    - hydrolysis of ATP causes a conformational change in the protein pump
    - solute molecule is consequently translocated across the membrane (against the gradient) and released

- axons of nerve cells transmit electrical impulses by translocating icons to create a voltage difference across the membrane
    - at rest, the sodium-potassium pump expels sodium ions from the nerve cell, while potassium ions (moves into cell)
    - when the neuron fires, these ions swap locations via facilitated diffusion via sodium and potassium channels

Sodium Potassium Pump
- an integral protein that exchanges 3 sodium ions (moves out of cell) with two potassium ions (move into cell)
- process of ion exchange against the gradient is energy-dependent and involves a number of key steps:
    - 3 sodium ions bind to intracellular sites on the sodium-potassium pump
    - phosphate group is transferred to the pup via the hydrolysis of ATP
    - pump undergoes a conformational change, translocating sodium across the membrane
    - conformational change exposes 2 potassium binding sites on the extracellular surface of the pump
    - phosphate group is released which causes the pump to return to its original conformation
    - translocates the potassium across the membrane, completing the ion exchange

Vesicular Transport
- materials destined for secretion are transported around the cell in membranous containers called vesicles

Endoplasmic Reticulum
- ER is a membranous network that is responsible for synthesizing secretory materials
    - rough ER embedded with ribosomes and synthesizes proteins destined for extracellular use
    - smooth ER is involved in lipid synthesis and also plays a role in carbohydrate metabolism
- materials transported from ER when membrane bulges and then buds to create a vesicle surrounding the material

Golgi Apparatus
- vesicle is then transported to the Golgi apparatus and fuses to an internal face of complex
    - materials move via vesicles from the internal cis face of the Golgi to the externally oriented trans face
    - while within the golgi apparatus, materials may be structurally modified

Plasma Membrane
- vesicles containing materials destined for extracellular use will be transported to the plasma membrane
- vesicle will fuse with the cell membrane and its materials will be expelled into the the extracellular fluid
- materials sorted by golgi apparatus may be either:
    - released immediately into the extracellular fluid
    - stored within an intracellular vesicles for a delayed release in response to a cellular signal

Bulk Transport
- membrane is principally held together by weak hydrophobic associations between the fatty acid tails of phospholipids
- weak association allows for membrane fluidity and flexibility, as the phospholipids can move around to some extent
- allows for spontaneous breaking and reforming of the bilayer, allowing larger materials to enter or leave the cell without having to cross membrane (active transport and requires ATP hydrolysis)

Endocytosis
- process by which large substances (or bulk amounts of smaller substance) enter the cell without crossing the membrane
    - the invagination of the membrane forms a flask-like depression which envelopes the extracellular material
    - invagination is then sealed off to form a intracellular vesicle containing the material
- two main types of endocytosis:
    - phagocytosis
        - process by which solid substances are ingested
            - transported to lysosome
    - pinocytosis