- Skeleton

SCIENCE

YOUR SKELETON EXPLAINED

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It gives you shape, holds you together and encases vital organs, but this living structure is so much more than a coat hanger for your body

Skeletons are often associated with death as part of the body you rarely see during life. However, you might be surprised to learn that the skeleton is living tissue. Far more than stiff, biological scaffolding, the skeleton comes with its own network of blood vessels, cells, proteins and minerals, continuously transforming and self-repairing to keep your body strong and healthy. The bones that make up your skeleton connect to form shields around delicate organs. The skull seals up when a baby is three months old and its joints close to complete the brain's armour. Meanwhile, the ribs cross over the heart and lungs like the bars of a cage and a string of vertebrae conceal your spinal cord. Bones also give the body structure. But the skeleton would fall limply into a pile of bones without the assistance of the rest of the skeletal system.

> "The bones that make up your skeleton connect to form shields around delicate organs"

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DID YOU KNOW? You are born without kneecaps. These bones form from cartilage at age two to five

Muscles, cartilage, ligaments, tendons and joints connect to the skeleton to protect the bones and enable the skeleton to move. Muscles are attached to the skeleton by tendons and serve as the puppeteers of bones, contracting and relaxing to manipulate joints, while ligaments join the bones together and cartilage tissue forms the padding between them. The body can dance, stretch, crouch, grab, poke and jump. All the actions you can perform are a result of 360 joints being perfectly positioned. But not all the skeleton's joints are the same. Some are ball-and-socket joints, found at the shoulder and hip, which allow backward, forward and rotating movements. Others are hinges in the fingers, knees, elbows and toes – limited to bending and straightening. The neck is a pivot joint and can perform limited rotations, and wrist joints are called ellipsoidal joints. Ellipsoidal joints give you flexibility to move in any direction except pivotal movements – for example, your wrist can't rotate independently of your forearm bones. When combined, this intricate collection of bones and joint structures grants you the ability to interact with the world.



DEM BONES

How a connected collection of bones works together to hold up your body

1 SKULL
Adults have 22 skull bones, which fuse together and harden to encase the brain.

2 CERVICAL SPINE
Seven vertebrae at the top of the spine support the weight of your head.

3 STERNUM
A flat, 15-centimetre T-shaped bone serves as a central connection point for the ribs.

4 RIBS
The human body has 12 pairs of ribs. Pairs one to seven are called true ribs – they're the only ones directly connecting the spine to the sternum.

5 LUMBAR VERTEBRAE
Five bones at the bottom of the spine support most of your body weight. These are the largest and thickest bones in the spine.

6 PELVIS
A woman's pelvis is about 25 per cent wider than a man's.

7 SACRUM
This singular triangular bone is formed when five separate vertebrae fuse together to stabilise the pelvis, typically before age 25.

8 FEMUR
Growing to an average length of around 46 centimetres, this is the longest, heaviest and strongest bone, which can support 30 times your body weight.

9 PATELLA
The kneecap is a shield for knee joints. Tendons, ligaments and muscles attach to move the knee.

10 FOOT
With 52 bones, a quarter of your total adult bone count is in your feet.

11 CLAVICLE
These long, curved collar bones connect your arms to your central body. They rotate when arms are lifted and are the most fracture-prone.

12 HUMERUS
This is the only bone in the upper arm, holding 13 muscles in place.

13 ULNA AND RADIUS
These two bones make up the forearm and assist with wrist and elbow movements. The ulna is slightly longer.

14 HAND
There are 27 bones in the hand, 14 of which are in the fingers.

15 FIBULA AND TIBIA
The tibia is a thicker, more weight-bearing bone in your shin, while the fibula is positioned on the outside to stabilise the ankle.

Did you know?
Joints in the skull don't move

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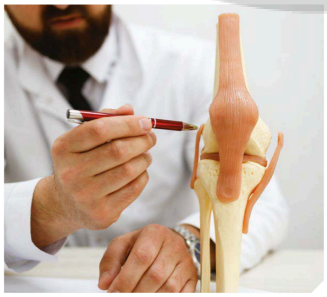
CUSHIONING CARTILAGE

Between the bones of the skeleton is a flexible type of connective tissue called cartilage. This serves as a shock-absorbing layer for the bones, reducing the impact of skeletal movement on the joints. Cartilage can also form much of entire organs, such as the ear. The cartilage found between the bones of the skeleton is called articular cartilage. Around 80 per cent of articular cartilage is made of water, which makes it highly elastic and flexible. The tissue is smooth and reduces the friction caused by two bones moving against each other. As a person ages, they begin to lose some of their cartilage as it dries out, which makes it more easily damaged. In old age, it's also more difficult for the body to repair and replace damaged cartilage tissue. When the skeleton loses cartilage, the body becomes stiffer, more difficult to move and joint pain increases.



This model of a knee joint shows the protective cartilage surrounding bones

MAKING MOVEMENTS

How a coordinated system of muscles, tendons and ligaments creates movement in the skeleton

7 MUSCLES
Muscle tissue contracts to generate force. They are attached to bones via tendons. As they shorten, they pull tendons that move the connected bone.

5 CALCANEAL TENDON
Also called the Achilles tendon, this tissue connects the calf muscle to the heel bone so you can stand on your tiptoes.

1 EXTENSOR DIGITORUM LONGUS TENDONS
These fibrous tissues connect muscle to the bones to extend toes and lift the foot upwards.

3 FIBULARIS TERTIUS TENDON
The tendon lifts the outer foot bone upwards when the fibularis tertius muscle contracts. This balances the foot when walking.

2 COLLATERAL LIGAMENTS
Ligaments connect tendons to bones. These ligaments stabilise the toe joints to keep them straight and prevent excessive movement.

"Muscles, cartilage, ligaments, tendons and joints protect the bones and enable the skeleton to move"

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DID YOU KNOW? The stapes is found in middle ear and is the human body's smallest and lightest bone



RED AND YELLOW BONE MARROW

There are two types of bone marrow. Red bone marrow is the type responsible for producing red blood cells, white blood cells and platelets – cell fragments in blood that help it clot. Red blood cells carry oxygen around the body's organs, while white blood cells make up our immune systems to kill infections and maintain health. Red bone marrow is constantly producing new cells to replace older ones as they die. Meanwhile, yellow bone marrow stores fat in the bones, which the skeleton uses for energy. Like red bone marrow, yellow bone marrow can produce red blood cells, but it only does this in emergency situations of extreme blood loss. To do so, the yellow bone marrow converts itself into red bone marrow. A person is born solely with red bone marrow. Around age seven, half of it is exchanged for yellow bone marrow.

6 INFERIOR EXTENSOR RETINACULUM
This connective tissue keeps the extensor muscles and tendons in place.

4 INFERIOR FIBULAR RETINACULUM
This is connective tissue that secures tendons to stop them moving out of place.

Did you know?
60 to 70 per cent of white blood cells are made by red bone marrow

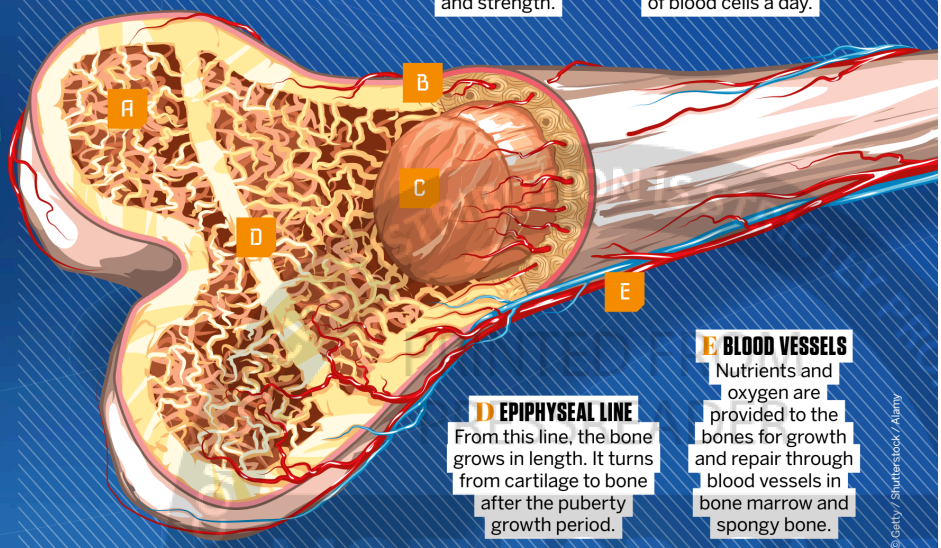
WHAT'S IN YOUR BONES?

Spongy tissue inside the skeleton produces blood cells and stores nutrients

A SPONGY BONE
20 per cent of the skeleton is spongy bone, with a lattice structure of irregular cavities. This provides structural support while remaining lightweight.

B COMPACT BONE
The outer layer of the skeleton is hard and dense, giving bones protection and strength.

C BONE MARROW
This soft, fatty tissue forms at the centre of bones and contains stem cells. These cells produce billions of blood cells a day.



D EPIPHYSEAL LINE
From this line, the bone grows in length. It turns from cartilage to bone after the puberty growth period.

E BLOOD VESSELS
Nutrients and oxygen are provided to the bones for growth and repair through blood vessels in bone marrow and spongy bone.

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MAINTAINING SKELETAL HEALTH

As you grow, and throughout adulthood, your lifestyle habits impact the health of your bones. Some of the vitamins and minerals required by your skeleton include vitamin D and calcium, which you can source from the foods you eat. Adults need to consume 700 micrograms of calcium a day to maintain optimal bone health, as calcium phosphate is used to harden and strengthen bones. Calcium can be sourced from foods such as milk, cheese, green leafy vegetables, tofu and soya beans. Vitamin D helps the body absorb calcium, and adults need ten micrograms of this. This can be obtained through selected foods, such as oily fish, egg yolks and fortified foods, but much of this vitamin is absorbed by being in the Sun. Vitamin D is made from cholesterol in the skin. As ultraviolet rays penetrate the skin, they interact with cholesterol to produce the vitamin.

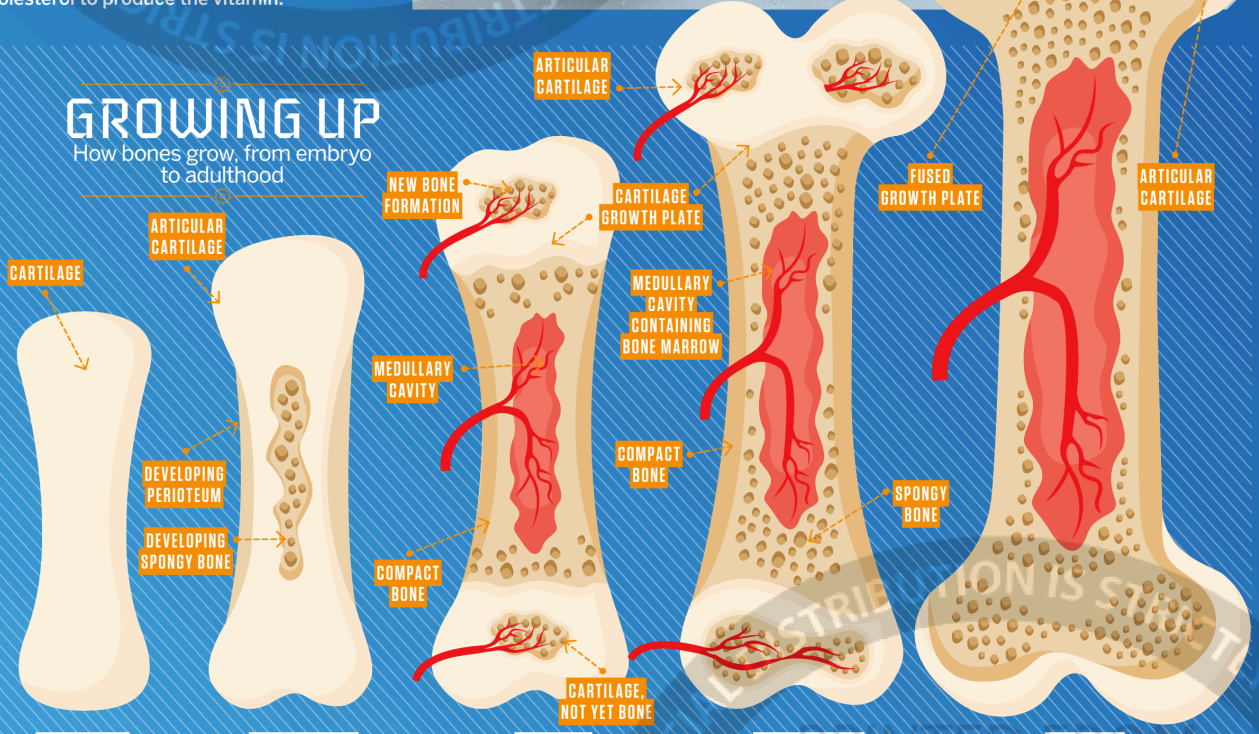
"Adults need to consume 700 micrograms of calcium a day"



Your body can't make its own calcium, so high-calcium food sources are essential

GROWING UP

How bones grow, from embryo to adulthood



1 EMBRYO
Bones begin as cartilage. While in the womb, some of this cartilage gradually gets replaced by bone in a process called endochondral ossification.

2 NEWBORN
A newborn baby has softer, more flexible bones than children and adults, as most of their structure is still cartilage. Spongy bone begins to develop at the centre.

3 CHILD
The growth plates, where new bone tissue is generated, are active during childhood as bones grow rapidly. Bone marrow accumulates at the centre of bones.

4 TEENAGER
Bone density increases drastically, triggered by hormonal changes during puberty. Towards the end of puberty, growth plates become inactive. Bone marrow is fully developed.

5 ADULT
The bones don't need to grow anymore, so they are fully matured and hardened. Bone density reaches its peak in early adulthood.

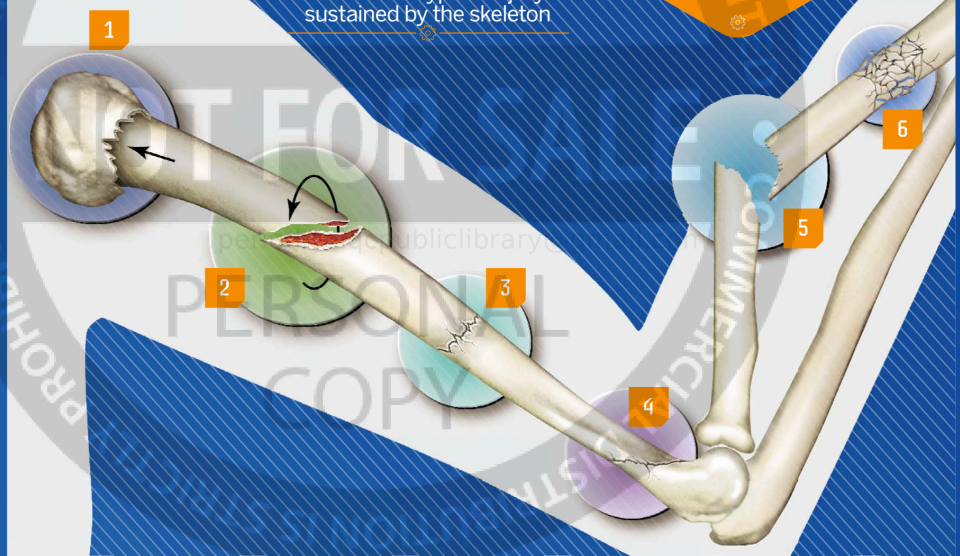
NOT FOR SALE

DID YOU KNOW? The only bone not connected to another is the hyoid at the base of your tongue

BONE BREAKS

How different types of impacts dictate the type of injury sustained by the skeleton

Did you know?
Around 50 per cent of adult bone breaks are in the arm



1 IMPACTED
An impacted fracture is caused when two ends of a broken bone are forced into each other. It is common in children under 12, often from incidents such as falling forcefully.

2 SPIRAL
If a bone is twisted forcefully, it can break in a spiral pattern. This can occur in sporting incidents that cause a limb to rotate at the centre of a bone.

3 TRANSVERSE
This is a horizontal break, perpendicular to the bone's length. It is caused when two forces are applied in opposing directions.

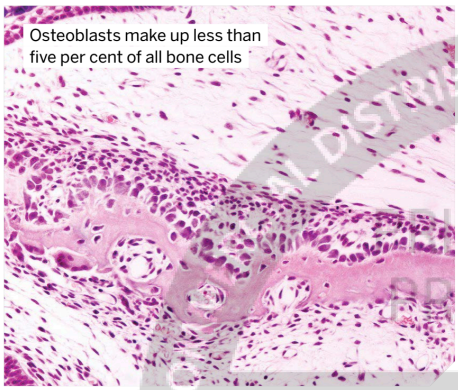
4 OBLIQUE
Oblique fractures form at an angle and can arise when the bone is suddenly impacted by an object at an angle, such as during a car accident.

5 COMPLETE
Complete breaks can be at any angle. To be complete, the bone has to be fully divided in two. The pieces need to be realigned to heal, as they are no longer in contact.

6 COMMINUTED
A comminuted fracture produces three or more bone fragments. This is caused by high-impact collisions and can cause bones to shatter.

HORMONAL REGULATION

As well as providing a sturdy frame for your body tissue and maintaining your circulatory and immune systems, the skeleton plays a part in controlling some chemical messengers called hormones. One of the hormones produced by bone-forming cells called osteoblasts is osteocalcin. This hormone helps the body regulate your energy, metabolism and fat storage. Other cells in the bone called osteocytes are mature bone cells which release the fibroblast growth factor-23 (FGF23) hormone. FGF23 regulates the levels of the mineral phosphate in the blood.


Osteoblasts make up less than five per cent of all bone cells

5 FACTS SKELETAL CONDITIONS

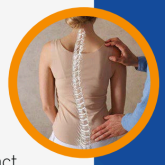
1 OSTEOPOROSIS
This condition is caused by a reduction in bone mass and density, often in correlation with old age. It makes the skeleton more injury-prone.



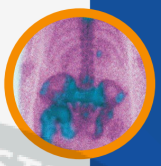
2 ARTHRITIS
Arthritis is the inflammation of the joints, causing painful swelling and stiffness. It can develop over time as joints wear down or can be an autoimmune disorder called rheumatoid arthritis.



3 SCOLIOSIS
Sometimes, the spine grows in a more curved shape than usual. Scoliosis can cause back pain and sometimes impact breathing as the spine protrudes forwards, limiting chest space.



4 PAGET'S DISEASE OF BONE
This chronic disorder results in bones being larger than normal. This structure makes them weaker and more fracture-prone.



5 RICKETS
Usually caused by vitamin D, calcium or phosphate deficiency, the symptoms of rickets are soft, weak and painful bones. It primarily affects children, delaying their growth and causing misshapen bones.



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