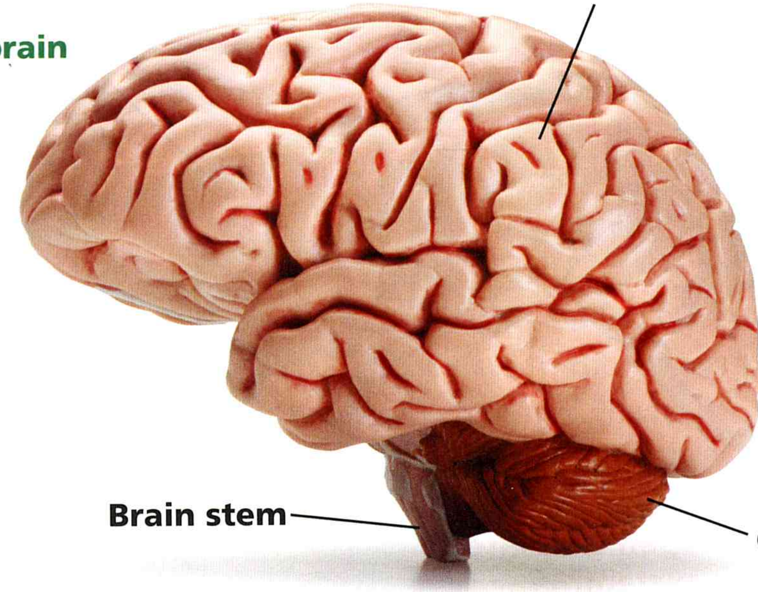


Stimulus and Response in Humans

Structures of the Brain

The human brain is a compact mass weighing about 1.5 kilograms (kg). The spinal cord extends from the brain down through a hole in the backbone. The brain and spinal cord make up the **central nervous system**. The central nervous system is completely enclosed in bone. The brain is surrounded entirely by the cranium, or skull.

The brain has three major parts, the cerebrum, the cerebellum, and the brain stem. The largest part of the human brain is the large, bumpy, folded cerebrum. It has two halves, the right and left hemispheres. The spheres are symmetrical and are connected to each other. The cerebrum makes up about 70 percent of the mass of the whole human nervous system. The lobes of the cerebrum have areas that have specific functions.

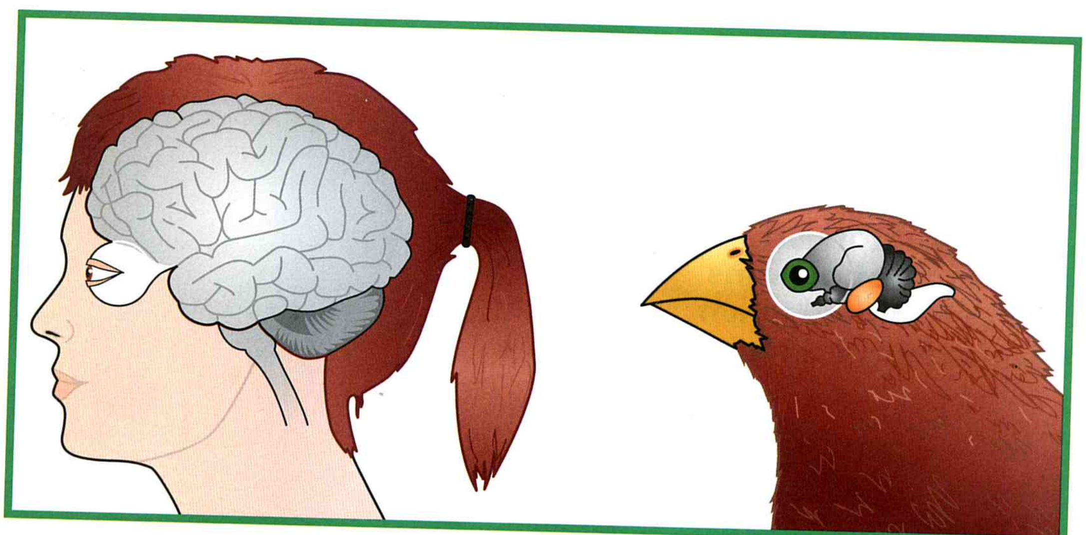
It also has a distinctive set of folds. The fold patterns are similar for all humans. This folded outer surface is called the cerebral cortex. The cerebral cortex processes the signals that come into the brain. Without this thin surface layer, we would not be able to think, recognize faces, or plan ahead.

The more folds a brain has, the more it can process. The cerebrum of a rat, for instance, is smooth, implying that it is not a big thinker. The brain of a dolphin, on the other hand, is more folded than a human's.

The small, roundish structure that lies below and to the back of the brain is the cerebellum. It makes up about 11 percent of the mass of the brain. It processes information from the muscles, tendons, and inner ear. It uses this information to manage and maintain balance and coordination.

At the center of the brain is a small, cordlike structure called the brain stem. It connects the brain and the spinal cord and relays messages to and from the cerebrum and the cerebellum. The brain stem regulates many body functions, such as heartbeat, breathing, and body temperature. You can survive damage to the cerebrum or cerebellum, but damage to the brain stem is usually fatal.

The brain stem also relays information from the body to other parts of the brain. In general, the right hemisphere of the brain receives from and sends messages to the left side of the body, and vice versa. The brain stem coordinates the crossover.



A diagram comparing a human brain with a bird brain

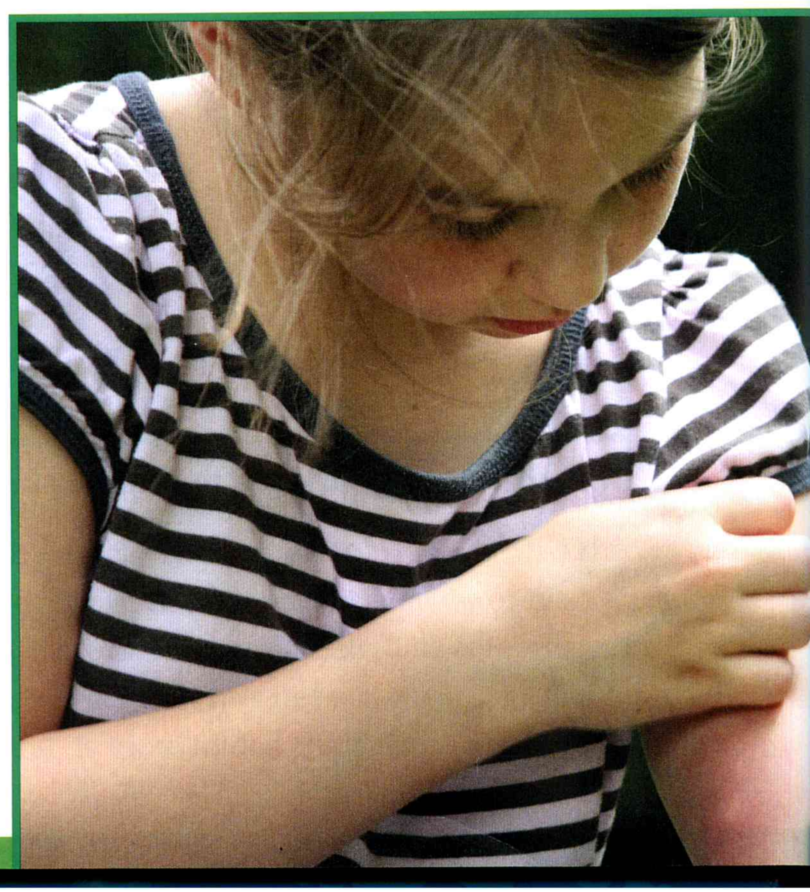
Brain Messages

If an ant is walking on your arm, you know it even if you don't see it. Its feet tickle you, and without even looking, you raise your other arm to brush the ant away. How are you able to do that?

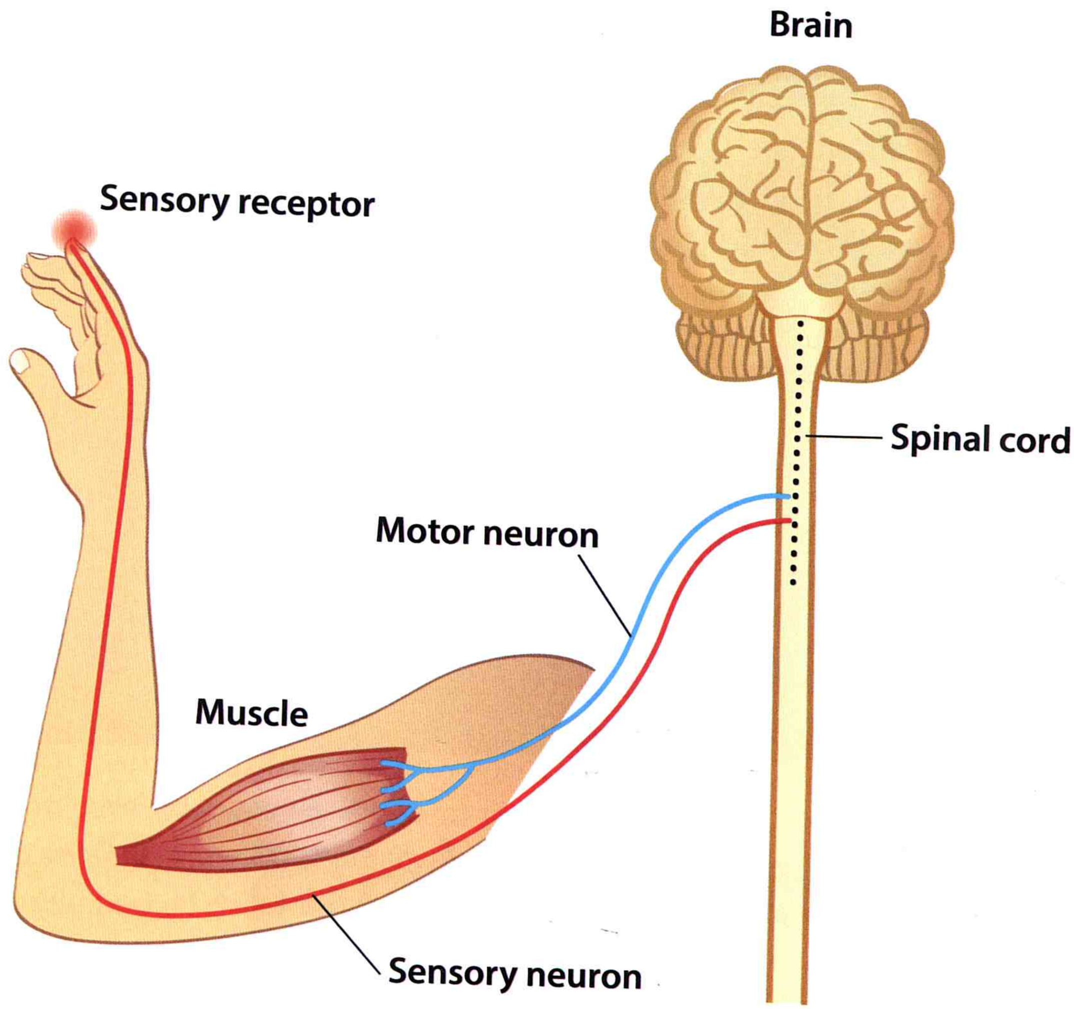
Your arm has touch receptors for the sensation we know as tickle. The ant walking on your arm is a **stimulus**. When a tickle receptor is stimulated, it sends a message to your brain, alerting you to a problem. Your brain decides how to **respond**. It sends a message to your arms, telling them what to do to brush away the ant.

The special cells that make up your brain and the rest of your nervous system are **neurons**. You have several hundreds of billions of neurons throughout your body and brain. Those neurons are constantly sending messages from one place to another.

Your touch receptors, photoreceptors (light sensors), and hearing, taste, and smell receptors are all on the ends of neurons. These **sensory neurons** send messages from the environment to the brain. The brain decides what to do about these messages. If your brain decides that you should act, it sends out messages to your muscles or other systems, telling them to snap into action. This call to action is sent on **motor neurons**.



The receptors on the ends of neurons tell your brain when something tickles.



Motor and sensory neurons keep your body in constant communication with your brain.

Sensory neurons and motor neurons are like wires carrying an electric signal. Sensory neurons carry messages to the brain, and motor neurons carry messages away from the brain. Sensory neurons give the brain information, and motor neurons send instructions to the muscles. Your arm responds to the message from the motor neurons by contracting certain muscles. Sensory neurons called stretch receptors give the brain feedback and tell it how much the muscles are stretched or contracted. This communication between the brain and muscles is happening constantly, all over your body.

Sending messages takes time. The longer the pathway, the longer it takes to produce a response. The interval is called response time. You might have noticed this delay when you stub your toe; you can see it being stubbed and hear the sound before you feel the pain! The pathway from your eyes and ears to your brain is much shorter than the pathway from your toes to your brain. So the sensory neurons in your eyes and ears get their messages to the brain before the sensory neurons in your toes can.