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.

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