Chapter 2 - Musculoskeletal system

The objectives of this chapter are to:

1. Name the organs that constitute the musculoskeletal system.
2. Define a long - short - flat - elongated - irregular bone and give an example of each.
3. Name the bones of the skeleton.
4. Define a joint.
5. Name different anatomical types of joints and give an example for each joint type.
6. Define a muscle.
7. Name different types of muscles.

1 - Skeleton

The skeleton is a framework of the human body. It consists of the bones, the cartilages and the joints. The skeleton can be subdivided into two major divisions, the axial skeleton, and the appendicular skeleton.

The skeleton is examined by utilizing medical imaging: plain X-ray, CT or MRI. Reconstructions can be made on the basis of the skeleton sections. Other procedures are also possible, such as bone scintigraphy, in which the injected radioactive product binds electively to the bones.

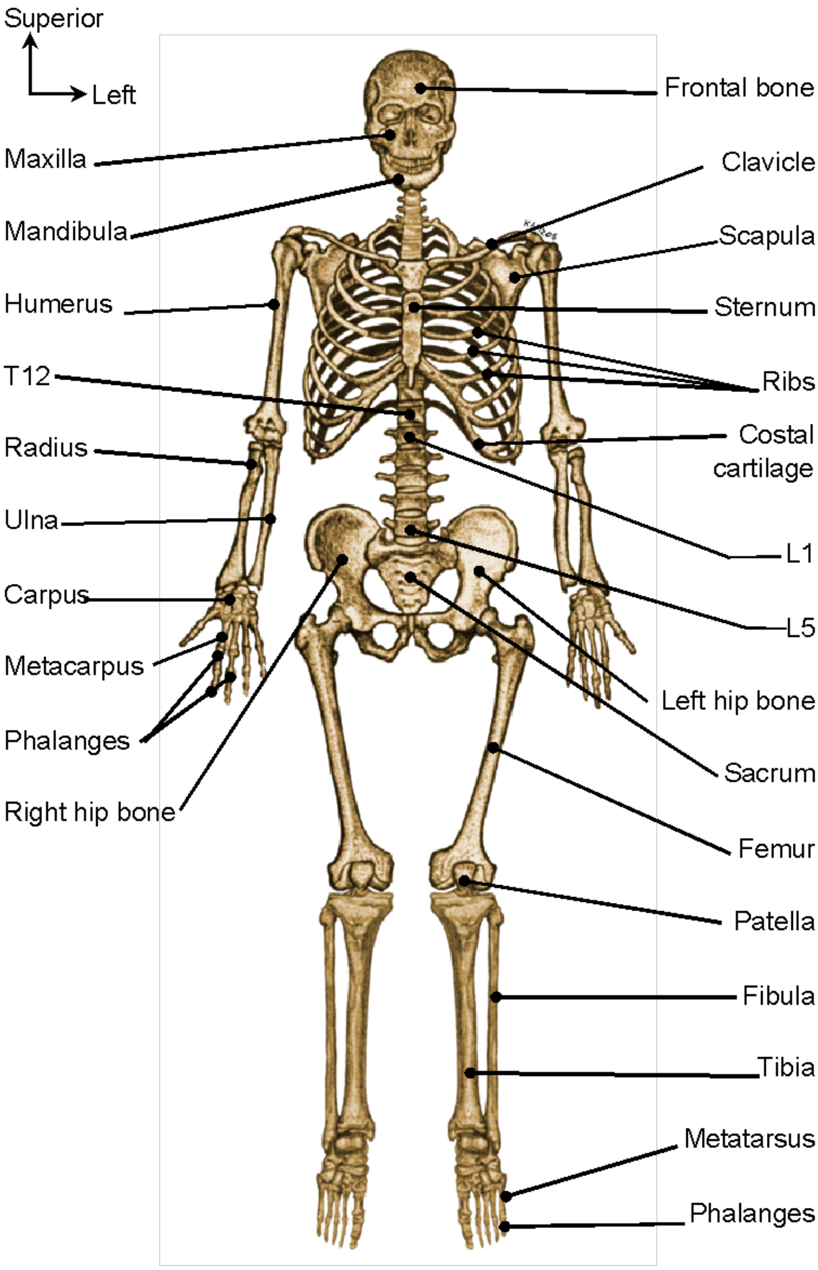


Figure 26: The human skeleton. Anterior view.

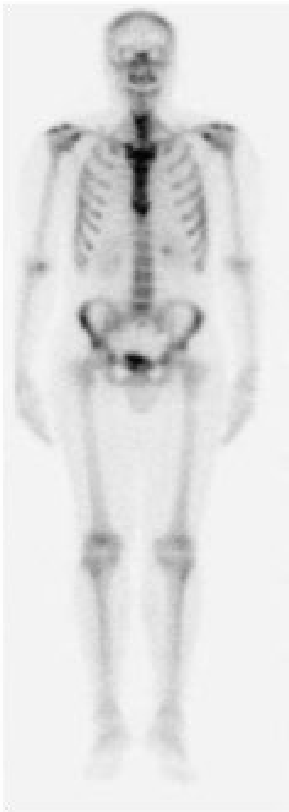


Figure 27: Bone scan. Anterior view.

1.1 - Bones of axial skeleton

The axial skeleton consists of the skeleton of the head, neck and trunk.

Bones of the head

The skeleton of the head is formed by the skull, also called cranium, and two extracranial bones.

Cranium

The cranium is divided into neurocranium and viscerocranium.

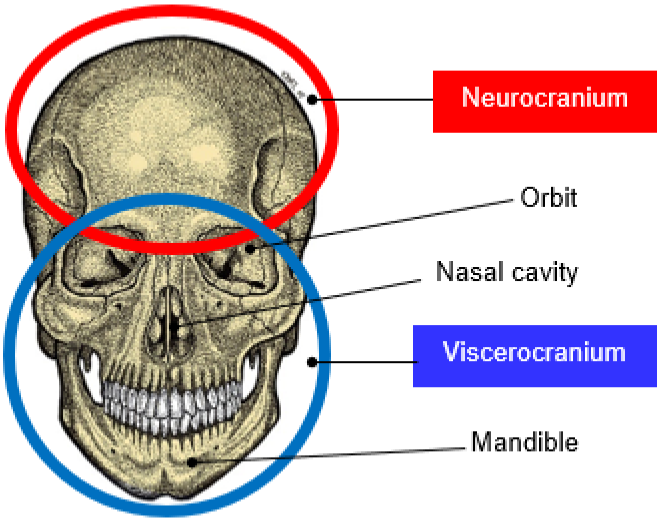


Figure 28: The cranium. Anterior view.

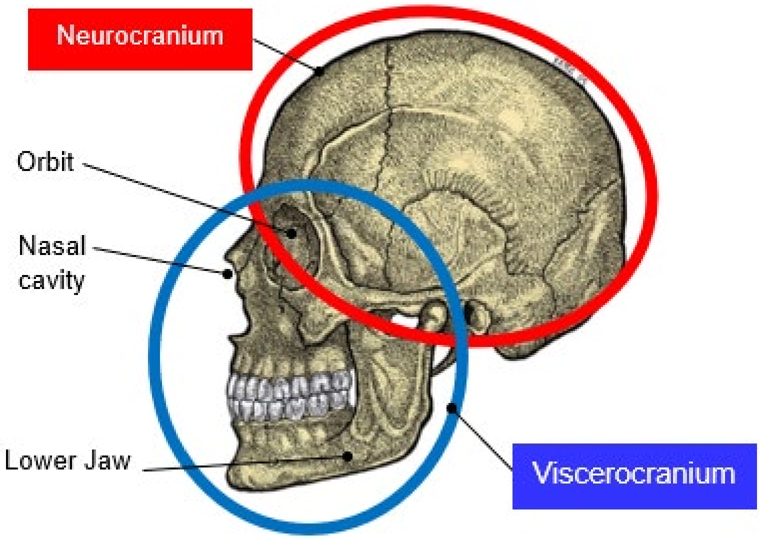


Figure 29: The cranium. Left lateral view.

The skeleton of the neurocranium is composed of:

- frontal bone,
- ethmoid bone,

- occipital bone,
- temporal bone (2),
- parietal bone (2).

The neurocranium encloses the cranial cavity. It can be divided in the calvaria and the cranial base.

The calvaria is "a covering" which is not penetrated by anatomical elements. It protects the brain.

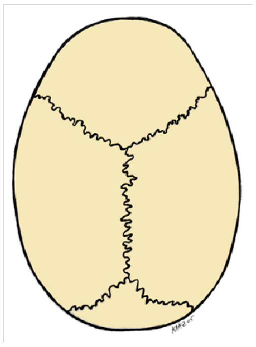


Figure 30: External surface of the calvaria.

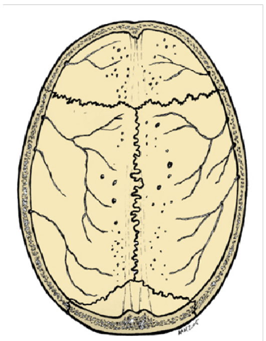
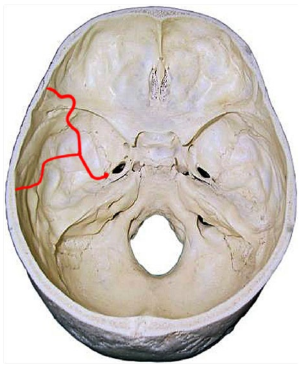


Figure 31: Internal surface of the calvaria.

The cranial base is divided into three cranial fossae and has several communication holes that allow the passage of anatomical elements.

Figure 32: Intracranial view of the cranial base.



The skeleton of the viscerocranium is composed of:

- vomer,
- maxilla (2),
- palatine bone (2),
- lacrimal bone (2),
- inferior nasal turbinate (2),
- nasal bone (2),
- zygomatic bone (2).

On the anterior aspect of the cranium, there are cavities:

- The left and right orbits house the eyeballs and the eye appendages.
- The bony nasal cavity houses the sense of smell and provide for the passage of air.

Extracranial bones

The extracranial bones are:

- mandible,
- hyoid bone.

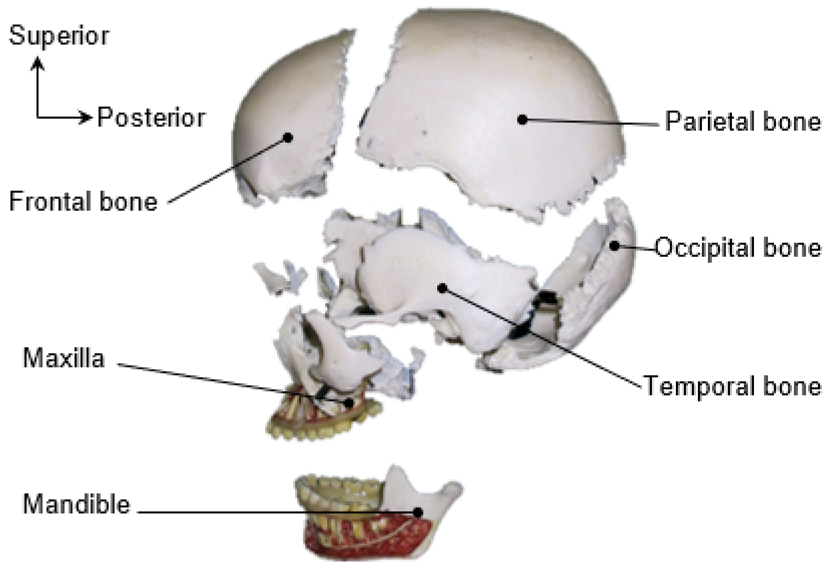


Figure 33: The bones of the head. Left lateral view.

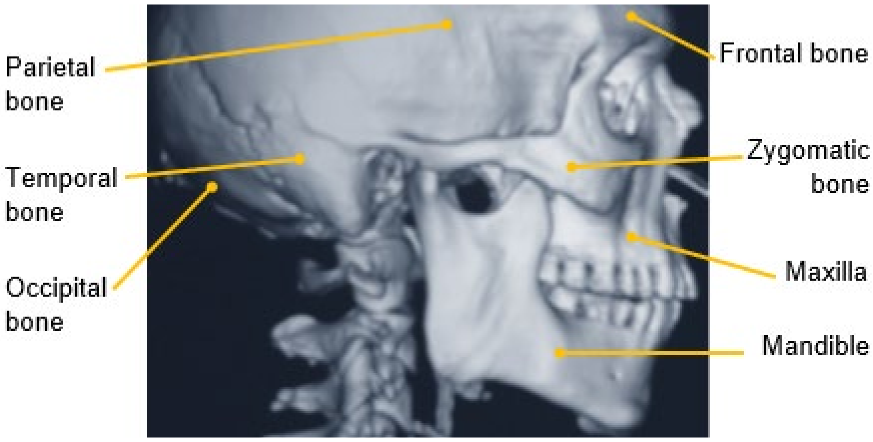


Figure 34: CT reconstruction of the skull. Right lateral view.

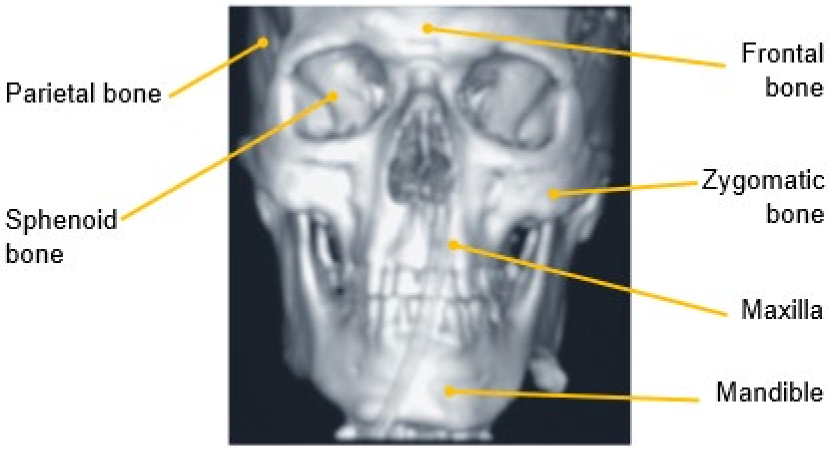


Figure 35: CT reconstruction of the skull. Anterior view.

Bones of vertebral column

The vertebral column (spine) consists of 33 vertebrae:

- 7 cervical vertebrae (vertebrae C1-C7),
- 12 thoracic vertebrae (vertebrae T1-T12),
- 5 lumbar vertebrae (vertebrae L1-L5),

- 5 sacral vertebrae fused into sacrum,
- 4 coccygeal vertebrae fused into coccyx.

Viewed from the front, the spine appears to be straight. In profile, it shows curvatures. These curvatures increase the resistance of the spine and have different values. They can be reduced or increased, depending largely on a genetic component.

The curvature of the spine with the concavity directed backwards is called lordosis. In adult, there are cervical and lumbar lordoses.

The curvature of the spine with the concavity directed forwards is called kyphosis. In adult, there are thoracic and sacral kyphoses).

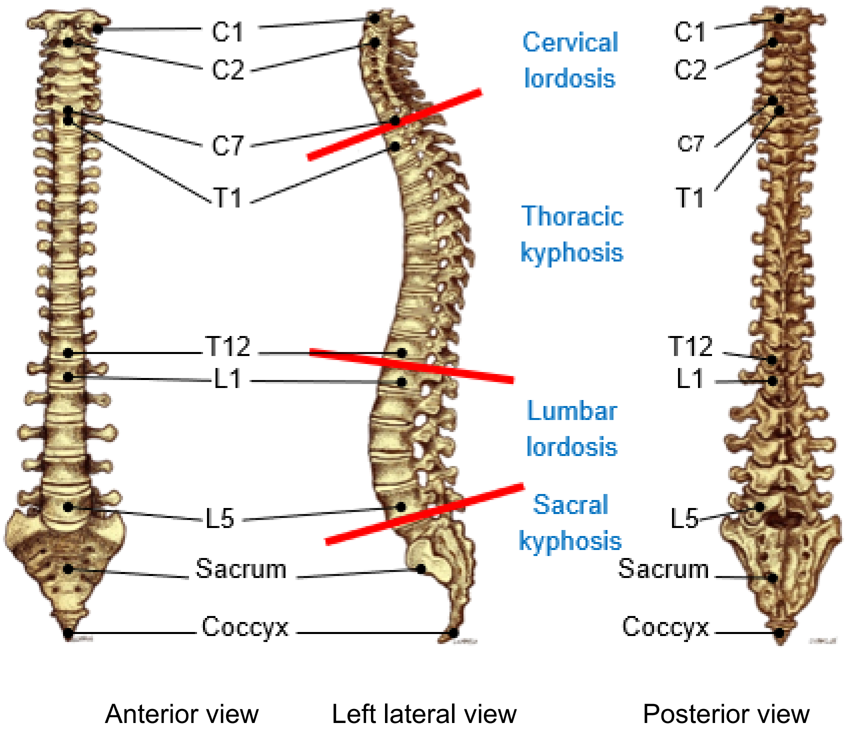


Figure 36: The spine.

The curvature in the frontal plane is called scoliosis and is pathological. In most cases, the cause cannot be determined (idiopathic scoliosis). It may be due to an unequal length of the lower limbs or paralysis of the trunk muscles.

Figure 37: Photo of a patient's back showing scoliosis.

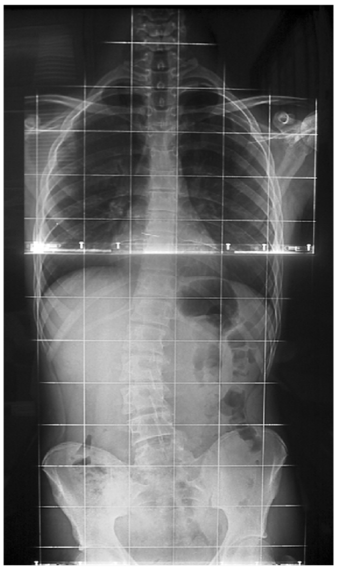


Figure 38: X-ray of the spine showing scoliosis.

Bones of thorax

The bones of thorax are sternum and 12 pairs of ribs.

The sternum is a flat bone in the centre of the anterior wall of the chest.

The ribs are paired bones. Posteriorly, thy are connected to the thoracic vertebrae. Anteriorly, the upper ribs are connected to the sternum. According to their connection with sternum, the ribs are divided into two groups.

- The ribs 1 to 7 are connected to the sternum by a costal cartilage. They are called the true ribs.

- The ribs 8 to 12 are not in connection with sternum. They are called the false ribs. The costal cartilages of ribs 8, 9, and 10 are connected to the costal cartilage of the rib above them. The ribs 11 and 12 end freely in the muscles of abdominal wall and are called the floating ribs.

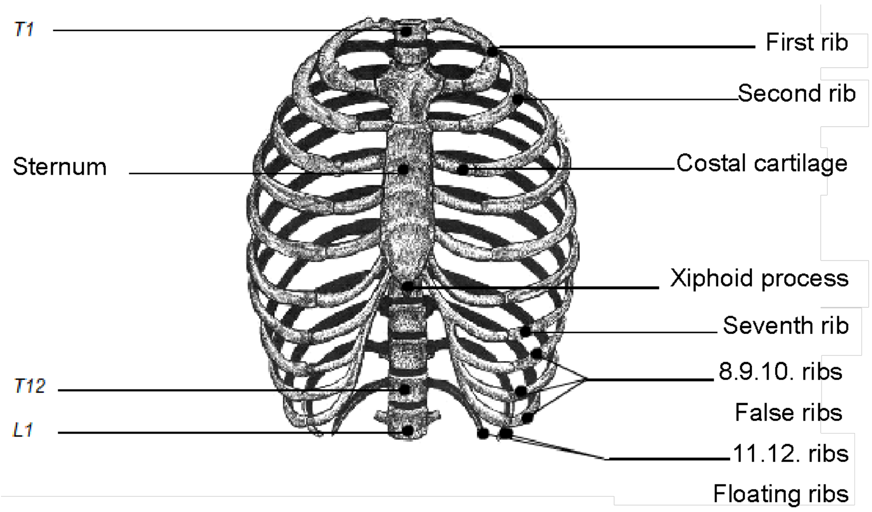


Figure 39: Skeleton of the thorax. Anterior view.

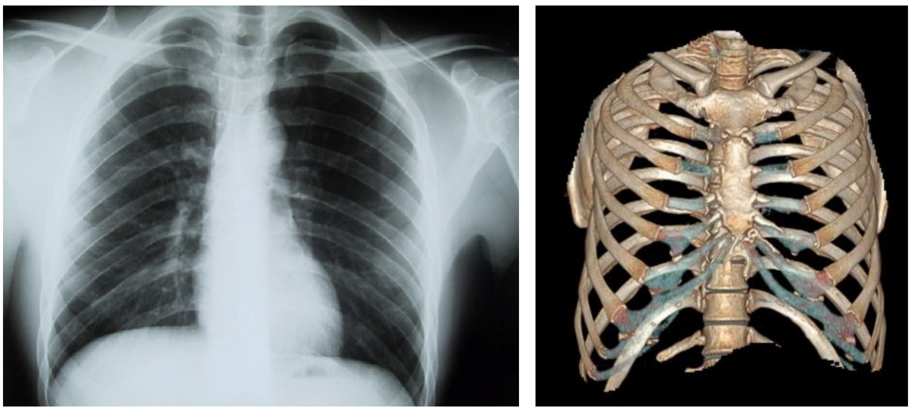


Figure 40: X-ray of the thoracic skeleton.

Bones protecting the abdominal cavity

The bones protecting the organs in the human cavity are the lower ribs, the lumbar spine, and superior part of pelvis above the terminal line called the greater pelvis. Pelvis is formed by the sacrum and pelvic girdle. The bones of pelvic girdle are classified among the bones of lower limb.

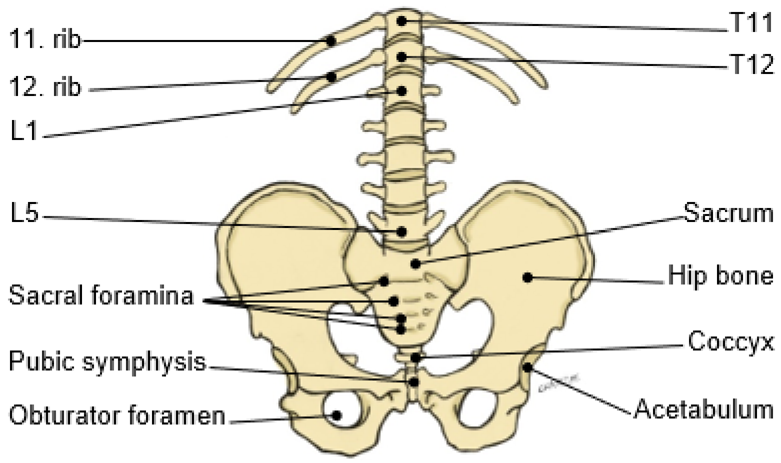


Figure 41: Bones protecting the abdominal cavity. Anterior view.

1.2 - Bones of appendicular skeleton

The appendicular skeleton is the skeleton of the upper and lower limbs.

Bones of upper limb

The bones of upper limb are divided into the bones of pelvic girdl and the bones of free part of upper limb.

Bones of pectoral girdle:

- scapula, clavicle.

Bones of free part of upper limb:

Arm: humerus.

Forearm: radius, ulna.

Hand:

- Carpus: 8 bones, arranged in 2 rows (listed from the thumb side to the little finger side):

  proximal row: scaphoid bone, lunate bone, triquetrum bone, pisiform bone;

  distal row: trapezium bone, trapezoid bone, capitate bone, hamate bone.

- Metacarpus: 5 metacarpal bones I to V, numbered from the thumb side to the little finger side.
- Fingers: 3 phalanges in the 2nd to 5th finger: proximal middle, and distal phalanx; 2 phalanges in the thumb: proximal and distal phalange.

Figure 42: Drawing of metacarpal bones and phalanges of hand.

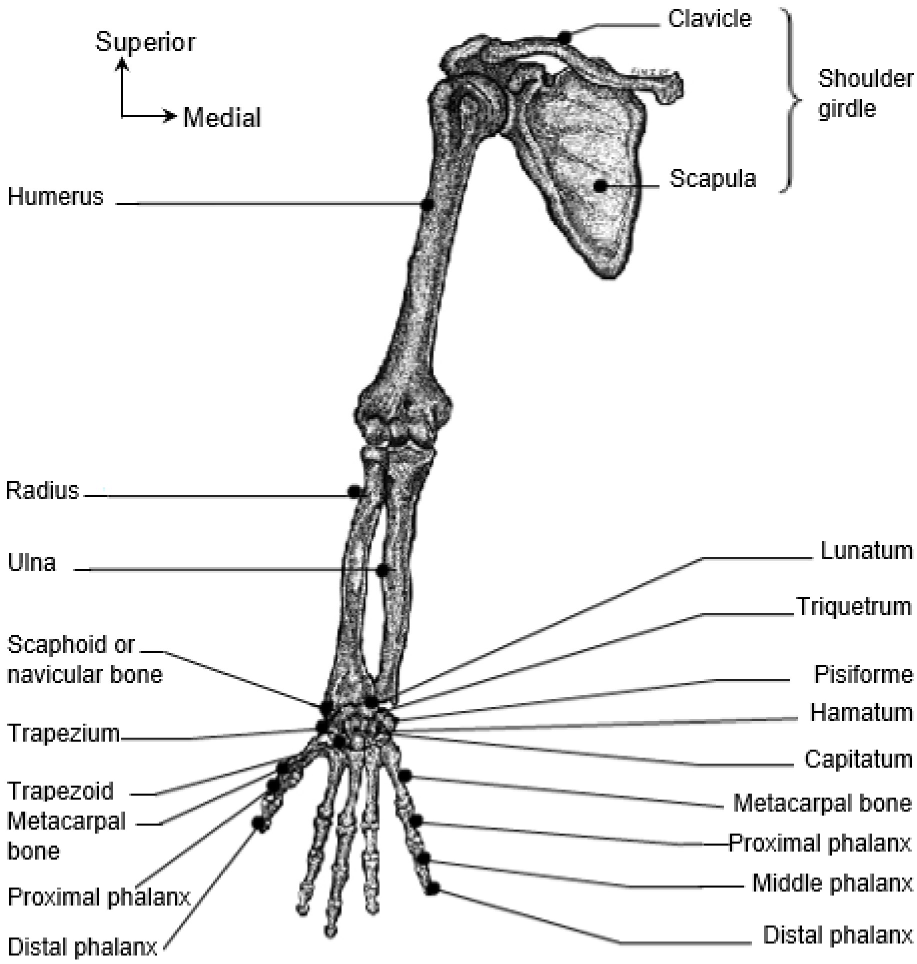


Figure 43: Skeleton of the right upper limb. Anterior view.

Bones of the lower limb

The bones of upper limb are divided into the bones of pelvic girdl and the bones of free part of upper limb.

Bones of pelvic girdle:

- hip bone: ilium, ischium, and pubis.

Bones of free part of lower limb:

Thigh: femur, patella.

Leg: tibia, fibula.

Foot:

- Tarsus: 7 bones: talus, calcaneus, navicular bone, cuboid bone, medial cuneiform bone, intermediate cuneiform bone, lateral cuneiform bone.
- Metatarsus: 5 metatarsal bones I to V, numbered from the great toe side to the little toe side.
- Toes: 3 phalanges in the 2nd to 5th toe: proximal middle, and distal phalanx; 2 phalanges in the thumb: proximal and distal phalanx.

Both lower limbs should be of equal length. Inequality in length causes lameness. Telemetry examinations are performed to investigate a possible axial deviation.

Figure 44: ***X-ray of lower limb skeleton (Telemetry).***

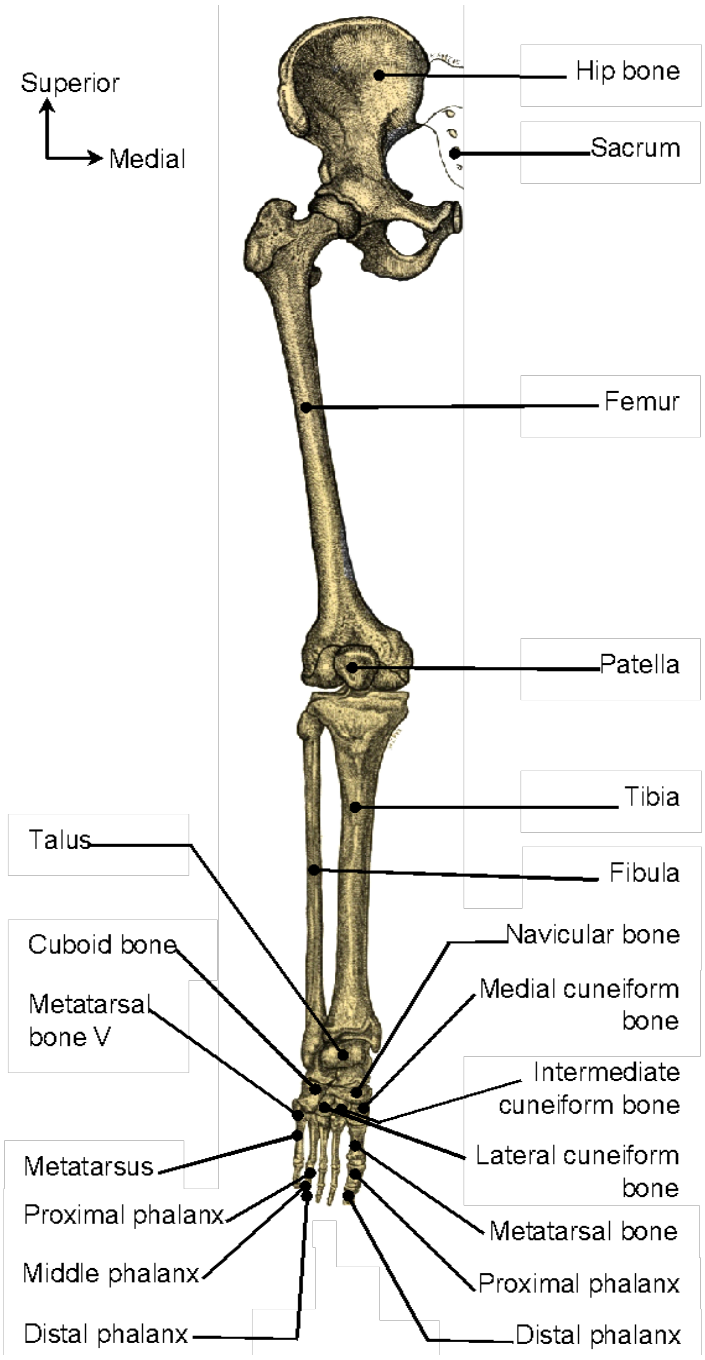


Figure 45: Skeleton of the right lower limb. Anterior view.

1.3 - Classification of bones

According to their form, bones can be classified into four main groups: long, flat, short, and irregular bones.

Long bones

In long bones, one dimension usually predominates over the other two. They have two extremities or epiphyses and one body (shaft) or diaphysis. The epiphysis and diaphysis are connected by a zone called the metaphysis.

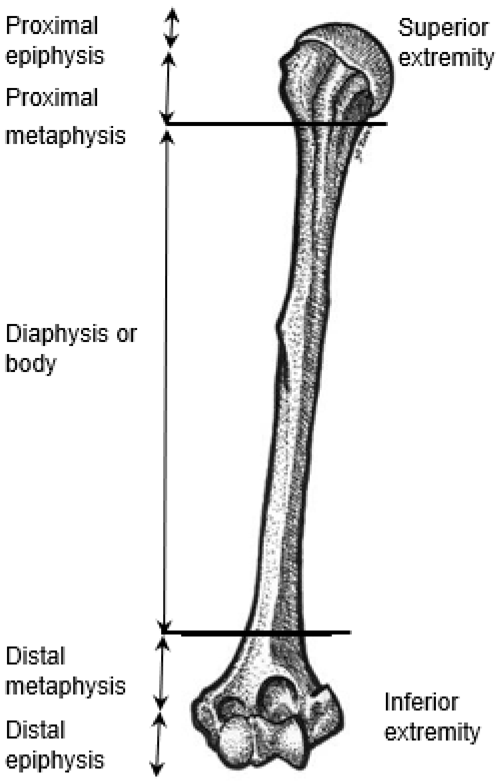


Figure 46: Drawing of the right humerus. Anterior view.

Figure 47: Photo of the right humerus. Anterior view.

Flat bones

In flat bones, the thickness is small or even zero, resulting in a hole in the bone. The periphery of these bones has thickenings on certain sides that form a zone of resistance (for example, the lateral edge of the scapula, the so-called scapular pillar).

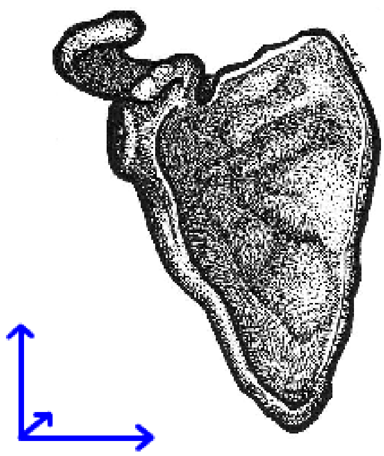


Figure 48: Drawing of the right scapula. Anterior view.

Figure 49: Photo of the right scapula. Anterior view.

Figure 50: X-ray showing a fracture of the pillar of left scapula. Anterior view.

Short bones

In short bones, the three dimensions are equivalent.

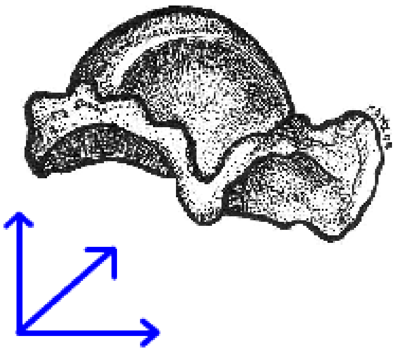


Figure 51: Drawing of the right talus. Lateral view-

Figure 52: Photo of the right talus. Lateral view.

1.4 - Architecture of the bone

According to the density and organisation of bone tissue, we distinguish the compact bone and the spongy bone.

Cortical bone (compact bone)

The cortical bone forms the surface of the bone and is thick. Its thickness varies depending on the type of bone.

At the level of the diaphysis of long bone, it is very thick and tubular in structure, surrounding the medullary cavity in which is the bone marrow. It is very strong and only breaks when subjected to very high energy.

At the level of the epiphysis of long bone and in short and flat bones, the compact bone surrounds the spongy bone which forms the inner part of the bone.

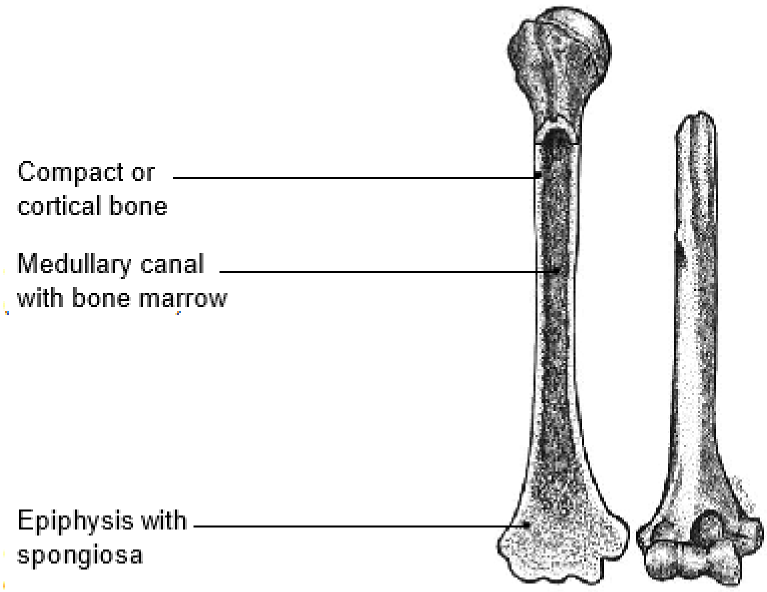


Figure 53: Frontal section of the right humerus. Anterior view.

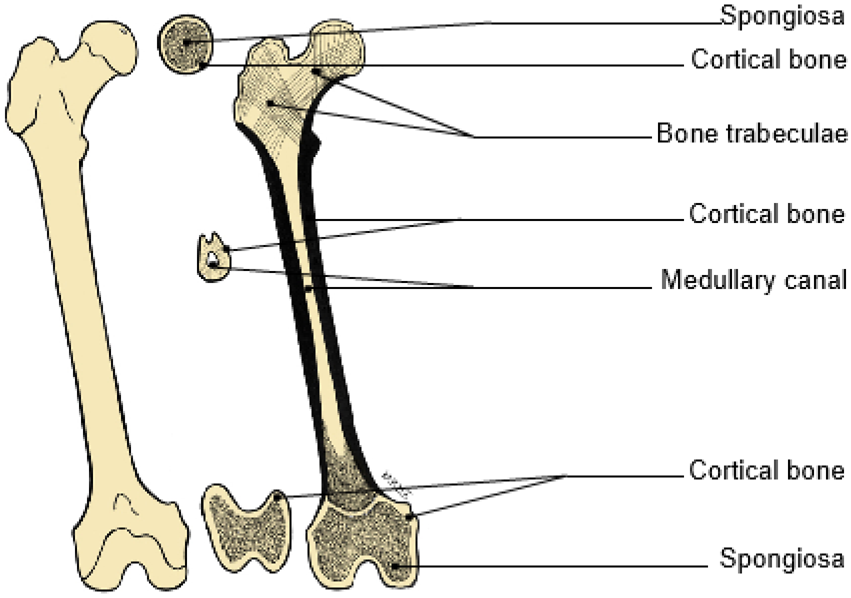


Figure 54: Frontal and transverse section of the right femur. Anterior view.

Spongy bone (cancellous bone)

The spongy bone forms large and complex parts of the bone. It is located at the level of the epiphyses of the long bones and in the flat and short bones. It can be compared to a honeycomb. It consists of a network of bony trabeculae, between which the red bone marrow is located.

The bony trabeculae represent lines of force that connect two parts of cortical bone. They can be organized in bundles and give the bone the necessary strength.

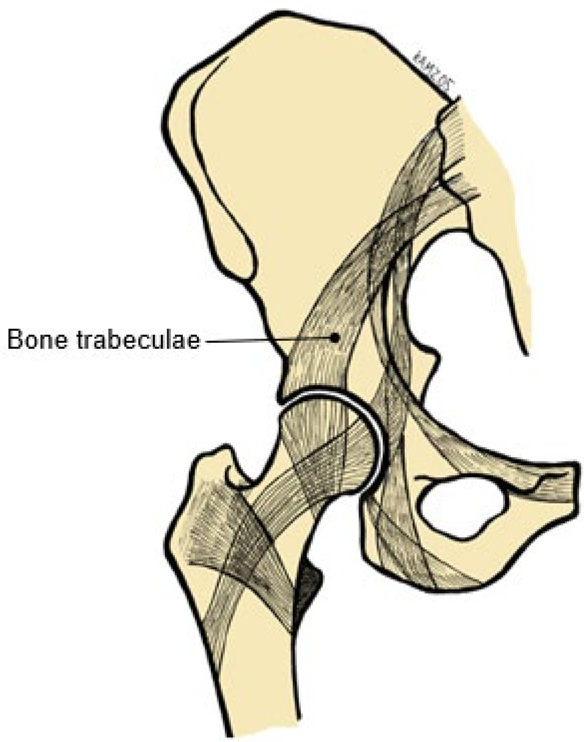


Figure 55: The direction of bony trabeculae in the right hip. Anterior view.

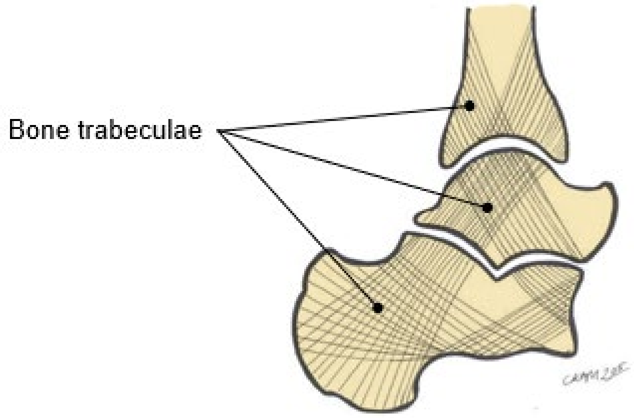


Figure 56: The direction of bony trabeculae in the ankle. Lateral view.

Figure 57: X-ray of the ankle showing the bony trabeculae. Lateral view.

Bone marrow

The bone marrow is located in the cavities of the spongy bone and in the medullary cavity of the long bones. In adult, the medullary cavity contains the yellow bone marrow, while the cavities of the spongy bone contain the red bone marrow with blood stem cells.

Periosteum

The bone is covered by a protective and nourishing fibrous membrane, the periosteum.

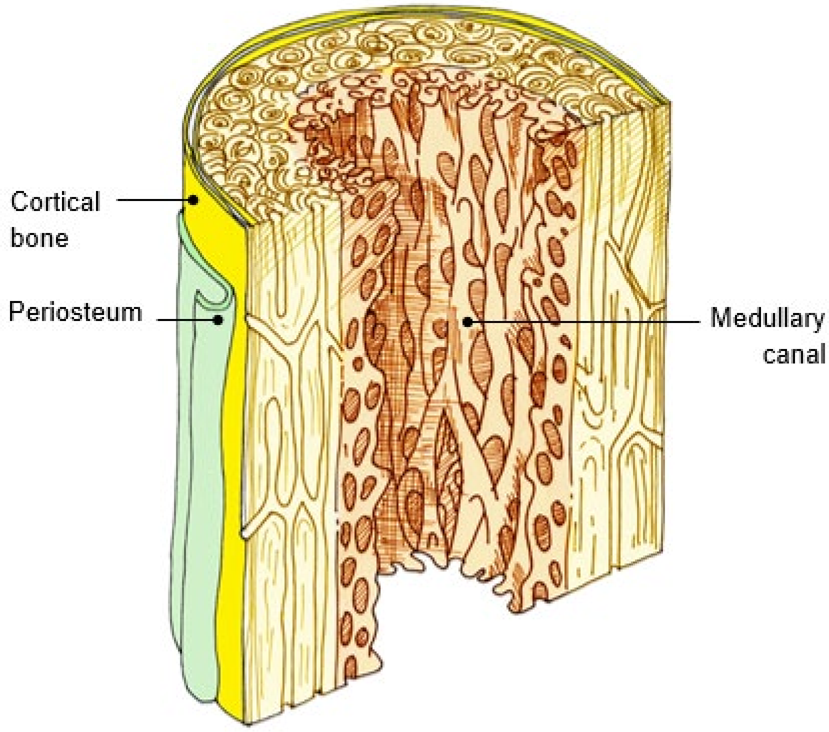


Figure 58: Section through a diaphysis wrapped in the periosteum.

1.5 - Growth of the long bone

Growth of the long bone occurs through two phenomena:

- Epiphyseal plates allow the bone to grow in length.
- Periosteum enables the appositional growth of the bone (the increase in diameter). The periosteum is the main element in fracture healing and forming of the periosteal callus.

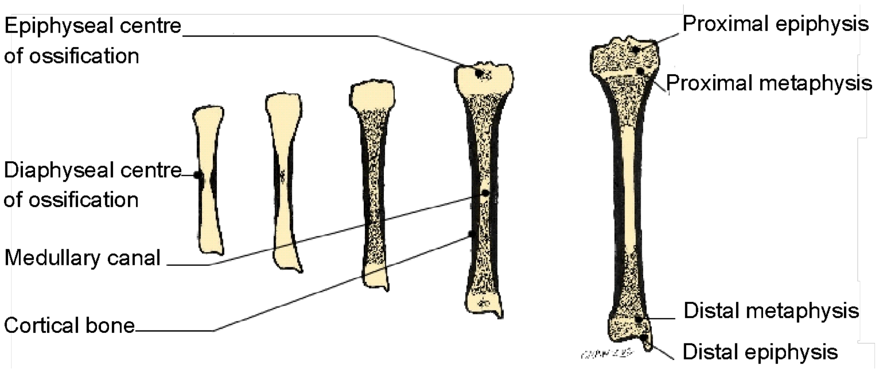


Figure 59: Growth of the long bone.

The long bone develops from hyaline cartilage. The ossification progresses from three main ossification centres: one primary centre in the diaphysis (it usually occurs during prenatal development) and two secondary centres, one in each epiphysis (they usually occur during postnatal development). The centres of different bones appear at the certain age according to the development, and therefore allow us to determine the age. Premature or delayed ossification is pathological.

Hyaline cartilage persists at the epiphyseal plate which is located between the diaphysis and epiphysis. The epiphyseal plate is responsible for the lengthwise growth of long bones and is therefore also called growth plate or growth cartilage.

It should be noted that ossification centres develop in a cartilage with a fixed morphology. They are capable of forming complex shapes with protrusions and grooves.

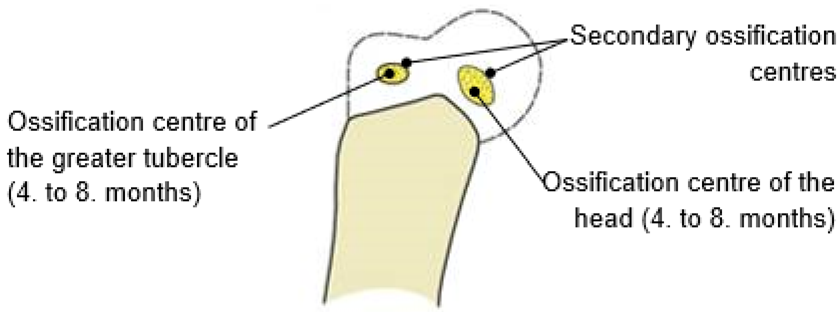


Figure 60: Ossification centres in the proximal epiphysis of humerus.

Next x-rays show the epiphyseal plates – growth cartilage.

Figure 61: X-ray of the left knee (anterior view).

Figure 62: X-ray of the right wrist (anterior view).

1.6 - Bone vascularisation

The bone is a living organ that is constantly renewing itself. Its blood supply is rich. Oxygenated blood is supplied by a nutrient artery that runs in the periosteum and enters the bone through the nutrient foramen. Deoxygenated blood flows via the veins. It should be noted that the growth cartilage is not vascularised.

There are venous lakes in which the blood stagnates, which enables bone development. The disadvantage of this venous stagnation is that it can be a source of infection which is then referred to as osteomyelitis.

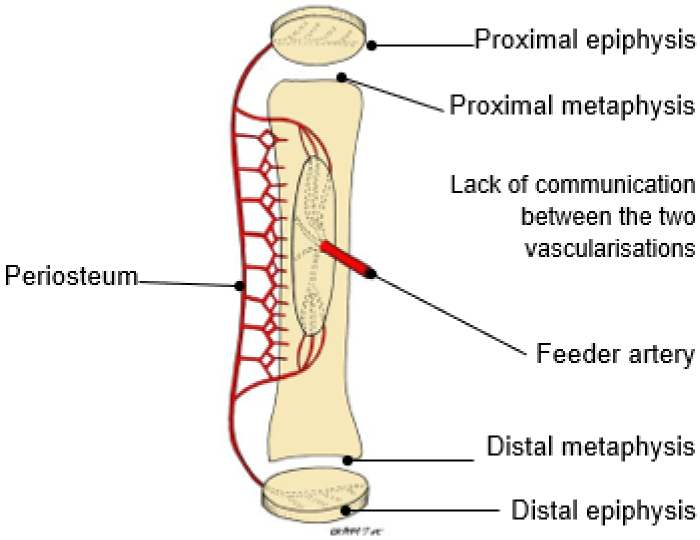


Figure 63: Bone vascularisation.

2 - Joints

A joint (articulation) is any connection by which two or more bones are joined together.

2.1 - Classification of joints

Joints are divided into three main groups: the fibrous joints, the cartilaginous joints, and the synovial joints.

Fibrous joints

In a fibrous joint, bones are joined by fibrous tissue. The degree of mobility is minimal, usually practically zero.

Syndesmosis

An example of syndesmosis is the inferior tibiofibular joint (tibiofibular syndesmosis): a fibrous tissue is inserted between the two bones. This allows for a stable mortise in which talus is inserted.

A gap between these two bones (diastasis) leads to instability.

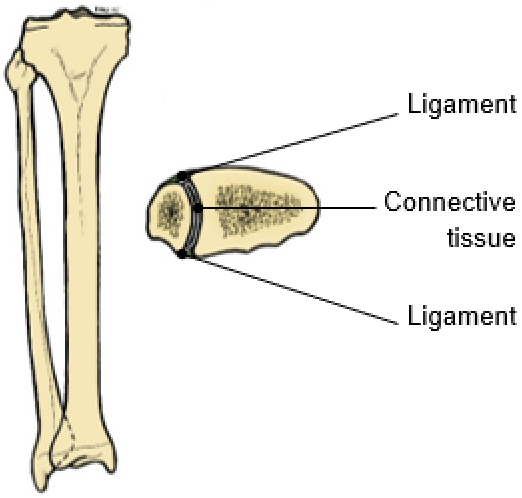


Figure 64: Inferior tibiofibular joint. Syndesmosis.

Suture

Sutures connect the flat bones of the skull. In adults, sutures ossificate and the volume of the cranial cavity is fixed. A premature ossification of the sutures is called craniosynostosis (craniostenosis) and can lead to skull deformities or even compression of the brain.

In new-borns, the bones are not fully ossified yet; the soft membranous spaces separating the bones are called fontanelles.

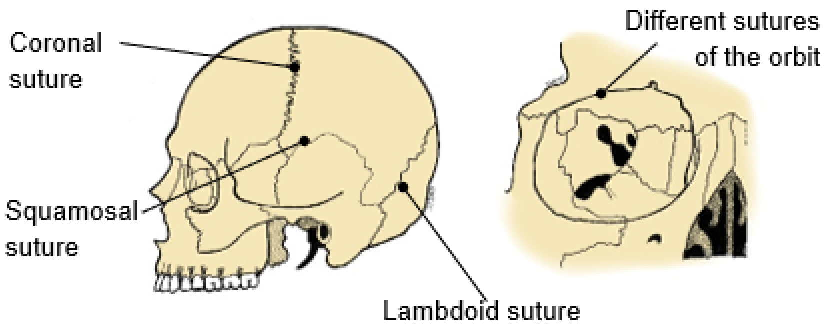


Figure 65: Sutures of skull.

Gomphosis

Gomphosis is a special type of syndesmosis that connects a tooth to the tooth socket. These joints are stable but can move a little. This can be achieved by wearing braces.

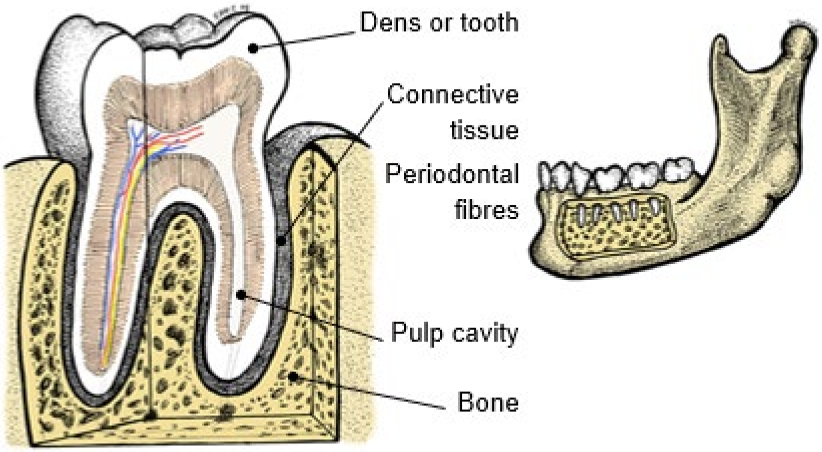


Figure 66: Gomphosis.

Cartilaginous joints

In a cartilaginous joint, bones are joined by cartilaginous tissue. A degree of mobility is insignificant.

Synchondrosis

Synchondrosis is a connection of bones by hyaline cartilage. Example: the first sternocostal joint.

Symphysis

Symphysis is a connection of bones by fibrous cartilage. Compressibility of the fibrocartilage tissue allows for small movements. Example: the intervertebral disk.

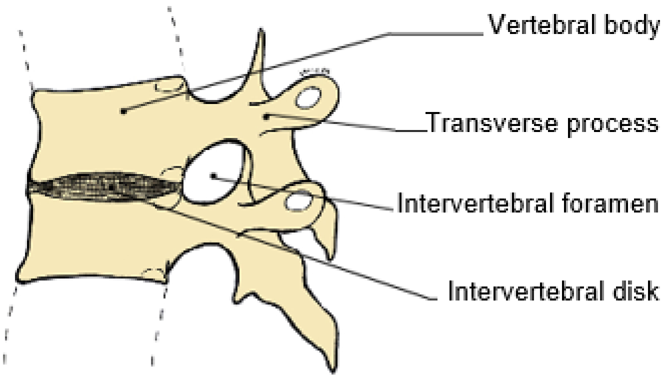


Figure 67: Intervertebral symphysis. Left lateral view.

Figure 68: Left lateral view of the spine.

Synovial joints

In a synovial joint, the bones are not directly joined; they are connected by an articular capsule which encloses a fluid-filled joint cavity. These joints are very mobile.

Synovial joint contains the following elements:

- The articular surfaces of at least two bones. The surfaces are covered by a pearly white, smooth hyaline cartilage called an articular cartilage. The joint's stability depends on the congruence between the articular surfaces.
- A joint capsule connecting the bones and enclosing a joint cavity. It has two layers. A fibrous layer (fibrous membrane) is an outer layer formed by dense fibrous tissue which stabilises the joint. It has a low extensibility. A tight capsule leads to a considerable restriction of movements. A synovial layer (synovial membrane) is an inner layer formed by serous

membrane – a specialised soft connective tissue that secrets a serous fluid called synovia.

- Synovia enables the articular surfaces to slide smoothly against each other. It lubricates the joint and supplies the articular cartilage with the nutrients.
- The ligaments connect the articulating bones and can form reinforcement of the joint capsule.
- Some synovial joints contain the articular fibrocartilage which improves the congruence between the articular surfaces. Fibrocartilage is not vascularised and therefore has a limited potential to repair. The articular fibrocartilage can be divided into tree forms. The articular disc is a thin fibrocartilaginous plate between the articular surfaces. The meniscus is a crescent-shaped fibrocartilage in the knee joint. It is thicker on the periphery and gets thinner towards the centre of the joint, thus having a triangular shape on the cut surface. The articular labrum is a complete or incomplete fibrocartilaginous ring attached to a margin of the concave articular surface, further increasing its concavity. It is thickest at the site of attachment and gets thinner peripherally, thus having a triangular shape on the cut surface Examples are glenoid labrum of the shoulder joint and acetabular labrum of the hip joint.

There are several types of synovial joints that differ according to the movements they enable.

Spheroidal (ball and socket) joint

A spheroidal articular surface of one bone lies in a cup-like concavity of the other bone. This is the most mobile type of joint. The mobility is possible in all three spatial planes around three axes that are perpendicular to each other. Possible movements are flexion and extension, abduction and adduction, circumduction as a combination of previous four movements, and internal and external rotation.

Example: the shoulder joint.

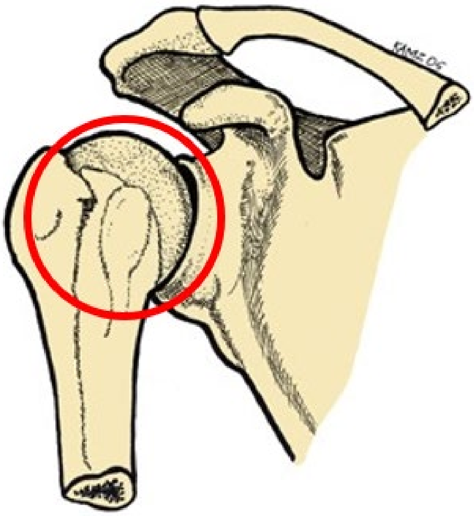


Figure 69: The right shoulder joint. Anterior view.

The frontal section of the shoulder joint shows the disproportion between the surface of the humeral head and the glenoid cavity of the scapula.

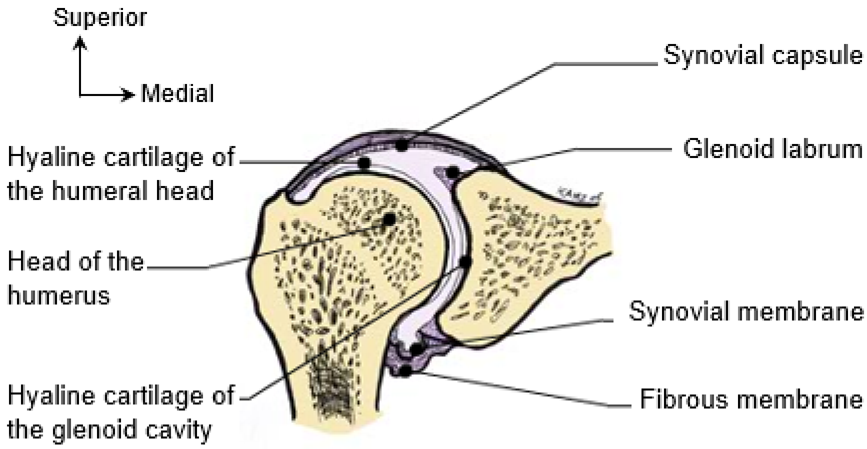


Figure 70: Frontal section of the right shoulder joint. Anterior view.

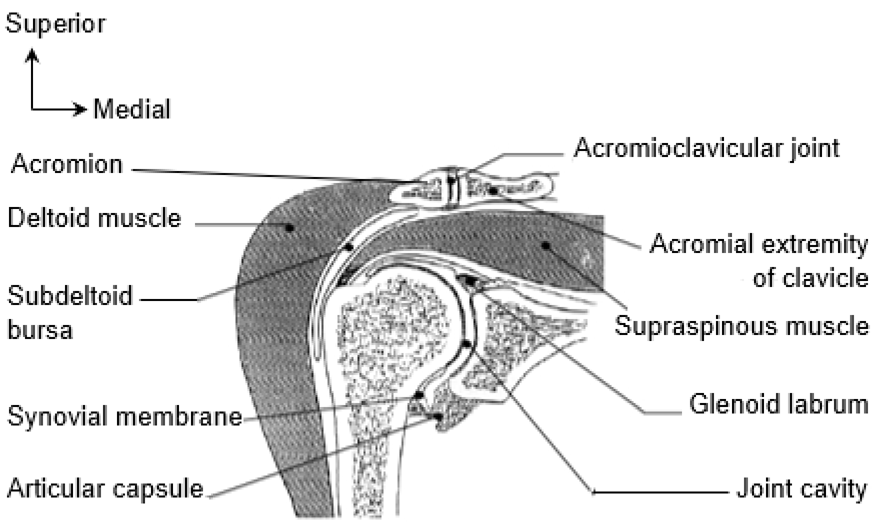


Figure 71: Frontal section of the right shoulder. Anterior view.

In a shoulder joint which has extensive mobility, the lax joint capsule allows high range of movements without stretching the capsule. Great mobility rhymes with great fragility! Anterior dislocation of the shoulder joint is the most common type of joint dislocation.

Figure 72: Photo and X-ray of the right shoulder with a glenohumeral dislocation. Anterior view.

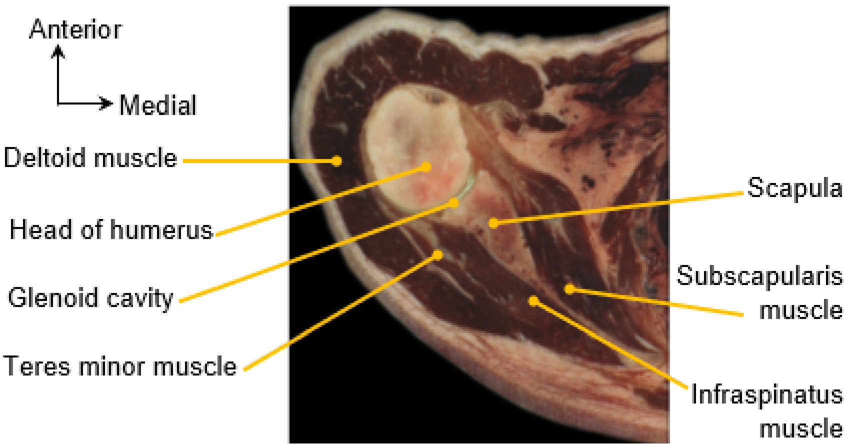


Figure 73: Cross-section of the right shoulder. Inferior view.

Another example of the ball and socket joint is the hip joint. It has much more limited range of movements due to the deep concave articular surface.

Figure 74: View of the acetabular cavity.

Ellipsoid (condylar) joint

An ovoid convex articular surface of one bone lies in an ellipsoid concavity of the other bone. Mobility is possible around two axes. Possible movements are flexion and extension, abduction and adduction, and circumduction as a combination of previous four movements.

Example: the radiocarpal joint.

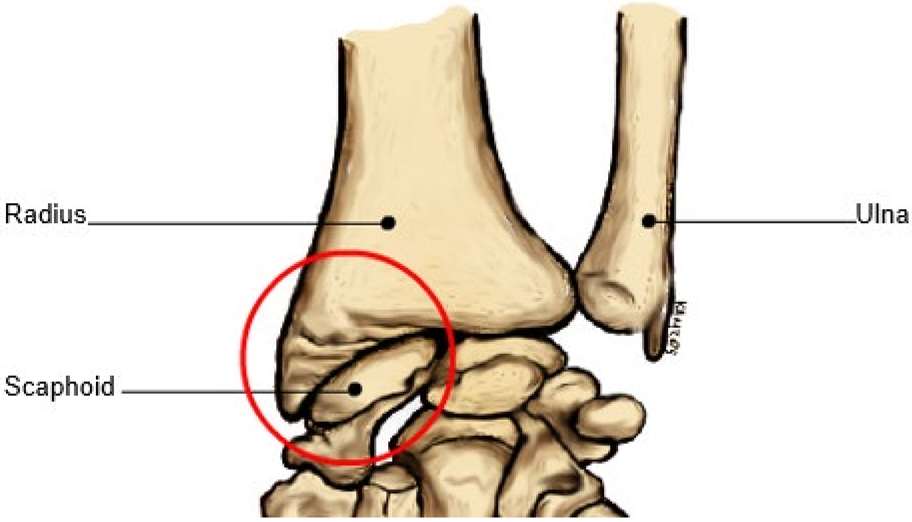


Figure 75: The right radiocarpal joint. Anterior view.

Saddle joint

A concave-convex articular surfaces of both bones interlock like two saddles perpendicular to one another. Mobility is possible around two axes.
Example: the carpometacarpal joint of the thumb.

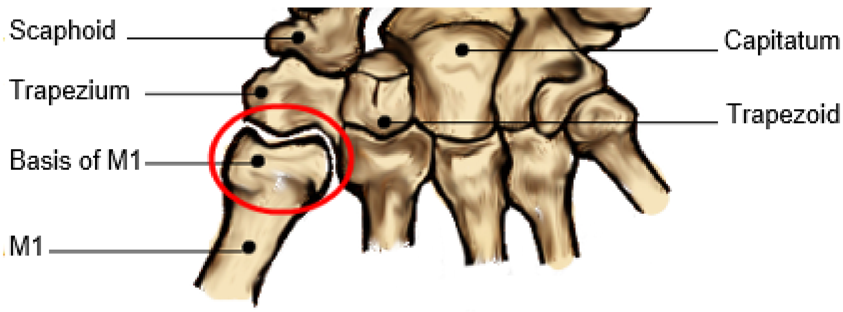


Figure 76: The right carpometacarpal joint of the thumb. Anterior view. M1 – first metacarpal bone.

Bicondylar joint

Two ovoid convex articular surfaces (condyles) of one bone articulate with corresponding articular surfaces of the other bone.

Example: the knee joint.

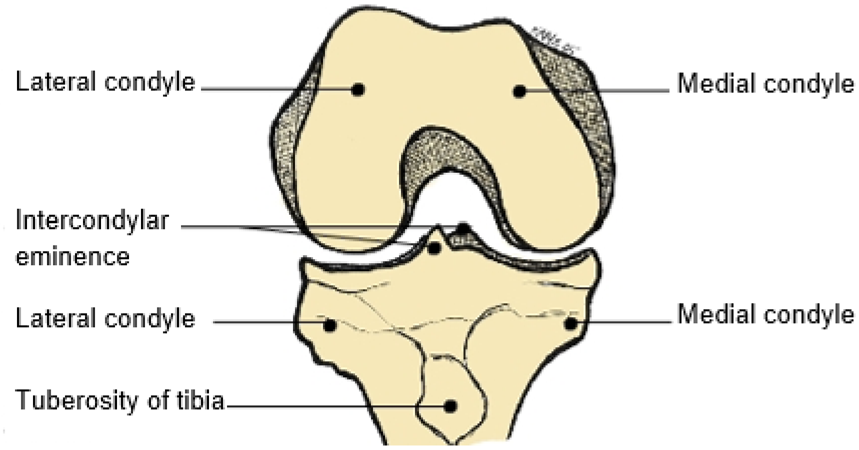


Figure 77: The knee joint in flexion (patella removed). Anterior view.

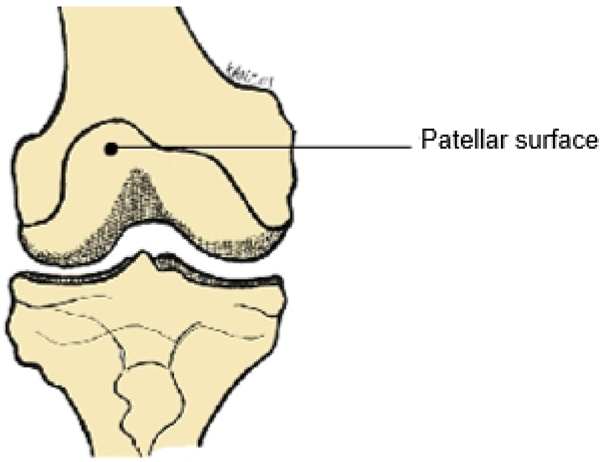


Figure 78: The knee joint in extension (patella removed). Anterior view.

In the knee joint, the condyles of femur and the condyles of tibia are not congruent. The stability of the joint depends on the menisci, ligaments and muscles.

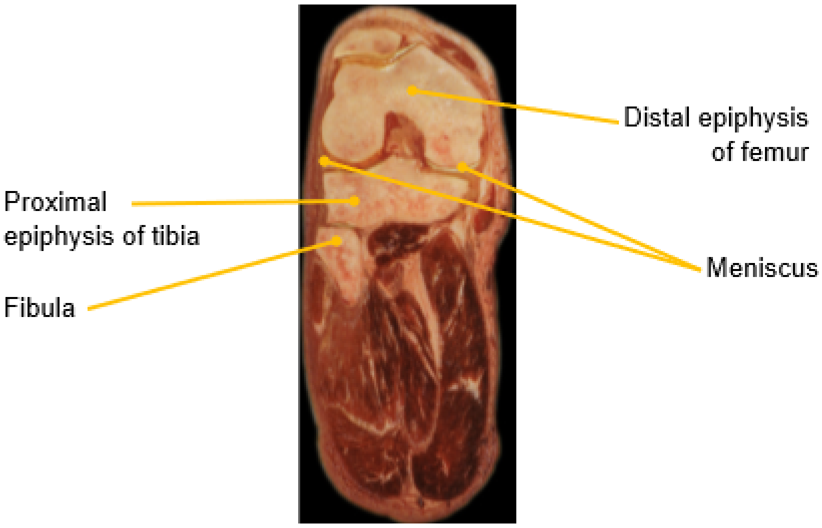


Figure 79: Frontal section of the knee joint in flexion. Anterior view.

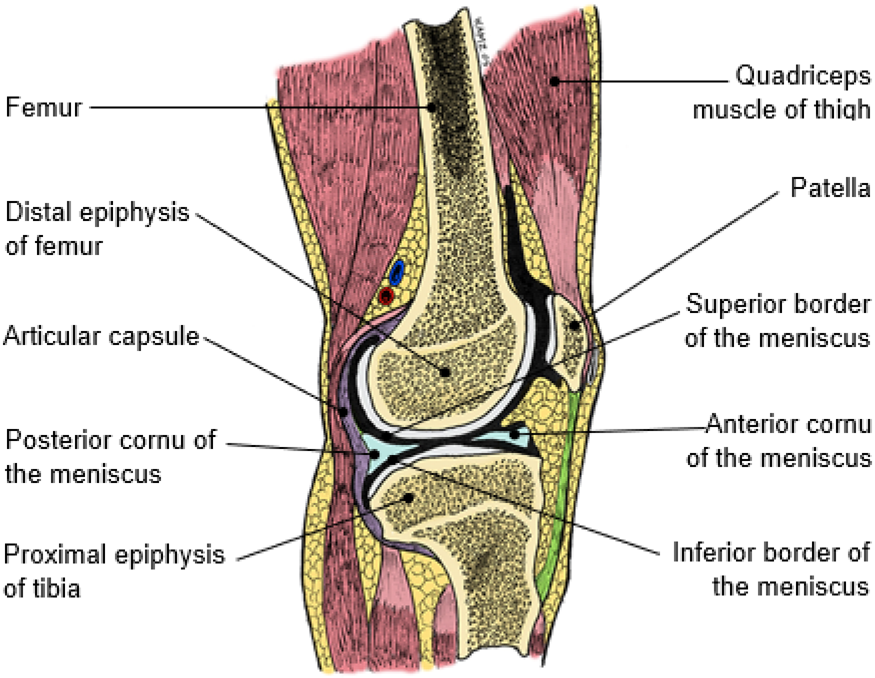


Figure 80: Sagittal section of the right knee.

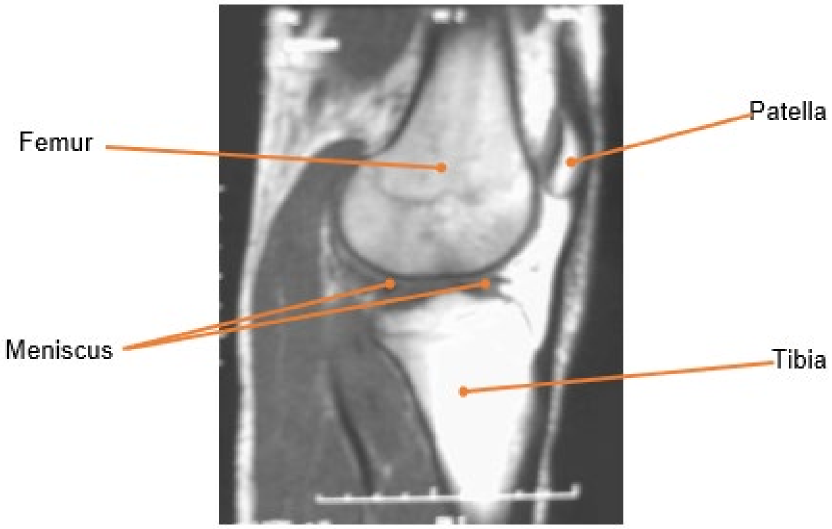


Figure 81: MRI, sagittal section of the right knee.

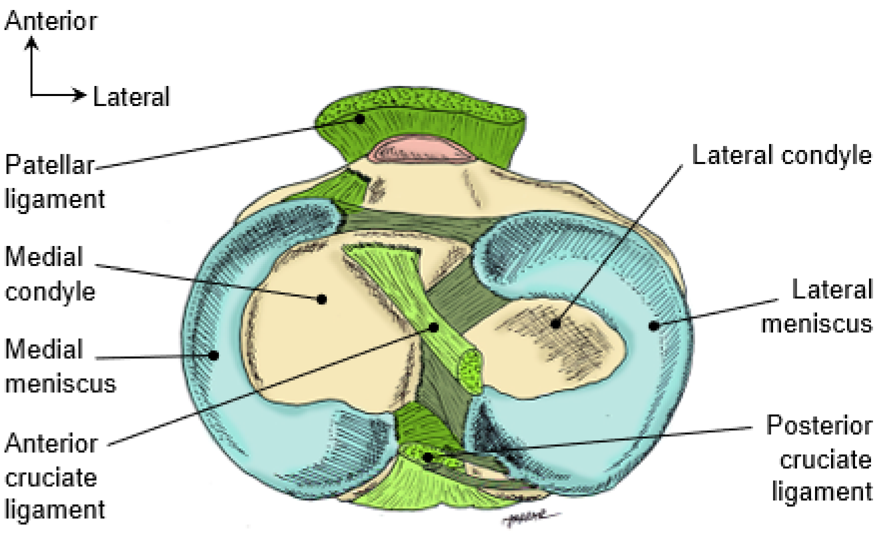


Figure 82: The right tibial plateau with the menisci. Superior view.

Figure 83: The left tibial plateau with the menisci. Superior view.

Hinge joint

A cylindric convex articular surface of one bone is perpendicular to the long axis of the bone and lies in a corresponding concavity of the other bone. Mobility is possible only in the sagittal plane, around single axis. Possible movements are flexion and extension.

Example: the humero-ulnar joint.

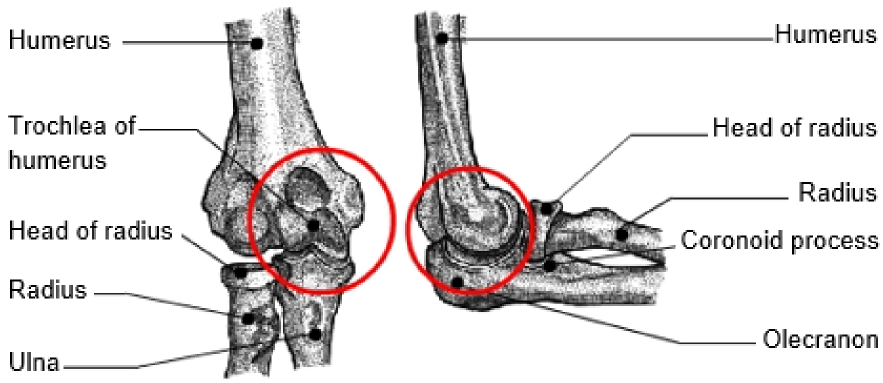


Figure 84: The right elbow joint. Anterior view in extension and left lateral view in flexion.

Although a hinge joint is stable, its dislocation is possible, but is usually accompanied by soft tissue trauma.

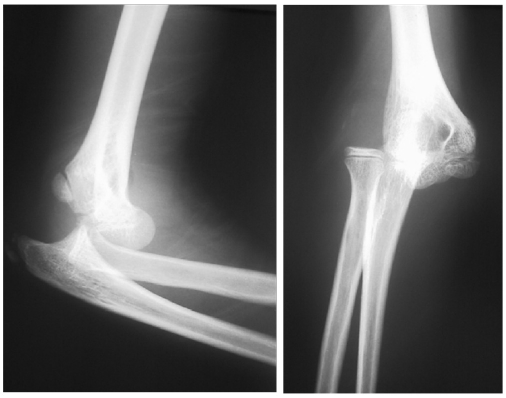


Figure 85: X-rays of the right elbow showing dislocation. Anterior and lateral projections.

Pivot joint

A cylindric convex articular surface of one bone is parallel to the long axis of the bone and lies in a corresponding concavity of the other bone. Mobility is possible around single, vertical axis. The possible movements are lateral and medial rotation

Example: the proximal and distal radioulnar joints. In the proximal radioulnar joint, the head of radius rotates in the radial incisura on proximal end of ulna. In the distal radioulnar joint, lower end of radius rotates around the head of ulna.

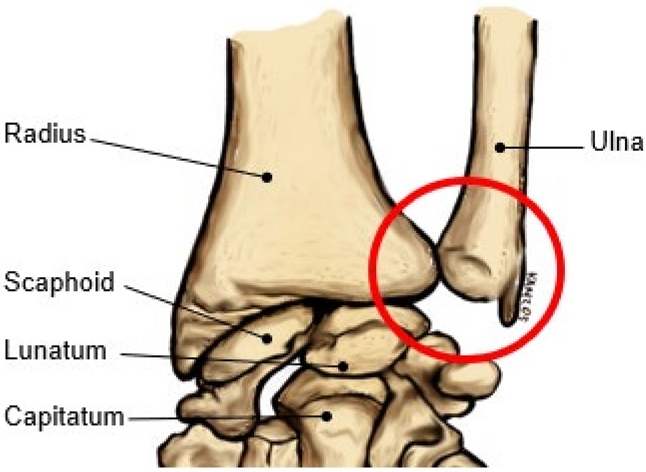


Figure 86: Distal radioulnar joint.

Plane joint

Articular surfaces of both bones are flat. The only possible movement is very restricted sliding or gliding. Movements are limited by tight joint capsule and strong ligaments.
Example: the acromioclavicular joint.

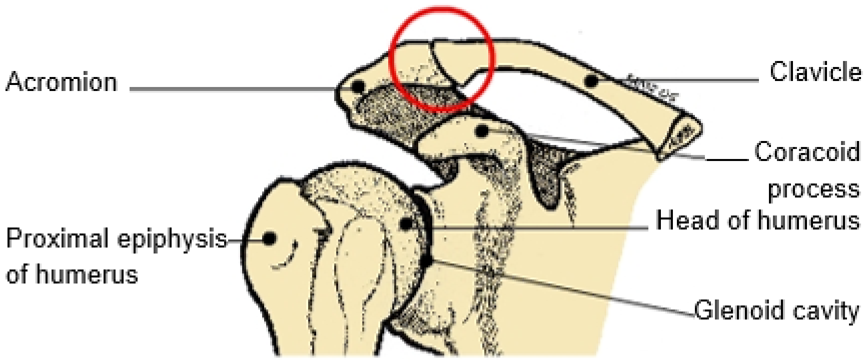


Figure 87: The right acromioclavicular joint. Anterior view.

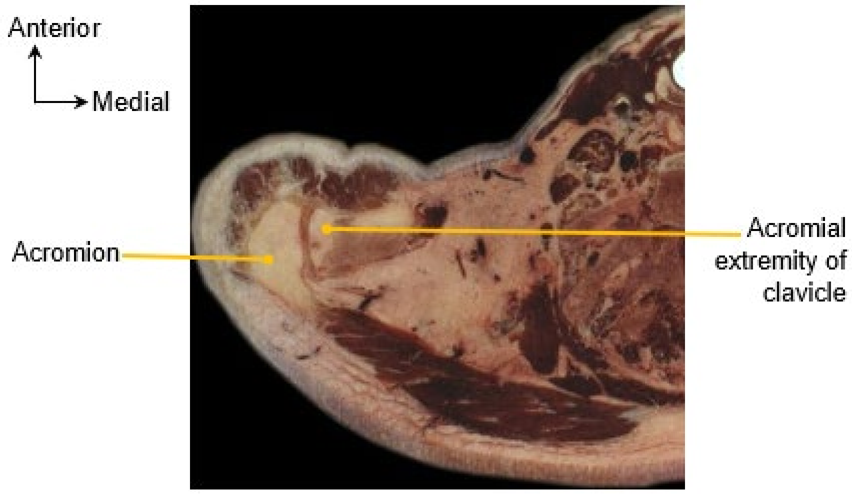


Figure 88: Cross-section of the right acromioclavicular joint. Inferior view.

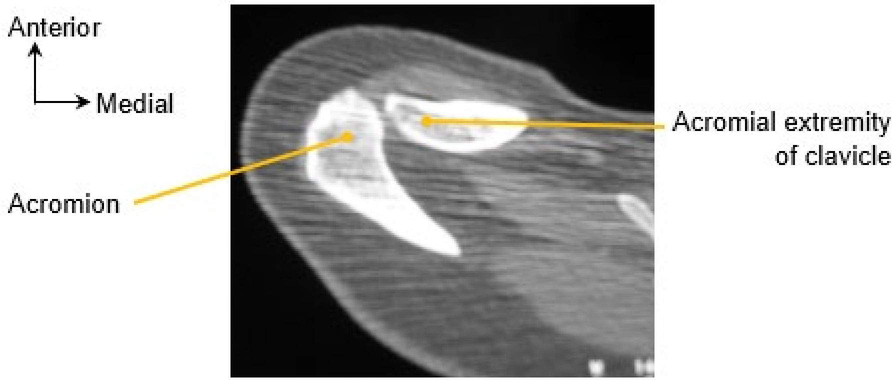


Figure 89: CT, cross-section of the right acromioclavicular joint. Inferior view.
Separations of this joint are frequent and often difficult to repair.

3 - The muscular system

The muscular system encompasses skeletal muscles, fasciae, synovial bursae and tendon sheaths. The main feature of muscles is their ability to contract.

Types of muscular tissue

The muscle is essentially composed of contractile muscle tissue interwoven with fibrous tissue. The muscle cells are also called muscle fibres, or myocytes.

There are three distinct types of muscle tissue: skeletal, smooth, and cardiac muscle tissue.

Striated (skeletal) muscle tissue has a stripped appearance under the microscope. It is innervated by somatic nervous system and contracts voluntarily. It is part of the muscular system.

Smooth muscle tissue does not have a stripped appearance under the microscope. It is innervated by autonomic nervous system and contracts involuntarily. It is mostly located in the wall of the hollow visceral organs (e.g. digestive tract, respiratory tract, urinary tract, blood vessels, etc.). It is part of the visceral and integrating systems.

Cardiac muscle tissue has a stripped appearance under the microscope, but with less stripes than the skeletal muscle tissue. It is innervated by autonomic nervous system and contracts involuntarily. It is located in the wall of the heart.

Skeletal muscles

The main functions of skeletal muscles are producing movements and maintaining the body posture.

The majority of skeletal muscles is attached to the skeletal system.

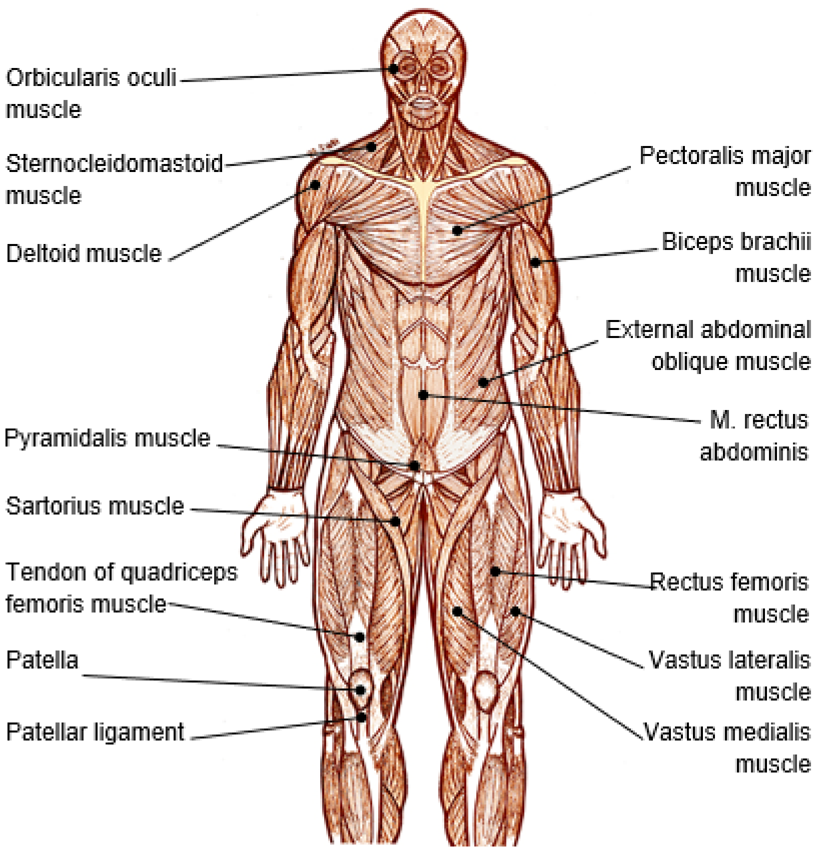


Figure 90: Skeletal muscles of the human body. Anterior view.

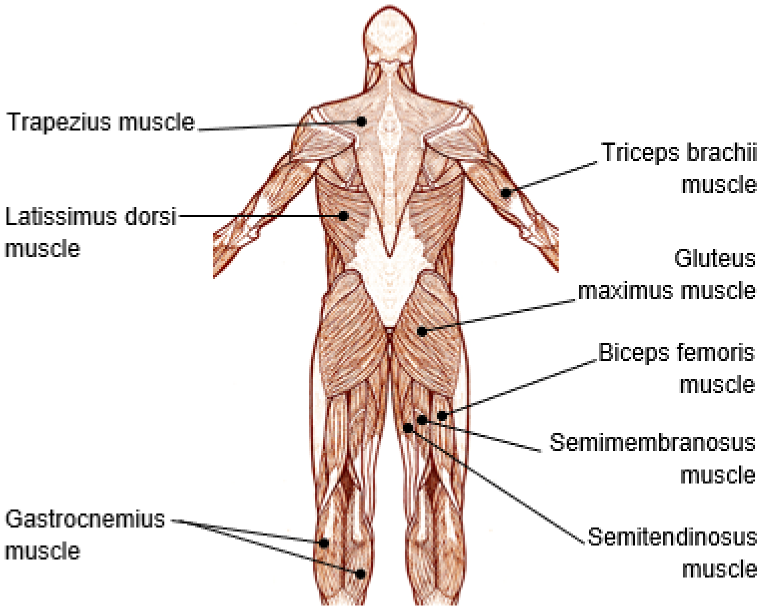


Figure 91: Skeletal muscles of the human body. Posterior view.

Figure 92: Hypertrophy of skeletal muscles.

Structure of skeletal muscles

Most skeletal muscles have fleshy contractile portion composed of striated skeletal muscle tissue and fibrous noncontractile portion composed of collagen fibres. The reddish contractile portion is called the belly, and white noncontractile portion is called the tendon. Muscles are typically attached to bones by tendons.

They may also have different shapes: we distinguish between flat muscles (e.g. latissimus dorsi muscle), fusiform muscles (e.g. sartorius muscle), circular or sphincter muscles (e.g. external anal sphincter), quadrate muscles (e.g. quadratus femoris muscle), multiheaded muscles (e.g. biceps brachii muscle, triceps brachii muscle), multi-bellied muscles (e.g. digastric muscle), etc. These characteristics determine the function of the muscles.

Figure 93: Flat muscle.

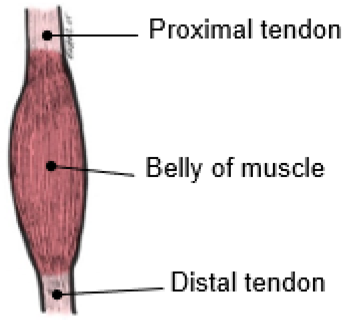


Figure 94: Fusiform muscle.

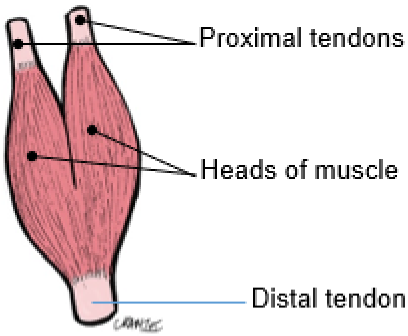


Figure 95: Bicipital muscle.

Figure 96: Biceps brachii muscle.

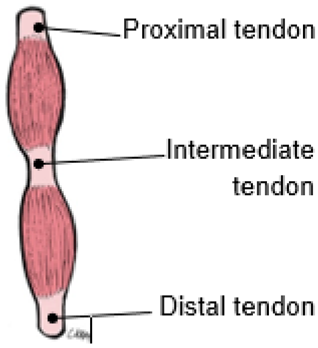


Figure 97: Digastric muscle.

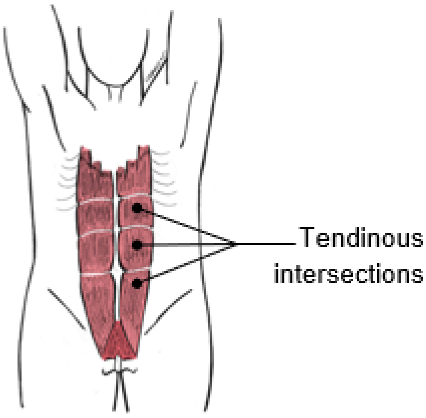


Figure 98: Rectus abdominis muscle.

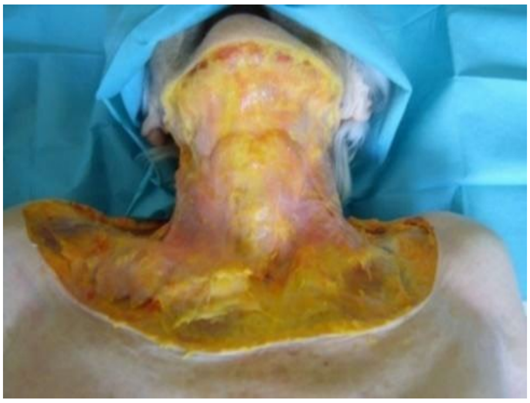


Figure 99: Neck dissection. Anterior view.

Figure 100: Dissection of the right femoral triangle showing anterior thigh muscles.

Figure 101: Dissection of the abdomen showing abdominal muscles.

Innervation of skeletal muscles

The innervation of skeletal muscles is both motor and sensory. Motor nerve fibres transfer the impulse for muscle contraction. Sensory nerve fibres transfer information from the receptors called the muscle spindles and Golgi tendon organs; they are involved in proprioception and protect the muscle from injury.

Motor neurons originate in the anterior horn of the spinal cord. Each muscle fibre is innervated by single motor neuron. The branches of one motor neuron can innervate several muscle fibres. Each individual motor neuron with all the muscle fibres that neuron innervates constitute a functional unit called the motor unit. The junction between the nerve ending at the muscle fibre is called a neuromuscular junction (motor end-plate). The transmission of signal for contraction from nerve fibre to muscle fibres is ensured by the neurotransmitter acetylcholine. The absence of acetylcholine is pathological and results in muscle weakness (myasthenia).

The force of contraction is determined by the number of muscle fibres contracting. The muscle fibres work in an on/off mode during contraction.

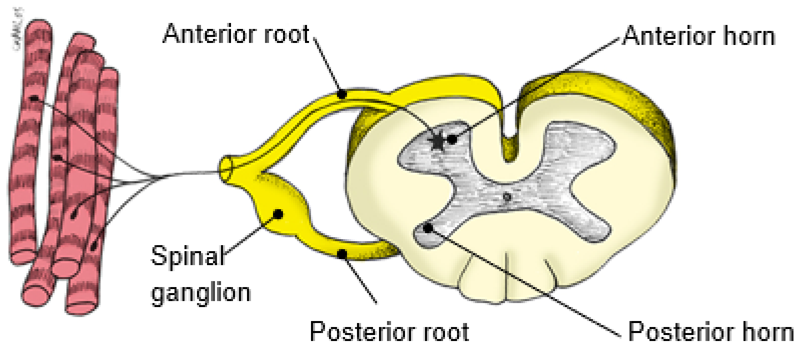


Figure 102: Motor innervation of skeletal muscles.

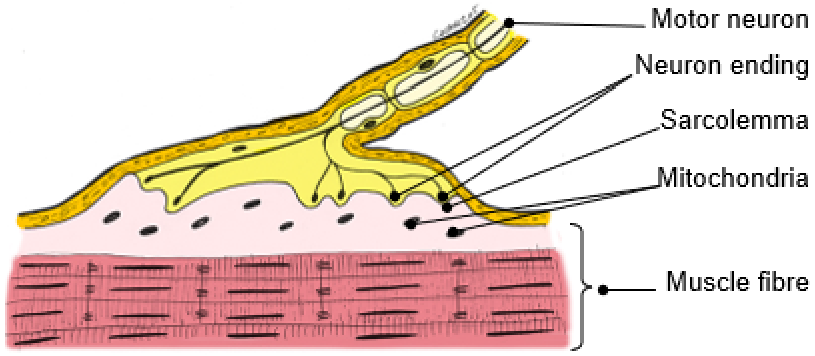


Figure 103: Motor end-plate

Muscles of upper limb

General overview of the muscle groups

The muscles are divided into compartments according to their topographical position. These compartments are delimited by fasciae. Compartments also contain the nerves and vessels.

Muscles perform different functions depending on their position. For example, the muscles in the anterior compartment of arm are flexors and the muscles in the posterior compartment of arm are extensors.

The muscles of the upper limb are divided in the following groups:

- scapulohumeral muscles,
- anterior compartment of arm,
- posterior compartment of arm,
- anterior compartment of forearm,
- posterior compartment of forearm,
- muscles of hand.

The movements of the upper limb are also enabled by the muscles of the back and the thorax.

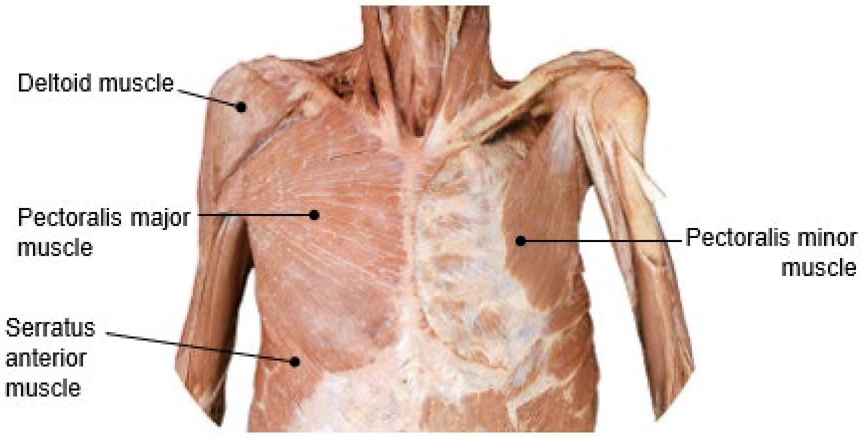


Figure 104: Muscles of thorax for the upper limb. Anterior view.

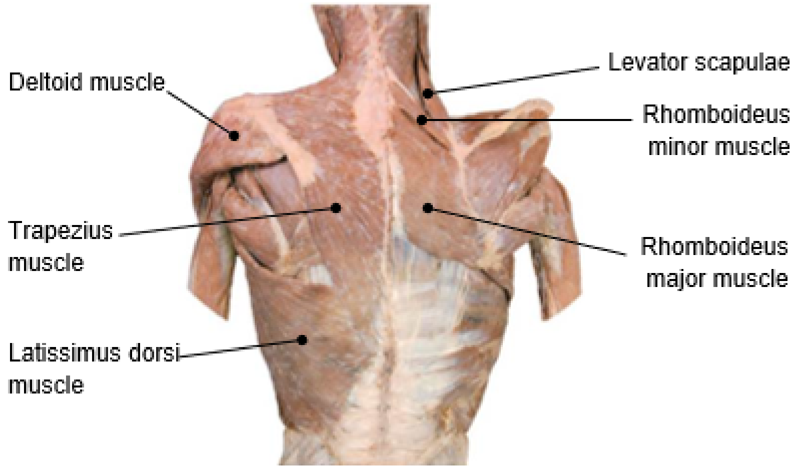


Figure 105: Muscles of back for the upper limb. Posterior view.

Organisation of muscles in compartments

On the arm, muscles are enveloped in the brachial fascia and divided in two muscle compartments: the anterior (flexor) compartment and the posterior (extensor) compartment. The two compartments are separated by the medial and lateral intermuscular septum of arm.

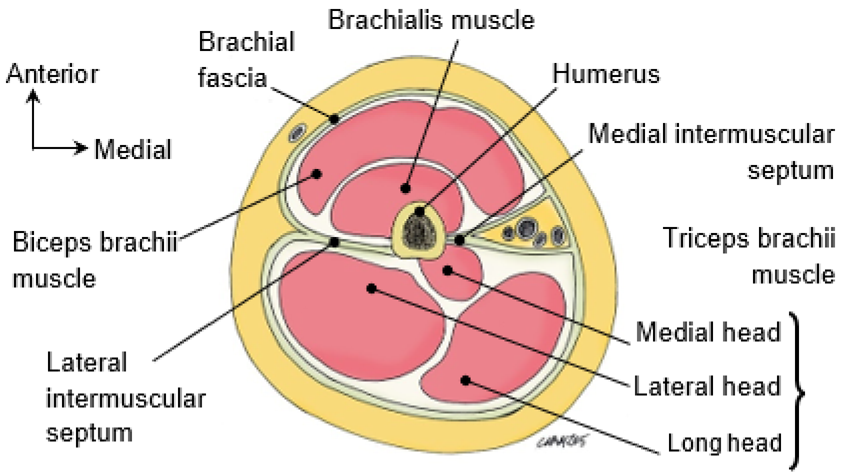


Figure 106: Schematic cross-section through the middle third of the right arm. Inferior view.

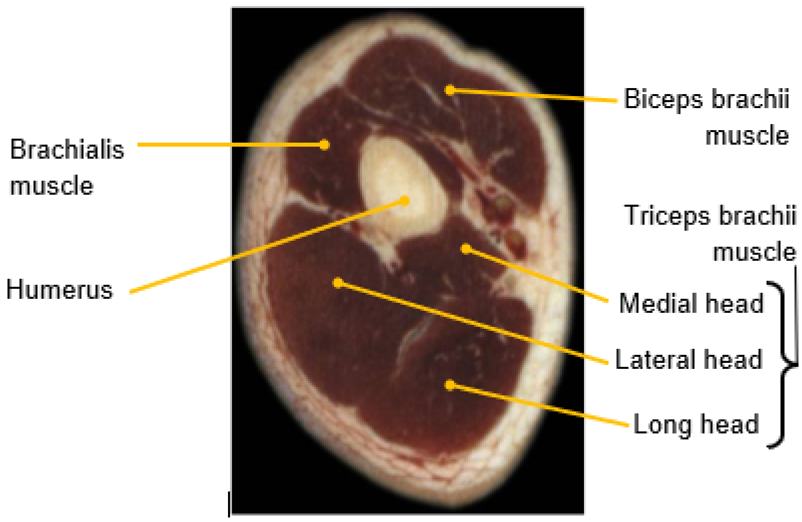


Figure 107: Cross-section through the middle third of the right arm. Inferior view.

On the forearm, muscles are enveloped in the antebrachial fascia and divided into anterior (flexor) and posterior (extensor) compartment. Each compartment is further divided into superficial and deep part. Muscles are numerous, enabling fine and precise movements of the hand and the fingers. In the anterior compartment lie two pronators, while in the posterior compartments lies the supinator.

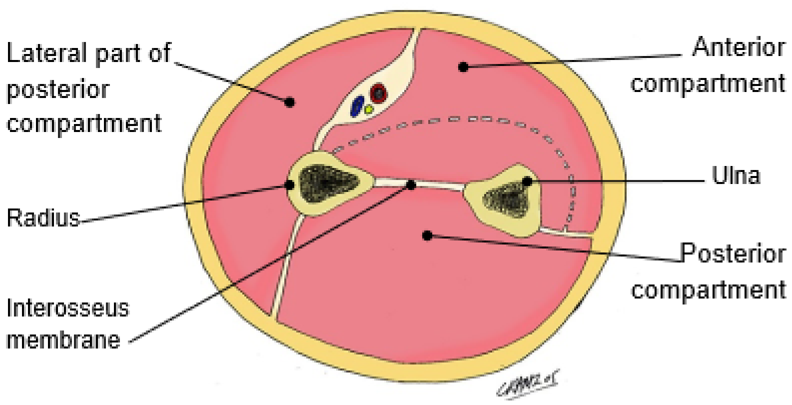


Figure 108: Schematic cross-section through the middle third of the right forearm. Inferior view.

Muscles of lower limb

General overview of the muscle groups

The muscles of the lower limb enable standing, walking, etc. They are divided into the following groups:

- Iliopsoas muscle,
- gluteal muscles,
- anterior compartment of thigh,
- medial compartment of thigh,
- posterior compartment of thigh,
- anterior compartment of leg,
- lateral compartment of leg,
- posterior compartment of leg,
- muscles of the foot.

Organisation of muscles in compartments

At the level of the gluteal region and the thigh, muscles are enveloped in the fascia lata.

In the gluteal region, muscles are divided in the superficial and deep gluteal muscles.

On the thigh, there are three muscle compartments separated by the medial and lateral femoral intermuscular septum. In the anterior compartment are mostly extensors of knee, in the posterior compartment are flexors of knee, and in the medial compartment are adductors of thigh.

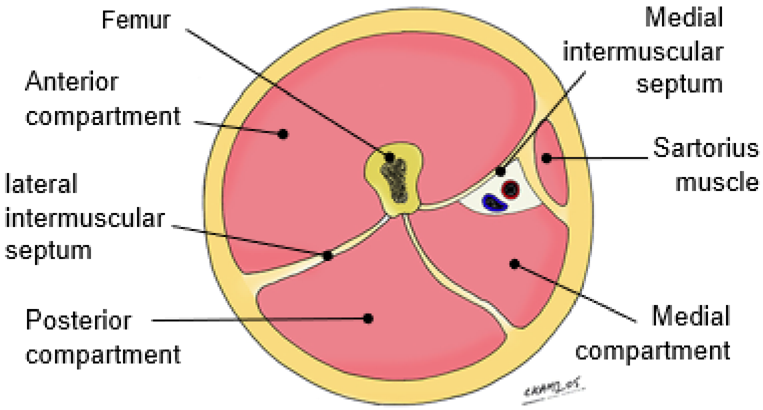


Figure 109: Schematic cross-section through the middle third of the right thigh. Inferior view.

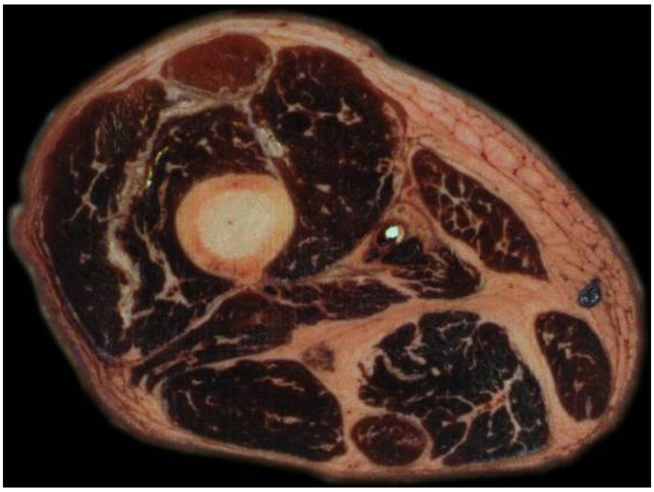


Figure 110: Cross-section through the middle third of the right thigh. Inferior view.

On the leg, muscles are enveloped in the crural fascia. They are separated into three compartments by the anterior and posterior intermuscular septum of the leg. In the anterior compartment, are the extensors of the foot and toes, in the posterior compartment are the flexors of the leg and toes, and in the lateral (fibular) compartment are the evertors of the leg.

The transverse crural intermuscular septum separates the posterior compartment into the superficial and deep part.

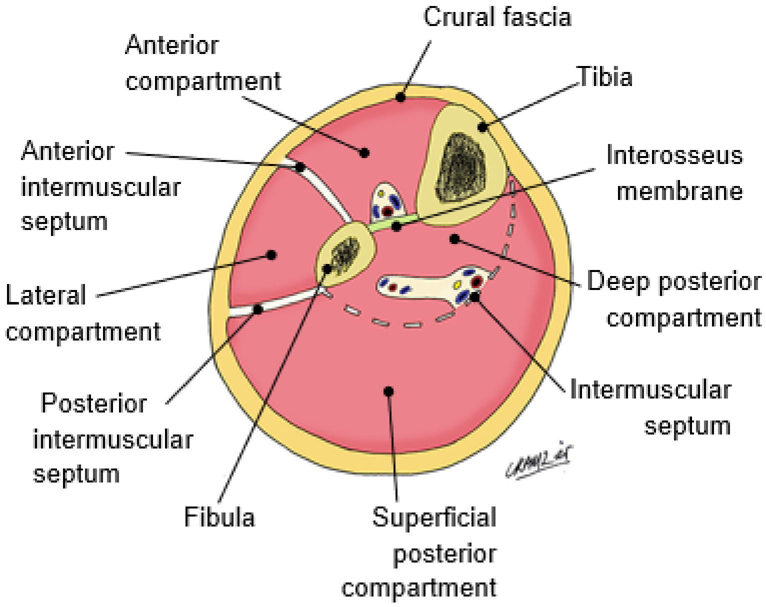


Figure 111: Schematic cross-section through the middle third of the right leg. Inferior view.

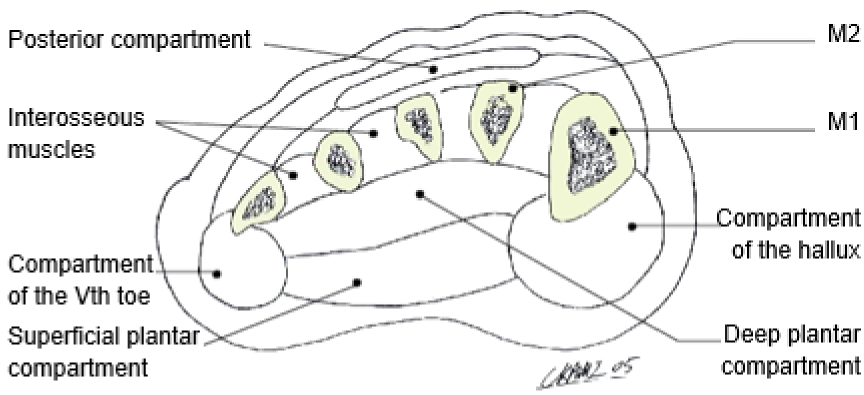


Figure 112: Schematic cross-section of the foot. M – metatarsal bone.

The photographs below show claw toes due to post-ischemic retraction of the leg muscles.

Right foot in profile ***Right foot from the front***

Figure 113: Volkmann syndrome.