Cartilage

It is a specialized form of connective tissue, and like all connective tissues is composed of cells called chondrocytes and extensive extracellular matrix which composed of fibers and ground substance. It differs from other types of connective tissue in the rigidity of the matrix. In cartilage, the ground substance is composed of **chondronectin**, which it is glycoprotein also it is rich in chondroitin sulfate. The matrix also contains collagen and elastic fibers that increase the tensile strength and the elasticity and adapt the tissue to the mechanical requirements.

The cartilage is avascular, no nerves or blood and lymphatic vessels. The nutrition occurs by diffusion nutrients from blood vessels in adjacent connective tissue which called **perichondrium**. The perichondrium is a sheath of dense connective tissue that harbors the vascular supply for the avascular cartilage and also contains nerves and lymphatic vessels. The **articular cartilage** that devoid from perichondrium its nutrition occurs by diffusion of oxygen and nutrients from the synovial fluid in joints. ted by the cartilage.

Generals functions of cartilage

1-To support soft tissues

2-Facilitating bone movements by provides chock absorbing and sliding area for joints.

3-It is important for the development and growth of long bones both before and after birth.

The classification of cartilage

There are three types of cartilage: hyaline cartilage, elastic cartilage, and fibrocartiage according the kind and abundance of fibers within the matrix.

1- Hyaline cartilage

It is the most common type of cartilage and widely distributed in the body. The fresh hyaline cartilage is bluish-white and translucent. In the embryo nearly all the skeleton is composed of hyaline cartilage which is replaced later by bone. In the adult, this cartilage is located in the walls of larger respiratory passage (nose, larynx, trachea), in the ventral ends of ribs, in the trachea and bronchi, and in the articular surfaces of bones within joints.

The matrix of hyaline cartilage is basophilic in appearance. It is composed of type II collagen fibers, and proteoglycans which is composed of **chondroitin sulfate**. In addition to the glycoprotein **chondronectin**, The matrix appears amorphous, homogenous in the fresh condition. The matrix contains type II collagen that arranged in interlacing network of fine fibrils, and due to the ground substance and the type II collagen fibers have the same refractive index. There is concentrated of the cartilage matrix around each lacuna which is rich in glycosaminoglcans and poor in collagen, this zone called the **territorial or capsular matrix.**

Chondrocytes are specialized cells that synthesize and secrete the extracellular matrix, and the cells themselves are located in the small cavities called lacunae within the matrix. These cells are ovoid or rounded in shape containing large, spherical centrally placed nucleus with one or more nucleoli.

The cytoplasm is granular and basophilic. These cells may be arranged single or in groups. The group consist of 2,4, or 8 cells within single lacuna (Figure 1). Each group representing the offspring of a single parent chondrocytes that originating from mitotic divisions this called **isogenous group** or **cell nest**.

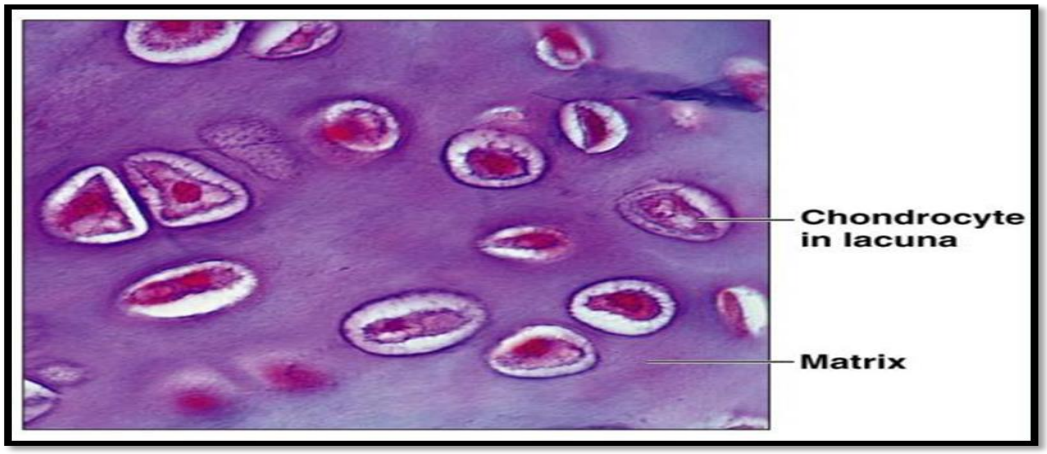


Figure (1): The structure of chondrocytes.

All the periphery of cartilage, the cells are ovoid and flattened parallel to the surface and these cells are called **young chondrocytes**. The other cells are **chondroblasts** and **chondrogenic** cells, both of which are in the perichondrium (Figure 2).

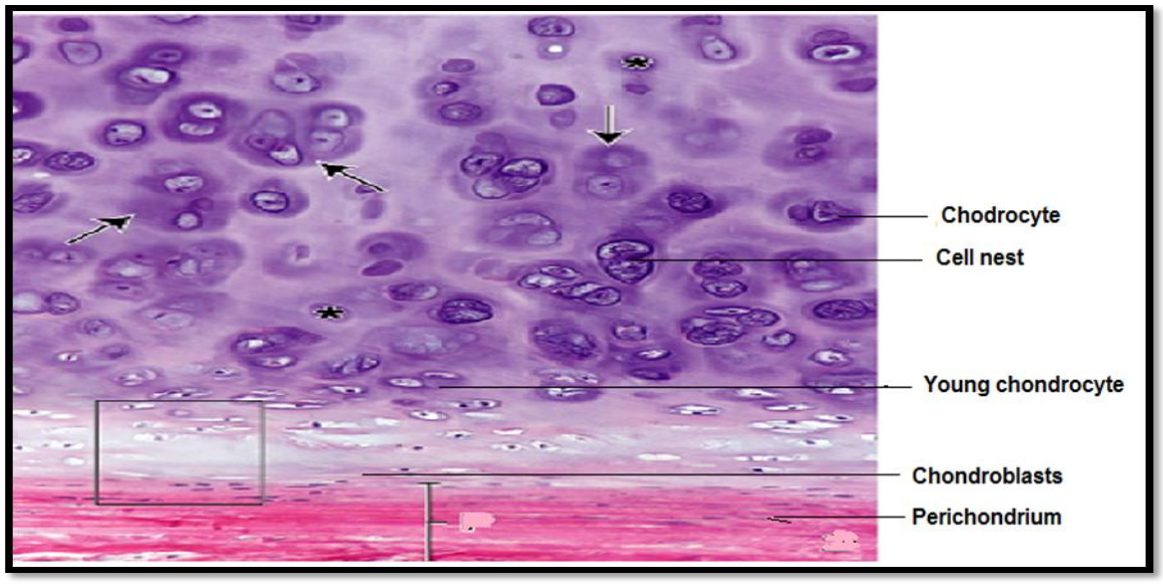


Figure (2): The characteristic features of hyaline cartilage.

The hyaline cartilage is surrounded by capsule like sheath of dense connective tissue called **perichondrium**. The outer layer is dense irregular connective tissue containing numerous fibroblasts. The inner layer is more delicate has fewer fibers and contain cells resemble fibroblasts called **chondrogenic** cells. These cells are spindle shaped, with ovoid nucleus. The cells undergo division and differentiate into chondroblasts. **Chondroblasts** can differentiate then into chondrocytes. The blood vessels and nerves occupy the outer layer of perichondrium and the nutrients must diffuse through the cartilage matrix to reach the **chondrocytes**. This sheath is essential for the growth and maintenance of cartilage.

Articular cartilage is made of hyaline cartilage that lacks the perichondrium. In this cartilage, the collagen fibers are first perpendicular and then bend gradually, forming a broad arch parallel to the cartilage surface. More deeply located chondrocytes are arranged in vertical rows. Superficially placed chondrocytes are flattened and are no longer organized in arrangements (Figure 3).

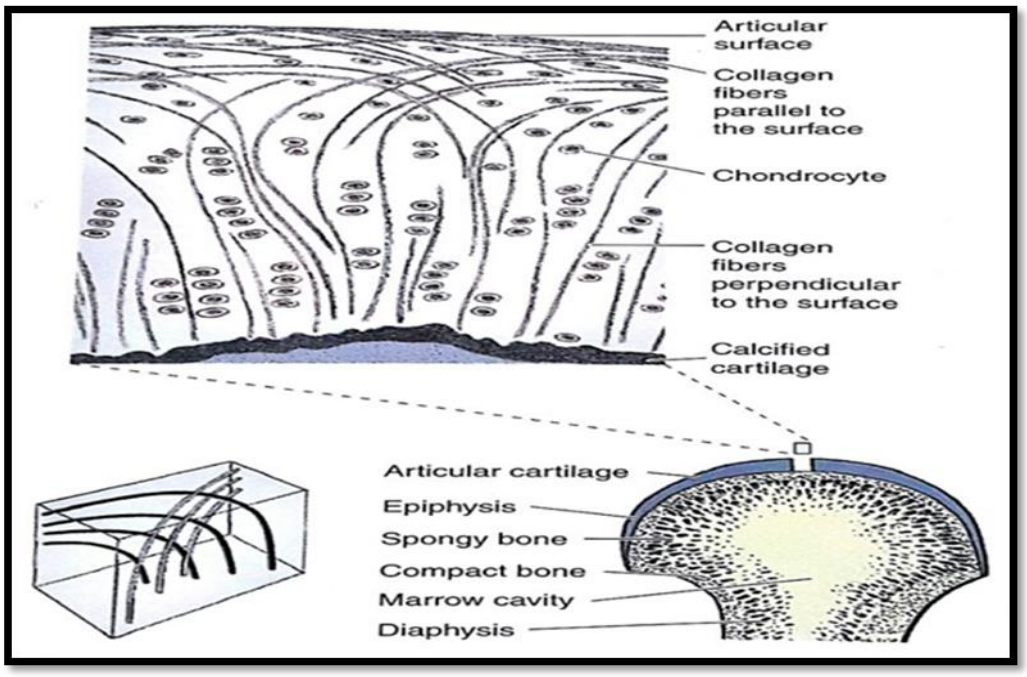
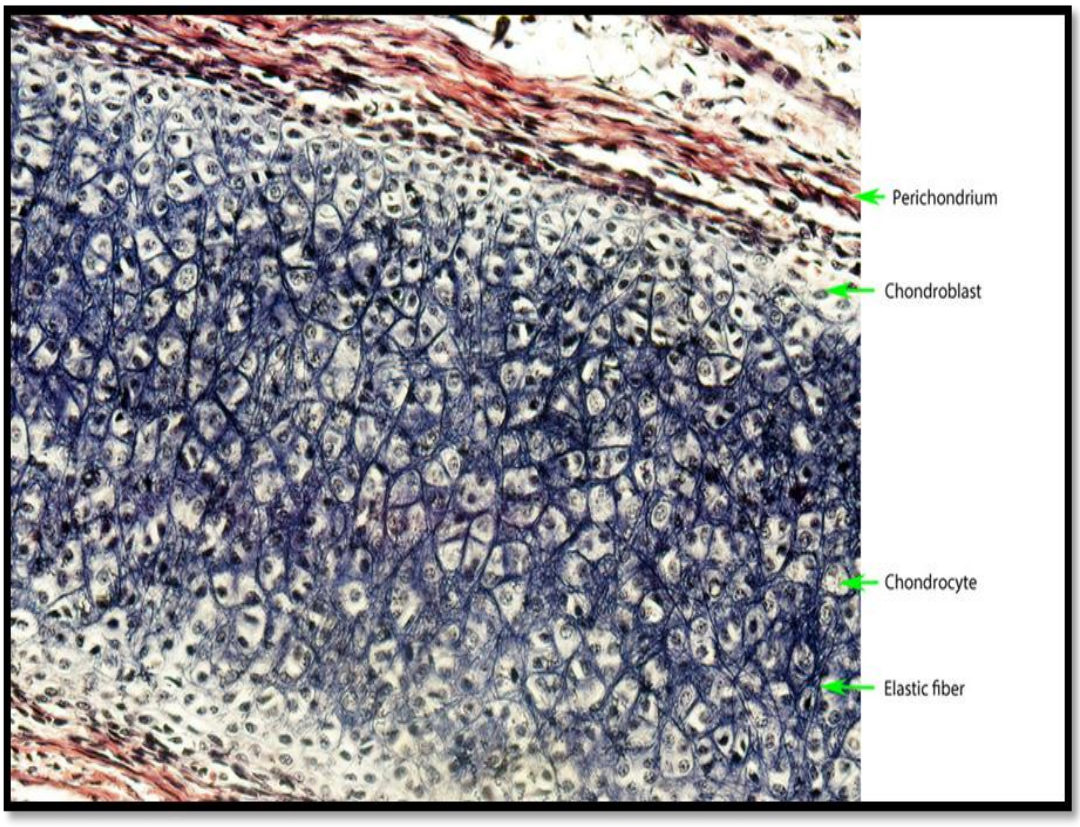


Figure (3): Articular cartilage.

2-Elastic cartilage

This cartilage is found in the auricle of the ear, the walls of the external auditory canal, the auditory tube, the epiglottis and certain cartilages of the larynx. The type is found in areas where support and flexibility is needed.

Elastic cartilage in fresh state appear yellowish in color due to the presence of elastin in the elastic fibers. It is essentially identical to hyaline cartilage except that it contains an abundant network of branching elastic fibers in addition to collagen II fibers. The chondrocytes are more abundant and larger than those of hyaline cartilage. This cartilage also surrounded by a perichodrium (Figure 4).



Figure(4): The characteristic features of elastic cartilage.

3-Fibrocartilage

This type is found in areas where a tough support or tensile strength is required. This cartilage present in intervertebral disks, in articular disks, in attachments of certain ligaments to bones.

This tissue is combination between dense connective tissue. and hyaline cartilage. This cartilage is composed of small regions of hyaline cartilage in which chondrocytes aligned either singly or in isogenous groups, but commonly is short rows alternating with thick coarse bundles of dense collagen fibers either running parallel with one another along the columns of chondrocytes or forming irregular bundles between these columns (Figure 5). The matrix of fibrocartilage is acidophilic where it contains a great numbers of coarse type I collagen fibers. This cartilage lacks perichondrium.

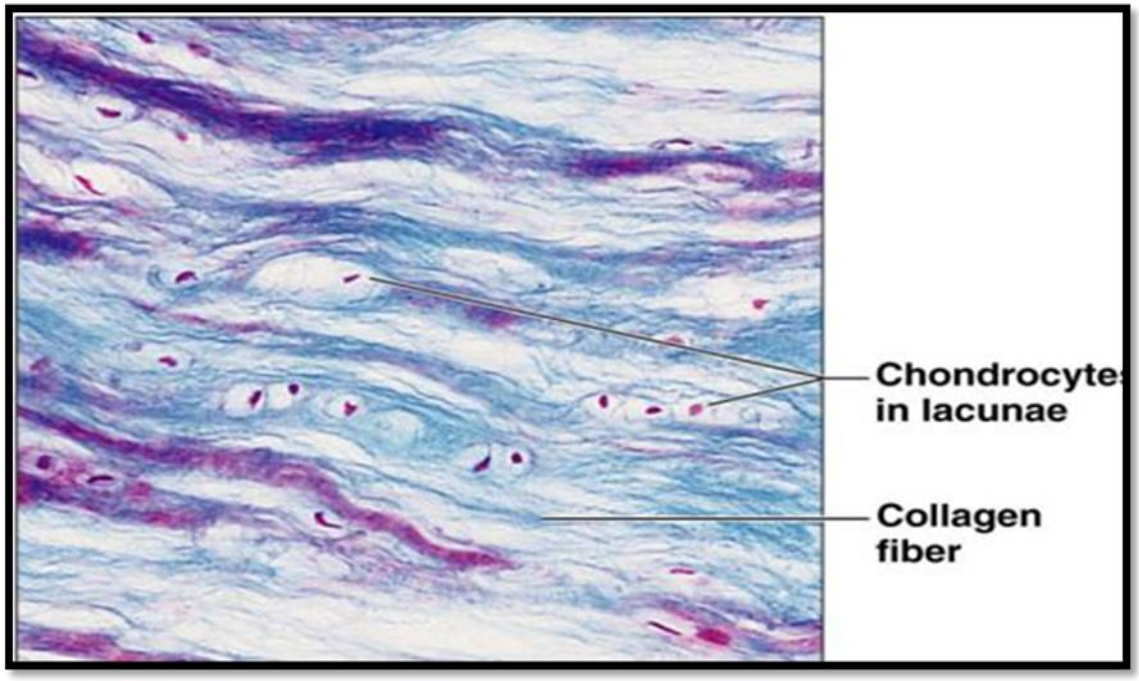


Figure (5): The characteristic features of fibrocartilage.

Development and growth of cartilage

The cartilage develops, like other types of connective tissue from the mesenchyme. The first modification aggregation of mesenchymal cells occurs within the matrix. These cells differentiate into chondroblasts which synthesis and deposit the ground substance around themselves then begin to separate from one another. These cells are more differentiate and become more separated due to increase in the elaboration of matrix around them. These cells become chondrocytes which surrounded by lacunae within the matrix. The differentiation of cartilage take place from the center outward, therefore the central cells are chondrocytes, whereas the peripheral cells are chondroblasts. The mesenchymal cells surrounding the developing cartilage are differentiate to form fibroblasts. These cells manufacture a dense irregular connective tissue called perichondrium.

Continued growth of cartilage occurs by two methods:

1-Interstitial growth (endogenous growth)

It is resulting from the mitotic division of preexisting chondrocytes. This growth less important than appositional growth and occur only during the early phases of cartilage formation, when it increases tissue mass by expanding the cartilage matrix from within. The young chondrocytes retain the ability to divide and proliferation and manufacture a new matrix. These cells pushed away from each other, forming separate lacunae and this enlarge the cartilage from within (Figure 6).

Interstisial growth also occurs in the epiphyseal plate of long bones and within articular cartilage. In the epiphyseal plate, interstitial growth is

important in increasing the length of long bones and in providing a cartilage model for endochondral bone formation.

2-Appositional growth (exogenous growth)

This process in which a new layers of cartilage are added to one surface. It results from activity within the inner layer of the perichondrium. The chondrogenic cells in the perichondrium undergo division and differentiate into chondroblasts which begin to elaborate the matrix (Figure 7). Then these cells differentiate into chondrocytes which become more surrounded themselves by the matrix that increases in it mass.

Repair of cartilage

The cartilage has limited ability for repair, damaged cartilage have inability to heal even in most minor injuries, This is due to limited ability of mature chondrocytes to proliferate.

Some repair can occur, but only if the defect (or injury) involves the perichondrium, where the repair results from the activity of chondrogenic cells that located in the perichondrium, where in this case few cartilage cells are produced. Repair mostly involves the production of dense connective tissue.

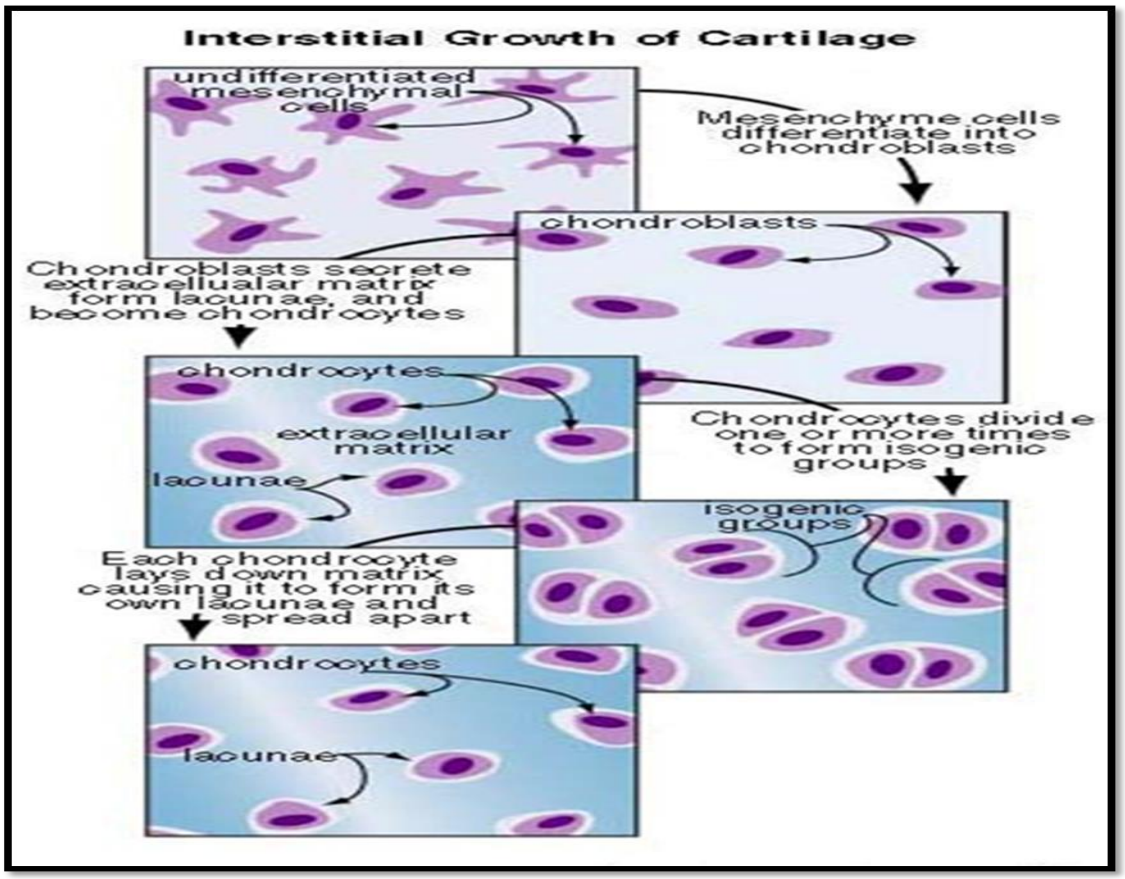


Figure (6): The Interstitial growth.

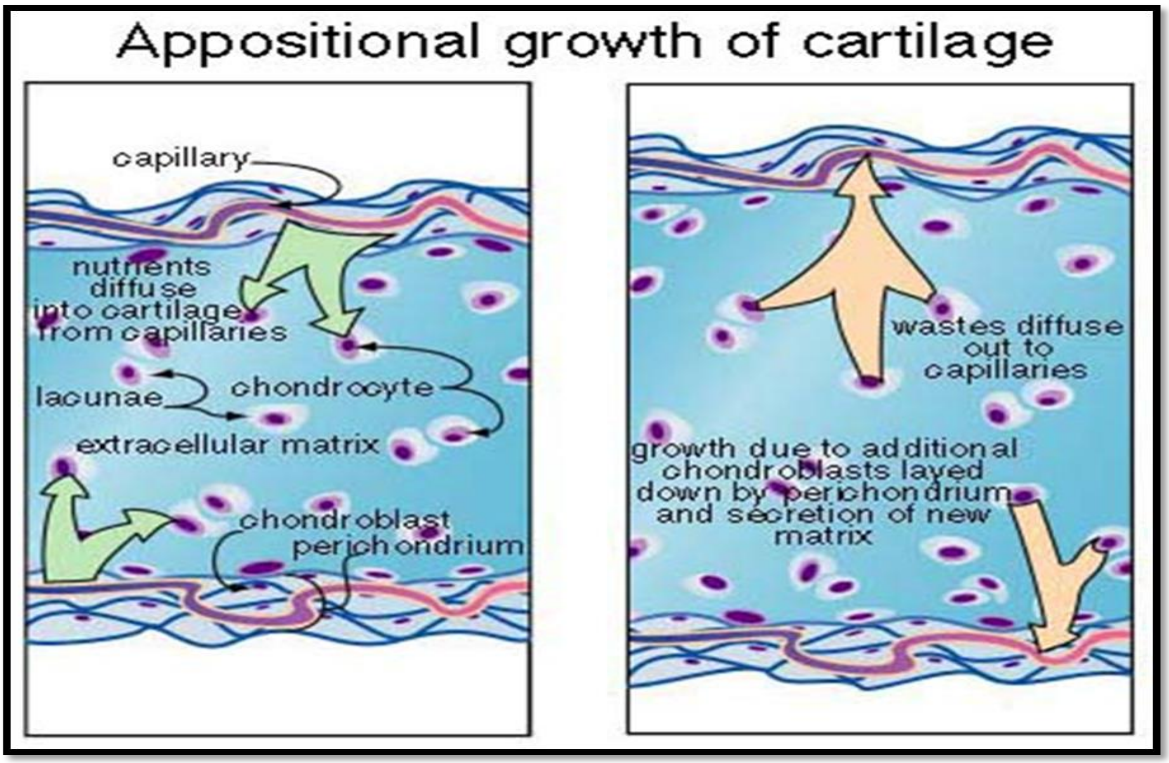


Figure (7): The appositional growth.