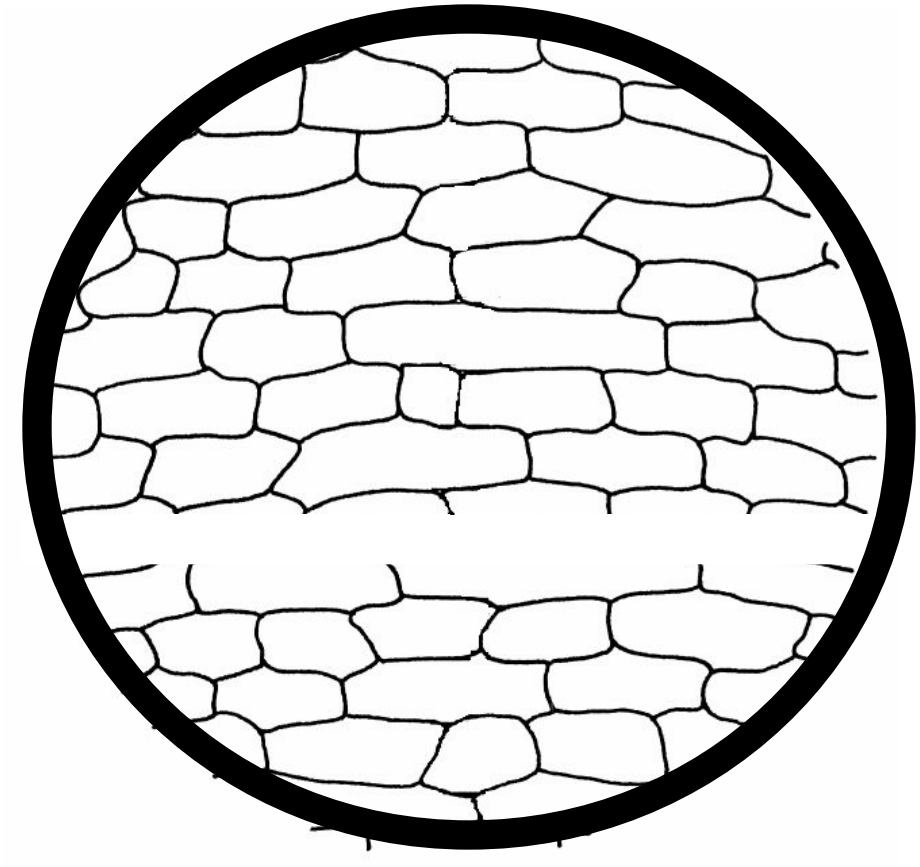
Ideally, we need a scale we can see directly alongside the cells we are observing:



Created on October 31 , 2016 @ 05:35 AM GMT

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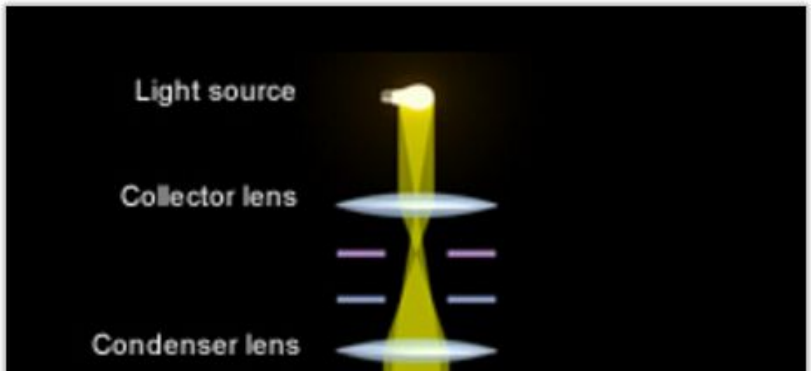
11.2A Cell biology 1 part

Topics:
1. Mechanism of the light microscope
2. Electron microscopes: advantages and disadvantages
3. Structure, function and properties of the cell membrane, including the fluid-mosaic model

A light microscope (LM) is an instrument that uses visible light and magnifying lenses to examine small objects not visible to the naked eye, or in finer detail than the naked eye allows.

Compound light microscope is a microscope with more than one lens and its own light source. In this type of microscope, there are ocular lenses in the binocular eyepieces and objective lenses in a rotating nosepiece closer to the specimen.

Although sometimes found as monocular with one ocular lens, the **compound binocular microscope** is more commonly used today.



Ainur Zhumataevna

"Live as if you were to die tomorrow. Learn as if you were to live forever."

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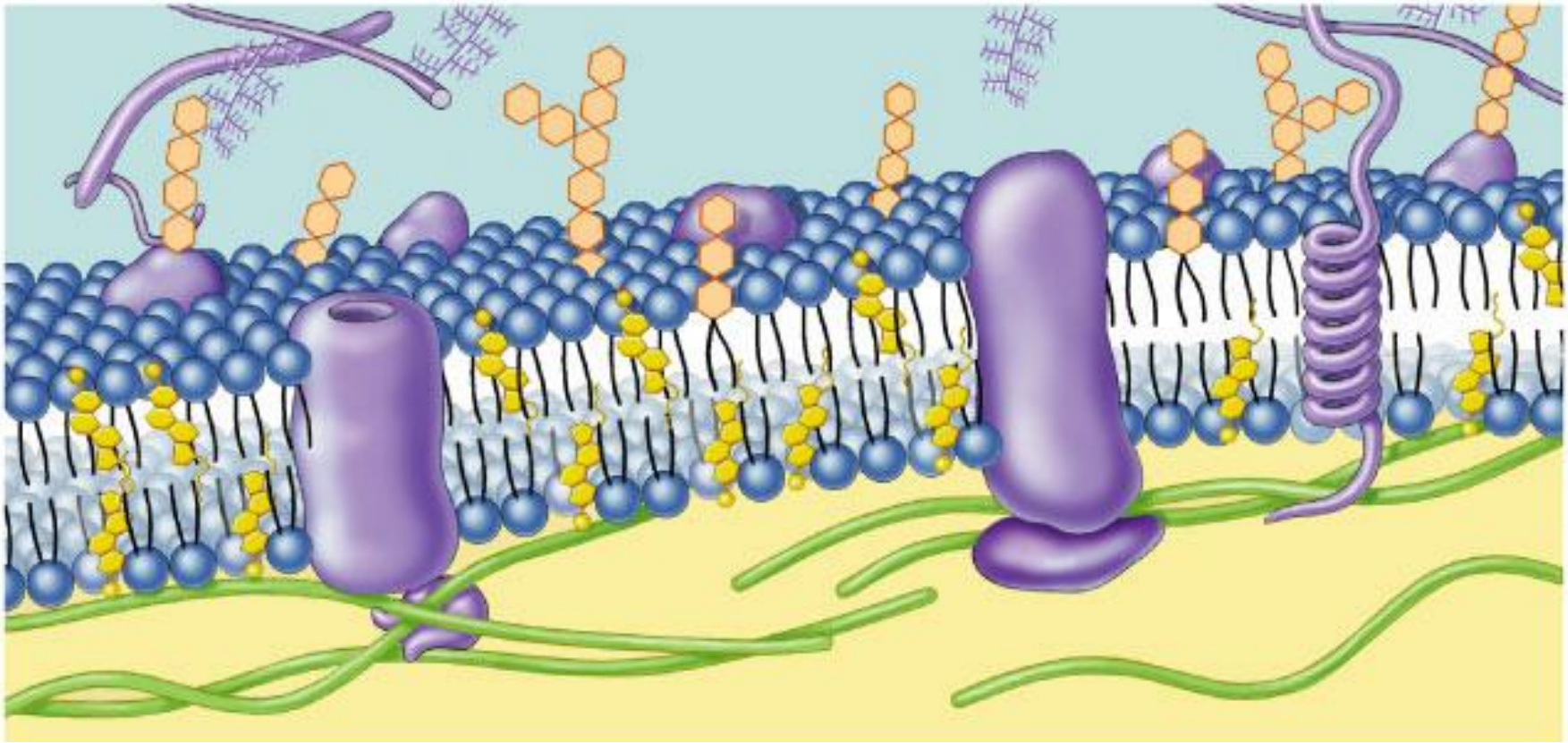
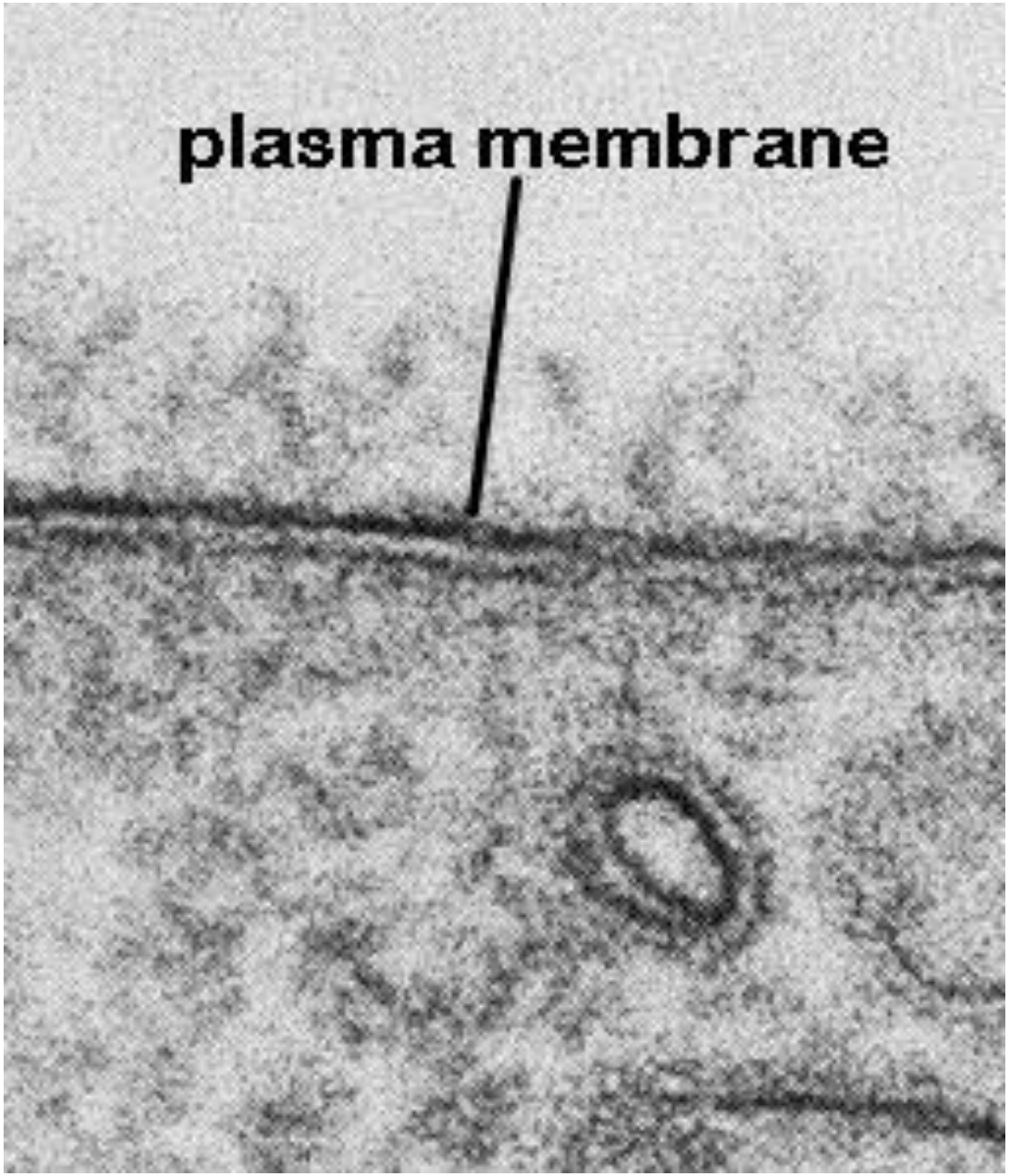
The Cell Membrane




plasma membrane

At the end of this lesson, you should be able to:

- Describe the function of the plasma membrane.
- Describe the fluid mosaic model of membrane structure.
- Explain how hydrophobic interactions determine membrane structure and function.
- Describe how proteins are arranged in membranes and how they contribute to membrane functioning.

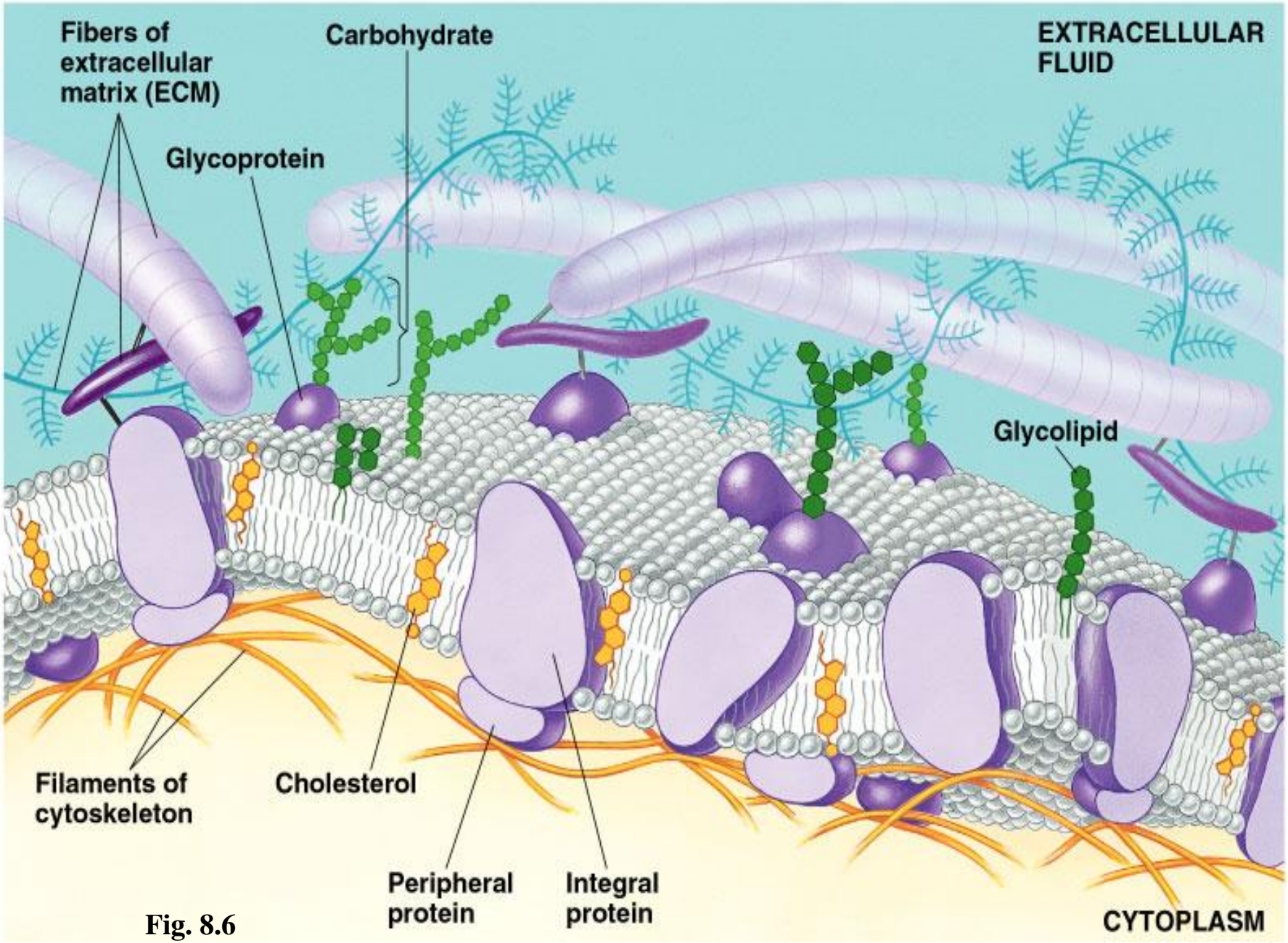


Fig. 8.6

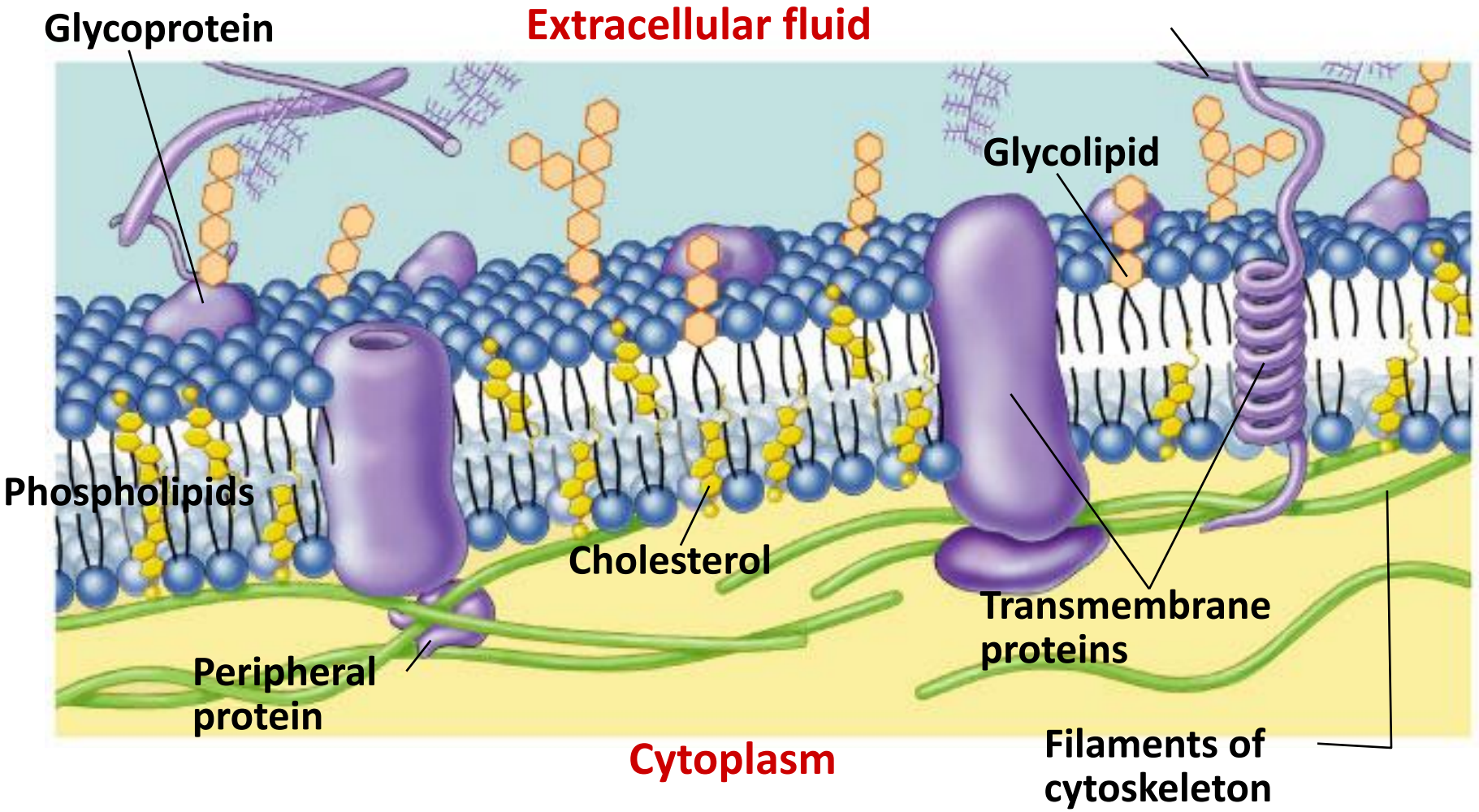
Overview

- The functions of the cell membrane depend on its structure.
- The different components/structures determine the cell membrane's various functions.
- The fluid-mosaic model is the widely recognized and accepted model of the cell membrane.

What's in it?

What are the different components of the cell membrane?

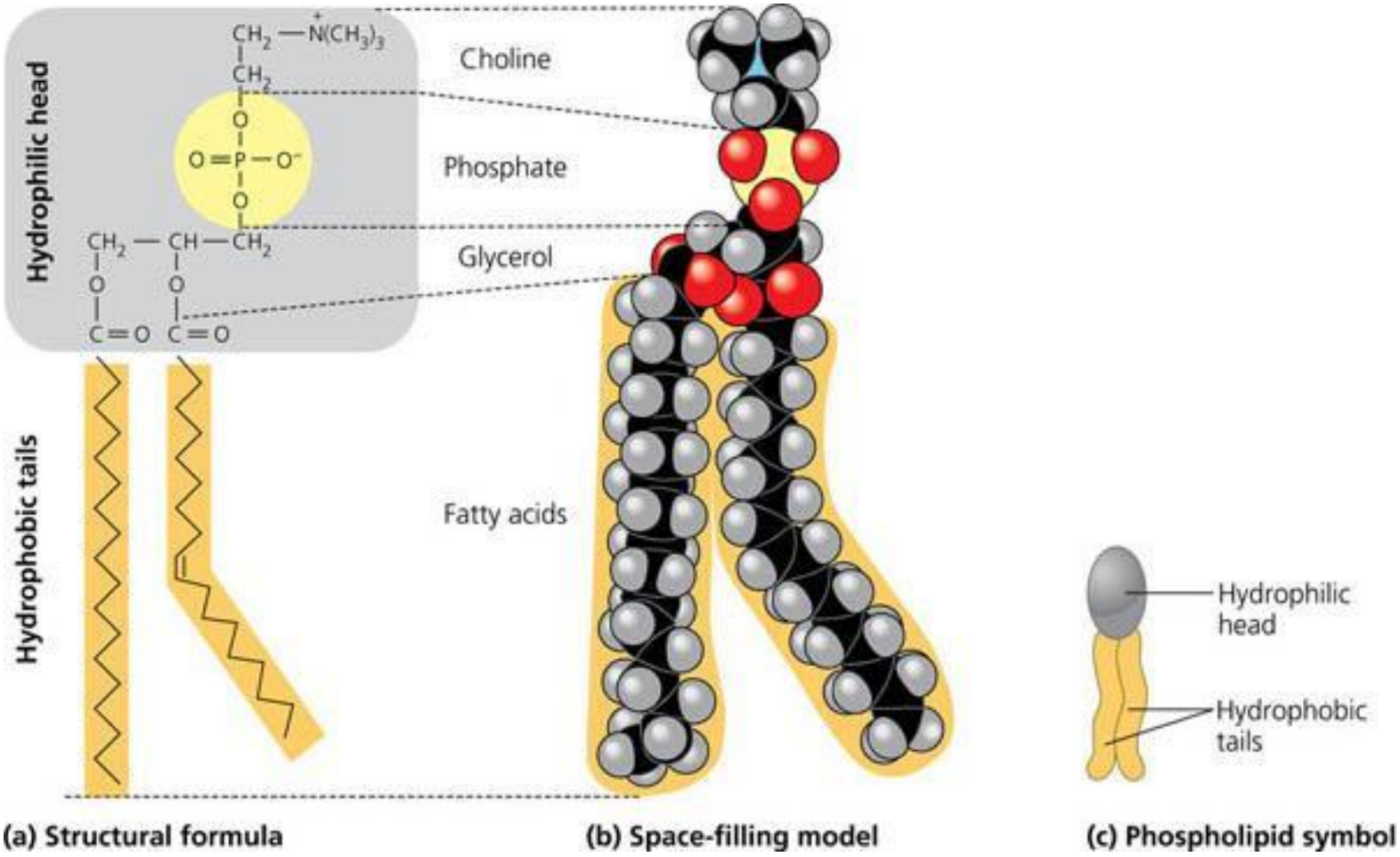
Membrane is a collage of proteins & other molecules embedded in the fluid matrix of the lipid bilayer



What are the different components of the cell membrane?

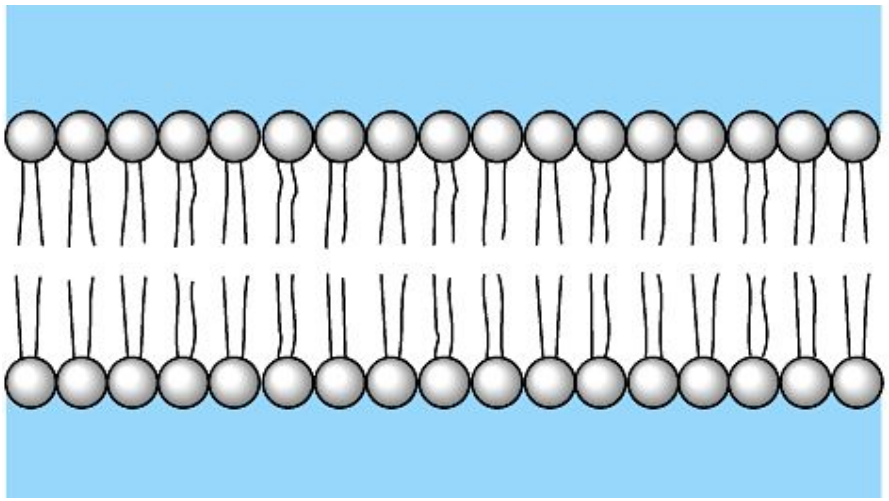
- lipids
- proteins
- carbohydrates

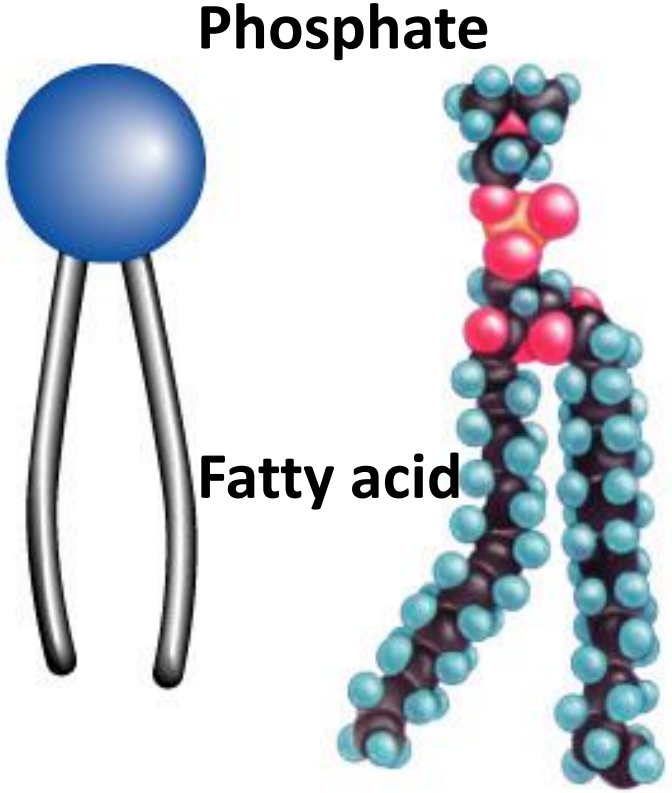
Amphipathic = has both hydrophilic and hydrophobic parts

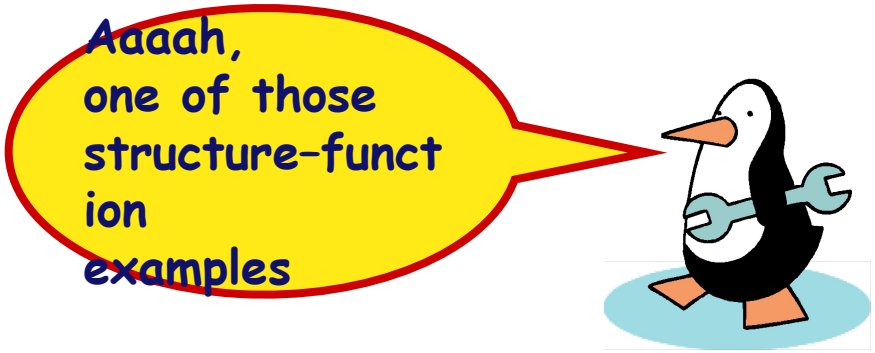


Phospholipids

- Fatty acid tails
  - hydrophobic
- Phosphate group head
  - hydrophilic
- arranged as a bilayer





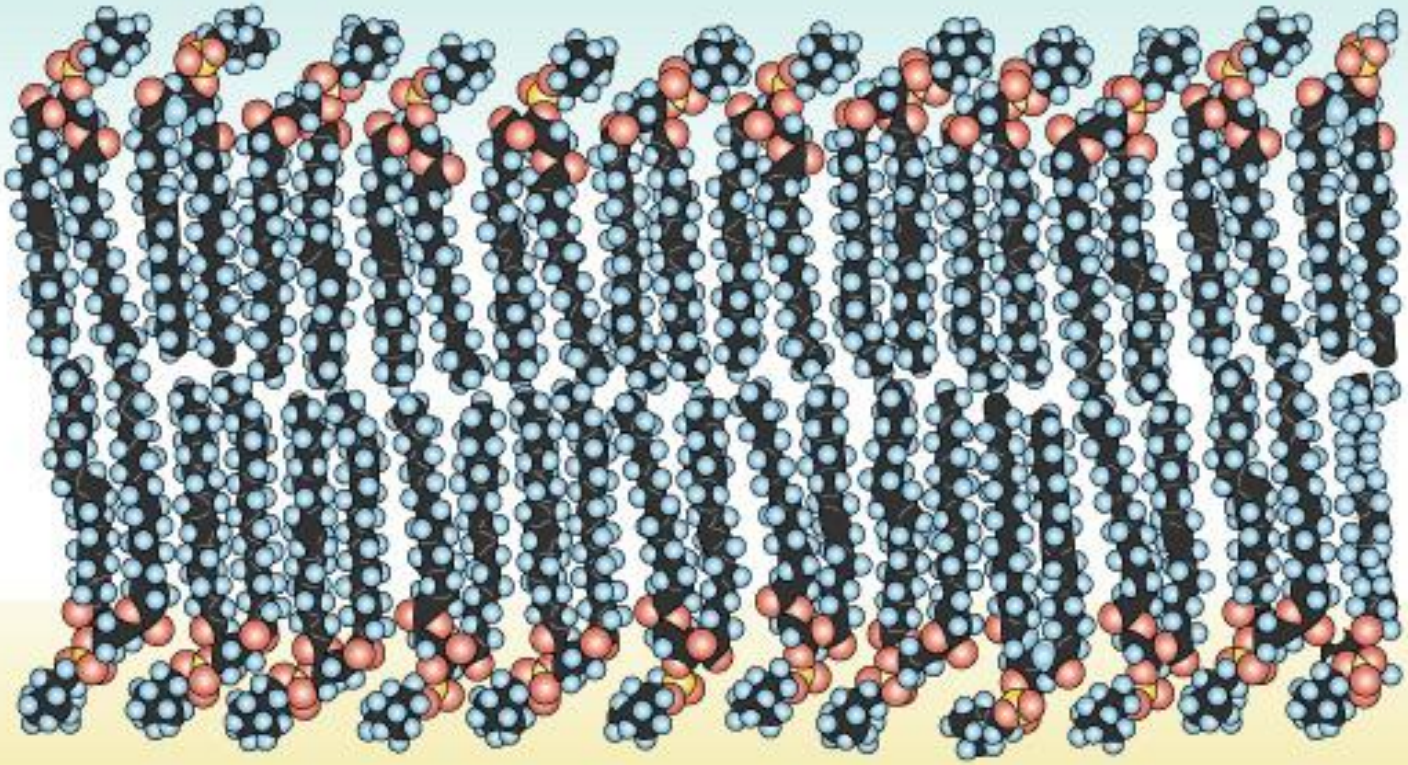


Phospholipid bilayer

polar
hydrophilic
heads

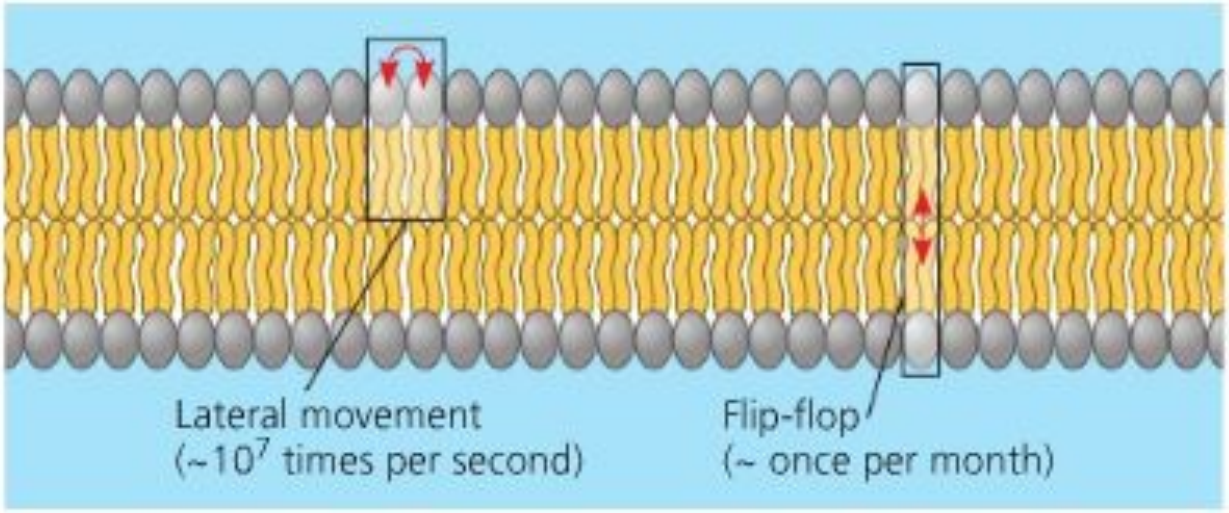
nonpolar
hydrophobic
tails

polar
hydrophilic
heads

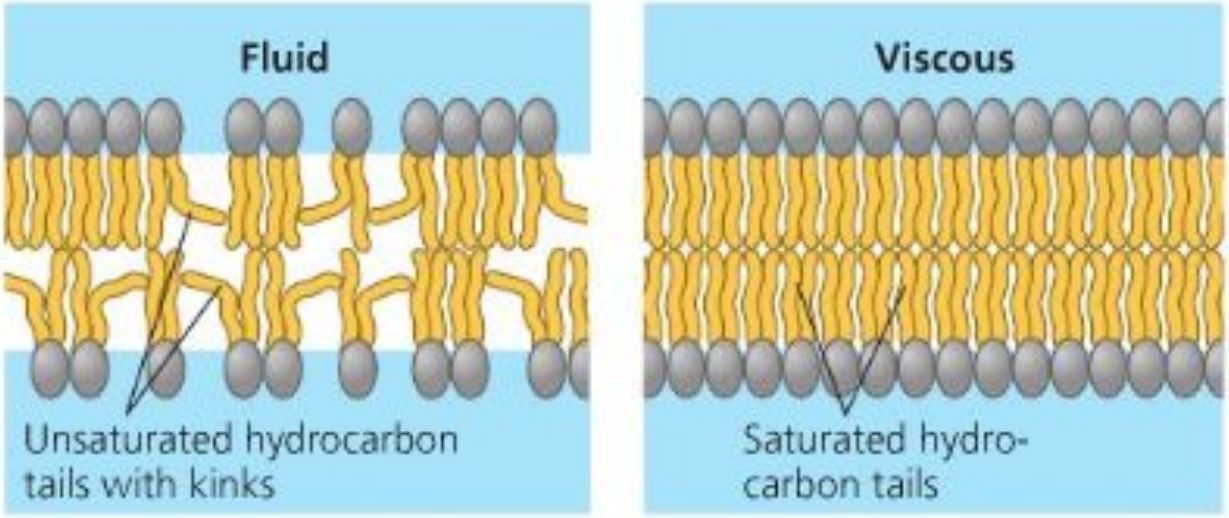


Behavior:

- fluid
- mobile



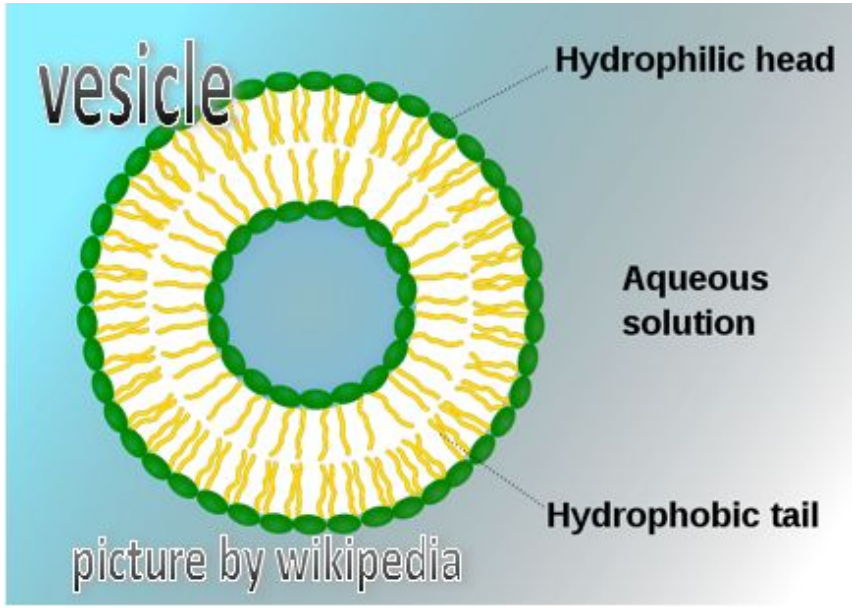
(a) Movement of phospholipids. Lipids move laterally in a membrane, but flip-flopping across the membrane is quite rare.

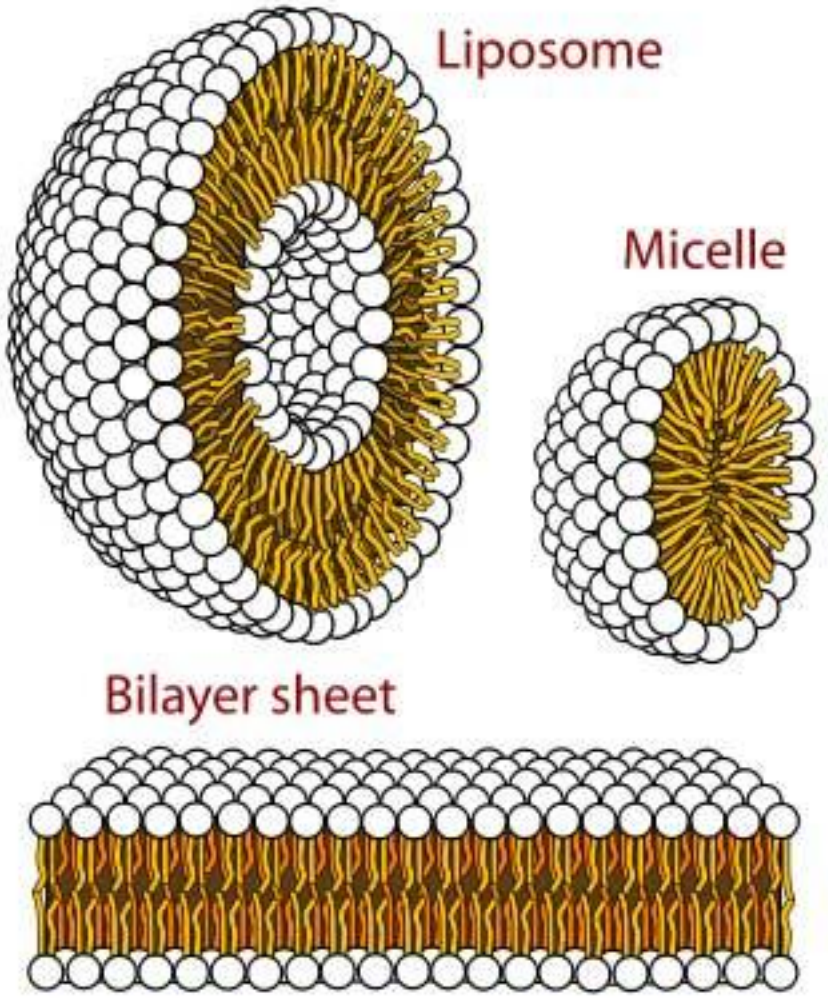


(b) Membrane fluidity. Unsaturated hydrocarbon tails of phospholipids have kinks that keep the molecules from packing together, enhancing membrane fluidity.

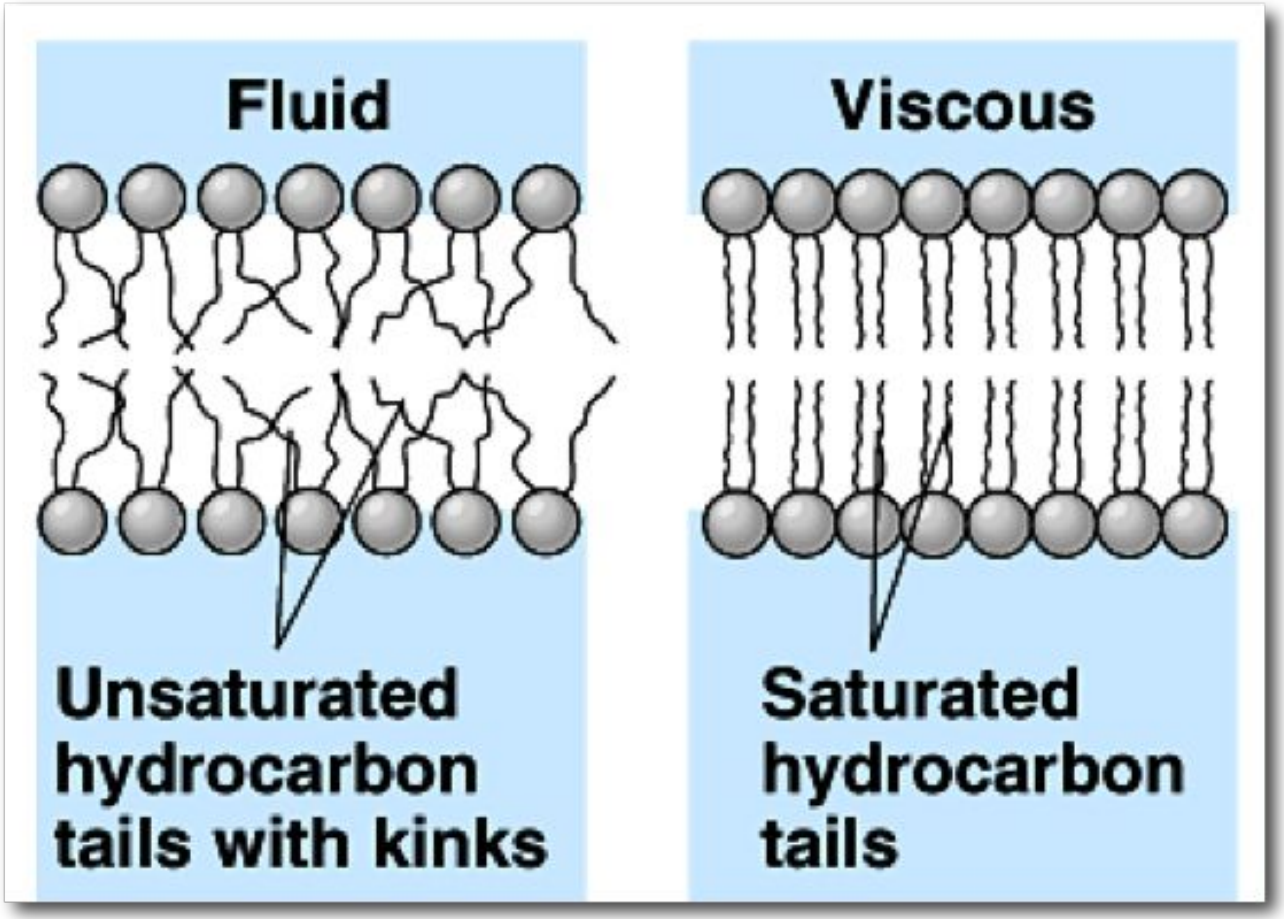
Behavior:

- form vesicles rather than free ends
- can reseal to form intact membranes





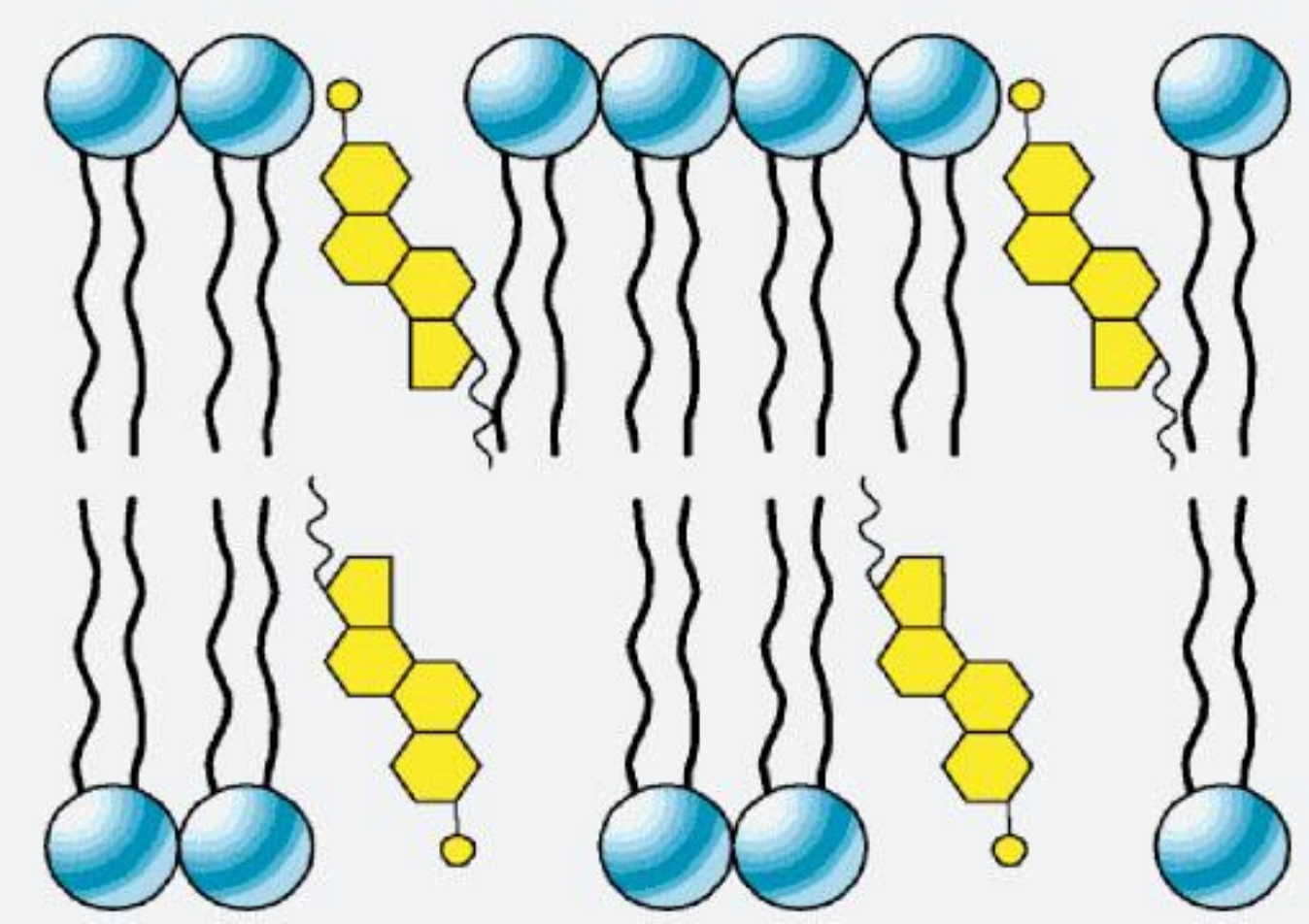
Behavior:


Fluid
Unsaturated hydrocarbon tails with kinks
Viscous
Saturated hydrocarbon tails

Membrane Fat Composition Varies!

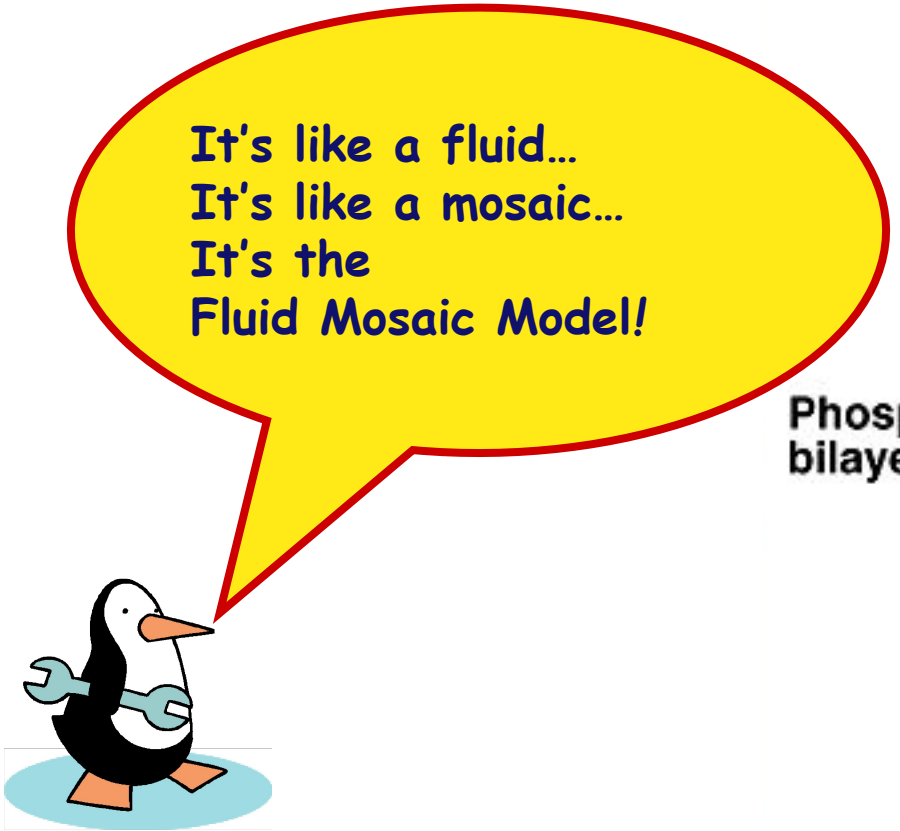
- % unsaturated fatty acids keep the bilipid layer fluid
- The number of unsaturated fatty acids in increases in autumn for cold-adapted organisms.

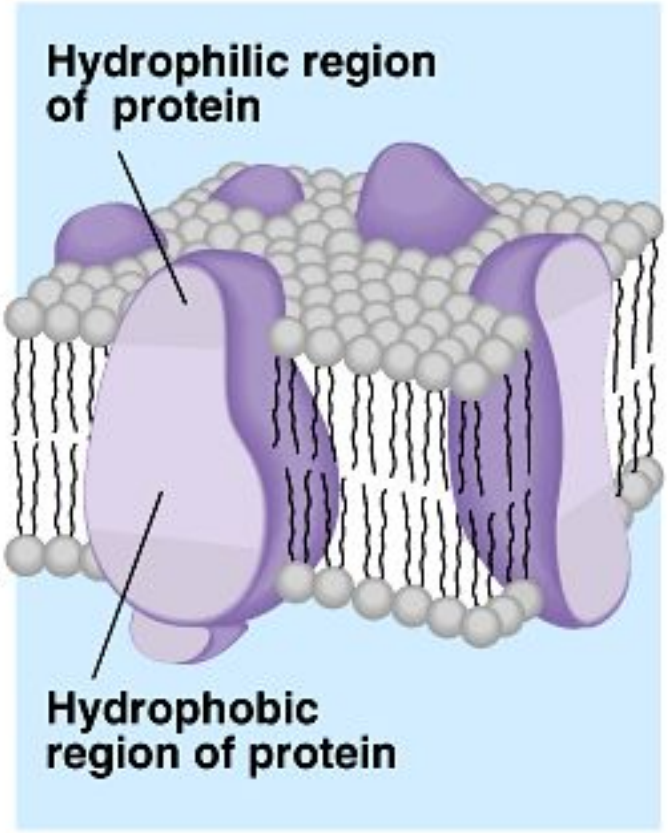
Cholesterol makes the bilipid layer more fluid.



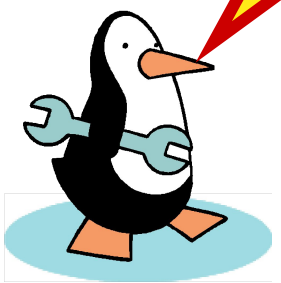
More than lipids…

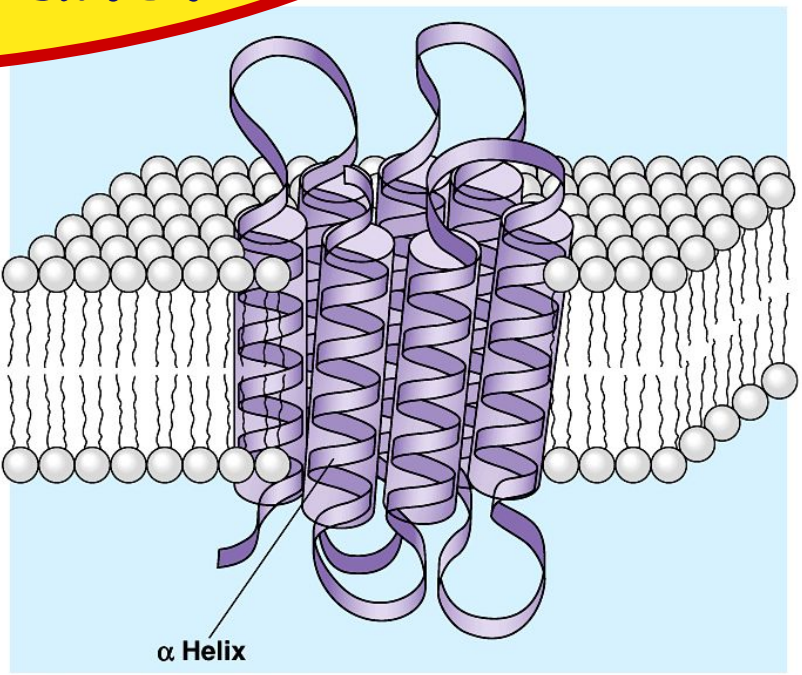
- In 1972, S.J. Singer & G. Nicolson proposed that membrane proteins are inserted into the phospholipid bilayer





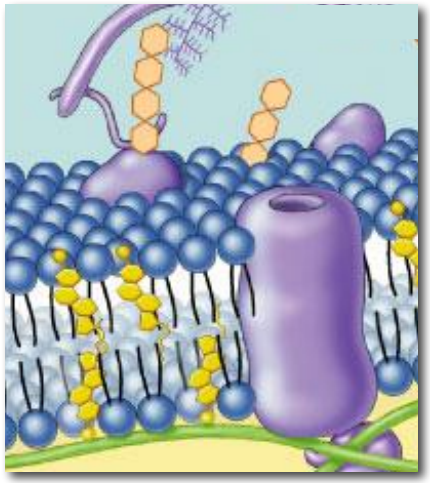
Why are
<u>proteins</u> the perfect
molecule to build
structures
in the cell membrane?



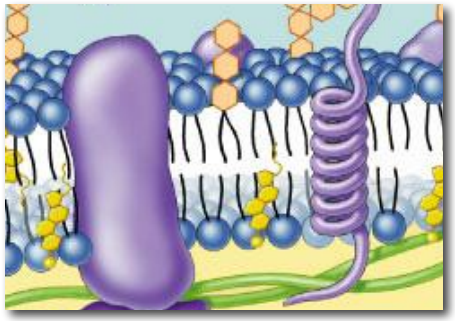


Membrane Proteins

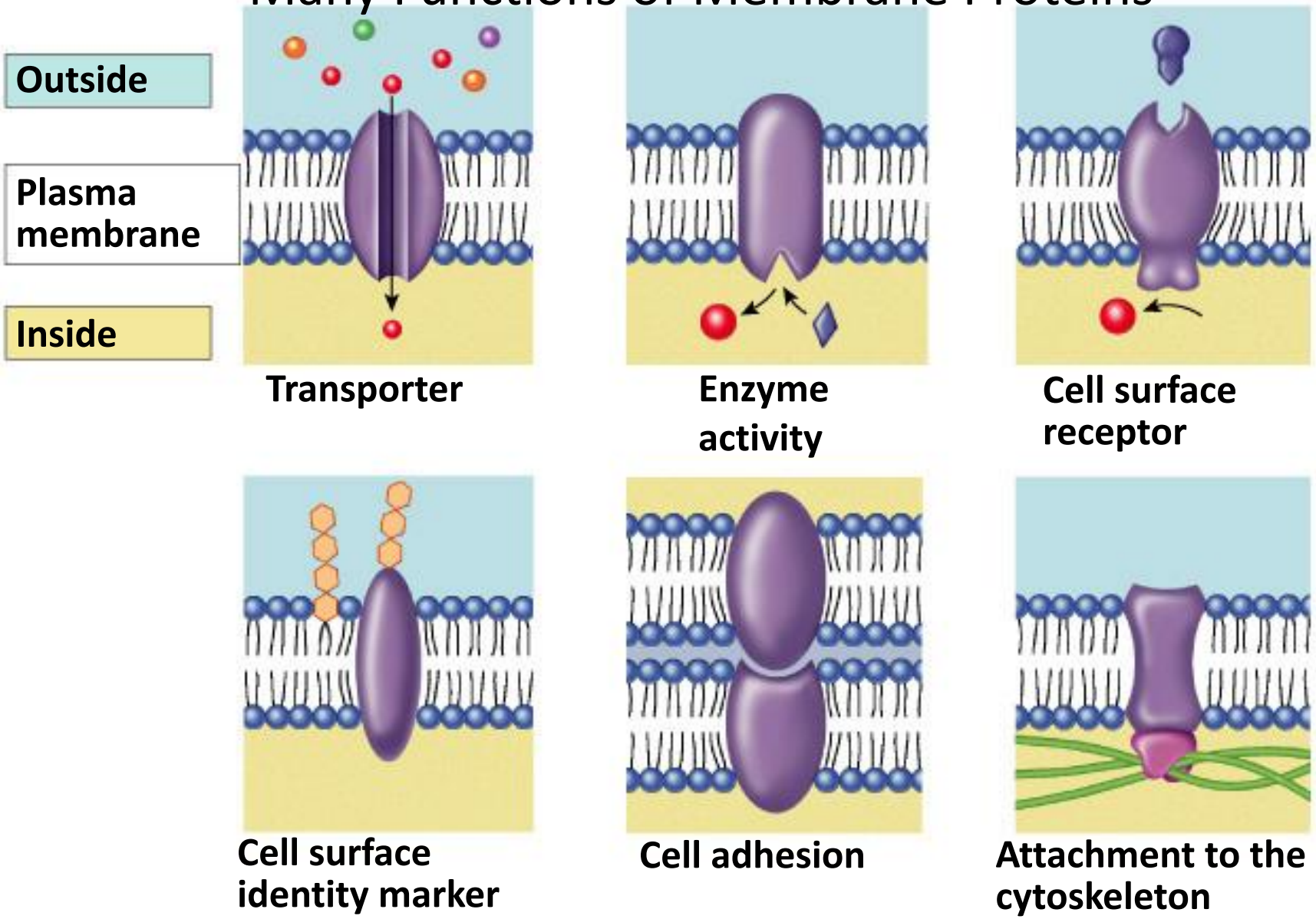
- Proteins determine membrane's specific functions
  - cell membrane & organelle membranes each have unique collections of proteins



- Membrane proteins:
  - peripheral proteins
    - loosely bound to surface of membrane
    - cell surface identity marker (antigens)
  - integral proteins
    - penetrate lipid bilayer, usually across whole membrane
    - transmembrane protein
    - transport proteins
      - channels, permeases (pumps)



Many Functions of Membrane Proteins



- The proteins in the plasma membrane may provide a variety of major cell functions.

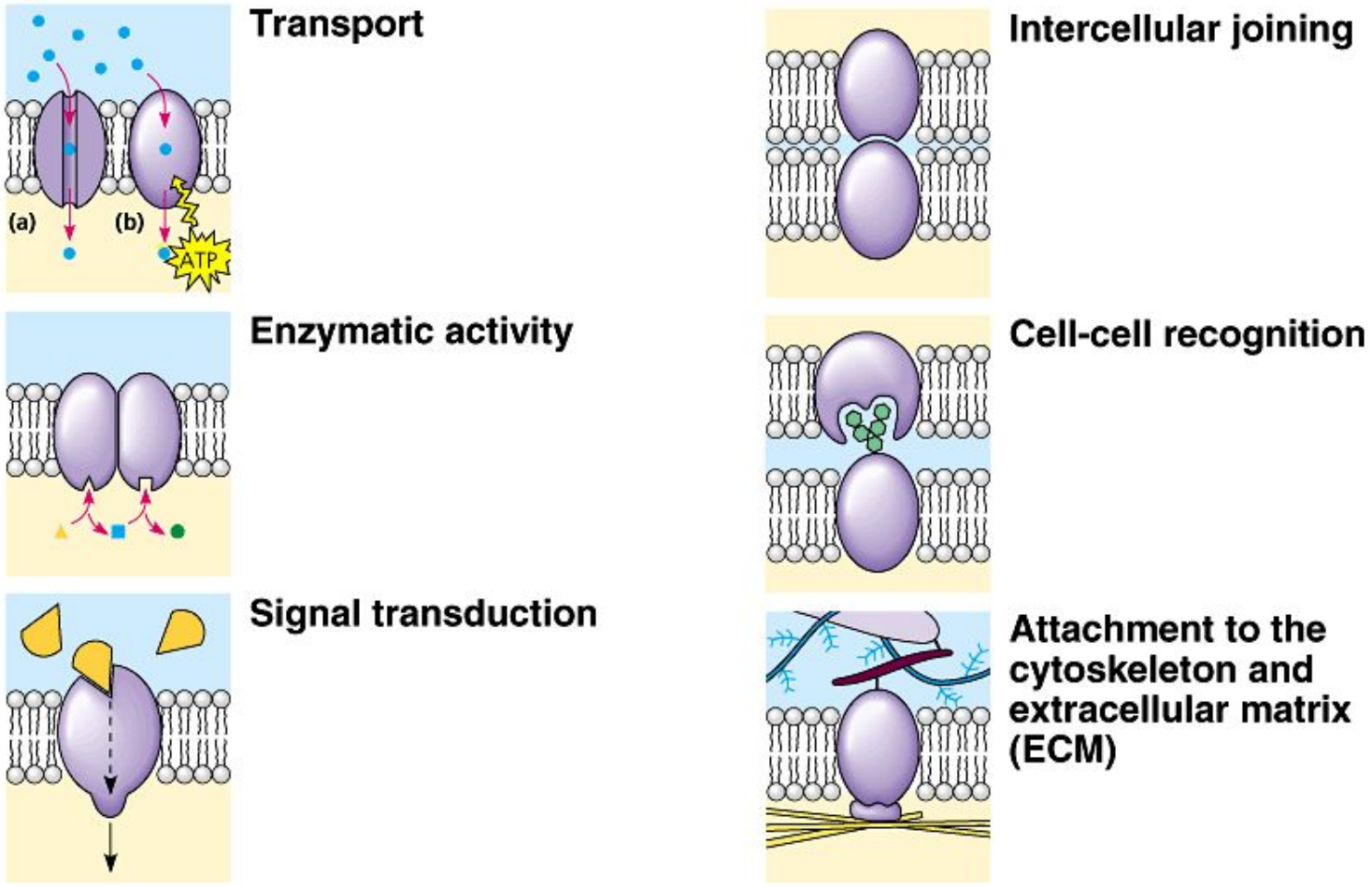
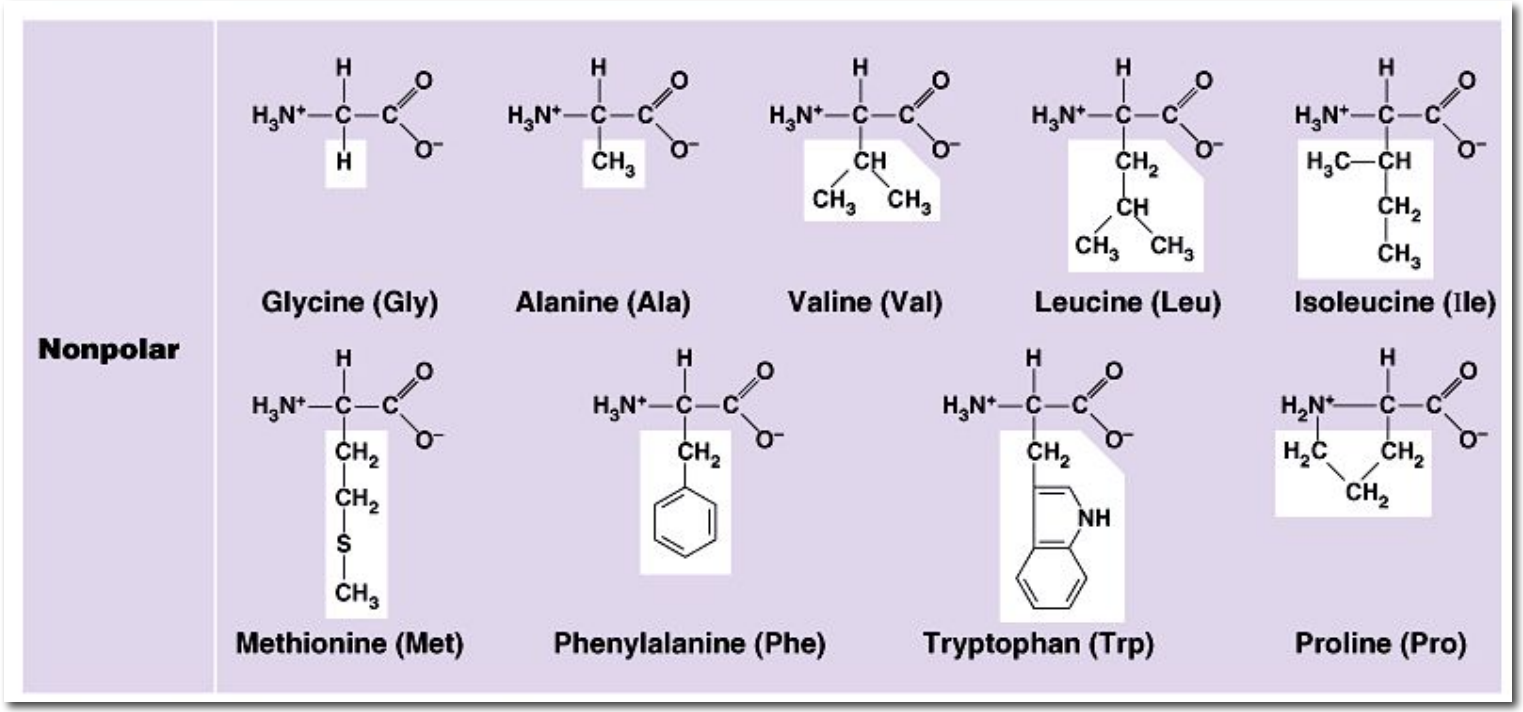


Fig. 8.9

Classes of amino acids

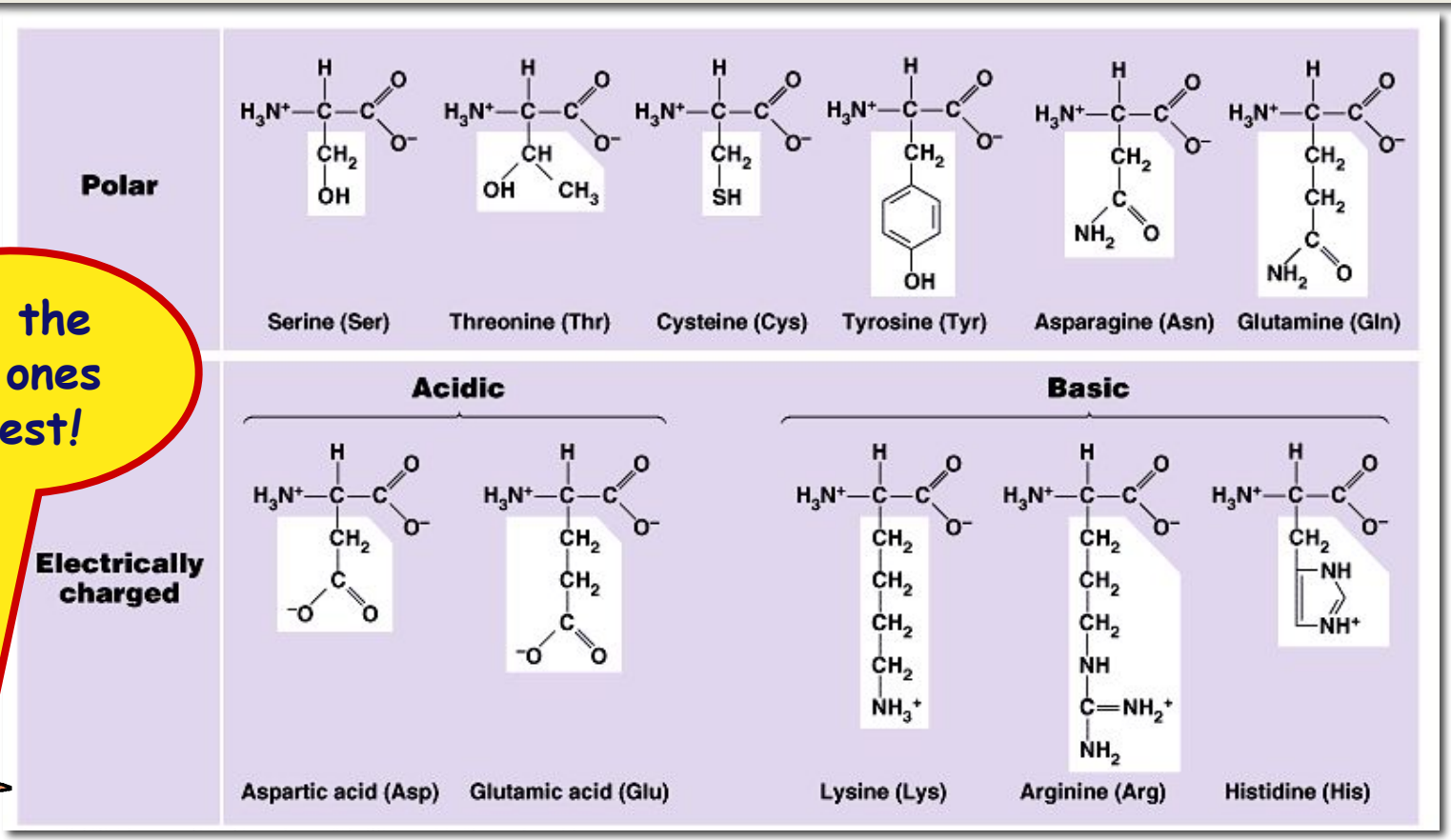
What do these amino acids have in common?

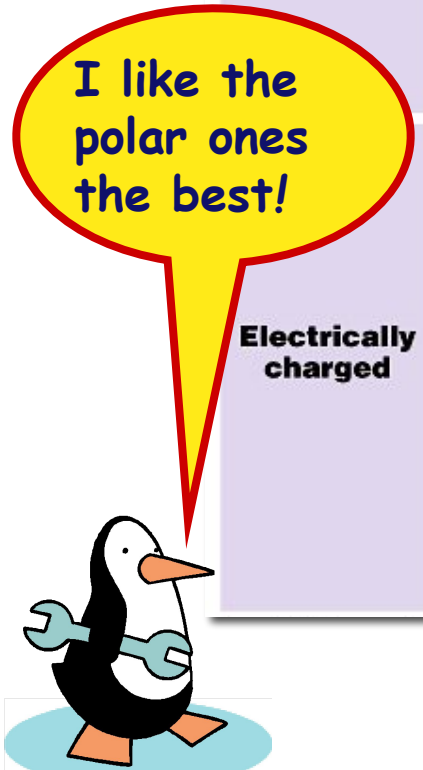


nonpolar & hydrophobic

Classes of amino acids

What do these amino acids have in common?

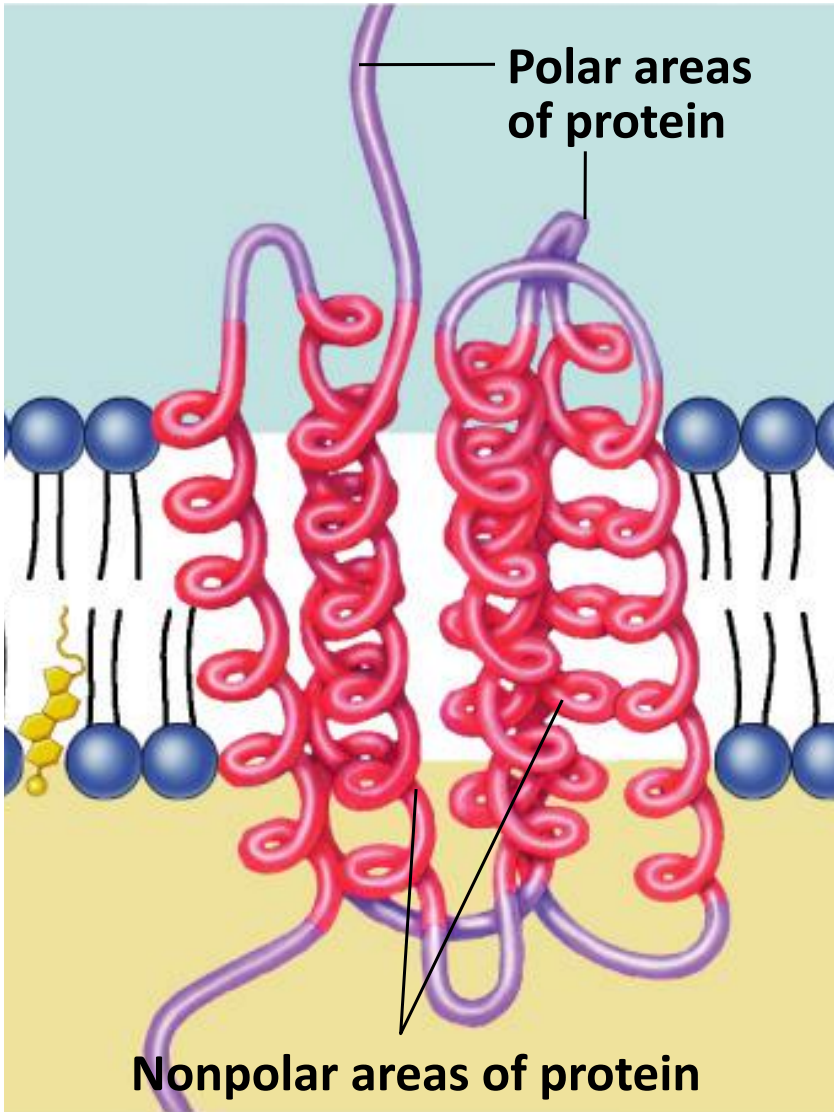




polar & hydrophilic

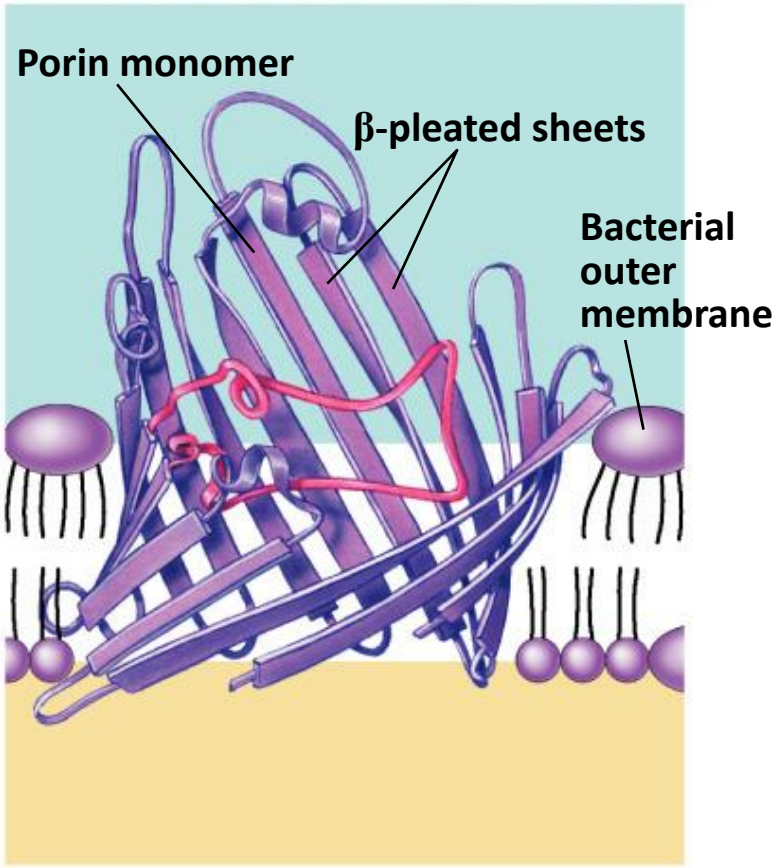
Proteins domains anchor molecule

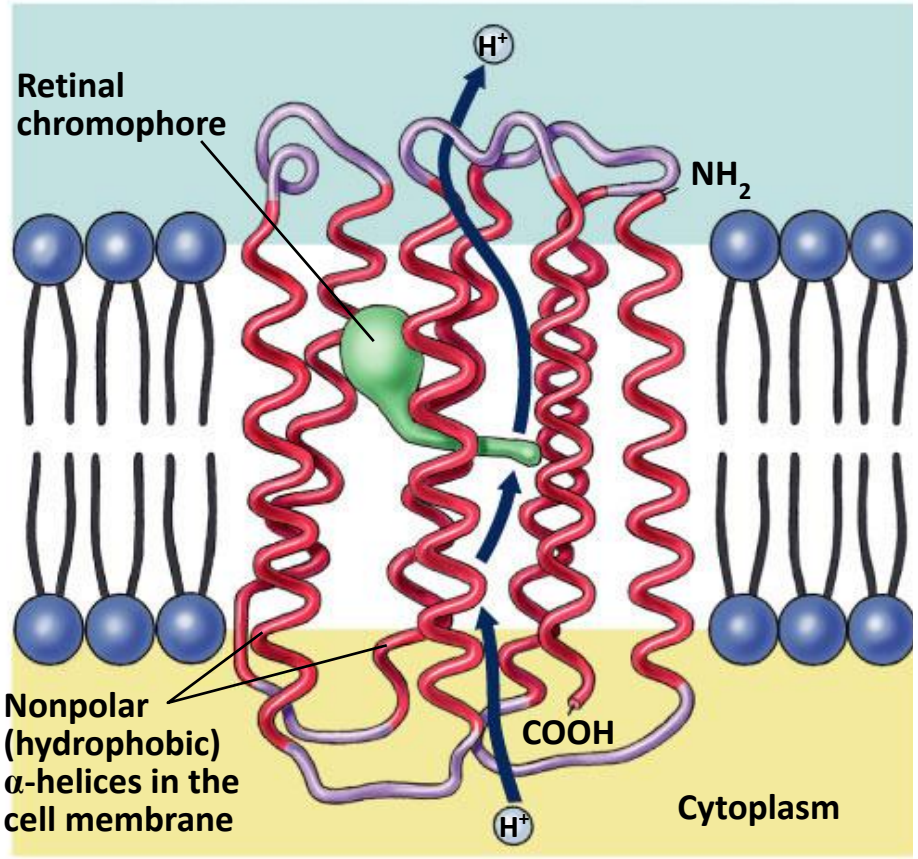
- Within membrane
  - nonpolar amino acids
    - hydrophobic
    - anchors protein into membrane
- On outer surfaces of membrane
  - polar amino acids
    - hydrophilic
    - extend into extracellular fluid & into cytosol



Examples

water channel in bacteria



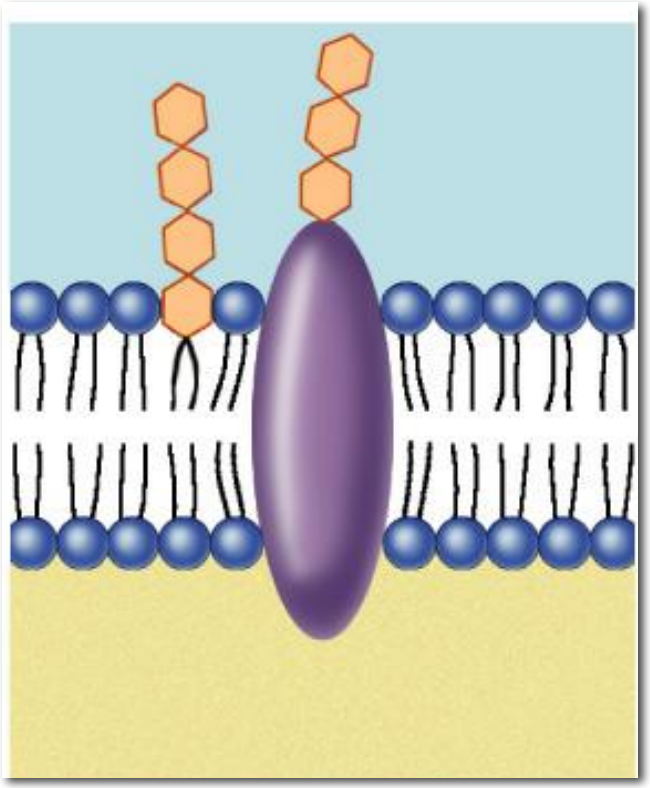


proton pump channel in photosynthetic bacteria

function through conformational change = shape change

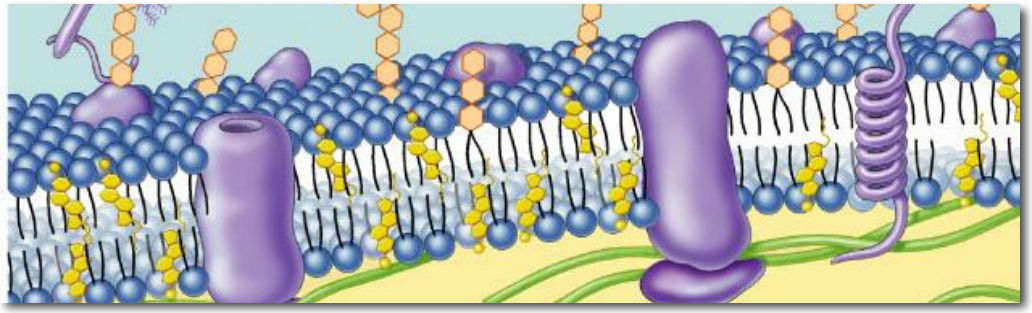
Membrane carbohydrates

- Play a key role in cell-cell recognition
  - ability of a cell to distinguish one cell from another
    - antigens
  - important in organ & tissue development
  - basis for rejection of foreign cells by immune system



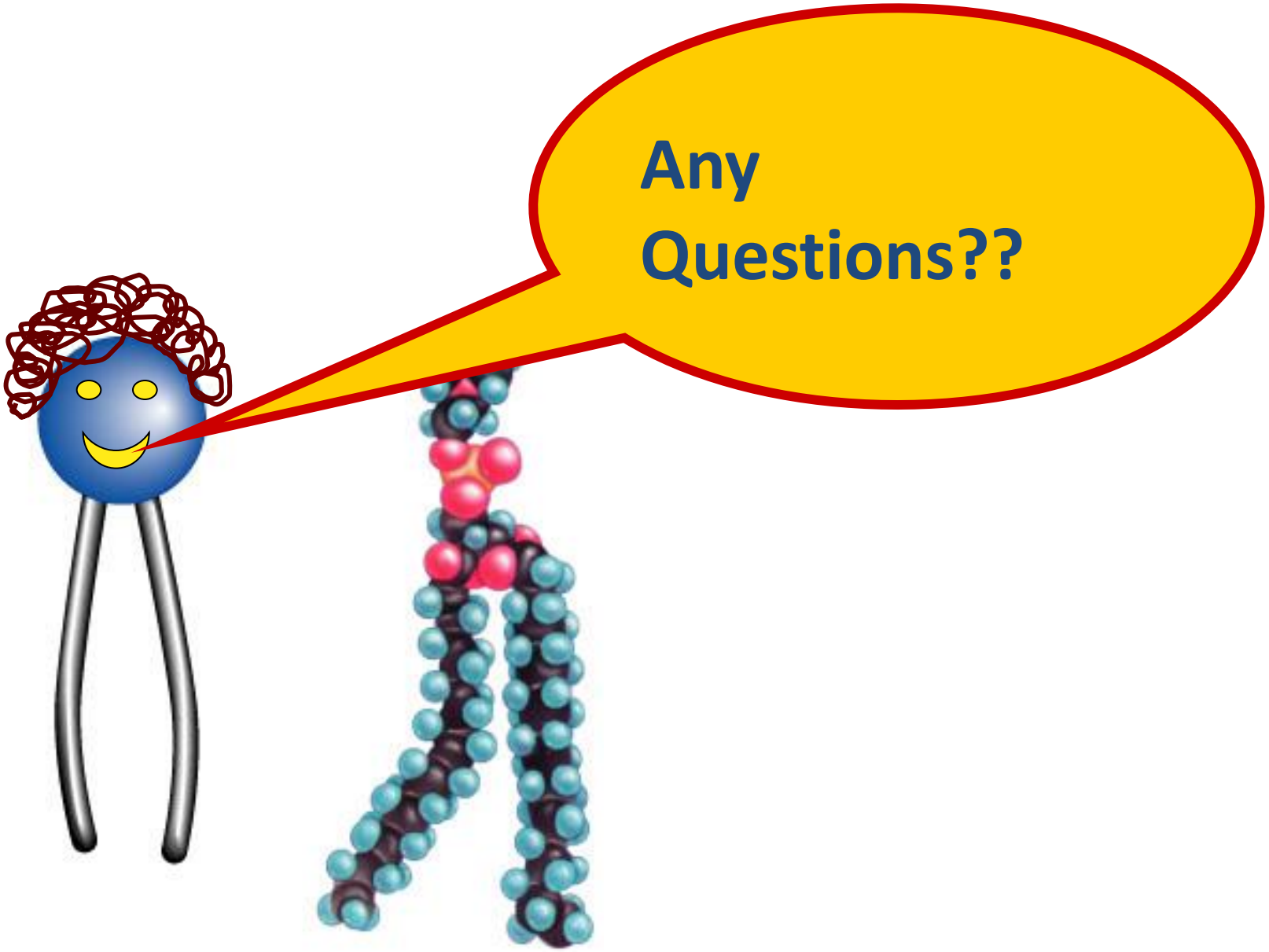
Summary

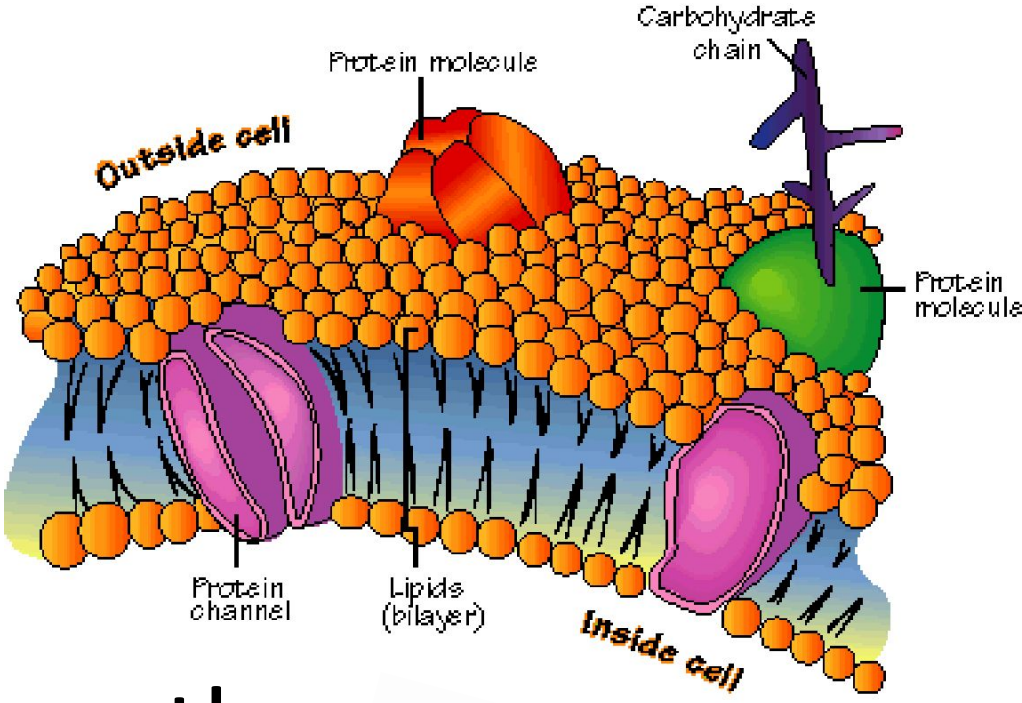
- Cell membrane separates living cell from nonliving surroundings
  - thin barrier = 8 nm thick
- Controls traffic in & out of the cell
  - selectively permeable
  - allows some substances to cross more easily than others
    - hydrophobic vs. hydrophilic
- Made of phospholipids, proteins& other macromolecules



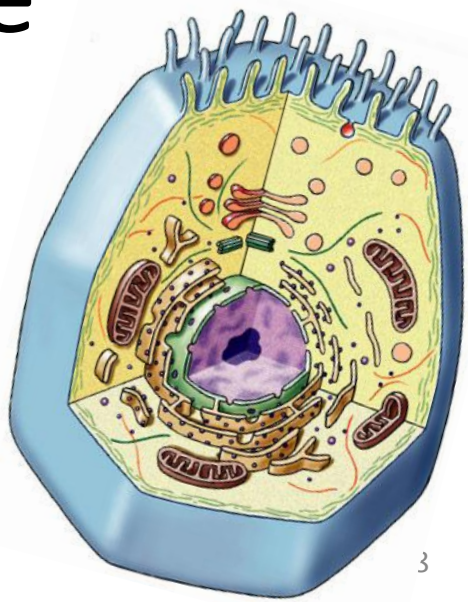
Functions of the plasma membrane:

- acts like the “skin of the cell”
- separates the intracellular components from the cell’s environment (extracellular fluid)
- controls the traffic of substances in and out of the cell (semi-permeable)
- participates in signal transduction
- provides an ID to the cell (cell recognition)


Any
Questions??

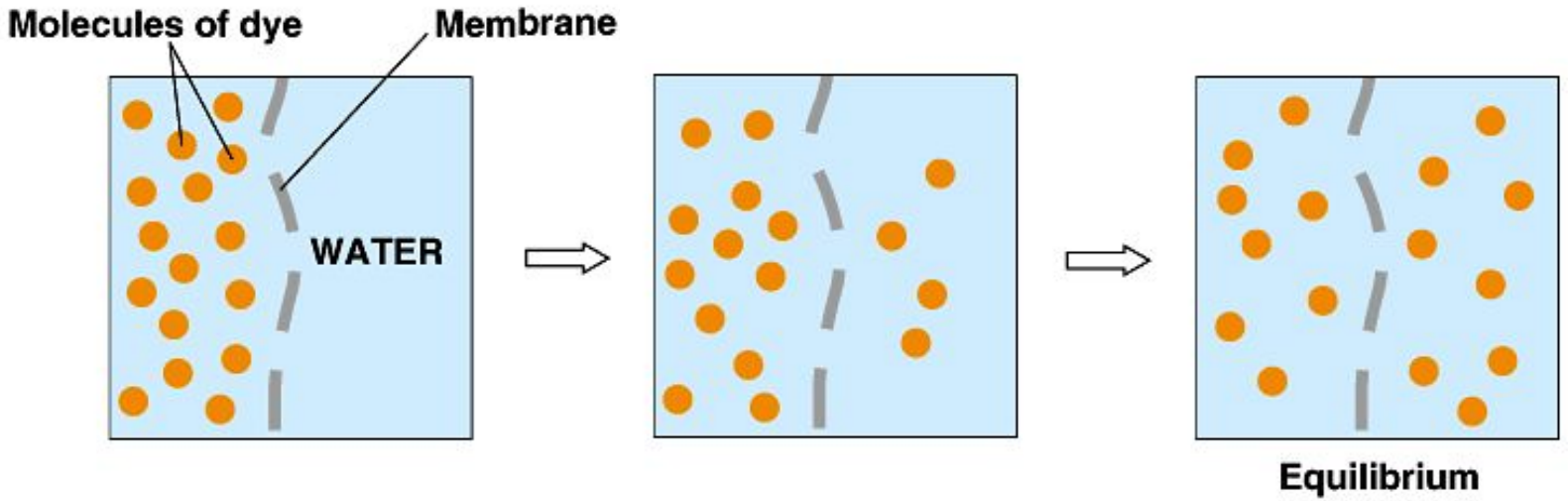


Movement across the Cell Membrane



Diffusion

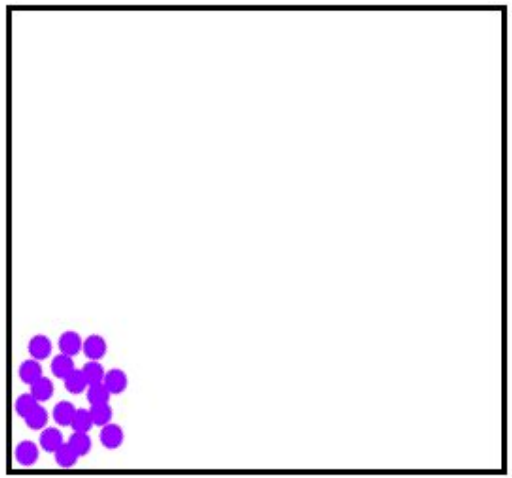
- 2nd Law of Thermodynamics
  governs biological systems
  - universe tends towards disorder (entropy)



- **Diffusion**
  - **movement from high→low concentration**

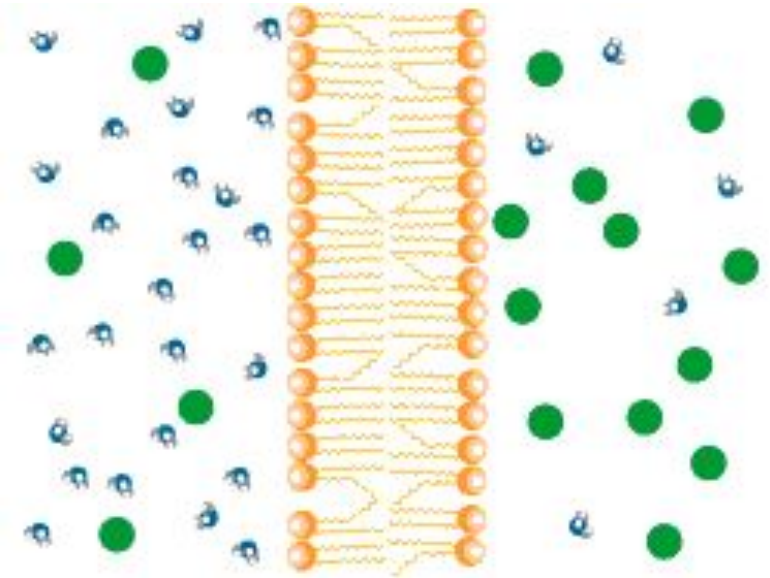
Diffusion

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



diffusion

movement of water



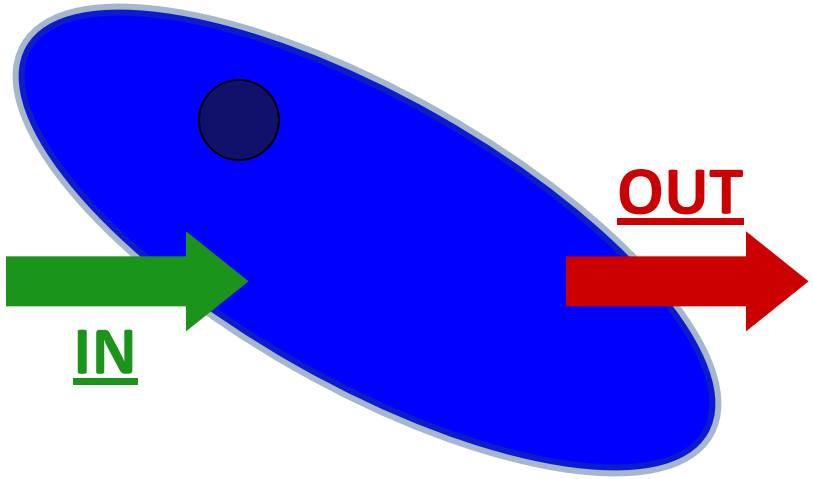
osmosis

Diffusion across cell membrane

- Cell membrane is the boundary between inside & outside…
  - separates cell from its environment

Can it be an impenetrable boundary? **NO!**

IN
food
carbohydrates
sugars, proteins
amino acids
lipids
salts, O_2,H_2O

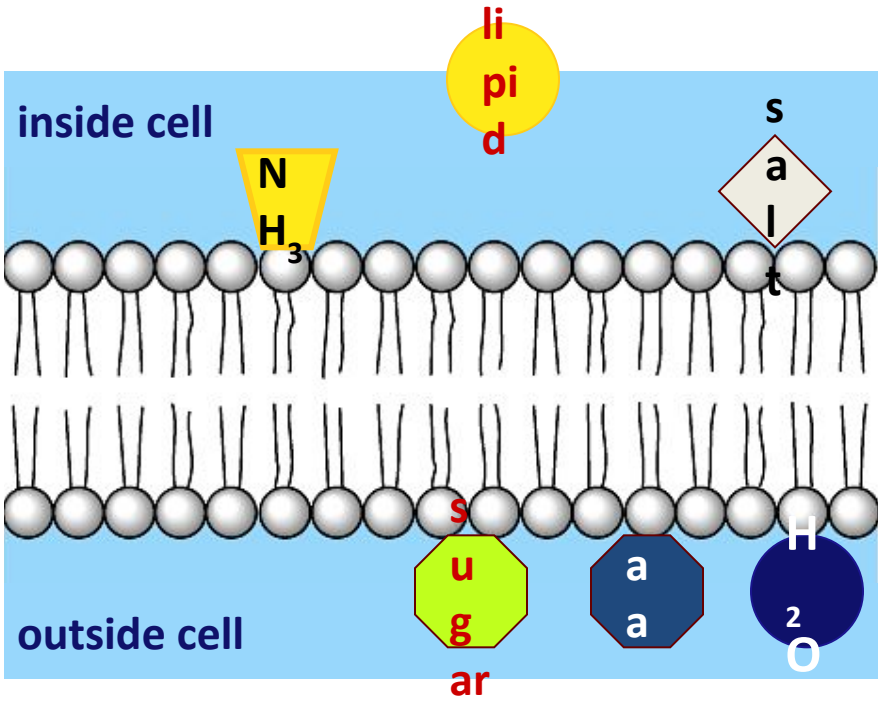


OUT
waste
ammonia
salts
CO_2
H_2O
products

cell needs materials in& products or waste out

Diffusion through phospholipid bilayer

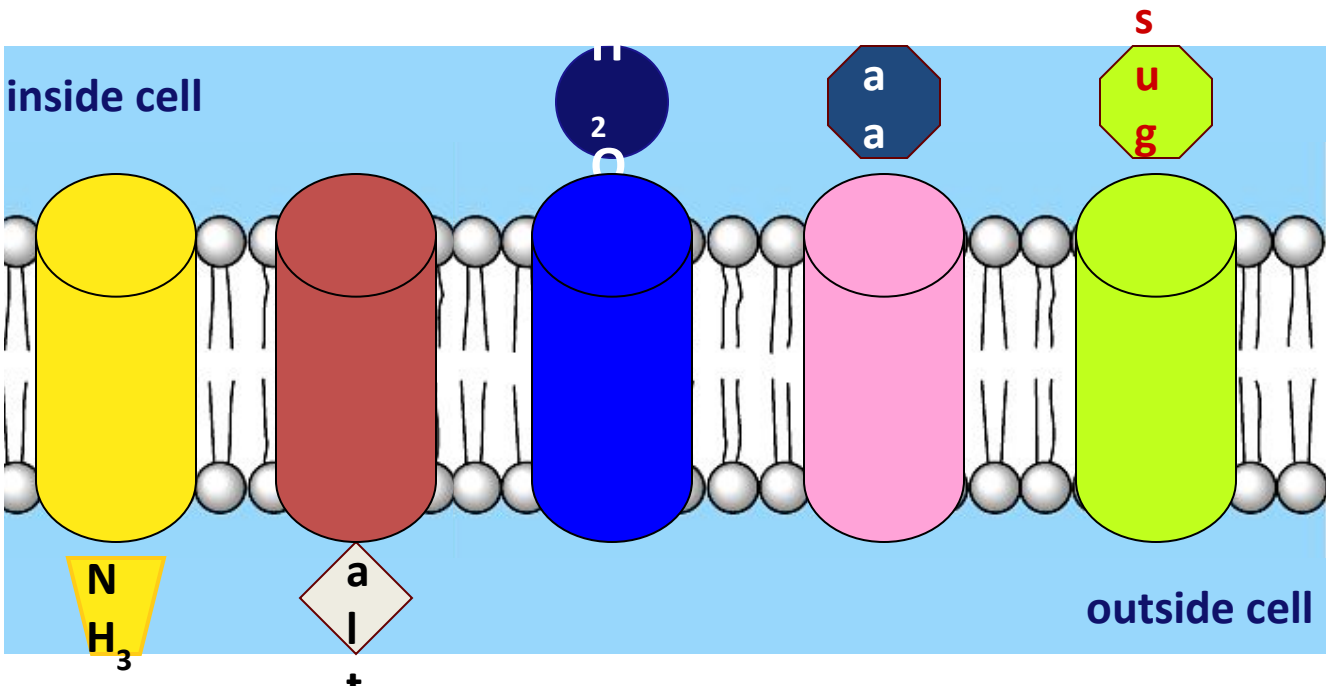
- What molecules can get through directly?
  - fats & other lipids

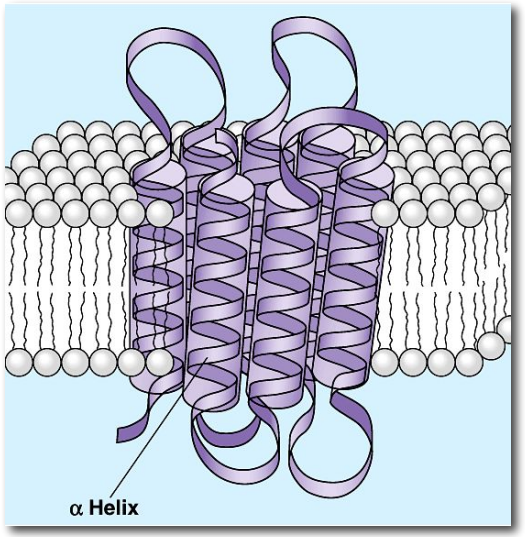


- **What molecules can <u>NOT</u> get through directly?**
  - **polar molecules**
    - **H_2O**
  - **ions**
    - **salts, ammonia**
  - **large molecules**
    - **starches, proteins**

Channels through cell membrane

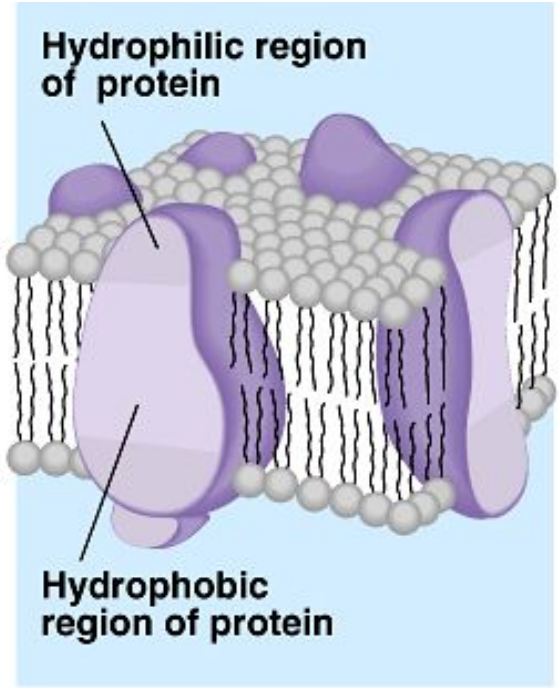
- Membrane becomes semi-permeable with protein channels
  - specific channels allow specific material across cell membrane





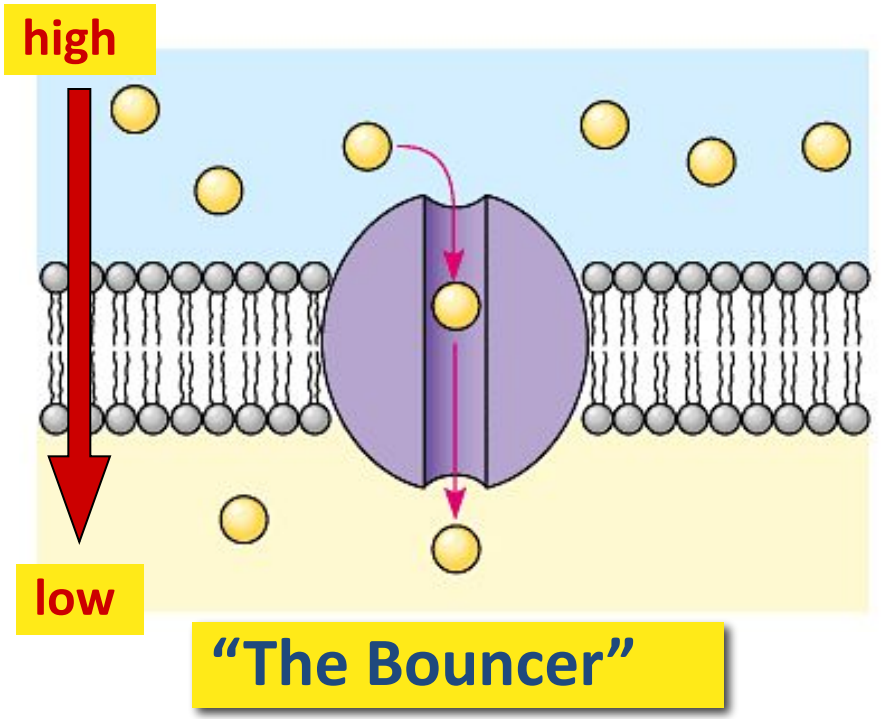
Facilitated Diffusion

- Diffusion through protein channels
  - channels move specific molecules across cell membrane
  - no energy needed



facilitated = with help

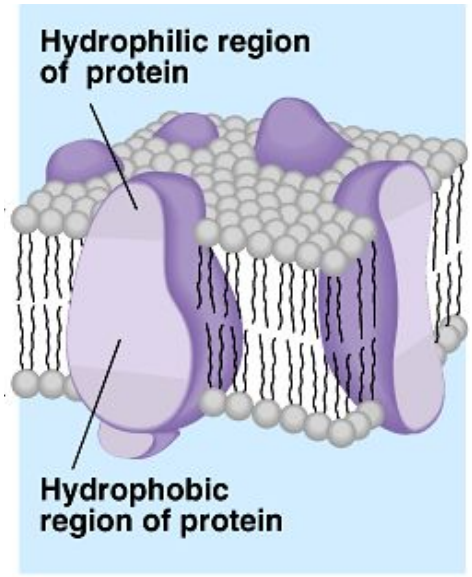
open channel = fast transport

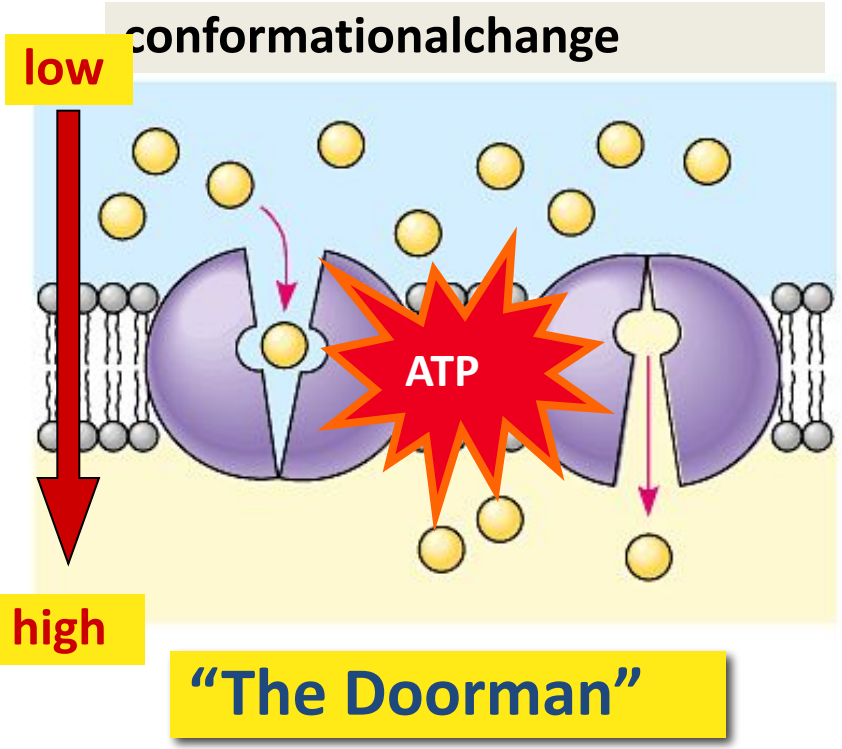


"The Bouncer"

Active Transport

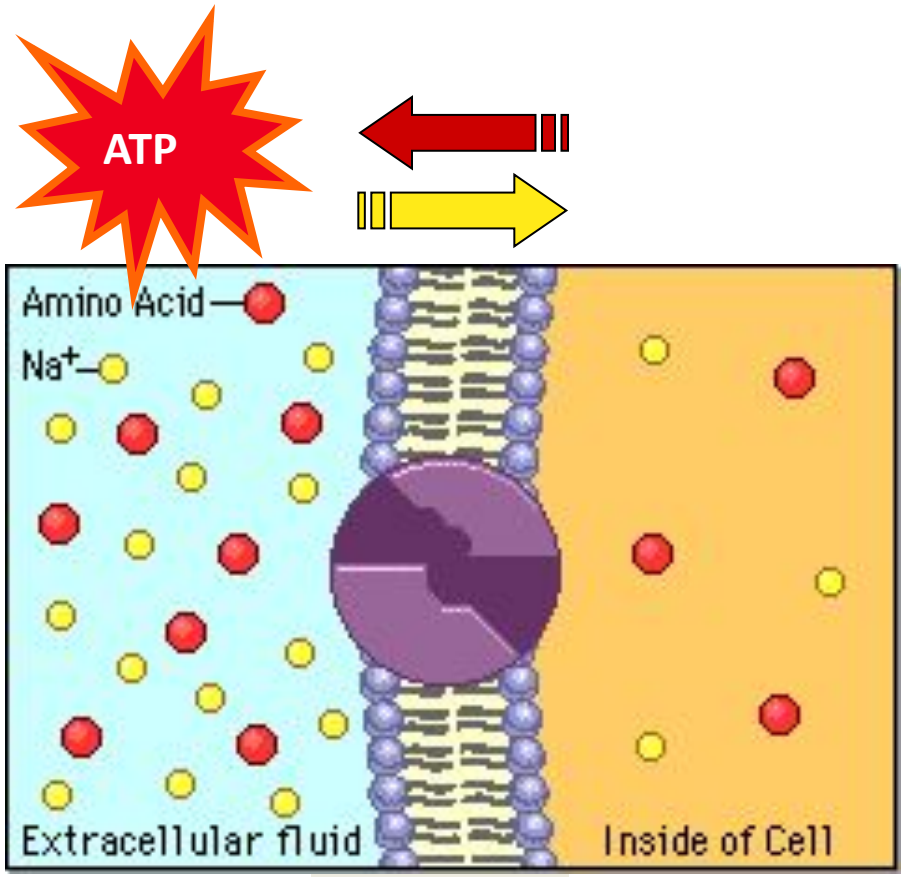
- Cells may need to move molecules *against* concentration gradient
  - shape change transports solute from one side of membrane to other
  - protein "pump"
  - "costs" energy = ATP



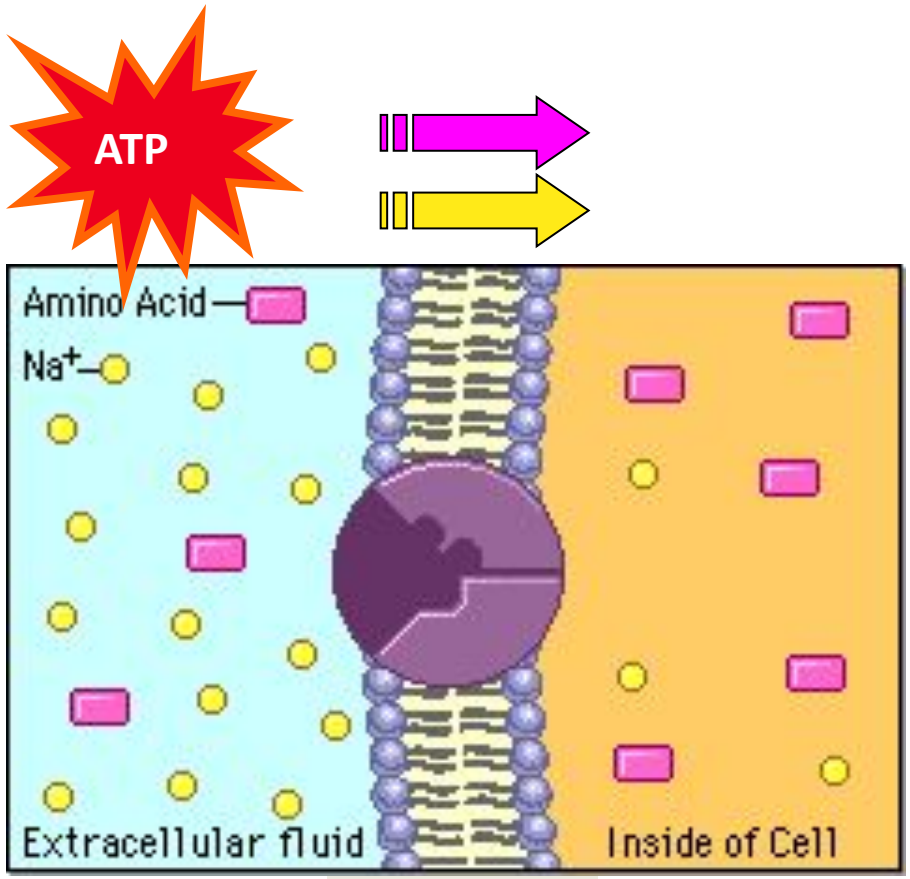


Active transport

- Many models & mechanisms



antiport

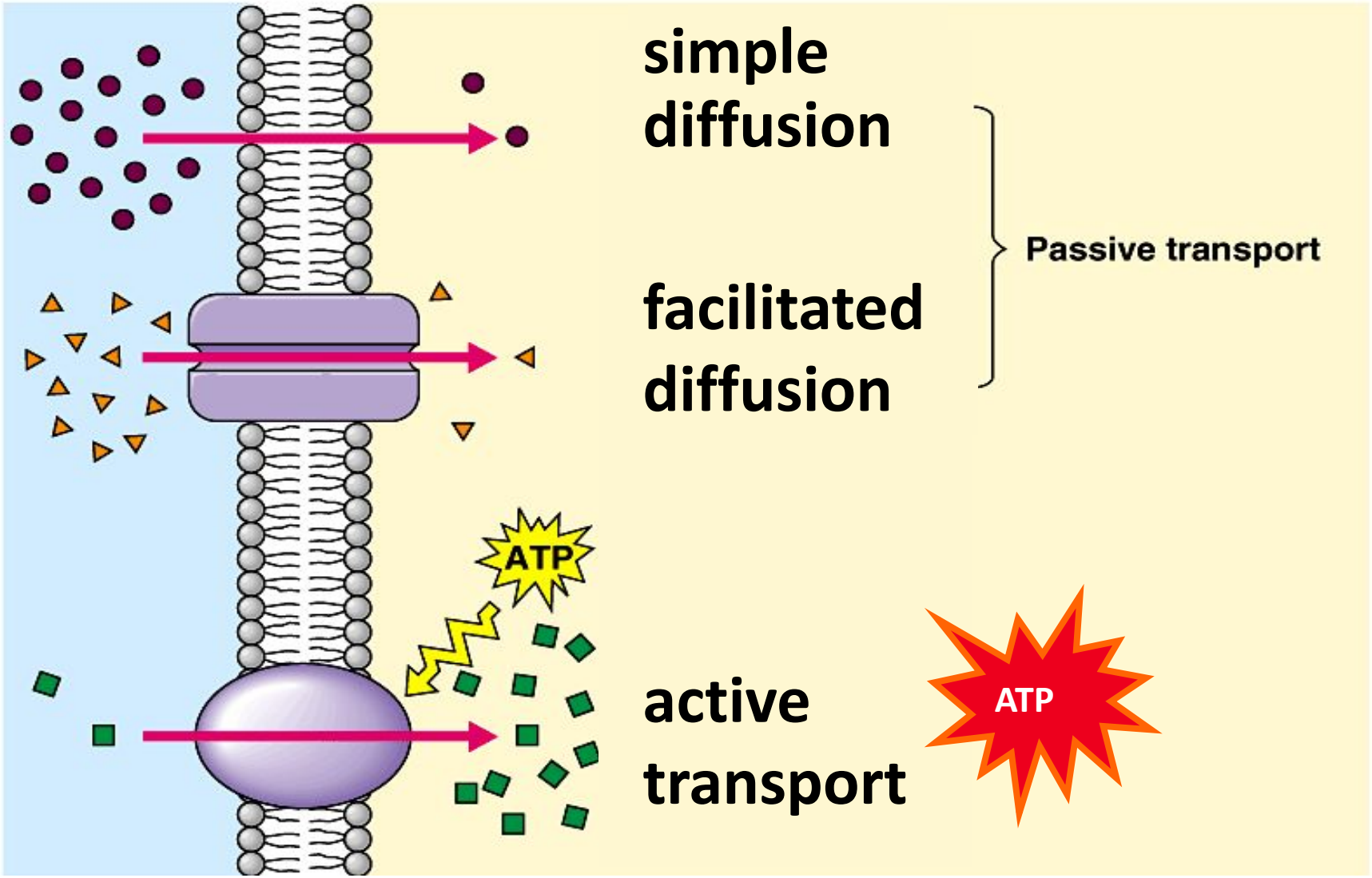


symport

Getting through cell membrane

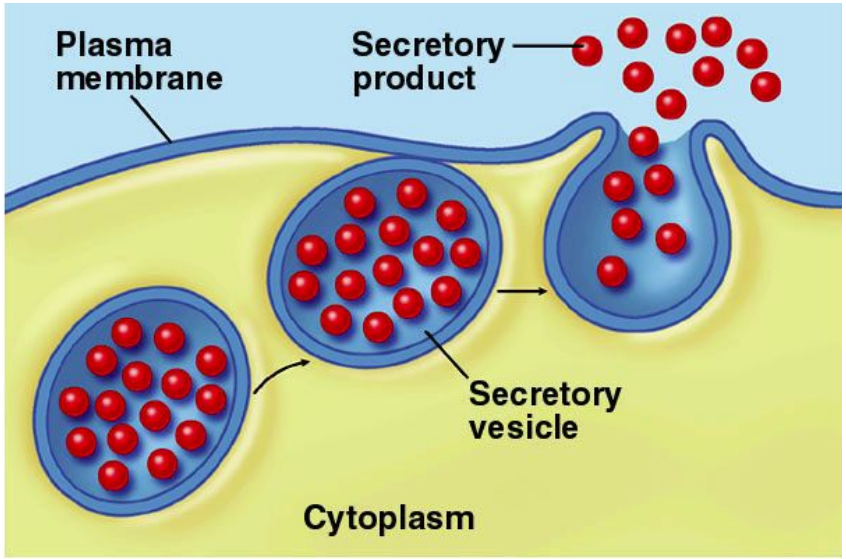
- Passive Transport
  - Simple diffusion
    - diffusion of nonpolar, hydrophobic molecules
      - lipids
      - high → low concentration gradient
  - Facilitated transport
    - diffusion of polar, hydrophilic molecules
    - through a protein channel
      - high → low concentration gradient
- Active transport
  - diffusion *against* concentration gradient
    - low → high
  - uses a protein pump
  - requires ATP

Transport summary



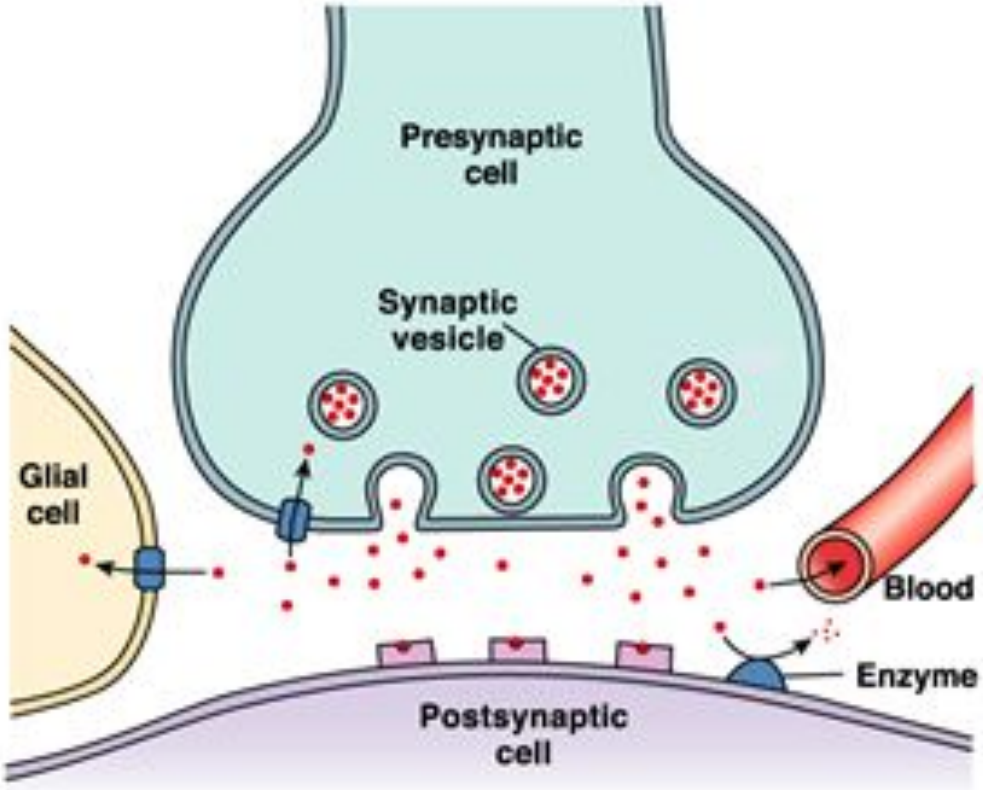
How about large molecules?

- Moving large molecules into & out of cell
  - through vesicles & vacuoles
  - endocytosis
    - phagocytosis = "cellular eating"
    - pinocytosis = "cellular drinking"
  - exocytosis



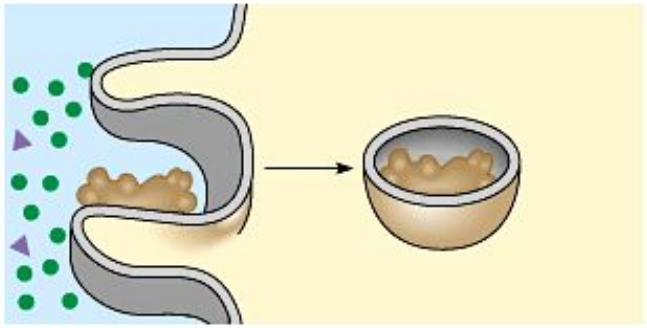
exocytosis

NT inactivation



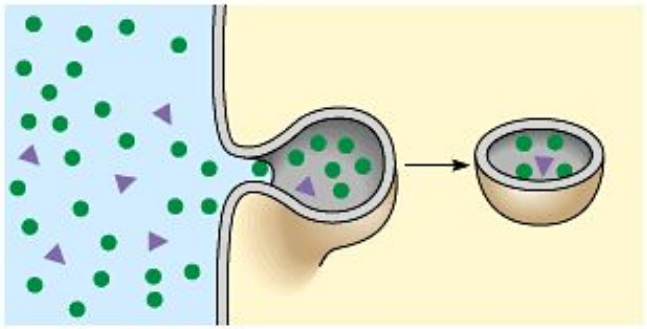
Endocytosis

phagocytosis



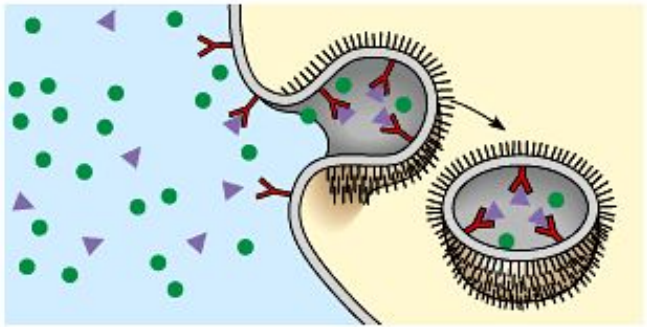
fuse with lysosome for digestion

pinocytosis



non-specific process

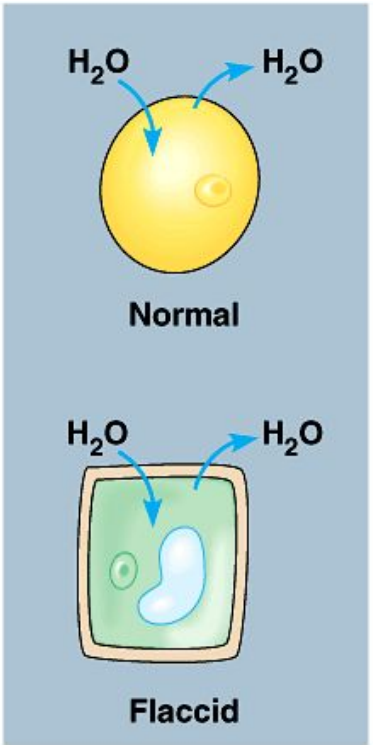
receptor-mediated endocytosis

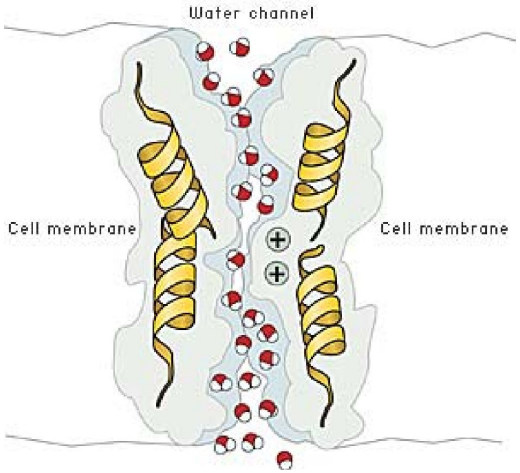


triggered by molecular signal

The Special Case of Water

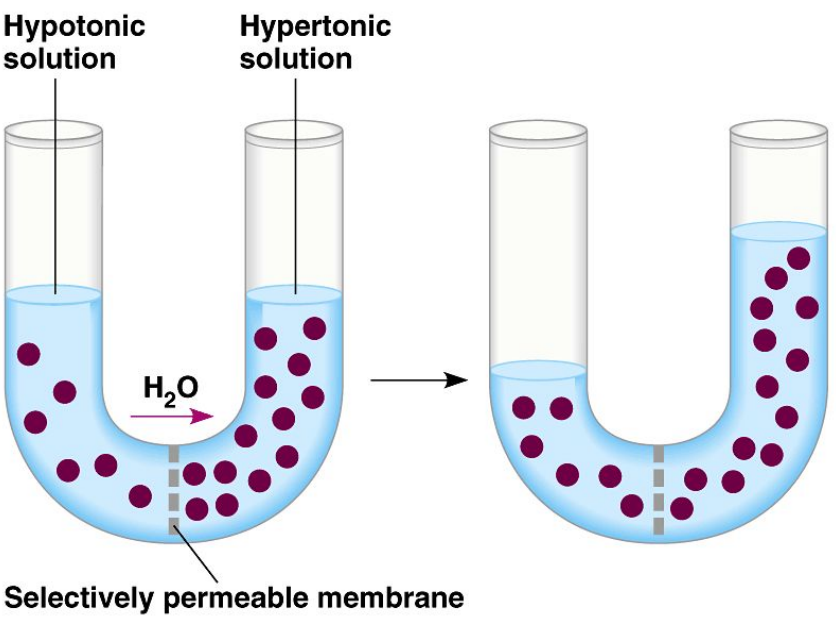
Movement of water across the cell membrane





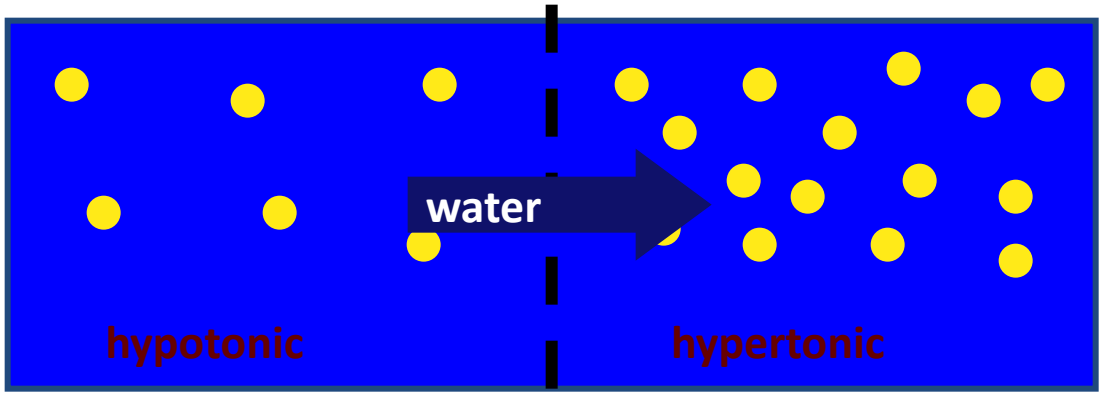
Osmosis is diffusion of water

- Water is very important to life, so we talk about water separately
- Diffusion of water from *high concentration* of <u>water</u> to *low concentration* of <u>wat</u>
  - across a semi-permeable membrane



Concentration of water

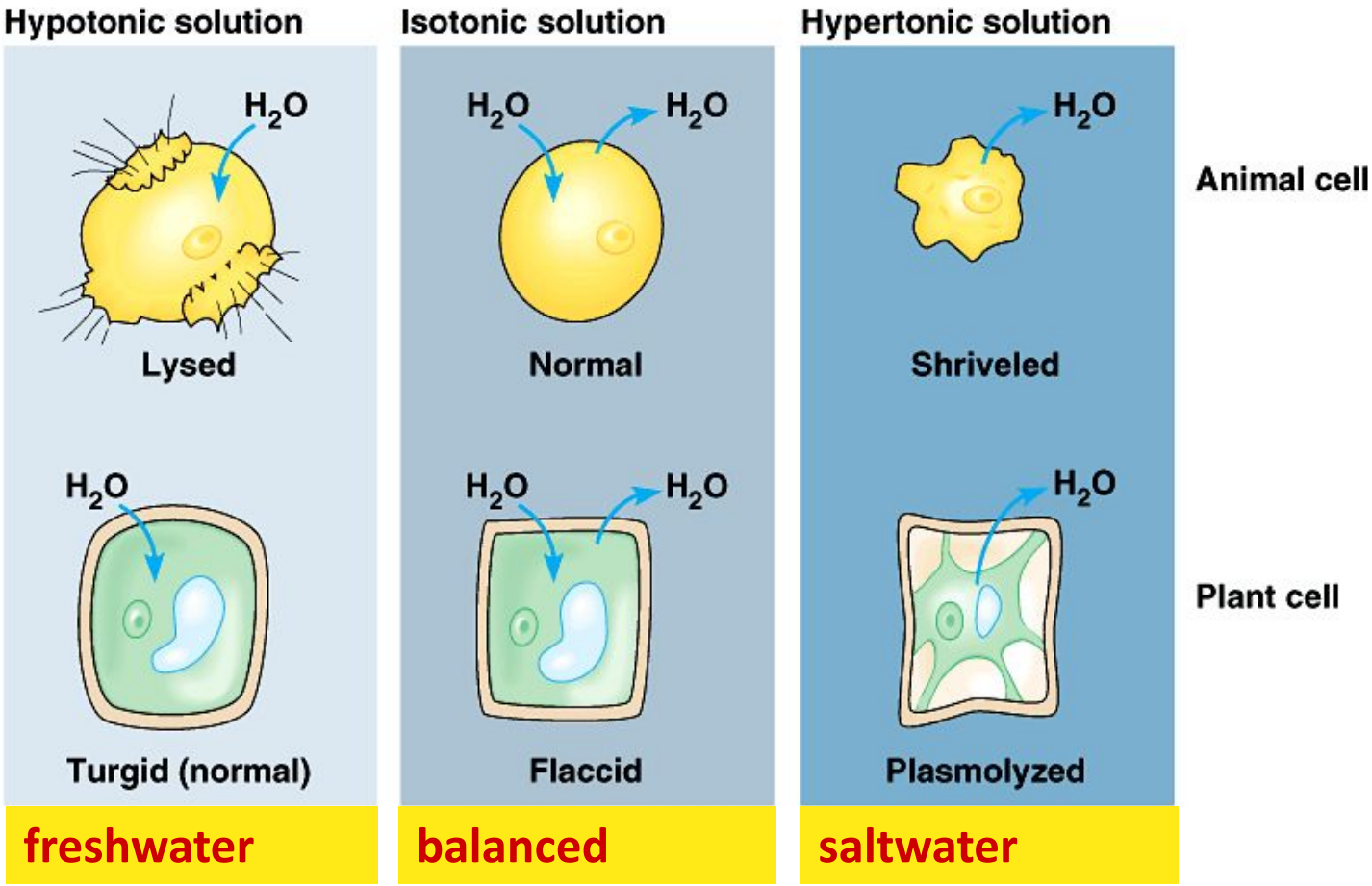
- Direction of osmosis is determined by comparing total solute concentrations
  - Hypertonic - more solute, less water
  - Hypotonic - less solute, more water
  - Isotonic - equal solute, equal water



net movement of water

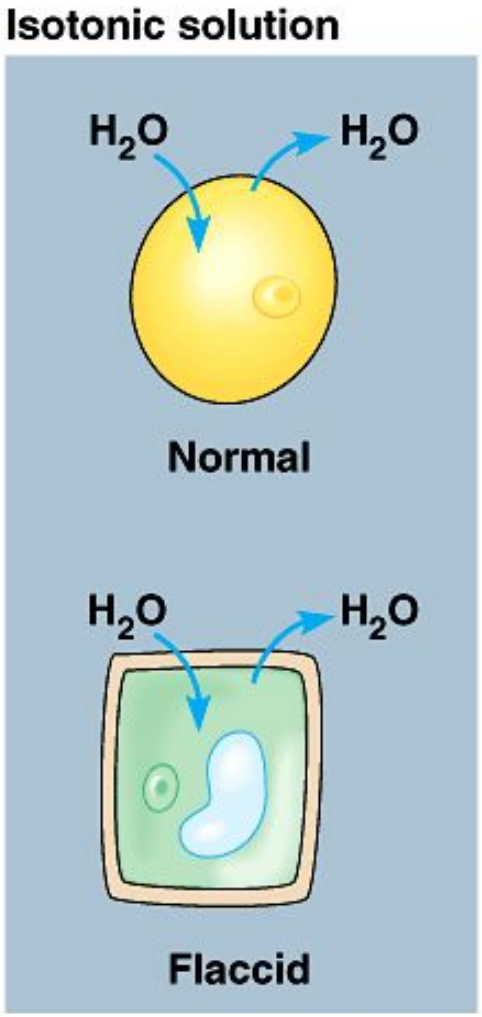
Managing water balance

- Cell survival depends on balancing water uptake & loss



Managing water balance

- Isotonic
  - animal cell immersed in mild salt solution
    - example: blood cells in blood plasma
    - problem: none
      - no net movement of water
        - » flows across membrane equally, in both directions
      - volume of cell is stable

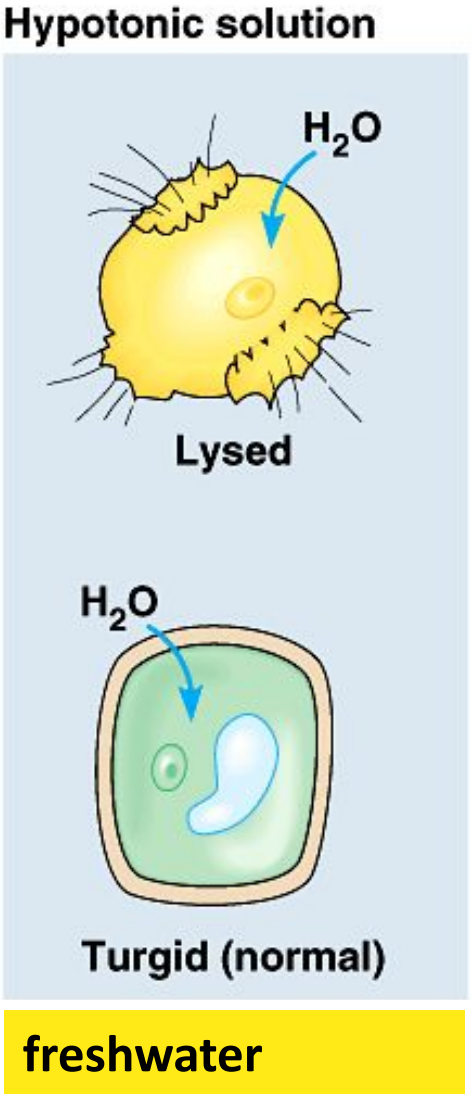


balanced

Managing water balance

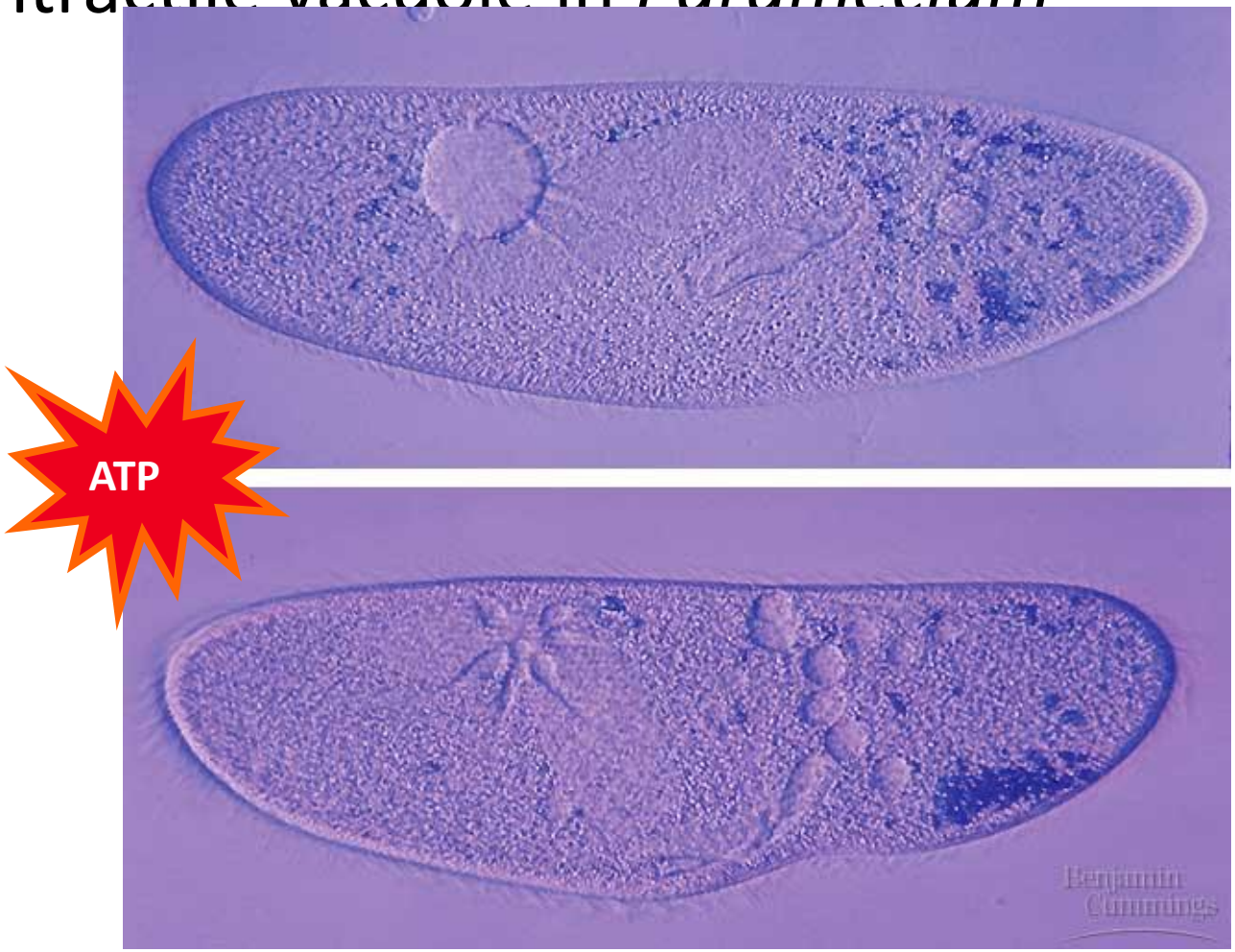
- Hypotonic
  - a cell in fresh water
    - example: *Paramecium*
    - problem: gains water, swells & can burst
      - water continually enters *Paramecium* cell
    - solution: contractile vacuole
      - pumps water out of cell
      - ATP
  - plant cells
    - turgid

ATP



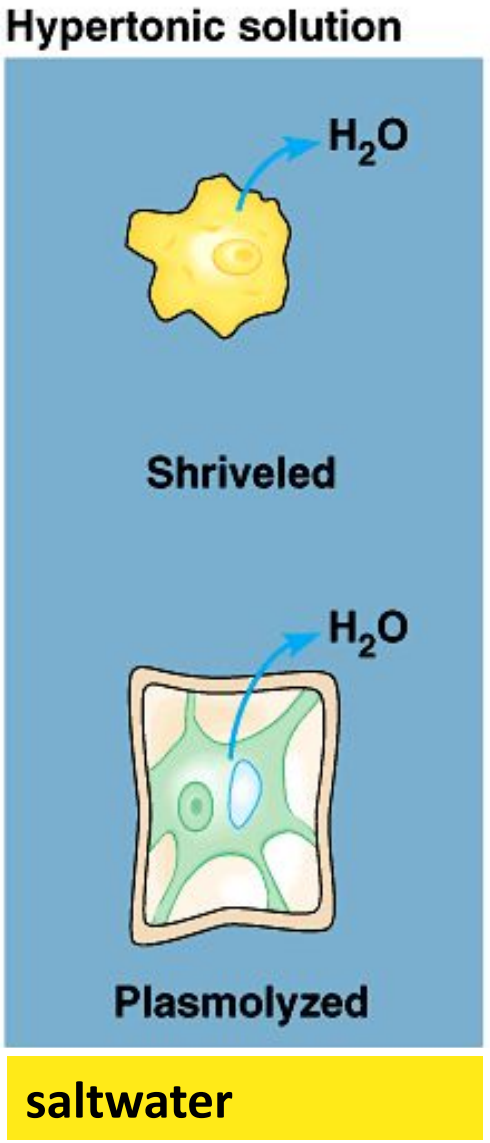
Water regulation

- Contractile vacuole in *Paramecium*



Managing water balance

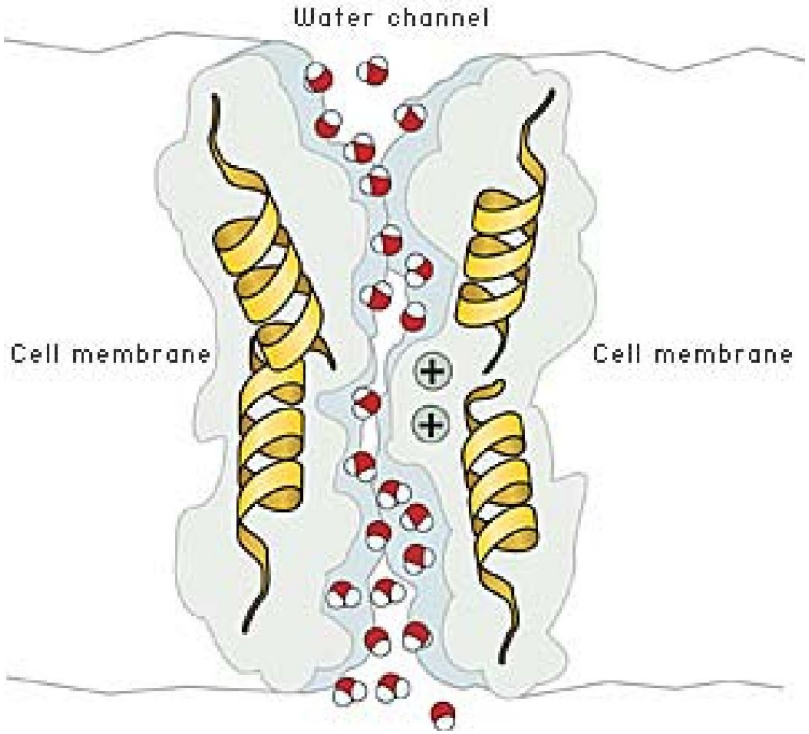
- Hypertonic
  - a cell in salt water
    - example: shellfish
    - problem: lose water & die
    - solution: take up water or pump out salt
  - plant cells
    - plasmolysis= wilt

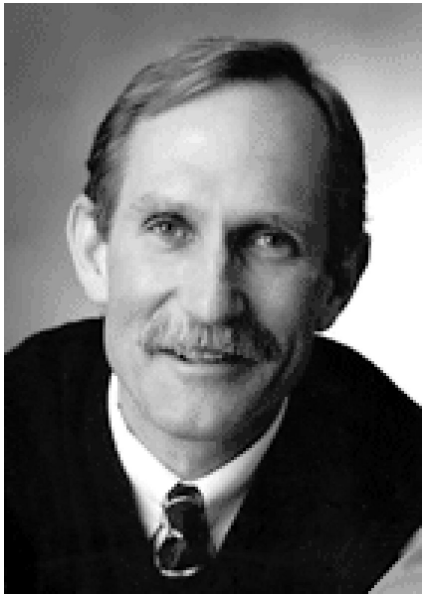


Aquaporins

1991 | 2003

- Water moves rapidly into & out of cells
  - evidence that there were water channels

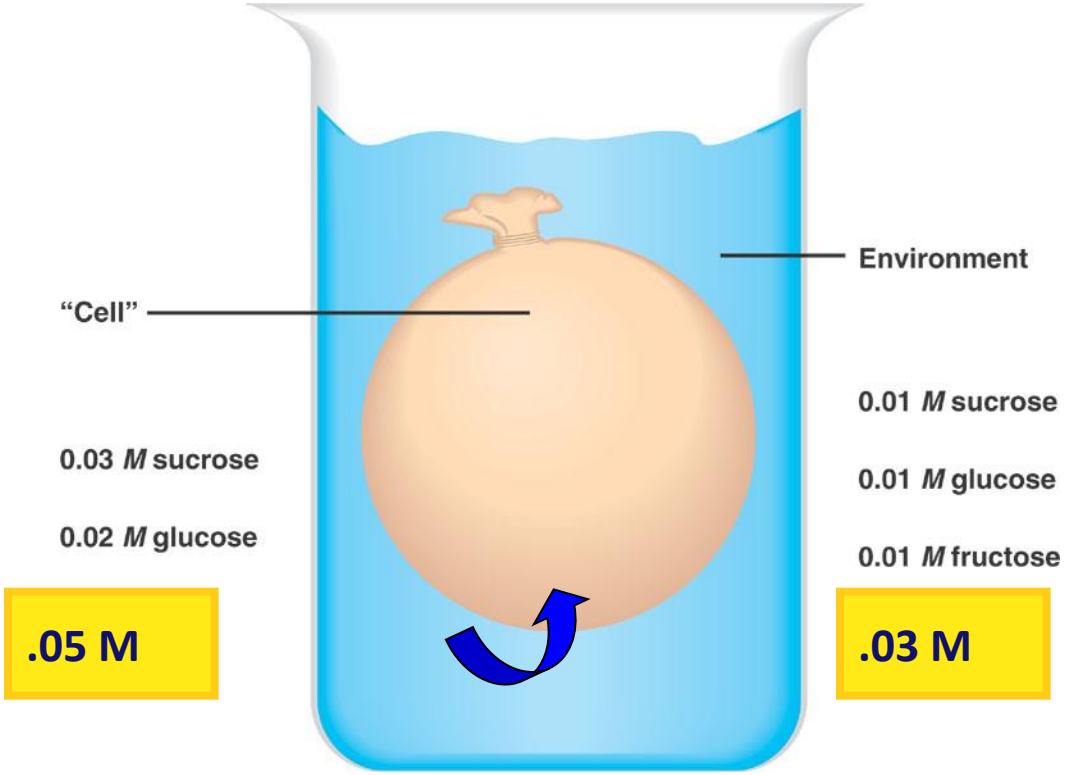




Peter Agre
John Hopkins

Roderick MacKinnon
Rockefeller

Osmosis…



Cell (compared to beaker) → hypertonic or hypotonic

Beaker (compared to cell) → hypertonic or hypotonic

Which way does the water flow? → in or out of cell

Any Questions??