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 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