Overview: Plasma Membrane

- Plasma membrane
  - boundary that separates the living cell from its surroundings
- Selective permeability
  - Allowance of some substances to cross more easily than others

Cell Membrane Model

- Fluid mosaic model
  - Membrane is a fluid structure with a “mosaic” of various proteins embedded in it
  - Phospholipids
    - most abundant lipid in the plasma membrane
  - amphipathic molecules
    - contain hydrophobic and hydrophilic regions
The Fluidity of Membranes

- Phospholipids
  - Can move within the bilayer
  - Most of the lipids, and some proteins, drift laterally
    - Rarely does a molecule flip-flop transversely across the membrane

Lateral movement (∼10^7 times per second)
Flip-flop (∼once per month)
Membrane Proteins

- Peripheral proteins
  - bound to the surface of the membrane
- Integral proteins
  - Penetrate the hydrophobic core
  - Transmembrane proteins
    - Integral proteins that span the membrane
  - Hydrophobic regions of an integral protein
    - consist of one or more stretches of nonpolar amino acids
    - often coiled into alpha helices

Membrane Proteins

- Six major functions of membrane proteins:
  - Transport
  - Enzymatic activity
  - Signal transduction
  - Cell-cell recognition
  - Intercellular joining
  - Attachment to the cytoskeleton and extracellular matrix (ECM)

Membrane Carbohydrates

- Membrane carbohydrates
  - Used by cells to recognize each other
    - By binding recognition proteins to surface carbohydrates
- Glycolipids
  - Carbohydrates covalently bonded to lipids
- Glycoproteins
  - Carbohydrates bonded to proteins
  - vary among species, individuals, and even cell types in an individual
Synthesis and Sidedness of Membranes

- Membranes have distinct inside and outside faces
  - Asymmetrical distribution
    - Proteins
    - Lipids
    - Associated carbohydrates
    - Determined when the membrane is built by the ER and Golgi apparatus
      - Components on the inside of ER or Golgi vesicle
        - end up on exterior of cell membrane

The Permeability of the Lipid Bilayer

- Hydrophobic (nonpolar) molecules
  - Dissolve in the lipid bilayer and pass through the membrane rapidly
    - Such as hydrocarbons
      - But only very small ones
  - Polar molecules
    - Do not cross the membrane easily
      - Repelled by inner hydrophobic region
      - Such as sugars

Transport Proteins

- Transport proteins
  - Allow passage of hydrophilic substances across the membrane
    - channel proteins
      - hydrophilic channel that certain molecules or ions can use as a tunnel
      - Aquaporins
        - Facilitate the passage of water
Transport Proteins

- **Carrier proteins**
  - Bind to molecules and change shape to shuttle them across the membrane
  - Specific for the substance it moves

![Transport Proteins Diagram]

Transport

- **Diffusion**
  - Tendency for molecules to spread out evenly into the available space
    - Due to Brownian movement
  - Dynamic equilibrium
    - As many molecules cross one way as cross in the other direction

![Diffusion Diagram]
Types of Transport: Passive – Simple Diffusion

- Passive transport
  - No energy input required
- Simple Diffusion
  - Substances move (diffuse) down their concentration gradient
    - difference in concentration of a substance from one area to another

Types of Transport: Passive – Osmosis

- Osmosis
  - diffusion of water across a selectively permeable membrane
    - from the region of lower solute concentration
    - to the region of higher solute concentration
  - Water will follow the solutes
### Water Balance of Cells Without Walls

**Tonicity**
- Ability of a solution to cause a cell to gain or lose water

**Isotonic solution**
- Solute concentration outside is the same as that inside the cell
- No net water movement across the plasma membrane

**Hypertonic solution**
- Solution with higher solute concentration

**Hypotonic solution**
- Solution with lower solute concentration

### Water Balance of Cells Without Walls

- Hypertonic or hypotonic environments create osmotic problems for organisms

**Osmoregulation**
- Control of water balance
- Necessary adaptation for life in such environments

- The protist Paramecium
  - Hypertonic to its pond water environment
  - Has a contractile vacuole that acts as a pump

### Water Balance of Cells with Walls

- Plant cell in a hypotonic solution
  - Swells until the wall opposes uptake
    - Cell is now turgid (firm)
  - If isotonic
    - No net movement of water into the cell
      - the cell becomes flaccid (limp)
  - Plant may wilt
Water Balance of Cells with Walls

- **Plasmolysis**
  - Hypertonic environment
    - Plant cells lose water
      - Membrane pulls away from the wall
      - Usually lethal

Types of Transport: Passive - Facilitated Diffusion

- **Facilitated diffusion**
  - Transport proteins facilitate (enable) passive movement of molecules across the plasma membrane
  - Channel proteins
    - Corridors that allow a specific molecule or ion to cross the membrane
      - Aquaporins for facilitated diffusion of water
      - Ion channels that open or close in response to a stimulus (gated channels)

Types of Transport: Active Transport

- **Active transport**
  - Moves substances against their concentration gradient
    - Requires energy
      - In the form of ATP
    - Performed by specific proteins embedded in the membranes
Types of Transport: Active Transport

- Active transport
  - allows cells to maintain concentration gradients that differ from their surroundings

- Sodium-potassium pump

Ion Pumps Maintain Membrane Potential

- Membrane potential
  - Voltage difference across a membrane
  - Voltage is created by differences in the distribution of positive and negative ions

MEMBRANE POTENTIAL: How does it get there? CHANNELS & PUMPS!
Electrogenic pump

- transport protein that generates voltage across a membrane
- sodium-potassium pump
  - major electrogenic pump of animal cells
- proton pump
  - Main electrogenic pump
  - of plants, fungi, and bacteria

Types of Transport: Active Transport - Exocytosis

- Exocytosis
  - Transport vesicles migrate to the membrane, fuse with it, and release their contents
  - Used by secretory cells to export their products

Types of Transport: Active Transport - Endocytosis

- Endocytosis
  - cell takes in macromolecules
    - by forming vesicles from the plasma membrane
    - reversal of exocytosis, involving different proteins
  - Three types of endocytosis:
    1. Phagocytosis ("cellular eating")
    2. Pinocytosis ("cellular drinking")
    3. Receptor-mediated endocytosis
Active Transport: Endocytosis - Phagocytosis

PHAGOCYTOSIS

EXTRACELLULAR FLUID

Pseudopodium

Food or other particle

Food vacuole

Bacterium

An amoeba engulfing a bacterium via phagocytosis (TEM)

Active Transport: Endocytosis - Pinocytosis

PINOCYTOSIS

Plasma membrane

Pinocytosis vesicles forming (arrows) in a cell lining a small blood vessel (TEM)

Active Transport: Receptor Mediated Endocytosis

RECEPTOR-MEDIATED ENDOCYTOSIS

Ligand

Coat protein

Coated pit

Coated vesicle

A coated pit and a coated vesicle fused with the plasma membrane during receptor mediated endocytosis (TEM)
### You should now be able to:

1. Define the following terms: amphipathic molecules, aquaporins, diffusion
2. Explain how membrane fluidity is influenced by temperature and membrane composition
3. Distinguish between the following pairs or sets of terms: peripheral and integral membrane proteins; channel and carrier proteins; osmosis, facilitated diffusion, and active transport; hypertonic, hypotonic, and isotonic solutions
4. Explain how transport proteins facilitate diffusion
5. Explain how an electrogenic pump creates voltage across a membrane, and name two electrogenic pumps
6. Explain how large molecules/substances are transported across a cell membrane