

# SKELETAL SYSTEM



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## Anatomy of the skeleton

The 206 bones of the skeletal system carry out six important anatomic and physiologic functions:

- ✋ They protect internal tissues and organs; for example, the 33 vertebrae surround and protect the spinal cord, brain, and heart.
- ✋ They stabilize and support the body.
- ✋ They provide surfaces for muscle, ligament, and tendon attachment.
- ✋ They move through lever action when contracted.
- ✋ They produce red blood cells (RBCs) in the bone marrow (a process called **hematopoiesis**, from the Greek ***haima***, or blood, and ***poiesis***, meaning *making* or *forming*).
- ✋ They store mineral salts; for example, approximately 99% of the body's calcium.



## ***Pump up your pronunciation***

### **Pronouncing key skeletal terms**

*Below is a list of key terms, along with the correct way to pronounce them.*

<u>Calcaneus</u>	<u>Kal-kay-nee-uhs</u>
<u>Coccyx</u>	<u>Kok-siks</u>
<u>Hematopoiesis</u>	<u>Hee-muh-toe-poy-ee-sis</u>
<u>Occipital</u>	<u>Ok-sip-uh-tuhl</u>
<u>Periosteum</u>	<u>Per-ee-os-tee-uhm</u>
<u>Xiphoid process</u>	<u>Zeye-foyd Prah-sess</u>

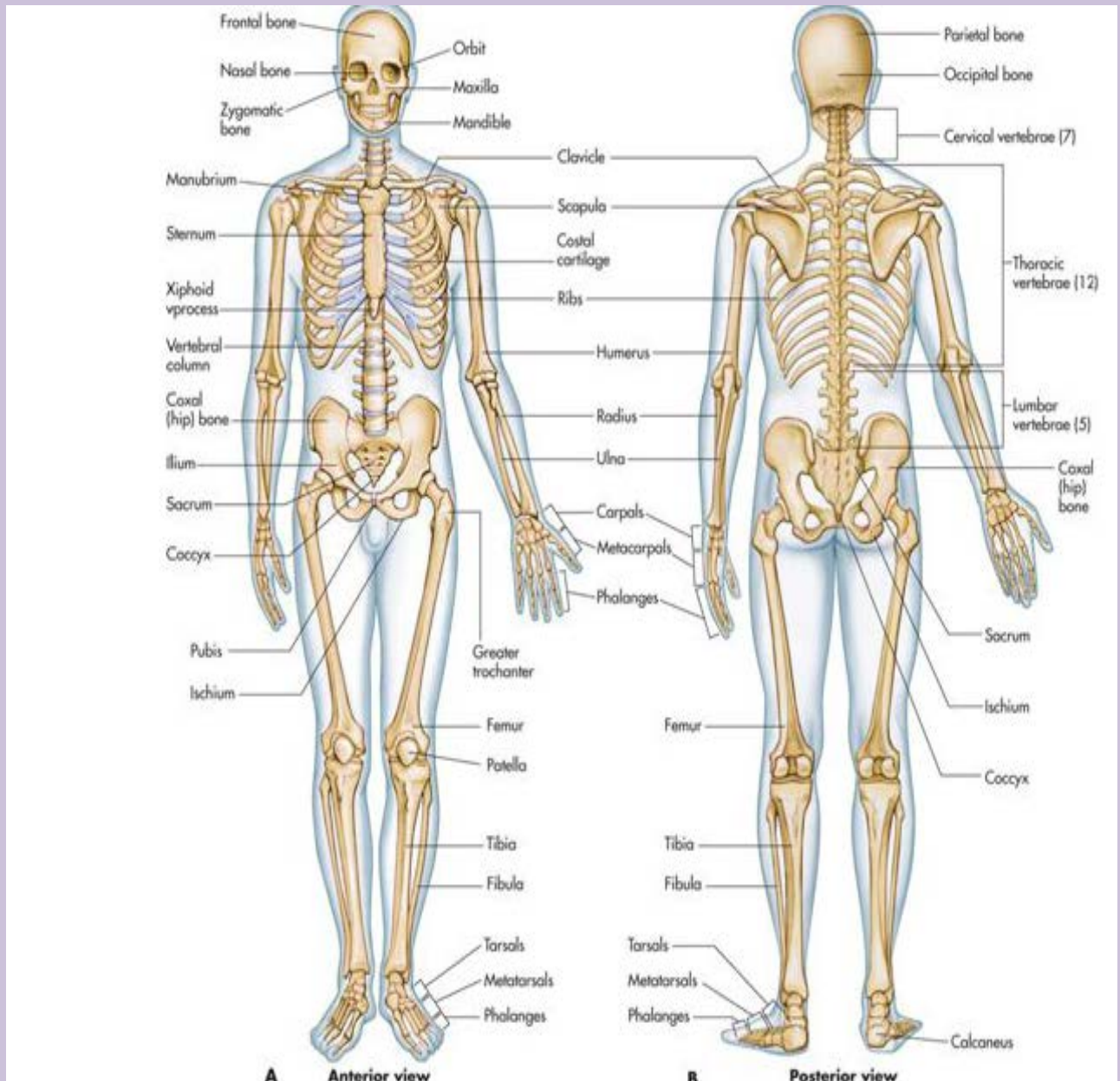
## **Bones-r-us**

The skeleton is divided into two parts: the **axial** (from the Latin ***axis***, meaning *axle* or *wheel*) and **appendicular** (from the Latin ***appendare***, meaning to *add* or *append*). The **axial skeleton** forms the body's vertical axis and contains 74 bones in the head and torso; it also includes 6 bones of the middle ear, for a total of **80** bones. (See *the body's bones*.)



## The body's bones

The human skeleton contains 206 bones; 80 form the axial skeleton and 126 form the appendicular skeleton. The illustrations below show some of the major bones and bone groups.



The **appendicular skeleton** contains 126 bones and includes the body's **appendages**, or upper and lower extremities



*Beyond the  
dictionary*

## The axial skeleton

The axial skeleton forms the long axis of the body and includes bones of the skull, vertebral column, and rib cage.

### The skull

The **skull** contains 28 irregular bones in two major areas:  
the brain case, or **cranium** (from the Greek *kranion*, meaning *upper part of the head*), and the **face**. Eight bones form the cranium, 14 bones make up the face, and the inner ears contain 6 **ossicles** (from the Latin *ossiculum*, meaning *bone*), or 3 small bones in each ear. The jaw bone, or **mandible** (from the Latin *mandibula*, meaning *jaw*) is the only movable bone in the skull. (See *Bones of the skull*.)

## Little fountain

**Fontanel**, also spelled **fontanelle**, derives from French and means *little fountain*. It can also refer to any membrane-covered area between two bones.

## Getting it together

**Sutures** are immobile joints that hold the skull bones together. The **coronal suture** unites the frontal bone and the two parietal bones. In infants, this suture isn't closed, leaving a diamond-shaped area (called the **anterior fontanel**), which is covered only by a membrane. This soft spot closes between ages 10 and 18 months. At the back of the head of infants, the **posterior fontanel** closes by age 2 months.

## A real airhead

**Sinuses** are air-filled spaces within the skull that lessen the bone weight, moisten incoming air, and act as resonating chambers for the voice.

## Up front

The sinuses, the forehead, and the area directly behind it are part of the **frontal bone**. This bone also forms the **orbits** (eye sockets) and the front part of the cranial floor.

## Take it from the top

The main part of the skull consists of a number of bones sutured together:

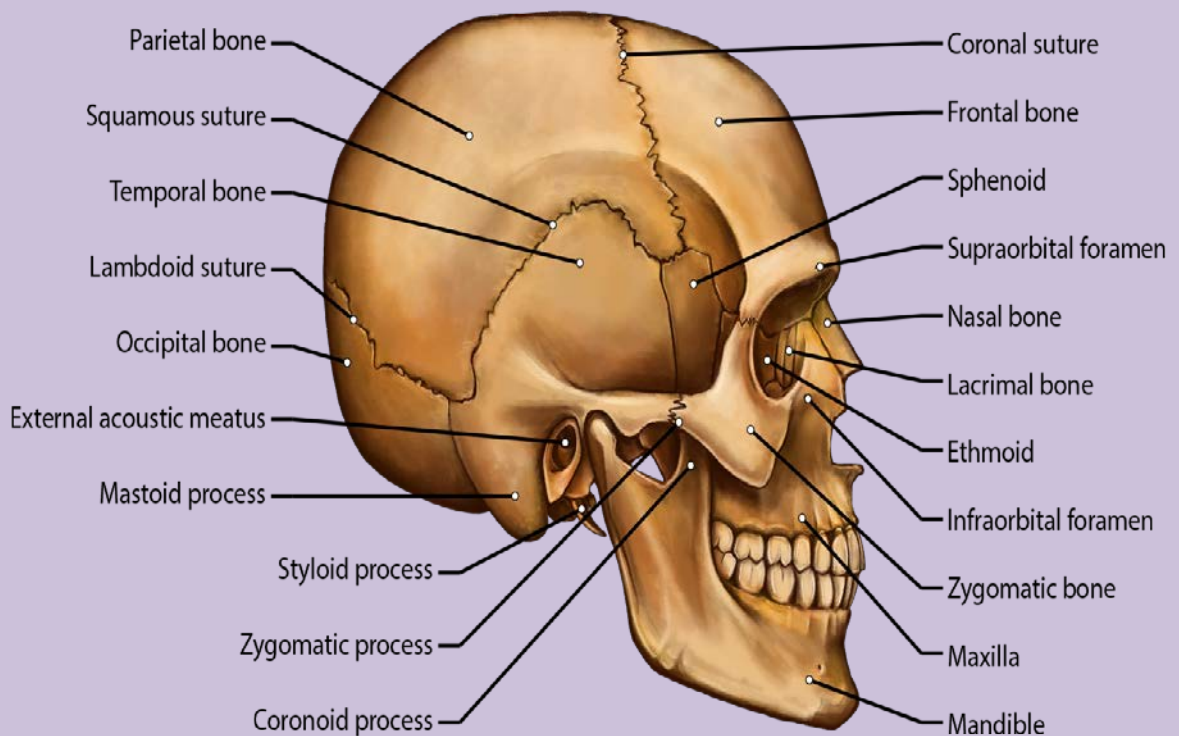
- The **coronal suture** connects the frontal bone with the parietal bones.
- Two **parietal bones** crown the head, forming the roof and the upper part of each side of the skull.
- The **squamous suture** connects the parietal bones with the temporal bones.
- **Temporal bones** form the lower part of the sides of the skull and part of its floor. They contain structures of the middle and inner ear and the mastoid sinuses.



## Anatomically speaking

### Bones of the skull

The skull is a complex bony structure. It's formed by two sets of bones, the cranial bones and the facial bones



- The **lambdoid suture** connects the parietal bones to the occipital bone.
- The **occipital bone** forms the rear portion and the base of the skull and forms a movable joint with the first cervical vertebra.
- A large opening at the base of the occipital bone, called the **foramen magnum** (meaning *large hole*), allows the spinal cord to pass from the encephalon into the spine.



### Memory jogger

As a way to remember

the bones of the skull, use your head and think "part of man":

**P**ARietal

**T**emporal

**O**ccipital

**F**rontal

**M**Alar

**N**asal.

### A bat in the belfry

The **sphenoid bone** looks like a bat with outstretched wings and legs extended to the back. Located in the cranial floor, this bone is an anchor for the frontal, parietal, occipital, and ethmoid bones. It also supports part of the eye sockets and forms the lateral walls of the skull. The **sphenoid sinuses** are large air-filled spaces within the sphenoid bone.

### Facial bones

The bones of the face include:

- two **maxillary bones** that form the upper jaw, nose, orbits, and roof of the mouth as well as the **maxillary sinuses**
- the cheekbones, called **zygomatic** or **malar bones**, that attach to chewing muscles
- two **nasal bones** that form the upper part of the bridge of the nose (**cartilage** forms the lower part)
- the **mandible** that forms the lower jaw
- two **lacrymal bones** that contain the lacrymal bag (part of the conduit through which tears drain in the nasal cannula)
- the **vomer** that's part of the nasal septum
- two **palatine bones** that form the posterior portion of the hard palate, lateral side of the nasal cavity, and small part of the orbit.

Joints between the vertebrae allow forward, backward, and sideways movement. Not all at once, though!



## The spinal column

The flexible spinal column contains 24 **vertebrae** (plural of **vertebra**), the **sacrum**, and the **coccyx**. (See *Some thorny words of the spine*.)

Joints between the vertebrae allow forward, backward, and sideways movement. The spinal column supports the head while suspending the ribs and organs in



### *Beyond the dictionary*

#### Some thorny words of the spine

**Spine** comes from the Latin word **spina**, which means *thorn*, and is related to **spike** as well. Latin writers likened the thorn to the prickly bones in animals and fish and, thus, the word also became the designation for the vertebral column.

#### Vertebra and spondylo

Also from Latin, **vertebra** derives from a verb meaning *to turn*. Therefore, it formerly connoted any joint—not just those of the spine. A Greek word, **spondylos**, has the same meaning as **vertebra**. It shows up in words like **spondylitis**, which is an inflammation of the vertebrae.

#### Sacrum and coccyx bringing up the rear

The **sacrum** was formerly known as the **os sacrum**, literally the *holy bone*, so called because it was thought to be a particularly choice bit and so was offered to the gods in sacrifice. The **coccyx** derives its name from the Greek word for the cuckoo, **kokkyx**. The Greek anatomist Galen thought this triangular bone resembled the shape of the bird's bill.

front. It also anchors the pelvic girdle and provides attachment points for many important muscles. The spinal column contains:

- seven **cervical** (neck) vertebrae, which support the skull and rotate
- twelve **thoracic** (chest) vertebrae, which attach to the ribs
- five **lumbar** (lower back) vertebrae, which support the small of the back
- the **sacrum**, a single bone that results from the fusion of five vertebrae and attaches to the pelvic girdle
- the **coccyx**, or tailbone, which is located at the bottom tip of the spinal column and is a single bone formed from the fusion of four or five vertebrae.

The spinal column is curved to increase its strength and make balance possible in an upright position. The vertebrae are cushioned by intervertebral disks composed of cartilage.

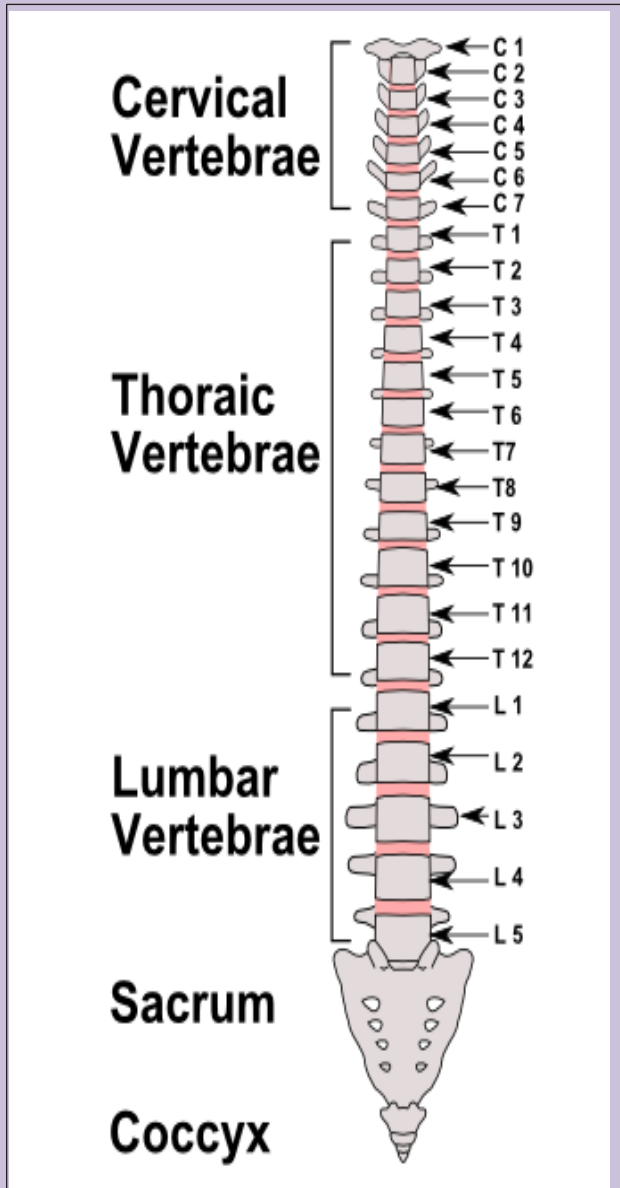




## *Anatomically speaking*

### A look at the spinal column

The 33 vertebrae of the spinal column surround and protect the spinal cord. They're divided into five sections: cervical vertebrae, thoracic vertebrae, lumbar vertebrae, sacrum, and coccyx.



Yep. I have 33 vertebrae----and they're all perfect specimens, if I do say so myself



## Sternum

Located in the center of the chest, the **sternum** is a flat, sword-shaped bone that's attached to the **clavicles** (collar- bones) and the innermost part of the first two pairs of ribs.

## Caged in

The sternum, ribs, and thoracic vertebrae form a protective enclosure around the vital organs. Known as the **thoracic cage**, or **thorax**, this flexible structure protects the heart and lungs and allows the lungs to expand during respiration.

## Ribs

The flat, curved bones attached to the thoracic portion of the spinal column are called **ribs**.

## Ribs—true or false?

The term **costal** refers to ribs. The first seven pairs of ribs are attached to the sternum by **costal cartilage**; they're called **true ribs**. The remaining five pairs of ribs are called **false ribs** because they aren't attached directly to the sternum. All ribs are independently attached to the spinal column.

The ulna and the radius articulate with the humerus to form the elbow joint

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## Appendicular skeleton

The appendicular skeleton includes the upper and lower extremities.

### The upper extremities

The **clavicles**, or collar bones, are two flat bones attached to the sternum on their anterior side and to the **scapulae** (shoulder blades) laterally. This forms the **sternoclavicular joint**.

The scapulae are a pair of large, triangular bones that are located at the back of the thorax. These bones, plus the clavicles, form the shoulder girdles.

## Armed and dangerous

The **humerus**, or upper arm bone, is a long bone with a shaft and two bulbous ends. The two long bones of the lower arm are the **ulna**, located on the little finger side of the humerus, and the **radius**, on the thumb side. These

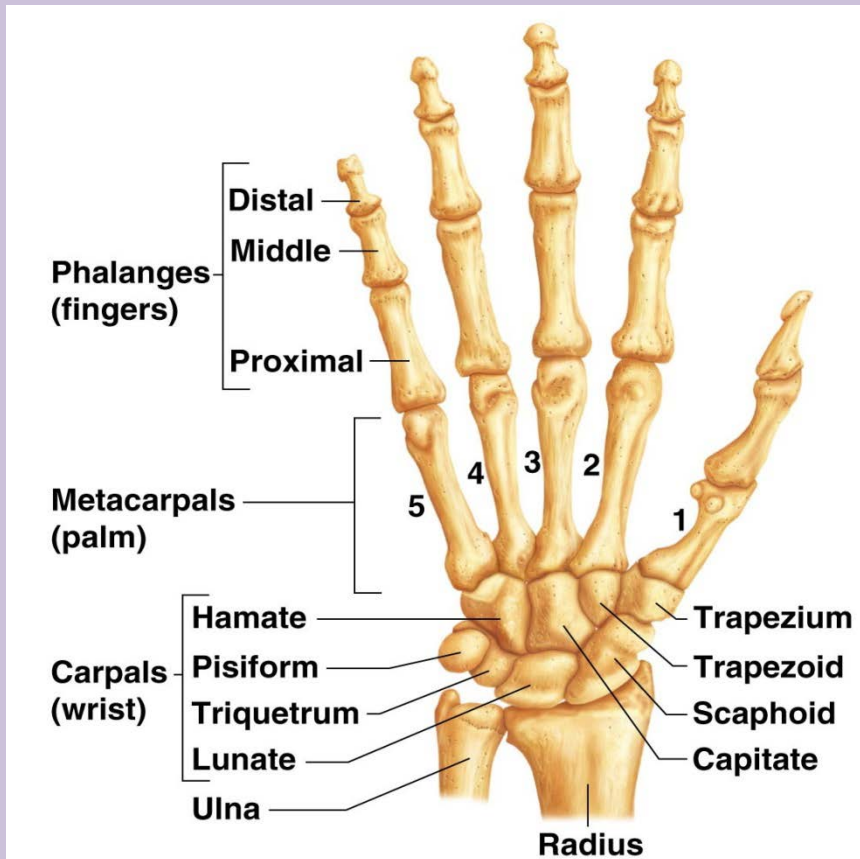




## *Anatomically speaking*

### **Bones of the hand**

A view of the right hand, illustrating the positions of the carpals, metacarpals, and phalanges.



bones articulate with the humerus to form the elbow joint. The **wrists** are composed of eight small, irregular **carpal** bones aligned in two rows. Ligaments bind the carpals together.

## A handful of terms

The bones of the hand are comprised of metacarpal bones and phalanges. (See *Bones of the hand*.)

The way these bones come together enables movement of the hand

- Five small long **metacarpal** bones attach to the carpals and form the palm of the hand.

**Phalanges**, or finger bones, are miniature long bones.

Each finger has three phalanges, while the thumb has two.

- The thumb **metacarpal** has a freely movable joint, allowing a wide range of movement between the thumb metacarpal and the **trapezium**, the carpal at the base of the thumb.

## Lower extremities

The lower extremities contain bones of the hip, thigh, leg, ankle, and foot.

## Girdle words

Three pairs of bones fuse during childhood to form the **pelvic girdle**, the broadest bone in the body. This bone supports the trunk, protects the abdominal organs within its basin, and attaches the lower extremities to the body. The three pairs of fused bones include the **ilium**, which is the largest and uppermost of the three; the **ischium**, the lower and strongest set of bones; and the **pubis**, a pair of anterior bones that meet at the **symphysis pubis**—a cartilaginous joint.

## Give 'em a leg up

The two **femurs**, or upper leg bones, are the longest and heaviest bones in the body. They connect at the proximal end with the hip, articulating with the **acetabulum**, or hip socket. The femurs connect with the **tibia** at the distal end. The kneecap, or **patella**, is a small, flat bone that protects the knee joint and overlaps the distal end of the femur and the proximal end of the tibia.

## Below the knee

The **tibia**, sometimes called the **shinbone**, is the largest and strongest of the lower leg bones. It articulates with the femur at the proximal end and meets the fibula and



## A phalanx of phalanges

**Phalanges** is the plural of the Greek word **phalange**, or **phalanx**. The latter term was applied to Greek and Roman army troop formations, noted for their closely joined and unified maneuvers.

It says here that the word patella, for kneecap, is a Latin word that means a small, flat dish—just what the kneecap looks like

like



the talus at the distal end. The **fibula** connects with the tibia at its proximal and distal ends. The fibula's distal end also articulates with the talus. The articulation of the fibula, tibia, and talus bones creates the bony prominence on the outside of the ankle, called the **lateral malleolus**.

### Now, fleetly, to the foot

The foot bones form a strong, stable arch with lengthwise and crosswise support. Strong ligaments and tendons of the leg muscles help the foot bones maintain their arched position:

- Seven short **tarsal bones** structurally resemble the wrist, and they articulate with the tibia and fibula:
  - The **talus bone (astragalus)** forms part of the ankle joint.
  - The heel, called the **calcaneus**, is the largest tarsal bone.
  - The **scaphoid bone** is also called the **navicular** because of its boat shape.
  - The **cuneiforms** (the **lateral**, **intermediate**, and **medial**) are three wedge-shaped bones that form the arch of the foot.
  - The **cuboid bone** articulates in the front with the metatarsal bones.
- Five **metatarsal bones** form the foot and articulate with the tarsal bone and the phalanges.
- The fourteen **phalanges** (toes) are similar to fingers, with three bones in each toe except the great toe, which, like the thumb, contains only two bones.

## Anatomy of bones

Bones are classified according to their shape:

- **Long bones** are the main bones of the limbs, except the patella, and those of the wrists and ankles.
- **Short bones** are the bones of the wrists and ankles.
- **Flat bones** include the sternum, scapulae, and cranium, among others.
- **Irregular bones** include the vertebrae and hip bones.

### Boning up on bone material

All bones consist of two types of bone material: an outer layer of dense, smooth **compact bone** and an inner layer

Words will never hurt me. But let's keep sticks out of it!



of spongy, **cancellous** (porous) bone. Compact bone is found especially in the shaft of long bones and in the outer layers of short, flat, and irregular bones. Cancellous bone fills the central regions of the epiphysis (the end of a long bone where bone formation takes place) and the inner portions of short, flat, and irregular bones.



### *Beyond the dictionary*

#### **Bone up on *osteo-* and *oss-***

**Osteon**, Greek for *bone*, provides a key word-forming root for medical terms relating to bones, **oste-** or **osteo-**. **Osteoblast** is a compound of **osteo-** and **-blast**; the latter is another common medical root derived from a Greek word that means a *bud* or a *shoot of a developing organism*. An **osteoblast** is thus *a cell that buds forth new bone tissue*. The Greek word **clast**, on the other hand, means *to break or fragment*. Therefore, an **osteoclast** is *a cell that breaks down bone*.

#### **The Romans had a name for it**

Another very common root for forming words is the Latin word **os**, or **oss-**, also meaning *bone*. This root is contained in words like **ossify**, meaning *to change or to become bone*, and **ossification**, *the process of becoming bone*.

As osteoblasts add new tissue to the outside of a bone, large phagocytic cells called **osteoclasts** eat away bony tissue in the medullary cavity to keep the bone from becoming too thick. A healthy bone is constantly broken down, resorbed, and repaired long after it stops growing in size. During adulthood, bone formation (or **ossification**) and bone **resorption** balance one another so that each bone remains a constant size. During childhood and adolescence, ossification is faster than resorption and bones grow larger.

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## **Cartilage**

Bones and joints need support as well as shock absorption. **Cartilage** is a dense connective tissue that has these capabilities. It consists of fibers embedded in a strong, gel-like substance. Unlike rigid bone, cartilage has the flexibility of firm plastic.

Cartilage supports and shapes various structures, such as the auditory canal and the intervertebral disks. It also cushions and absorbs shock. Cartilage has no blood or nerve supply.

## Types of cartilage

Cartilage may be fibrous, hyaline, or elastic:

- **Fibrous cartilage** forms at the meniscus and the inter-vertebral disks.
- **Hyaline cartilage** covers articular bone surfaces (where one or more bones meet at a joint), connects the ribs and sternum, and appears in the trachea, bronchi, and nasal septum.
- **Elastic cartilage** is located in the auditory canal, external ear, and epiglottis.

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## Bone movement

Bones are rigid structures that can't bend without being damaged, so individual bones move at joint sites, or **Articulations**. Every bone in the body except the hyoid bone, which anchors the tongue, is connected to another bone by flexible connective tissue.

## How does it move?

### Classifying joints

Joints can be classified by the type of movement they allow and by their structure.

The three classes of joints identified by the range of movement they allow are:

- **synarthrosis**—immovable
- **amphiarthrosis**—slightly movable
- **diarthrosis**—freely movable.

## What is it made of?

By structure, a joint may be classified as fibrous, cartilaginous, or synovial. In **fibrous joints**, the articular surfaces of the two bones are bound closely by fibrous connective tissue and little movement is possible. The cranial sutures are examples of fibrous joints.

In **cartilaginous joints**, cartilage connects one bone to another; these joints allow slight movement. An example is the symphysis pubis (the junction of the pelvic bones).

Body surfaces in the **synovial joints** are covered by articular cartilage and joined by **ligaments** (dense, strong, flexible bands of fibrous connective tissue that bind bones to other bones) lined with synovial membrane. Freely movable, synovial joints include most joints of the arms and legs. Synovial joints also include an **articular capsule**—a sac-like envelope, whose outer layer

Our joints are jumpin'! It must be that diarthrosis

