**The key: 7.013 Recitation 18 – Spring 2018**

1. **Under resting conditions which ion(s) has a higher concentration within the neuron? List the channels/pumps that maintain the resting membrane potential.**
   
   *Open channels (open Na+, open K+, open Cl-) which allows specific ions to diffuse down their concentration gradient and Na+K+ ATPase pump that pumps 3 Na+ ions out for every 2K+ ions getting into the cell.*

2. **Under depolarization phase, which ion(s) has a higher concentration within the neuron? List the channels/pumps that maintain the resting membrane potential.**
   
   *Na+ ions (due to voltage gated Na+ channels) , but can also include Ca2+ due to ligand gated Ca2+ channels.*

3. **What are nodes in neuron and how are they related to the conduction of action potential?**
   
   *These are non-insulated regions on the axons between the myelin sheath where you see the action potential.*

4. **Which cell types have resting potential and which can generate action potential?**
   
   *All cell types have resting membrane potential but neurons and muscle cells can generate action potential.*

5. **Dopamine is one of major neurotransmitters in the mammalian brain that regulates mood, cognition and locomotion. Dopamine acts on two types of receptors: the D1 receptor is an inhibitory ligand-gated channel, the D2 receptor activates the G proteins, and is excitatory. The released neurotransmitter is taken back into the presynaptic cell, for re-use.**
   
   **a)** On what part of the neuron are the dopamine receptors localized?
   
   *The dopamine receptors are located on post-synaptic membrane.*

   **b)** Is either D1 or D2 a metabotropic receptor? **Explain.**
   
   *Metabotropic receptors are not ion channels, but rather modulate the activity of ion channels through second messengers. Since the D2 receptors act via G proteins, they are metabotropic receptors.*

   **c)** The D1 receptor is inhibitory and transports K+ ions. Would K+ be moved into or out of the postsynaptic cell? **Explain** the mechanism underlying this inhibitory effect.
   
   *At resting membrane potential the concentration of K+ is higher inside the cell compared to outside. The binding of dopamine to its D1 receptor will therefore move K+ ions out of the cell. As a result the membrane potential will be more negative relative to that at the resting state i.e. it is hyperpolarized, and further from threshold potential. Thus the chances of the post-synaptic neuron to fire an action potential will be reduced.*

   **d)** The D2 receptor is excitatory, and its ion targets are believed to include Ca2+. Would Ca2+ be moved into or out of the postsynaptic cell? **Explain** the mechanism underlying this excitatory effect.
   
   *The D2 receptors will promote the movement of Ca2+ ions into the cell, since Ca2+ concentration is higher outside the cell than inside. Thus, the inside of the cell becomes more positive relative to the unstimulated state; and the membrane potential will become closer to threshold potential and an action potential.*
6. At any one synapse, you can find multiple neurotransmitters and multiple receptors. If several different excitatory and inhibitory neurotransmitters and receptors are being used at a single synapse, explain how a postsynaptic neuron “decides” whether to fire an action potential or not. 

The decision whether to fire an action potential or not is made at the axon hillock of the post-synaptic neuron that summates all the changes, which take place when the cell body of this neuron synapses with the axon terminus of multiple pre-synaptic neurons.