Connective tissue

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Connective tissue with solid intercellular substance

- **Cartilage, Bone**
- There are three types of cartilage:
  - **Hyaline** - most common, found in the ribs, nose, trachea. Is a precursor of bone.
  - **Fibro** - is found in invertebral discs, joint capsules, ligaments.
  - **Elastic** - is found in the external ear, epiglottis and larynx.
Cartilage

- Cartilage is a strong, flexible and semi-rigid supporting tissue.
- It can withstand compression forces, and yet it can bend.
- It is made up of cells called **chondroblasts** and **chondrocytes**, (chondro - cartilage) and
- **extracellular matrix**, made up about 10% **aggrecan**, 75% **water**, and a mix of **collagen fibres** and other constituents.
Cells

- The extracellular matrix of cartilage is secreted by chondroblasts, (chondro = cartilage), which are found in the outer covering layer of cartilage.

- Chondroblasts produce in rEPR matrix and fibres.
- Secrete them.
- Then they become trapped inside it, and mature into cells called chondrocytes.
n In growing cartilage, the chondrocytes can divide, and the daughter cells remain close together in groups, forming a 'nest' of 2-4 cells – isogenic group.

n The matrix enclosed compartments that they sit in are called lacunae. (lacunae = little lakes/small pits).

n The active chondrocytes have lots of rough endoplasmic reticulum.
The surface of most cartilage is covered by a layer of collagen connective tissue called the **perichondrium** (peri = around).

The outer layer of the perichondrium contains collagen producing fibroblasts, and

the inner layer contains chondroblasts.
Hyaline cartilage in the adult is found in the nose, parts of the respiratory tract, at the ends of ribs and at the articular surfaces of bones.
Hyaline cartilage

- This type of cartilage has a glassy appearance when fresh, hence its name, as *hyalos* is Greek for glassy.
- It looks slightly basophilic overall in H&E sections.
- **Hyaline cartilage** has widely dispersed fine collagen fibres (type II), which strengthen it. The collagen fibres are hard to see in sections.
- It has a **perichondrium**, and it is the weakest of the three types of cartilage.
Hyaline cartilage

- The chondrocytes are more evident and can be seen to be clustered in groups, called *isogenous groups*.
- Such isogenous groups reflect the last mitotic division of a chondrocyte whose daughter cells have not secreted much more matrix around themselves.
- Within the matrix, cartilage cells sit in spaces called *lacunae*.
Hyaline cartilage

- One chondrocyte in the periphery.
- 2-3 cells – deep in the middle of the cartilage.
- Metachromasia of the matrix
- Because of the GAGs.
Fibrocartilage

- This is the strongest kind of cartilage, because it has alternating layers of hyaline cartilage matrix and thick layers of dense collagen fibres oriented in the direction of functional stresses.

- This type of cartilage does not have a perichondrium as it is usually a transitional layer between hyaline cartilage and tendon or ligament.
Fibrocartilage

invertebral discs,
the cruciate ligament of the knee

- chondrocytes in lacunae,
- thick bundles of collagen fibres
- many rows of isogenous groups
Elastic cartilage

- In **elastic** cartilage, the chondrocytes are found in a threadlike network of **elastic fibres** within the matrix.

- **Elastic** cartilage provides strength, and elasticity, and maintains the shape of certain structure such.

- It has a **perichondrium**.
Elastic cartilage

In H&E sections, elastic cartilage looks the same as hyaline cartilage, so it has to be specially stained to show the elastic fibres. For example, the Van Giesen stain, orcein.

- Elastic cartilage is found in:
  - the external ear, the walls of the external auditory canal, the Eustachian tube, the epiglottis and the larynx.
Elastic cartilage

- No more 2 chondrocytes in the isogenic groups.
Bone is a connective tissue distinguished by the fact that its matrix is mineralized by calcium phosphate in the form of crystals very similar to hydroxyapatite.

The minerals are both in the (Type I) collagen fibers which constitute about 95% of the matrix, and in the ground substance.

Bone is both resilient and hard. Its resilience is due to the organic matter (collagen), its hardness due to the inorganic minerals.

There are two kinds of mature bone: compact bone and spongy bone.
Bone: *Types of cell found in bone.*

Cells that are involved in growing bone:
**Osteoblasts**, lining the surface of bone, secrete collagen
the organic matrix of bone (osteoid), which becomes calcified soon after it has been deposited.
As they become trapped in the organic matrix, they become **osteocytes**.

**Osteocytes** maintain bone tissue.
Fine processes from these cells ramify through bone, and form gap junctions with other osteocytes.
Osteocytes

- Osteocytes sit in the calcified matrix, in small spaces called lacunae (lacuna).

- Long processes from the osteocyte lie in small channels called canaliculi (small canals).

- These are channels for the transport of nutrients and waste.
Osteoclasts

Cells that are involved in remodelling, growth and repair of bone.

Large/giant multinucleated cells (simplasts), they are intimately associated with the surface of bone with a 'ruffled border' that resorbs bone matrix, a lot of lysosomes, prominent Golgi apparatus, and vesicles.

Secrete enzymes such as carbonic anhydrase, which hydrolyses the matrix.
Osteoclasts are **not** derived from osteoprogenitor cells. They are derived from blood monocytes/macrophages.
Compact bone and spongy bone are found in specific locations. In long bones, most of the thickness of the diaphysis is made of compact bone, with a small amount of spongy bone facing the marrow cavity. The ends (epiphyses) of long bones, however, consist mostly of spongy bone covered with a shell of compact bone. The flat bones of the skull have a middle layer of spongy bone sandwiched between two relatively thick layers of compact bone.
Compact bone is composed of cylindrical structures called osteons or Haversian systems.

An osteon consists of concentric lamellae of bone matrix, mainly collagen fibres, surrounding a central canal called the Haversian canal, which contains small blood vessels and nerves.

The collagen fibres within any one lamella are generally parallel with one another. Canals called Volkmann’s canals link the Haversian canals of different osteons with one another and with the marrow cavity. They provide the major route for blood vessels from the marrow cavity to the Haversian canals of osteons.
Between the lamellae of an osteon are lacunae containing bone cells called osteocytes. Canaliculi connect the lacunae with one another and with the Haversian canal. The canaliculi contain the processes of the osteocytes, which communicate with one another via gap junctions.

Thus nutrients and other substances, such as hormones, can pass from blood vessels in the Haversian canal to distant osteocytes via a sort of bucket brigade.