3

Directing Your Muscles–The Nervous System

How Your Nervous System Works

You see a mouth-watering chocolate chip cookie. It smells so good! How do you control the muscles of your hands and arms so that you can grab that cookie and get it to your mouth? How do you get your jaw to move so you can devour it? To grab a cookie and eat it—or make any other movement—you need your nervous system.

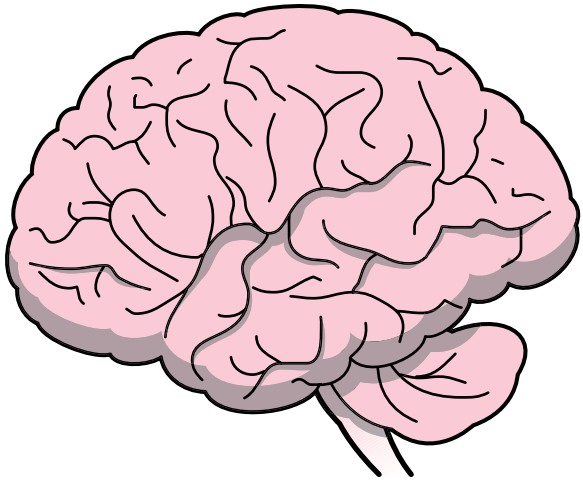
The nervous system includes the **brain**, **spinal cord**, and a huge network of **nerves** that extend throughout your body.

Your Brain—Command Central

Human Body Fact

Your brain is only about 1/50th of your body weight. But it gets about 1/5th of your body's blood supply.

Your brain is the control center for your body. It gets information (sent through your nerves) about what's going on inside and outside your body. It uses this information to make decisions that keep your body running as it should.



Once it makes a decision, your brain sends out instructions to the body parts that will carry it out. Remember the cookie? You see it. Your brain gets information about its yummy smell. Your brain also gets information that you're hungry. So your brain sends out instructions to the muscles in your arm and hand so you can grab it!

Your Senses—Providing Information

Your brain gets most of its information from your five senses: sight, smell, hearing, touch, and taste. For example, the first information your brain receives about that freshly baked cookie might be about its smell or the way it looks. Later, if you're lucky, your brain might get information about how it tastes.

Each of your senses gives you important information. For example:

- Your sense of **sight** might let you see that a car is approaching so you can get out of the way. Or it might guide you as you use a tweezers to pull out a splinter.
- Your sense of **smell** helps you recognize when something is burning.
- Through your sense of **hearing**, you know when a fire alarm is ringing or a baby is crying.
- Your sense of **touch** lets you know when bathwater is hot or when a bug is crawling up your leg!
- And your sense of **taste** lets you enjoy your favorite meal.

Your Nerves—Sending the Messages

A network of nerves goes from your brain to all parts of your body. Information travels all over that network, from your senses to your brain and back to your body parts, including your muscles. Your nerves send messages to and from your brain at incredibly fast speeds. Once your brain decides what to do, it sends messages back to your muscles through your nerves.

This network is constantly sending messages to keep you safe and healthy and get you where you want to go.

Human Body Facts

- Humans tend to depend most on our sense of sight. For many animals, their sense of smell is more important than their sense of sight.
- With your sense of smell, you can tell the difference between thousands of different odors.
- Pain is your body's way of protecting itself, through your sense of touch. When you feel pain, you get the message to stop doing something that hurts.

Your Spinal Cord—The Main Pathway Messages Travel On

Your spinal cord is the main pathway to and from your brain. Nerves going to the brain, and nerves going away from the brain, are part of it. Nerves from your arms, legs, and other parts of your body send messages through it. All the nerves that meet here are bundled together as one large, rope-like "cord" that goes up and down your back inside your spine.

If the nerves that make up the spinal cord are severely damaged, your brain cannot receive or send information. Fortunately, your spinal cord is protected by a part of your skeleton known as the vertebral column, or spinal column. This protection is limited, though. Diving accidents and serious falls, among other things, can damage the spinal cord. When someone injures their spinal cord, they can become partly or completely paralyzed, meaning they cannot move certain parts of their body. The muscles of the arms and legs are fine but, without the message to "move" from the brain, they can't move the body's limbs.

Try This!

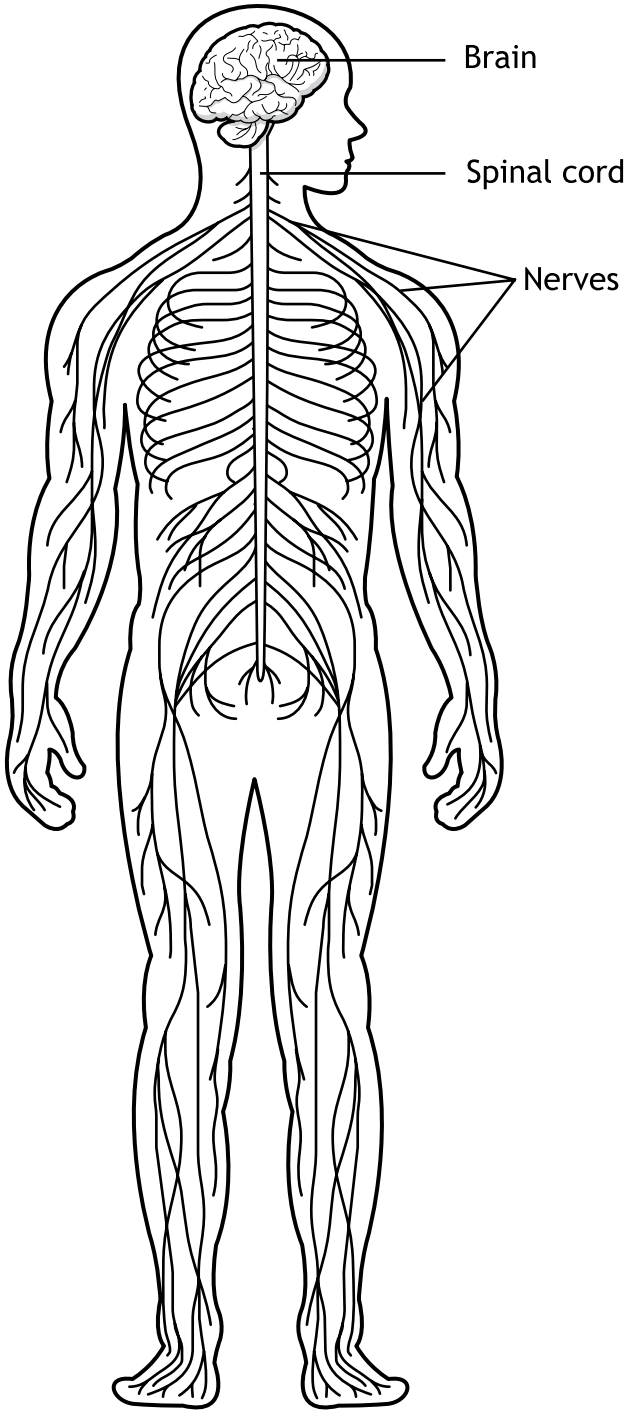
Feel the individual vertebrae that make up your vertebral column. Think about how they protect your nerves but still allow you to bend your back.

How Do All the Parts of Your Nervous System Work Together?

What does the brain do with the information it receives about a cookie? That part depends on a lot of different things. Are you hungry? Have you eaten dinner yet? Is it the last cookie? Is the cookie yours or does it belong to someone else? Your brain considers all this information.

If you decide to eat the cookie, your brain sends out messages down the spinal cord to the muscles of your arm and hand.

These messages "tell" the muscles to contract. This moves the bones in your arm so you can grab the cookie and put it in your mouth. Yum!



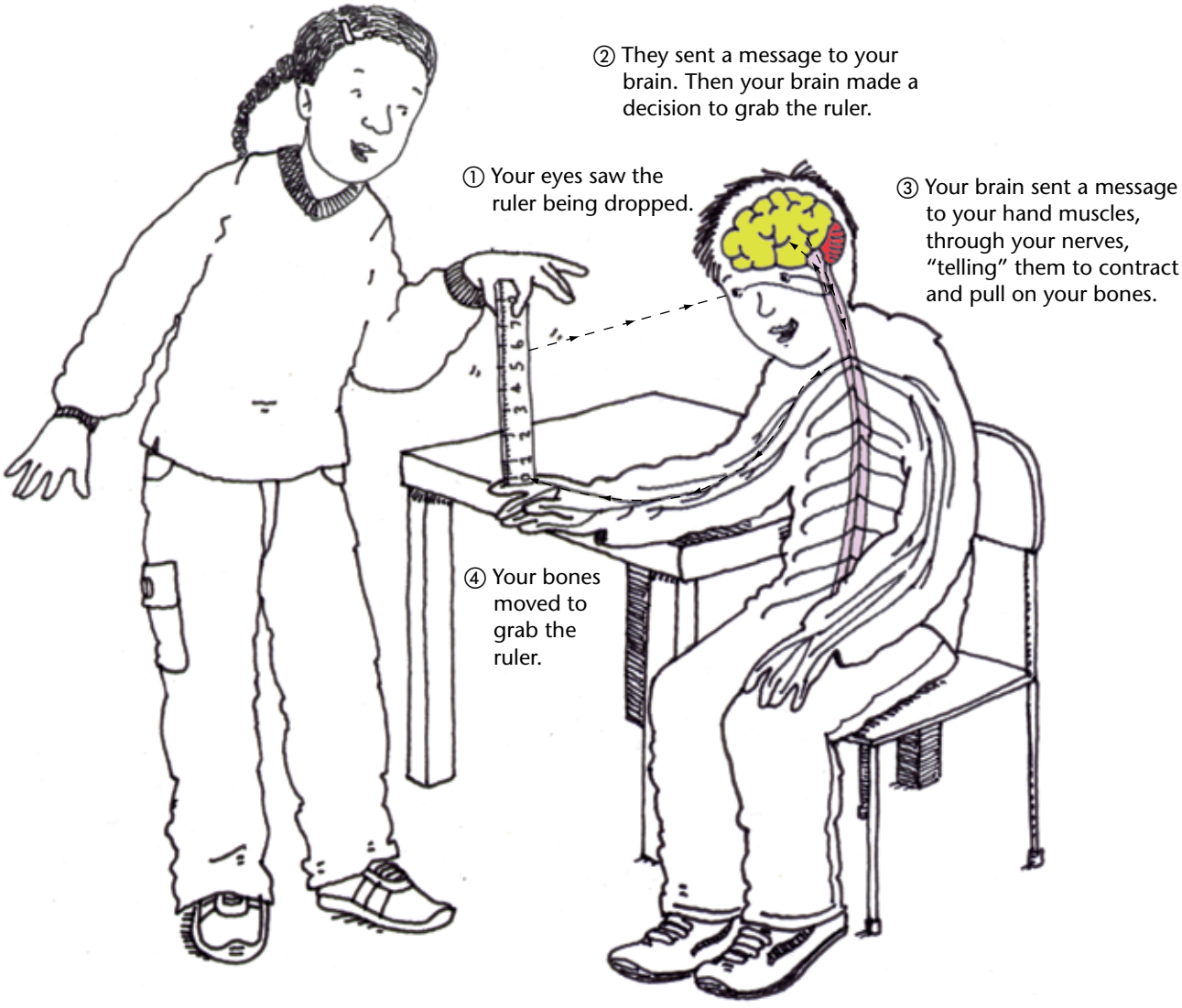
Think About It!

Look at the spinal cord in this picture. What parts of your body would you be unable to move if your spinal cord was damaged at the neck? What if it was cut below the chest?

Reaction Time

In science class you tested your **reaction time**—the time it takes for you to react to something. You saw how your senses, brain, and muscles all worked together to help you catch a ruler that was dropped between your fingers.

Here's what took place between the time the ruler was dropped and the time you caught it:



Having quick reaction times can keep you safe from harm. For example, reacting quickly can help you avoid hitting something by swerving (turning sharply) on your bike.

Quick reaction times can also help you when you play sports. Have you ever moved quickly to stop someone from making a goal, caught a ball someone threw suddenly, or blocked a kick?

Health Connection

Alcohol, certain drugs, and lack of sleep can increase reaction times, so it takes longer to respond to dangerous situations. In some cases, this can be a matter of life and death—when someone is driving a car, for instance.

Moving Without Thinking About It—Reflexes

Sometimes information from your senses reaches the spinal cord and causes an almost instant response in your muscles—before you even know what has happened. These messages don't go to your brain. They travel straight from your senses to your spinal cord and back out to your muscles.

Human Body Fact

Babies can't make many controlled movements, but they have lots of reflexes. For example, if you touch a baby's cheek, they will automatically turn their head to the side. Scientists believe they do this to search for food. These reflexes disappear as babies grow and are able to control their movements.

These automatic responses—called **reflexes**—protect your body from harm. For example, if you touch a hot stove, you're likely to remove your hand before your brain is even aware of what has happened. Since the response happens without a decision by the brain, it can happen very quickly. Speed is important, since the longer your hand remains on the stove, the more likely your skin is to be burned.

Think About It!

Did you know that the size of your pupils gets smaller when the amount of light in a room increases? Why do you think this happens? Is this something you think about or does it happen automatically?

Diseases and Other Problems of the Nervous System

Many people have diseases and conditions that affect their nerves and muscles. Think about how much harder it might be to do some of your daily activities if you had one of these diseases.

Muscular dystrophy is a group of inherited (passed on from your parents) diseases. Over time, this disease weakens a person's voluntary muscles—the muscles you can control. In one form of muscular dystrophy called Duchenne's muscular dystrophy, people don't have enough of a substance that muscles need (called dystrophin). Sometimes they don't have any dystrophin at all in their body. Without it, a person's muscles become weaker and weaker. First, the muscles in the arms, legs, and trunk weaken. Later, a person's heart and "breathing" muscles are affected. Duchenne's muscular dystrophy, or DMD, begins in young children (usually boys) ages two to six. It is rare for someone with DMD to survive beyond their early 30s.

ALS (Lou Gehrig's Disease) is a disease that weakens a person's muscles until they no longer work. ALS slowly damages the nerves that control muscles. Over time, as the nerves are destroyed, the muscles they control become weaker and weaker. Eventually, the muscles become paralyzed, making it impossible to walk, talk, swallow, and eventually breathe. People with ALS usually only live three to five years after they find out they have it. In most cases, the cause of ALS is unknown.

Parkinson's disease is a brain disorder that leads to uncontrolled shaking and other movement problems. It occurs when the part of the brain involved in voluntary movement—movements you control—doesn't work properly. Normally, this part of the brain produces a substance called dopamine that helps

Health Connection

You cannot catch these diseases. Show how much you know about nerves and muscles by explaining this to anyone who thinks otherwise.

your muscles move smoothly. People who don't have dopamine can have tremors (shaking), stiffness, poor balance, and a shuffling walk. This makes it hard to do daily activities such as eating, writing, and talking. People don't usually get Parkinson's disease until they are at least 65 years old.

Cerebral palsy is a chronic (life-long) condition that occurs when the parts of an infant's brain that control movement are permanently damaged, either before or soon after birth. Children with cerebral palsy are often unable to sit, stand, walk, talk, write, eat, or play like other children.

People Doing Science

Stephen Hawking is a scientist who has studied many things. He is best known for his theories (ideas) about how the universe began. He has been called the most brilliant scientist since Albert Einstein.

Hawking has lived with ALS for over thirty years. He cannot move much of his body and cannot even speak (his vocal cords were damaged in an operation). In fact, he can only use two fingers in his right hand. Still, he has written a best-selling book and gives sold-out lectures. How does he do it? He "talks" through a computer "communicator" on his wheelchair. He presses a switch to choose words from lists and make sentences. Then the computer turns these words into speech, so Hawking can give lectures, share his research, and "talk" with his family and friends.