

# The Human Body

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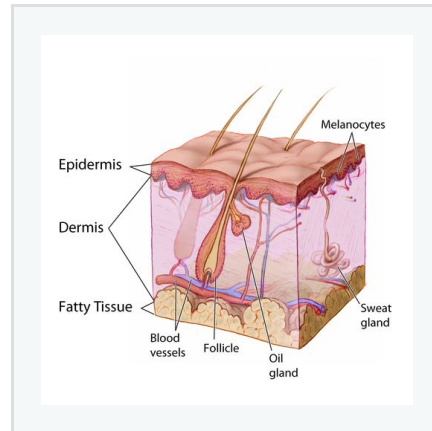
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# Skin: The Great Protector



Your body is constantly under attack. Dirt and germs surround your body. Only one thing stands between dirt and the organs inside your body—skin.

## The Largest Organ

Skin may not seem very important, but it is. It protects your body from burns, dirt, germs, and dangerous rays from the sun. It keeps fluids inside your body. And it contains all the nerves that allow you to feel things.

Skin is the largest organ in your body. If you stretched out an adult's skin into a flat sheet, it would cover an area of about 21 square feet. A square foot is a square whose sides each measure 1 foot.

Skin may cover a large area, but it is very thin. It is only about 1/8 inch thick. Despite being so thin, skin is made of three layers. The outermost layer is the epidermis. Just below the outermost layer is the dermis. Beneath those two layers is the subcutaneous tissue.

## The Layers

The epidermis contains a chemical called keratin. Keratin makes skin tough and waterproof. Keratin keeps germs out of your body.

The dermis is mainly made of blood vessels and nerve endings. The dermis provides the epidermis with food and oxygen.

The lowest layer, the subcutaneous tissue protects the body from blows. It also regulates the body's temperature.

All three layers of your skin protect you. Because your skin protects you, you should protect it by keeping it clean and eating a healthful diet. You should use sunblock when you are in the sun. If you take care of your skin, it will last a lifetime.

# Move Your Muscles!

By Sharon Guynup

## Muscles keep you on the go. Here's how they work and why you need to keep them in tip-top shape.

Picture this: You're out shooting hoops with your friends. As you take a jump shot, you suddenly feel your leg twist beneath you. *Ouch!* You might have sprained your ankle. But why did you sprain it? How can you keep from hurting it again? What is a sprain, anyway?

It all has to do with your muscles (more on that sprain later). When you walk down the street, ride your bike, or even yell hello to a friend, you are using muscles. The good news: Everyone can have stronger muscles and prevent injuries.



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## Muscles: A Lot of Work!

More than 630 muscles keep your body going. They make up about 40 percent of your body weight. Some muscles—like your heart—work without your having to do a thing. Those are called *involuntary muscles*. Other involuntary muscles include those that help you digest your food and go to the bathroom. Another type of muscle is *skeletal muscle*. Those are the muscles you control. They help you run, jump, and do all kinds of activities. And they can be injured if you don't take proper care of them.

Skeletal muscles are different sizes and shapes, depending on their job. Back muscles are some of the biggest and strongest muscles in your body because they hold you upright. Smaller muscles in your hands let you bend your fingers.

Skeletal muscles work in a simple way. They react when they receive electrical signals from your nerves and brain. For example, when you swing a bat to whack a baseball, a nerve signal travels from your brain to your arm muscles, making them move. Nerve signals also let your brain know whether a muscle has been hurt (if you twist your arm while swinging that bat).

## What Pain Means

Taking good care of your muscles can help prevent you from sitting on the sidelines. This happened to Anita R., a 10-year-old soccer player from New York City. Anita felt pain under her right kneecap. "If I put pressure on it or went up and down the stairs a lot, it would sting and throb," Anita says. Her doctor thought that she "was kicking more [with] one leg and had more muscle in that leg than in the other." Anita had to go to physical therapy, where she did exercises to help her knee heal.

Muscles, ligaments, and tendons can tear if you push them too hard. A tough run might lead to a pain in your leg. How do you know what's happening when you feel a pain in a muscle? Here's what might be going on.

- **Aches** may be caused by tension, overuse, or muscle injury from hard exercise.
- **Sprains and strains** can also result from being active. A sprain is a stretched or torn ligament. Such an injury might happen if you trip or fall. One-third of all sports injuries are sprains. A strain is a torn or pulled muscle or tendon. It can happen when you pick up something heavy.
- A **repetitive stress injury (RSI)** is a damaged muscle, tendon, or ligament caused by making the same hand or wrist motion again and again. Teens who spend a lot of time playing musical instruments or video games are at risk for RSIs. Two RSIs are *tendonitis*, a swollen tendon, and *carpal tunnel syndrome*, which is caused by swelling in a tunnel-shaped area formed by bone and ligaments in the wrist.

To avoid hurting your muscles, warm them up before exercising, says David Waymann, an exercise physiologist at the University of Michigan Health System. Walk or jog in place for at least five minutes to get blood to your muscles. "Don't use stretching as a substitute for a warm-up," Waymann says. After exercising, cool down by walking slowly. Finally, stretch for a few minutes to keep joints and muscles from getting stiff.

Keeping your weight at a healthy level can keep your joints safe from extra strain, advises Dr. Letha Griffin, an orthopedist in Atlanta.

When you aren't active, muscles can get weak and shrink. Use them or lose them! Exercise regularly to strengthen muscles. Don't play when you're tired, sick, or in pain, and don't overdo it. Take care of your muscles, and they'll keep you on the go!

## Fun Facts About Muscles

Where are the busiest muscles in your body? In your eyes! Scientists estimate that the eye muscles move about 100,000 times a day.

Your muscles are always partly contracted. That maintains muscle tone, keeping muscles firm and healthy. It is the only skeletal muscle activity that you cannot control.

The body's largest muscle is the gluteus maximus muscle in the buttocks.

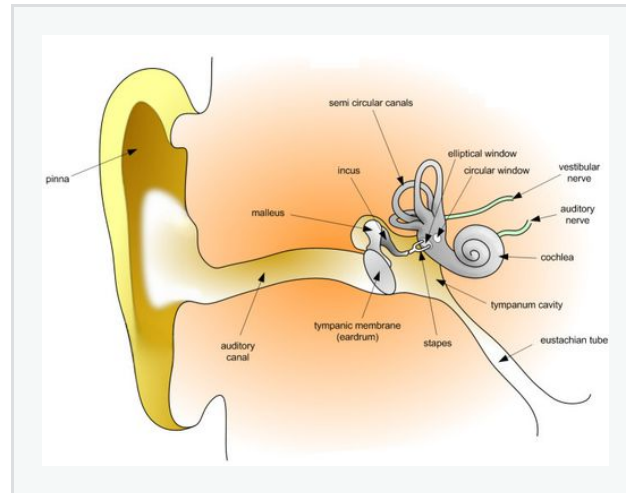
Growing pains can cause intense muscle aches in your legs. They usually start before bedtime and sometimes continue through the night. They usually stop when kids stop growing.

## Muscles On the Move

**Skeletal muscles, along with bones, joints, tendons, ligaments, and cartilage, make up the musculoskeletal system. Here's what they do:**

- **Joints** are flexible connections where two or more bones meet. Two examples are elbows and knees.
- Bones are held together by strong straps of tissue called **ligaments**. Think of ligaments as seat belts that keep your joints in place.
- The skeletal muscles are attached to bones by tough cords called **tendons**. Tendons and bones move along with your muscles, such as when you wave your hand or tilt your head.
- Slippery, rubbery **cartilage** makes the connections between the bones flexible. Cartilage also protects bones from wear and tear.
- Muscles contain fibers. **Slow-twitch muscle fibers** can work hard for a long time without getting tired on a long run or bike ride. **Fast-twitch fibers** help with quick movements, such as jumping to catch a ball or sprinting. Most muscles are a mixture of slow- and fast-twitch fibers.

# Now Hear This! Care for Your Ears



*parts of the human ear*

Everyone in the pet store heard it. It was a young child's voice, but very, very loud. "HELLO, MR. TURTLE!" it said. "HELLO! HELLO!"

"Sh-h-h," said the voice's mother. "Why are you yelling so loudly at the turtle?"

"He doesn't have any ears!" the child wailed. "He can't hear me unless I talk loud."

"Yes, he does," the mother explained. "You just can't see them. They aren't on the outside of his head like ours."

The child in the pet store was looking for the turtle's *outer ears*. Turtles don't have them, but humans do. The outer ear does several jobs. It gathers sound waves and produces earwax. It even allows you to identify where sounds come from.

The outer ear is called the *pinna* (PIN-uh) or *auricle* (OR-ric-le). It is made up of cartilage and skin. There are no bones in your outer ears, but read on! The outer ear gathers in sound waves moving through the air because of its shell shape.

Next the sound waves go down the funnel-shaped ear canal. Special glands in the skin of the outer ear canal produce earwax. This sticky, gummy wax prevents the skin of the outer ear canal from becoming dry and scaly. Earwax also traps dirt and discourages insects from entering the ear. When the wax becomes dry, it flakes off, carrying dust and dirt with it. Then these glands make new

earwax.

Ears working as a pair help tell you where a sound is coming from. If a sound comes from your left, then the sound waves entering your left ear will arrive at your brain slightly before the sound waves entering your right ear. Your brain then tells you that the sound is coming from your left. Your brain also uses how loud a sound is to decide where it came from. This process is called sound *localization* (low-kul-ih-ZAY-shun).

## The Middle Ear

The eardrum is made up of three layers. The outer layer is a thin part of the skin of the ear canal. The center layer of the eardrum vibrates with the sound collected by the outer ear. It is protected by the other layers because it continues to grow. It can heal itself if it becomes torn or punctured. The inside layer is a membrane that continues in the middle ear.

The middle ear begins at the eardrum, which is like the head of a drum. It vibrates with sound. Here is where your "ear bones" come into play. Three tiny bones, called *ossicles* (OS-ik-ulz), are behind the eardrum. They help carry the sound. The *malleus* (MAL-le-us), or *hammer*, which looks something like a hammer, is the first bone. It attaches to the eardrum. The second bone is the *incus* (IN-kus), or *anvil*. It attaches to the hammer. The third bone is the *stapes* (STAY-pee-z), or *stirrup*. It attaches to the anvil. When the eardrum vibrates with sound, it sets first the hammer, then the anvil, and then the stirrup into motion.

The middle ear also helps balance the pressure on the inside of the eardrum. This helps protect it from injury. The *Eustachian* (you-STAY-shun) tube connects to the back of the throat and acts like a pressure valve.

The tube decreases pressure when you cough or swallow, creating a popping sound. Sometimes when you are in an airplane, your ears "pop" several times. That's your Eustachian tube opening and reducing the pressure behind your eardrum.

## The Inner Ear

The inner ear has two jobs: It changes sound into nerve signals, and it helps you keep your balance.



A round structure called the *cochlea* (COKE-lee-uh) is filled with liquid and lined with tiny hairs. These change as sound vibrations pass through the liquid and set various hairs in motion. They change sound into nerve signals, which your brain can understand.

Different pitches of sound and different volumes will vibrate various hairs and different numbers of hairs. The nerve signals are then taken by the *auditory* (AUD-uh-tore-ee) nerve to your brain.

Three small loops located behind the cochlea are called *semicircular canals*. They, too, are filled with liquid and lined with hairs. They help you to keep your balance. Each time you move, the moving liquid and the movement of the hairs tell your brain what position your head is in.

Your brain tells your body which muscles to move to help keep you upright. But sometimes your brain gets tricked. Your eyes tell your brain that you have stopped twirling around, but the liquid in your ears keeps moving. One message says you are still moving. The other message says you have stopped. You feel dizzy until your brain gets only one message.

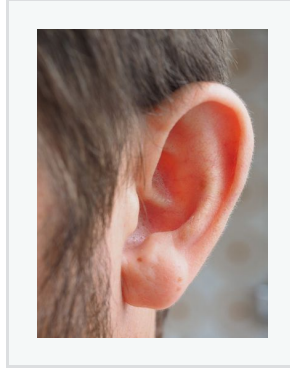
## Protect Your Ears

You now know that your ears do some important jobs. For them to be their healthiest, you must help protect them from infection and injury. Follow these simple steps:

1. Keep your outer ears clean and dry. A little soap and warm water on a clean washcloth are all you need. Dry your ears carefully with a soft towel.
2. Do not put anything in your ears. Period. Objects can injure the canal or even the eardrum. This can lead to infection.
3. Cover your ears in cold weather to prevent frostbite.
4. Protect your hearing from very loud noise. Turn down the volume on your headphones. Wear earplugs in noisy places.
5. Using a sunscreen? Don't forget to rub some on and behind your ears.

With proper care, your ears will give you a lifetime of hearing enjoyment. Take time to notice all the sounds you can hear when you are inside and outside. Close your eyes. Now identify all the sounds you can hear. Appreciate your sense of hearing.

# Three Cheers for Ears!



Jake pulled a portable CD player from his backpack and settled in for the long bus ride to the science museum. "You're lucky," Sam said as he plunked himself down on the seat beside him. "My mom won't let me listen to music with headphones. She says if it's too loud, it can make you go deaf."

"I sure hope not," said Jake. "My grandpa is losing his hearing. Now he has to wear a hearing aid."

At the museum, Jake and Sam decided to find out if Sam's mom was right. They headed over to the human body exhibit and stood in front of a gigantic model of an ear. A museum guide was explaining how ears help you hear. "That flap on the side of your head is only a part of your whole ear," she said. "Tiny, complicated structures inside your ear do the main job of hearing."

Jake and Sam moved closer to the model. "Hey, look, it says there's a drum," said Sam.

"And a hammer," added Jake.

"That's right," the guide explained. "The eardrum is a thin piece of skin that's stretched tight like a drum. It vibrates or moves very fast when sound waves hit it. These vibrations are carried to three tiny bones called the hammer, anvil, and stirrup. They conduct, or pass, the vibrations to your inner ear, where they are changed into nerve signals and sent to your brain. Your brain makes sense of the sounds you hear."

## What Is Hearing Loss?

"What happens when you can't hear?" Jake asked.

"That depends," the guide replied. "If something like wax, for example, gets stuck in your ear canal, it can block sound waves from getting to your eardrum. This type of problem is called conductive hearing loss."

"Ew-w-w! Earwax is gross," said Sam.

"Actually, earwax protects your ears," the guide explained. "It contains special chemicals that fight infections and prevent dust and dirt from getting inside. Plug your ears with your fingers, and you'll know what conductive hearing loss is like."

"The sounds outside are soft, but my own voice sounds really loud," said Sam.

"Has anyone ever had an ear infection?" the guide asked.

Most of the kids nodded.

"Well, an infection can also make you lose your hearing for a while." The guide continued, "If the tube that goes from your middle ear to the back of your throat gets blocked, germs can get trapped inside. Your ear will hurt and feel like it's ready to burst. When the doctor looks with a special flashlight, the eardrum appears red and doesn't move in and out as it should. If you have an ear infection, you may have to take medicine for it. Sometimes doctors have to operate to open up blocked tubes or put in new tubes to keep the middle ear from getting infected."

"Sensory (SEN-suh-ree) hearing loss means part of the inner ear is not working. A person may hear some sounds but not others, or sounds may be muffled. Sensory hearing loss can be caused by a number of things. Sometimes the ears don't develop properly before a baby is born. There are also some serious infections that can cause sensory hearing loss in kids. Sensory hearing loss is usually permanent. Kids with sensory hearing loss may need to wear hearing aids."

## Did You Know?

Your ears are amazing structures. Here are some fascinating facts about ears and hearing.

- The three bones in your ear that help you hear are the smallest bones in your body.
- The famous composer Ludwig van Beethoven (1770–1827) started to lose his hearing when he

was just 26. He wrote some of his greatest music without being able to hear it.

- Hearing tests tell how well your ears work. To take the test, you wear headphones and sit in a special room so you don't hear any stray noise. A machine makes different tones. You listen first with one ear and then the other and raise your hand each time you hear a sound. The tones start loud and get softer and softer until you can't hear them anymore. That tells the doctor how well you can hear.
- Ever wonder why your ears feel funny in a tunnel or on an airplane? There is air both inside and outside your eardrum. To balance the air pressure, you need to let more air into the inside of your ear. Yawning, chewing, swallowing, or blowing your nose until your ears "pop" helps you hear normally again.

## Now Hear This

"What about loud music?" Sam wanted to know. "Can that make you lose your hearing?"

"Any kind of loud noise can damage your hearing if it goes on for a while," the guide explained. "If the music is so loud that your ears start hurting or you have to yell to be heard over it, there's a good chance your ears could be injured."

"What if you listen with headphones?" asked Jake. "Sam's mom says they're bad for your ears."

"She's partly right. If someone standing near you can hear music coming through earphones you are wearing, the music is too loud." The guide went on, "Listening to loud noise can cause *tinnitus* (TIN-uh-tus), which is the term for ringing in your ears. If the noise isn't too loud and you don't listen too long, your hearing can return to normal. But you can damage your hearing permanently if the noise is too loud or you are exposed to it too long. That's why construction workers wear ear protection. Their equipment can be extremely loud.

"Using headphones can be dangerous if the volume is too high. Don't crank it up, and you should be fine as long as you give your ears a rest once in a while."

# Pumping Up the Heart

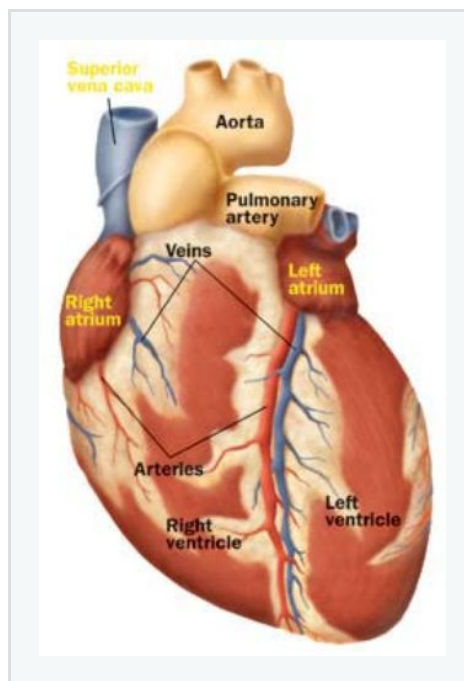
Make a fist with one of your hands. Your fist is about the size of your heart.

Your heart beats between 85 and 90 times per minute. It pumps about 5 quarts of blood through your body's 60,000 miles of blood vessels in one minute!

Even though the heart is a powerful muscle, many people's hearts don't work properly. A study by Dr. Eric Rose indicates that a mechanical pump might help many of those patients.

## Pump May Save Lives

Some people's heart muscles are so weak that the heart can't pump enough blood through the body. That condition is called heart failure, and it can be deadly.



Leigh Haeger

*The drawing shows some parts of the heart.  
Look up what each part does.*

A report from the American Heart Association says about a little more than 5 million Americans suffered from heart failure in 2013. Another report says that about 400,000 Americans develop it each year.

Powerful drugs or a heart transplant can help many people who suffer from heart failure. But the drugs don't always work, and heart transplants are risky.

For years, doctors have inserted a mechanical pump in the bodies of some patients who were waiting for a heart transplant. The pump helped the heart do its job.

The study by Dr. Rose shows that the pump could be used permanently, instead of a heart transplant. Pumps may be able to save the lives of up to 100,000 Americans a year, the study says.

## The VAD

The mechanical pump is known as a VAD, or ventricular assist device. VADs come in several sizes and shapes. The smallest pump sizes can be implanted in a person's heart and belly. A tube goes from the pump through the skin to a control unit placed on the person's waistline. The control unit is connected to at least one battery pack that sits in a strap by the side of the person's body.

"This technology is going to make huge leaps in the next two to three years," heart surgeon Robert Kormos predicted.

# Rise Up

By Stephen Fraser

## A treatment enabled a paralyzed man to stand and take steps again.

It was an evening in July 2006. The Beavers, Oregon State University's baseball team, had recently won the College World Series. One of the team's pitchers, Rob Summers, 20, was retrieving his gym bag from his parked car when another car hit him. "The car then drove off, leaving me there with no help," says Summers.



Courtesy Rob Summers

The impact rendered Summers *paraplegic*—unable to move his lower body. His doctors told him he'd never walk again—hard news for an active young man to hear.

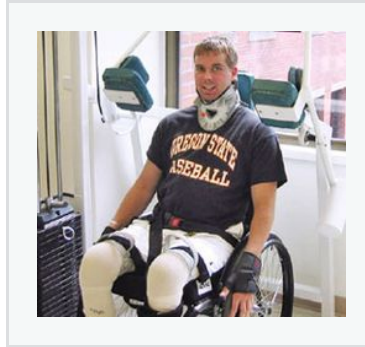
"They told me that I had no hope," says Summers. "My comment was, 'You don't know me very well. I'm going to fight until I get well again.'"

Five years later, Summers regained the ability to stand and could take steps on a treadmill. His recovery "remains unprecedented," European researchers commented in the British medical journal *The Lancet*. "We are entering a new era."

## Information Highway

The car that hit Summers seriously injured the lower part of his *spinal cord*—the column of nervous tissue that runs through the backbone. It carries messages to and from the brain, the body's central

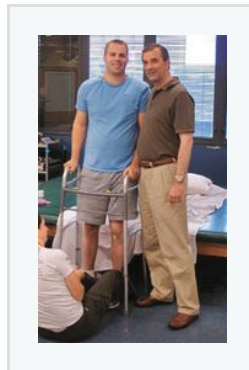
organ. Radiating outward from the spinal cord is a web of *motor neurons*, which govern movement. The damage done to Summers's spinal cord stopped the brain's messages from reaching many of the motor neurons in his lower body, preventing him from standing or walking.



Courtesy Rob Summers

*Rob Summers after the accident that rendered him a paraplegic.*

After the accident, Summers underwent two years of standard therapy—muscle massages, lessons in how to use a wheelchair, and the like. Before then, little more could be done for paraplegic patients. Summers had the good fortune, though, to be chosen for an experimental research project. “Rob was an ideal candidate,” says one of the project’s researchers, Susan Harkema, a professor of neurosurgery at the University of Louisville in Kentucky. “He was young and in otherwise good health. He’s also a very determined, disciplined person—an extraordinary young man.”



Courtesy Rob Summers

*Summers stood with his father, Mike Summers.*

In a four-and-a-half-hour operation, the research team implanted electrodes in Summers's spinal cord. The electrodes were then wired to a pulse generator that was implanted in his back. The pulse generator is remotely controlled by a device outside the body.



## Body's Wiring

After the surgery, Harkema and her team began the treatment. They switched on the pulse generator for two hours a day, electrically stimulating the nerves in his spinal cord. Nerves can respond to electrical stimulation because the messages they carry take the form of electric signals. Nerves are the body's "wiring."

On the third day of electrical stimulation, Summers was able to stand with assistance. "It was unbelievable," he says. "There was so much going through my head at that point. I was amazed; I was in shock."

By 2012, Summers could not only stand but also could walk slowly on a treadmill with the aid of an assistant and a supporting harness. He was able move his hips, knees, ankles, and toes voluntarily. The exercise had enabled his leg muscles to regain some of their former mass.

## Sensory Signals

The brain does more than just control movement. It receives messages from all parts of the body. Many of the messages come from the eyes, ears, nose, skin, and muscles. Those messages travel by way of the *sensory neurons*. Summers's spinal cord wasn't totally damaged. It could still receive limited sensory signals from the muscles in his lower body.

That residual feeling in his lower body might be what enabled the experimental treatment to succeed, says Harkema. Sensory messages from the legs might have been traveling to Summers's electrically stimulated spinal cord, prompting it to send signals along the motor neurons and make the legs move.

"Our big finding is that the spinal cord is as sophisticated as the brain," says Harkema. "It has a memory. When you walk, it remembers that you are on two legs or one. The spinal cord basically takes information from the brain and then handles all the details. We didn't know that before."

Patients who don't have some physical sensation, as Summers does, may not be helped by the treatment, says Harkema.

## Body Control

Spinal cord damage can do more than impair limb function. Victims can lose bladder and bowel control. Those functions are regulated by another part of the nervous system—the *autonomic nervous system*—that radiates from the spinal column. It controls automatic processes in the body, such as heart rate, blood pressure, sweating, and salivation. Summers has regained function in his bladder and bowels. He also has been able to discontinue a variety of expensive medications prescribed to alleviate pain and prevent heart disease.

“Now I can stand,” says Summers. “I’ve gotten my confidence back to just go out in public.” His goal is to stand and walk completely normally. “I’m working toward that every day.”

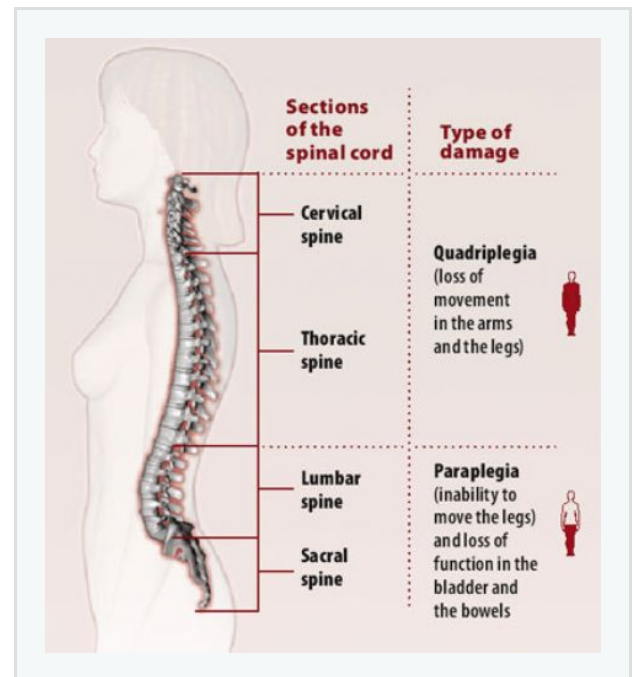


Frazier Rehab Institute; Courtesy Rob Summers

*Monitoring Summers' Leg Movements Right: Neurosurgeon Susan Harkema*

## Broken Cord

The spinal cord carries nervous signals back and forth between the brain and the rest of the body. An injury to it can cause a complete or partial loss of function depending on the severity of the damage.



KRT/Newscom