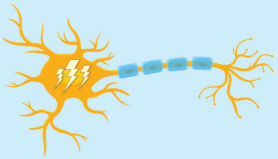
TOPIC: COMMUNICATION IN THE NERVOUS SYSTEM

Electrochemical Communication

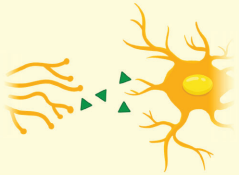
◆ Neurons communicate through electrical impulses and chemical signals.

Electrical communication happens _____ neurons.



Called _____ potentials.

Chemical communication happens _____ neurons.



Involves _____transmitters.

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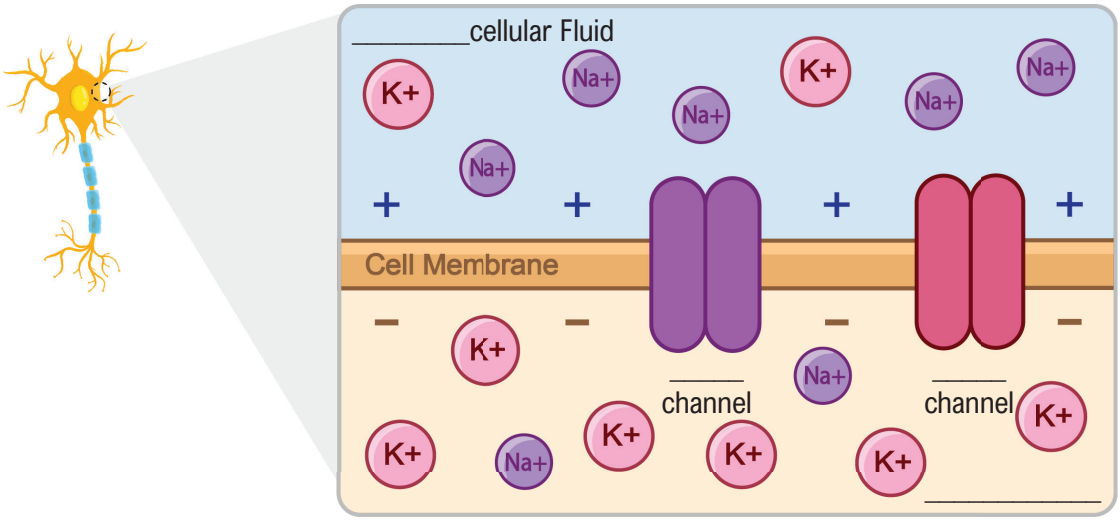
Electrical Communication – Action Potentials: Part 1

- **Ions:** Particles that carry a small _____ charge.
  - Some important ions in the brain are sodium (_____) and potassium (_____).
- A neuron's membrane has **ion** _____ that allow ions to flow in/out of the cell.
  - Some channels are _____ **gated**, meaning they open/close when the neuron reaches a specific voltage.
- Ions follow their *electrical gradient*: ions move toward areas of _____ charge.



EXAMPLE

True or False: If false, choose the answer that best corrects the statement.

Ions are attracted toward areas of opposite charge.

a) True.

b) False: Ions are attracted toward areas of the same charge.

c) False: Electrical charges do not influence the movement of ions.

d) False: Ions are repelled by areas of opposite charge.

PRACTICE

What is the role of ion channels in a neuron?

a) To allow vital nutrients in and out of the cell.

b) To allow for the movement of ions in and out of the cell.

c) To create an equal distribution of sodium and potassium on each side of the cell membrane.

d) To protect the neuron from invading pathogens.

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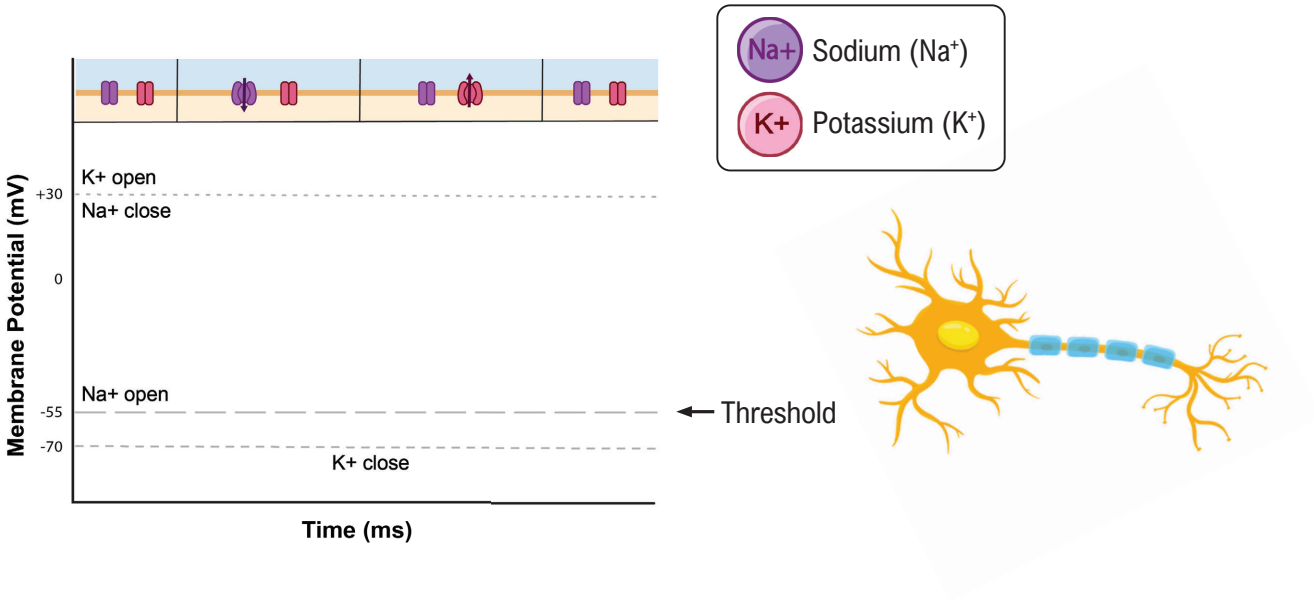
Electrical Communication – Action Potentials: Part 2

- Neurons start at **resting potential**, with an internal voltage of about _____mV.
- When internal voltage reaches _____ mV (**threshold**) an action potential will occur.
- **Action potential:** A rapid change in _____ within a neuron; the basis for neural signaling.
  - Action potentials are ____**-or-nothing** events .
- Once the threshold is reached, an action potential follows the following sequence:
  1. **Depolarization:** Sodium floods in; voltage gets more _____.
  2. **Repolarization:** Potassium floods out; voltage gets more _____.
  3. **Refractory period:** Voltage _____ negative than resting potential; neuron _____ fire.
  4. Return to **resting potential**.



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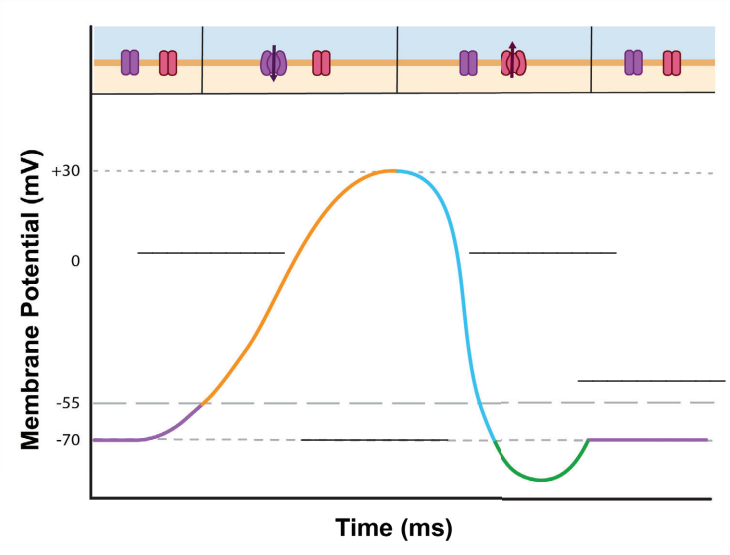
EXAMPLE

For the following graph, use the words in the box to label each section of the graph.



a) Refractory period.
b) Depolarization.
c) Return to resting potential.
d) Repolarization.

PRACTICE

Which of the follow statements about action potentials are true?

I) A neuron's resting potential is -55 mV.

II) An all-or-nothing response means once the threshold is reached, the action potential will fire.

III) The refractory period means there is a time where the neuron can't fire.

a) I & II only. b) I & III only. c) II & III only. d) I, II, & III.

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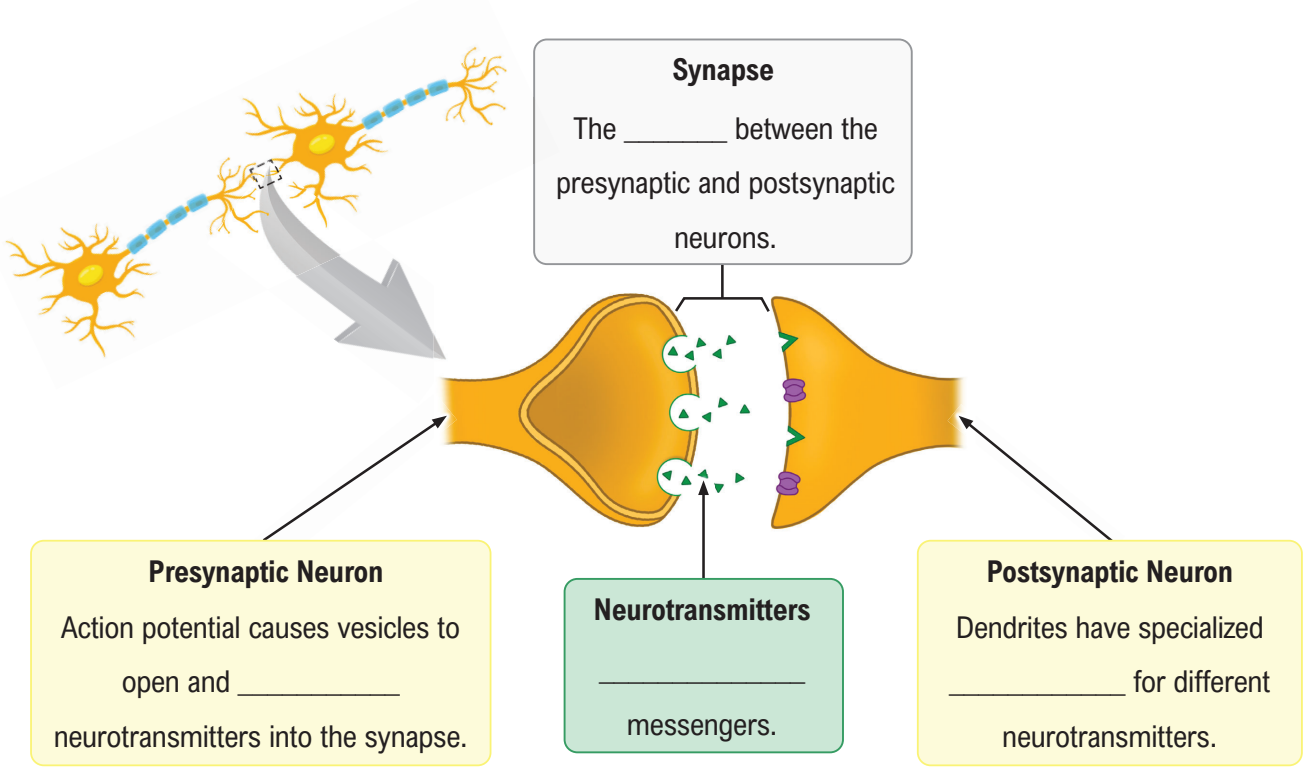
Chemical Communication – The Synapse

◆ When an action potential reaches the terminal button, it gets converted into a _____ message.



Synapse

The _____ between the presynaptic and postsynaptic neurons.

Presynaptic Neuron

Action potential causes vesicles to open and _____ neurotransmitters into the synapse.

Neurotransmitters

_____ messengers.

Postsynaptic Neuron

Dendrites have specialized _____ for different neurotransmitters.

◆ When a neurotransmitter binds to a receptor, ___ channels open, changing the voltage of the postsynaptic neuron.

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EXAMPLE

Fill in the pathway below with the steps necessary for a signal coming from an axon to be passed to a dendrite.

a) Neurotransmitters cross the synapse.
b) Terminal vesicles open in response to an incoming action potential.
c) Neurotransmitters leave the vesicle of the presynaptic neuron.

Action potential moves down the axon. → _____ → _____ → _____ → Specialized receptors on the dendrite receive the neurotransmitter.

PRACTICE

The _____ is the gap between two neurons.

a) Synapse.
b) Neurochemical.
c) Gap of Ranvier.
d) Neuronal chasm.

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Chemical Communication – Neurotransmitters Part 1

- Neurotransmitters can be:
  - **Excitatory:** ____creases the probability of the neuron firing an action potential.
  - **Inhibitory:** ____creases the probability of the neuron firing an action potential.
- The table below contains some important neurotransmitters:

Neurotransmitter	Known Effects
Glutamate	Major _____ neurotransmitter in the brain.
Gamma-aminobutyric acid (GABA)	Major _____ neurotransmitter in the brain.
Serotonin	_____, sleep, and appetite.
Dopamine	_____ processing, movement, attention, and cognitive function.
Norepinephrine	Involved in fight or flight response.

EXAMPLE

Match the neurotransmitters below with their known effects. Not all known effects are given.

Glutamate: _____
GABA: _____
Serotonin: _____
Dopamine: _____
Norepinephrine: _____

a) Reward processing.
b) Excitatory neurotransmitter in the brain.
c) Appetite & mood.
d) Fight or flight response.
e) Inhibitory neurotransmitter in the brain.

PRACTICE

Benzodiazepines are a class of drugs that enhance the activity of GABA. Which of the following could you conclude based on this information?

a) Benzodiazepines have an excitatory effect on the brain.
b) Benzodiazepines have an inhibitory effect on the brain.
c) Benzodiazepines will be most active on muscle tissues.
d) Benzodiazepines will affect the reward processing system in the brain.

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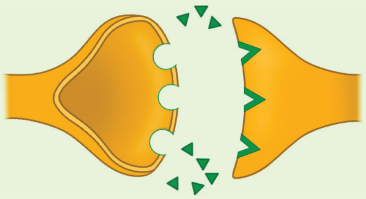
Chemical Communication – Neurotransmitters Part 2

◆ Leftover neurotransmitters are removed from the synapse via several mechanisms:

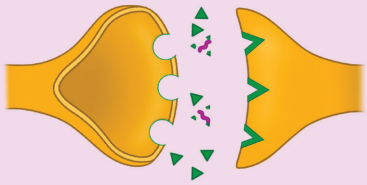
Diffusion

Neurotransmitters _____ out of the synapse into extracellular space.



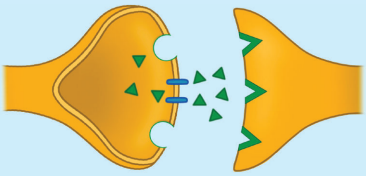
Degradation

A chemical reaction _____ neurotransmitters down in the synapse.



Reuptake

Neurotransmitters are ____absorbed back into the ____synaptic terminals.



PRACTICE

Selective Serotonin Reuptake Inhibitors (SSRIs) are a class of drugs that prevent the reuptake of serotonin. Based on this, which of the following statements is true regarding SSRIs?

a) SSRIs stop neurotransmitters from drifting out of the synapse.

b) SSRIs close the receptors on the postsynaptic neuron.

c) SSRIs decrease the amount of time that serotonin is in the synapse.

d) SSRIs increase the amount of time that serotonin is in the synapse.

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Putting it All Together

- Neurons receive signals from hundreds (or even thousands) of other neurons simultaneously!
- Those signals can be excitatory, inhibitory, or both.
- If the excitatory messages outweigh the inhibitory ones, we get neural communication!