Welcome students. This module is part of the TYBSc Microbiology course for semester 6. The course code is MID 104 cell biology. This is unit 1 Cell to Cell interactions and the module is Eukaryotic Cell Membrane. I am Nadine de Souza from St Xavier's College, Mapusa.

The outline of this module includes the structure of the cell membrane, the components of the cell membrane, and the functions of the cell membrane. At the end of the module, the students will be able to identify and describe the model of the eukaryotic cell membrane, describe the various components of the cell membrane and explain the role and functions of the plasma membrane.

Let us now begin. Each cell of your body is covered in a tiny bubble of a membrane. This plasma membrane of the eukaryotic cell separates inner cell constituents from the cells surrounding. It is also called the cell membrane. It defines the borders of the cell and allows the controlled interaction of the cell with its environment. Cells need to be able to regulate specific amount of substances that they take in, excrete or exclude. Also, cells must be able to recognize and communicate with each other. This is possible by the functioning of the plasma membrane. By nature, the plasma membrane is a flexible and fluid structure. The basic architecture of the cell membrane is made up of a lipid bilayer, proteins and carbohydrates. It's dynamic nature and selective permeability to polar molecules allows it to play a role in defining the structure of intracellular organelles. In addition to being the boundary of the cell, the essential functions of the plasma membrane include: The transport of solutes into and out of the cell, aiding in cell-cell interactions and signal transduction, which is the response of the cell to external stimuli, separating various cellular compartments as well as acting as a selectively permeable barrier to different molecules in the cell environment and finally providing a framework for biochemical activities of the cell.

A little bit about the history of the plasma membrane. Various theories were proposed to explain the structure of the plasma membrane. Initial insights on the lipid bilayer structure were proposed by Gorter and Grendel in 1925.This was followed by the Sandwich model by Davson and Danielli in 1935, where they proposed that the plasma membrane was made up of a phospholipid bilayer that lies between two layers of globular proteins, much like a sandwich. In 1959, Robertson proposed the unit membrane model describing a three layered trilaminar structure with an inner lipid layer and two outer protein layers.

Finally, the now most widely accepted fluid mosaic model was described by Singer and Nicholson in 1972. According to this model, the phospholipid bilayer of the plasma membrane exists in a fluid state. The various proteins and carbohydrate complexes are embedded in this bilayer, appearing like a mosaic arrangement. These components move about freely and fluidly in the plane of the membrane.

Let us now understand the structure of the plasma membrane in detail. If you look at the figure, the essential basic unit of the lipid bilayer is the phospholipid moiety, which is amphipathic in nature. Amphipathic means having both a hydrophilic as well as a hydrophobic component. The individual phospholipid moiety consists of a polar, water loving or hydrophilic head made up of phosphate and glycerol and two hydrophobic tails, which are nonpolar and made up of saturated and unsaturated fatty acids. The major molecule of the plasma membrane is lipids. The main types of lipids associated with the plasma membrane are phosphoglycerides, sphingolipids and sterols. Most membrane lipids contain a phosphate group hence called phospholipids. Because most membrane phospholipids are built on a glycerol backbone, they are called as phosphoglycerides. The phospholipids of animal cells are phosphatidylcholine, phosphatidylethanolamine, phosphatidylserine, phosphatidylinositol. These phosphoglycerides are classified as such according to their head group. In addition, they also have an amphipathic nature. A less abundant class of membrane lipids are sphingolipids, which are derivatives of sphingosine an amino alcohol linked to a fatty acid. Sphingomyelin is the most abundant sphingolipid. Glycolipids, which are derivatives of sphingolipids, contain carbohydrates covalently attached to the lipid molecule. The nervous system is found to be particularly rich in various glycolipids. The simplest glycolipid is a cerebroside containing a single sugar residue, which may be either a glucose or a galactose molecule. The third type of membrane lipids, is sterols, of which the well known cholesterol is the most abundant. Cholesterol is absent from the plasma membranes of most plant and all bacterial cells. In plants, the sterol present is stigmasterol, whereas in fungal species it is ergosterol. The basic structure of sterols is a four ring isoprenoid based hydrocarbon. These molecules provide structural support to the membrane and aid in maintaining membrane fluidity.

The next membrane components are membrane proteins. The three distinct groups of membrane proteins are integral proteins, peripheral proteins, and lipid anchored proteins. Integral or transmembrane proteins span across the membrane and penetrate the lipid bilayer. They are tightly bound to the membrane and their domains protrude on either side of the lipid bilayer. They function as receptors, transporters and in electron transfer. Peripheral proteins, from their name, are located entirely outside the lipid bilayer and are loosely associated with the membrane by weak electrostatic bonds. The hydrophobic tail of lipid anchored proteins is covalently attached to lipid molecules in the membrane. If you see here, we can see certain integral membrane proteins which are present right across the bilayer and peripheral membrane proteins which do not interact with the hydrophobic core but are located on the surface of the phospholipid bilayer. The final component of the plasma membrane is membrane carbohydrates, which are of two types, glycoproteins and glycolipids. Glycosylation is a reaction by which oligosaccharides, having less than 15 sugars per chain, are linked to either protein or lipid moieties. They play a role in mediating the interaction of a cell with its environment and sorting of membrane proteins. Glycolipids act as receptors for extracellular ligands and aid in signal transduction.

Two notable and distinct features of the plasma membrane are its fluidity and dynamic nature. The fluidity of the membrane means that if you insert a very fine needle into the cell, the membrane will simply flow apart around the needle, and once the needle is removed, the membrane will flow back together seamlessly. The fluidity or viscosity of the bilayer is a function of its lipid composition and the temperature of the cell in which it is present. If the temperature is warm, the lipid exists in a relatively fluid state. Because of their orientation within the bilayer, cholesterol molecules disrupt the close packing of fatty acid chains and interfere with their mobility. The dynamic nature of the membrane allows the movement of lipids and proteins occurring within the membrane. It also allows the formation of transient structures such as lipid rafts, which further aid in the plasma membrane functioning. This completes the module giving us an insight into the plasma membrane, its structure and its role in cell functioning. The references for this module are listed.
Thank you.