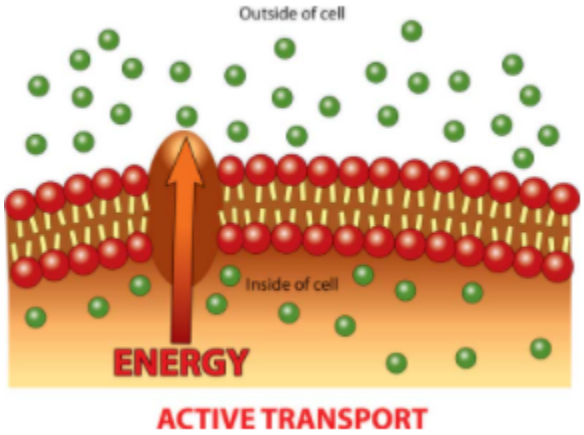
Active transport:

Active transport is the movement of substances from an area of **lower concentration to an area of higher concentration.** For example, cells like to have a large amount of glucose and amino acids. Thus, even if the concentration of glucose inside the cells is high compared to that in the external environment, the cell still wants to transport more glucose in. To counteract the force of simple diffusion and **to move materials against the concentration gradient, energy is required.** In addition, membrane protein carriers are involved.

Imagine pushing a boat AGAINST the current of a river. That would require a lot of energy whereas the boat would travel by itself with the current.

What is Active Transport?

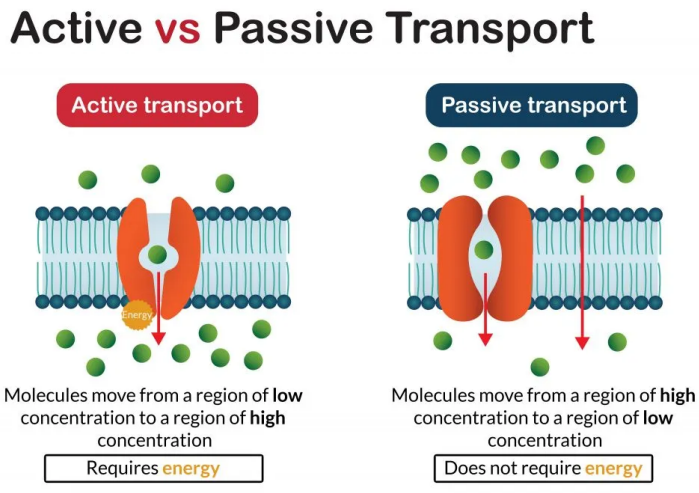
The movement of molecules, atoms, and ions against a concentration gradient across a cell membrane using the cell's energy, in the form of ATP, is called active transport. This is sometimes also called an active transport pump because the cell is literally using energy to "pump" the molecules through the membrane, against the concentration gradient.



Why would a cell use active transport?

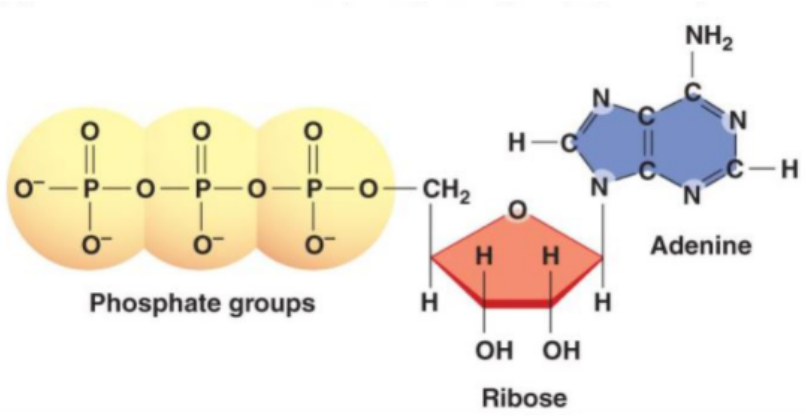
A cell uses active transport to maintain an intracellular environment that is different from that outside the cell. For example:

- It allows a cell to bring in and store nutrients that are already in high concentration inside the cell.
- It also allows a cell to completely remove harmful waste products from the intracellular environment.
- Active transport is necessary for homeostasis—a process by which a constant internal environment is maintained, despite changes in the external environment.



ATP: The Energy Molecule of the Cell

ATP, or adenosine triphosphate, is the molecule that provides ready energy to a cell. When nutrients such as carbohydrates are broken down, their energy becomes stored in the three (tri-) phosphate-to-oxygen bonds of the ATP molecule.

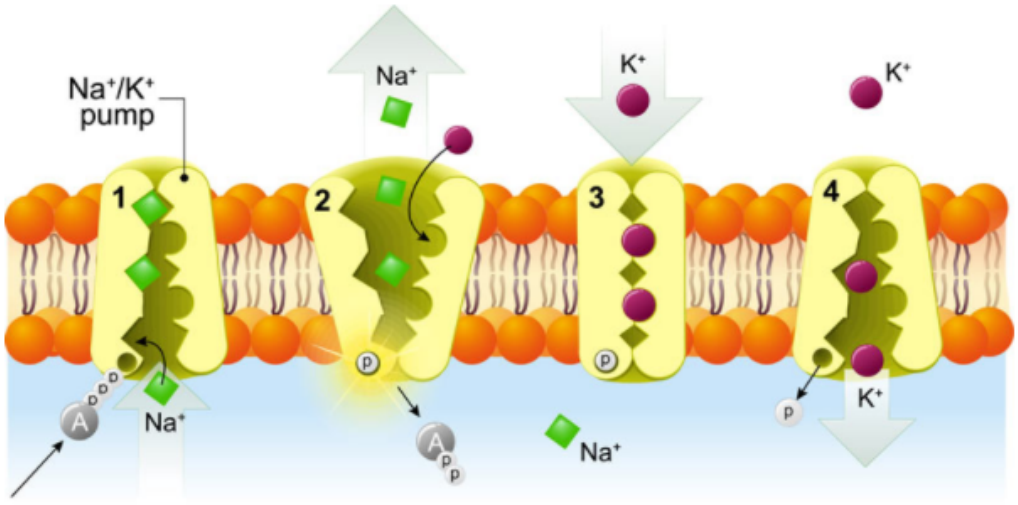


A molecule of ATP

How Active Transport Works:

1. An ion is drawn onto the transport protein.
2. ATP (energy) is used to move the ion through the membrane.
3. The ion is released inside, on the other side of the membrane, where its concentration is higher.

An example of an active transport system is the sodium-potassium pump found in the cell membranes of nerve cells. A nerve cell uses active transport to move the sodium and potassium ions **against their concentration gradients (from a low concentration to a high concentration).**



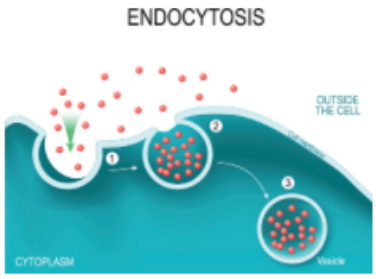
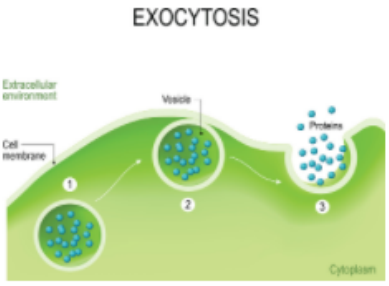
An ATP molecule with its triphosphate group, a ribose molecule, and an adenine molecule.

Bulk transport:

Up to this point we have examined how relatively small molecules are transported through the cell membrane via passive or active transport. However, some molecules are too large to be transported through the cell membrane. The cell uses a special method to move these molecules so that they do not have to pass through the phospholipid bilayer called **vesicles**. The cell membrane can fold in on itself to wrap around and seal large objects in a sac called a vesicle. Like active transport, the cell must **expend energy** to use vesicles, in order to transport larger molecules (such as proteins and polysaccharides) across the cell membrane. Bulk transport is a type of **active transport** and **requires energy** in the form of ATP.

The two general forms of bulk transport are **endocytosis**, which transports materials into the cell, and **exocytosis**, which transports materials out of the cell.

Use your text p. 70 to summarize the two types of bulk transport.

Type of Transport	Description of Process	Diagram of Process
Endocytosis		
Exocytosis		

Consolidation Questions:

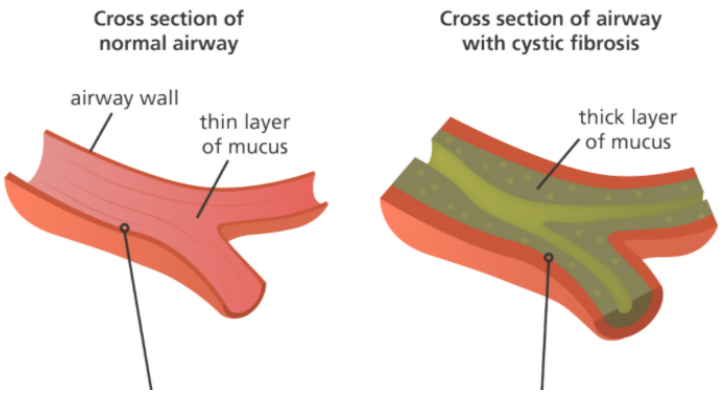
1. Complete the following table comparing the methods of cell transport.

	Requires Energy (Yes or No)	Molecules move with the concentration gradient (from high to low) (Yes or No)	Size of molecules transported in/out of the cell (small/large)	Molecules transported through cell membrane (Yes or No)
Active Transport				
Endocytosis				
Exocytosis				
Osmosis				
Facilitated Diffusion				

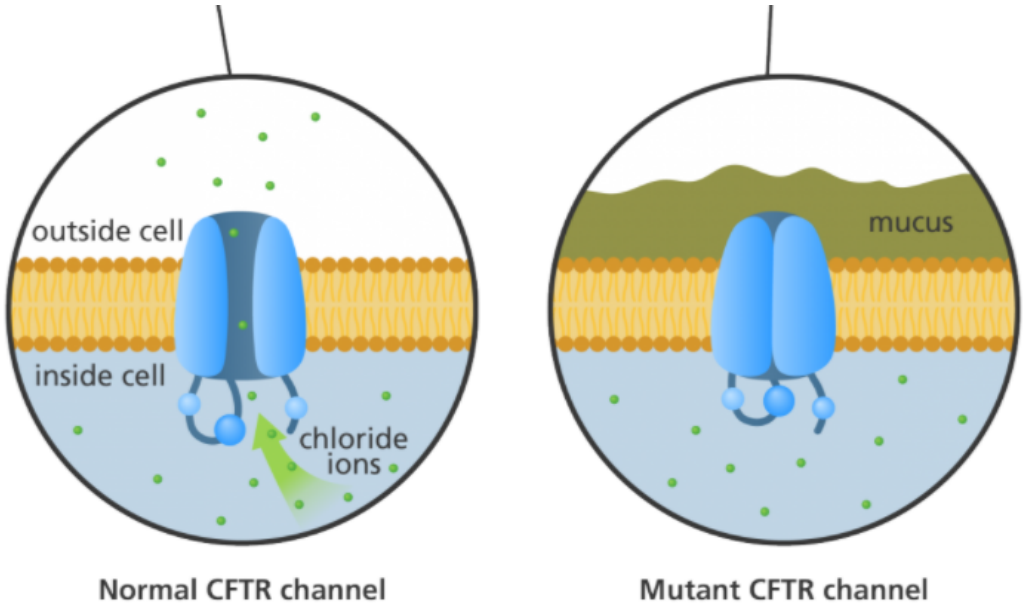
2. Read the following case study and answer the questions that follow.

Case Study: Cystic Fibrosis & Active Transport

Cystic fibrosis (CF) is a hereditary disease that affects the entire body, including the lungs, the digestive system, and the reproductive system. People are born with cystic fibrosis if they inherit the CF gene from both parents. In CF, mucous glands in the respiratory and digestive systems produce thick, sticky mucus, which interferes with breathing and digestion. Mucus clogs passageways in the lungs, causing breathing difficulties, and blocks ducts in the pancreas, preventing digestive enzymes from reaching the intestines. The build up of mucus can destroy the pancreas and, with it, the ability to produce necessary digestive enzymes. The presence of sticky mucus in the lungs causes bacteria and viruses to get stuck; cilia on the epithelial cells that line the lung spaces are unable to remove them. The presence of bacteria and viruses leads to lung infections that reduce the ability of the lungs to absorb oxygen and release carbon dioxide. Eventually, patients experience respiratory failure that usually leads to death. Persons with CF must consume a large number of artificial enzymes (up to 40 pills a day) with every meal to help them absorb nutrients from food. They must also do physical exercises to keep their lungs free of congestion and infection. The most common symptoms of CF are abnormally thick mucus, difficulty breathing, frequent respiratory infections, salty-tasting skin, and impaired growth.



Mucus is a protein-rich, water-based fluid produced by certain cells in the body. The amount of water in mucus depends on the ability of ions to move by active transport across the membranes of these cells. Under normal conditions, chloride ions are actively transported out of the cells into the ducts of the pancreas, against a concentration gradient. The increased concentration of chloride ions in the duct spaces causes water to move, by osmosis, into the space as well. Water in the mucus allows it to flow smoothly. The basic defect in cystic fibrosis is an abnormality in the transmembrane proteins that act as active transport channels for chloride ions. The resulting buildup of chloride ions in the cells causes less water to move into the extracellular (outside the cell) space by osmosis, thereby increasing the viscosity (thickness) of mucus. The defective chloride ion channel has been identified, and is called the cystic fibrosis transmembrane conductance regulator (CFTR).



Normal CFTR channel Mutant CFTR channel

While no cure has yet been found for cystic fibrosis, the symptoms can be managed with a combination of good nutrition, antibiotics to treat infections, and mechanical devices and medications to clear the excess mucus. Scientists are currently exploring gene therapy in the hopes of finding a cure in the future.

Questions on Case Study:

1. Describe the symptoms of cystic fibrosis.
2. Describe two problems associated with the presence of thick, sticky mucus
    a) In the lungs and breathing passageways
    b) In the digestive system

3. What are the treatments for CF?
4. Why are the present treatments for CF not considered to be a cure for the disease?