

Chapter 4 – Membrane Structure and Function

4.1 Plasma Membrane Structure and Function

What is the main function of the plasma membrane?

The plasma membrane separates the internal environment of the cell from the external and regulates the entrance and exit of molecules of it.

What are the main structural components of the plasma membrane and how does each function?

The plasma membrane is made up of glycolipids and glycoproteins (which are phospholipids and proteins with attached carbohydrate sugar chains). The proteins allow substances to move across the membrane (channel proteins), combine with substances to help it move across a membrane (carrier proteins), allow molecules to bind to it so that its shape changes and triggers a cellular response (receptor protein), and enzymatic proteins which catalyze a specific reaction.

4.2 The Permeability of the Plasma Membrane

Can substances freely pass across the plasma membrane? If so, what types?

Yes they can, but usually its passage requires some sort of transport (either through diffusion, facilitated transport, active transport, exocytosis, or endocytosis). Small noncharged molecules like carbon dioxide, oxygen, glycerol, water, and alcohol can diffuse across the membrane freely, as they can slip between the hydrophilic heads of the phospholipids and pass through the hydrophobic tails of the membrane.

What does it mean for a plasma membrane to be differentially permeable?

Differentially permeable simply means that the membrane only allows certain substances to pass in and out of the membrane.

4.3 Diffusion and Osmosis

What happens when diffusion occurs? Osmosis?

When diffusion occurs, molecules move from a higher concentration area to a lower concentration (down their concentration gradient) until equilibrium is achieved and they are distributed equally. Osmosis, on the other hand, is the diffusion of water across a differentially permeable membrane due to concentration differences.

How can a cell be affected by the diffusion of water across the plasma membrane?

Depending on what type of solution a cell is submerged in, water can affect it in various ways. In an isotonic solution, a cell neither gains nor loses water, whereas in a hypotonic solution, a cell gains water. In a hypertonic solution, on the other hand, a cell loses water and the cytoplasm shrinks.

4.4 Transport by Carrier Proteins

What is the purpose of carrier proteins in the plasma membrane?

4.5 Exocytosis and Endocytosis

What is exocytosis and endocytosis?

Exocytosis occurs when vesicle formation takes a molecule out of a cell by fusing with the plasma membrane as secretion occurs. Endocytosis occurs when it is taken into a cell – a portion of the plasma membrane invaginates to envelop the substance and then the membrane pinches off to form an intracellular vesicle.

How do vesicles interact with the plasma membrane and move substances into and out of the cell?

They do so through phagocytosis (which digests large particles), pinocytosis (occurs when vesicles form around a liquid or around very small particles), and receptor-mediated endocytosis (which allows cells to take up specific kinds of molecules and then process them within the cell).

Figure 4.1 – Fluid-mosaic Model of Plasma Membrane Structure

What is the fluid-mosaic model of a plasma membrane structure?

Model of the boundary membrane of living cells, showing it as consisting of a tightly packed double layer of phospholipid molecules, in which various proteins and other molecules float

Figure 4.2 – Membrane Protein Diversity

What are some of the functions performed by proteins found in the plasma membrane?

The proteins allow substances to move across the membrane (channel proteins), combine with substances to help it move across a membrane (carrier proteins), allow molecules to bind to it so that its shape changes and triggers a cellular response (receptor protein), and enzymatic proteins which catalyze a specific reaction.

Figure 4.8 Facilitated Transport

What is facilitated transport? How is it different from active transport?

Facilitated transport allows the passage of molecules such as glucose and amino acids across the plasma membrane (as they're not lipid soluble) through the use of carrier proteins. In facilitated transport the substances follow their concentration gradient, whereas in active transport substances are moved against it. Not only that, but active transport also requires a carrier protein and energy for it to occur.

Figure 4.10 – The Sodium-potassium Pump

What is the sodium-potassium pump?

The sodium-potassium pump uses active transport to move sodium ions to the outside of a cell and potassium ions to the inside of a cell. The carrier protein that allows for these substances to be pumped is known as the sodium-potassium pump.

Figure 4.12 – Three Methods of Endocytosis

What are the three methods of endocytosis?

The three methods of endocytosis are phagocytosis, pinocytosis, and receptor-mediated endocytosis.

Testing Yourself

1. **Label this diagram of the plasma membrane**
 A. Glycolipid B. Glycoprotein C. Carbohydrate (sugar) Chain
 D. Hydrophilic Heads E. Hydrophobic Tails F. Phospholipid Bilayer
 G. Filaments of Cytoskeleton H. Peripheral Protein I. Cholesterol
 J. Integral Protein
2. **The fluid-mosaic model of the membrane structure refers to**
 B. The fluidity of phospholipids and the pattern of proteins in the membrane.
3. **A phospholipid molecule has a head and two tails. The tails are found**
 B. In the interior of the membrane.
4. **Besides phospholipids, the other lipid molecule that is vital to an animal's plasma membrane is**
 A. Cholesterol
5. **Which of the following is NOT a function of proteins present in the plasma membrane? Proteins**
 E. Produce lipid molecules
6. **The carbohydrate chains projecting from the plasma membrane are involved in**
 D. All of these are correct
7. **During diffusion,**
 C. There is a net movement of molecules from the area of higher to lower concentration.
8. **When a cell is placed in a hypotonic solution,**
 C. Water enters the cell toward the area of higher solute concentration
9. **When a cell is placed in a hypertonic solution,**
 B. Water exits the cell toward the area of lower solute concentration
10. **After putting salt on roads after icy conditions, why does the grass often die on the roadside?**
 B. The salt creates a hypertonic environment, which kills the grass.
11. **Plants wilt on a hot summer day because of a decrease in**
 A. Turgor pressure
12. **Pickles appear wrinkled and shriveled because they have been placed in a _____ solution.**
 A. Hypertonic
13. **Active transport**
 E. All of these are correct.
14. **The sodium-potassium pump**
 E. All of these are correct.
15. **The movement of water from an area of high to low water concentration would be called**
 B. Osmosis
16. **Which of the following is a passive method of substances entering or leaving a cell?**
 C. Facilitated transport
17. **Facilitated transport differs from diffusion in that facilitated transport**
 A. Involves the use of a carrier protein
18. **Receptor-mediated endocytosis**
 B. Brings specific substances into the cell
19. **Write hypotonic solution or hypertonic solution beneath each cell. Justify your conclusions.**
 A. Hypertonic – water is leaving the cell. B. Hypotonic – water is coming into the cell

eLearning Connection Questions

1. Why is the term "fluid-mosaic" used to describe the plasma membrane?

The phospholipids of the plasma membrane give it a fluid consistency, and the proteins of the plasma membrane are arranged in a sort of a mosaic, thus the term "fluid-mosaic".

2. What is the glycocalyx?

The glycocalyx are the carbohydrate chains of cell recognition proteins that give the cell a 'sugar coat' that protects it, facilitates adhesion between cells, allows for the reception of signal molecules, and cell-to-cell recognition.

3. What is meant by "differentially permeable?"

Differentially permeable means that some substances can move across the plasma membrane of a cell and some can't (it is selective).

4. How does passive transport differ from active transport?

Passive transport doesn't use chemical energy, whereas active transport does (i.e. in the form of ATP). Passive transport involves diffusion and facilitated transport, whereas active transport involves exocytosis and endocytosis.

5. Why does oxygen diffuse from the lungs into the blood and not in the opposite direction?

Oxygen diffuses from an area of greater concentration to an area of lesser concentration. It is assumed that oxygen concentration is greater in the lungs.

6. If a cell is placed into a hypotonic solution, in what direction will there be movement of water?

Water will move into the cell from the surrounding solution.

7. What does it mean when membrane carrier proteins are "specific?"

Membrane carrier proteins can each combine with only one type of molecule.

8. What is the sodium-potassium pump?

The sodium-potassium pump is a carrier protein that uses energy to actively transport sodium ions to the outside of the cell and potassium ions to the inside.

9. Pinocytosis differs from phagocytosis in what way?

Pinocytosis occurs when vesicles form around very small particles or liquids, while phagocytosis occurs when the cell takes in larger particles.