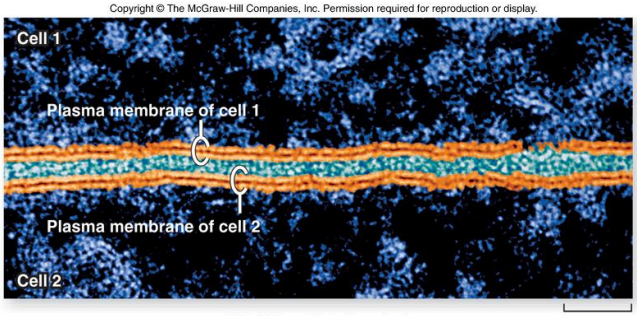
Membranes

Chapter 5



Membrane Structure

Lipid Bilayer model:

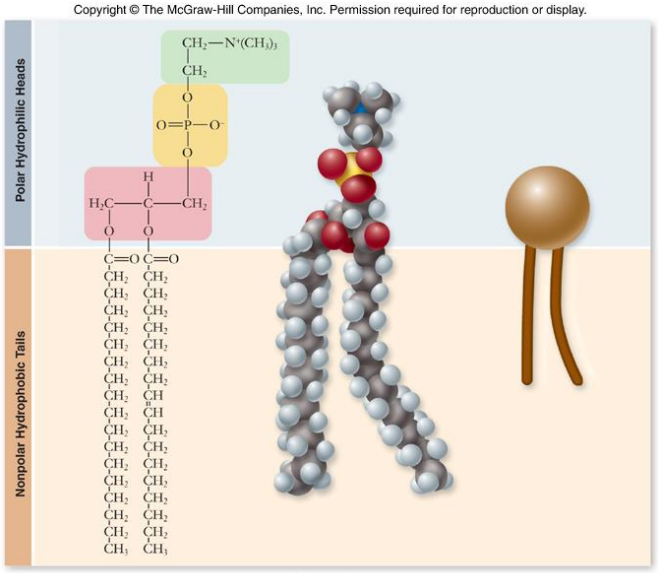
- double phospholipid layer
- Gorter & Grendel: 1925

Fluid Mosaic model: consist of

-**phospholipids** arranged in a bilayer

-**globular proteins** inserted in lipid bilayer

-Singer & Nicolson: 1972



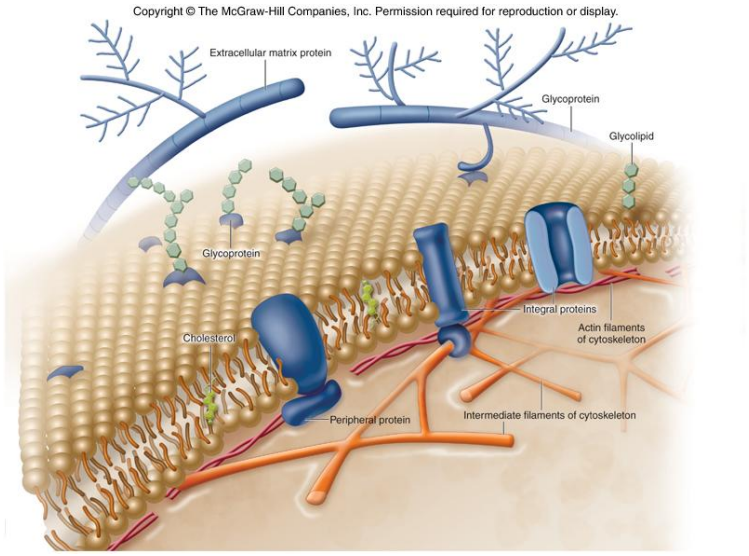
3

Membrane Structure

Cellular membranes 4 components:

1. phospholipid bilayer
2. transmembrane proteins
3. interior protein network
4. cell surface markers

4



5

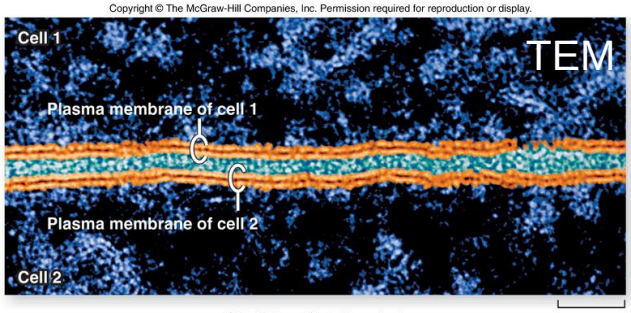
Membrane Structure

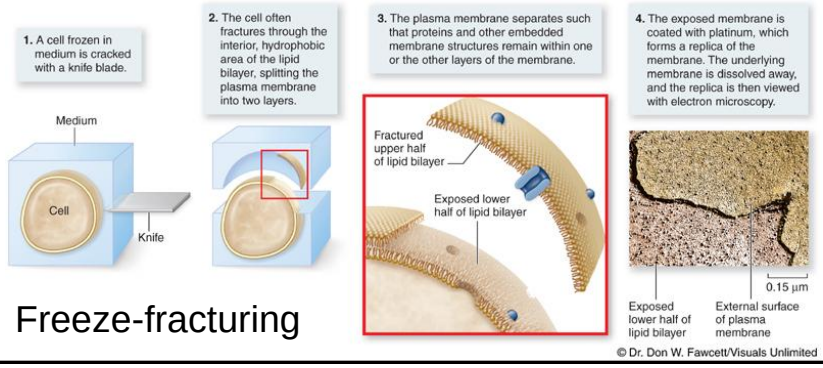
Membrane structure: using electron microscopy

Transmission electron microscopes (TEM) show 2 layers of a membrane

Freeze-fracturing techniques separate layers & reveal membrane proteins

6





Freeze-fracturing

Phospholipids

Phospholipid structure consists of

- **glycerol** – 3-carbon polyalcohol acting as backbone for phospholipid
- **phosphate group** attached to glycerol
- **2 fatty acids** attached to glycerol

Phospholipids

Fatty acids **nonpolar** chains of C & H

-nonpolar nature→ **hydrophobic** (“water-fearing”).

Phosphate group **polar** & **hydrophilic** “water-loving”

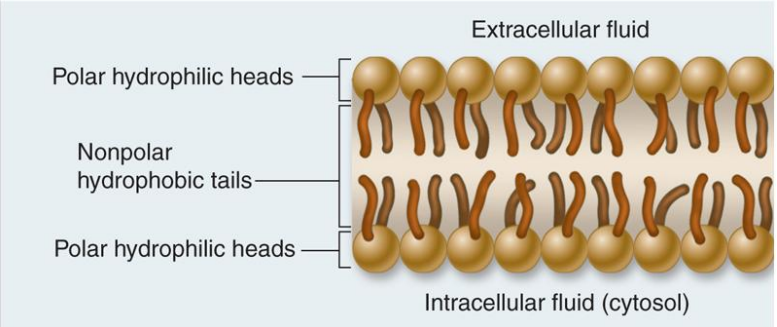
9

Phospholipids

Partially hydrophilic, partially hydrophobic phospholipid spontaneously forms a bilayer:

-fatty acids on inside

-phosphate groups on both surfaces of bilayer



10

Phospholipids

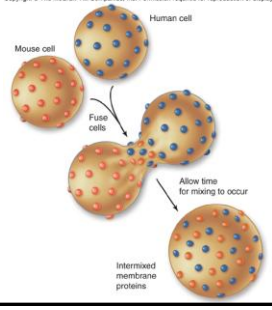
Phospholipid bilayers fluid

-hydrogen bonding of water holds 2 layers together

-individual phospholipids & unanchored proteins can move through membrane

-saturated fatty acids make membrane less fluid than unsaturated fatty acids

-warm temps → membrane more fluid than cold temps



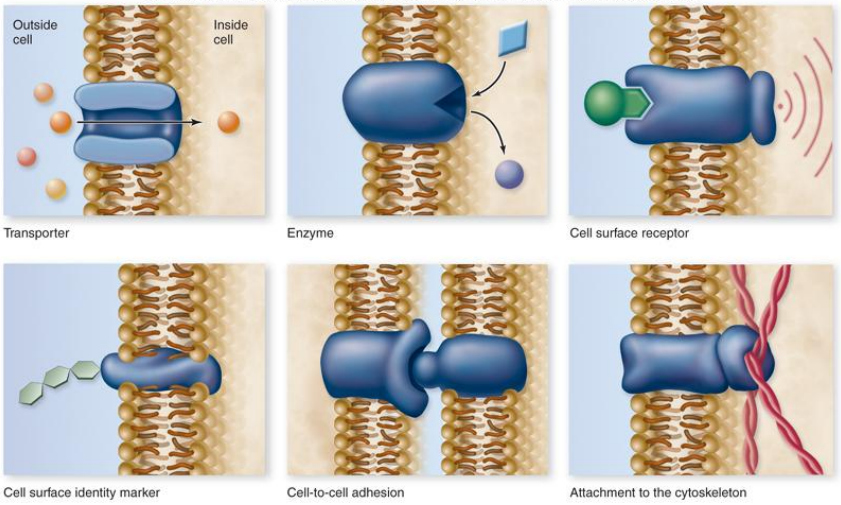
11

Membrane Proteins

Membrane proteins various functions:

1. transporters
2. enzymes
3. cell surface receptors
4. cell surface identity markers
5. cell-to-cell adhesion proteins
6. attachments to the cytoskeleton

12



13

Membrane Proteins

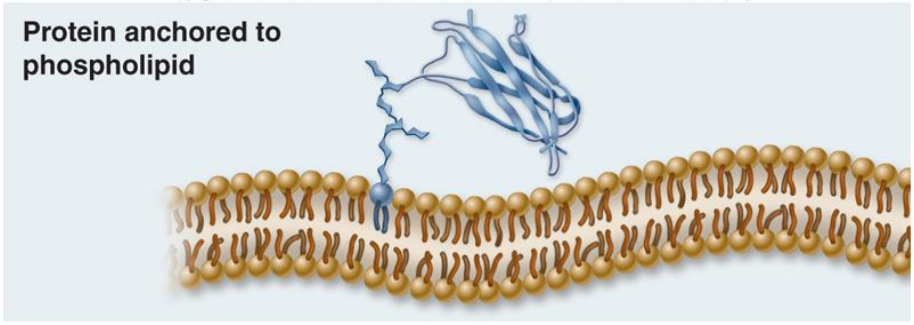
Peripheral membrane proteins

-anchored to a phospholipid in one layer of membrane

-possess nonpolar regions inserted in lipid bilayer

-free to move throughout one layer of bilayer

14



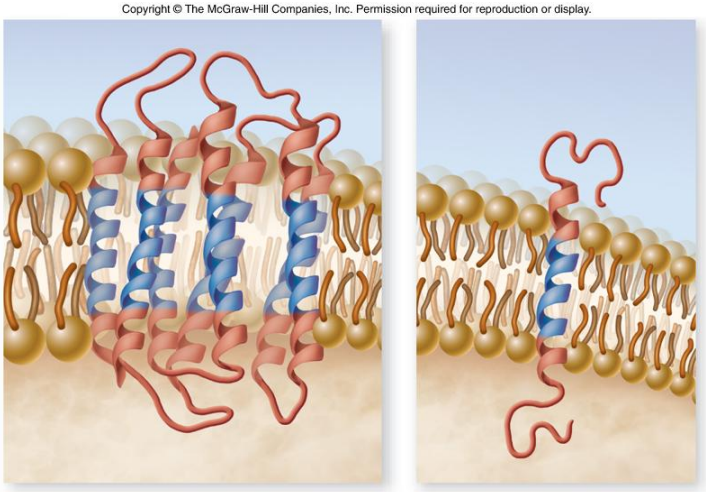
15

Membrane Proteins

Integral membrane proteins

- -span lipid bilayer (transmembrane proteins)
- -nonpolar regions of protein embedded in interior of bilayer
- -polar regions of protein protrude from both sides of bilayer

16



a. *b.*

17

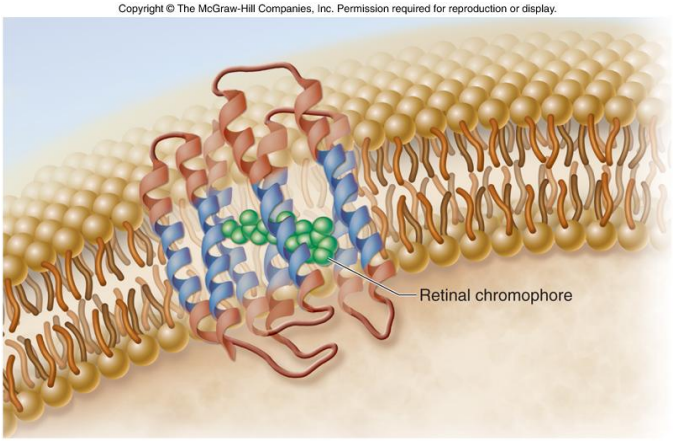
Membrane Proteins

Integral proteins possess at least one **transmembrane domain**

-region of protein containing hydrophobic amino acids

-spans lipid bilayer

18



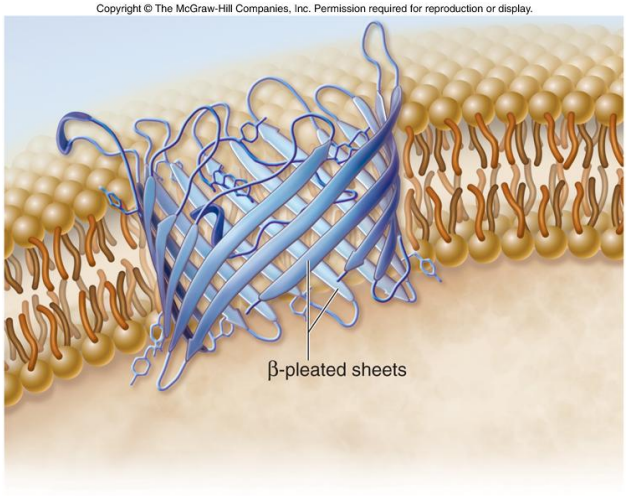
19

Membrane Proteins

Extensive nonpolar regions within a transmembrane protein can create a pore through membrane

- β sheets in protein secondary structure form cylinder called **β-barrel**
- β-barrel interior polar & allows water & small polar molecules to pass through membrane

20



21

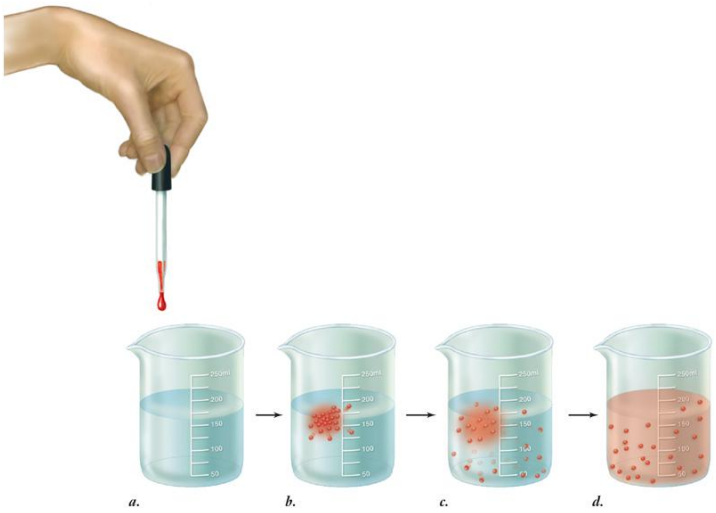
Passive Transport

Diffusion: movement of molecules from high concentration to low concentration

Passive transport: movement of molecules through membrane in which

1) no energy required
2) molecules move with **concentration gradient**

22



23

Passive Transport

Selective permeability: integral membrane proteins allow cell to be selective about what passes through membrane

Channel proteins have polar interior allowing polar molecules to pass through

Carrier proteins bind to specific molecule to facilitate its passage

24

Passive Transport

Channel proteins include:

- **ion channels** allow passage of ions (charged atoms or molecules) associated with water
- **gated channels** are opened or closed in response to a stimulus
- stimulus may be chemical or electrical

25

Passive Transport

Carrier proteins bind to molecule they transport across membrane

Facilitated diffusion: movement of a molecule from high to low concentration with help of a carrier protein

- is specific
- is passive
- saturates when all carriers occupied

26

Passive Transport

In an aqueous solution

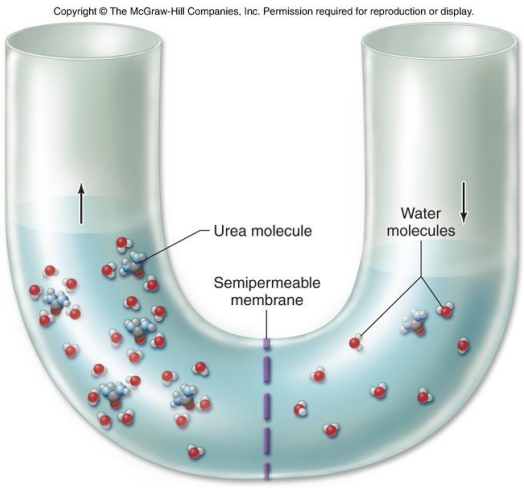
-water is **solvent**

-dissolved substances are **solutes**

Osmosis: movement of *water* from an area of high to low concentration of *water*

-movement of water toward an area of high *solute* concentration

27



28

Passive Transport

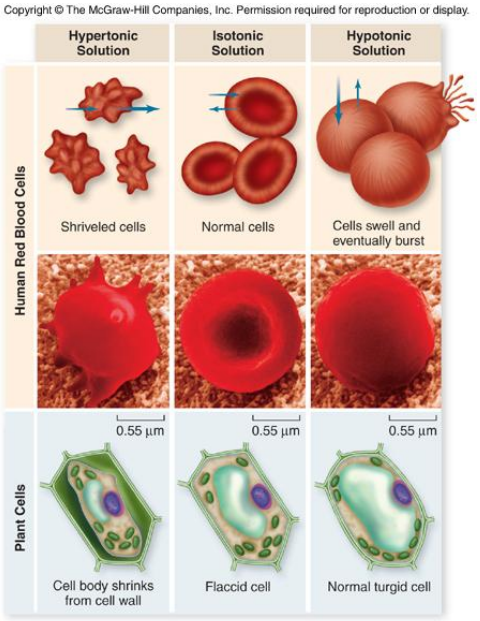
Two solutions with different osmotic concs

- **hypertonic solution:** higher solute conc
- **hypotonic solution:** lower solute conc

Osmosis moves water through **aquaporins** toward hypertonic solution

29

Tonicity response of cell when immersed in a solution



30

Passive Transport

Organisms maintain osmotic balance in different ways.

1. Some cells use **extrusion** where water ejected through contractile vacuoles
2. **Isosmotic regulation** involves keeping cells isotonic with their environment.
3. Plant cells use **turgor pressure** to push cell membrane against cell wall & keep cell rigid

31

Active Transport

Active transport

-requires energy – ATP used directly or indirectly to fuel active transport

-moves substances from low to high concentration (against a conc gradient)

-requires use of carrier proteins

32

Active Transport

Carrier proteins used in active transport include:

- **uniporters** – move one molecule at a time
- **symporters** – move two molecules in same direction
- **antiporters** – move two molecules in opposite directions

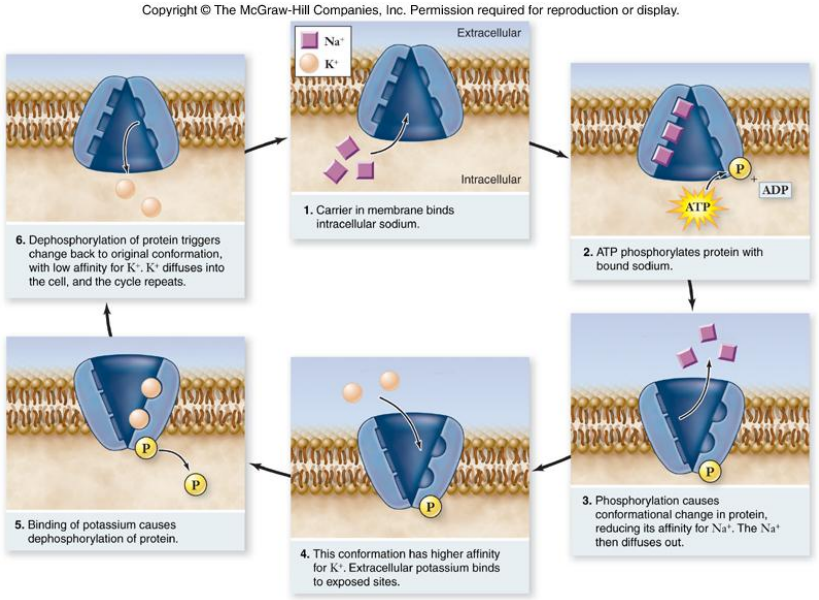
33

Active Transport

Sodium-potassium (Na^+-K^+) pump

- **active transport** mechanism
- antiporter move 3 Na^+ out of cell & 2 K^+ into cell
- ATP energy used to change conformation of carrier protein
- affinity of carrier protein for either Na^+ or K^+ changes so ions can be carried across membrane

34



35

Active Transport

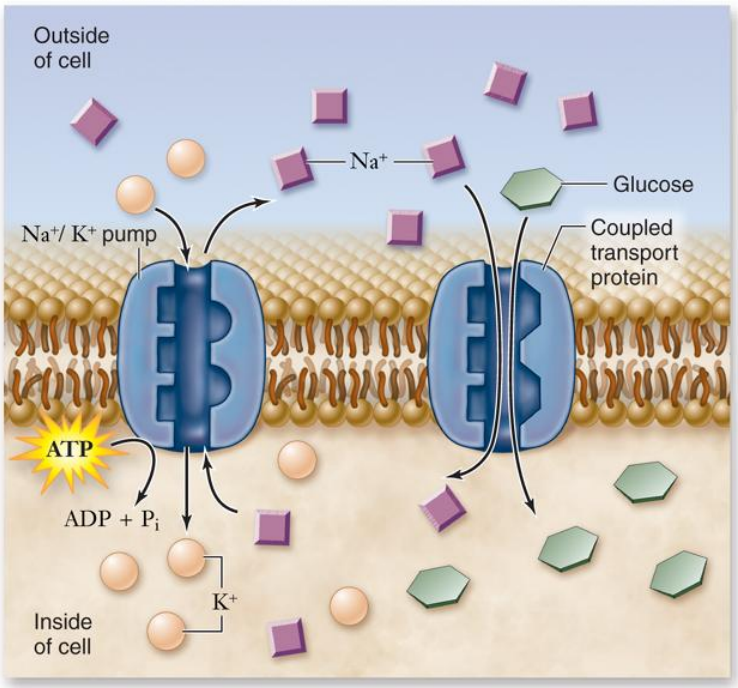
Coupled transport

-uses energy released when a molecule moves by diffusion to supply energy to active transport of a different molecule

-symporter used

-glucose-Na^+ symporter captures energy from Na^+ diffusion to move glucose against a concentration gradient

36



37

Bulk Transport

Bulk transport of substances accomplished by

1. **endocytosis** – movement of substances into cell
2. **exocytosis** – movement of materials out of cell

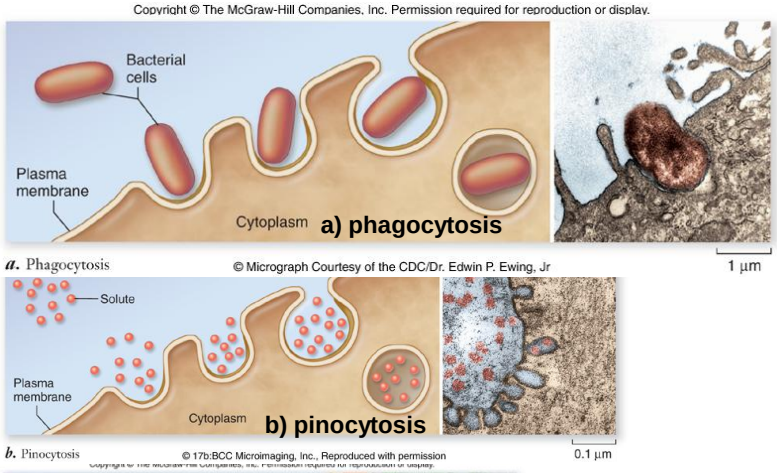
38

Bulk Transport

Endocytosis occurs when plasma membrane envelops food particles & liquids

1. **phagocytosis**: cell takes in particulate matter
2. **pinocytosis**: cell takes in only fluid
3. **receptor-mediated endocytosis**: specific molecules taken in after they bind to a receptor

39



a. Phagocytosis © Micrograph Courtesy of the CDC/Dr. Edwin P. Ewing, Jr

b. Pinocytosis © 17b:BCC Microimaging, Inc., Reproduced with permission

c. Receptor-mediated endocytosis

40

Bulk Transport

Exocytosis: material discharged from cell

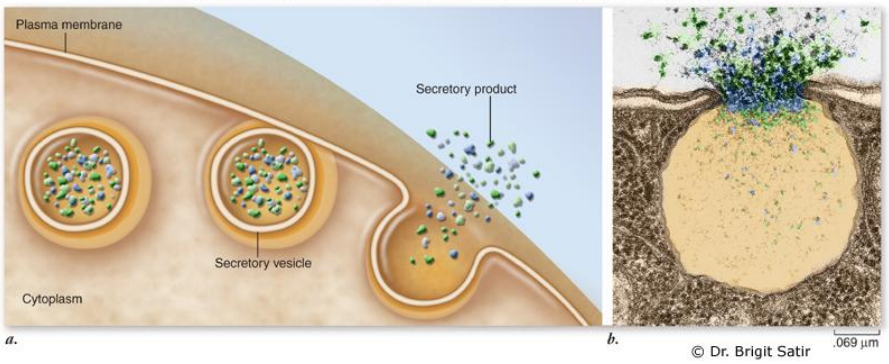
-vesicles in cytoplasm fuse with cell membrane & release their contents to cell exterior

-plants: export cell wall material

-animals secrete

1) hormones
2) neurotransmitters
3) digestive enzymes

41



42