BIOL1040 Module 1

Principles of Cell Function

Membrane Structure and Function:

7.1

Cellular membranes are fluid mosaics of lipids and proteins

- The most abundant lipids in most membranes are phospholipids.
    - The ability of phospholipids to form membranes is inherent in their molecular structure.
    - A phospholipid is amphipathic:
        - Meaning that it has both a hydrophilic region and a hydrophobic region.
    - A phospholipid bilayer can exist as a stable boundary between two aqueous compartments because they're arranged to shelter the hydrophobic tails from the water while exposing the hydrophilic head.
- Most membrane proteins are amphipathic.
    - Hydrophilic regions are exposed to the extra and intra cellular environment, providing the hydrophobic regions with a nonaqueous environment.
- The fluid mosaic model states that the membrane is a mosaic of protein molecules bobbing in a fluid bilayer of phospholipids.

The Fluidity of Membranes

- Most lipids and some proteins can shift laterally (10^7 times/second).
- Rarely a lipid will 'flip-flop' across the membrane, switching from one phospholipid layer to the other.
- Proteins tend to move more slowly, but they do drift.
    - Some are driven along cytoskeleton fibres in the cell by motor proteins.
    - Many others are immobile because they're attached to the cytoskeleton or extracellular matrix.
- Membrane fluidity changes with temperature.
    - As the temperature decreases, phospholipids settle into a closely packed arrangement and the membrane solidifies.
        - The temperature at which this happens depends on the types of lipids it is made of.
        - Unsaturated = lower solidifying temperature.
            - They cannot pack together as closely due to kinks in the lipid tail.
            - Membrane more fluid.
        - The presence of steroid cholesterol acts as a fluidity buffer in the membrane of animal cells.
            - Influences membrane fluidity at different temperatures.
            - At high temperatures, it makes the membrane less fluid by restraining phospholipid movement.
            - At low temperatures, it hinders the packing together of phospholipids.
- Membranes must be fluid to work properly as it impacts both permeability and movement of membrane proteins.
    - When solidified, enzymatic proteins in membrane may become inactive.
    - If too fluid, protein function is also not supported.

Membrane Proteins and their Function:

- Membrane proteins determine most of the membrane's function.
    - Different cells have different membrane proteins.
- There are two major types of membrane proteins:
    - Integral proteins
        - Which penetrate the hydrophobic interior of the lipid bilayer.
        - The majority are transmembrane proteins and others just extend partway through cell membrane.
    - Peripheral proteins
        - Are not embedded in the lipid bilayer.
        - Instead they're appendages loosely bound to the surface of the membrane.

- The 6 Major Functions of Membrane Proteins:
    - Transport
        - Assists in transporting molecules across the cellular membrane.
    - Enzymatic activity
        - Catalyses chemical reactions.
    - Signal transduction
        - Protein may act as a receptor, receiving signals from molecules in the extracellular environment.
    - Cell-cell recognition
        - Some glycoproteins serve as identification tags that allow binding.
    - Intercellular joining
        - Membrane proteins of adjacent cells may hook together.
    - Attachment to intra/extracellular environment.
        - Helps to maintain cell shape and stabilises cell location.

7.1 Summary

- In the fluid mosaic model, amphipathic proteins are embedded in the phospholipid bilayer.
    - Proteins with related functions are often clustered together in patches.
- Phospholipids and some proteins move laterally within the membrane.
    - The unsaturated hydrocarbon trails of some phospholipids keen membranes fluid at lower temperatures, while cholesterol helps membranes resist changes in fluidity caused by temperature changes.
    - Differences in membrane lipid composition, as well as the ability to change lipid composition, are evolutionary adaptions that ensure membrane fluidity.
- Integral proteins are embedded in the lipid bilayer; peripheral proteins are attached to the membrane surface.
    - The functions of membrane proteins include transport, enzymatic activity, signal transduction, cell-cell recognition, intercellular joining, and attachment to intra/extracellular environments.
    - Glycoproteins and glycolipids on the exterior side of the plasma membrane interact with the surface molecules of other cells.
- Membrane proteins and lipids are synthesised in the ER and modified in the ER and Golgi apparatus.
    - Inside and outside face of membranes differ in molecular composition.