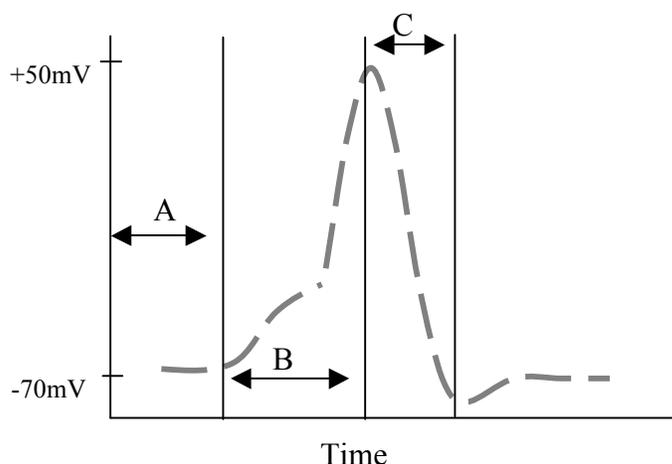


Solution Key- Section 16

Questions:

1. Shown below is a plot of axonal membrane potential as a function of time, measured at a single position on the axon.



For each of the three time points indicated, fill in the following table. Name the phase of membrane potential that describes the time point, the channels/pumps that are involved, and explain how these channels/pumps maintain that phase.

Time point	Phase	All the ion channel/ Pump involved	Explanation
A	Resting	Na ⁺ /K ⁺ pump & open K ⁺ channels	Na ⁺ /K ⁺ pump creates a difference in concentration for both Na ⁺ and K ⁺ across the cell membrane. The relative concentration of Na ⁺ is high outside as compared to inside and the relative concentration of K ⁺ is low outside as compared to inside the cell. The open K ⁺ channel always allows K ⁺ to flow out of the cell. As K ⁺ moves out of the cell, down its concentration gradient, the inside of the cell becomes negative with respect to the outside of the cell. K ⁺ moves out of the cell until the driving force of the concentration gradient equals the driving force of the electrochemical gradient, which for most cells set the resting membrane potential at -70 mV.
B	Depolarization	Voltage gated Na ⁺ Channels	During the action potential Na ⁺ ions to move into the cells making the inside more positive relative to outside thus depolarizing the membrane.
C	Repolarization	Voltage gated K ⁺ Channels, Na/K pump	During action potential it causes the K ⁺ ions to move out of the cells making the inside more negative relative to outside thus repolarizing the membrane.

2. 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 Ca^{2+} . Would Ca^{2+} be moved into or out of the postsynaptic cell? Explain the mechanism underlying this excitatory effect.

The D2 receptors will promote the movement of Ca^{2+} ions into the cell, since Ca^{2+} 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.

MIT OpenCourseWare
<http://ocw.mit.edu>

7.013 Introductory Biology
Spring 2013

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.