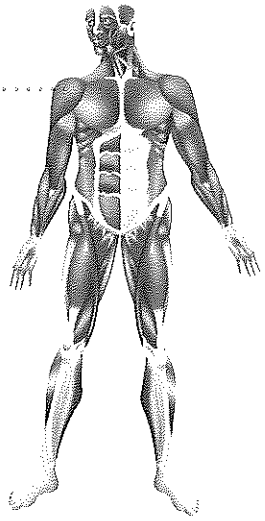
nd Your Body

You and Your Body

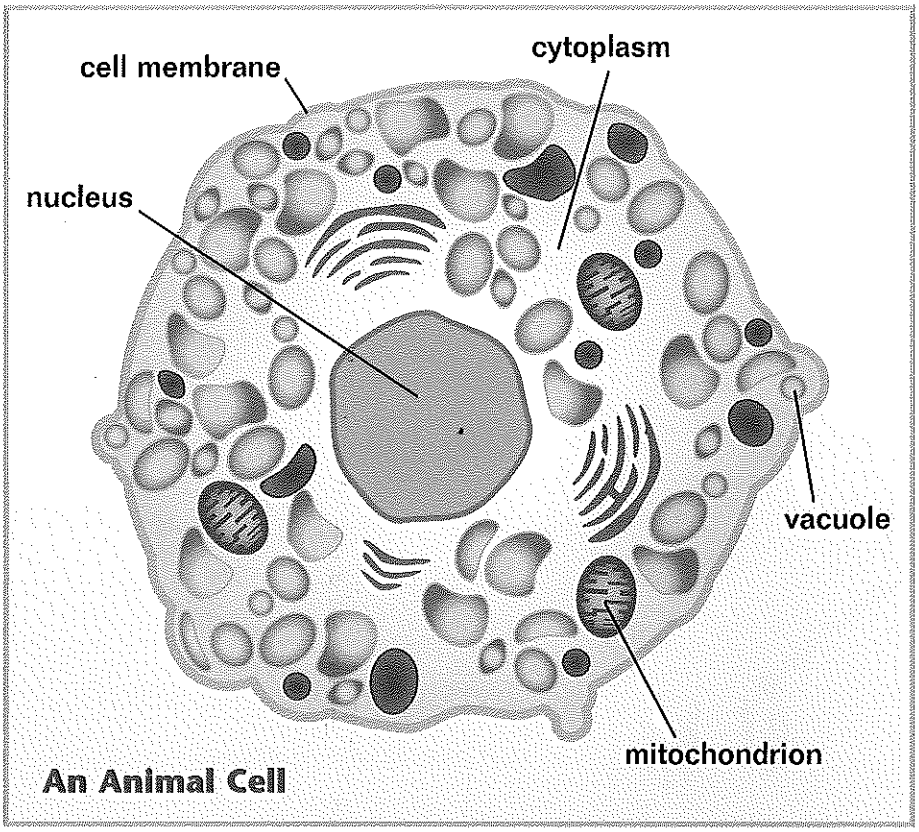


CONTENTS

Body Building Blocks

Our bodies are made of trillions of tiny building blocks called **cells.** There are blood cells, bone cells, muscle cells, and many other types of cells.

Cells are the smallest unit of life. They are so tiny that about 5,000 cells could fit on the head of a pin. Cells may be small, but they are not simple. In fact, every human begins life as one cell that is smaller than the period at the end of this sentence. Inside that cell is all the information needed to build a unique person.



An Animal Cell

Cells have different shapes and sizes depending on their jobs. However, all animal cells are made up of the same basic parts. A central **nucleus** controls the work of the cell. Throughout the cell is the **cytoplasm,** a jelly-like fluid. The cytoplasm is made of water, protein, and chemicals that help keep the cell working.

Work that happens inside every cell keeps the body functioning. Each cell part performs a different task. In the mitochondria, sugar from the food we eat is changed into energy that can be used to fuel the body. Vacuoles dispose of wastes and store water. A covering around the cell called a **cell membrane** protects all the other cell parts.

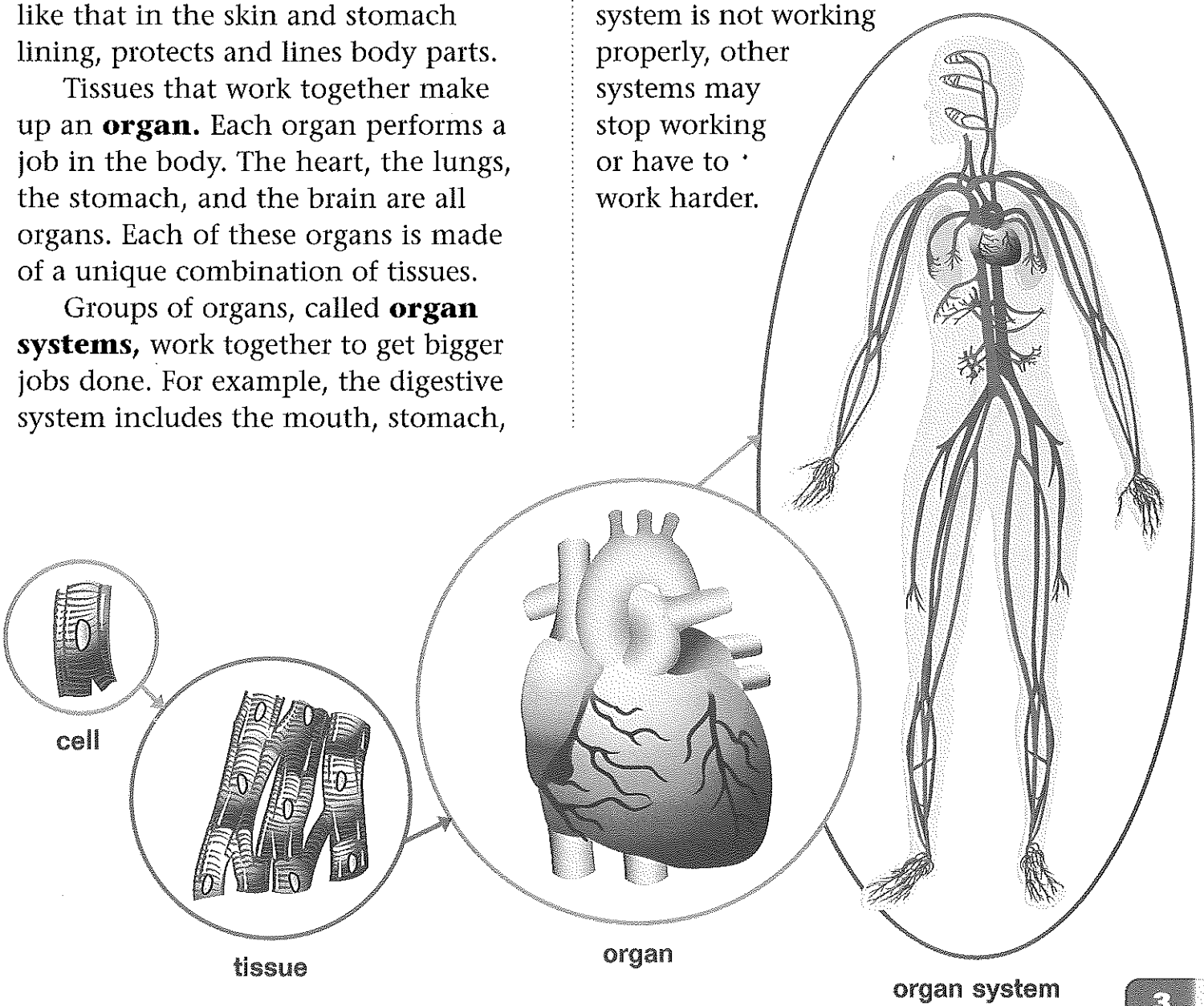
Cells can produce new cells by dividing in two, over and over again. **Cell division** occurs so that dead cells can be replaced and body parts can grow.

Similar cells that are grouped together form **tissues.** For example, muscle tissue is made of muscle cells working together. There are four basic types of tissue. Muscle tissue contracts to move body parts. Nerve tissue carries electrical signals throughout the body, to and from the brain and spinal cord. Connective tissue connects and supports body parts. Epithelial tissue, like that in the skin and stomach lining, protects and lines body parts.

Tissues that work together make up an **organ.** Each organ performs a job in the body. The heart, the lungs, the stomach, and the brain are all organs. Each of these organs is made of a unique combination of tissues.

Groups of organs, called **organ systems,** work together to get bigger jobs done. For example, the digestive system includes the mouth, stomach, small and large intestines, and other organs. The digestive system breaks down the food we eat into nutrients that can be used by the body for energy, growth, and repair.

The human body has many different organ systems. Each system does a particular job. When all the systems work well and work together, the body is healthy. If one body system is not working properly, other systems may stop working or have to work harder.



What Are the Body's Main Systems?

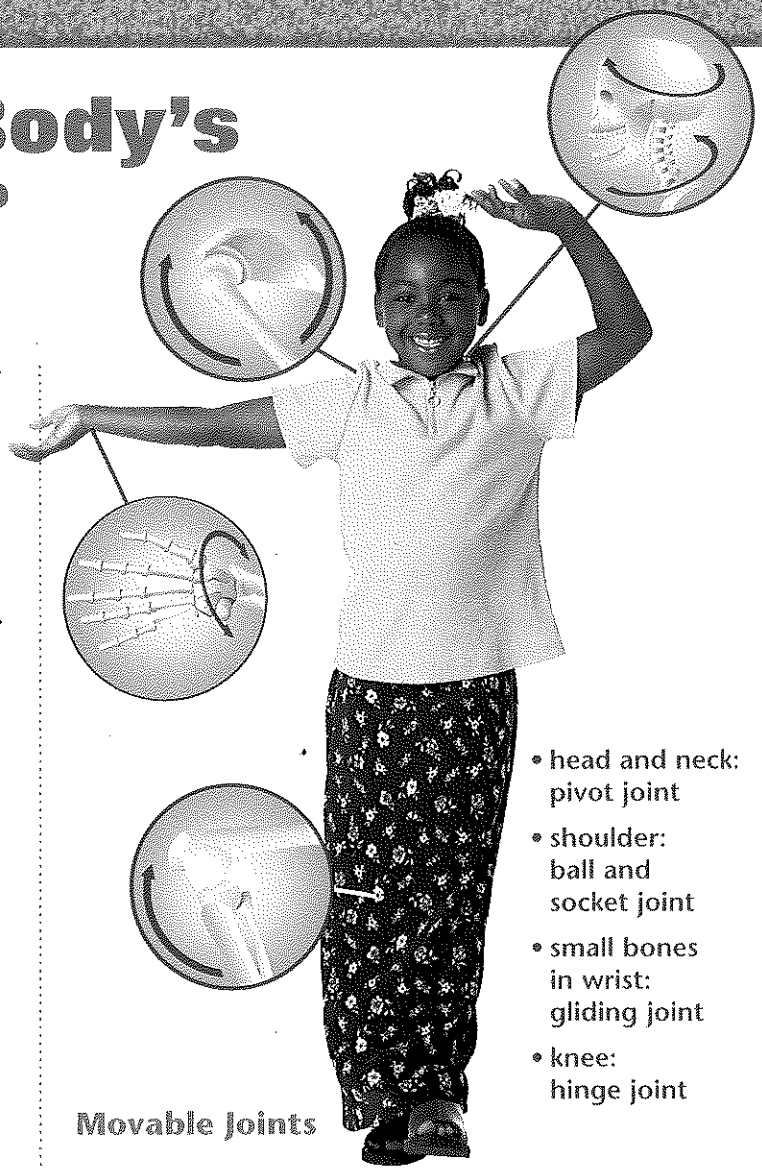
Skeletal System

The **skeletal system** is made up of the bones in the body. The bones work together to do three jobs. First, they give support and structure to the body. Second, they protect the organs. Third, they provide places for muscles to attach.

Humans have **endoskeletons,** which means that our bones are on the insides of our bodies. Some animals, like insects, spiders, and lobsters have skeletons on the outsides of their bodies. These animals have **exoskeletons**.

An adult human has 206 bones, each with a different shape and size. The skull, which protects the brain, is like a round, thick helmet. The ribs, which protect the heart and lungs, are curved, thin, and lined up in rows. The largest bone in the body, the femur, is in the upper leg. The length of the femur is usually about one-fourth of a person's height. The three smallest bones are inside the ear. Each bone is smaller than an apple seed.

Joints are the places where bones connect. Some joints work like hinges so the body can move. Knees, elbows, hips, and shoulders are all movable joints. Other joints, like those in the skull, do not allow movement.



Movable Joints

Bones are made of protein and calcium. Calcium makes bones hard and strong, but bones are hard only on the outside. Inside bones are spaces filled with a soft tissue, or **marrow.** Red marrow produces the body's blood cells. Yellow marrow is mostly fat cells. When needed, the body can turn yellow marrow into red marrow to make blood cells.

Some body parts are made of a soft material called **cartilage**. Our ears and noses are made of cartilage.

Muscular System

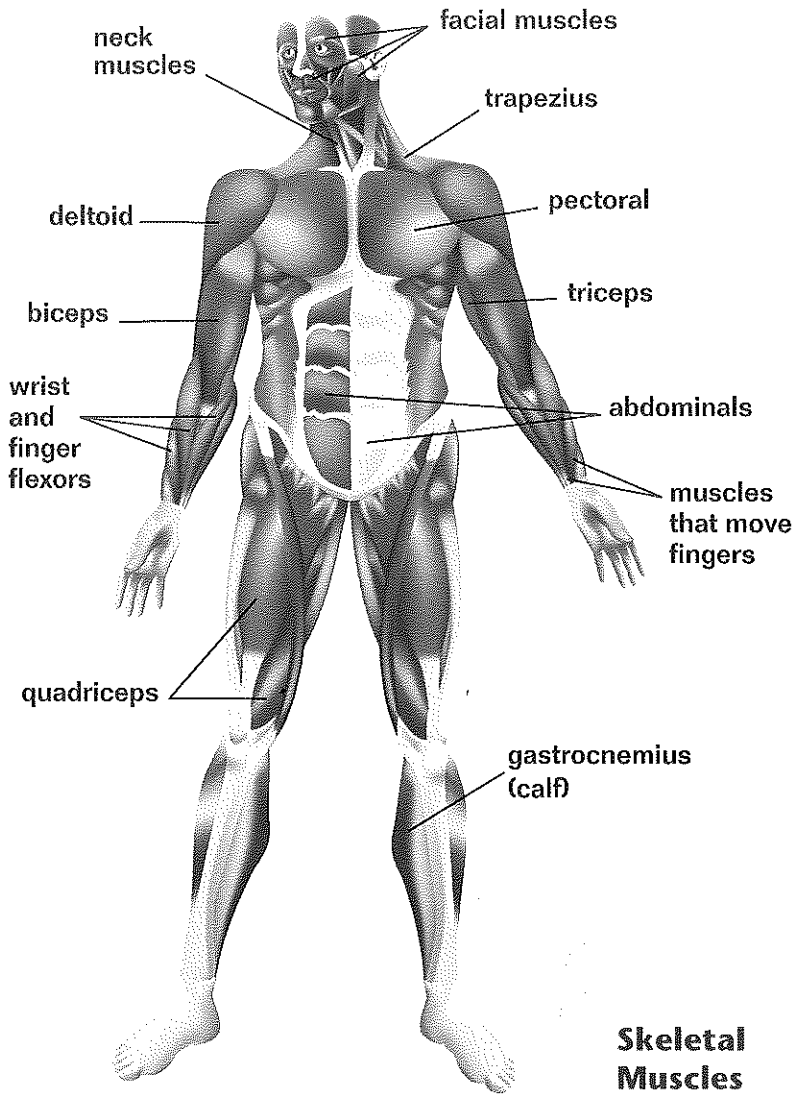
Muscles are in the moving business. Day and night, the **muscular system** is always at work, moving the body and its parts. Even when we sit very still, we are using many muscles.

The body has three kinds of **muscle** tissue. **Cardiac muscles** make up the heart. These thick, strong muscles pump blood throughout the body every minute of every day. **Smooth muscles** are found inside many organs, such as the stomach and intestines. This kind of muscle moves food through the digestive system. Both cardiac and smooth muscles work even when we are asleep.

Muscles that are attached to bones are **skeletal muscles.** This muscle tissue is made of long, thin cells. The job of skeletal muscle is to move bones so we can reach, run, jump, and move in countless other ways. We can control the movement of these muscles, so they are often called *voluntary* muscles.

Skeletal muscles are attached to the bones by rope-like **tendons.** Muscles cause the bones to move at the joints. At every joint, strong tissues called **ligaments** hold the bones together.

All muscles work by contracting, or getting shorter. When muscles relax, they stretch out to full length again. A muscle that causes a body part to bend when it contracts is called a **flexor** muscle. A muscle that causes a body part to straighten out when it contracts is called an **extensor** muscle.

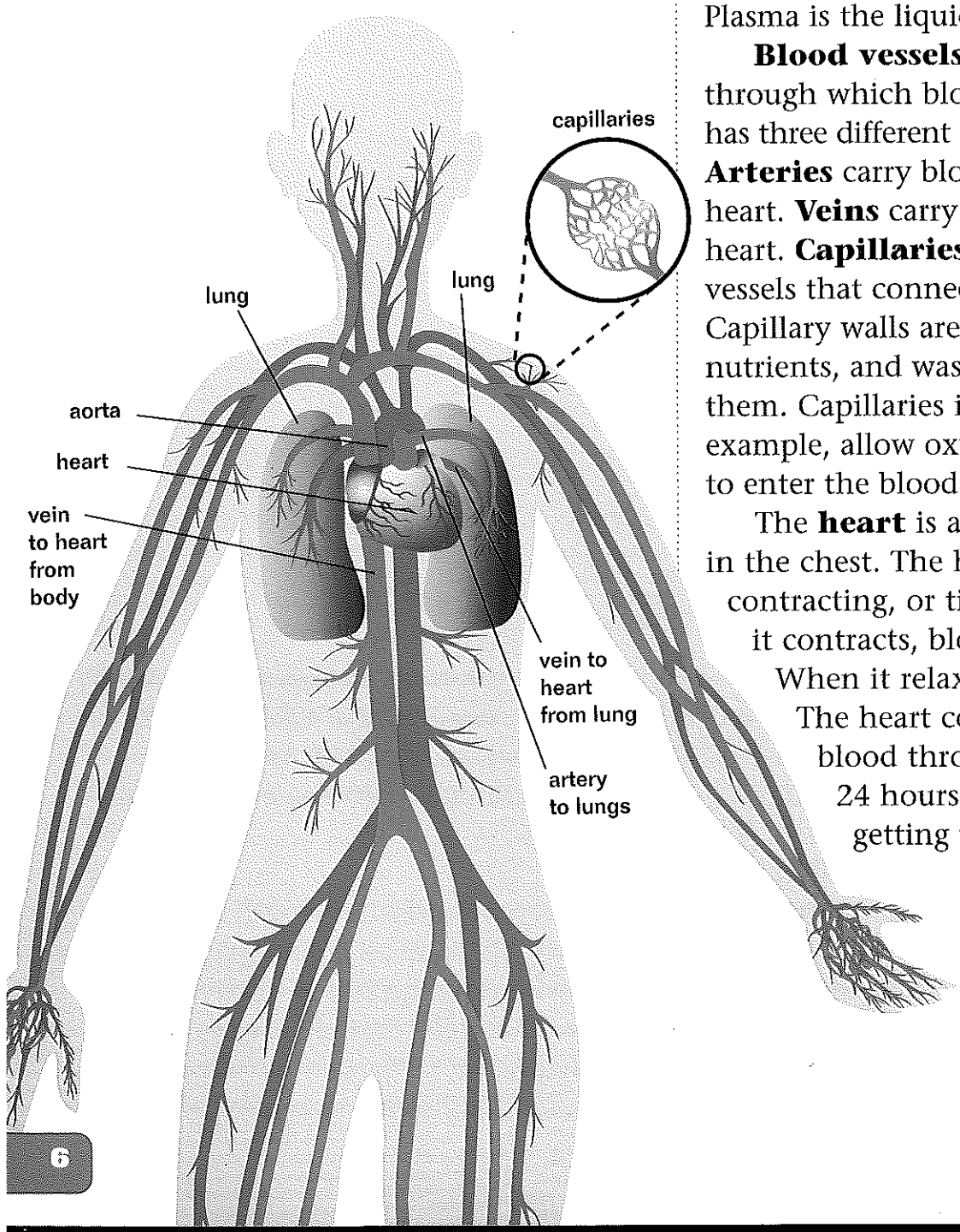


Skeletal Muscles

Skeletal, or voluntary, muscles often work in pairs. When one muscle in a pair contracts, the other relaxes. The biceps and triceps muscles in the upper arm work in this way.

Circulatory System

The **circulatory system** is the body's transportation system. This system moves **blood** through the body, delivering nutrients and oxygen to all of our cells and removing carbon dioxide and waste.

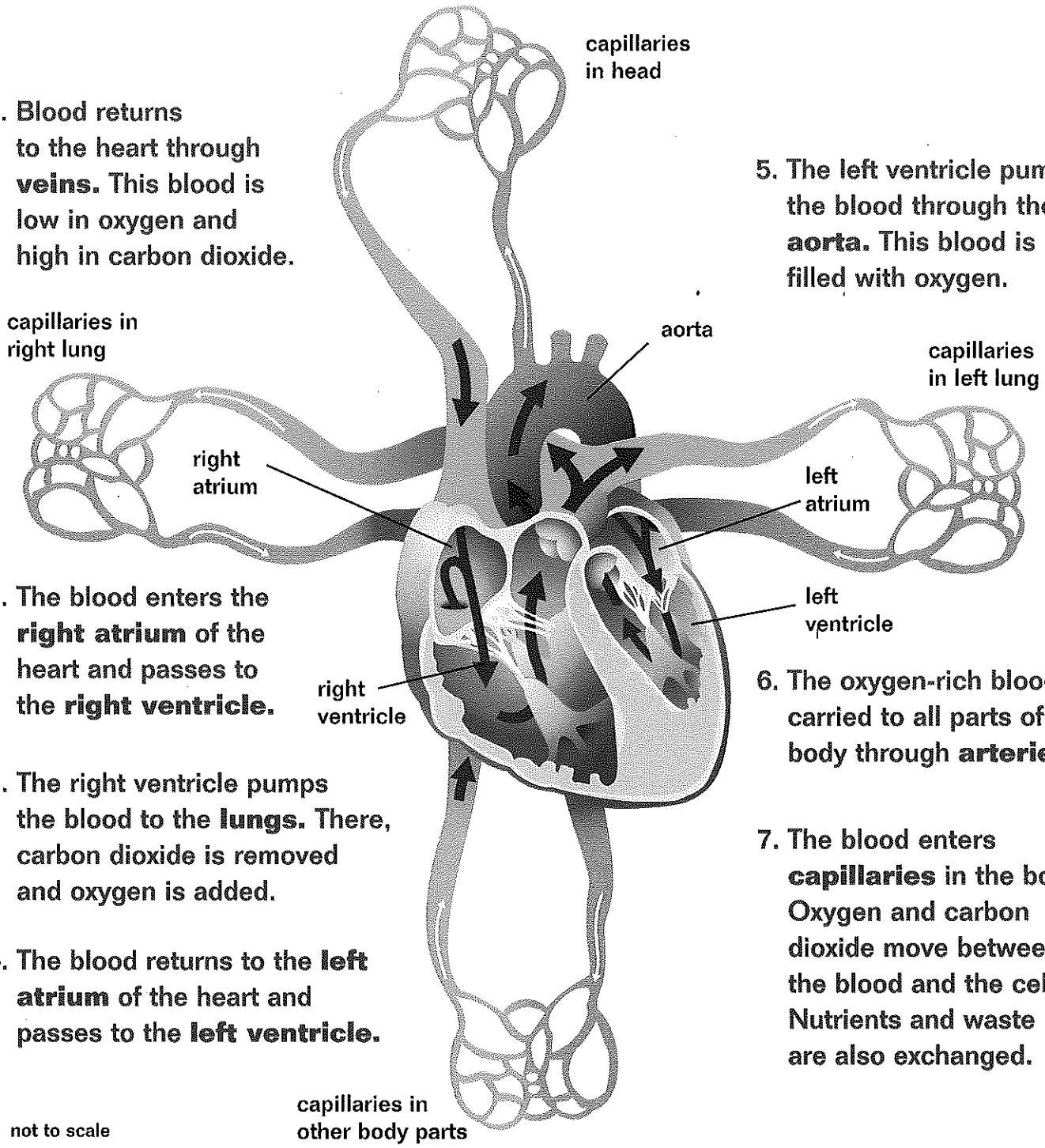


Blood is made of different kinds of cells. Red blood cells give blood its color. These cells carry oxygen to other cells in the body. White blood cells help defend the body against illness. Platelets are parts of cells that help heal cuts. Plasma is the liquid part of the blood.

Blood vessels are the tubes through which blood flows. The body has three different kinds of blood vessels. **Arteries** carry blood away from the heart. **Veins** carry blood toward the heart. **Capillaries** are very tiny blood vessels that connect arteries to veins. Capillary walls are so thin that oxygen, nutrients, and wastes can pass through them. Capillaries in the lungs, for example, allow oxygen from the lungs to enter the blood.

The **heart** is a fist-sized muscle in the chest. The heart pumps by contracting, or tightening. When it contracts, blood flows out. When it relaxes, blood flows in. The heart continues to pump blood throughout the body 24 hours a day without getting tired.

The largest artery leaving the heart is the **aorta**. It branches into smaller and smaller arteries. Every heartbeat sends a spurt of blood through these arteries. This causes them to expand and then relax. We can feel these pulses by touching the artery in the neck or wrist. Each pulse is one beat of the heart.



1. Blood returns to the heart through **veins.** This blood is low in oxygen and high in carbon dioxide.

2. The blood enters the **right atrium** of the heart and passes to the **right ventricle.**

3. The right ventricle pumps the blood to the **lungs.** There, carbon dioxide is removed and oxygen is added.

4. The blood returns to the **left atrium** of the heart and passes to the **left ventricle.**

5. The left ventricle pumps the blood through the **aorta.** This blood is filled with oxygen.

6. The oxygen-rich blood is carried to all parts of the body through **arteries.**

7. The blood enters **capillaries** in the body. Oxygen and carbon dioxide move between the blood and the cells. Nutrients and waste are also exchanged.

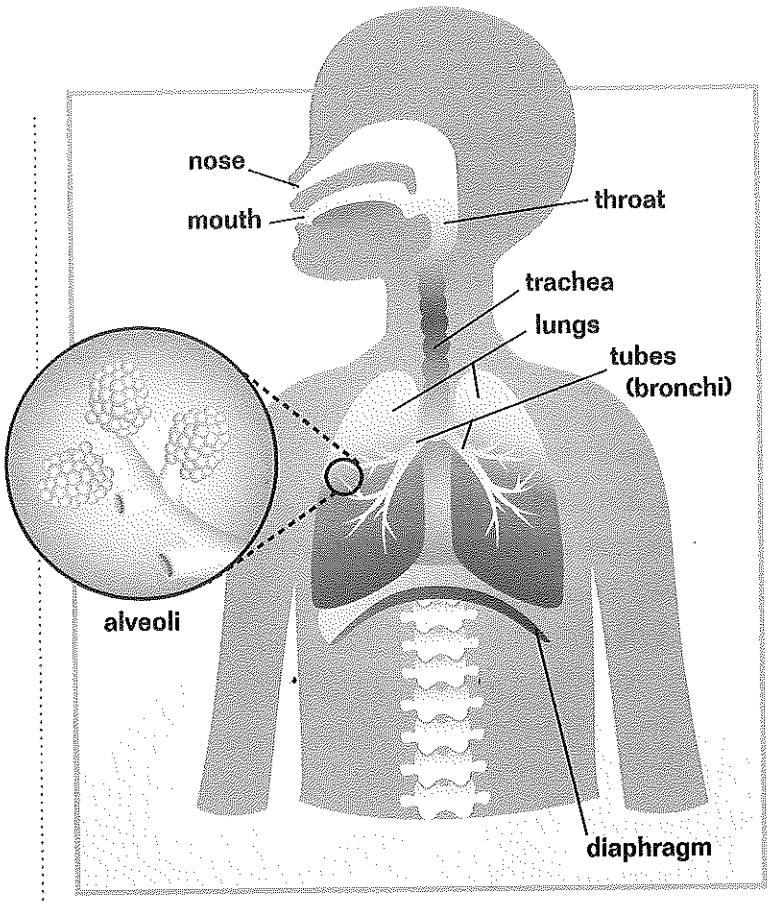
not to scale

Respiratory System

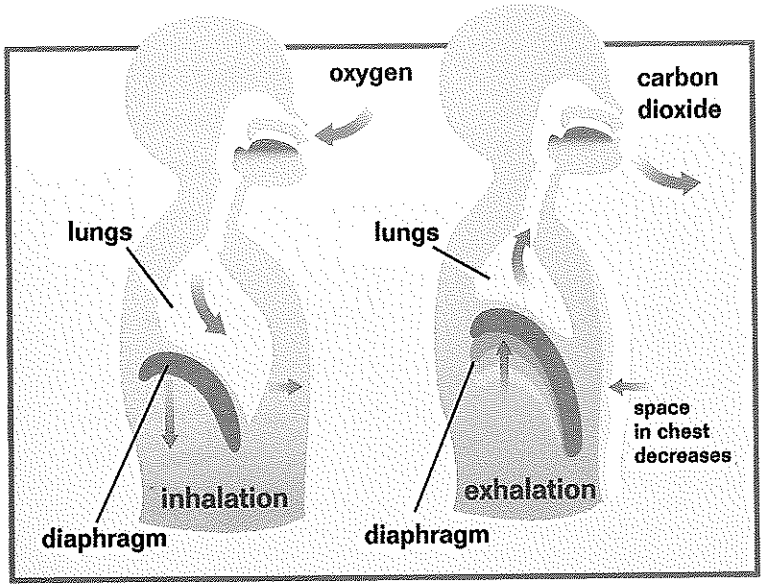
The **respiratory system** handles the body's air supply. Air is the source of oxygen, which every cell in the body needs. When cells turn food into energy, they use up oxygen and give off carbon dioxide. This process is called **respiration**. As we breathe air in and out, we bring in oxygen and get rid of carbon dioxide.

Air enters the body through the nose or mouth when we breathe in, or inhale. Then it goes down the throat into the windpipe, or **trachea**. The trachea forks into two tubes. One leads to the left **lung,** and the other leads to the right lung. The tubes divide into smaller and smaller tubes inside the lungs.

At the ends of the tubes, the air fills millions of sacs called **alveoli**. These sacs are covered with tiny blood vessels. Here, oxygen passes from the lungs to the blood, and carbon dioxide passes from the blood to the lungs. Then we breathe out, or exhale, and the air goes out of the body the same way it came in.



Like every other body movement, breathing happens because of muscles. The **diaphragm** is a large muscle between the chest and the stomach area. When the diaphragm contracts, it moves downward. Smaller muscles move the ribs out. The chest expands, and air rushes in to fill the lungs. When the diaphragm relaxes, it moves upward. The chest and lungs shrink, and the air rushes out.



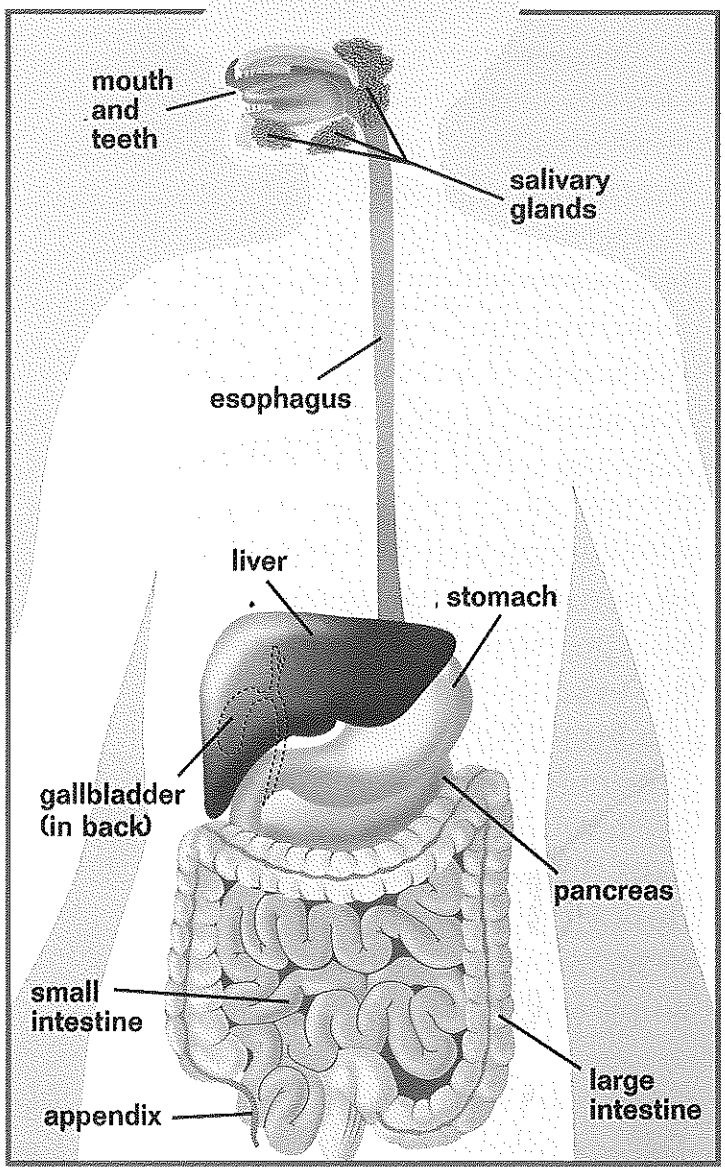
Digestive System

The **digestive system** breaks down the food we eat into small parts that the body can use. Digestion begins as soon as we bite into our food. It ends many hours later, when the nutrients in the food have passed into the blood stream.

Digestion takes place in two steps. Physical digestion breaks up bites of food into smaller pieces. Chemical digestion breaks down large food molecules into smaller, more useful molecules. Both of these processes begin in the mouth. Our teeth grind food into smaller pieces. The saliva in our mouths begins to change starches (large molecules) into sugars (smaller molecules).

When we swallow, the food begins its journey through a long pathway called the digestive tract. The breakdown of food continues in the stomach. There, foods are squeezed and mixed with digestive juices. Most chemical digestion takes place after food leaves the stomach and enters the small intestine. The inner lining of this organ contains millions of finger-like bumps called **villi.** These villi are filled with capillaries. The digested food molecules are small enough to pass through capillary walls into the blood stream.

Water and foods that are not digested pass into the large intestine.



There, the water is absorbed into the blood stream. The solid wastes move through the large intestine and out of the body.

The body needs more than 40 different nutrients for good health. The digestive system can deliver all these nutrients, but only if we eat the right kinds of foods!

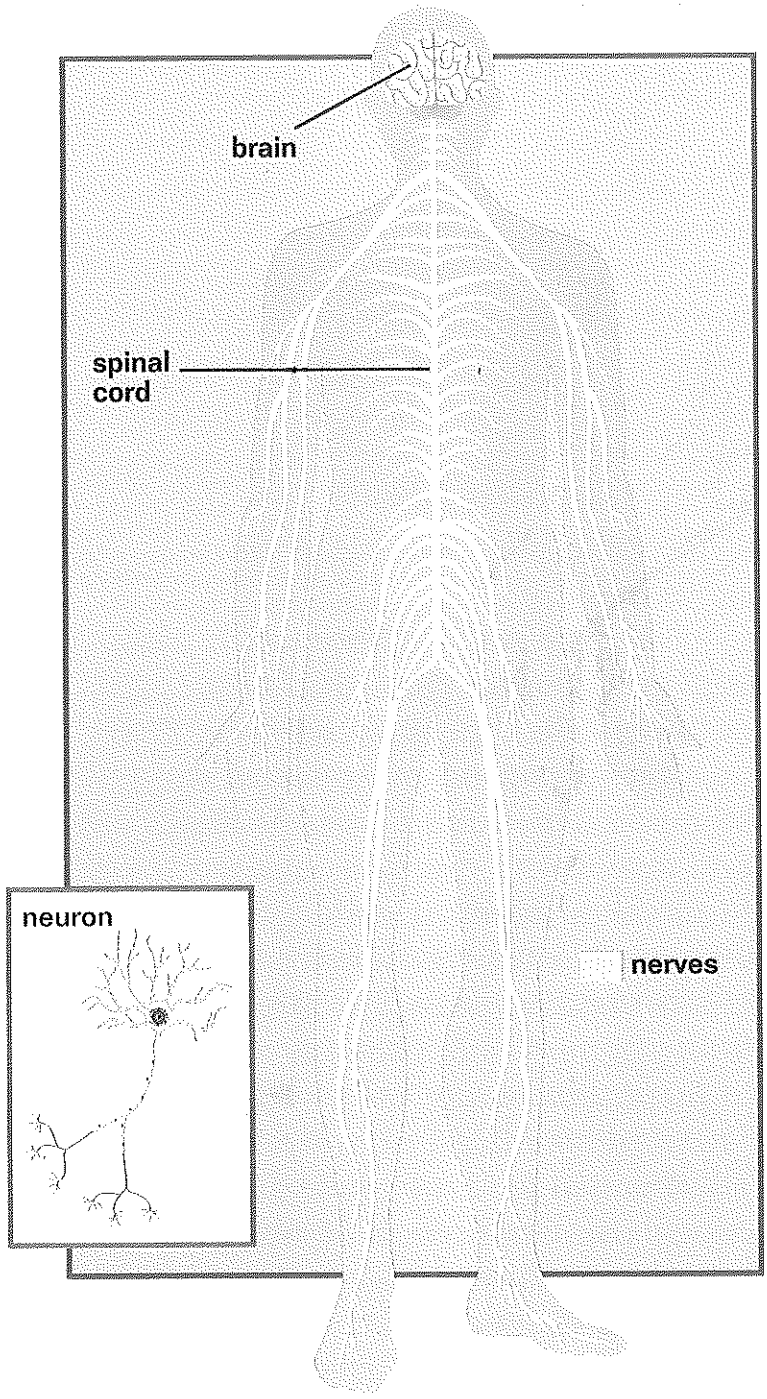
Nervous System

The **nervous system** handles communication in the body. This system collects information from inside and outside the body. It carries signals along nerve pathways to the **brain.** The brain figures out what the signals mean and directs the body's response. The nervous system also keeps other body systems running smoothly.

Signals to and from the brain travel along hair-like cells called **neurons**. Sometimes neurons are bundled together to form nerves. For example, the olfactory nerve is a bundle of neurons that carries information between the nose and the brain. Signals from many other parts of the body must first pass through the **spinal cord**, a bundle of nerves inside the backbone, before going to the brain.

At one end of some neurons is a structure that detects information. These structures, known as **receptors**, are found in many parts of the body. Receptors in our five sense organs take in information about our surroundings.

Signals from receptors travel along **sensory nerves**. Signals from the brain or spinal cord travel along **motor nerves** to your muscles.



Other Body Systems

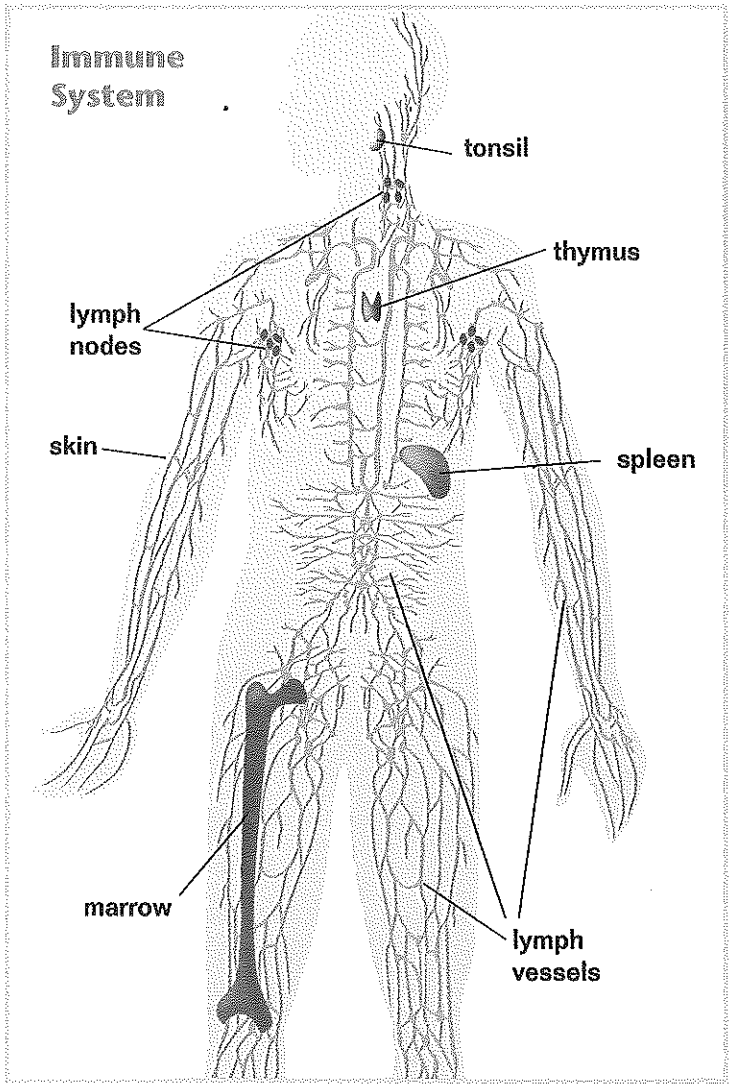
Like the nervous system, the **endocrine system** helps direct the body's activities. Instead of using nerves, this system sends chemical signals. Special organs called **glands** produce chemicals called hormones. **Hormones** speed up or slow down the work of other tissues and organs. The hormones are carried to the body cells by the blood.

The **immune system** works to defend the body against disease-causing organisms, called **pathogens**. If pathogens enter the body and begin to damage cells, the immune system goes to work. A special fluid carries white blood cells to the injured tissues to fight off the pathogens. White blood cells are made in the bone marrow, thymus, lymph nodes, tonsils, and spleen.

In another response to disease, special cells produce chemicals called **antibodies**. Every kind of pathogen has molecules on it known as **antigens**. The antibodies fit onto the antigens and destroy the pathogens.

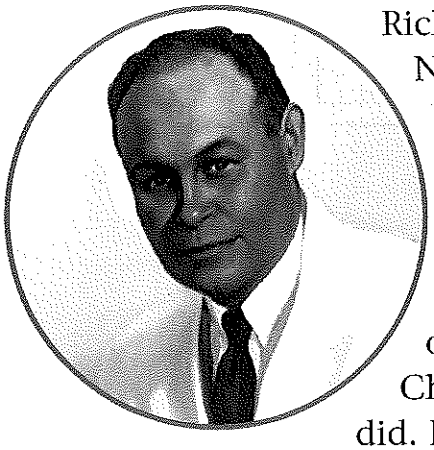
The body has several other systems. For example, the function of the **reproductive system** is to produce offspring, new human individuals. The **excretory system** is made up of all the parts of the body that handle removal of materials the body does not need.

Skin is the body's protective covering. A cut or scrape may leave the body open to infection.



Charles Drew, M.D. (1904–1950)

Inventor of Preserved Blood Plasma



Richard and Nora Drew insisted that their five children do well in school. Their oldest child, Charles, always did. He was also a star in football, basketball, baseball, and track. In fact, he received a sports scholarship to college. But by the time he graduated, Charles decided to become a doctor.

After medical school, Dr. Drew taught and worked in a laboratory as a scientist. He earned another medical degree with his experiments about blood.

Whole blood contains red cells, white cells, and a liquid called plasma. A person who is injured or sick may need blood. A blood transfusion can be lifesaving. At that time, donations of whole blood were stored in blood banks. However, whole blood did not stay fresh for more than a week.

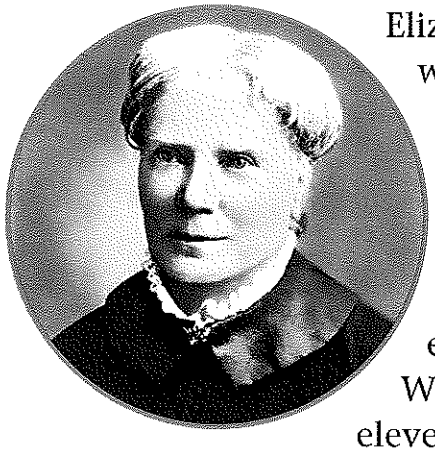
Dr. Drew studied how plasma alone could be used instead of whole blood. He researched and developed a way to preserve plasma for long periods of time. This meant the plasma could be shipped wherever it was needed.

During World War II plasma was needed for wounded soldiers. Dr. Drew was in charge of collecting, preserving, and shipping plasma across the Atlantic Ocean to the British military. He started the use of "bloodmobiles," trucks with refrigerators. Next he was asked to make sure American soldiers would have enough plasma. He became the director of the American Red Cross Blood Bank.

Then Dr. Drew returned to teaching. He became a professor at Howard University. He received many honorary degrees and awards for his work with blood.

Elizabeth Blackwell, M.D. (1821–1910)

Medical Pioneer



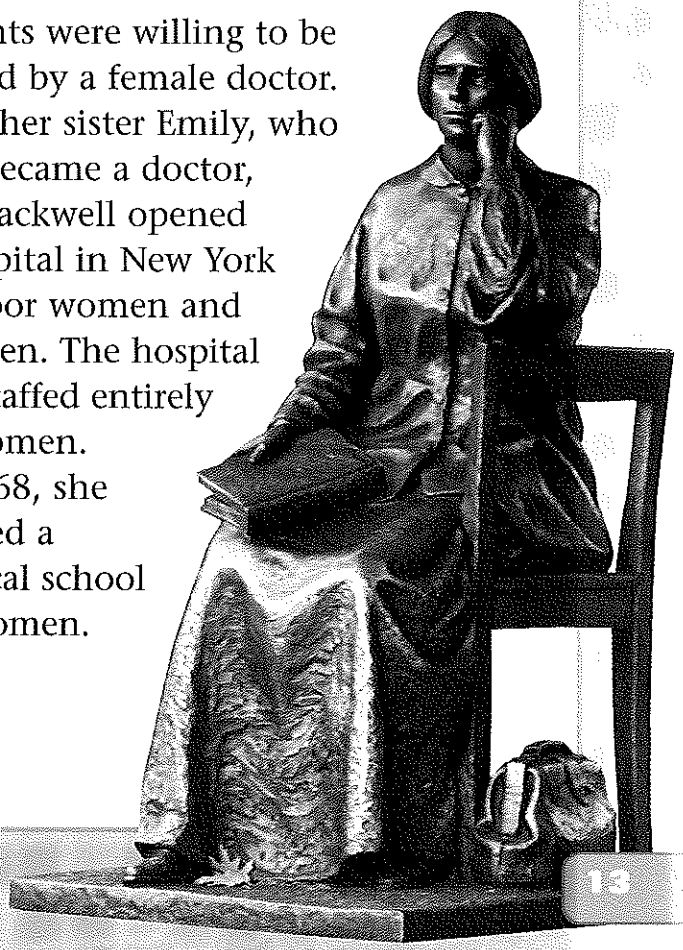
Elizabeth Blackwell was born in Bristol, England. There, her father made sure that she got a good education. When she was eleven years old, her large family immigrated to the United States. When she was old enough, Blackwell became a teacher to earn money for her family.

A friend who was dying of cancer told Blackwell that she would make a wonderful doctor. The dying woman's words seemed to inspire Blackwell. Almost everyone discouraged her. At the time, women were not encouraged to go into fields such as medicine. Yet Blackwell managed to find a doctor who would teach her privately.

Some doctors, including a few women, practiced medicine without a degree. But Blackwell wanted full status as a doctor. She applied to medical schools but was rejected seventeen times because she was a woman.

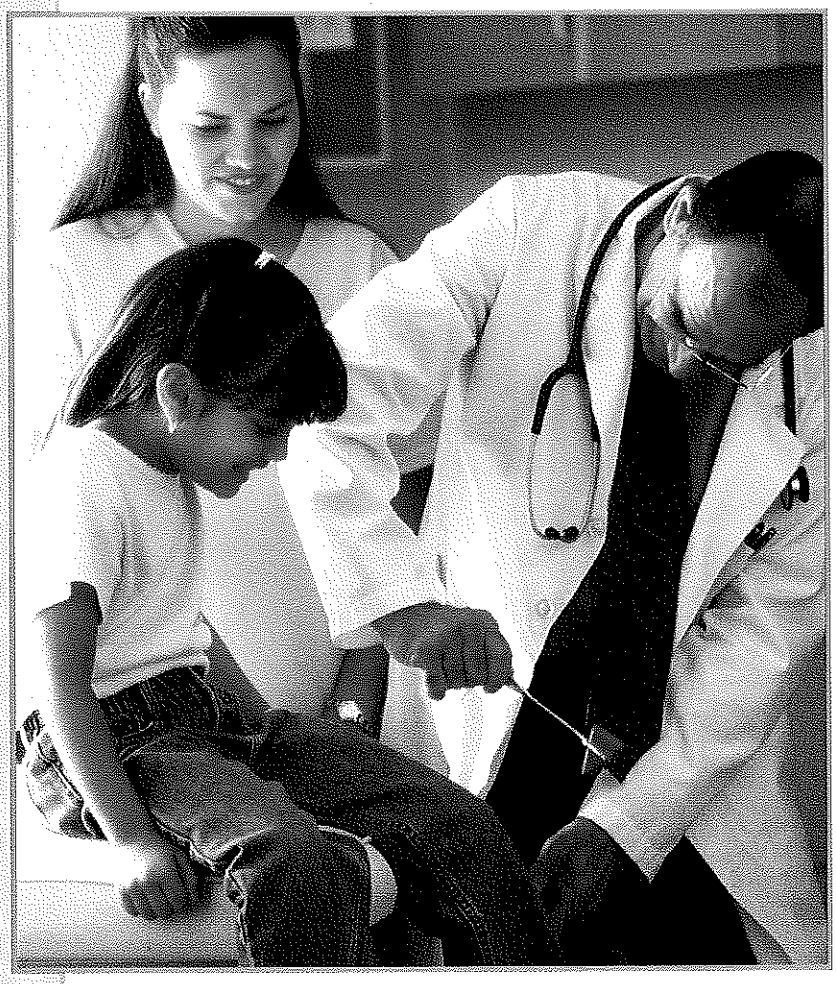
In 1847, the admissions panel at Geneva Medical College in Geneva, New York, received her application and they admitted her. Two years later, Blackwell graduated first in her class. She was the first woman in the U.S. to be awarded a medical degree.

Even so, Dr. Blackwell's battles weren't over. Few male doctors wanted to work with her. Few patients were willing to be treated by a female doctor. With her sister Emily, who also became a doctor, Dr. Blackwell opened a hospital in New York for poor women and children. The hospital was staffed entirely by women. In 1868, she opened a medical school for women.



How a Reflex Works

Your brain works very fast. Even so, sending signals to and from the brain still takes a little time. The delay from the time receptors pick up information until the moment your body responds is called **reaction time.**



In certain situations, your nerves can work together *without* involving your brain. If you touch something hot, you pull your hand away. You don't have to think about it. It happens automatically. This reaction is called a **reflex.** Reflexes help protect you.

If you touch a hot stove, receptors in your hand send the signal to your spinal cord. Then signals quickly pass from the spinal cord right back to your hand. Your arm muscles contract and pull your hand away. By this time, signals traveling up your spinal cord have reached your brain. Your brain interprets the signal as "Hot!" Luckily for you, your hand is already out of danger.

Other examples of reflexes include blinking when something comes toward your face or jumping when someone behind you makes a loud noise. Sneezing is also a reflex. It happens when something irritates your nose.

Doctors sometimes test reflexes to make sure the nervous system is healthy.

Glossary

alveoli small sacs in the lungs where gases are exchanged

antibody chemical that attacks an antigen

antigen molecule on the outside of a pathogen

aorta large artery leaving the left ventricle of the heart

artery blood vessel that carries blood away from the heart

atrium one of the heart's upper chambers

blood fluid in the circulatory system that delivers oxygen and nutrients to body cells and removes carbon dioxide and waste

blood vessel tube that carries blood through the body

brain organ in the skull that is a central part of the nervous system

calcium mineral that bones are made of

capillary tiny blood vessel where materials pass between the cells and blood

cardiac muscle type of muscle tissue found only in the heart

cartilage tissue similar to bone but softer

cell basic building block of all living things

cell division when cells divide to make new cells

cell membrane surrounds and protects a cell

circulatory system organ system that moves blood through the body to deliver nutrients and oxygen and remove wastes

cytoplasm jelly-like fluid that fills a cell and holds cell parts

diaphragm muscle under the lungs that is part of the respiratory system

digestive system organ system that breaks down food so the body can absorb nutrients

endocrine system system of glands that produce hormones, chemical signals that tell the body what to do

endoskeleton skeleton on the inside of the body

excretory system organ system that removes waste from the body

exoskeleton skeleton on the outside of the body

extensor muscle that straightens a part of the body at a joint

flexor muscle that bends a part of the body at a joint

gland organ in the endocrine system that produces chemicals

heart muscle in the chest that is part of the circulatory system

hormone chemical that controls the activities of an organ or tissue

immune system body's natural defense system against disease-causing organisms

joint place where bones are joined together

ligament strong tissue that holds bones together at movable joints

lung sponge-like organ used to take air into the body

marrow soft tissue inside bones

motor nerve pathway for signals from the brain or spinal cord to muscles

muscle tissue that causes body parts to move

muscular system organ system that handles movement of body parts

nervous system organ system that controls communication in the body

neuron cell that carries information through the nervous system

nucleus control center of the cell

nutrient substance the body uses for energy, growth, and repair

organ group of tissues that work together to perform a specific function

organ system group of organs that performs a major function in the body

pathogen disease-causing organism

protein large complex molecule needed for tissue growth and repair

reaction time time between the moment receptors pick up information and the beginning of a response

receptor structure at the end of a neuron that detects information

reflex fast reaction when nerves work without involving the brain

reproductive system organ system used in producing offspring

respiration body process that uses oxygen to release energy in food

respiratory system system that takes in oxygen and removes carbon dioxide

sensory nerves pathways for signals from receptors to the brain

skeletal muscle type of muscle tissue that moves our bones; also called *voluntary* muscle

skeletal system system of bones and cartilage that supports the body

smooth muscle type of muscle tissue found in many internal organs

spinal cord large bundle of nerves inside the backbone

tendon tissue that attaches skeletal muscles to bones

tissue group of similar cells with the same function

trachea main tube, or windpipe, through which air passes to and from the lungs

vein blood vessel that carries blood toward the heart

ventricle one of the heart's lower chambers

villi tiny finger-like bumps in the small intestine

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FAST FACTS

- An adult's heart beats about 100,000 times a day.
- Babies are born with about 350 bones. As children grow, some of their bones join together. Adults have 206 bones.
- The hands and feet contain more than half the bones in the human body.
- There are about 100,000 hairs on a human head.
- About sixty percent of the body's weight comes from water.
- The body grows new cells to replace dead cells. Three hundred million cells are replaced each minute.
- If a person's arteries, veins, and capillaries were put together end-to-end, they would measure about 160,000 kilometers (100,000 miles). That is more than twice the distance around the world.

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