The skeletal system

Level 2 Anatomy and physiology
for exercise and fitness instructors

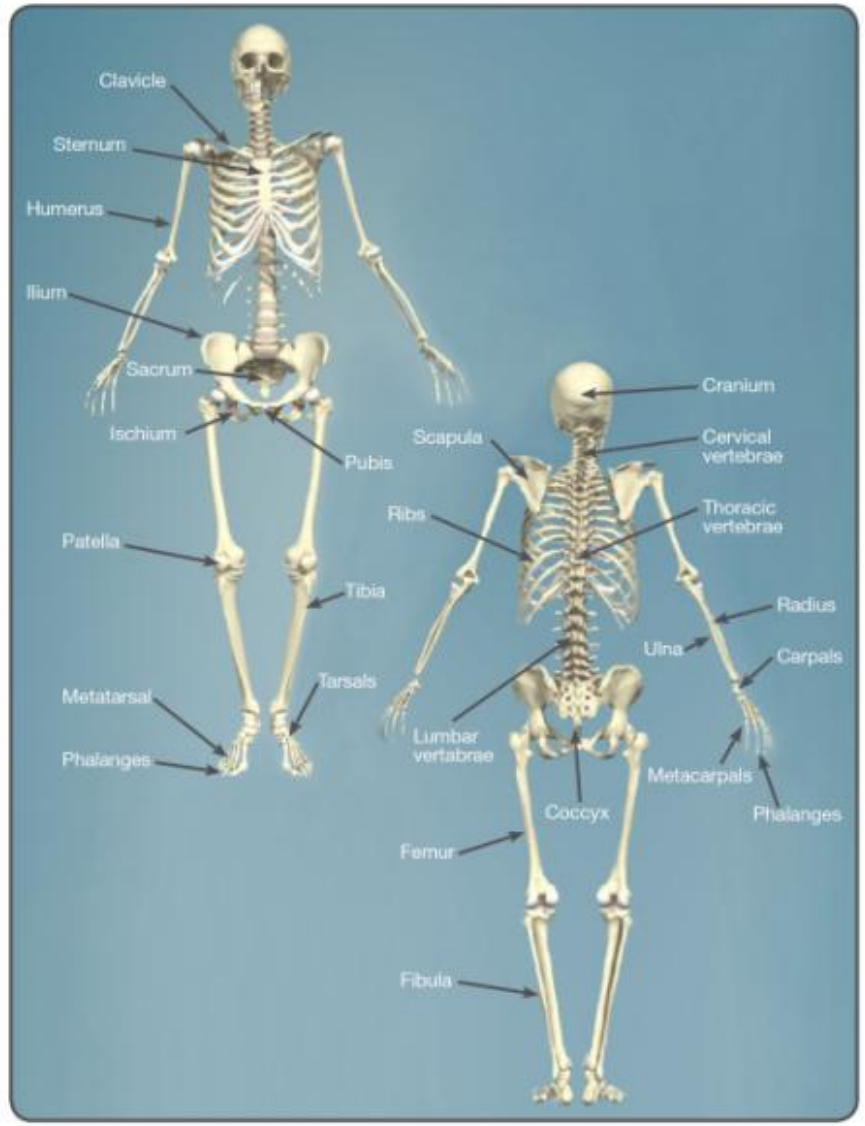
Learning outcomes

By the end of this session you will be able to:

- Describe the basic functions of the skeleton
- Identify the structures of the axial and appendicular skeleton
- Explain the classification of bones
- Explain the structure of a long bone
- Explain the stages of bone growth
- Describe posture in terms of curves of the spine

The skeletal system

- 206 bones
- Bones are attached to other bones by ligaments
- Bones are attached to muscles by tendons
- Cartilage covers the end of bones at a joint and allows friction free movement


Clavicle
Sternum
Humerus
Ilium
Sacrum
Ischium
Pubis
Patella
Tibia
Tarsals
Metatarsal
Phalanges
Cranium
Scapula
Cervical vertebrae
Ribs
Thoracic vertebrae
Radius
Ulna
Carpals
Lumbar vertabrae
Metacarpals
Phalanges
Coccyx
Femur
Fibula

Functions of the skeleton

Muscle attachment and movement
Long bones act as levers. Muscles attach to these bones and pull on them to create movement

Storage of minerals
Minerals such as calcium and phosphate ions are stored in the bones

Protection
Protects vital organs and delicate structures

Functions of the skeleton

Shape
Gives the body its characteristic shape and provides a framework for support

Production
The marrow cavity of some bones, such as the sternum, is a site of production for red and white blood cells

Axial skeleton

Appendicular skeleton

Axial skeleton

- 80 bones
- Lies on the long axis or midline of the body
- Provides protection

- Cranium
- Sternum
- Ribs
- Cervical vertebrae
- Thoracic vertebrae
- Lumbar vertebrae
- Sacral vertebrae
- Coccyx

Appendicular skeleton

- 126 bones
- Provides movement

- Scapula
- Clavicle
- Humerus
- Ulna
- Radius
- Carpals
- Metacarpals
- Phalanges

- Ilium
- Ischium
- Pubis
- femur
- Patella
- Tibia
- Fibula
- Tarsals
- Metatarsals

Bones classified by shape

Long bones - movement

In the limbs. Length greater than breadth

Tubular shaft and usually an epiphysis at each end covered by hyaline cartilage

Short bones – movement/strength

Primarily in the hand and foot. Roughly cuboid in shape

Irregular bones - protection

A thin shell of compact bone and an interior of cancellous bone

Flat bones – muscle attachment

Thin layers of compact bone separated by a layer of cancellous bone

Sesamoid bones – small bones embedded within a tendon

Examples

Long bones - Femur, tibia, fibula, humerus

Short bones - Tarsals and the carpals

Irregular bones - Vertebrae and some facial bones

Flat bones - Cranium, ilium, sternum, rib cage

Sesamoid bones- Patella (knee cap)

Structure of a long bone

Compact bone forms the main shaft of the bone

Spongy bone (cancellous bone) is found at the ends of the bone

Red marrow produces red and white blood cells is found within the cavity of the bone shaft

Structure of a long bone

Epiphysis – the ends of the bone, made of cancellous bone which is spongy tissue designed to withstand compression forces

Diaphysis – shaft of the bone, made of compact bone which is dense and very strong

Periosteum – a hard, protective fibrous sheath around the bone (not the ends). It contains a rich supply of blood vessels that brings nutrients for bone cells and takes away waste matter

Epiphyseal plates (growth plates) – separate the shaft from the ends of the bone. Areas of growing tissue in children and adolescents and the weakest areas of a growing skeleton and vulnerable to damage. When growth is complete, the growth plates close and are replaced with solid bone

Medullary cavity (middle of the bone) – contains red and yellow bone marrow (production of red and white blood cells and platelets)

Hyaline/articular cartilage – covers the top of each epiphysis. It is tough, smooth and helps to reduce friction between the bones, as well as providing shock absorption for the joint

Capillaries – supply blood to all parts of the bone

Bone growth

Bones are living and need a good blood supply in order to bring nutrients and oxygen, and to get rid of waste products

The bone also needs nerves to send information to the brain about pain or damage caused to a bone

Bones at birth are mainly cartilage. As the skeleton matures calcium and magnesium are deposited within the cartilage by osteoblasts (bone building cells)

Bone growth

The process of bone growth is called **ossification**

Ossification is complete by the age of about 25 years

The cartilage gives the bones their resilience and calcium gives them their hardness

Bone growth – birth to 25 years (approx)

Long bones continue to grow until about 18 years but keep maturing until 25-30 years

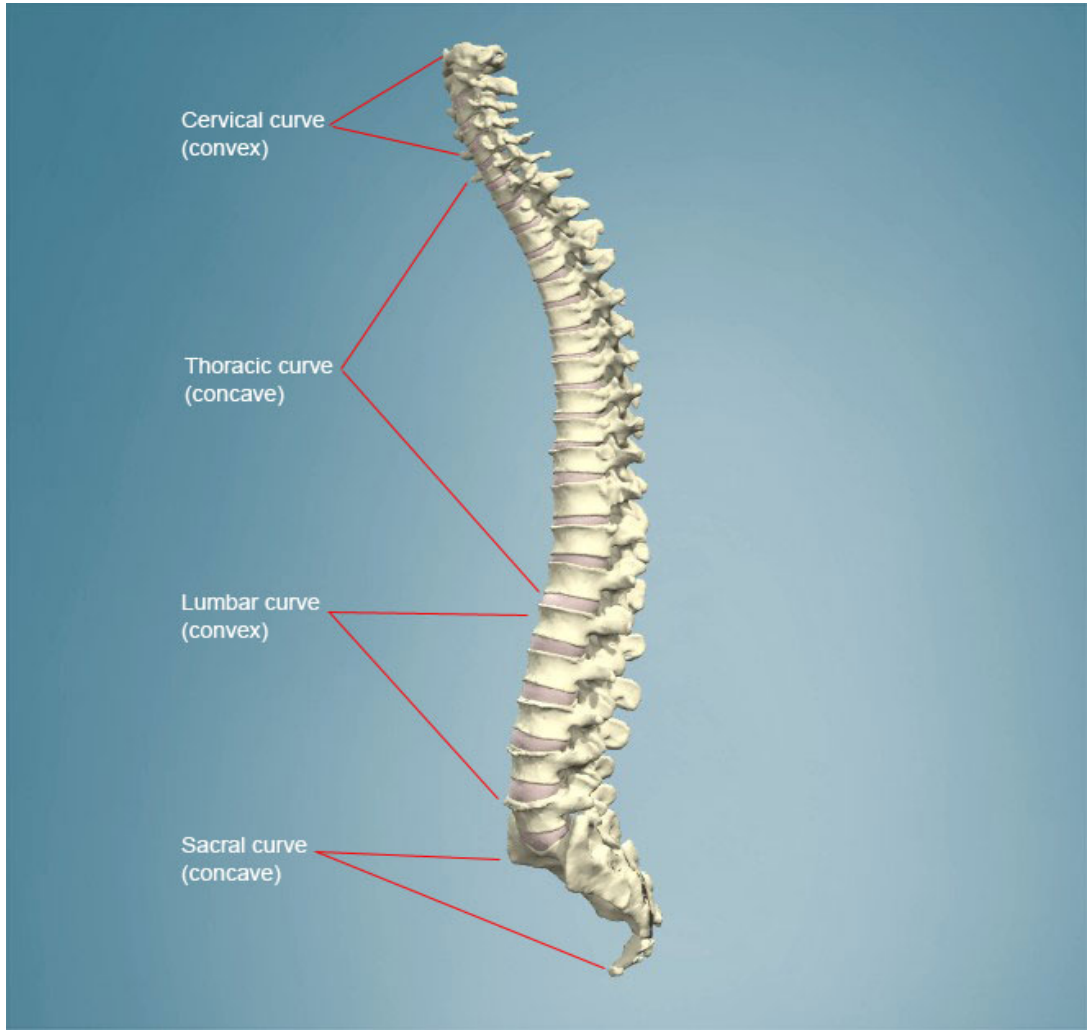
- When a human being is conceived, groups of cells crowd together in the shape of a bone and secrete a cartilage matrix
- 8 weeks after conception, the main bones have already formed in cartilage and connective tissue membranes
- Some of the cells expand in size and then burst

- The cell contents stimulate the cartilage on the outside to turn into bones
- This makes it harder for nutrients to get into the bone
- Cells inside start to die and form small cavities in the middle of the bone
- A nutrient artery penetrates the bone, bringing blood and nutrients into the disintegrating cartilage (nutrients such as calcium give the bone resilience, and magnesium gives the bone its hardness)

- The nutrients ‘wake up’ the bone-building cells (osteoblasts), which start laying down a bone matrix over what is left of the cartilage
- As the process continues to the end of the bone, bone-clearers (osteoclasts) clear up, creating a cavity for bone marrow
- The epiphyseal plate (growth plate) at the ends of each bone is a highly active area of cartilage and bone manufacture

- On one side of the plate (nearest the end of the bone), cartilage is constantly being produced
- On the other side of the plate (the one nearest the centre of the bone), osteoblasts are laying down bone matrix on top of this cartilage
- This whole process just keeps moving forwards, with calcified bone being cleared up by the osteoclasts and the osteoblasts constantly build new bone over the new cartilage

Vertebral column (Spine)



Vertebral column (Spine) 33 bones

7 cervical vertebrae – the first is called the atlas which supports the skull and forms a pivot with the axis (second cervical vertebrae)

12 Thoracic vertebrae form joints with the ribs to form the ribcage

5 Lumbar vertebrae - the largest and strongest vertebrae

5 Sacral - fused to form the sacrum

4 Coccygeal - fused to form the coccyx

Vertebral column (Spine)

All the vertebrae join to one another to form a flexible column that:

- Supports the trunk and head
- Encloses and protects the spinal cord

In between each vertebrae there are intervertebral discs (fibrous cartilage) which act as shock absorbers between each of the vertebrae

Curves of the spine

4 ‘natural’ curves named after the vertebrae that form them:

- Cervical
- Thoracic
- Lumbar
- Sacral

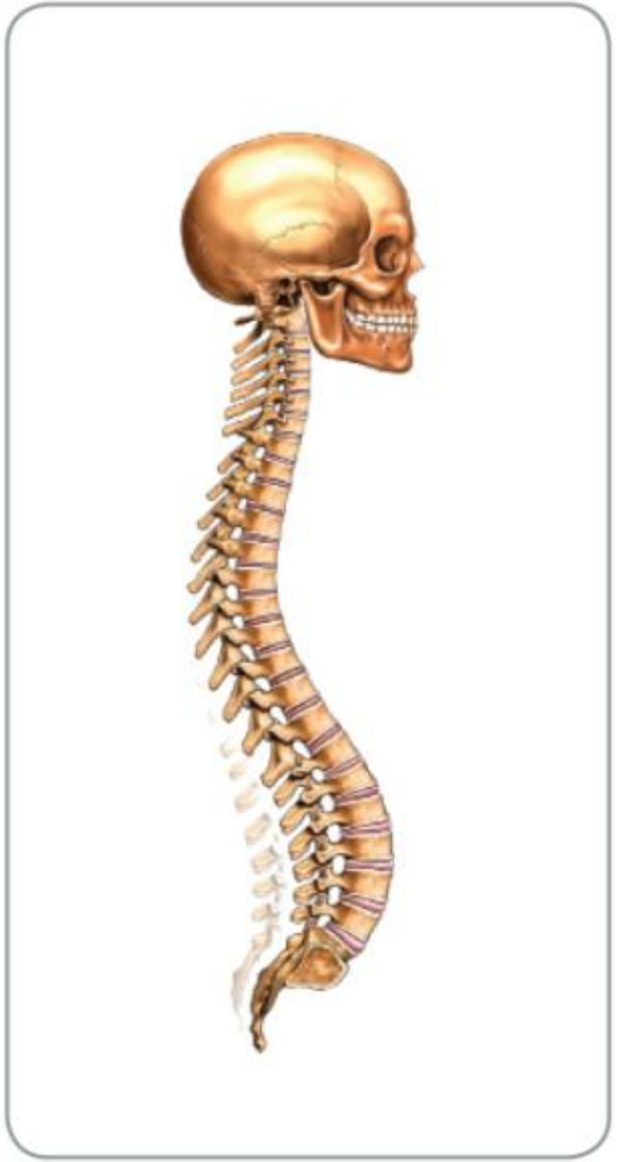
These curves centre the head above the body and make walking and maintaining an upright posture more easy

Exaggerated curvatures of the spine

Genetic and lifestyle factors can cause spinal curvature to become exaggerated or excessive.

- Fashion
- Work/school
- Emotional state
- Sport
- Hereditary
- Injuries
- Age
- Pregnancy
- Disability
- Obesity

Hyper-lordosis



Hyper-lordosis

- An exaggerated inward curvature of the lumbar spine
- The lower back has a hollowed appearance and the buttocks may appear more prominent
- Can be caused by poor posture or development problems during childhood or pregnancy

A number of muscles are affected by lordosis:

- Erector spinae (shortened)
- Gluteus maximus (lengthened)
- Hamstrings (usually overactive to substitute for weaker glutes)
- Hip flexors (shortened)
- Transverse abdominis (weakened)
- Rectus abdominis (lengthened)

Hyper-kyphosis

Hyper-kyphosis

An exaggerated rounding (hump) in the thoracic vertebrae, slouched appearance, often with a forward jutting head

Can be caused by:

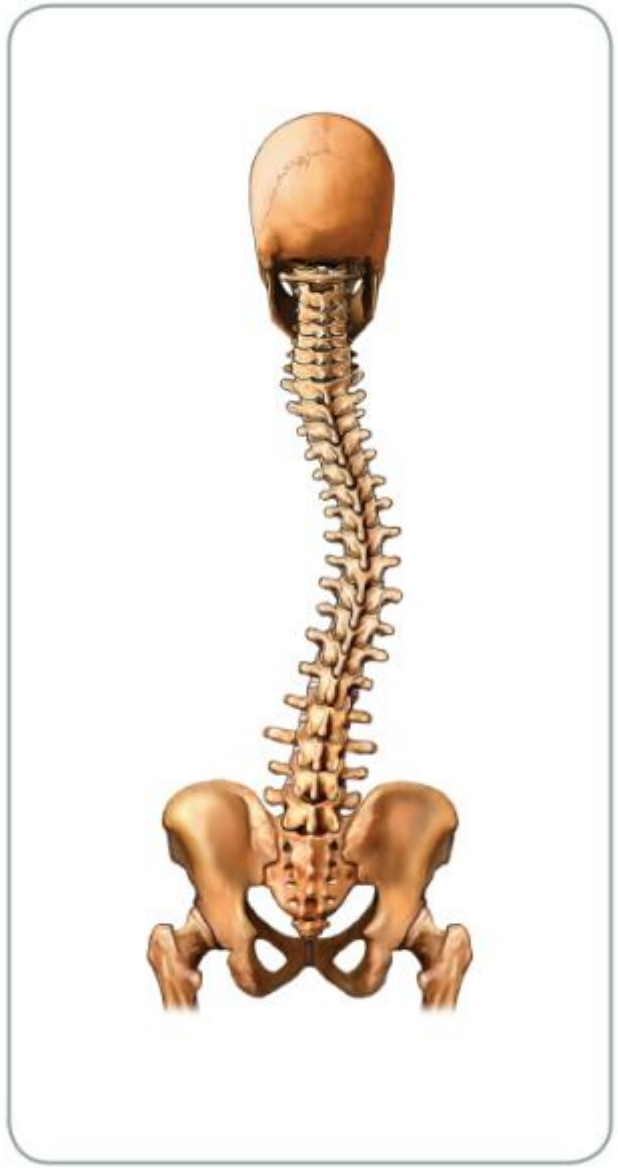
- Genetics
- Lifestyle factors – e.g. sitting for long periods of time with bad posture in front of a computer
- Structural deformity of the spine that may occur at birth (congenital defect)
- Degenerative disease e.g. arthritis

Hyper-kyphosis

Excessively shortened or lengthened muscles in the front and back of the upper body

- Pectorals (shortened)
- Trapezius (lower and middle sections lengthened, upper section shortened)
- Rhomboids (lengthened)

Scoliosis



Scoliosis

A lateral or sideways curvature of the spine giving an S-shape, rather than a straight line, when observed from the front or the back
Some vertebrae may rotate slightly, giving the appearance of unevenness in the waist or the shoulder

Most commonly caused by a congenital defect but it can result from poor posture

Scoliosis is not easy to correct and would require working a physiotherapist