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Cell Membrane Structure

Membrane lipids have: Polar/hydrophilic heads and nonpolar/hydrophobic fatty acid tails

- Phospholipids are the most abundant group of membrane lipids - they will always have a polar head that contains a phosphate group and other hydrophilic atoms such as nitrogen. Hydrophilic literally means “water-loving”. There are a huge variety of phospholipids, each with critical roles in the overall functioning of the membrane - compositions vary between organs, between tissues within organs, and even within a single cell, with the top (or apical) membrane of the cell very different than the bottom (or basal) membrane.
- Glycolipids: are sugar-bound lipids - these sugars make their heads polar, too.
- Cholesterol makes up about 20% of the membrane lipids. It decreases membrane permeability by packing in between other lipids. This important shield prevents substances from entering or leaving without permission.
    - A popular area of research right now is learning how cholesterol organizes where the protein components - channels and receptors - are located within the membrane.

Fatty acids of membrane lipids

- Unlike triglycerides, membrane lipids usually only have two fatty acid tails. These long carbon chains are nonpolar and hydrophobic (hydrophobic literally means “water-fearing”).
- Fatty acid tails are saturated or unsaturated, and these differences provide even more fine-tuning and adjustment for membrane functioning.
- More saturated fatty acids will provide greater stability, whereas more polyunsaturated fatty acids provide for more flexibility in the membrane.
- The unsaturated fatty acids are also crucially involved with sending signals from the membrane down deeper into the cytoplasm of the cell.

The membrane lipids orient their hydrophobic fatty acid tails toward each and form a lipid bilayer.

Channel proteins select for substances based on size and charge.

- Glucose and water are two examples of polar but uncharged molecules that pass into cells by specific glucose and aquaporin (water) channels.
- Charged ions such as sodium, potassium, and calcium all require specific channels to move through the membrane.
- Small nonpolar gases such as oxygen and carbon dioxide are among a relatively small list of substances that can diffuse freely through the membrane; no channel needed.
- Some channels have gates. For example, sodium voltage-gated channels only open when the membrane is a particular membrane potential.
- Some channels are pumps that use a lot of ATP energy! For example, the Na+/K+ ATPase pump.

Peripheral and transmembrane proteins

- Peripheral proteins remain on the surface of the bilayer
- Transmembrane or integral proteins pass all the way through the membrane.
- These proteins serve roles as enzymes, or as receptors that bind hormones or even proteins on the surface of viruses or bacteria.

- Once bound and activated, these cell membrane proteins may
    - open channels
    - trigger endocytosis (engulf something from outside of the cell)
        - So you see that these normal cell functions can be taken advantage of by pathogens as these disease-causers seek ways to get inside our cells.
    - send signals to the inside of the cell.

Glycoproteins

- Cell membrane proteins that have sugars bound to them.
- They are the cell identifiers and make sure all nearby cells know who a cell is.
    - Unauthorized cells that do not have the “proper identifying” glycoproteins are destroyed, because the body assumes they are either cancerous or otherwise ill cells, or that they are microbes that could cause disease.
- Glycoproteins are best thought of as antigens, because for healthcare students, there are so many pertinent examples you will learn about as you progress through your studies.
    - Red blood cells have different glycoproteins that are classified as the blood type antigens A, B, and Rh.
    - Vaccines are an injection (or other mode of delivery into the body) of an antigen from a pathogen (or, as in the case of the Sars-CoV-2 vaccines, injection of the DNA or RNA that causes our cells to MAKE the pathogen’s antigen).
    - Autoimmune disease occurs when your immune system attacks your own antigens on your own cells. Autoimmune disease symptoms are based on which organ or cell type is being inappropriately attacked.
    - Allergies are when your immune system attacks environmental antigens, such as pollen, dander, medicine, bee sting, or foods.

The glycocalyx

- Includes all the massive numbers of sugars on the cell membrane’s surface, whether from glycoproteins or glycolipids.
    - Disturbances in a healthy glycocalyx is a popular area of research - for example, atherosclerosis is associated with disruption of the glycocalyx on the endothelial cells that line blood vessels.

Cytoskeletal elements - particularly actin

- Found inside of the cell, up against the under surface of the cell membrane.
- Give the cell its shape
    - such as the microvilli of an intestinal cell
    - dendrites and axon terminals of a neuron.