Terms

- Neuron
  - A type of cell that is responsible for transmitting signals that result in our thoughts, emotions, and behaviors
- Agonist
  - Something that *excites* a neuron, causing it to release neurotransmitters
- Antagonist
  - Something that *inhibits* a neuron. For example, something that blocks signals that it should release neurotransmitters
- Resting membrane potential
  - Difference in electrical charge between interior and exterior of a neuron
  - -70 millivolts (the inside is negatively charged)
- Threshold of excitation
  - The amount of change in electrical charge that results in a neuron generating an action potential
- Action potential
  - A temporary reversal in the charge inside a neuron
  - i.e., the interior becomes positively charged
  - Results in the release of neurotransmitters
- ATP
  - Abbreviation for adenosine triphosphate
  - Produced by mitochondria
  - Used to power ion pumps
- Diffusion
  - Molecules move from areas of high concentration to areas of low concentration
- Electrostatic pressure
  - Positively charged ions are attracted to negatively charged ions, and visa versa
- Atom
  - Are made up of protons, neutrons, and electrons
- Molecule
  - Multiple atoms bonded together
- Ion
  - An atom or molecule with an electric charge resulting from the loss or gain of an electron. Ions that are often found in and around neurons include sodium (Na+), chlorine (Cl-), and potassium (K+)
- Cation
  - An ion with a positive charge
- Anion
  - An ion with a negative charge
- Ion gates or channels
  - Passages between the interior and exterior of a neuron that open in response to the neuron reaching its threshold of excitation
  - Ion pumps on the axon are only found at the nodes of Ranvier, as the rest of the axon is covered by myelin
- Neurotransmitter dependent ion channels
    - Special ion channels that open when a particular neurotransmitter binds to receptor cites located on the ion channels
- Ion pumps
  - Sodium potassium transporters are responsible for pumping Na+ ions out and K+ ions in

        - Two K+ ions enter the neuron for every three Na+ ions that leave
        - These pumps are powered by ATP, which is produced by mitochondria in the soma
- Ionotripic receptors
    - Neurotransmitter receptors that are connected to ion channels
- Reuptake
    - The process of taking neurotransmitters back into the sending neuron

Cell parts

- Soma
    - Cell body
    - Contains organelles
- Dendrites
    - Receive neurotransmitter messages
- Axons
    - Connect soma to terminal buttons
- Myelin sheath
    - Protective sheath covering most of the axon
    - Myelin on neurons in the central nervous system are produced by special glial cells called oligodendrocytes
- Nodes of Ranvier
    - Gaps between myelin sheath on the axon
- Terminal buttons
    - Also called axon terminals
    - Send neurotransmitter signals
- Synapse
    - Space between neurons (synaptic gap), the membrane of the sending neuron (presynaptic membrane), and the membrane of the receiving neuron (postsynaptic gap)
- Synaptic vesicles
    - Found in presynaptic terminal buttons
    - Contain neurotransmitters
- Neurotransmitter
    - Chemical substance that binds to receptors on neurons, either exciting or inhibiting them.

Signaling within cells

- Resting axon carries a charge of -70 millivolts
    - Called resting membrane potential
    - Change in membrane potential results in a message being transmitted along the axon
- Why do neurons carry a charge?
    - Ions inside and outside of the neuron are responsible for this
        - Some ions are positively charged, such as Na+ and K+
        - Some ions are negatively charged, such as Cl-
    - Blood brain barrier protects the delicate balance of ions inside of the brain and spinal column
    - Ion gates use energy to transport ions into or out of a neuron, thus changing the charge
        - These gates are generally powered by ATP
        - Some of these gates open when neurotransmitters bind to them
- Threshold of Excitation
    - Membrane potential reverses
        - Inside of neuron becomes positively charged
        - This reversal is called the *action potential*

    - When the threshold of excitation is reached, many ion pumps open at once, permitting a lot of Na+ and then K+ ions to enter
        - This is called the action potential
- Action potential
    - Happens when neurotransmitters bind to ion channels, thus allowing enough ions into the cell to sufficiently excite (threshold of excitation) the cell.
    - Cell rapidly becomes positively charged
        - Diffusion
        - Electrostatic pressure
    - After the action potential, Na+ ion channels close while K+ channels remain open. K+ ions are repelled by the Na+ ions (electrostatic pressure) and exit the cell. The neuron is in a refractory period, and the channels will not open again until enough K+ ions have exited the cell so that the neuron has returned to its resting potential of -70 millivolts
        - The neuron becomes even more negatively charged shortly after it has reached an action potential than it is while it is at rest due to a buildup of K+ ions outside of the neuron.
            - K+ ions diffuse, and the neuron returns to its resting potential
    - Na+ and K+ ion pumps use ATP to return the neuron to its balance of Na+ and K+ ions, so it is ready for the next action potential

Signaling between neurons

- Action potential causes synaptic vesicles containing neurotransmitters to fuse with the presynaptic membrane
    - vesicles then break open and release neurotransmitter into synaptic gap
- Neurotransmitters cross the synaptic gap and bind with receptors on neurotransmitter-dependent ion channels located on the postsynaptic membrane
    - Receptors on these ion channels are called ionotropic receptors
    - If enough ion channels open, the neuron will reach its threshold of excitation, which will generate an action potential, thereby releasing more neurotransmitters to neighboring neurons
- Some neurotransmitters inhibit neurons from reaching their action potentials
    - Bind to ion channels that admit negatively charged ions
    - Bind to K+ ion channels
        - Because there is a higher concentration of K+ inside of a neuron than outside, K+ will diffuse out of the ion channels, thereby producing a more negative charge in the neuron
- Stopping post-synaptic potentials
    - Neurotransmitters are generally taken back into the sending neuron
        - This is called reuptake
    - One neurotransmitter, acetylcholine (ACh) is destroyed by an enzyme called acetylcholinesterase (AChE)
        - ACh is responsible for muscle movement
        - Nicotine is an ACh agonist