Cell Membranes

Explain why membranes are referred to as fluid mosaic in structure.
It is referred to as 'fluid" because the cell membrane comprises of **phospholipids** and **proteins** which are **free to move laterally** within a layer and the phospholipids can **flip flop** from one layer to the other although this is a rare occurrence. It is referred to as 'mosaic" because the **random arrangement** of the **proteins** embedded amongst the phospholipid molecules resemble a mosaic pattern.

Describe the roles of components of the plasma membrane.		
Component	**Structure**	**Role**
Phospholipids	Formed when **two hydrophobic hydrocarbon tails** and a **hydrophilic phosphate head** are attached to a **glycerol** resulting in an **amphipathic** molecule. Form a **bilayer** which is the main component of the cell membrane.	Acts as a **barrier** to the movement of **ions**, **polar** and **large molecules** across the cell membrane. Phospholipid bilayer is a **fluid** layer in which **proteins** move. Phospholipid bilayer serves as a **barrier** between the intracellular and extracellular environments to **retain cell contents** and allowing for **compartmentalization** within the cell.
Cholesterol	Cholesterol has a **hydrophobic four fused ringed structure** with a **hydrophilic –OH end** making it an **amphipathic** molecule. Aligns with **phospholipids** in the cell membrane with the –OH group interacting with the hydrophilic phosphate heads and the hydrophobic ring structure interacting with the long hydrophobic hydrocarbon tails of phospholipids.	**Regulates membrane fluidity** by preventing excessive fluidity at high temperatures by restricting phospholipid movement. This prevents increasing **permeability** of the membrane. Prevents freezing at low temperatures by preventing close packing of phospholipids, allowing **transport of membrane proteins** to regions of the membrane where they are needed.

Describe the roles of components of the plasma membrane.		
Component	**Structure**	**Role**
Proteins	Unilateral, transmembrane and peripheral proteins present. Contain **amino acids** with **charged** or **polar R groups** that interact with the **charged phosphate head** of the phospholipid bilayer and aqueous environment. Contains **amino acids** with **non-polar R groups** that form **hydrophobic interactions** with the **non-polar hydrophobic hydrocarbon core** of the phospholipid bilayer. Hence, it is **amphipathic**, allowing for its insertion into the cell membrane.	Transmembrane channel or carrier proteins allow for **facilitated diffusion** of **polar** or **charged** molecules or ions across the membrane. Carrier proteins assist in the **active transport** of **polar** or **charged** molecules or ions across the membrane **against their concentration gradient** using **ATP**. Act as **enzymes** that catalyze chemical reactions. Act as **receptor proteins** which a **specific ligand** will bind to. The formation of the ligand-receptor complex will initiate an intracellular signaling cascade for **signal transduction**. **Stabilize** the membrane structure as proteins can be non-covalently bonded to the cytoskeleton and the extracellular matrix.
Glycoproteins	Proteins with **covalently attached carbohydrate molecules**.	The **diverse** carbohydrate component allows for **unique shapes** that allow them to act as markers for **cell-cell recognition** to distinguish cells as **self or non-self** as the basis of the immune system. Cell-cell recognition also results in **cell adhesion** allowing cells to be **attached** to one another to form **tissues** and **organs**. Acts as **receptors** for certain bacterial toxins to bind to host cells. Forms the **glycocalyx** of certain bacteria. Glycolipids are found in **myelin sheath** used for electrical insulation of nerve cells.
Glycolipids	Lipids with **covalently attached carbohydrate molecules**.	

Describe the role of membranes.
Membranes act as a **boundary** between the inside and outside of a cell, between organelles and the cytoplasm, and between compartments within an organelle. Being **selectively permeable**, allow the **regulation** of the **movement of substances** across the membrane. **Non-polar and uncharged** molecules are able to **dissolve and diffuse** through the **hydrophobic core** of the phospholipid bilayer, while **polar** or **charged** molecules are **repelled** by the hydrophobic core and must be transported across the membrane by **transport proteins**. Membranes allow for compartmentalization, allowing for the formation of **unique environments** for **highly specialized activities**, the **spatial separation** of biochemical processes and thus their **sequential operation** within a cell and the **accumulation of ions** to high concentrations. Membranes act as a surface for the **localization** of **functionally related proteins** which ae grouped together for **sequential biochemical processes** to occur. Membranes increase the **surface area** for chemical reactions. Membranes have a **unique combination** of glycolipids, glycoproteins and proteins on their surface that enable **communication** of the cell with its surroundings. It enables **cell-cell recognition** and **adhesion**, allowing for tissue formation, allows viruses to infect host cells and allows **ligands** to bind to specific **receptors** to initiate **signal transduction**.

Movement of Substances	Movement of substances allows the cell to: a. **Obtain nutrients** for energy such as glucose and oxygen and **raw materials**. b. **Excrete waste** and **secrete useful substances** like enzymes. c. Generate **ionic gradients**. d. Maintain a **suitable pH** and **ionic concentration** within the cell for enzymatic activity.					
Types of Transport	**Type of Transport**	**Type of Molecule**	**Concentration Gradient**	**Transport Protein**	**ATP Usage**	**Explanation**
	Simple Diffusion	Non-Polar	Down	No	Yes	Movement of **small**, **non-polar** move from a region of high concentration to region of low concentration **down a concentration gradient** and **without the use of ATP**. These molecules can pass through the **hydrophobic core** of the phospholipids bilayer readily.
	Osmosis	Water	Down	No	Yes	**Diffusion** of water molecules from a region of **higher water potential** to a region of **lower water potential** through the **selectively permeable membrane**. Water, although polar, is **small enough** to diffuse directly across the membrane through **transient pores** that arise when the phospholipids are in **lateral motion**. Water can also move through the **aquaporin** proteins that facilitate their diffusion of water across the membrane **down their concentration gradient**.
	Facilitated Diffusion	Polar Charged	Down	Yes	No	Movement of **polar** or **charged** molecules, that are **hydrophilic** and hence unable to diffuse through the **hydrophobic core** of the phospholipid bilayer, via **transport proteins down a concentration gradient** across the membrane **without requiring ATP**. **Channel proteins** provide a **hydrophilic channel** across the membrane which is selective for **specific** solute. **Carrier proteins** undergo a **change in conformation** to bring the solute from one side of the membrane to the other when a **specific** solute binds to it.
F	**Type of**	**Type of**	**Concentration**	**Transport**	**ATP**	**Explanation**

Transport	Molecule	Gradient	Protein	Usage	
Active Transport	Polar Charged	Up	Yes	Yes	Movement of **polar** or **charged** molecules or ions through a transmembrane **transport protein against a concentration gradient** across the membrane requiring **ATP**. Transport proteins are solute **specific** carrier proteins.
Bulk Transport	Large	Any	No	Yes	Movement of **macromolecules** too **large** to cross the membrane via a channel in and out of the cell with the usage of **ATP** for the **rearrangement of microtubules**. A channel with a big enough hydrophilic channel for macromolecules will allow many other molecules to pass through as well. **Endocytosis** involves the cell taking up material. a. **Phagocytosis** where the cell membrane extends outwards, forming **pseudopodia** that **engulf** the macromolecule. The ends of the pseudopodia **fuse** and a **vesicle** containing the **solid** matter is pinched off and enters into the cytoplasm. b. **Pinocytosis** where a small area of the plasma membrane **invaginates** to bring in **vesicle** of **aqueous** medium. c. **Receptor-mediated*** endocytosis occurs where **specific ligands** bind to **receptor proteins** on the membrane causing **invagination** of the membrane. **Exocytosis** involves the cell secreting molecules when **secretory vesicles** are transported towards the plasma membrane along **microtubules** and **fuse** with the plasma membrane, releasing the macromolecule.