Movers & Shapers

by Dr. Patricia Macnair
Movement and support

Imagine your body without any bones. You would be floppy and unable to move. The bones form a skeleton, or framework, that supports the body and protects the internal organs. Muscles cover the bones. Together, they give the body its shape and allow you to move.

You need to use more than 60 muscles and bones in each hand and arm just to lift a glass.

Pulling power

In order to make a movement, the muscles and bones must work together as a team. When muscles contract, or get shorter, they pull on the bones. This makes different parts of the body change position. Most movements are controlled by the brain.
No rest
Your muscles and bones never stop working. Even when you are standing still, they are busy holding the body in the same position. And all day and night the muscles and bones in your rib cage move in order to help you breathe.

Guard duty
Bones and muscles also have the important job of protecting the organs inside your body. The skull forms a hard cage around the brain. Your ribs shield the heart and lungs, and the bones and muscles of the pelvis protect the bladder and reproductive organs.

Info lab
- A bone is stronger than a steel bar that is the same weight.
- More than half of the bones in your body are found in your hands and feet.
- Muscles are grouped in pairs.
- Muscles make up around half of the weight of your body.
Bony framework

The skeleton is made up of bones of all shapes and sizes. Arm and leg bones are long and thin, while hand bones are small and rounded. Although bones are hard and rigid, they can grow and change their shape.

The human body has 206 bones. These are joined together to form the skeleton.

Compact bone is found on the outside of most bones. It is made of very strong tubes that are fused together.

Inside a bone

The surface of each bone is covered with a thin layer containing blood vessels and nerves. Underneath is hard bone called compact bone. This forms a shell around a layer of light but very strong spongy bone.
The shape of the skeleton helps the body balance upright, leaving the hands free. Bones in the feet make a wide base. The pelvis, formed from the hip bones, supports the upper body.

**Bone marrow**

Spongy bone is packed with jellylike red bone marrow. This is where blood cells are made. As a child grows into an adult, the red bone marrow in long bones is replaced by yellow bone marrow, which stores fat.

- At birth babies have more than 300 bones.
- Adults have 206 bones—many of the bones you are born with fuse together as you grow older.

**Getting it right**

Over time bones can change their shape because they are made of millions of living cells. This is why it is very important to have your feet measured when you buy shoes. Shoes that are too tight can damage the bones of your feet.

- Special scans can detect if the bones of a living person are diseased. This picture shows a healthy skeleton.

- Spongy bone is not solid; it is made up of a network of bony struts. The spaces are filled with bone marrow.
The joints

Wherever two or more bones meet, you will find a joint. In some joints the bones are fixed tightly together. In others the bones can move freely, allowing different parts of the body to bend or twist. Without this flexibility, it would be almost impossible for you to move.

Smooth operators

Joints have to work smoothly in order to prevent wear and tear. In joints like the knee the bone ends have a slippery coating called cartilage. A fluid in between the layers of cartilage stops the bones from rubbing together.

- This picture was taken with an endoscope. It shows the cartilage inside a knee joint.

- Joints and other parts of the body can be examined with a special instrument called an endoscope.

- Two bones meet at the knee, forming a joint. Fluid in the space between the cartilage helps the joint work smoothly.
Chain of bones
Your spine is often called the backbone, but if it was just one stiff bone, you would be unable to bend over. Instead it is made up of many vertebrae, or small bones, with narrow joints in between each one of them.

- The joints between each vertebra of the spine can move slightly apart.

Info lab
- The body contains more than 400 joints. Most allow a wide range of movements.
- The ligaments that hold the hip joint together are very strong, so it rarely dislocates.
- If you twist your ankle suddenly, you may tear and stretch the ligaments in the ankle joints. This is known as a sprained ankle.

Dislocation
Bones are held very tightly in place at each joint by tough bands called ligaments. If a bone is knocked hard enough, it may move out of place. This is called a dislocation, and the joint will not bend correctly until the bone is put back into the right place.

- This X-ray shows a dislocated knuckle or finger joint. You can see how the two bones have been pushed apart.
How joints move

Joints move in many different ways. Some joints work like a hinge—bend your knee to see this in action. Others, such as the shoulder, let you make movements in many directions.

**Ball and socket**

Your hip and shoulder are examples of ball-and-socket joints. One bone rotates just like a ball that is inside a cuplike socket formed by another bone. Ball-and-socket joints are the most movable of all joints.

**Hinges and pivots**

The knee, elbow, fingers, and toes contain hinge joints. These move backward and forward in only one direction. The elbow also contains a pivot joint, which lets you turn your hand over and then back again.

- If a hip joint becomes diseased, it can be replaced with an artificial joint made out of metal (shown in red).

Info lab

- People with “double joints” do not have extra joints—they are just more flexible.
- Every step you take involves the 33 joints in each of your feet.
- In some of the ankle and wrist joints the bones glide over each other.
The saddle joint is only found in the hands.

The pivot joint at the top of the spine allows the head to turn.

This performer can twist and turn her body into this shape because she has very flexible joints.

Thumb power

The saddle joint is found at the base of the thumb. This joint lets you move each thumb in a wide circle. Along with your fingers, your thumbs help you grip objects in your hands.

Flexibility

Imagine being able to put your feet behind your ears! Some people have extremely flexible joints, so they can bend their bodies into unusual and extreme positions.

The body has several different types of joints. Each one allows a different movement, from bending a knee to moving an arm in a circle.
Bendable body parts

Try folding your ears forward. They should bend easily and then spring back when you let go! This happens because they are made of a flexible tissue called cartilage. Your nose and voice box, which is the bumpy part in your neck, also contain cartilage.

On the nose

Your nose is made of several pieces of cartilage. They form the sides of your nose and give your nostrils their shape. A central piece of cartilage, called the septum, divides the inside of the nose into two chambers.

Cartilage is soft enough for an earring to be pierced through it.

The upper part of the nose is made of hard bone. Plates of cartilage (gray) form the rest of the nose.

In this picture, taken with a microscope, you can see a layer of cartilage (green) surrounded by skin. The holes contain cells that make cartilage.
You can wiggle your nose from side to side and squash it out of shape because the sides and lower part are made of cartilage.

**Info lab**

- Breastbone cartilage does not turn to bone until at least the age of 40.
- The larynx, or voice box, is also known as the “Adam’s apple” in men.
- The folds of your ear, which are made of cartilage, help the ear “catch” sounds.

**Soft skeleton**

For the first six weeks a baby developing in its mother’s womb has a skeleton made of cartilage. Cartilage is softer and more flexible than bone and grows and changes more quickly.

**Growth and repair**

Cartilage is easily damaged, especially in the knee joints. Many athletes have to retire because of cartilage injuries. But scientists are now able to grow new cartilage in laboratories, giving hope to injured athletes.

**Cartilage into bone**

In young children the bones still contain large areas of cartilage in between more rigid bone. These pieces of cartilage are called growth plates—because they let bones grow. Over time most cartilage is replaced by bone.
Muscles that get you moving

Without muscles, you would not be able to scratch your head, open a door, or turn a single page of this book! The muscles you use for these and most other movements are joined to the bones. Muscles work by pulling on the bones.

Under the skin

There are almost 650 muscles in your body that you can control and move. This type of muscle, called skeletal muscle, is connected firmly to the bones by tough, stringlike cords. These cords are the tendons.

Muscle is made from long muscle cells, called fibers, packed together in bundles (right). Under a microscope, these fibers look striped (above).

Underneath your skin are hundreds of overlapping muscles. Most are attached to your skeleton.
The buttocks muscle is one of the strongest muscles in the body.

Muscles work by pulling in only one direction—they cannot push things away.

You use more than 200 different muscles when you walk.

**How muscles work**

Muscles move the body because they are attached to the skeleton. When a muscle contracts, it gets shorter and pulls on a bone. Try bending an arm. If you put your hand on the upper part of your arm, you should feel the muscle become fatter as it gets shorter.

**Muscle pairs**

The muscles we use for movement are controlled and coordinated by the brain. Most muscles work in pairs. One pulls in one direction, and the other pulls in the opposite direction.

- The biceps muscle near the front of each upper arm bends the arm up at the elbow. The triceps, at the back, straightens out the arm.
The skull

The skull is like a hard box made of bone. It contains and protects the brain and other soft body parts, such as the eyes, ears, and tongue, which can be damaged easily. Nerves and blood vessels go in and out from the brain through holes in the skull.

Bone head

The skull is formed from 22 bones. Eight of these are large, flat bones that make up a domed box called the cranium. This surrounds the brain. The remaining bones give shape to the face. Only one skull bone can move—the mandible, or jawbone.

Balancing act

The bones of the cranium fit together very tightly and cannot move or slip unless the skull is hit with great force. The skull is balanced on top of the backbone. The spinal cord runs along the backbone and into the brain through a large opening at the base of the skull.
Info lab

- The bones around the nose are hollow in order to keep the skull as light as possible.
- The fontanels of a baby become bone between the age of 12 and 18 months old.

Safety first

Although the skull is strong, sometimes it needs extra help in order to protect its precious contents. In many sports, such as cycling, skateboarding, or football, it is important to wear protective headgear.

Fontanels

In small babies the bones of the skull have not yet knitted together. Instead the bones are connected by a stretchy material. The gaps between the bones are called fontanels. These allow the skull to get bigger as the baby’s brain grows.
Spine and ribs

Feel the bumps running down the middle of your back. Each one is a ringlike bone called a vertebra. These bones form the spine, or backbone, which is the central part of the skeleton. Twelve pairs of curved rib bones are also attached to the spine.

- The ribs curve around the chest on both sides of the spine. Most are connected to the sternum, or breastbone, at the front.

Support system

The spine is made up of curved sections. Each one has a different job to do, from supporting the head to carrying the weight of your body. The different sections of the spine together form a gentle “S” shape. This helps make the spine flexible and strong.

- The spine has 33 bones—24 separate vertebrae and nine that are fused together.
- Here part of the vertebrae has broken off in an accident and is pressing against the spinal cord.
Around one in 20 people is born with an extra pair of ribs.

The vertebrae create a tunnel of bone that protects the spinal cord. This carries messages to and from your brain.

The bottom two pairs of ribs do not join together with the breastbone.

The ribs form a protective cage around your lungs and heart. When you breathe, your rib cage moves up and down, helping your lungs suck in air and squeeze it out again.

Antishock

When you move, stand, or jump, you put pressure on your spine. Between each vertebra there are padded disks of cartilage. These cushion and protect the bones of the spine from damage.

The atlas is found at the top of the spine. This vertebra, along with the one below it, allows you to shake and nod your head.

The atlas, which supports your head, is named after a character from one of the myths of ancient Greece. This sculpture shows Atlas carrying Earth on his shoulders.
When you are walking, running, or just standing still, your legs and feet have to carry the weight of your whole body. The femur, or thighbone, in the upper part of the leg, is connected to the body by the pelvis. The femur is the largest and strongest bone in the body.

### Bone basin
The basin-shaped pelvis is where the upper and lower body meet. The pelvis is made from two curved hip bones joined together at the front. At the back the hip bones are connected to the backbone.

### Under pressure
When you are moving, your feet push your body forward. They also stop you from falling over! The bones and ligaments of the foot form curves called arches. These can bend under the weight of the body, and they turn the feet into excellent shock absorbers.
All in a name

The sartorius muscle is the longest muscle in the body. Found in the thigh, it is around 1 ft. (30cm) long and pulls the knee up and rotates the thigh outward. The sartorius also lets you sit cross-legged. Ancient Roman tailors, called sartors, sat like this when they sewed.

Info lab

- There are 26 bones, 33 joints, and more than 100 muscles, tendons, and ligaments in each foot.
- The muscles of your feet expand slightly during the day.
- The bones and muscles of the arms and legs are very similar.

Bones and muscles in our legs and arms support the body everyday. This gymnast uses both his arms and legs as he performs his gymnastic routine.

A runner winces in pain after injuring her ankle.

Each foot contains seven tarsals, or anklebones, five metatarsals, or sole bones, and 14 phalanges, or toe bones.

sartorius muscle

tarsals  metatarsals  phalanges
(anklebones)  (sole bones)  (toe bones)