The Neurons

- Functional classes (CNS and PNS)
  - Sensory (collect internal and external information)
  - Motor (controls muscles)
  - Interneurons

- Morphology (shape)
  - Study of neuron shape is called neuro-anatomy
  - In some cases, the shape of a neuron is indicative of function
  - 3 basic shapes
    - Multi-polar (2.1)
      - Dendrites have spines
      - Axons have myelin sheath
      - Neuron takes information from the dendrites to the soma to the axon to the terminal boutons in the form of neurotransmitters
      - Inside a multipolar neuron
        - Soma
          - Membrane (lipid bilayer (fat))
          - Cytoplasm
          - Nucleus (chromosomes, DNA, genes, protein, enzymes)
          - Microtubules (axoplasmic transport)
          - Mitochondria (energy and ATP symbiosis)
          - Cytoskeleton (assembly of microtubules and other proteins that together produce the shape of the neuron)
    - Unipolar
      - Spinal Chord
      - Brain to muscle or gland
      - Dendrite and axon
    - Bipolar (2.2)
      - Sensory
      - External/internal stimulus to the brain
      - One axon, one dendrite

- Nerve (axon bundle)
  - Synapses
    - How neurons communicate with each other
    - Space between terminal boutons and dendrites
    - Pre-synaptic: terminal bouton and prior
    - Post-synaptic dendrites and after

Neurons

- Neurons
  - Take care of by Glial Cells
  - 5x more glial cells than neurons
three types

- **Astrocytes**
  - Buffer for chemical substance (kill and absorb or secrete)
  - Structural support
  - Cleanup (phagocytosis)
  - Nourishment (e.g. lactate)
  - Active interface between blood vessels and neurons

- **Oligodendrocytes**
  - Extend arms to axon and wrap around axon
  - Schwann cells wrap themselves around an axon

- **Microglia**
  - Phagocytes (clean up)
  - Part of immune system
  - Active during inflammatory reaction due to brain damage

✓ Check your understanding
- Trace from spine to spine of communication between cells
- what are the three types of neurons?

**Blood Brain Barrier**
- selective permeability (only takes in what is needed)
- active transport (e.g. glucose)
- Area Postrema (controls vomiting)

**How Neurons Work**
- Neurons are electrical devices

<table>
<thead>
<tr>
<th>Electron</th>
<th>Ions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry charge</td>
<td>Molecule that carries electron</td>
</tr>
<tr>
<td>Free-floating</td>
<td>Channeled information</td>
</tr>
</tbody>
</table>

- Example
  - Squid have giant axons
  - Axons generate a voltage (-70mV)

- Resting Membrane Potential
  - diffusion: high to low concentration
  - electrostatic pressure: same charges repel
  - Extracellular
    - Low concentration K+
    - High Concentration of Na+ and Cl-
      - Force of diffusion flows high to low into the cell
      - Electrostatic pressure based on cell repulsion pushes the ion back out
  - Intracellular
    - Anion
    - High concentration K+
      - Force of diffusion flows high to low out of the cell
      - Electrostatic pressure based on cell repulsion pushes the ion back in
• Low concentration of Na+ and Cl-
  • Sodium Potassium Pump (2.16)
    ▪ 3 sodium out 2 potassium in to establish equilibrium
• When there is a change in equilibrium
  • Hyperpolarization (voltage decreases)
  • Depolarization (membrane potential voltage increases)
• Action potential (2.14)
  • Neurons respond to this
  • All or None Conduction Law (in axon)
• In the membrane
  • Voltage dependent ion channels
    ▪ Ions move in/out of cells using ion channels
    ▪ Channels open when depolarized
    ▪ K+ channels are slower than Na+ channel (2.17)
    ▪ Na+ open and depolarize
    ▪ K+ open and hyperpolarize cell
• Conduction of a Depolarization
  • In Dendrites: passive propagation
    ● Lose power
  • In Axons: Active Propagation
    ● Myelin sheath isolate the axon and preserve voltage
    ● Regenerate the voltage at the nodes of Ranvier
• Rate Law
  • Greater the stimulant the greater the number of action potentials
  • Spontaneous (weak) vs. Elicited (strong)
✓ Check Your Understanding
  • True  Sodium ions are more numerous outside the cell and depolarize the neurons when they enter
  • False  There are 5X more neurons than glial cells
  • Trace information from spines to the terminal boutons
    ▪ Information arrives at the spines/ dendrites. It is than summed at the soma and than sent out on the axon to the terminal boutons