TOPIC 5: SYNAPSES AND NEURONAL INTEGRATION

I. Introduction
- A. How is information transferred from neuron to neuron?
  1. The electrical signal that moves down a neuron must be passed to the next neuron
  2. The junction between two neurons is called a **synapse**

II. Synapse Structure (Fig 8.2)
- A. Axon terminals of presynaptic neuron junction with dendrites & cell body of postsynaptic neuron
- B. Synapse is area of communication between neurons, with information moving from presynaptic neuron to postsynaptic neuron *only*.
- C. The postsynaptic neuron may receive input from thousands of presynaptic neurons.

III. Synaptic Function (Fig 8.2; IPCD Nervous System 2, Synaptic Transmission 6)
- A. Action potential reaches the axon terminal of the *presynaptic neuron*
- B. which triggers the opening of voltage gated Ca^{++} channels and the subsequent entry of Ca^{++} into the presynaptic neuron.
- C. The entry of Ca^{++} into presynaptic neuron causes *synaptic vesicles* inside the synaptic knob to release *neurotransmitters* into the *synaptic cleft* through the process of exocytosis.
- D. After diffusing across the synaptic cleft, the neurotransmitters bind to receptor sites on the membrane of the *postsynaptic neuron*.
- E. Neurotransmitters are quickly removed from synapse by
  1. *inactivation by enzymes* or by being
  2. *actively taken back into synaptic knob* or by simply
  3. *diffusing away*.
  4. This occurs to ready the postsynaptic membrane to receive another message

IV. Result of synaptic function (IPCD Nervous System 2, Synaptic Potentials 7, 8, 9)
- A. Excitatory Postsynaptic Potential (EPSP) occurs at an *excitatory synapse* (Fig 8.4a)
  1. Excitatory pre-synaptic neuron releases neurotransmitter
  2. Neurotransmitter binds to receptor on the postsynaptic membrane
  3. Na^+ and K^+ channels on postsynaptic membrane open
  4. Lots of Na^+ flow into cell, a few K^+ move out of cell
  5. With this net influx of positive ions into the cell, the membrane depolarizes a little, so that it is *closer to threshold*
- B. Inhibitory Postsynaptic Potential (IPSP) occurs at an *inhibitory synapse* (Fig 8.5)
  1. Inhibitory pre-synaptic neuron releases neurotransmitter
  2. Neurotransmitter binds to receptor on membrane
  3. K^+ channels on membrane open
  4. K^+ leaves cell
  5. Net result is inside of cell becomes more negative relative to the outside of the cell, which is a
  6. hyperpolarization of the membrane so that membrane is *further from threshold*
- C. Grand Postsynaptic Potential (GPSP) Fig 8.8
  1. Within entire postsynaptic neuron, the sum of all EPSP and IPSP = GPSP
  2. Multiple rapid excitatory firings of a single presynaptic neuron can result in *Temporal Summation*, which causes an action potential in the postsynaptic neuron
  3. Simultaneous excitatory firings from multiple presynaptic neurons can result in *Spatial Summation*, which causes an action potential in the postsynaptic neuron.
  4. Excitatory firings and inhibitory firings can cancel each other out