

CARTILAGE/UGSEM 3/ HONS/SDG

Cartilage is a resilient connective tissue composed of cells embedded in an extracellular matrix that is gel-like and has a rigid consistency.

Important for:

support to softer tissues
formation and growth of long bones

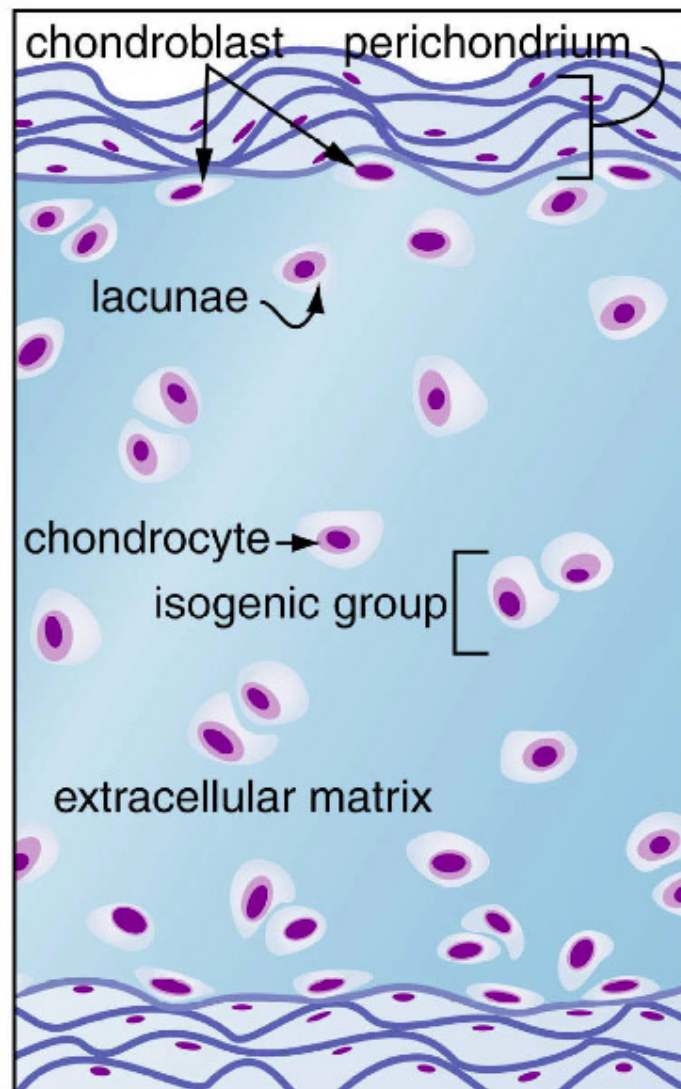
Consists of:

extracellular matrix containing mainly,
collagen and/or elastin fibers
proteoglycans
water

Collagen provides tensile strength and durability, however, proteoglycans are also important. For example, if you inject papain (an enzyme that digests the protein cores of proteoglycans) into the ears of a rabbit, after a few hours the ears will lose their stiffness and droop.

Three types of cartilage - extracellular matrix differs in terms of concentration of **collagen** and **elastin** fibers.

Hyaline Cartilage



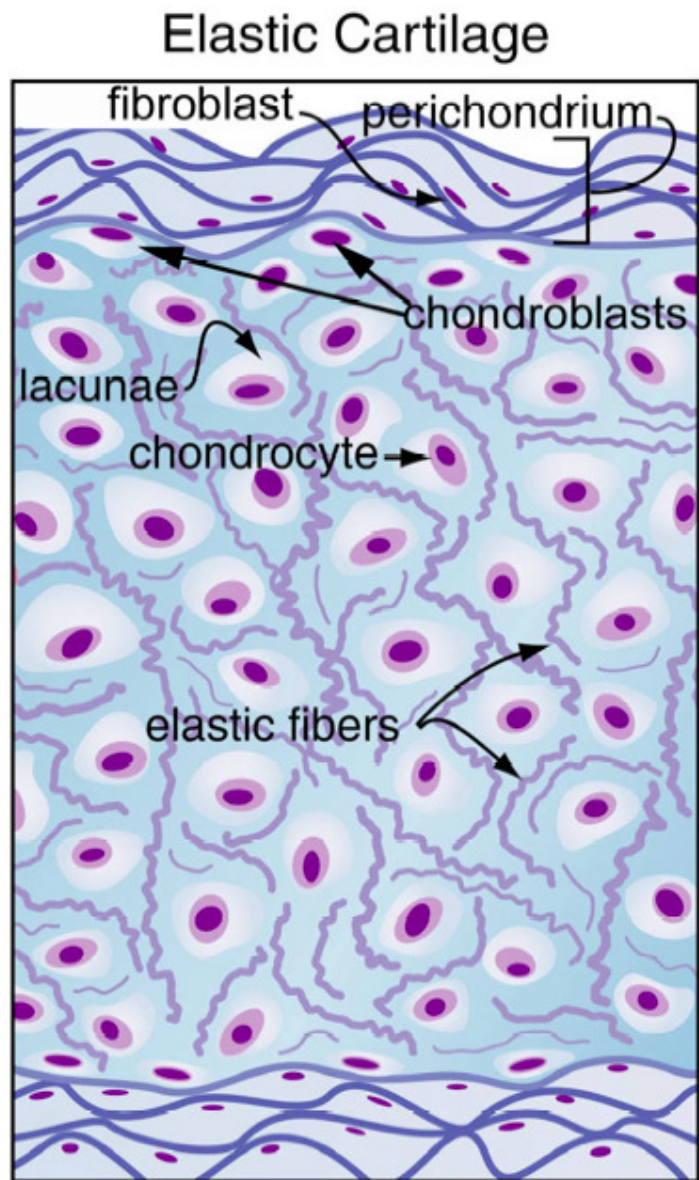
Copyright R.

Nims& S.C. Kempf 12/2000

1. Hyaline cartilage

- a. dominant component of extracellular
- b. matrix is collagen.
- c. Bluish-white in life
- d. translucent
- e. important in formation and growth of long bones
- f. In adult, mainly found lining outer wall of respiratory system and on surfaces of bone joints

where it is called Articular cartilage.
g. Undergoes calcification in bone formation and also as part of aging process.

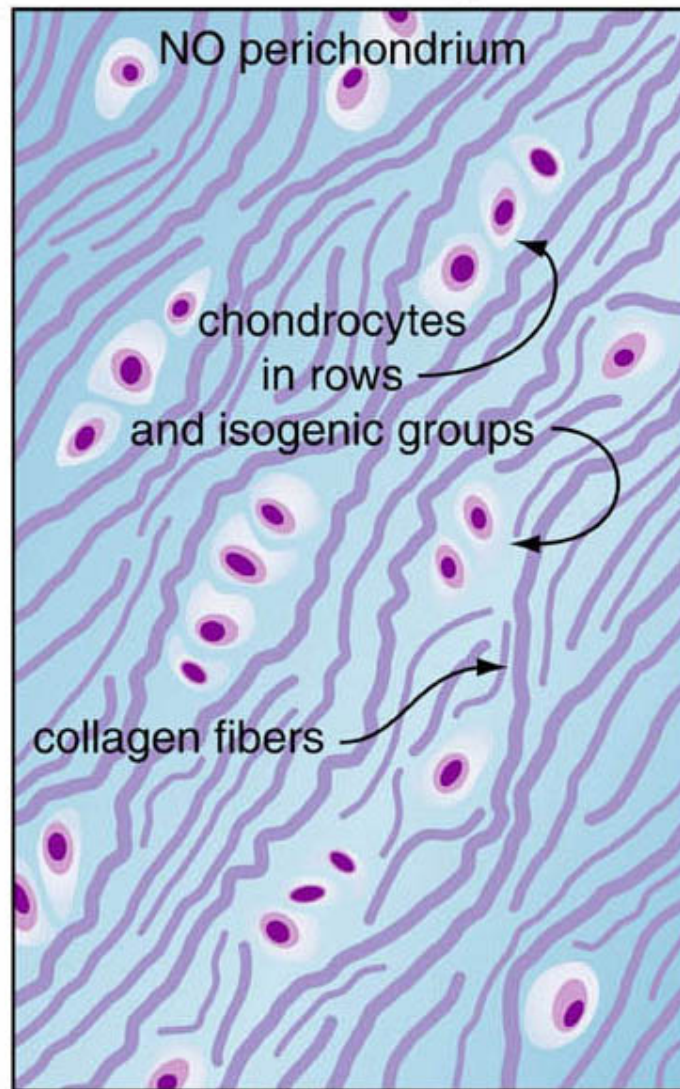


Copyright R. Nims and S.C. Kempf 12/2006

2. Elastic cartilage

- a. high concentration of elastin fibers
- b. in extracellular matrix. (Example - external ears)
- c. does not calcify

Fibrocartilage



© R. Nims/S.C. Kempf 12/2000

3. Fibrous cartilage (fibrocartilage)

- a. found at connection of tendons to bone.
- b. contains very large bundles of collagen fibers.
- c. resists compression and shear forces.
- d. also found in intervertebral discs.

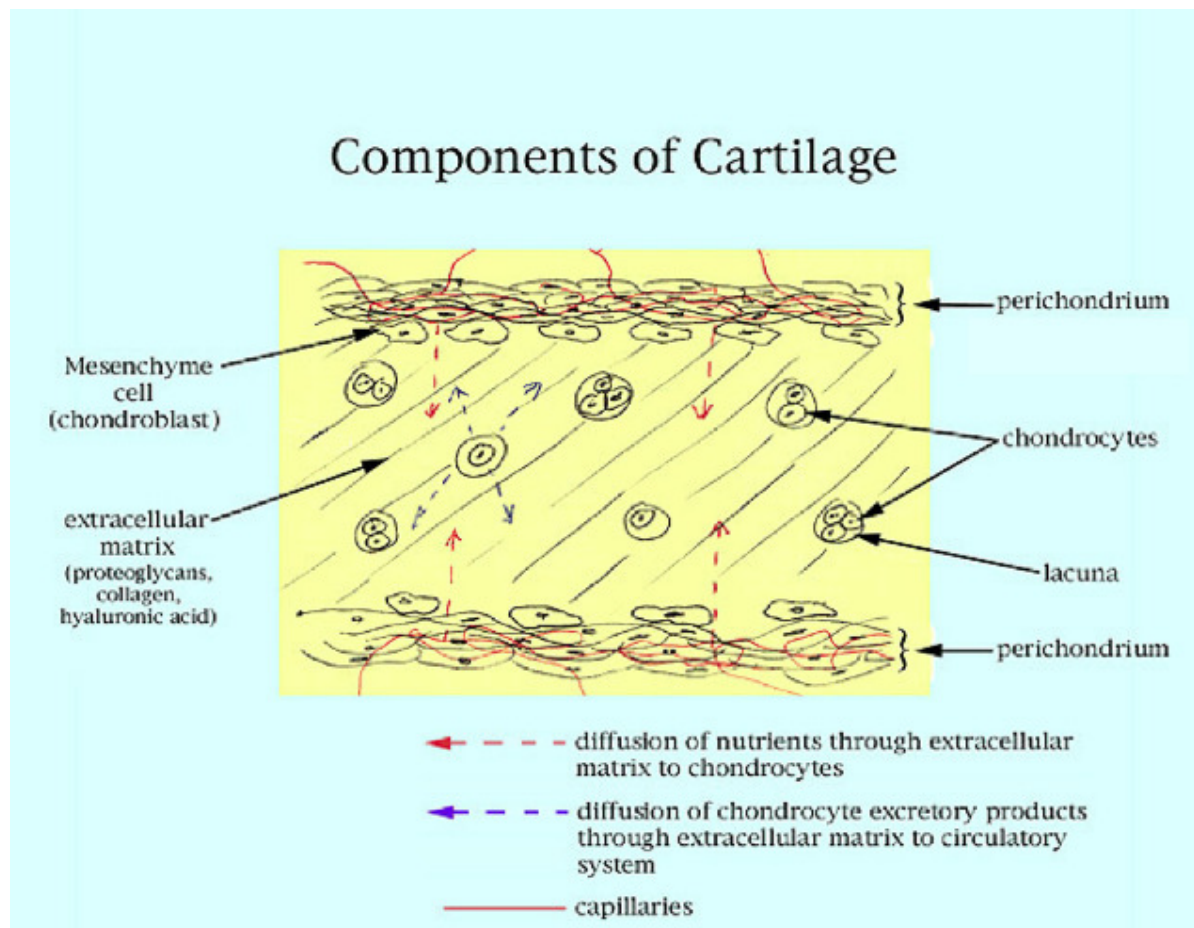
STRUCTURE AND FORMATION OF CARTILAGE

This tissue acts to support softer tissues and also is important in the formation and healing of endochondral bones such as the long bones of the arm and leg. The qualities of the different types of cartilage depend on differences in the

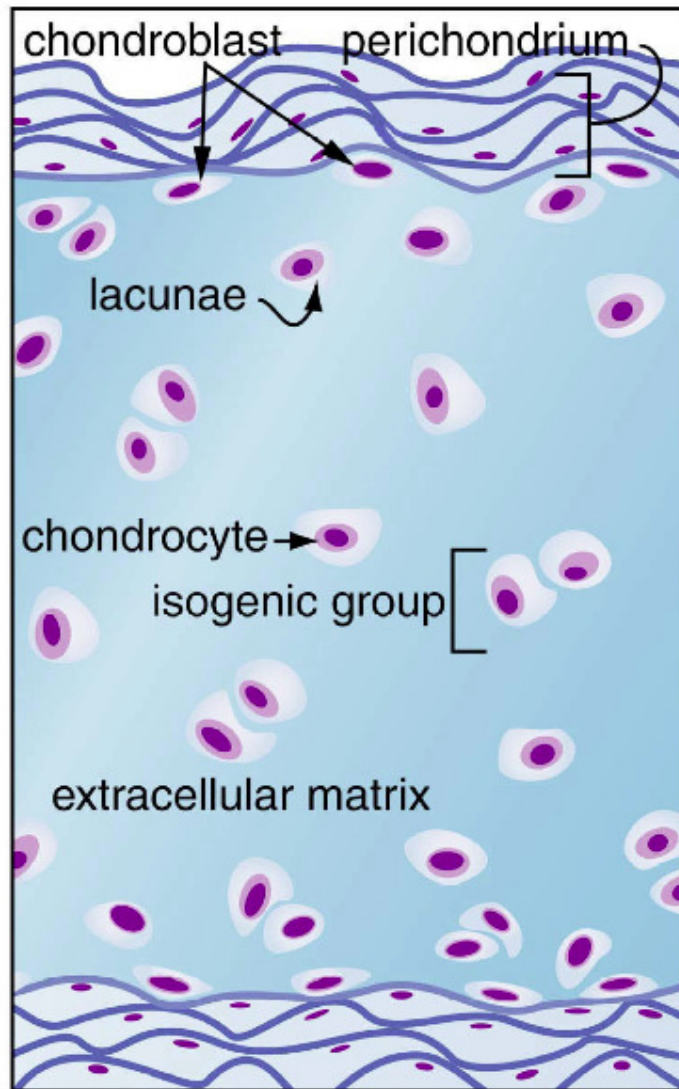
concentration of collagen and elastin fibers in the extracellular matrix and on the proteoglycan molecules that these fibers are associated with.

Cartilage is devoid of blood vessels. Thus the nutrition of cells within the cartilage matrix is dependent on the diffusion of nutrients from blood capillaries in the perichondrium and/or adjacent tissues through the matrix.

Hyaline and elastic cartilage are surrounded by a connective tissue capsule called the PERICHONDRIUM that contains the capillaries from which the nutrients diffuse into the cartilage matrix. Articular hyaline cartilage and fibrocartilage do not have a perichondrium.



Hyaline Cartilage



Hyaline cartilage is the most common cartilage in the body. It is bluish-white and translucent. Important in the formation of long bones of the body in embryo and during growth.

In adult, mainly found lining the respiratory passages such as trachea. Also at ventral ends of ribs and as **ARTICULAR CARTILAGE** on the bone surfaces within joints.

Dominant component of extracellular matrix is collagen fibers. Other components are sulfated proteoglycans and hyaluronic acid.

Main tissue components

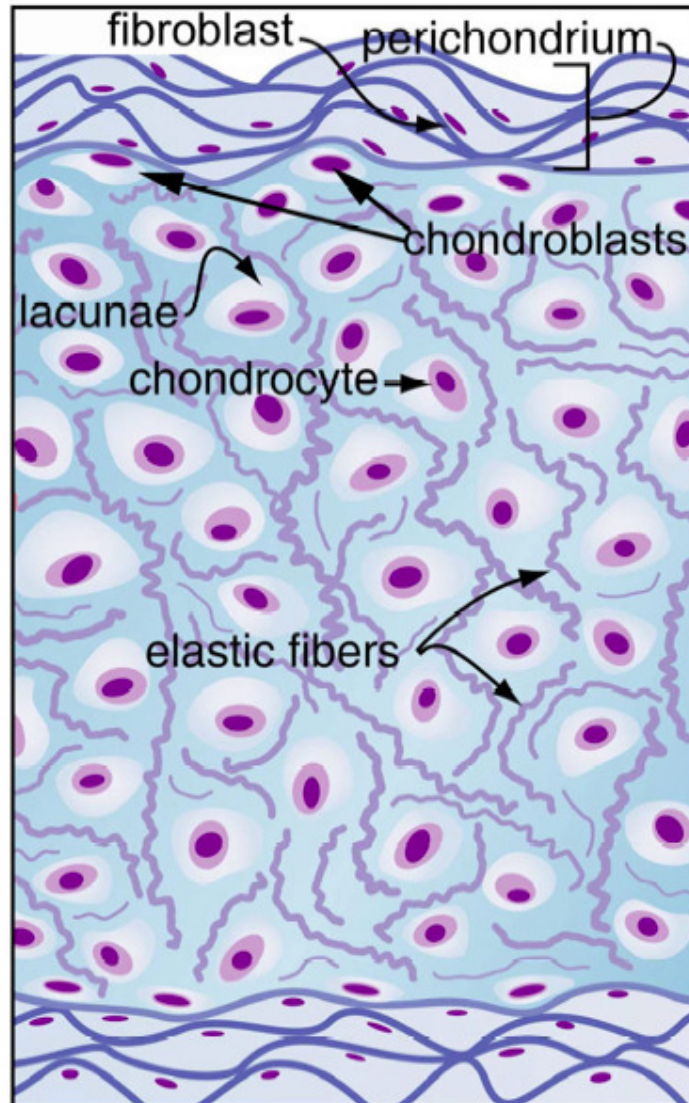
1. **perichondrium** - vascularized connective tissue sheath surrounding cartilage (except in case of articular cartilage). Rich in collagen. Contains fibroblasts that secrete the materials for the collagen fibers. Inner layer (next to cartilage matrix) contains cells that are thought by some to be fibroblasts and by others to be undifferentiated mesenchyme cells. In either case, these cells can differentiate to form chondroblasts.

2. **chondroblasts** - immature cartilage cells. Secrete extracellular matrix, but are not yet rigidly embedded in that matrix.

3. **chondrocytes** - mature cartilage cells that are embedded in rigid extracellular matrix. These cells reside in small spaces within the matrix that are called lacunae. May be more than one cell in a lacuna. Living chondrocytes have an elliptic shape. Organelle systems in cytoplasm are typical of cells that secrete. Chondrocytes in hyaline cartilage that are grouped together are called isogenic groups.

ELASTIC CARTILAGE

Elastic Cartilage

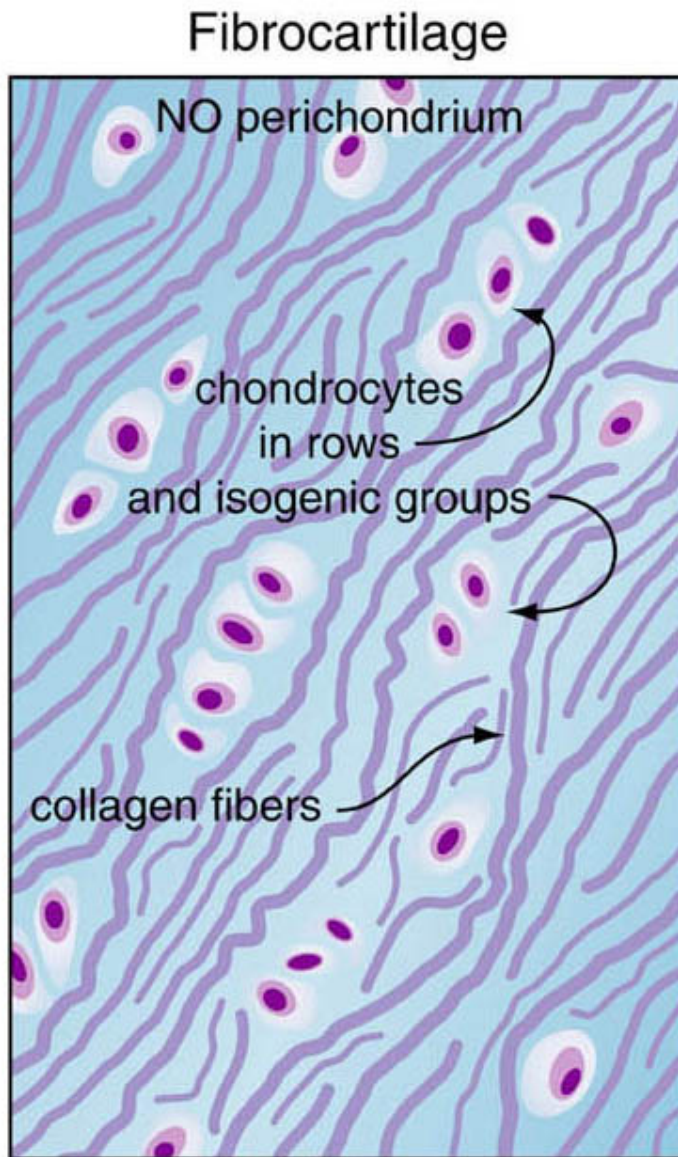


Copyright R. Nims and S.C. Kempf 12/2006

Similar to hyaline cartilage except,

1. matrix impregnated with elastic fibers
2. yellow in color
3. chondrocytes are more closely packed and only one chondrocyte per lacuna. No isogenic groups
4. does not calcify under normal conditions and does not show ossification in old age.
5. exhibits less accumulation of glycogen and lipids than hyaline cartilage.

FIBROCARTILAGE



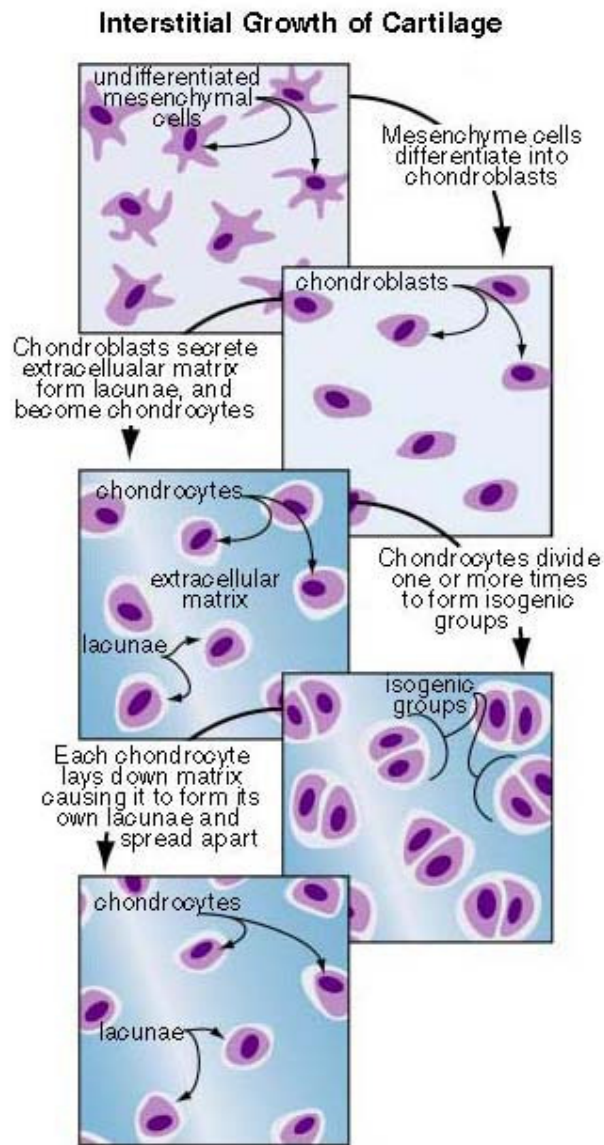
© R. Nims/S.C. Kempf 12/2000

An irregular, dense, fibrous tissue with thinly dispersed, encapsulated chondrocytes. No perichondrium, so it blends with adjacent connective tissue. Most easily seen in articular disks such as the intervertebral disks. Also found where tendon connects to bone. Shows resistance to compression, durability and high tensile strength.

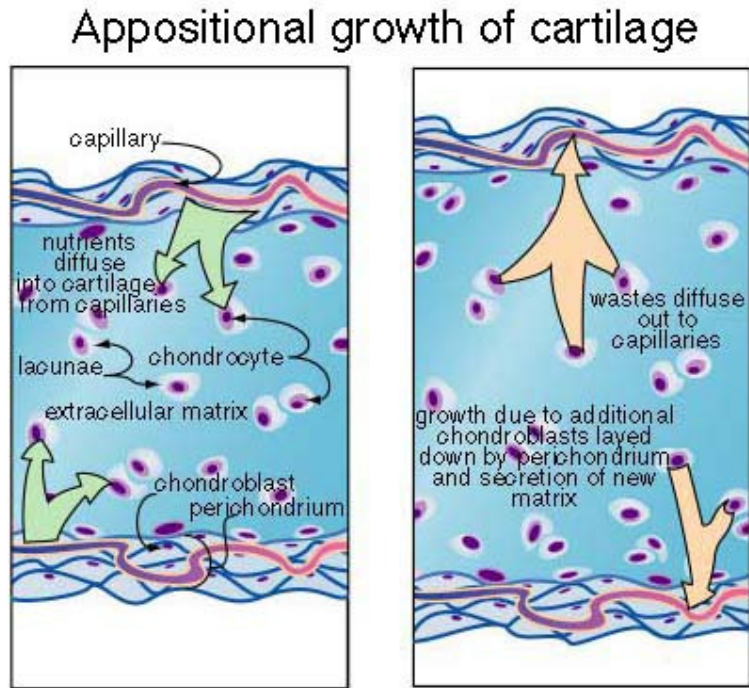
HISTOGENESIS OF CARTILAGE

As the embryo develops, mesenchymal cells will aggregate into closely knit clusters and differentiate into chondroblasts. These cells will begin to secrete collagen and mucopolysaccharide matrix containing chondroitin sulfate. The matrix secretion will cause the chondroblasts to be pushed apart.

As this occurs, the cartilage cells will undergo divisions. This will result in small clusters of chondroblasts within the developing matrix which will also start to secrete matrix and be pushed away from each other. This sort of growth of cartilage is termed **interstitial growth** due to the fact that the extracellular matrix is secreted into spaces between the cells.



Growth of cartilage can also be **appositional**, that is a layer of chondroblasts can lay down matrix at the outer edge of a mass of cartilage.



© R. Nims/S.C. Kempf 12/2000

As the cartilage continues to grow, the central regions become more rigid due to various secretory products and the cells in this region become embedded in rigid matrix and take on the characteristics of mature chondrocytes. The outer edge of the cartilage mass becomes invested with additional mesenchymal cells that differentiate into fibroblasts to form a specialized connective tissue covering for the cartilage known as perichondrium. Chondroblasts that differentiate from mesenchyme cells at the inner edge of the perichondrium also secrete matrix causing appositional growth of the cartilage mass.

Similar histogenesis can result in elastic (external ear) or fibrous cartilage (intervertebral discs) in other parts of the body.