QUIZ 03 (NOT GRADED)- KEY

Instructions: Download the quiz from Blackboard (in Quiz Questions Folder), print a copy and use the paper copy to work through the various questions and problems. Mark the correct answers on it. When you are ready to **submit** your answers, you will see the quiz posted under Quiz Answer Sheets.

Click the quiz name to launch the quiz. Enter your answers to each of the corresponding numbered questions onto the **blank answer sheet** (the questions will not be repeated, simply a blank page for your answers). The quiz may be saved if you do not finish entering your answers in one sitting. When you are finished with the quiz, make sure to **submit** your answers and they will be recorded.

For each question, select the one **best answer** from among those given (multiple choice). Each question is worth one (1) point.

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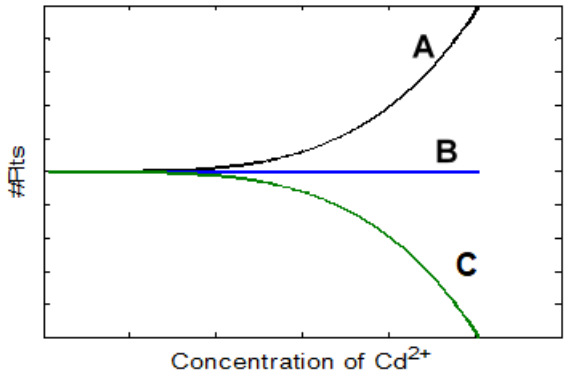
1. You perform a freeze-fracture study to measure the fusion of synaptic vesicles with the pre-synaptic plasma membrane. You measure the number of pits (released vesicles) while sequentially adding more and more of the calcium channel blocker, Cd^{2+}. What would be the shape of the relationship between the concentration of Cd^{2+} and the number of pits measured?



   a. A
   b. B
   c. A or B, depending on if it is releasing glutamate or GABA
   d. C
   e. Not enough information to tell

Answer Key: As you increase cadmium, there should be fewer fusion events and thus fewer pits due to a lack of calcium initiating synaptic release of vesicles.

2. You have mutated the nicotinic acetylcholine receptor so that its channel is now twice as permeant to K^+ as to Na^+ instead of being roughly equally permeant to the two cations. What should this do to the effect of ACh on the neuron? In this neuron, the resting potential is -65 mV; E_{Na} = +40 mV; E_K = -70 mV.

   a. V_{Rev} for the receptor will be more depolarized than usual.
   b. ACh will cause the neuron to hyperpolarize from its resting potential.
   c. The ACh-evoked EPSP will be smaller than usual.
   d. ACh will more easily be able to evoke an action potential in the neuron.
   e. a and d.

Answer Key: This will hyperpolarize the Vrev of the channel, making it more difficult for Ach to depolarize the cell. This will NOT affect the RMP of the cell, since Ach Rs are not channels that are open at rest.

3. Use the following values for both this (#3) and the **next** (#4) question:
   E_{Na} = +50 mV
   E_K = -70 mV
   E_{Ca} = +150 mV
   Resting potential of neuron = -60 mV
   Threshold for action potential = -45 mV.

   You are a molecular biologist experimenting with the ionotropic receptor for a new neurotransmitter, Ronaldamine, in mice. This receptor is permeant only to Na^+ and K^+, and it has a V_{rev} of +0 mV. From this, you conclude that the receptor's channel is:

   a. Equally permeant to Na^+ and K^+.
   b. More permeant to Na^+ than K^+.
   c. More permeant to K^+ than Na^+
   d. Permeant only to K^+.
   e. Impossible to tell from the information given.

   Answer Key: If it were equally permeant to Na and K, the Vrev would be halfway between Ek and Ena ((-70mV+50mv)/2 = -10mV). Therefore, it has to be more permeant to Na, since 0 is more depolarized than -10mV in the direction closer to E_{Na}.

4. You next mutate the channel of the receptor described above so that it becomes equally permeant to Ca^{++}, K^+, and Na^+. You can now conclude the following:

   a. This switches the receptor from a transmitter receptor to a neuromodulator type receptor.
   b. The receptor was previously excitatory and is now even more so.
   c. The receptor was previously inhibitory and is now even more so.
   d. This switches the receptor from excitatory to inhibitory.
   e. This switches the receptor from inhibitory to excitatory.

Answer Key: Now Vrev will be the average of Ek, Ena and Eca: (+50+150-70)/3 =43.3mV. Since 43mV>-45mV (APthresh), it is now excitatory, rather than inhibitory (0mv>-45mV).

5. Bad luck! You have been bitten by Bungarus multicinctus, a snake from Thailand whose venom contains alpha-bungarotoxin, which selectively blocks the channel of nicotinic acetylcholine receptors on skeletal muscle. What happens next?

   a. The V_{rev} of the AChR becomes more negative
   b. The resting potential of the muscle fibers become more positive.
   c. Motoneuron-evoked EPSPs get smaller.
   d. You die of flaccid paralysis

e. c and d

Answer Key: channel blockers won't change the Vrev of the channel or the resting potential, it will only hinder the normal neurotransmitter's binding to their receptor, which means in this case, your muscle won't be able to contract anymore.

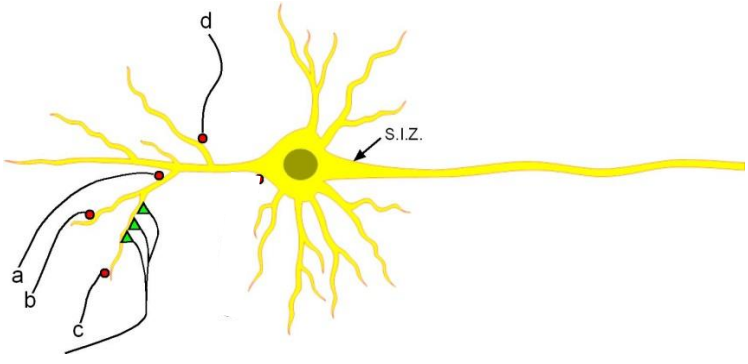
6. Given the steps shown below, which of the following is the correct sequence for transmission at an ionotropic chemical synapse?

   1) Neurotransmitter binds with receptors associated with the postsynaptic membrane.
   2) Ca2+ ions rush into neuron's cytoplasm.
   3) Action potential depolarizes the synaptic terminal membrane.
   4) Ligand-gated ion channels open.
   5) Synaptic vesicles fuse with the membrane and release neurotransmitter into the synaptic cleft.

   a. 1, 2, 3, 4, 5
   b. 2, 3, 5, 4, 1
   c. 3, 2, 5, 1, 4
   d. 4, 3, 1, 2, 5
   e. 5, 1, 2, 4, 3

Answer Key: If you did not understand this, review Lecture 9 slides that cover how vesicles are filled with NT, then move down the neuron towards the synapse, bind with the SNARE complex, and are released into the synapse.

7. This cell receives synchronized excitatory inputs via the three green triangle boutons resulting in a strong EPSP. Each of the four round red terminals is an inhibitory synapse that produces an identical hyperpolarizing current in the post-synaptic cell. Which of these inhibitory synapses, when activated at the same time as the EPSP, has the best chance of reducing the membrane depolarization from the EPSP at the spike initiation zone?



   a. a
   b. b
   c. c
   d. d
   e. Not enough information

Answer key: A is correct, because it is located between the excitatory synapses and the S.I.Z. This means that the depolarization which passively flows down the axon could be shunted by this inhibitory synapse.

8. Which one of the following statements is **false**?

   a. Metabotropic receptors act via G-proteins.

b. G proteins made up of alpha (α), beta (β) and gamma (γ) subunits that can move along the membrane.
c. Some G-proteins directly bind to and open ion channels.
d. Metabotropic receptors are inhibitory.
e. Some G-protein signal pathways involve the activation of protein kinases which phosphorylate proteins.

Answer key: D. Can be excitatory or inihibitory.

9. You are studying EPSP-IPSP interactions in a simple invertebrate neuron that receives only one large excitatory synapse and one large inhibitory synapse, both next to one another on the cell body of the post-synaptic neuron. The excitatory input alone generates and EPSP of 10 mV, and, in voltage clamp, an EPSC (excitatory post-synaptic current) of -100 pA. The inhibitory input alone generates an IPSP of 2 mV and an IPSC of +20 pA. You stimulate both inputs simultaneously while voltage-clamping the neuron at its resting potential. The summed synaptic current is:

a. Cannot tell from this information.
b. More than the arithmetic sum of the two currents, -120 pA
c. Less than the arithmetic sum of the two currents, -60 pA
d. The arithmetic sum of the two independent currents, -80 pA

Answer key: Because you have clamped the neuron at its resting potential, the synaptic currents do not change the driving force for either one, so they simply add linearly. If you allowed the voltage to change, they would not add linearly.

10. After much labor, you prove that acetylcholine is the transmitter used by the golden cell of the Glorious Rainbowfish. With this knowledge, you can conclude that this neuron's synapses are:

a. Excitatory.
b. Inhibitory.
c. Modulatory.
d. Electronic.
e. Unable to decide with the information given.

Answer key: The effect is not determined by the transmitter, but rather the receptors. Often, receptors for a given transmitter can have excitatory, inhibitory and/or neuromodulatory effects. $GABA_A$ receptors are generally inhibitory ligand-gated channels, whereas $GABA_B$ receptors are neuromodulatory, G-protein-coupled receptors.

Thought Questions (ungraded)

11. Many neurons have a high density of inhibitory synapses located very near to the Spike Initiation Zone (SIZ). Why would inhibitory synapses be located there rather than at other locations on the neuron?

Answer key: To veto all excitatory inputs to cell. At the Spike Initiation Zone, they can shunt all the passively propagated EPSPs from everywhere in the dendritic arborization, and have a maximal effect on the decision to spike or not.