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Popular Article

# Characteristic Features of Cartilage in Animals

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## Introduction

The cartilage is a supportive tissue in the animal body. Cartilage is specialized for a supportive role possesses considerable tensile strength which provides weight bearing ability, movement and organ integrity. It is composed of amorphous gel like matrix, and cells. The matrix is composed of collagenous fibres (mainly type II but type I predominant in fibro-cartilage) and the firm but pliable ground substance. Biochemically, ground substance has high content of glycosaminoglycans (GAGs) and also keratan sulfate, hyaluronic acid etc. This framework of matrix provides high tensile strength of cartilage and also binding ability to water results increase in elasticity and plasticity. These qualities of cartilage provide its roles in cushioning, movement and support. The two types of cells *viz*., chondroblasts and chondrocytes are recognized in cartilage. The chondroblasts are actively dividing cells that forms matrix of cartilage. These cells are found in the inner chondrogenic layer of perichondrium. After complete matrix formation chondroblast become fewer active cells, chondrocytes. Each chondrocyte is located within a lacuna and distributed throughout the matrix. The cartilage is avascular, aneural and alymphatic in character. The nutrients supply to cartilage cells depends upon diffusion through matrix. The nutrient diffuses from nearby capillaries located in the perichondrium and in the articular cartilage supplied from synovial fluid. The process of cartilage repair is limited due to its avascular nature and low metabolic activity of chondrocytes. Clinical or surgical management techniques can enhance cartilage repair.

## Development of Cartilage

The cartilage formation begins in the developing embryo with a clustering of mesenchymal cells. These mesenchymal cells become enlarged, losses their processes and produce ground substance

and procollagen (type II). These differentiated cells are called chondroblasts and the cell clusters are called centers of chondrification. As the intercellular matrix increases, the cells become spherical and isolated from each other in lacunae; at this point, they are called chondrocytes. Chondroblasts are divided by the process of mitosis and lead to formation of new cartilaginous cells resulting substantial expansion of cartilage from within and is referred to as interstitial growth. Simultaneously, the mesenchymal cells are surrounding the cartilage differentiates into the perichondrium. In appositional growth, chondroblasts from the outer layer surrounding the cartilage secrete new matrix which is then deposited on the surface results thickening of cartilage. The chondrogenic layer of perichondrium persist ability to produce cartilage in adult, but it is dormant until a need arises for new cartilage. In elastic cartilage, fibroblast cells produce chondroblasts and mature elastic fibres in the matrix.

**Types of Cartilage**

Three types of cartilage have been recognized in animals i.e., Hyaline cartilage, Elastic cartilage and Fibrocartilage. Their classification is based on relative amount of amorphous ground substance and the type of fibres embedded within the matrix.

**Hyaline Cartilage:**

Hyaline cartilage has a white glossy in appearance when viewed grossly. Microscopically, it is surrounded by perichondrium which has fibrous and cellular layers except on articular surfaces. The cells are prominent part of perichondrium only in young growing cartilage. The chondroblasts cells secrete matrix and surround themselves in the secretion. The small lacunae form in the matrix in which the cell resides without any contact with other cells. In mature hyaline cartilage, chondroblasts differentiated into chondrocytes. Hyaline cartilage is located on the articular surfaces of bones in synovial joints, nose, larynx, trachea and bronchi. It is also forms the entire appendicular and axial skeleton in the embryo.

The articular cartilage is a highly specialized connective tissue of synovial joints. Its main function is to provide a smooth, lubricated surface for articulation and to facilitate the transmissions of loads with a low frictional coefficient. The articular cartilage is avascular, aneural and alymphatic that makes it harsh biomechanical environment. Due to lack of perichondrium on articular cartilage, it has a limited capacity of intrinsic healing and repair. Hence, preservation of articular cartilage highly depends on maintaining its organized structure.

Hyaline cartilage also plays a important role in nose by providing structural support and shape to the nasal cavity. It provides flexibility, support for the nasal septum and the external nose including the nostrils and the tip of nose. Similarly, hyaline cartilage provides necessary support and stability in the trachea and bronchi and prevents these airways from collapsing during breathing.



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**Elastic Cartilage**:

Macroscopically, elastic cartilage is yellow and more flexible than hyaline cartilage due to the presence of elastic fibres. It is similar with those of hyaline cartilage other than having elastic fibres. The elastic fibres are few in number near perichondrium but in matrix it forms a dense network. Elastic cartilage occurs in those places where elasticity as well as some rigidity is required i.e., external ear (pinna), external auditory canal, auditory tube, parts of the laryngeal cartilages *viz.,* epiglottis.

**Fibrocartilage:**

It provides additional strength to cartilage and dense collagenous tissue. Fibrocartilage occurs least frequently out of three cartilages; however, it often interposed between dense collagenous tissue and hyaline cartilage, tendons or ligaments. It is also found in the intervertebral disks and forms menisci in the stifle joint. Fibrocartilage forms the cardiac skeleton in dogs. It joins the atrial and ventricular heart muscles. The amorphous ground substance of fibrocartilage is predominantly occupied by collagen fibre bundles. The cartilaginous cells which reside between bundles secrete small quantity of matrix. Fibrocartilage lacks a distinct perichondrium. It is surrounded by outer fibrous layer in some locations but a chondrogenic layer is absent.

**Nutrition and Cartilage Repair:**

Cartilage is avascular in nature. It totally depends for nutrition upon diffusion of nutrients through the gelled matrix diffuse from nearby capillaries within the perichondrium or from synovial fluid contacts directly to articular cartilage surface. When the calcification of matrix is occurs, the chondrocytes become die due to absence of diffusion. This process is commonly found in aging of animals but it is natural in endochondral bone development. Cartilage repair is not in same proportion in all types of cartilage. The same type of cartilage also shows variation in repair on the different locations. The age of animal is also playing significant role in repair of cartilage. In the young and growing animals, the continuous proliferation and differentiation of mesenchymal cells of the perichondrium is responsible for interstitial growth of cartilage, hence, damage of hyaline or elastic cartilage during this period is repaired. But, in adults, the perichondrium is not so active; therefore, some of its regenerative ability diminishes. The repair of adult cartilage is mediated by a fibrous connective tissue derived from the perichondrium. Fibrocartilage reacts differently to injury due to lack of distinct perichondrium. The healing potency of menisci and intervertebral disks tear is poor due to compromised vascular supply. However, careful surgical management of meniscal tears in the canine stifle, with proper attention of peripheral vessels gives satisfactory results. The hyaline cartilage of the articular ends of bone is lacks of perichondrium. The superficial damage in the articular cartilage until adulthood may be repaired by mechanism of interstitial growth. In adults, articular cartilage repair depends on extent of damage and location. Superficial damage can be repaired by compensatory secretion by the chondrocytes. If



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thickness defect occurs, it may be repaired by transplanting autologous perichondral grafts over the damage surface. The complex structure of articular cartilage makes its treatment and repair significant challenge.

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