THE CELL MEMBRANE

Composition

- The cell membrane is a selectively permeable membrane that regulates the steady traffic that enters and leaves the cell.
    - The membrane consists of a phospholipid bilayer.
        - The phospholipid bilayer is amphatic meaning that it has both a hydrophobic and hydrophilic region.
    - Cholesterol molecules are embedded in the interior of the bilayer to stabilize the membrane.

Membrane Proteins

- Integral Proteins- have non polar regions that span completely throughout hydrophobic interior of the membrane. Used as transporters/ channels.
- Peripheral Proteins are loosely bound to the surface of the membrane.
    - Functions of Proteins
        - Transport: Molecules, electrons, and ions are carried through the channels, pumps etc.
        - Enzymatic Activity: One membrane bound enzyme is adenylate cyclase, which synthesizes cyclic AMP (cAMP) from ATP.
        - Signal Tran Transduction: Binding sites on protein receptors fit chemical messengers like hormones. The protein changes shape and relays the message inside the cell.
        - Cell-to-Cell recognition: Some glycoprotein serve as the identification flags that are recognized by other cells.
        - Cell-to-Cell attachment: Desmosomes, gap junctions, and tight junction.
        - Attachment to the Cytoskeleton and Extracellular Matrix:This helps maintain cell shape and stabilizes the location of certain membrane proteins.

Selective Permeability

- Selective Permeability means that the cell gets to choose what crosses the membrane via Passive transport and Active transport.
- Important for homeostasis because it allows the cell to get essential molecules while keeping out harmful substances.

TYPES OF TRANSPORT

Passive Transport

- Diffusion
- always from a [high] → [low]
- No ATP required since following the concentration gradient; spontaneous process
- Concentration gradient represents potential energy

- Osmosis - diffusion of water
- 2 types of diffusion: simple & facilitated
- Simple Diffusion -
    - no protein required
    - hydrophobic and tiny uncharged polar molecules
- Facilitated Diffusion -
    - requires hydrophilic protein channel to get across the membrane
    - speeds up diffusion
    - hydrophilic molecules and ions
    - 2 types of proteins: channel and carrier
        - Channel protein:
            - acts as a corridor for specific molecules to pass through
            - hydrophilic channel - lets polar molecules through the membrane
            - allows for small ions to to pass
        - Carrier protein:
            - holds onto molecule
            - changes shape allowing entry and exit

Active Transport

- against the concentration gradient; [low] → [high]
- uses up ATP - need energy to go against the gradient

Pumps/Carriers

- carries particles across the membrane via active transport
- like the carrier protein in facilitated diffusion, just against the gradient
- changing shape requires energy; phosphorylation ($ATP \rightarrow ADP + PO_4$)
- electrochemical gradient - combination of chemical force (and ions concentration gradient) and an electrical force (the effect of membrane potential on ion's movement)

    membrane potential = voltage across a cell membrane
- electrogenic pump - a transport protein that generates voltage across a membrane (Na-K pump proton pump)

Cotransport

- when one active transport pump indirectly drives the active transport of several other solutes
- push H^+ out of cell via active transport against gradient
- push sucrose into cell w/ H^+ via active transport of sucrose and electrochemical gradient for H^+

Pinocytosis

- cell drinking
- uptake of large, dissolved particles
- plasma membrane invaginates around the particles and encloses them in a vesicle

Phagocytosis

- engulfing of large particles or small cells by pseudopods
- cell membrane wraps around the particle and encloses it in a vacuole
- how white blood cells engulf bacteria

Receptor-mediated Endocytosis

- enables the cell to take up large quantities of very specific molecules
- extracellular substances bind to receptors on the membrane
- once the substances bind to the receptors, the receptors migrate and cluster along the membrane, turn inward, and form a vesicle

Exocytosis?

- excretion of biological molecules by the fusion of vesicles
- vesicle membrane touches plasma membrane and the two fuse together and release the molecules in the vesicle to the outside of the cell

CELL SIGNALING

Local and Long Distance

- Chemical messages sent out from cells have a specific destination that may or may not be near by.
- Eukaryotic cells communicate by direct contact, a type of local signaling
- Local
    - Paracrine signaling: a secreting cell acts on nearby target cells by discharging molecules of a local regulator into extracellular fluid.
    - Synaptic signaling: A nerve cell releases neurotransmitter molecules into a synapse, stimulating the target cell.
- Long distance
    - Endocrine (hormonal) signaling: specialized endocrine cells secrete hormones into body fluids, often blood. Hormones reach virtually all body cells, but are bound only by some cells.

Reception

- All cell membrane receptors are similar.
    - They span the entire thickness of the membrane and are therefore in contact with both the extracellular environment and the cytoplasm.
- Hydrophilic signaling molecules cannot diffuse through the membrane.
- One the signal is inside the cell, the signal is carried by a second messenger.
    - The most common second messenger is cyclic AMP (cAMP).
- Notice that the ligand, the first messenger, never enters the cell.
- Three examples of cell surface receptors are ion channels receptors, G-protein-coupled receptors, and protein kinase receptors.
- Ligand receptor complex either activates a pathway in the cytoplasm immediately or migrates to the nucleus where it acts as a transcription factor and switches genes on or off.

Transduction

- Cells interpret signals once they receive them through signal transduction pathway.
- Signal Transduction pathways begin when very low concentrations of specific signaling chemicals, ligands, reach target cells.
    - the ligand binds to the receptor, either on the cell membrane or inside the cytoplasm, of the target cell, in the same way a key fits in a lock.
- Ultimately the signal transduction pathway leads to a cellular response.

Response

- Transduction leads to a multitude of responses, either in the cytoplasm or in the nucleus.

Signal Transduction pathways

1. They are characterized by a signal, a transduction, and a response.
2. They are highly specific and regulated.
3. One signal molecule can cause a cascade effect, releasing thousands of molecules inside a cell.
4. These pathways evolved millions of years ago in common ancestor.