



# Hand on a Hot Stove

## Teacher Information

..... just add students™

### Summary

Students model the neuron pathways involved in reflex actions, conscious sensations, voluntary movements, and memories. They apply their understanding by diagnosing the sites of nerve damage for six patients.

### Core Concepts

- Neurons are connected to form pathways that result in sensations, behaviors and memories.
- Damage to neuron pathways can be diagnosed by studying changes in an individual's behaviors.

### Time Required

Two 40-minute class periods

### Kit contains

- Colored *Wikki Stix* for modeling neuron pathways
- 1 red starflake bead
- **Body Diagram**
- **Neuron Pathway Damage** diagram
- **Biology Brief: A Reflex Arc**

### Optional

An animation to illustrate the nerve pathways in this activity may be downloaded from <http://lifesciences.envmed.rochester.edu>.

### Reusing kits

Kit materials may be reused. No refills are required for this kit. Teachers will need to instruct students to return the reusable kit materials to the kit bag. Consider laminating printed parts of the kits that will be reused.

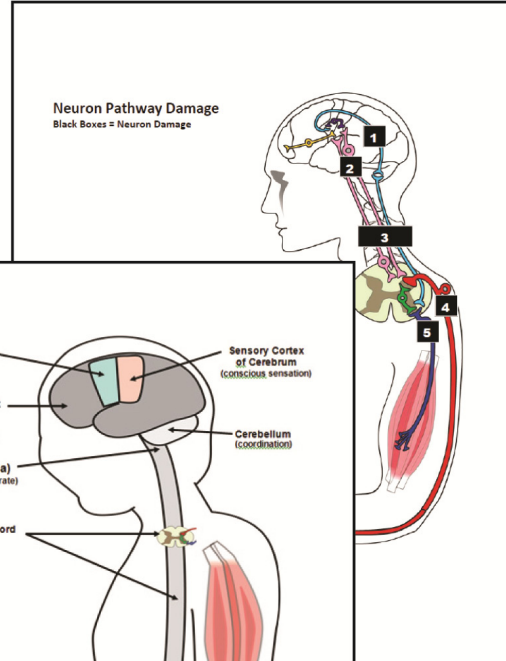
### Warning: Choking Hazard

This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit component.

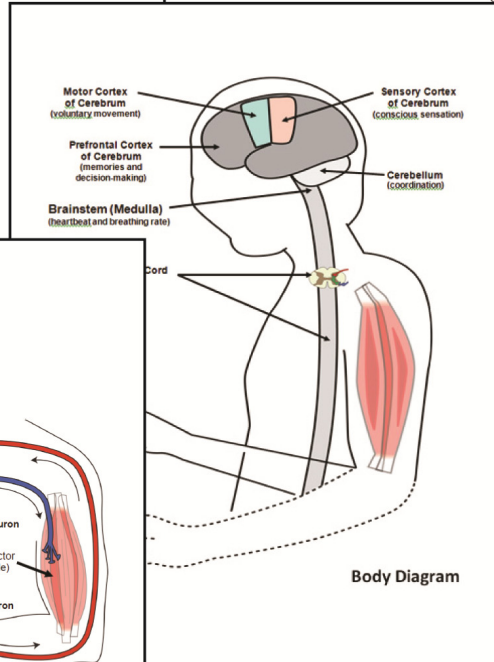
# Kit Contents Quick Guide

**Wikki Stix**

Red				
Dark Blue		Green	Yellow	Yellow
Light Blue	Light Blue	Light Blue	Light Blue	Light Blue
Pink	Pink	Pink	Pink	Pink



Starflake  
Bead



**Biology Brief: A Reflex Arc**

A reflex occurs when nerve impulses travel over a simple neuron pathway called a reflex arc. Reflex arcs have five basic parts: receptors, sensory neurons, interneurons, motor neurons, and effectors.

1. Receptors located in the skin or sense organs detect a stimulus and create an impulse.
2. Sensory neurons conduct nerve impulses towards the central nervous system (brain and spinal cord). A single sensory neuron carries messages from a receptor to the spinal cord.
3. Interneurons in the central nervous system (brain and spinal cord) connect sensory neurons to motor neurons. One or more interneurons in the spinal cord carry messages from a sensory neuron to a motor neuron.
4. Motor neurons conduct nerve impulses from the central nervous system (brain and spinal cord) to an effector. A single motor neuron carries messages from the spinal cord to an effector.
5. Effectors respond to the impulses by contracting (if the effector is a muscle fiber) or secreting enzymes or hormones (if the effector is a gland).

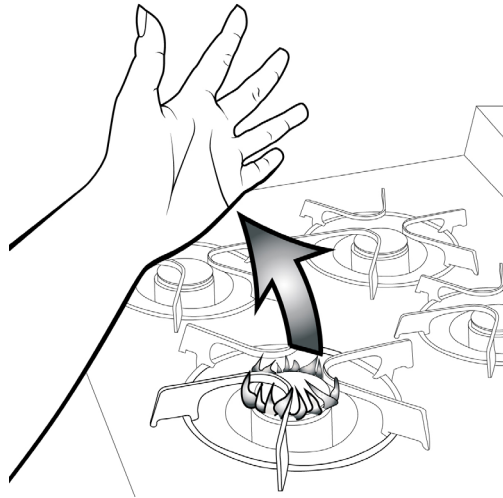
Body Diagram

# Hand on a Hot Stove

## *Teacher Answer Key*

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Introduction: When You Put Your Hand on a Hot Stove



Think about what happens if you accidentally place your hand on a hot stove. Use numbers 1–5 to place these statements in the order in which they happen.

- \_\_\_ You wave or shake your hand voluntarily to cool it.
- \_\_\_ Your arm moves to automatically move your hand away from the stove.
- \_\_\_ You feel pain in your hand.
- \_\_\_ You remember that you should not touch a hot stove.
- \_\_\_ You touch a hot stove

## Part I: What is a reflex?

### Reflexes

If you touch something that is very hot, your hand moves away quickly before you even feel the pain. You don't have to think about it because the response is a **reflex** that does not involve the brain. A reflex is a rapid, unlearned, involuntary (automatic) response to a stimulus (change in the environment).

Reflexes are responses that protect the body from potentially harmful events that require immediate action. They involve relatively few neurons (nerve cells) so that they can occur rapidly. There are a wide variety of reflexes that we experience every day such as sneezing, coughing, and blinking. We also automatically duck when an object is thrown at us, and our pupils automatically change size in response to light. These reflexes have evolved because they protect the body from potentially harmful events. Most reflexes protect people from injury or deal with things that require immediate action.

Reflex actions do not involve the higher brain regions involved in conscious sensation, decision-making, and voluntary movement. Involving higher brain regions would take too long, potentially exposing the body to risks. Using the reflex pathway as a shortcut allows reflexes to occur very rapidly.

1. What is a reflex?
2. What is the purpose for most reflexes?
3. Why are higher brain centers not involved in making reflex responses?

4. State two ways that reflex actions are different from other actions such as walking, talking, or driving a car.

5. Put an X in front of the actions that are likely to be reflex responses to stimuli.

\_\_\_ Sneezing    \_\_\_ Running    \_\_\_ Blinking    \_\_\_ Talking

## Part 2: A Reflex Arc

A reflex arc is a part of the nervous system involved in making a reflex response. You will use the information in the **Biology Brief: A Reflex Arc**, the *Wikki Stix*, and the **Body Diagram** to make a model of the neurons in a reflex arc.

**Wikki Stix = Neuron**

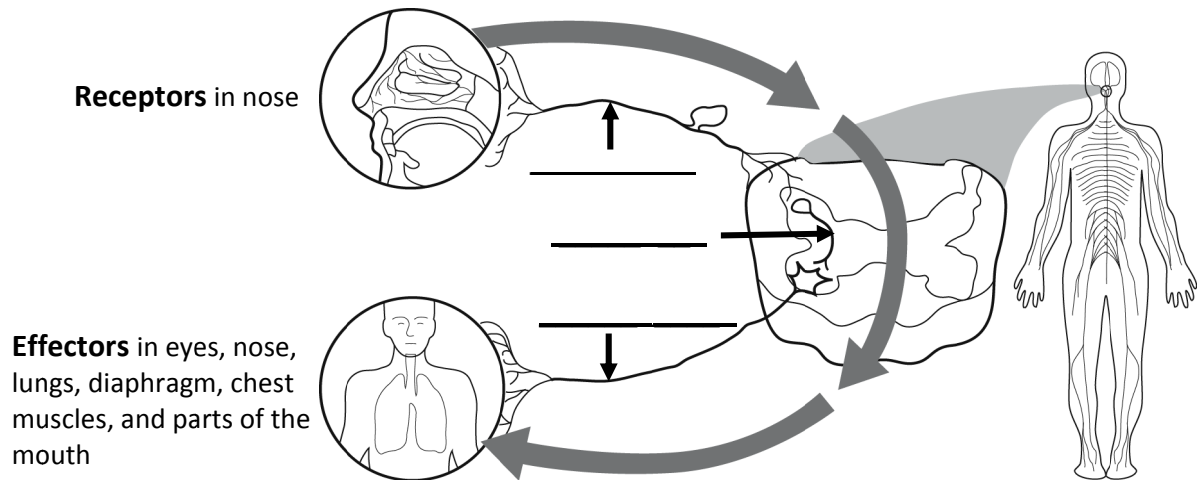


*Wikki Stix are colored strings coated with wax. They stick to each other and to surfaces.*

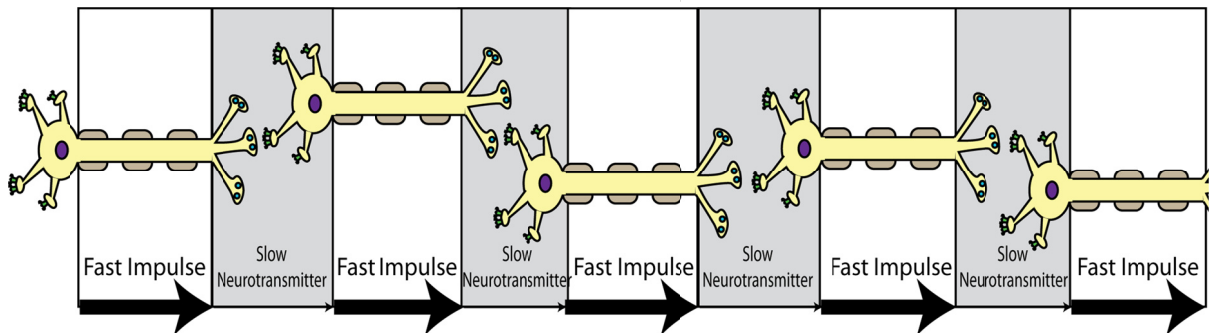
1. What is the stimulus that triggers the “hand on a hot stove” reflex?
2. Place the red bead in the appropriate location on the Body Diagram to represent a **receptor** that detects the stimulus.
3. Which type of neuron conducts the impulse from the receptor to the spinal cord?

4. Arrange the **RED Wikki Stix** on the Body Diagram to show a **sensory neuron** that connects the receptor to the spinal cord. *Note: Press the Wikki Stix down on the Body Diagram so that it sticks to the diagram.*
5. What is the function of a sensory neuron?
6. Which type of neuron conducts the impulse from a sensory neuron to a motor neuron?
7. Arrange the **GREEN Wikki Stix** to show an **interneuron** in the spinal cord on the Body Diagram.
8. What is the function of an interneuron?
9. Which type of neuron conducts the impulse from the spinal cord to an effector?
10. Arrange the **DARK BLUE Wikki Stix** on the Body Diagram to show a **motor neuron**.
11. What is the function of a motor neuron?
12. What is the **effector** in the reflex that allows you to automatically move your hand away from a hot stove?
13. What is the function of the effector?

14. Sneezing is a reflex that involves the brainstem (medulla)—the part of the brain responsible for automatically controlling some body functions essential for survival. Label the **interneuron**, **motor neuron**, and **sensory neuron** on the sneeze reflex diagram below.



15. Impulses travel very rapidly over neurons. It takes more time for neurotransmitters to diffuse across synapses.



What is the advantage to having relatively few neurons in a reflex arc pathway?

16. Do you think that a person with severe brain damage could make a reflex response to a stimulus applied to the hand or foot? Explain why or why not?

17. Put an X in front of the responses to the “hand on a hot stove” that result from a reflex arc?

- You move your hand voluntarily to cool it.
- Your hand automatically moves away from the stove.
- You feel pain in your hand.
- You remember that you should not touch a hot stove.
- You touch a hot stove

**Important! Leave the *Wikki Stix* attached to the Body Diagram.**



## Part 3: Using Your Brain

You are capable of behaviors that are more complex than simple reflexes. Complex behaviors require the involvement of parts of the brain. For example, when you put your hand on a hot stove, you use your brain for things that are not reflexes, such as conscious sensations, voluntary movements, and memories.

In Part 3 you will use the Body Diagram and *Wikki Stix* to show neuron pathways involved in complex behaviors.

### Conscious Sensations

Conscious sensations include the sensations such as touch, temperature, pressure, and pain. To feel pain, impulses travel from the receptors in your hand to the spinal cord through sensory neurons. In the spinal cord, the sensory neurons synapse with interneurons that carry impulses to the sensory cortex area of the cerebrum in your brain. When the impulses arrive at the sensory cortex of the cerebrum, you experience the sensation of PAIN!

1. You feel pain when impulses reach the \_\_\_\_\_ of the cerebrum.
2. Add several **PINK** *Wikki Stix* to the Body Diagram to show the route that impulses take to get from the sensory neuron in the spinal cord to the part of the brain that enables you to feel the conscious sensation of pain.
3. Explain the following observation: When you touch a hot stove, it takes longer to feel the pain than it does for your hand to automatically move away from a hot stove.

### Voluntary Movements

Once you feel pain, voluntary movements occur. For example, you cool your hand by shaking it or placing it in cold water. Impulses for voluntary movement begin in the motor cortex of the cerebrum. The motor cortex sends impulses via interneurons to the cerebellum where motor activity is coordinated. Then, the impulses are sent via interneurons in the spinal cord to the motor neurons that control the muscles involved in arm and hand movement.

4. Impulses that control voluntary muscle movement begin in the \_\_\_\_\_ of the cerebrum.
5. What part of the brain helps make voluntary movement coordinated? \_\_\_\_\_
6. Add several **LIGHT BLUE Wikki Stix** to the Body Diagram to show the pathway that impulses take to result in voluntary and coordinated movement of the arm and hand.
7. Explain at least two differences between a reflex response and a voluntary movement.

### Memories

Impulses from the sensory cortex are conducted over interneurons to the **prefrontal cortex of the cerebrum** to be “recorded” as **memories** that associate the sight of a hot stove with pain. These memories cause you to be more careful when you are near a hot stove.

8. Memories are formed in the \_\_\_\_\_ of the cerebrum.
9. Add one or two **YELLOW Wikki Stix** to your Body Diagram to show the pathway that impulses take to form the memory that stoves are hot and should not be touched.

10. Put an X on the processes that require parts of the brain.

- \_\_\_\_\_ You move your hand voluntarily to cool it.
- \_\_\_\_\_ Your hand automatically moves away from the stove.
- \_\_\_\_\_ You feel pain in your hand.
- \_\_\_\_\_ You remember that you should not touch a hot stove.

11. Name the part of the brain which is responsible for:

- Conscious sensation of painful stimuli
- Coordination of voluntary muscle activity
- Initiation (starting) of voluntary muscle activity such as hand movement
- Memory that touching a hot stove is painful
- Decision to be careful when working around a hot stove

12. Explain why actions that require involvement of the brain happen more slowly than reflexes.

13. Interneurons are neurons that function entirely within the central nervous system (spinal cord and brain). Circle the colors of Wikki Stix that represent interneurons in your model:

Green                  Red                  Dark Blue                  Light Blue                  Pink                  Yellow

## Part 4: What's Wrong with the Patients?

A person's ability to respond to stimuli may be disrupted when a neuron pathway is damaged by severing (cutting), compression (squeezing), or death of neurons. Neuron damage prevents impulses from traveling through the neuron pathways. Doctors do a neurological examination by exposing a patient to stimuli and then observing the patient's responses. If the patient responds abnormally, additional testing can be used to develop a diagnosis to determine how the neuron pathways are disrupted.

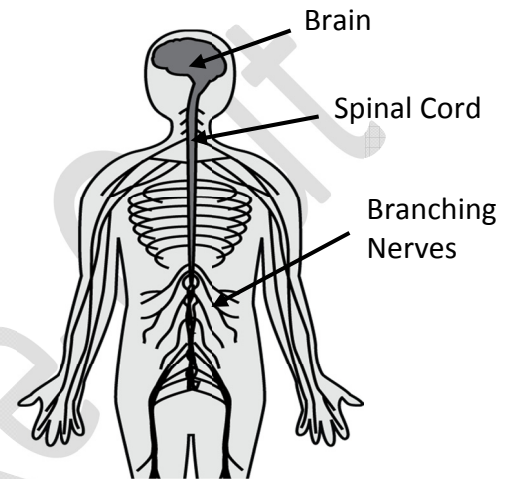
1. Use the **Neuron Pathway Damage** diagram. The numbered black boxes on this diagram indicate where neuron pathways might be damaged. For each of the patients described in the chart below, write the number from the Neuron Pathway Damage diagram that best explains each of the patient's symptoms.

Patient's response when their hand is poked with a needle	Number on <i>Neuron Pathway Damage</i> diagram
Anna can feel pain and her arm automatically moves away. She can voluntarily move her arm.	No Damage
Bart can feel pain and his arm automatically moves away. He cannot voluntarily move his arm.	
Connie's arm automatically moves away but she does not feel pain. She can voluntarily move her arm.	
David does not feel any pain and his arm does not move automatically. He can voluntarily move his arm.	
Erin's arm automatically moves. She does not feel pain and she cannot move her arm.	
Fred can feel pain. His arm does not move automatically and he cannot voluntarily move his arm.	

2. Another patient had a stroke (a blood clot in the brain). He can feel pain and make a reflex response to touching a hot object. He can also move his hand voluntarily. However, he has trouble remembering to be careful when working around a hot stove. Which part of his nervous system may be damaged by the stroke?

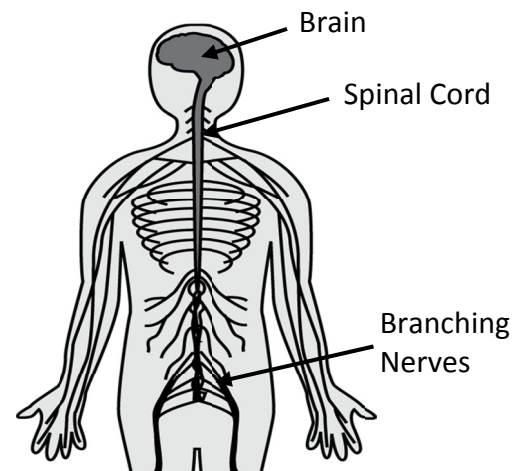
3. A baby is born with normal reflex responses and sensations. He can voluntarily move his arms and legs but these movements are jerky and uncoordinated. What part of his nervous system may be damaged?

4. Christopher Reeve (the actor who played the role of Superman in the 1978 movie) was injured when he was thrown from a horse. Even with surgery and rehabilitation, his arms, breathing muscles, and legs were paralyzed. Reeve could operate a wheelchair by sipping or puffing on a straw. His condition, called **quadriplegia**, put him at constant risk for related illnesses such as pneumonia, infections, blood clots, and wounds that do not heal.



On the diagram on the right, draw an X to indicate approximately where Christopher Reeve's nervous system was damaged.

5. Alex was texting while he was driving. He crashed into a tree and was seriously injured. Following surgery and rehabilitation, Alex has normal reflexes and he can move his arms, but his legs are paralyzed. His condition is called **paraplegia**. Mechanical, electrical, and computer engineers at a local university are working to develop moving braces that will enable Alex to stand and possibly walk.



On the diagram on the right, draw an X to indicate approximately where Alex's nervous system was damaged.

- Return the following items to the kit bag:**
- All Wikki Stix
  - Red bead
  - Body Diagram
  - Neuron Pathway Damage Diagram
  - Biology Brief: A Reflex Arc