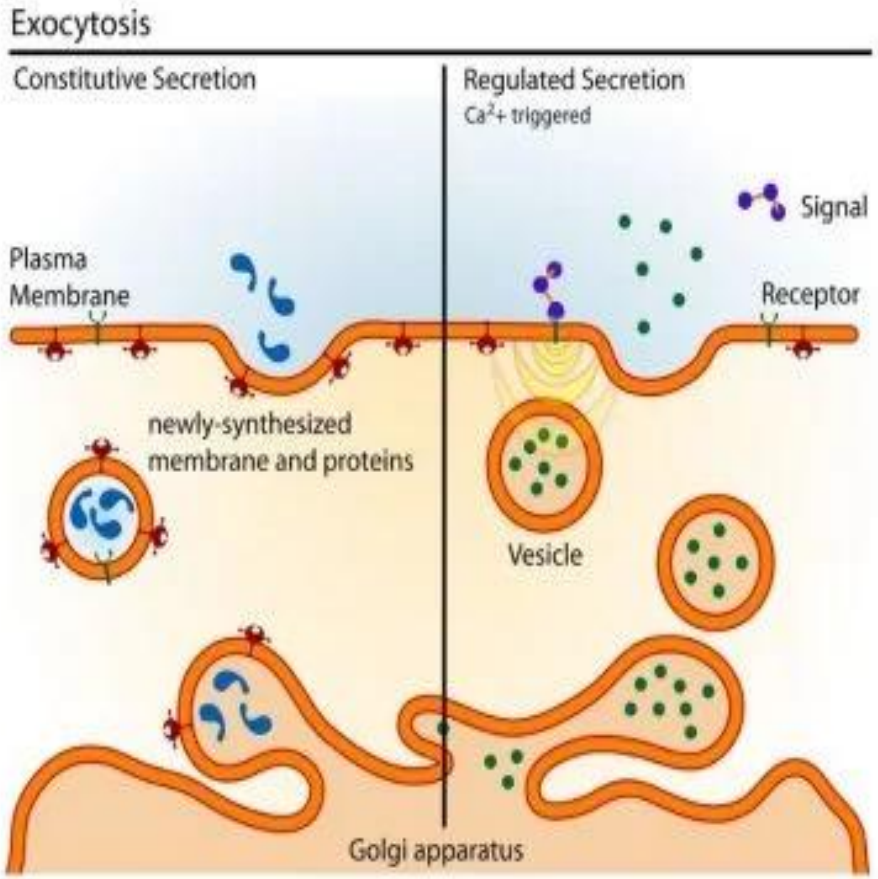
Internal ion concentrations differ inside and out, creating voltage and acidity differences.
Gated channels allow flow along concentration gradients only when opened. Can be opened by change in voltage, by signal molecules (ligands) or movement.



Transport in Vesicles: Exo- and endocytosis



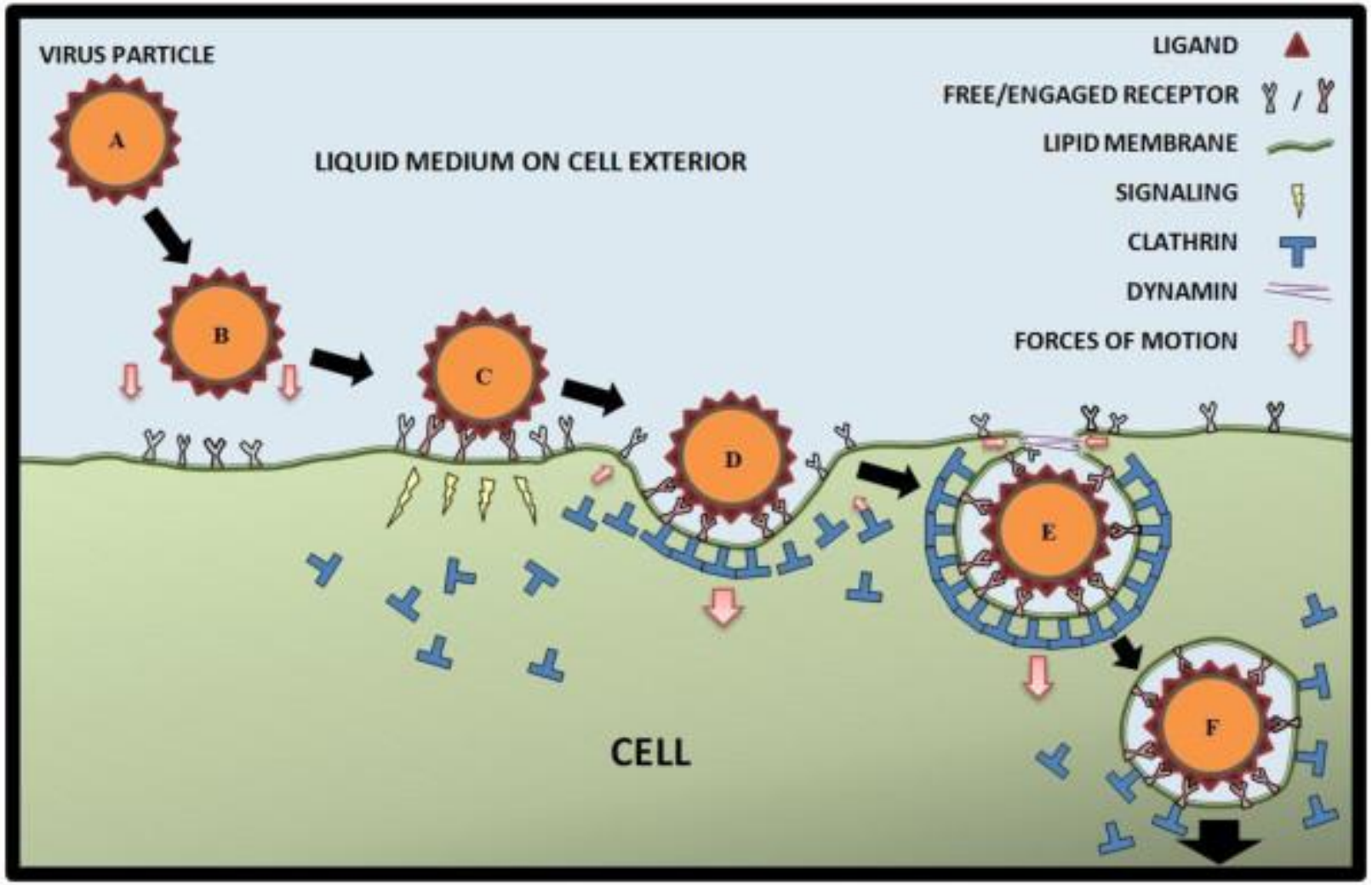




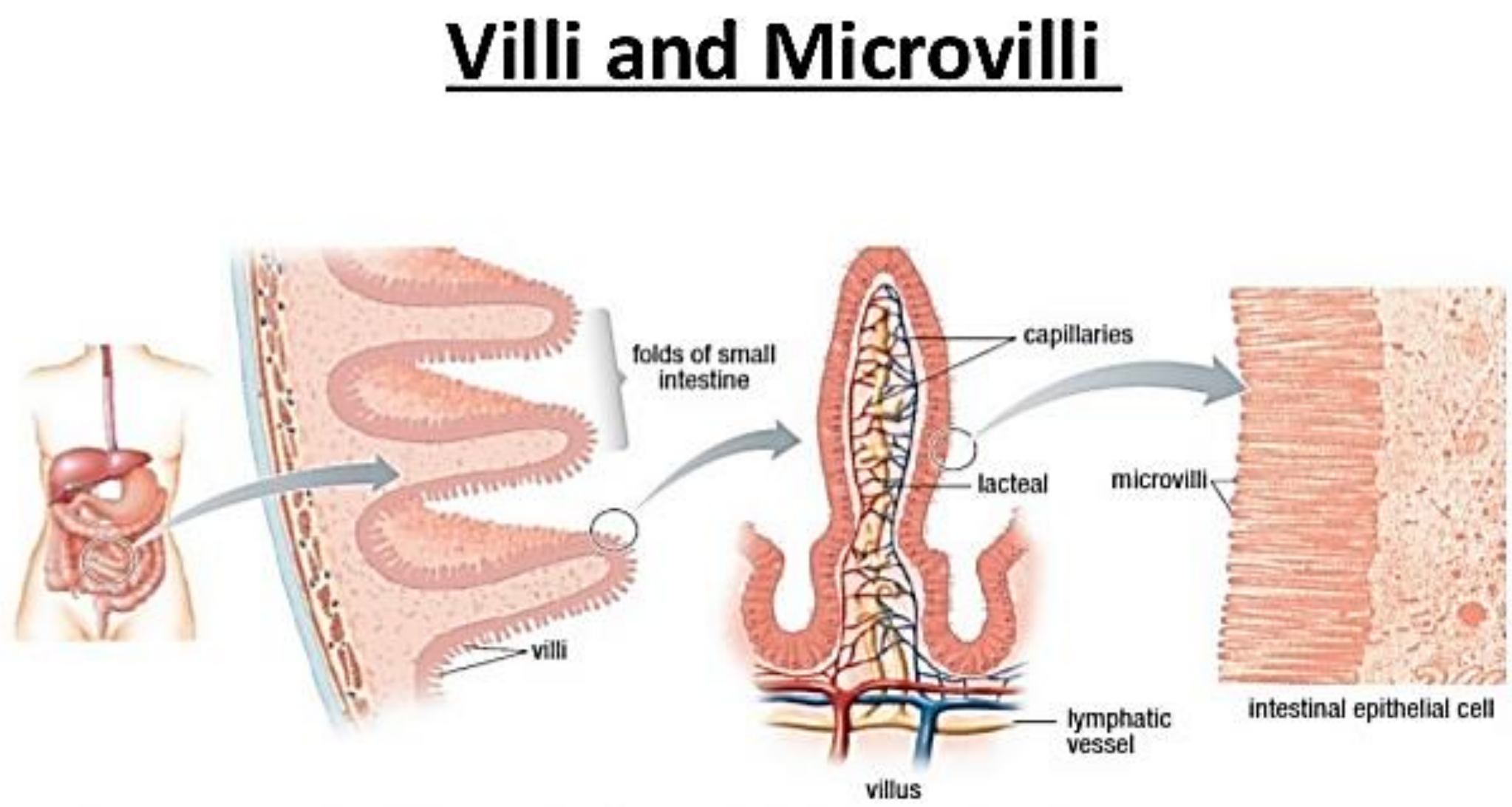
Viruses (HIV, SARS)

Receptor-mediated endocytosis

Used to absorb metabolites, cholesterol, hormones, proteins - and sometimes viruses.

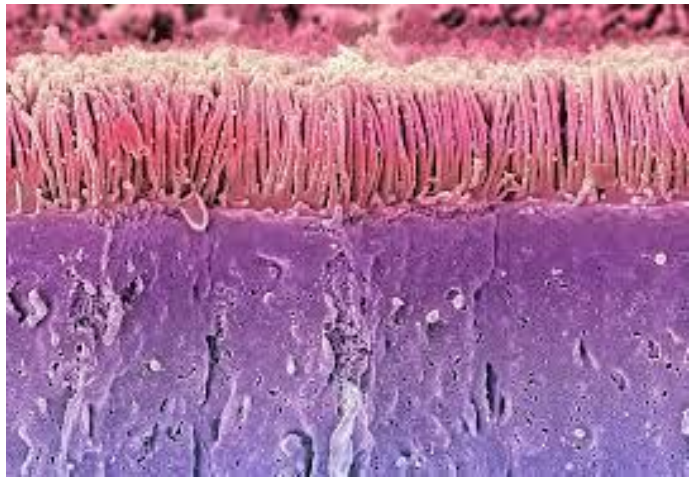


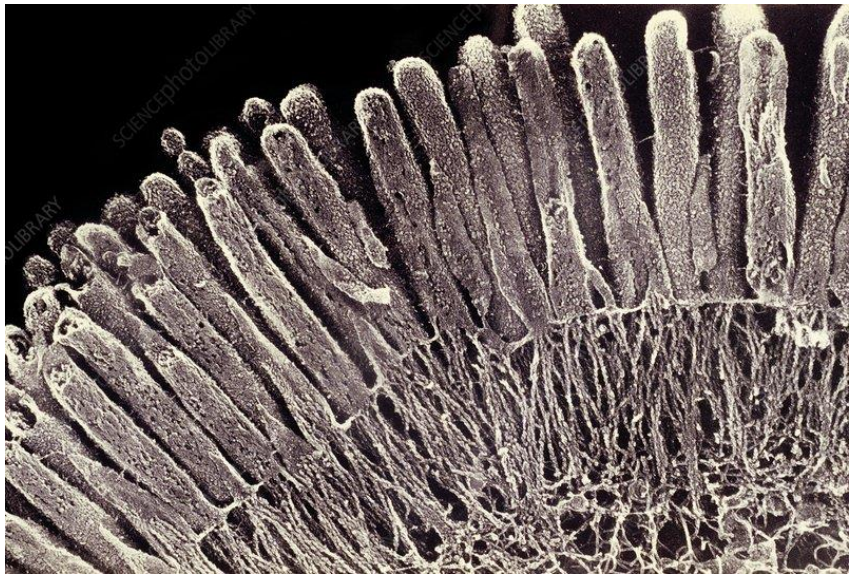
Membrane specializations: permeability

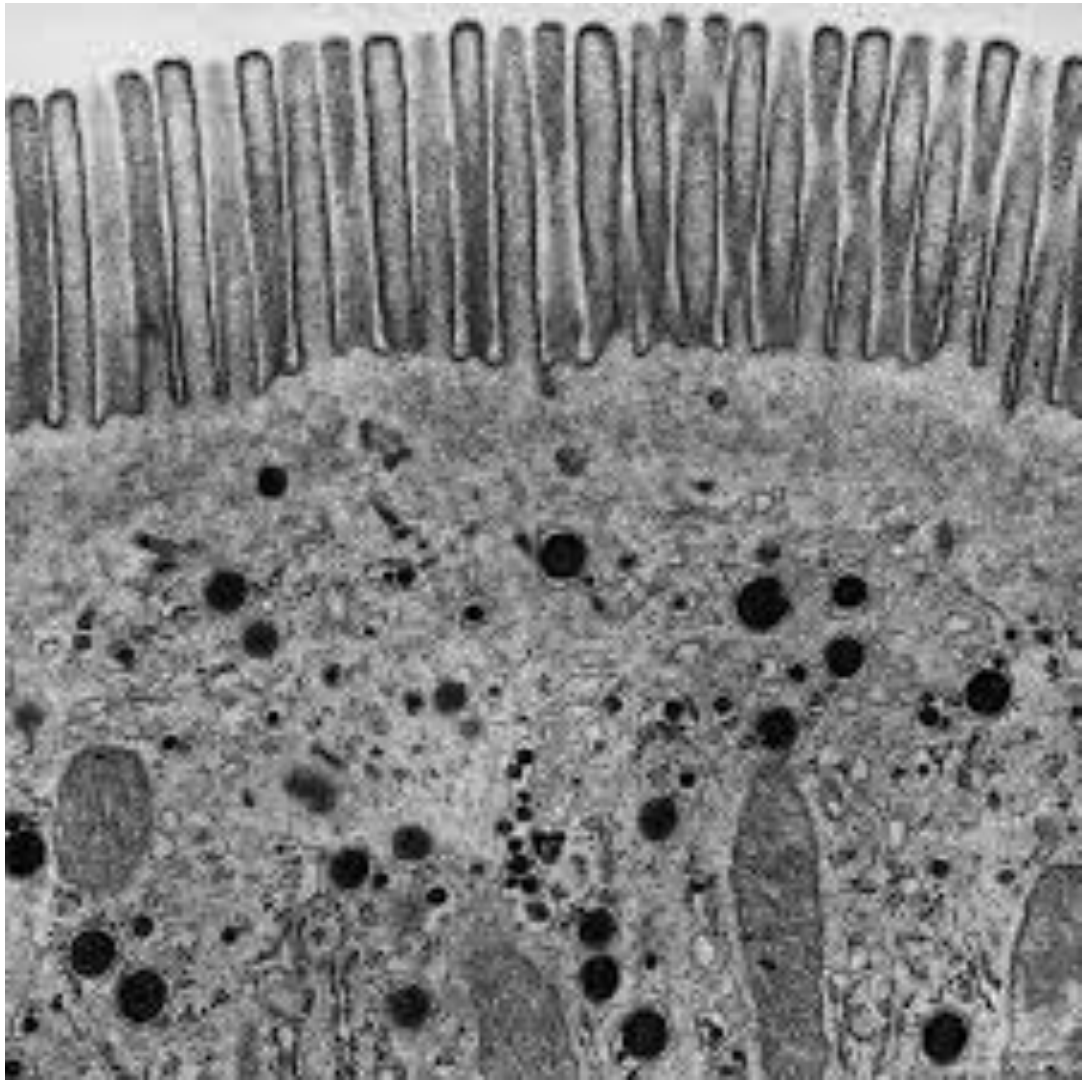


Microvilli: increased surface area

More surface area means more transporters.

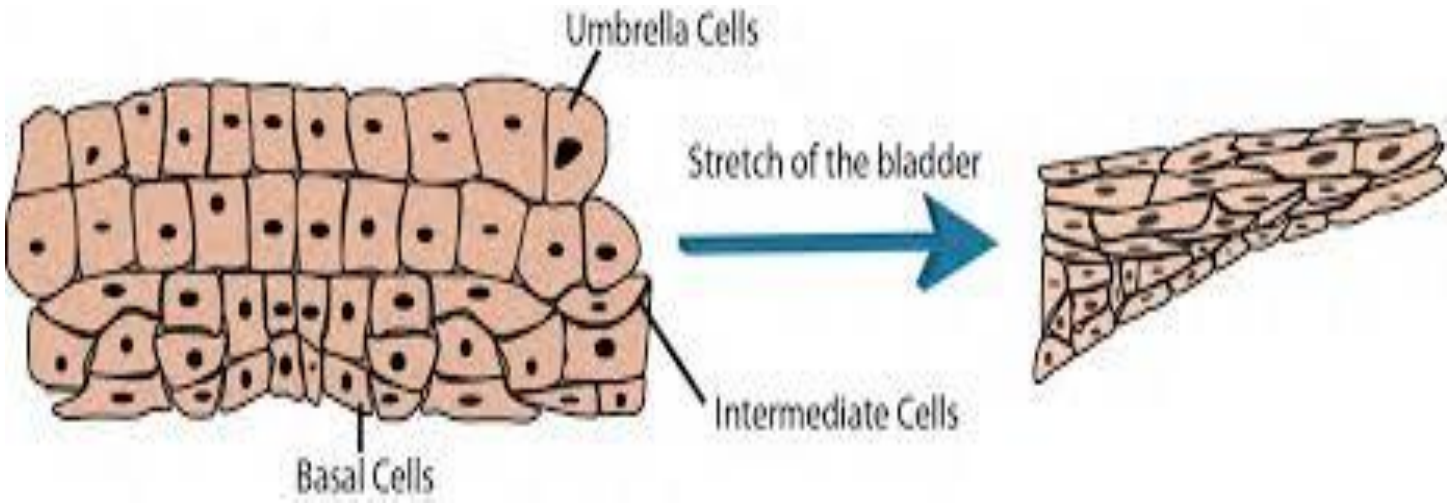


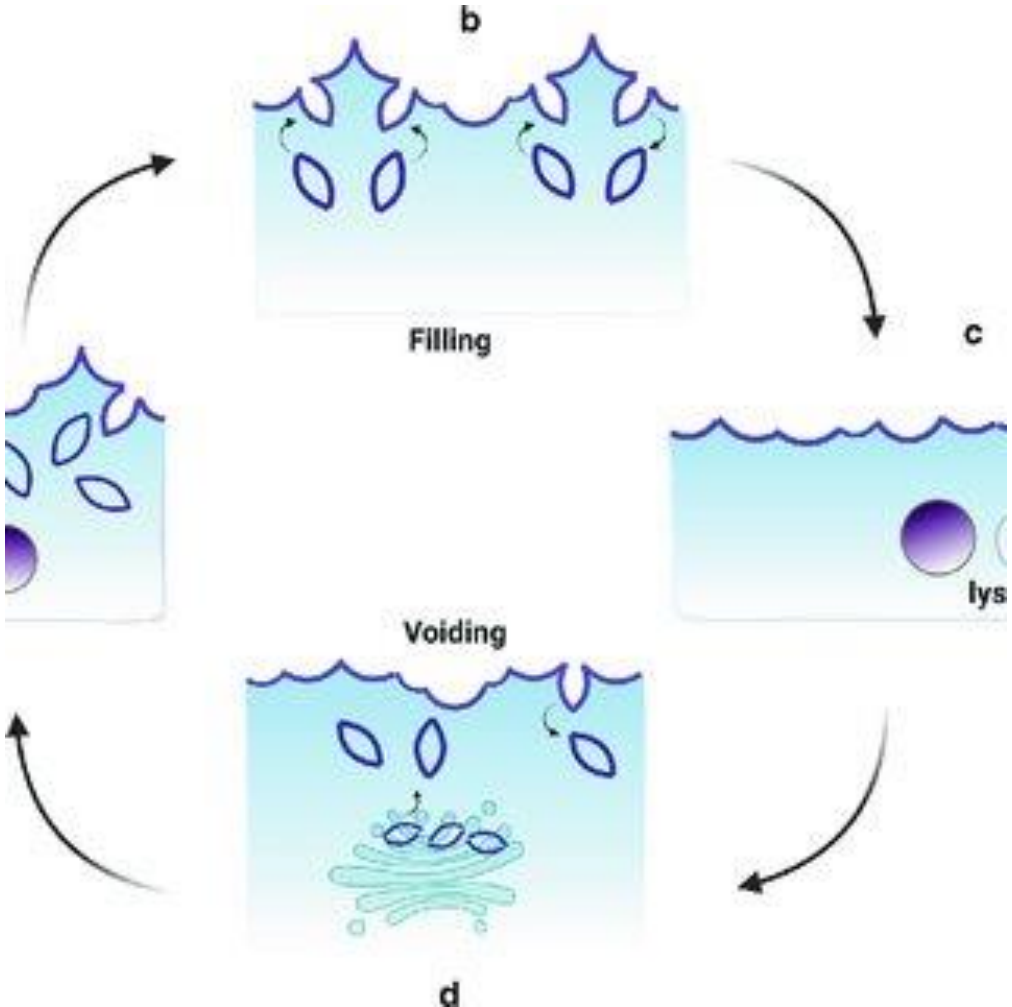




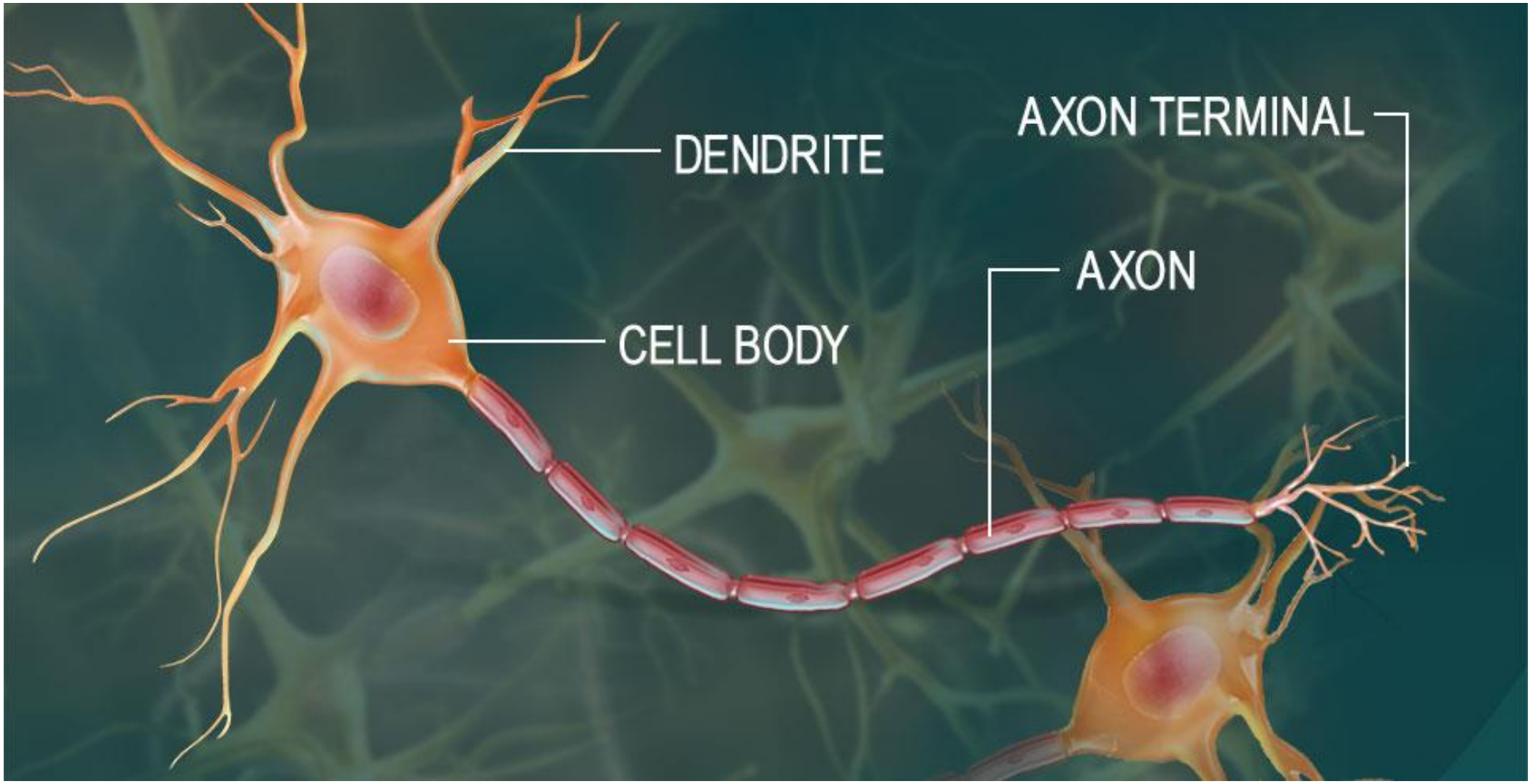
Mechanical changes

When bladder fills, stretch causes vesicles of membrane to be added to the surface, so cells can enlarge. When stretch is released, the membrane is taken back into the cell and recycled.



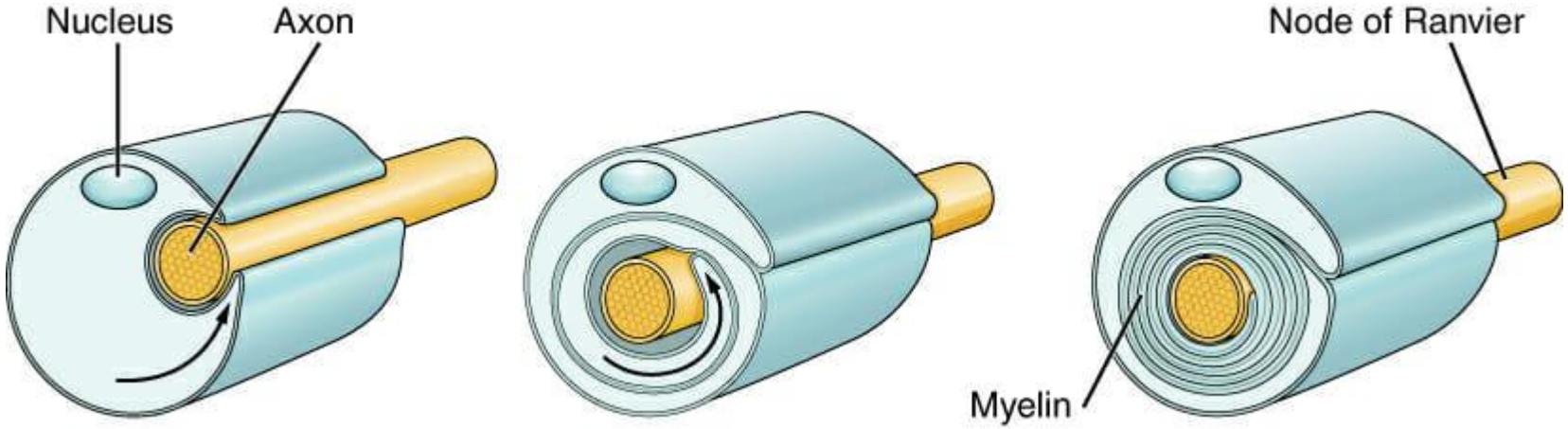


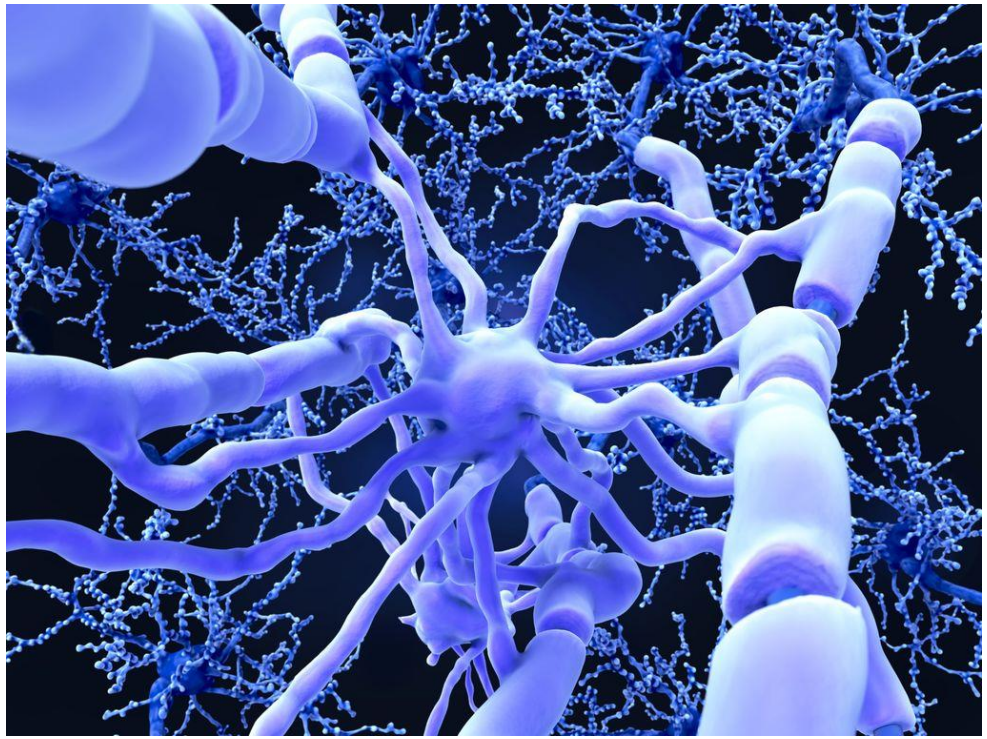
Neuron Function

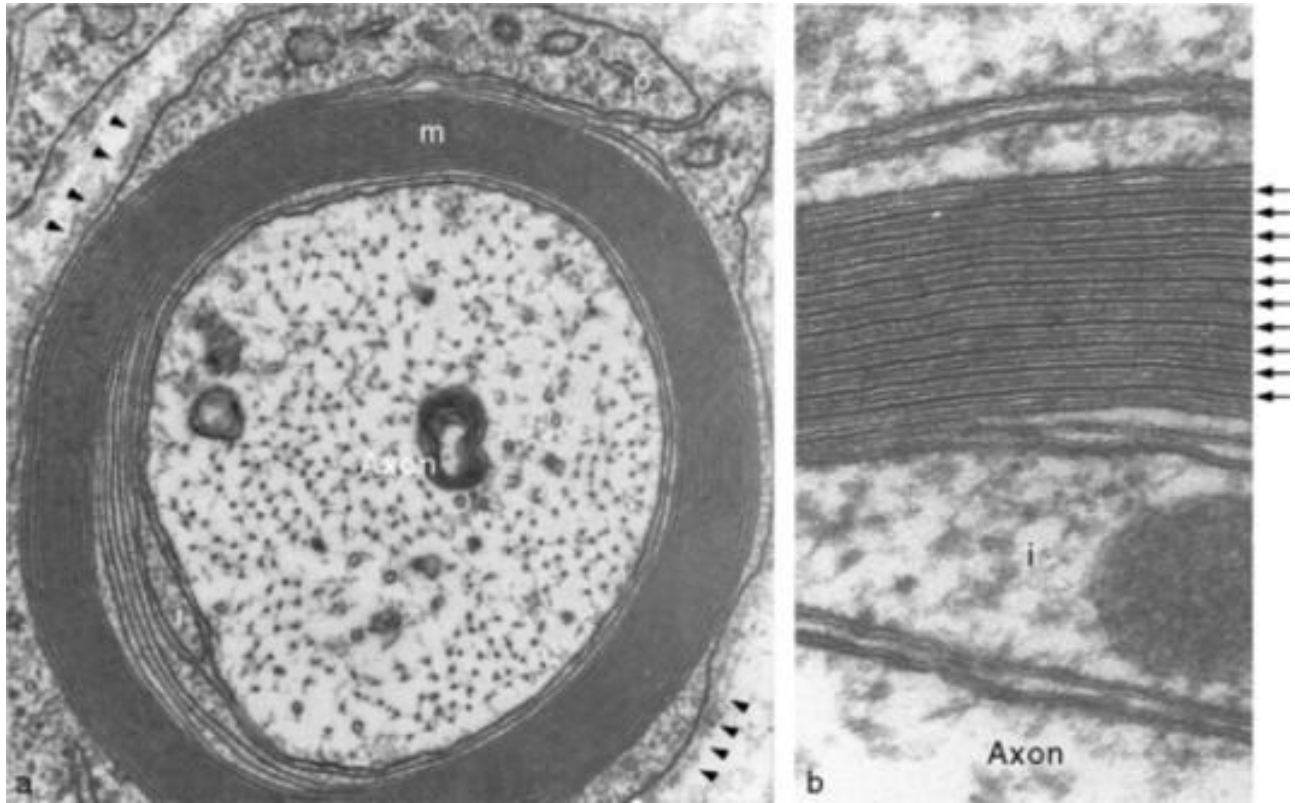


Insulation

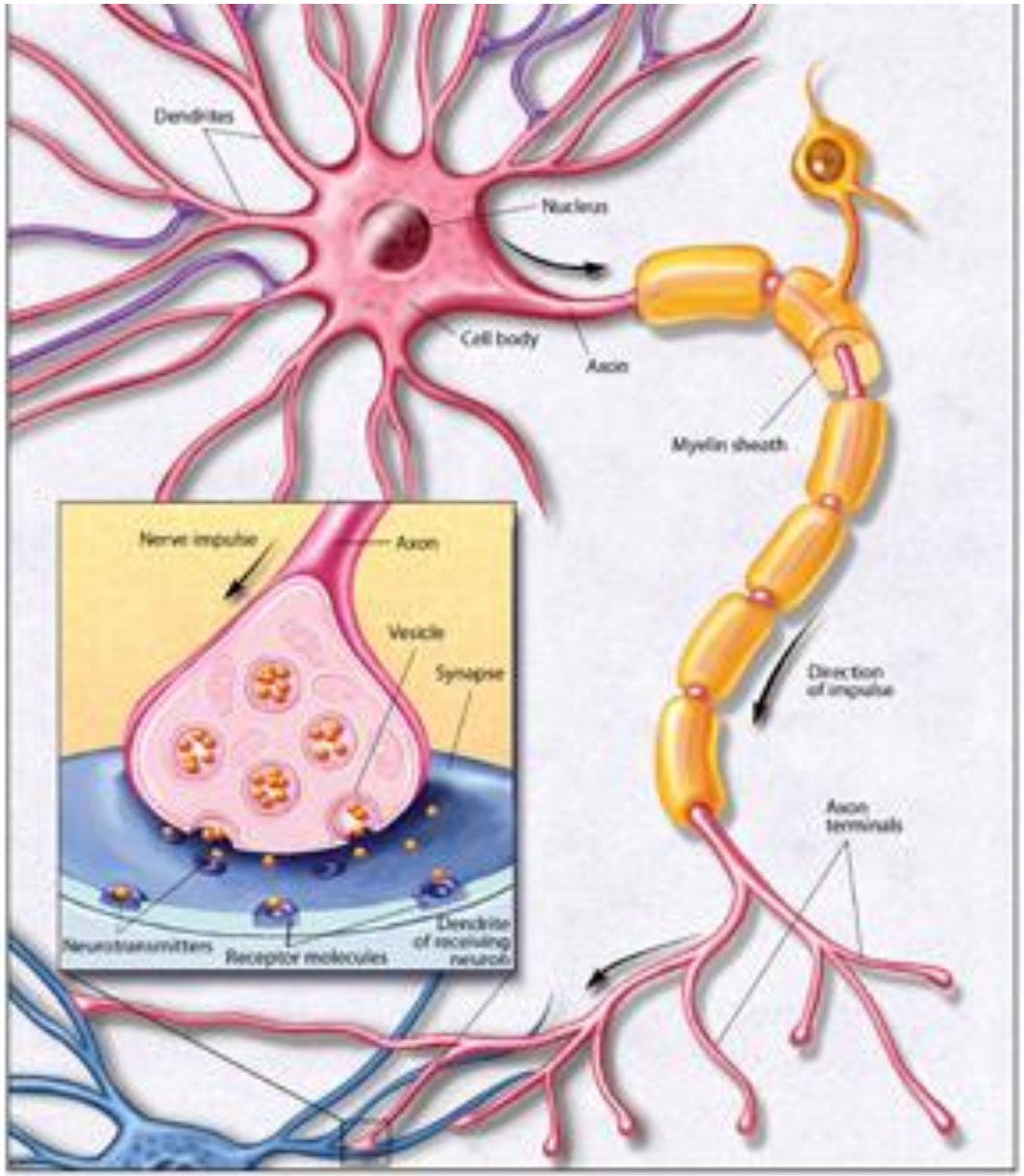
Layers of fatty membrane from glial cells insulate axons and make signal go faster.

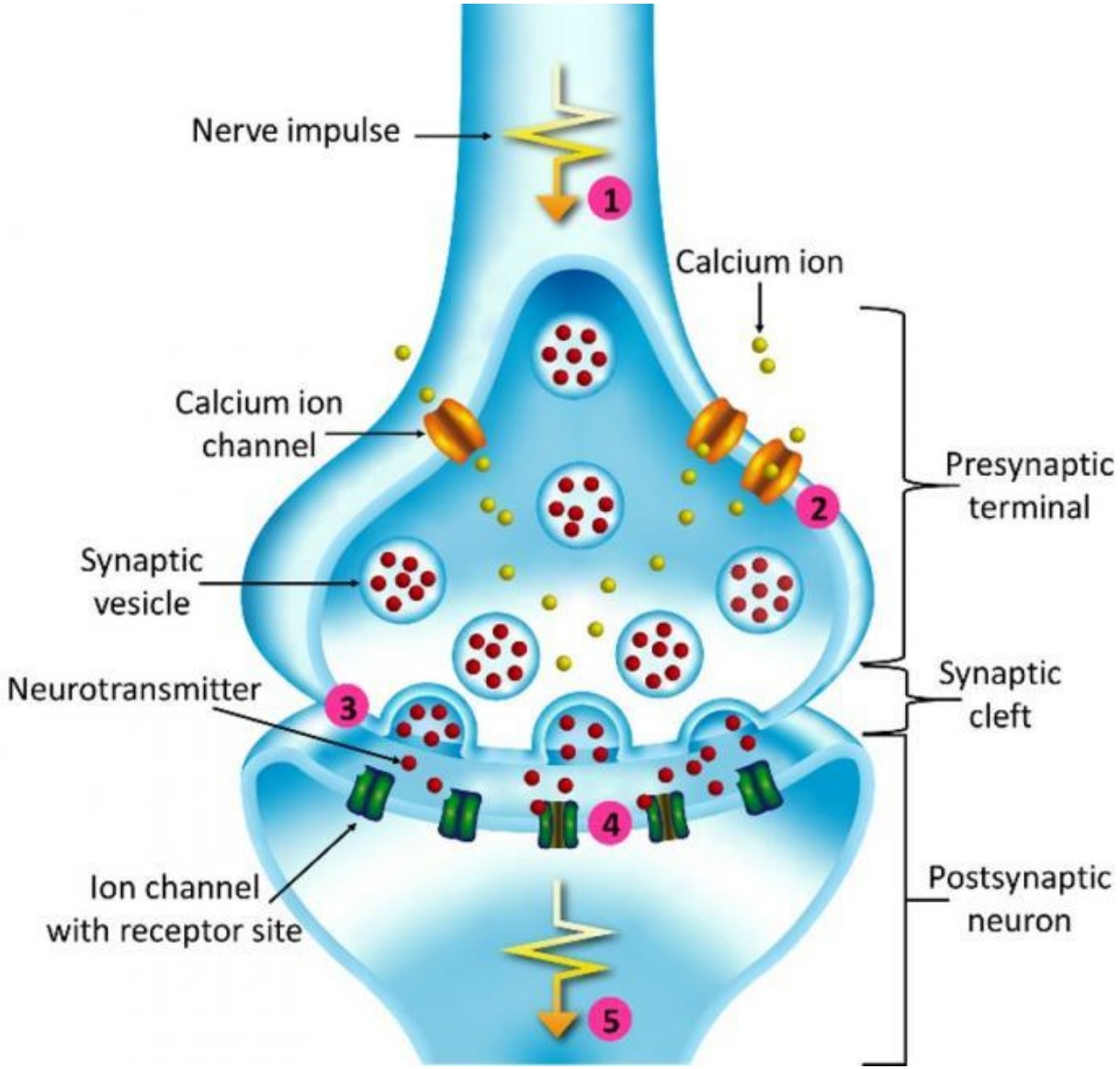




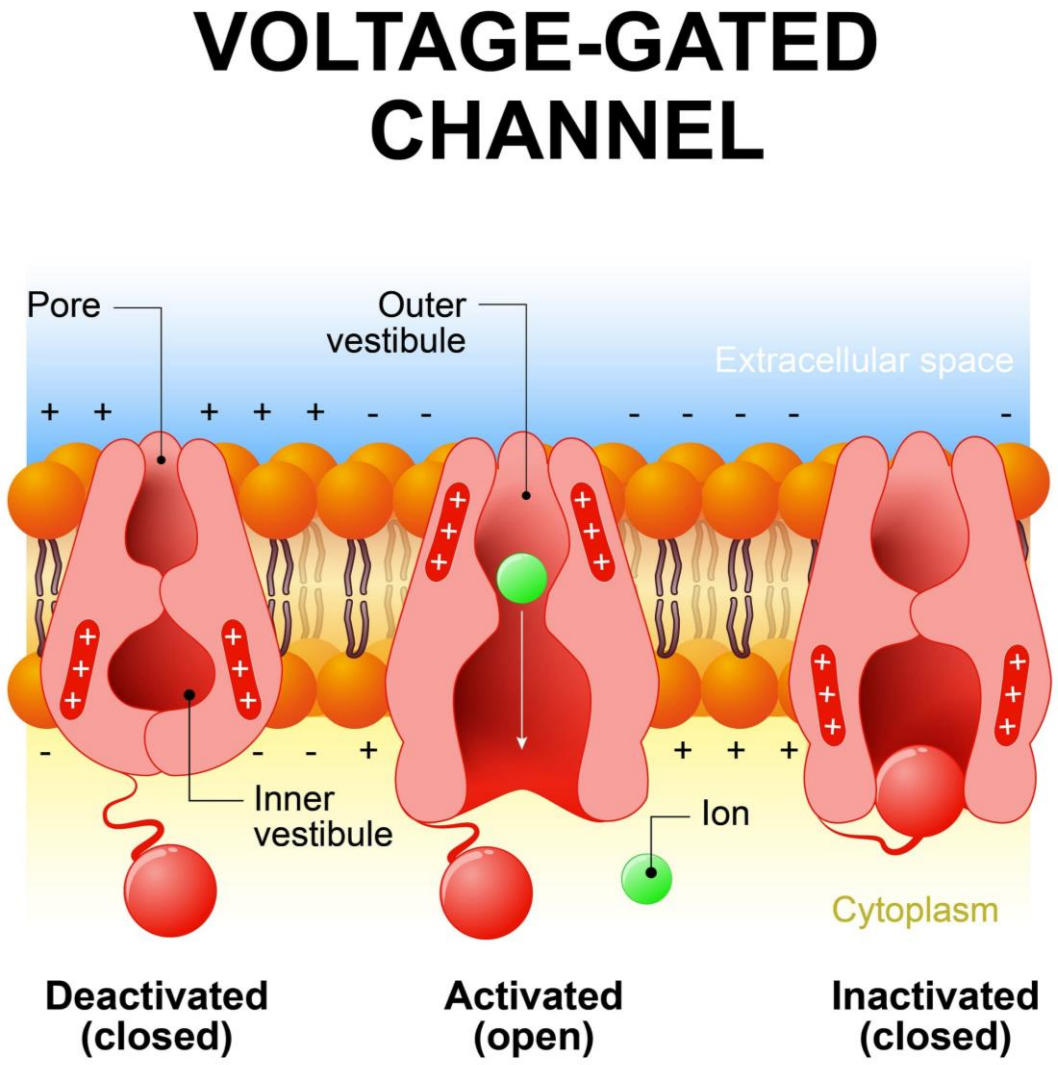


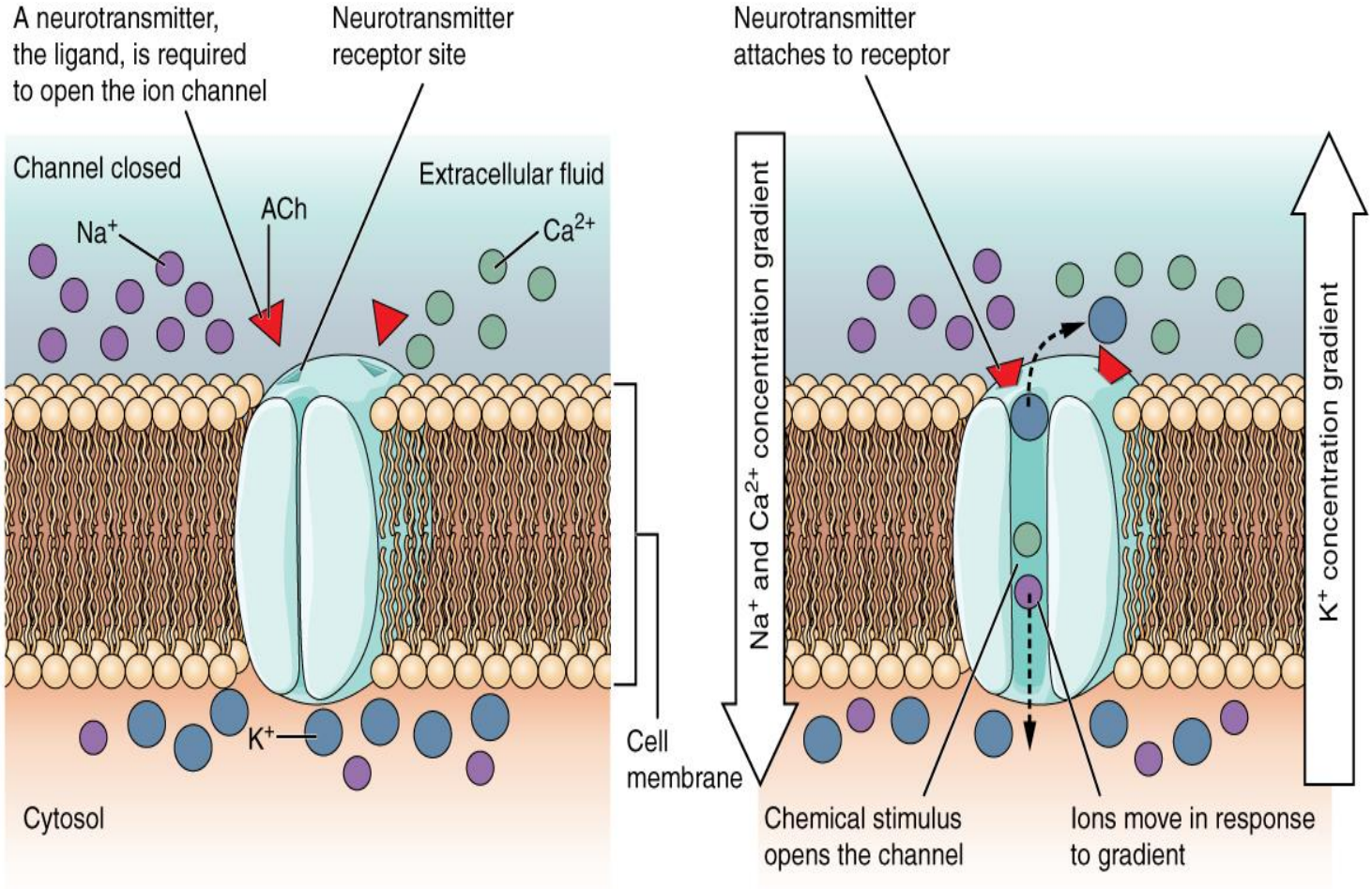
Voltage - controlled exocytosis



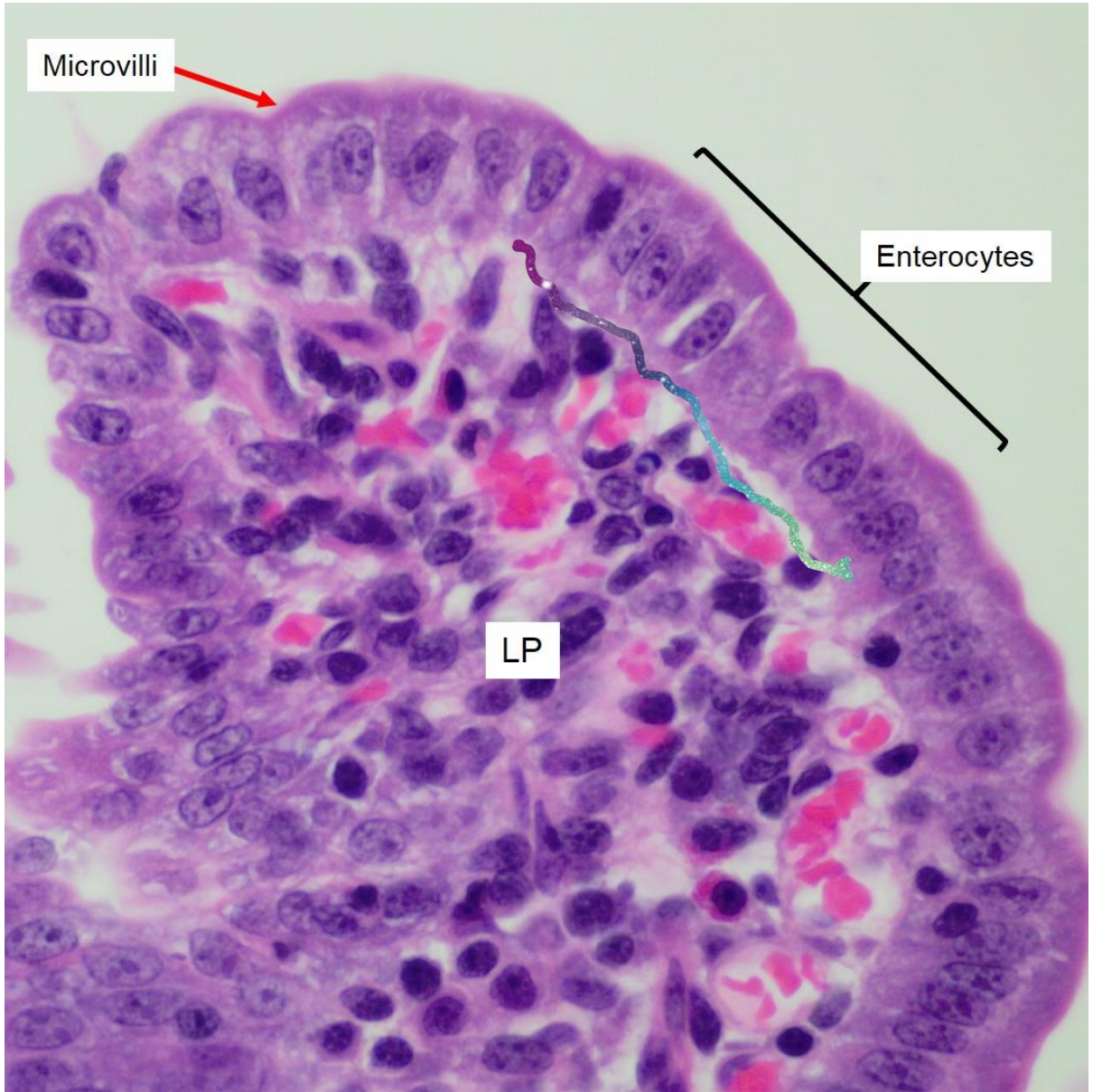


Voltage - gated vs receptor – gated channels

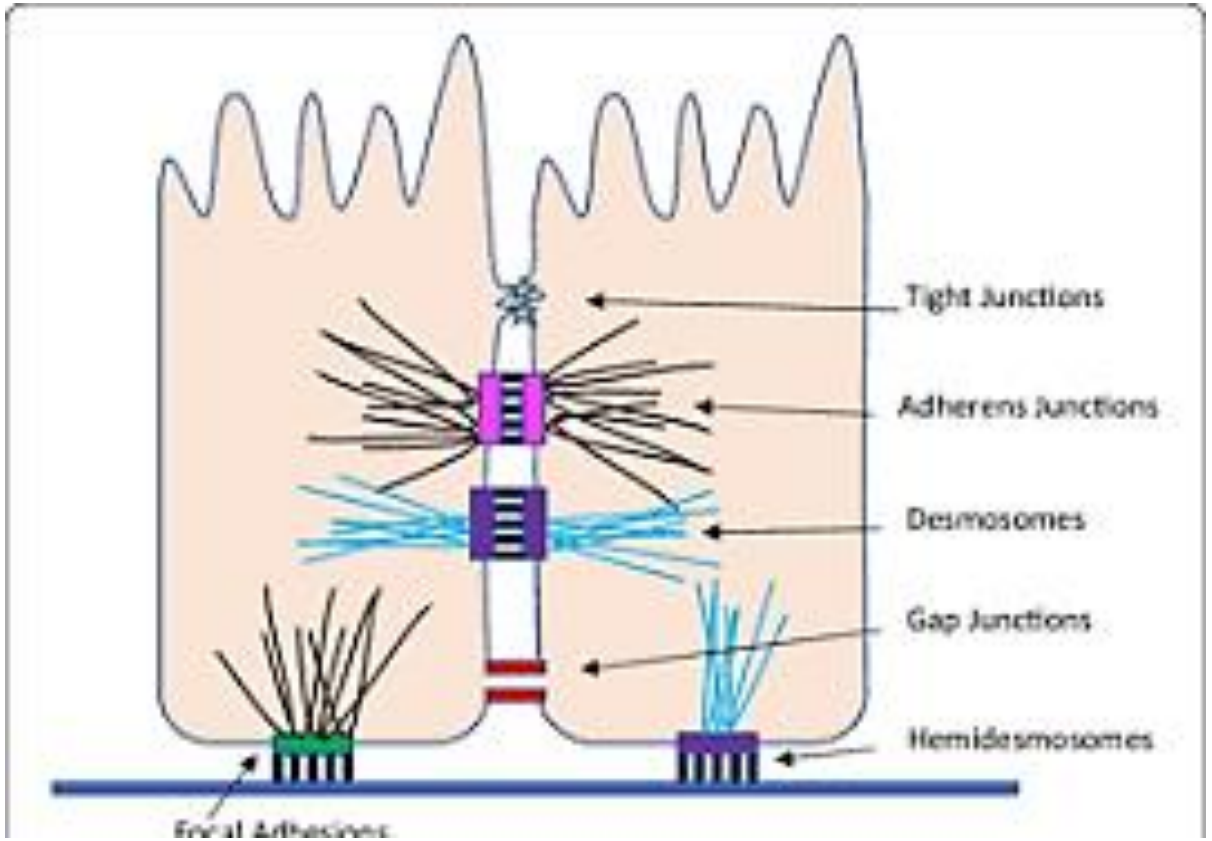




Cell adhesion

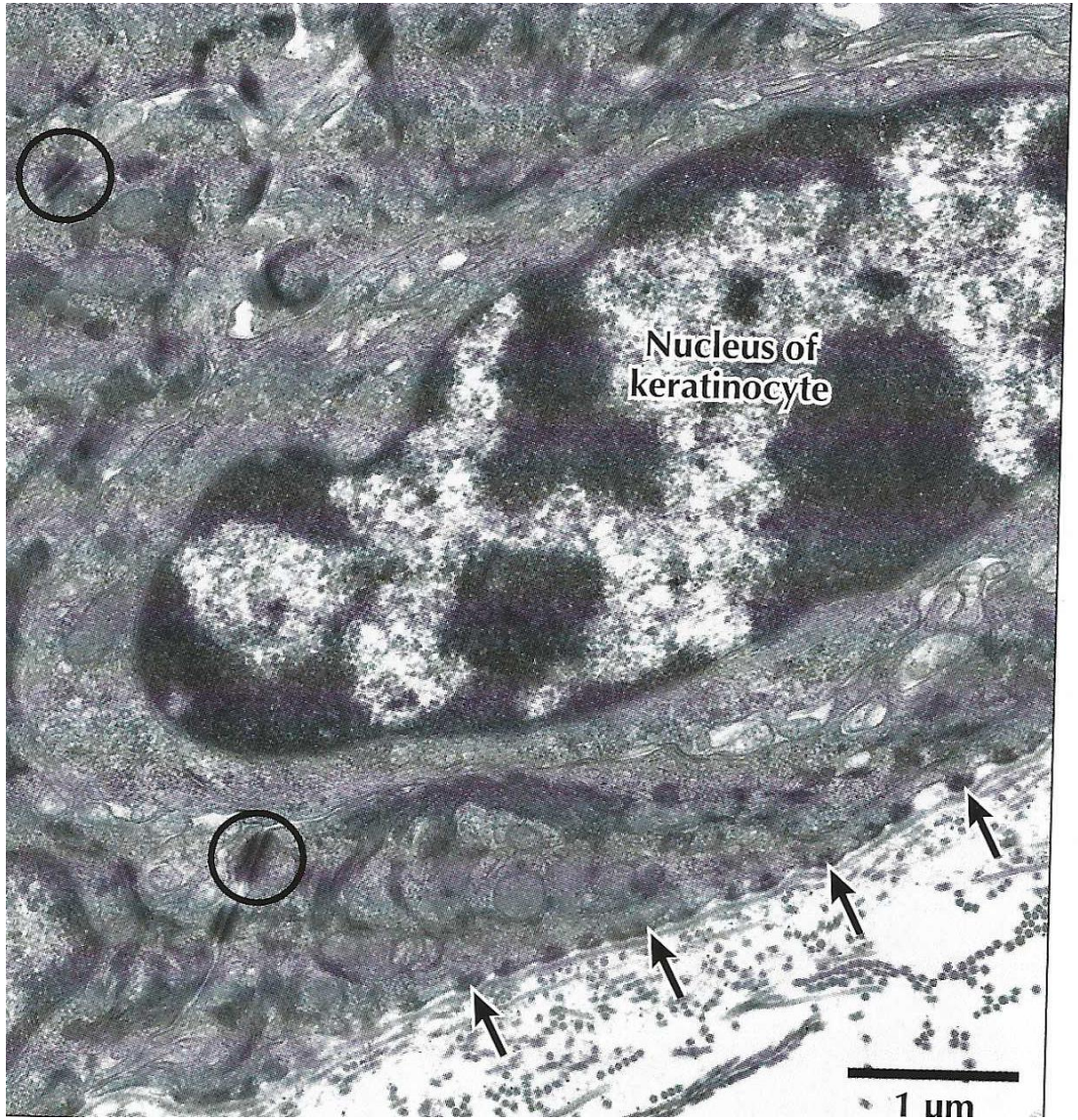


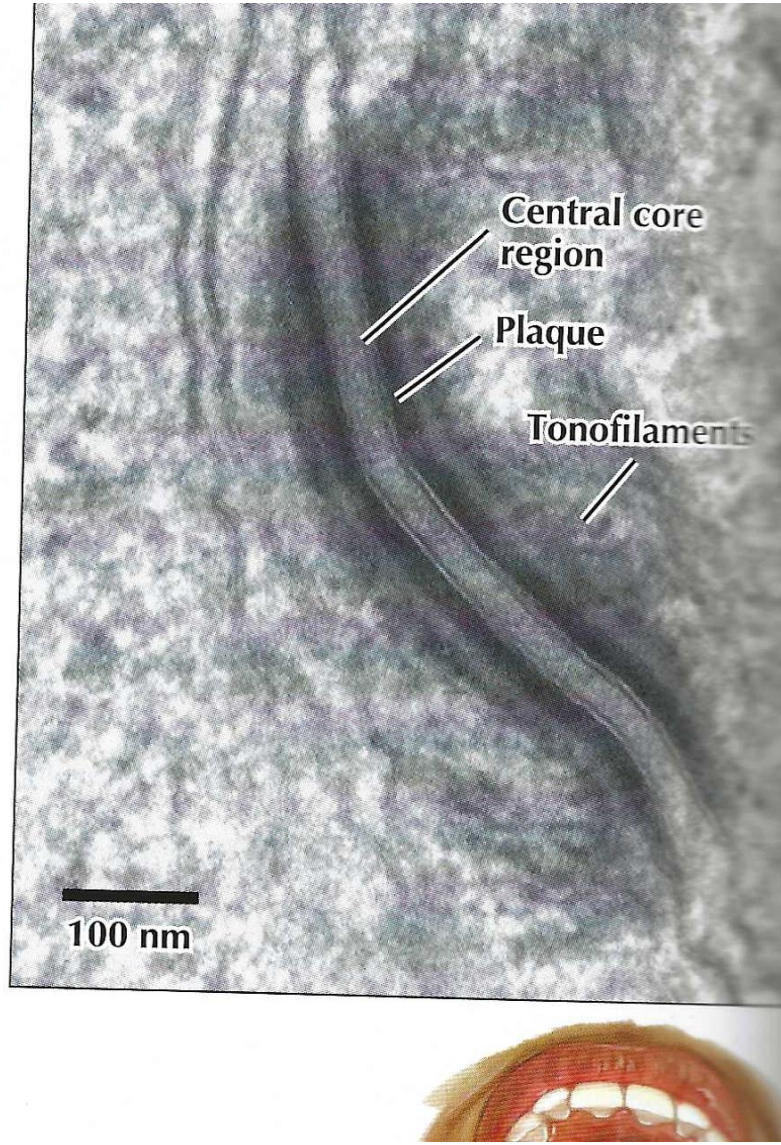
CAMs hold cells together to form tissues, and also hold tissues together to form organs.



Desmosomes

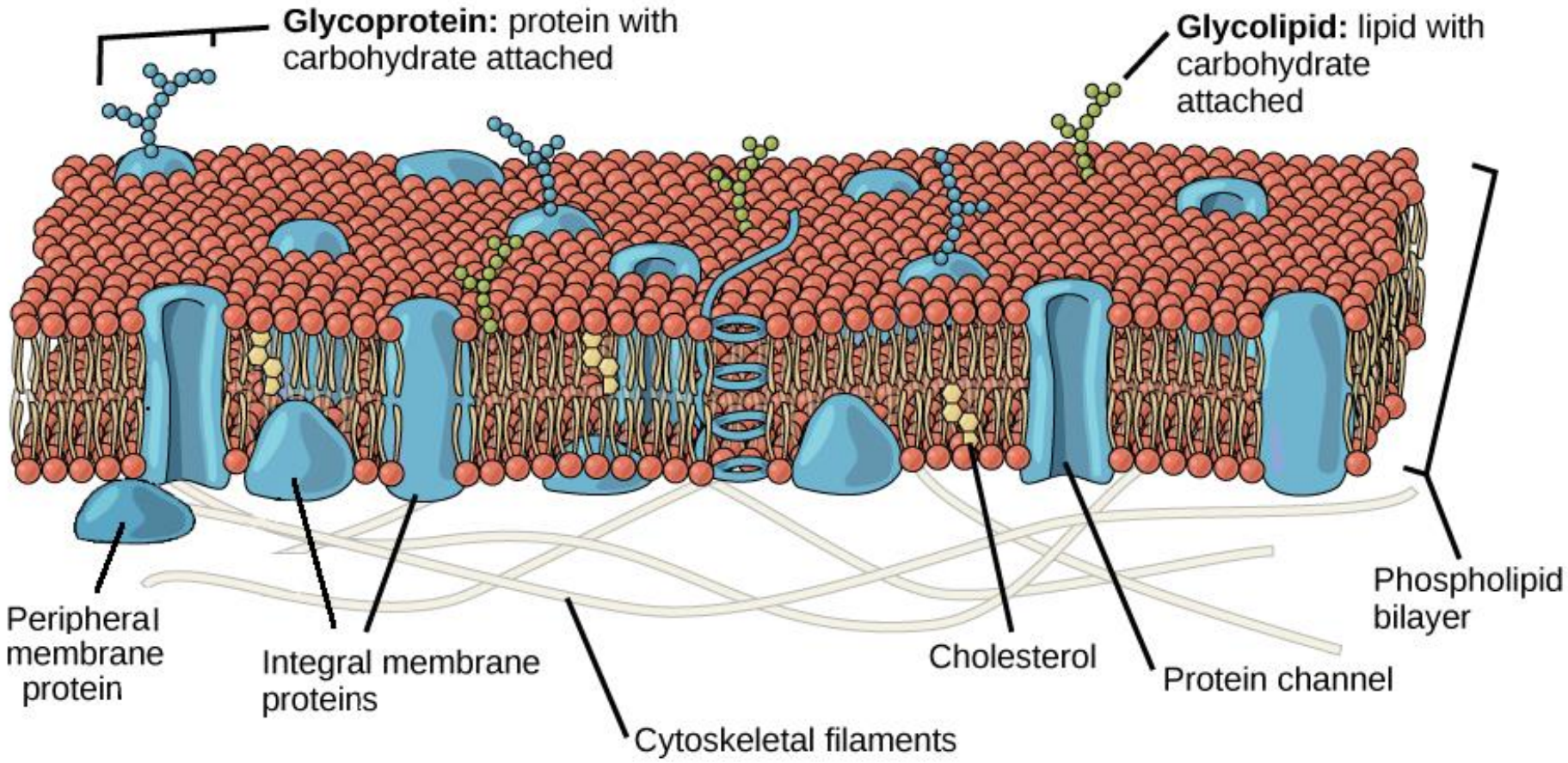
Attachment sites, stabilized by cytoskeleton





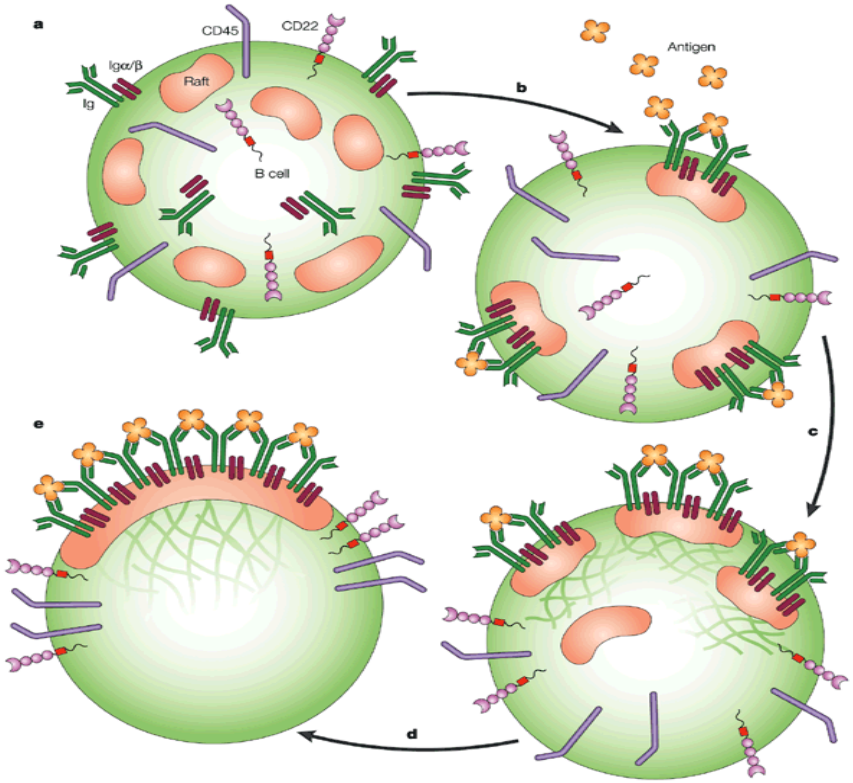
Cell Recognition

The glycoproteins and glycolipids on the outside function as cell identity markers. Recognize other like cells for tissue formation or inform immune system of invaders.



Immune cell function

Formation of rafts, so many different factors can interact



Immune cell engulfing bacteria


CELL MEMBRANES
ARE WAY MORE COMPLICATED
THAN YOU THINK