The Plasma Membrane

**Main Idea** The plasma membrane helps to maintain a cell's homeostasis.

**Real-World Reading Link** When you approach your school, you might pass through a gate in a fence that surrounds the school grounds. This fence prevents people who should not be there from entering and the gate allows students, staff, and parents to enter. Prokaryotic cells and eukaryotic cells have a structure that maintains control of their internal environments.

**Function of the Plasma Membrane**

Recall from Chapter 1 that the process of maintaining balance in an organism's internal environment is called homeostasis. Homeostasis is essential to the survival of a cell. One of the structures that is primarily responsible for homeostasis is the plasma membrane. The plasma membrane is a thin, flexible boundary between a cell and its environment that allows nutrients into the cell and allows waste and other products to leave the cell. All prokaryotic cells and eukaryotic cells have a plasma membrane to separate them from the watery environments in which they exist.

A key property of the plasma membrane is **selective permeability** (pur mee uh BIH luh tee), by which a membrane allows some substances to pass through while keeping others out. Consider a fish net as an analogy of selective permeability. The net shown in Figure 7.5 has holes that allow water and other substances in the water to pass through but not the fish. Depending on the size of the holes in the net, some kinds of fish might pass through, while others are caught. The diagram in Figure 7.5 illustrates selective permeability of the plasma membrane. The arrows show that substances enter and leave the cell through the plasma membrane. Control of how, when, and how much of these substances enter and leave a cell relies on the structure of the plasma membrane.

**Reading Check** Define the term selective permeability.
**Structure of the Plasma Membrane**

**Connection to Chemistry** Most of the molecules in the plasma membrane are lipids. Recall from Chapter 6 that lipids are large molecules that are composed of glycerol and three fatty acids. If a phosphate group replaces a fatty acid, a phospholipid forms. A phospholipid (fahs-luhh-pil-uhd) is a molecule that has a glycerol backbone, two fatty acid chains, and a phosphate-containing group. The plasma membrane is composed of a **phospholipid bilayer**, in which two layers of phospholipids are arranged tail-to-tail, as shown in Figure 7.6. In the plasma membrane, phospholipids arrange themselves in a way that allows the plasma membrane to exist in the watery environment.

**The phospholipid bilayer** Notice in Figure 7.6 that each phospholipid is diagrammed as a head with two tails. The phosphate group in each phospholipid makes the head polar. The polar head is attracted to water because water also is polar. The two fatty acid tails are nonpolar and are repelled by water.

The two layers of phospholipid molecules make a sandwich, with the fatty acid tails forming the interior of the plasma membrane and the phospholipid heads facing the watery environments found inside and outside the cell, as shown in Figure 7.6. This bilayer structure is critical for the formation and function of the plasma membrane. The phospholipids are arranged in such a way that the polar heads can be closest to the water molecules and the nonpolar tails can be farthest away from the water molecules.

When many phospholipid molecules come together in this manner, a barrier is created that is polar at its surfaces and nonpolar in the middle. Water-soluble substances will not move easily through the plasma membrane because they are stopped by the nonpolar middle. Therefore, the plasma membrane can separate the environment inside the cell from the environment outside the cell.

**Vocabulary**

**Science usage v. Common usage**

**Polar**

*Science usage*: having an unequal distribution of charge.

*The positive end of a polar molecule attracts the negative end of a polar molecule.*

*Common usage*: relating to a geographic pole or region.

*The polar ice cap in Greenland is, on average, 1.6 km thick.*
Other components of the plasma membrane Moving with and among the phospholipids in the plasma membrane are cholesterol, proteins, and carbohydrates. When found on the outer surface of the plasma membrane, proteins called receptors transmit signals to the inside of the cell. Proteins at the inner surface anchor the plasma membrane to the cell’s internal support structure, giving the cell its shape. Other proteins span the entire membrane and create tunnels through which certain substances enter and leave the cell. These transport proteins move needed substances or waste materials through the plasma membrane, and therefore contribute to the selective permeability of the plasma membrane.

✅ Reading Check Describe the benefit of a bilayer structure for the plasma membrane

Locate the cholesterol molecules in Figure 7.6. Nonpolar cholesterol is repelled by water and is positioned among the phospholipids. Cholesterol helps to prevent the fatty-acid tails of the phospholipid bilayer from sticking together, which contributes to the fluidity of the plasma membrane. Although avoiding a high-cholesterol diet is recommended, cholesterol plays a critical role in plasma membrane structure and it is an important substance for maintaining homeostasis in a cell.

Other substances in the membrane, such as carbohydrates attached to proteins, stick out from the plasma membrane to define the cell’s characteristics and help cells identify chemical signals. For example, carbohydrates in the membrane might help disease-fighting cells recognize and attack a potentially harmful cell.

DATA ANALYSIS LAB 7.1

Based on Real Data*

Interpret the Diagram

How are protein channels involved in the death of nerve cells after a stroke? A stroke occurs when a blood clot blocks the flow of oxygen-containing blood in a portion of the brain. Nerve cells in the brain that release glutamate are sensitive to the lack of oxygen and release a flood of glutamate when oxygen is low. During the glutamate flood, the calcium pump is destroyed. This affects the movement of calcium ions into and out of nerve cells. When cells contain excess calcium, homeostasis is disrupted.

Think Critically
1. Interpret How does the glutamate flood destroy the calcium pump?
2. Predict what would happen if Ca²⁺ levels were lowered in the nerve cell during a stroke.

Data and Observations

Glutamate-releasing nerve ending

Calcium

Glutamate

Calcium pump

Enzyme destroys calcium pump

Enzyme activated by low oxygen and excess calcium

Ca²⁺ stores in the cell

Figure 7.7 The fluid mosaic model refers to a plasma membrane with substances that can move around within the membrane.

Concepts in Motion
Interactive Figure To see an animation of the fluid mosaic model, visit biologygmh.com.

Together, the phospholipids in the bilayer create a “sea” in which other molecules can float, like apples floating in a barrel of water. This “sea” concept is the basis for the fluid mosaic model of the plasma membrane. The phospholipids can move sideways within the membrane just as apples move around in water. At the same time, other components in the membrane, such as proteins, also move among the phospholipids. Because there are different substances in the plasma membrane, a pattern, or mosaic, is created on the surface. You can see this pattern in Figure 7.7. The components of the plasma membrane are in constant motion, sliding past one another.

Section 7.2 Assessment

Section Summary
- Selective permeability is a property of the plasma membrane that allows it to control what enters and leaves the cell.
- The plasma membrane is made up of two layers of phospholipid molecules.
- Cholesterol and transport proteins aid in the function of the plasma membrane.
- The fluid mosaic model describes the plasma membrane.

Understand Main Ideas
1. **Main Idea** Describe how the plasma membrane helps maintain homeostasis in a cell.
2. **Explain** how the inside of a cell remains separate from its environment.
3. **Diagram** the plasma membrane; label each component.
4. **Identify** the molecules in the plasma membrane that provide basic membrane structure, cell identity, and membrane fluidity.

Think Critically
5. **Explain** what effect more cholesterol in the plasma membrane will have on the membrane.

**Writing in Biology**
6. Using what you know about the term mosaic, write a paragraph describing another biological mosaic.