2019

AP® CollegeBoard

AP® Biology

Sample Student Responses and Scoring Commentary

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Free Response Question 4

- ☑ **Scoring Guideline**
- ☑ **Student Samples**
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AP® BIOLOGY
2019 SCORING GUIDELINES

Question 4

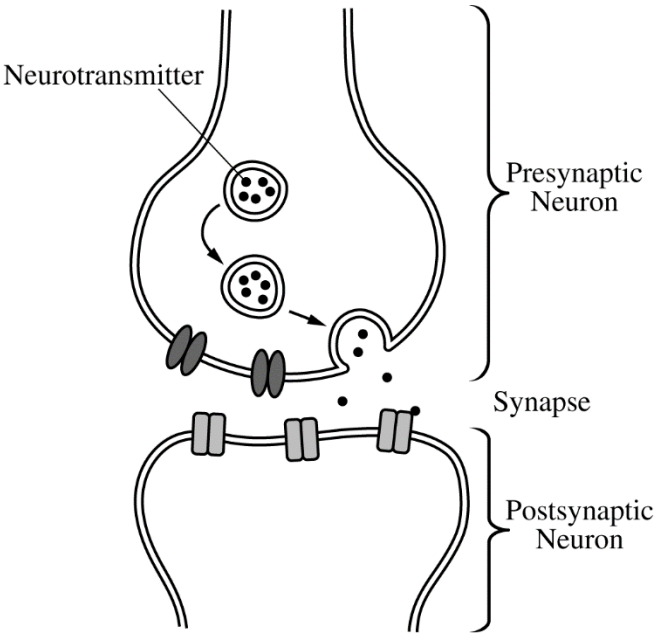


Figure 1. Release of neurotransmitters into the synapse in response to an action potential

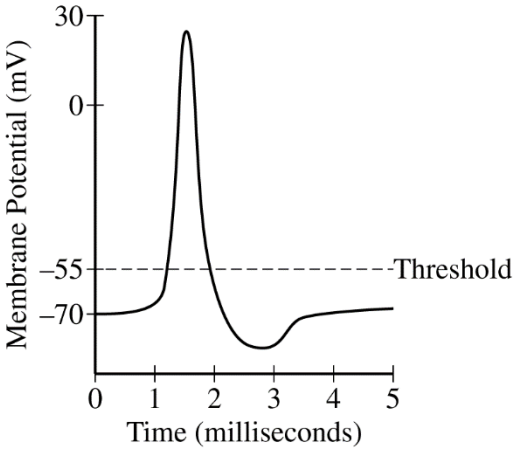


Figure 2. Model of a typical action potential in a neuron

Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

(a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

Description (1 point)

- It will increase the number of action potentials.

Prediction (1 point)

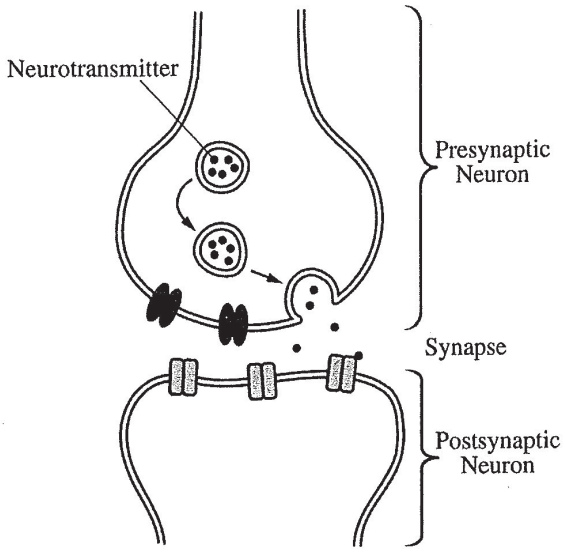
- It will stay the same.

(b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

(1 point per row; 2 points max.)

	Prediction	Reasoning
Model A	Effective	Acetylcholine is in the synapse.
Model B	Not effective	Acetylcholine is not in the cytoplasm of the postsynaptic cell.

4A1



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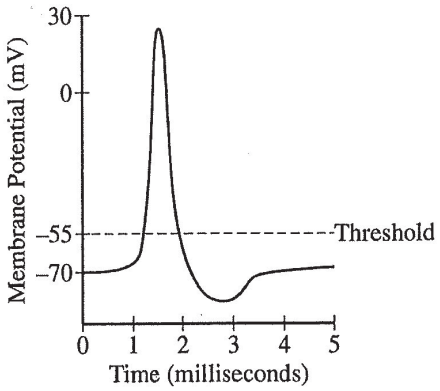

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4 Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

(a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

(b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

PAGE FOR ANSWERING QUESTION 4

a) The number of action potentials will increase as a result of the neurotoxin as Acetylcholine will be increased and thus, bind to the receptors more frequently. The maximum membrane potential should remain the same however.

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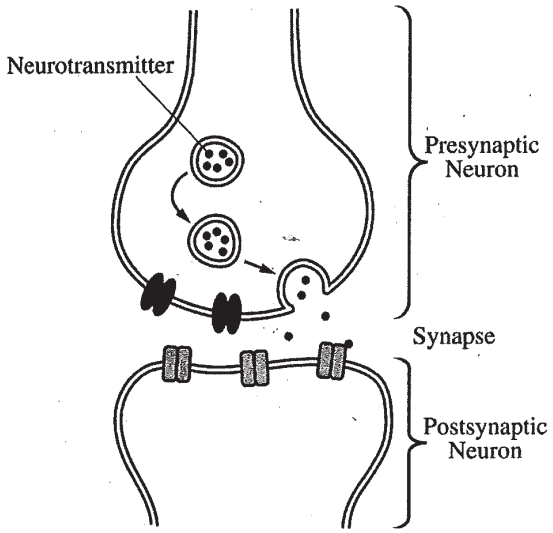
ADDITIONAL PAGE FOR ANSWERING QUESTION 4

b) Model A will be effective in preventing the effects of the neurotoxin, as AChE will degrade the Acetylcholine in the synaptic cleft, where it affects the action potential cascade. Model B will be ineffective as there is no Acetylcholine in the post-synaptic cell, so the AChE will not prevent the effects of the neurotoxin.



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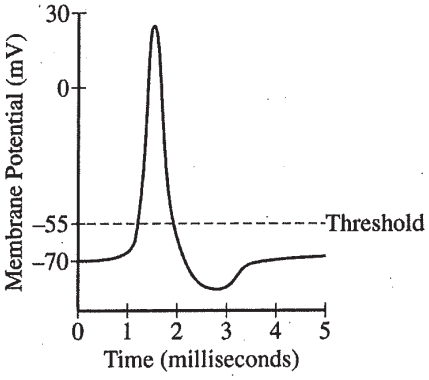


Figure 2. Model of a typical action potential in a neuron

4. Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

   (a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

   (b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

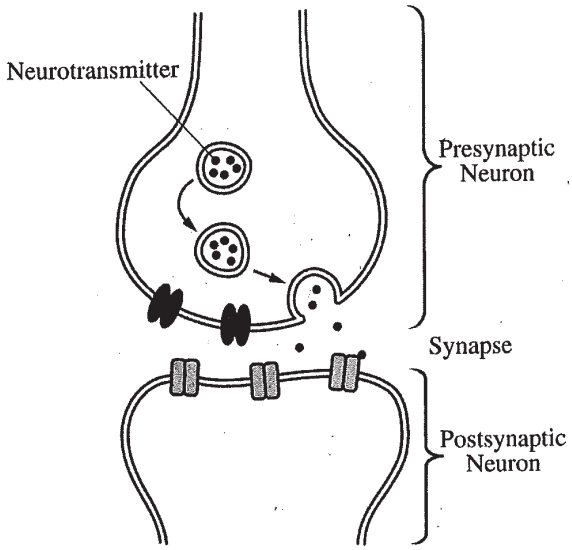
PAGE FOR ANSWERING QUESTION 4

A) The neurotoxin will increase the number of action potentials because more neurotransmitters will be available in the synapse to bind to the postsynaptic neuron receptors and start an action potential.

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

B) Model A would be effective because it would break down some acetylcholine in the synapse to bring the number of neurotransmitters down to normal levels. Model B would be ineffective because it does nothing to the number of neurotransmitters because the acetylcholine will leave the presynaptic neuron ~~then~~, go into the synapse, bind to the receptors on the outside of the postsynaptic neuron, then return to the presynaptic neuron through reuptake so if ~~the~~ acetylcholinesterase is in the cytoplasm of the postsynaptic cell, it won't come into contact with the acetylcholine being released.

HC



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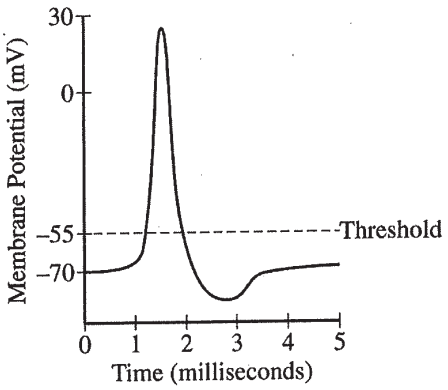

Figure 2. Model of a typical action potential in a neuron

4. Acetylcholine is a neurotransmitter that can activate an action potential in a postsynaptic neuron (Figures 1 and 2). A researcher is investigating the effect of a particular neurotoxin that causes the amount of acetylcholine released from presynaptic neurons to increase.

   (a) **Describe** the immediate effect of the neurotoxin on the number of action potentials in a postsynaptic neuron. **Predict** whether the maximum membrane potential of the postsynaptic neuron will increase, decrease, or stay the same.

   (b) The researcher proposes two models, A and B, for using acetylcholinesterase (AChE), an enzyme that degrades acetylcholine, to prevent the effect of the neurotoxin. In model A, AChE is added to the synapse. In model B, AChE is added to the cytoplasm of the postsynaptic cell. **Predict** the effectiveness of EACH proposed model. **Provide reasoning** to support your predictions.

PAGE FOR ANSWERING QUESTION 4

a) there will be more action potentials and the maximum membrane potential will stay the same

b) for the AChE added to the synapse is going to be more effective in having less action potentials while if it is added to the post synaptic neuron there will be no effect on the action potentials

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2019 SCORING COMMENTARY

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Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Students were provided with a figure showing the release of a neurotransmitter into a synapse and a graph showing a model of a typical action potential in a neuron. Information was provided that researchers were investigating the effect of a neurotoxin that causes the amount of the neurotransmitter, acetylcholine, released from presynaptic neurons to increase. Students were asked to describe the effect of the neurotoxin on the number of action potentials and to predict the effect of the neurotoxin on the maximum membrane potential of the postsynaptic neuron. Then students were asked to consider two models where acetylcholinesterase (AChE—an enzyme that degrades acetylcholine) was added to the system: In model A, AChE was added to the synapse, and in model B the enzyme was added to the cytoplasm of the post-synaptic neuron. Students were asked to predict the effectiveness of each model to prevent the effects of the neurotoxin and to provide reasoning for their predictions. This question required basic knowledge of the nervous system at the cellular level, specifically how signals are passed from cell to cell to cause action potentials. Students also needed to predict the effects of changes to the system.

Sample: 4A
Score: 4

The response earned 1 point in part (a) for describing that the number of action potentials will increase "as a result of the neurotoxin." The response earned 1 point in part (a) for predicting that the maximum membrane potential should remain the same. The response earned 1 point in part (b) for predicting that Model A will be effective and reasoning that "AChE will degrade the Acetylcholine in the synaptic cleft." The response earned 1 point in part (b) for predicting Model B will be ineffective and reasoning that "there is no Acetylcholine in the post-synaptic cell."

Sample: 4B
Score: 3

The response earned 1 point in part (a) for describing that the neurotoxin will increase the number of action potentials. The response earned 1 point in part (b) for predicting that Model A will be effective and reasoning that "it would break down some acetylcholine in the synapse." The response earned 1 point in part (b) for predicting that Model B will be ineffective and reasoning that acetylcholinesterase in the cytoplasm of the postsynaptic cell "won't come into contact with the acetylcholine being released."

Sample: 4C
Score: 2

The response earned 1 point in part (a) for describing that there will be more action potentials. The response earned 1 point in part (a) for predicting that the maximum membrane potential will stay the same.