1 Musculoskeletal tissues

Figure 1.1 Gross anatomy of bone

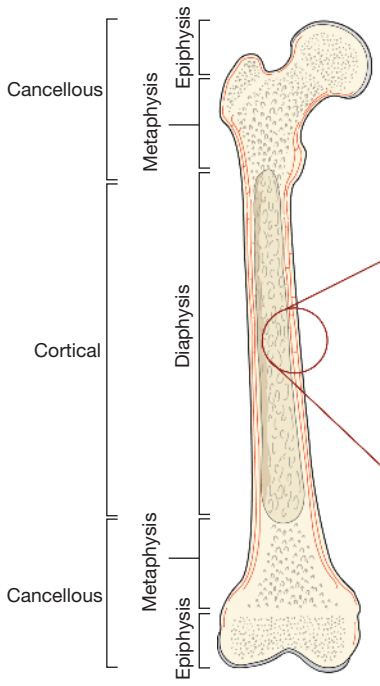


Figure 1.2 Cross-section of lamellar bone

Figure 1.3 An osteon

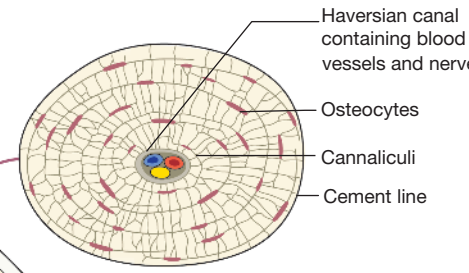


Figure 1.4 Articular cartilage

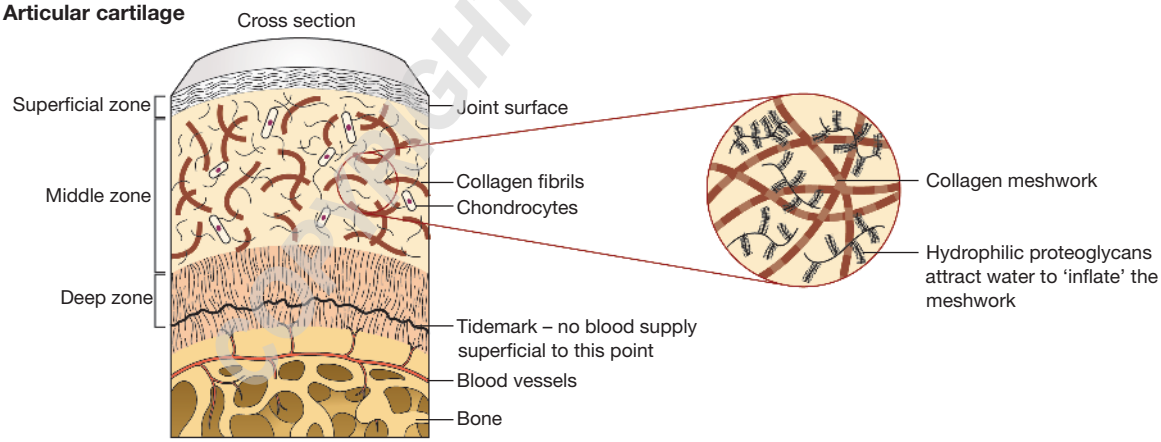
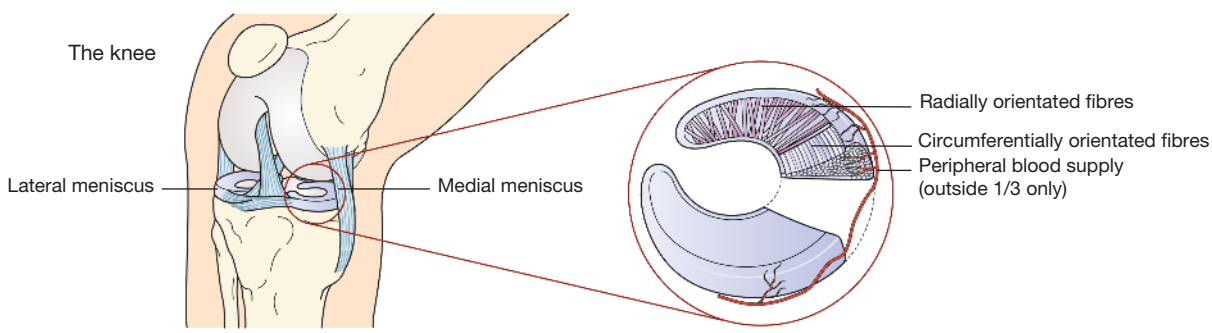


Figure 1.5 Meniscus



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Bone

Bone is living tissue and serves three functions:

- **Biochemical** – calcium and phosphate reservoir.
- **Haematological** – haemopoiesis
- **Biomechanical** – support of the limbs.

Bone is composed of **10% cells**, **90% matrix**.

- The **matrix** provides strength. It is itself composed of:
  - 40% **organic matrix** – sheets of collagen that resist tension;
  - 60% **inorganic matrix** – crystals of a compound called hydroxyapatite, which is a molecule compound of calcium and phosphate. It is good at resisting compression.
- The **cells** produce and maintain the bone and there are three types:
  - **Osteoblasts** – bone-forming cells, producing collagen.
  - **Osteocytes** – as osteoblasts lay down collagen, some become trapped within the matrix. These cells go into a dormant state, only reactivating if needed in the future.
  - **Osteoclasts** – bone-resorbing cells, derived from macrophages; they produce acid to dissolve bone. They are important for normal bone turnover and remodelling after fractures.

There are two types of bone in the body:

- **Immature** or **woven bone**, which is found in children's growing bones and fracture callus. The arrangement of collagen fibres is random and strength is therefore low.
- **Mature** or **lamellar bone**, which is normal adult bone. The collagen fibres are highly organised into sheets (called lamellae) and therefore the bone is very strong.

Lamellar bone can be subdivided into cortical or cancellous bone:

- **Cortical bone** is the densest and strongest form and makes up the hard outer surfaces of a long bone. The lamellae are arranged in rings called osteons (see Figure 1.3).
- **Cancellous bone** is found in the centre and metaphyseal regions of long bones. It is less strong and less dense, with a 'spongy' appearance. It contains many cells.

The surface of bones is covered with **periosteum**. This is composed of an inner **cambial layer**, which is very vascular and contains many osteoblasts, contributing to circumferential growth. The outer **fibrous layer** is strong and tough. It is continuous with joint capsules and ligament insertions. In children the periosteum is very thick, which is of clinical relevance when treating fractures.

Cartilage

Cartilage is a connective tissue produced by chondroblasts. There are three main types of cartilage: fibrocartilage; elastic cartilage and hyaline cartilage. Of particular interest to the orthopaedic surgeon is **hyaline cartilage**, which lines the ends of the bones within a synovial joint.

Hyaline cartilage is composed of ground substance and cells.

- **Ground substance** is made up of:
  - **Proteoglycans**, which are large molecules consisting of multiple sugar molecules attached to a protein backbone. They are very hydrophilic and attract water to keep the cartilage turgid.
  - **Collagen** in an interlinked meshwork of long molecules. This resists shear force and the meshwork is 'inflated' by the water-attracting proteoglycans to resist compression.
- **Cells** are mainly chondrocytes, which produce the proteoglycans and collagen.

Articular cartilage is highly structured and can be divided into distinct zones (see Figure 1.4). This specialised structure resists shear at the surface, and compression at the base. As a compound structure, the cartilage functions to:

- reduce friction between joint surfaces;
- assist in producing lubricating fluid;
- distribute load evenly across the joint surface.

Cartilage is avascular, aneural and alymphatic. This means that it cannot heal itself in the event of injury. If the injury is superficial to the tidemark, no healing will occur. If the injury extends below the tidemark, bleeding will occur. The defect will go on to heal with scar tissue, which is unspecialised and poorly structured fibrocartilage. Although not as good as hyaline cartilage, it is better than having a large defect. This is the principle by which microfracture works (see Chapter 3).

Meniscus

The menisci are found within the knee joint (although similar structures are also seen in the sternoclavicular and temporomandibular joints, these are of little clinical relevance to the orthopaedic surgeon). There are two crescenteric menisci in each knee – a medial and lateral meniscus.

They are composed of fibres of fibrocartilage, arranged in longitudinal and radial bands. They serve to:

- evenly distribute load across the knee joint, especially in flexion;
- absorb impact;
- aid in stabilising the knee.

Menisci can become torn, resulting in locking and clicking of the knee joint. The menisci have a poor blood supply. In adults, only the peripheral third is vascular. Therefore, unless a tear is within this zone, it will not heal. Most meniscal tears are therefore treated by excision of the torn segment. Once part of the meniscus has been lost, greater forces are transmitted to the articular cartilage, increasing the risk of developing arthritis in the future.

Ligaments and tendons

Ligaments connect bone to bone and stabilise joints. Tendons connect muscles to bone and act to convert muscle contraction into movement.

Ligaments and tendons are composed of longitudinally aligned collagen fibres and are very strong in tension. Ligaments are slightly more elastic than tendons. Over-stretching a ligament results in a sprain.