

III- Cartilage and Bone Tissue

III-1- Cartilage

Cartilage tissues are skeletal connective tissues of mesenchymal origin, composed of cells called chondrocytes. These chondrocytes are associated with fibers and a ground substance. The fibers and ground substance together constitute the extracellular matrix of cartilage tissue. In adults, there are three types: hyaline cartilage; elastic cartilage; fibrous cartilage.

III-1-1- Description of Cartilage Tissue

1- Cells of Cartilage Tissue

Chondrocytes, or cartilage cells, have a large nucleus. Their cytoplasm is granular and contains glycogen and lipid inclusions. Chondrocytes are isolated within small lacunae or chondroplasts (the cavity where the chondrocyte resides). Most often, one chondrocyte is observed per chondroplast.

Chondrocytes synthesize tropocollagen molecules and ground substance, which gives cartilage its characteristics of rigidity and plasticity.

2- The ground substance of cartilage tissue

It is translucent, whitish, and has a semi-solid, resistant, and elastic consistency.

3- The fibers of cartilage tissue

Collagen and elastic fibers can be observed in cartilage. They have the same structure as those found in connective tissue.

III-1-2- Classification

Several types of cartilage are distinguished, differing in the relative proportions of their fundamental components: hyaline cartilage, fibrous cartilage, and elastic cartilage.

1- Hyaline Cartilage

It is the most widespread type of cartilage tissue; the matrix of hyaline cartilage has a homogeneous appearance. It is composed of collagen fibrils and the ground substance.

It is present in fetuses, where it constitutes the largest part of the skeleton, and therefore plays an important role in bone development. In children, its contribution to the skeleton gradually decreases with growth, while in adults, it is less abundant and located primarily in the articular cartilages, the nose, the trachea, the larynx, and the inner ear.

2- Elastic Cartilage

This cartilage contains not only collagen fibers but also numerous elastic fibers. It is found in the auricle (outer ear) and external auditory canal, as well as the laryngeal cartilage. Elastic

cartilage is yellow due to its high elastic fiber content. It is more elastic than hyaline cartilage and can undergo significant deformation.

3- Fibrous Cartilage

This cartilage is reinforced by thick bundles of collagen fibers. It withstands very high pressure while maintaining a degree of elasticity. In humans, it is located in the intervertebral discs and the menisci of the knee. It also forms large tendons. The matrix contains numerous collagen fibers visible under a light microscope. The chondrocytes are more or less spindle-shaped.

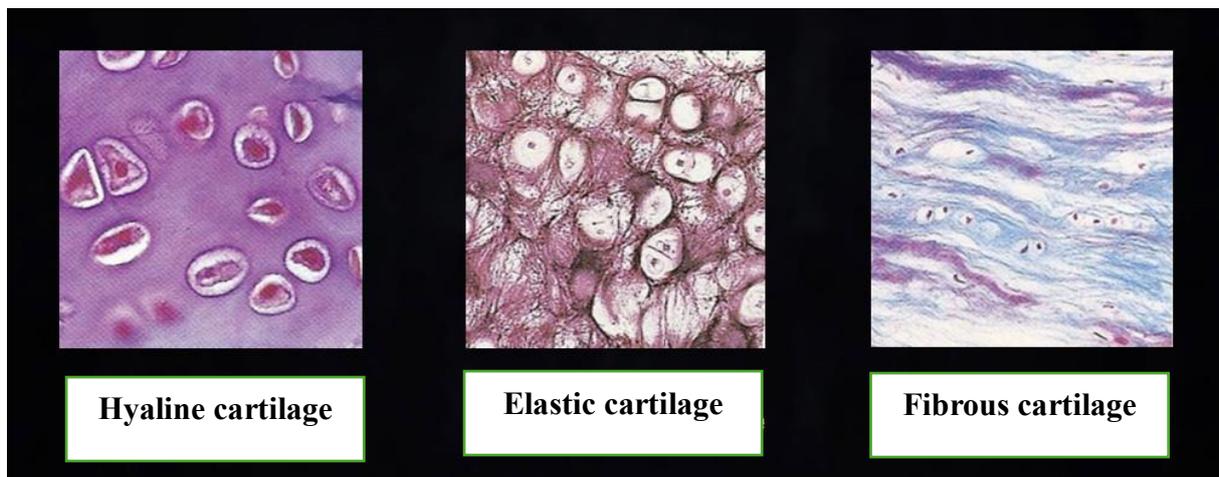


Figure: Types of cartilage

III-2- Bone Tissue (Bone)

Bone tissue, like cartilage tissue, is a "skeletal tissue," a specialized connective tissue characterized by the solid nature of its extracellular matrix (ECM). The bone matrix has the particularity of calcifying. It derives from mesoderm.

III-2-1- The functions of bone tissue

Bone tissue has 3 functions:

1- Mechanical function (protection): bone tissue is one of the strongest tissues in the body, capable of withstanding mechanical stresses, giving bone its role in supporting the body and protecting organs.

2- Metabolic function: Bone tissue is a dynamic tissue, constantly remodeled under mechanical pressure, leading to the release or storage of mineral salts, and thus largely ensuring (in conjunction with the intestines and kidneys) the control of calcium and phosphate metabolism.

3- Hematopoietic function: Bones contain, within their medullary spaces, hematopoietic marrow, whose stem cells, which give rise to the three lineages of blood cells, are located in close proximity to bone cells.

III-2-2- Description

III-2-2-1- Bone Cells

There are two types of cells: bone-forming cells and bone-resorbing cells.

1- Bone-forming Cells

These cells build bone tissue.

a- Lining Cells

These cells line all bone surfaces in adults. They do not have synthetic activity. Under the influence of stimuli, these cells are capable of multiplying and differentiating into active osteoblasts.

b- Osteoblasts

These are young cells. They represent long, thin cytoplasmic extensions, and their cytoplasm is very rich in organelles. These cells are located on the surface of growing bone areas and are involved in the biosynthesis of collagen fibers and most of the constituent elements of the matrix or osteoid substance. Therefore, the osteoblast's function is the mineralization of bone substance.

c- Osteocytes

These are differentiated osteoblasts, incapable of dividing completely, surrounded by the mineralized bone extracellular matrix (ECM). Osteocytes reside in locules (osteoplasts). They participate in maintaining the bone matrix and contribute to calcium homeostasis.

2- Osteo-resorbing cells

- Osteoclasts

These are located on the surface of bone tissue in areas of resorption. They are very large cells, round or oval in shape, multinucleated (containing 30 to 50 nuclei). The cytoplasm contains numerous lysosomes; the pole in contact with the bone matrix has a well-developed brush border, which delimits a space: this is the digestive chamber.

Unlike the previous cells, these cells have the role of breaking down bone tissue.

III-2-2-2- Ground Substance

It consists of an organic component (25%) containing glycoproteins, a mineral component (70%) containing mineral salts responsible for the rigidity of the bone matrix (calcium salts, carbonates, citrates, calcium phosphates, etc.), and very little water (5%).

III-2-2-3- Fibers

Collagen fibers are the fibers found in bone tissue.

III-2-3- Types of Bone Tissue

1- Compact (Haversian) Bone Tissue

It is primarily composed of osteons, or Haversian systems, made up of cylindrical bone lamellae arranged concentrically around the Haversian canal. Between the lamellae are the osteoplasts, which contain the cell bodies of the osteocytes. The Haversian canal contains blood capillaries and nerve fibers.

2- Spongy bone tissue

Spongy bone tissue is mainly located in short bones and flat bones (sternum, iliac wings) as well as in the epiphyses of long bones.