Bones make up the skeletal system of the human body. The adult human has two hundred and six bones. There are several types of bones that are grouped together due to their general features, such as shape, placement and additional properties. They are usually classified into five types of bones that include the flat, long, short, irregular, and sesamoid bones.
The human bones have a number of important functions in the body. Most importantly, they are responsible for somatic rigidity, structural outline, erect posture and movement (e.g. bipedal gait). Due to their rigidity, bones are the main 'protectors' of the internal organs and other structures found in the body.
A bone is a somatic structure that is composed of calcified connective tissue. Ground substance and collagen fibers create a matrix that contains osteocytes. These cells are the most common cell found in mature bone and responsible for maintaining bone growth and density. Within the bone matrix both calcium and phosphate are abundantly stored, strengthening and densifying the structure.

Bones are composed of two typesTrusted Source of tissue.

Compact (cortical) bone is a hard outer layer that is dense, strong, and durable. It makes up around 80% of adult bone mass and forms the outer layer of bone.

Cancellous (trabecular or spongy) bone makes up the remaining 20% of bone and consists of a network of trabeculae, or rod-like, structures. It is lighter, less dense, and more flexible than compact bone.

Bones also contain:

- osteoblasts and osteocytes, responsible for creating bone
- osteoclasts, or bone-resorbing cells
- osteoid, a mix of collagen and other proteins
- inorganic mineral salts within the matrix
- nerves and blood vessels
- bone marrow
- cartilage
- membranes, including the endosteum and periosteum

Bone cells

Bones are not static tissue but need constant maintenance and remodeling. There are threeTrusted Source main cell types involved in this process.

- Osteoblasts are responsible for generating and repairing bone. They produce a protein mixture that doctors call osteoid, which is mineralized and becomes bone.
- Osteocytes are inactive osteoblasts that are mineralized and remain within the bone they have created. They communicate with other bone cells and help support metabolic functions within the bone.
- Osteoclasts are large cells with more than one nucleus. They useTrusted Source acids resulting from certain reactions to break down used bone. This process is called resorption. Osteoclasts help remodel injured bones and create pathways for nerves and blood vessels to travel through.

Bone marrow

Bone marrow is present in almost all bones where cancellous, or spongy, bone is present.

Bone marrow produces blood cells, including:

- red blood cells, which deliver oxygen to cells
- white blood cells, essential for the body's immune system
- platelets, which the body uses for clotting

The marrow produces around 2 million red blood cells every second. It also produces lymphocytes, or the white blood cells involved in the immune response.

Extracellular matrix

Bones are essentially living cells embedded in a mineral-based organic matrix. This extracellular matrix consists of organic components (mostly type 1 collagen) and inorganic components, including hydroxyapatite and other salts, such as calcium and phosphate.

Collagen gives bone its tensile strength, namely resistance to pulling apart. Hydroxyapatite gives the bones compressive strength, or resistance to compression.

Bone Structure and Morphology

The bone is made up of varied composition, that is about 30% flexible matrix and 70% bound minerals that are embedded with specialised bone cells. This unique constitution of the bone allows it to be strong and hard while being lightweight. The bone matrix is composed of collagen (90-95%) and ground substances. The collagen fibres provide elasticity and resistance to the structure. The matrix also contains calcium phosphate that hardens the bone structure.

The bones have an external layer called the cortex. It is a hard exterior that gives the white and smooth appearance to the bones. It forms around 80% of the total mass of the human skeleton. The cortical surface of the bone is covered by the periosteum on the outside and by endosteum on the inside. The interior of the bone is filled with a spongy tissue that is referred to as cancellous bone or trabeculae. It is an open porous network of intersecting plates and spicules that gives it a higher surface area to volume ratio. It is a vascular tissue that often contains red bone marrow and is responsible for hematopoiesis.

Bone marrow or myeloid tissue is found in the cancellous tissue in newborns that produces red blood cells. As the child grows, the red bone marrow is converted to adipose tissue, that is a fatty substance.

Cells of the Bone

The bone consists of four types of cells which have different functions. Let us look at them briefly.

Osteoblasts

Osteoblasts are large cuboidal cells that form about 4-6% of the total bone cells. These cells synthesise and mineralise bone during bone synthesis and remodelling. They form a closely packed sheet-like surface on the bone. They are formed by the differentiation of osteogenic cells. It produces many cellular products such as alkaline phosphatase, growth factors, collagenase and collagen fibres.

The osteoblasts get surrounded by the bone matrix and cellular products and are then referred to as osteocytes.

Osteocyte

Osteocytes are oblate shaped cells that are derived from osteogenic cells or osteoblasts. They constitute almost 95% of the total bone cells. They are located in small spaces in the bone matrix called lacunae. The cytoplasmic processes of the osteocytes extend towards other osteocytes in small channels called canaliculi. Through these channels, the nutrients and waste products are exchanged that helps in maintaining the viability of osteocytes.

They are the most abundant and long living cells of the bone. They also take part in bone deposition, resorption and remodelling.

Osteoclast

Osteoclasts are large multinucleated cells that break down bone tissues. Bones are dynamic tissues that undergo constant remodelling to put up with the stress and requirements of our body. Osteoclasts are phagocytic cells that are derived from the macrophage-monocyte cell lineage.

The major function of these cells is bone resorption. Bone resorption is the process of breaking down of bone tissues by the osteoclasts to release minerals such as calcium into blood circulation.

Osteoclasts achieve the destruction of bone tissues by secreting certain enzymes such as acid phosphatase. This enzyme is capable of digesting collagen as well as calcium and phosphorus. The bone tissues are first broken down into fragments that are later engulfed by the osteoclasts and digested within the cytoplasmic vacuoles. The minerals released from the digestion are released into the bloodstream.

Osteogenic Cells

Osteogenic cells or osteoprogenitor cells are stem cells present in the bone. These are precursor cells that give rise to specialised cells, viz., osteocytes and osteoblasts. These cells reside in the bone marrow.

Osteogenic cells are proliferative cells that are derived from the mesenchymal stem cells. Morphologically, they appear like a flattened, spindle-shaped cell.

What do bones do?

Bones serve various functions that affect the whole body. StudiesTrusted Source show that, in addition to structure and movement, bones support energy metabolism, the production of blood cells, the immune system, and brain function.

Mechanics

Bones provide a frame to support the body. Muscles, tendons, and ligaments attach to bones. Without anchoring to bones, muscles could not move the body.

Protection

Some bones protect the body’s internal organs. For instance, the skull protects the brain, and the ribs protect the heart and lungs.

Synthesis

Cancellous bone is a vital reservoir for developing red blood cells, platelets, and white blood cells. Also, the body destroys defective and old red blood cells in bone marrow.

Metabolism

The metabolic functions of bone are

- **Storage:** Bones act as a reserve for minerals, particularly calcium and phosphorous. Bone marrow adipose tissue can also store fatty acids.
- **Endocrine function:** Bones produce the precursors to various hormones, including those involved in growth, insulin production, and brain development. They release hormones that act on the kidneys and influence blood sugar regulation and fat deposition.
- **Calcium balance:** Bones can raise or reduce calcium in the blood by forming bone, or breaking it down in a process called resorption.
- **pH balance:** Some researchTrusted Source has suggested bones can release or absorb alkaline salts, helping blood to stay at the right pH level, but scientists need more studies to confirm this.
- **Detoxification:** Bones can absorbTrusted Source heavy metals such as lead, mercury, and arsenic from the blood.

Each bone is connected with one or more bones and are united via a joint (only exception: hyoid bone). With the attached tendons and musculature, the skeleton acts as a lever that drives the force of movement. The inner core of bones (medulla) contains either red bone marrow (primary site of hematopoiesis) or is filled with yellow bone marrow filled with adipose tissue.
The main outcomes of bone development (e.g. skull bones development) are endochondral and membranous forms. This particular characteristic along with the general shape of the bone are used to classify the skeletal system. The bones are mainly classified into five types that include:

- Long bones
- Short bones
- Flat bones
- Sesamoid bones

- Irregular bones

Types of bones

Long bones

These are mostly compacted bones with little marrow and include most of the bones in the limbs. They tend to support weight and help movement. These bones develop via endochondral ossification, a process in which the hyaline cartilage plate is slowly replaced. A shaft, or diaphysis, connects the two ends known as the epiphyses (plural for epiphysis). The marrow cavity is enclosed by the diaphysis which is thick, compact bone. The epiphysis is mainly spongy bone and is covered by a thin layer of compact bone; the articular ends participate in the joints.

The metaphysis is situated on the border of the diaphysis and the epiphysis at the neck of the bone and is the place of growth during development. Long bones are bones that are longer than they are wide. The mid section of the long bone is called diaphysis that is predominantly made up of cortical bone and also contains bone marrow and adipose tissue. The diaphysis flares and forms an internal cancellous structure called metaphysis. The epiphysis is the rounded end of the long bones (on both sides) that has an internal cancellous structure.

Examples of the long bones in humans include the femur, tibia, and fibula of the legs; humerus, radius and ulna of the arms; clavicle (collar bone), metatarsals and metacarpals of the feet and hand respectively.

Some examples of this type of bones include:

- The humerus
- The fibula
- The tibia
- The metacarpal bones
- The phalanges
- The radius and ulna.

Short bones

The short bones are usually as long as they are wide. They are usually found in the carpus of the hand and tarsus of the foot. These have a squat, cubed shape and include bones of the wrist and ankle.

In the short bones, a thin external layer of compact bone covers vast spongy bone and marrow, making a shape that is more or less cuboid. Short bones are the ones that are as long as they are wide. They are cube shaped bones that have a thin cortical layer and

a thick spongy interior. They provide stability and support to our body. Examples of short bones include tarsals and carpals in the foot and hand, respectively.

The main function of the short bones is to provide stability and some degree of movement. Some examples of these bones are:

- The scaphoid bone
- The lunate bone
- The calcaneus
- The talus
- The navicular bone

Flat bones

These have a flat, broad surface. They consist of two outer layers of compact bone and an inner layer of spongy bone. The bones of the skull, breastbone, ribs, and shoulder blades are flat bones. They tend to have a protective role. In flat bones, the two layers of compact bone cover both spongy bone and bone marrow space. They grow by replacing connective tissue. Fibrocartilage covers their articular surfaces. Flat bones are thin and curved bones that are composed of spongy cancellous tissue sandwiched between two thin layers of cortical bone. The main function of flat bones is to provide a broader surface area for the attachment of muscles. They usually form broad, flat plates as in the sternum, cranium (skull), rib cage and ilium (pelvis). This group includes the following bones:

- The skull bones
- The ribs
- The sternum
- The scapulae

The prime function of flat bones is to protect internal organs such as the brain, heart, and pelvic organs. Also, due to their flat shape, these bones provide large areas for muscle attachments.

Irregular bones

Due to their variable and irregular shape and structure, the irregular bones do not fit into any other category. In irregular bones, the thin layer of compact bone covers a mass of mostly spongy bone.

The complex shape of these bones help them to protect internal structures. For example, the irregular pelvic bones protect the contents of the pelvis. Irregular bones, as the name suggests, do not fit into any of the bone types and form peculiar bony shapes in the human endoskeleton. They are composed of cancellous tissue that is enclosed between a thin layer of cortical bone. Examples of the irregular bones include hyoid, sacrum, coccyx, maxilla, mandible, etc.

Some examples of these types of bones include:

- The bones of the spine (i.e. vertebrae)
- The bones of the pelvis (ilium, ischium and pubis)

Sesamoid bones

Sesamoid bones are embedded within tendons. These bones are usually small and oval-shaped. These are embeddedTrusted Source in muscles and tendons near the surfaces of joints. They include the patella or kneecap. They protect tendons from wear and stress.

The sesamoid bones are found at the end of long bones in the upper and lower limbs, where the tendons cross.

Some examples of the sesamoid bones are the patella bone in the knee or the pisiform bone of the carpus.

The main function of the sesamoid bone is to protect the tendons from excess stress and wear by reducing friction.

- **Irregular bones:** These bones do not fit into the first four categories and have an unusual shape. They include the bones of the spine and pelvis. They often protect organs or tissues.

- The bones of the skeleton belong to two groups: The appendicular and axial skeletons.
- The appendicular skeleton comprises 126Trusted Source bones, including those of the limbs, shoulders, and pelvic girdle. It provides structure and support to other parts of the body.
- The axial skeleton has less range of motion than the appendicular skeleton. It comprises the bones of the skull, vertebral column, and thoracic cage.

Bone remodeling

The body is always remodeling bone. This allows the body to fix damaged bone, reshape the skeleton during growth, and regulate calcium levels.

Remodeling is a two-part process. During formation, the body lays down new bone tissue. In resorption, osteoclasts break down and remove bone.

If one part of the skeleton comes under increased stress over time — for instance, during exercise — the sections of bone under most pressure will become thicker in response.

Osteocytes, osteoclasts, and osteoblasts play key rolesTrusted Source, but other elements also contribute. These include parathyroid hormone, vitamin D, estrogen, and testosterone.

What is osteoporosis?

Osteoporosis is a bone disease that involves a reductionTrusted Source in bone mineral density. This increases the risk of fractures.

It most commonly occurs in females after menopause. However, it can affect males too, and it can start before menopause.

Osteoporosis occurs either when removal or resorption of bone happens too quickly, new bone forms too slowly, or for both reasons.

Risk factors include:

- low calcium levels
- vitamin D deficiency
- smoking tobacco
- using corticosteroids
- a high alcohol intake

Functions of bone

The bones mainly provide structural stability to the human body. Due to the development of the complex bony structures (e.g. spine) the humans are able to maintain erect posture, to walk on two feet (bipedal gait) and for all sorts of other activities not seen in animals.

Due to their rigid structure, bones are key in the protection of internal organs and other internal structures. Some bones protect other structures by reducing stress and friction (e.g. sesamoid bones) while some bones join together to form more complex structures to surround vital organs and protect them (e.g. skull, thoracic cage, pelvis).

Bones also harbor bone marrow which is crucial in production of blood cells in adults. In addition, the bone tissue can act as a storage for blood cells and minerals.