Cell recognition proteins are integral proteins that serve to mark a cell's identity so that it can be recognized by other cells. A recognition protein may also act as a receptor that can selectively bind a specific molecule outside the cell. When molecules bind to the recognition protein it causes a chemical reaction within the cell. Some integral proteins serve roles as both receptors and ion channels. The receptors on nerve cells that bind neurotransmitters, such as dopamine, are an example of integral proteins that carry out both functions. When a dopamine molecule binds to a dopamine receptor protein, a channel within the protein opens to allow specific ions to flow into the cell.

Peripheral proteins are typically found on the inner or outer surface of the lipid bilayer but can also be attached to integral proteins (Figure 5.2). These proteins perform a specific function for the cell. Peripheral proteins may serve as enzymes, as structural attachments for the cytoskeleton's fibers, or as part of the cell's recognition sites. Some peripheral proteins on the surface of intestinal cells, for example, act as digestive enzymes to break down nutrients.

Carbohydrates

Carbohydrates are the third major plasma membrane component. Carbohydrates are always on the cell exterior and are bound either to proteins, forming **glycoproteins**, or to lipids, forming **glycolipids** (Figure 5.2). The attached carbohydrate on glycoproteins aid in cell recognition. The carbohydrates that extend from membrane proteins and even from some membrane lipids collectively form the glycocalyx. The **glycocalyx** is a fuzzy-appearing coating that surrounds the cell and has various roles. For example, it may allow the cell to bind to another cell, it may contain receptors for hormones, or it might have enzymes to break down nutrients. The glycocalyces found in a person's body are a result of that person's genetic makeup. They help identify cells as belonging to the same individual. This identity is the primary way that a person's immune defense cells "know" not to attack the person's own body cells. It is also the reason organs donated by another person might be rejected.

Cholesterol

Cholesterol, which inserts within the phospholipid bilayer, is an important hydrophobic component of the membrane that helps with fluidity (Figure 5.2). It prevents phospholipids from packing too closely together, which would cause the membrane to become rigid and prevent molecules such as oxygen, carbon dioxide, and other small nonpolar molecules from moving directly through the membrane. Cholesterol also resists extreme changes in temperature. It will help keep the plasma membrane fluid even if the environment increases or decreased in temperature. The fluidity of the cell membrane is necessary for some enzymes and transport proteins to work properly within the membrane.

Plasma Membrane Components and Locations

Component	Location
Phospholipid	Main membrane fabric
Cholesterol	Attached between phospholipids and between the two phospholipid layers
Integral proteins (for example, aquaporins)	Embedded within the phospholipid layer(s); may or may not penetrate through both layers
Peripheral proteins	On the phospholipid bilayer's inner or outer surface; not embedded within the phospholipids
Carbohydrates (components of glycoproteins and glycolipids)	Generally attached to proteins on the outside membrane layer

Table 5.1 Plasma membrane components and the location of each component. (Modified by Elizabeth O'Grady original work of Clark et al. / Biology 2E OpenStax)

EVOLUTION CONNECTION - How Viruses Infect Specific Organs

Glycoproteins and glycolipids on the cells' surfaces give many viruses an opportunity for infection. HIV and hepatitis viruses infect only specific organs or cells in the human body. HIV can penetrate the plasma membranes of a group of cells called T-helper cells, as well as some monocytes and central nervous system cells. The hepatitis virus attacks liver cells.

These viruses are able to invade these cells because the cells have binding sites on their surfaces that the virus can recognize (Figure 5.5). Unfortunately, these recognition sites on HIV change at a rapid rate because of mutations, making it challenging to develop an effective vaccine against the virus. Viruses appear to be incredibly adaptable, and the rate at which populations are evolving is astounding. A person infected with HIV quickly develops different populations of the virus that vary in their surface markers. Although the immune system may be able to fight one population, as new populations arise it becomes more and more difficult for the immune system to keep up. In the case of HIV, the problem is compounded because the virus specifically infects and destroys cells involved in the immune response.

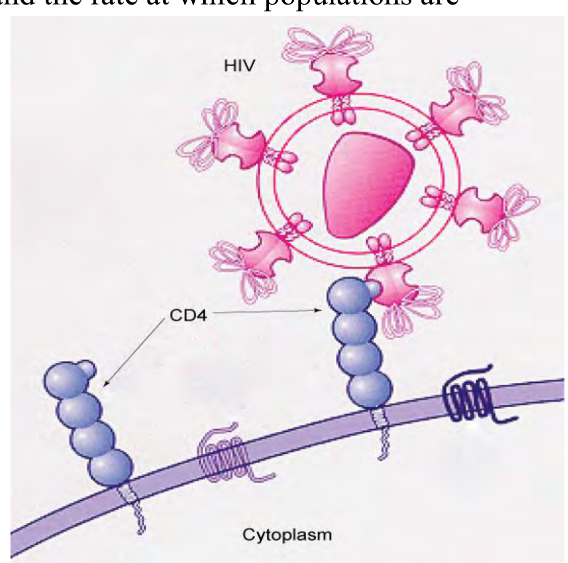

Figure 5.5 HIV binds to the CD4 receptor, a glycoprotein on T cell surfaces. (credit: modification of work by NIH, NIAID / Concepts of Biology OpenStax)

Section Summary

The modern understanding of the plasma membrane is referred to as the fluid mosaic model. The plasma membrane is composed of a bilayer of phospholipids. The membrane is studded with proteins, some of which span the membrane. Some of these proteins serve to transport materials into or out of the cell. Carbohydrates are attached to some of the proteins and lipids on the outward-facing surface of the membrane. These form complexes that function to identify the cell to other cells. The fluid nature of the membrane can be explained by the fatty acid tails, the presence of cholesterol embedded in the membrane, and the mosaic nature of the proteins and protein-carbohydrate complexes. Plasma membranes enclose the borders of cells, but rather than being a static bag, they are dynamic and constantly in flux.

Exercises

1. Which plasma membrane component can be either found on its surface or embedded in the membrane structure?
    a. protein
    b. cholesterol
    c. carbohydrate
    d. phospholipid

2. The phospholipids tails of the plasma membrane are composed of _____ and are _______?
    a. phosphate groups; hydrophobic
    b. fatty acid groups; hydrophilic
    c. phosphate groups; hydrophilic
    d. fatty acid groups; hydrophobic

3. Why is it advantageous for the cell membrane to be fluid in nature?

Answers

1. (a)
2. (d)
3. The fluidity of the cell membrane is necessary for the operation of some enzymes and transport mechanisms within the membrane.