



Histology

Sheet #7

Lecture title : Cartilage

Lecture Date : 1/4/2021

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Cartilage

Cartilage: is a specialized type of connective tissue designed to give support, bear weight and withstand tension, torsion and bending. ✓

Features of Cartilage

Cartilage is avascular & is nourished by the diffusion of nutrients from capillaries in adjacent CT (*perichondrium*) or by *synovial fluid* (joint cavities).

Chondrocytes exhibit low metabolic activity (as might be expected of cells in cartilage grows → in avascular tissue) slowly.

Cartilage has no lymphatic vessels or nerves.

Generally the connective tissue is vascularized tissue except :
Dense regular connective tissue, as ligament tendons. -
Cartilage, because there is no blood vessels inside it. -

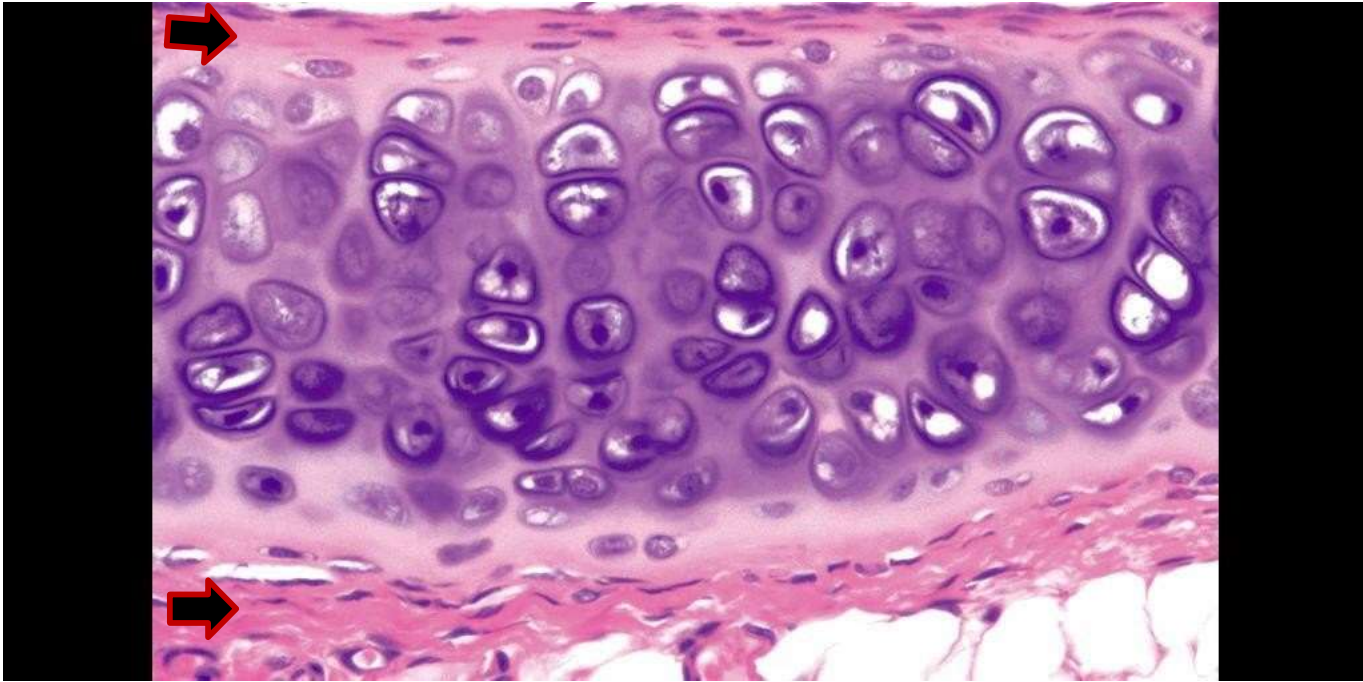
Cartilage and the epithelial tissue **are avascular.**

There is two ways of cartilage nourishment :

By the membrane that surround the cartilage which is called perichondrium. -
By the synovial fluid. -

The cartilage grows slowly because:

It is an avascular. -
It cells (chondrocytes) have low metabolic activity. -
So when the cartilage is injured it won't recover easily.



Perichondrium

- Sheath of dense irregular CT surrounds cartilage in most places. ✓
- It harbors the cartilage's vascular supply, as well as nerves and lymphatic vessels. ✓
- It has function in growth & repair. ✓

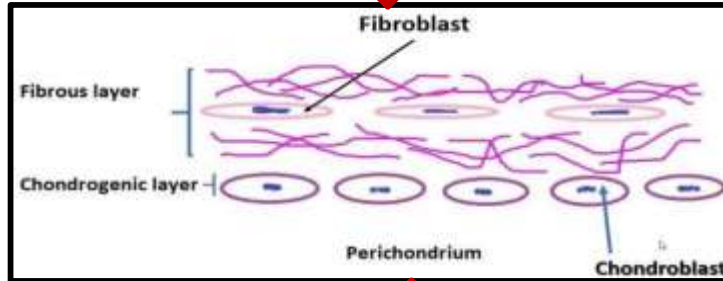
Peri : around
Chondrium : cartilage

Chondrogenic : cells that produce cartilage cells.

Perichondrium

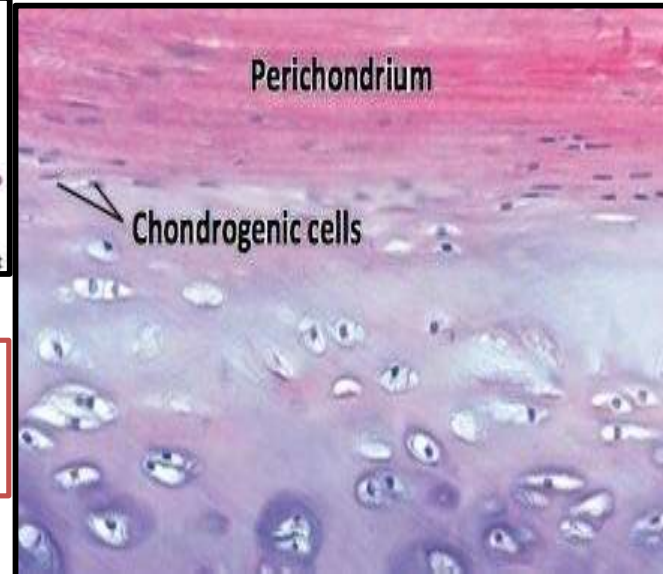
Outer (fibrous) layer

rich in ***type I collagen*** fibers
& contains numerous ***fibroblasts***



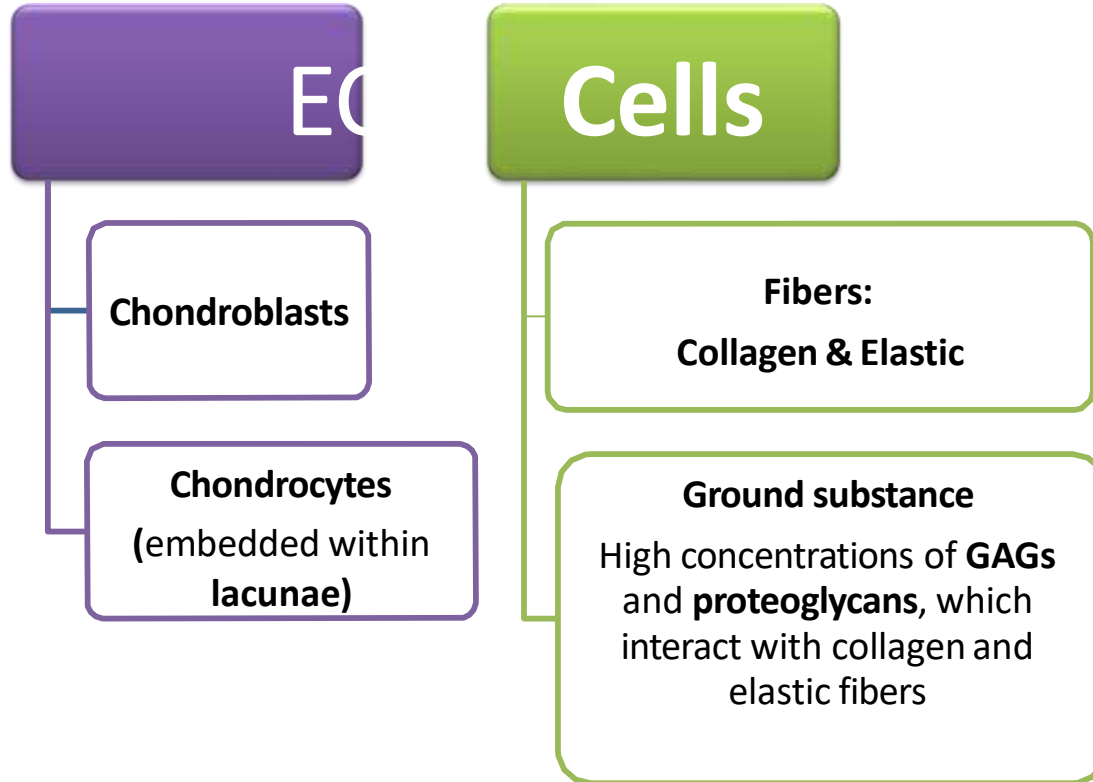
Inner (chondrogenic) layer

Contain undifferentiated **chondrogenic cells**
which can differentiate to chondroblasts



The inner layer of the perichondrium is called cellular layer
Because it contains chondrogenic cells that form the cartilage cells.

Components of Cartilage



Chondroblasts are **immature, active cells**.

Chondrocytes are **mature cells**, they are the **inactive** form of chondroblasts.

Lacunae is the white space that surrounds the cartilage cells (chondrogenic).

The cartilage is **semi-solid**.

Two types of collagen are found in the cartilage:
Collagen type **I** and type **II**.-

GAGs that are linked to proteins are called proteoglycans.

Multiadhesive glycoproteins are also found in the cartilage in order to link the fibers with proteoglycans.

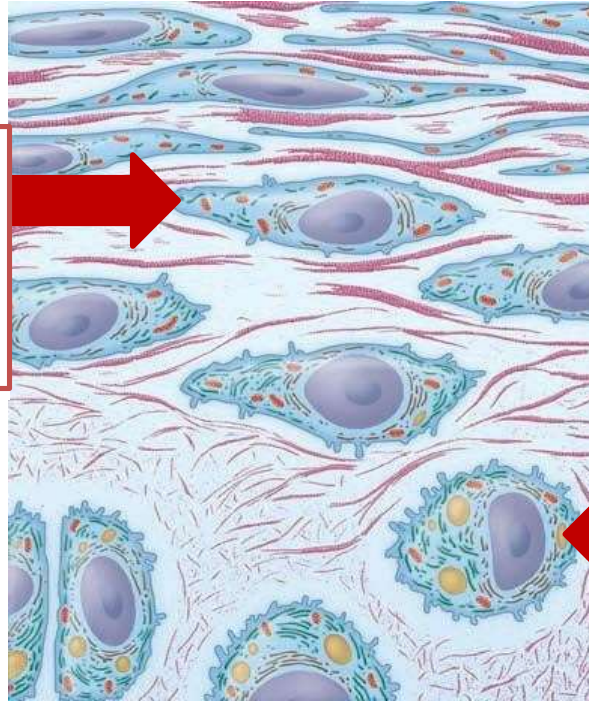
The ECM of **some** cartilages is basophilic because of the high concentration of GAGs.

Cells of Cartilage

They are derived from undifferentiated mesenchymal cells ✓

Chondroblasts :

Immature cells with branched cytoplasmic processes, they multiply to chondrocytes.



Chondrocytes

(older & mature cells)

Chondroblasts multiply to produce chondrocytes by Mitosis.

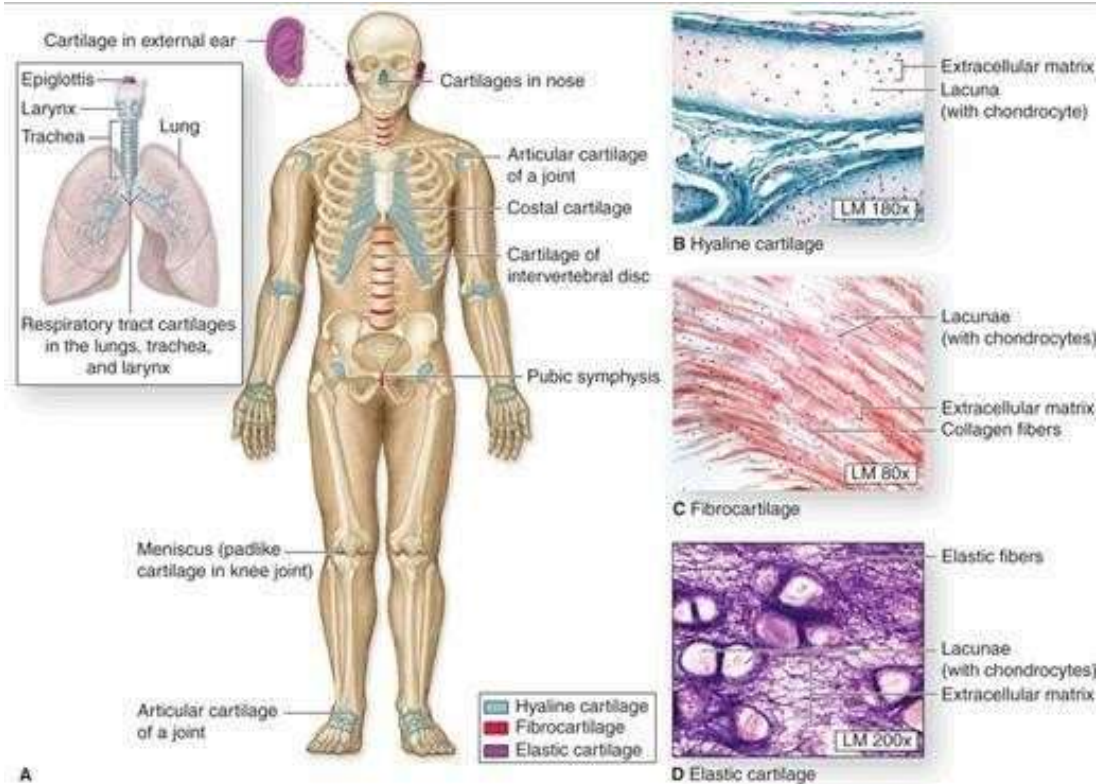
The cell is called mature when:

- It loses the ability to divide by mitosis -**
- Its metabolic activity is low. -**

The mature cartilage is the one that is in our bodies postnatal (after birth) , and the chondrocytes are shown clearly in it .

The chondroblasts in the mature cartilage are shown on the sides of the perichondrium.

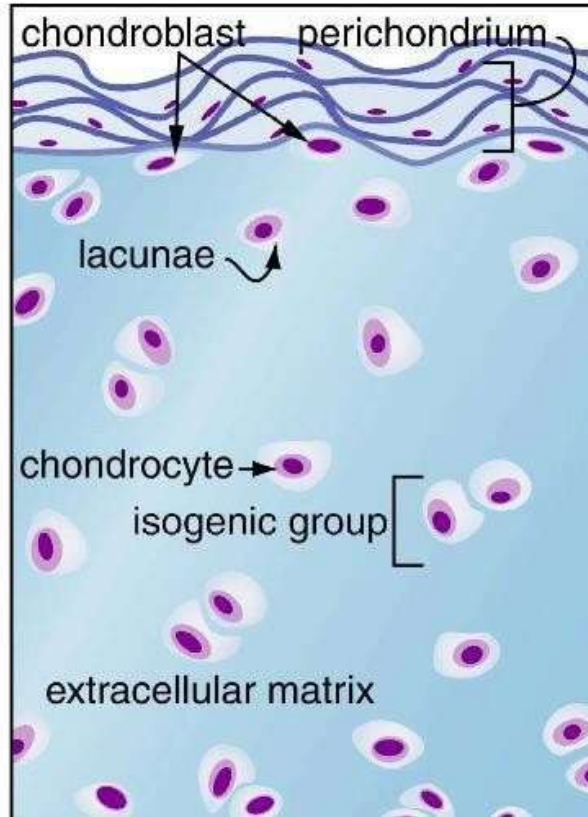
Classification of Cartilage



NOTE : The classification of the cartilages is well explained in slides number 26,27,28.

Hyaline Cartilage

- Most abundant type ✓
- Homogeneous and semitransparent in the fresh state. ✓
- Chondrocytes occur singly ✓ or in small, mitotically derived isogenous group.
- ECM rich in type II collagen & aggrecan complexes with bound water ✓



The ECM in Hyaline cartilage is **basophilic** because of the high concentration of GAGs.

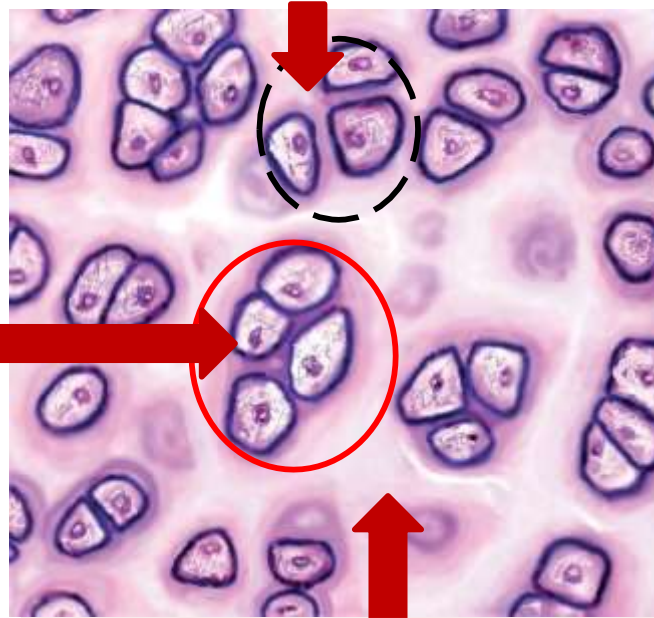
The ECM is rich with **aggrecan** (proteoglycan).

The most abundant component in Hyaline cartilage is : the ECM , cells.

Most of Hyaline cartilages are surrounded by perichondrium cells.

Territorial matrix

(matrix around the cells)
brighter and deep in color
than other areas (rich in GAGs
and poor in collagen).



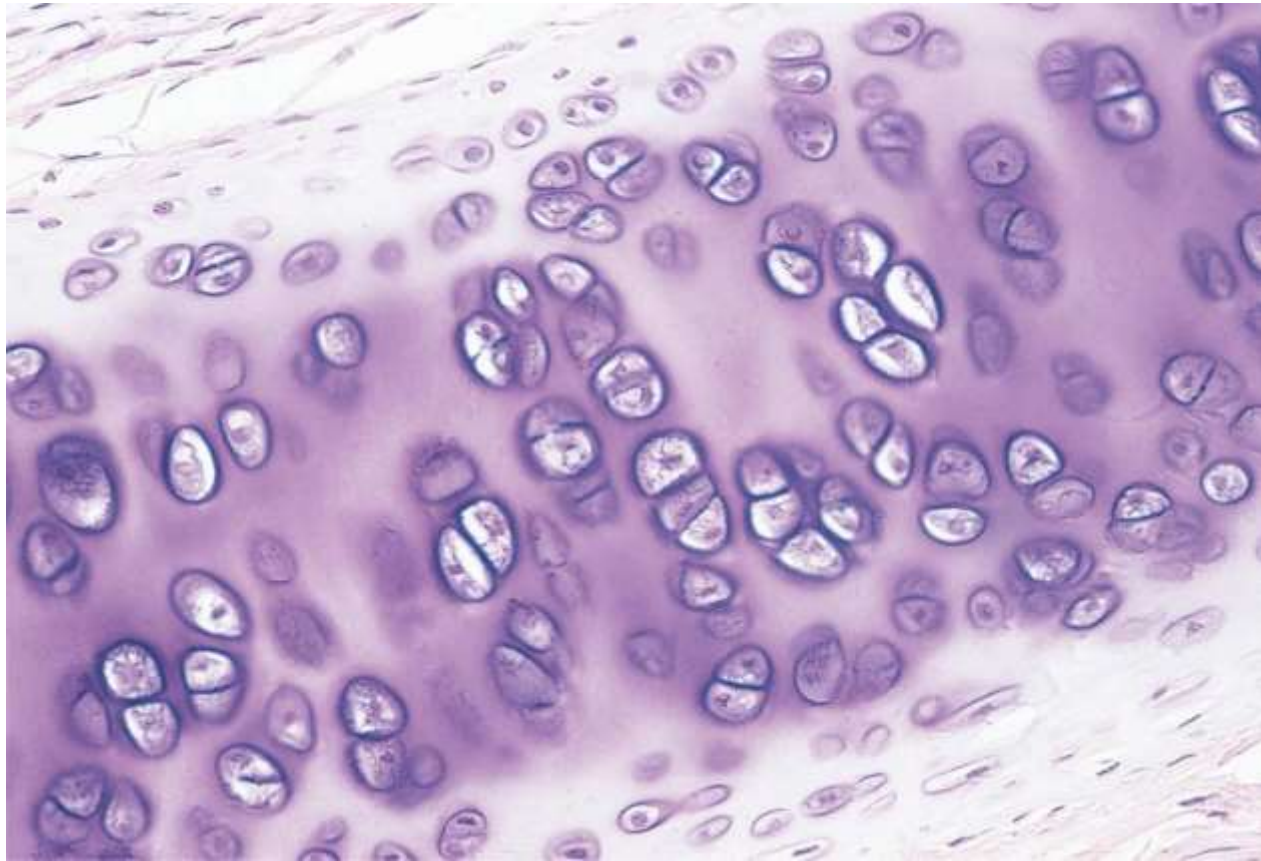
Isogenous aggregates

groups of cells up to
eight that originate
from mitotic divisions
of a single
chondroblast

Inter-territorial matrix

(matrix between the cells)
lightly colored matrix separated
two groups of cells

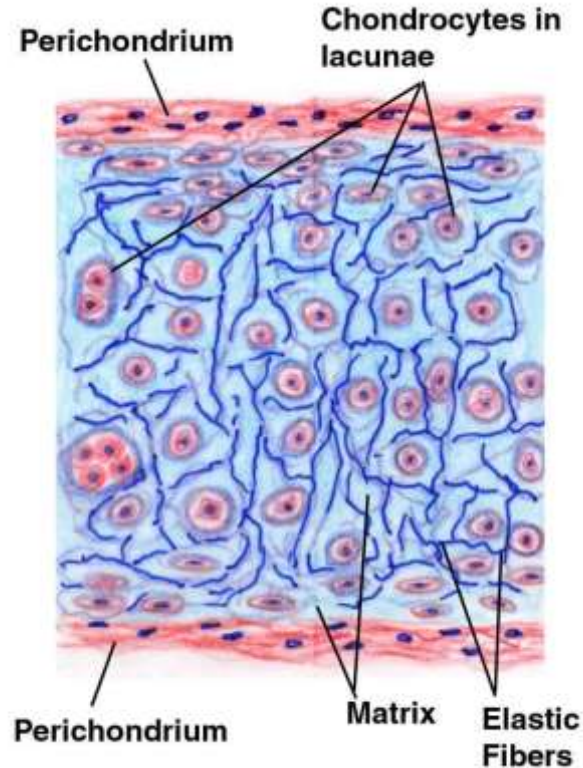
The presence of isogenous aggregates shows the mitotic activity of a single chondroblast.



Elastic Cartilage

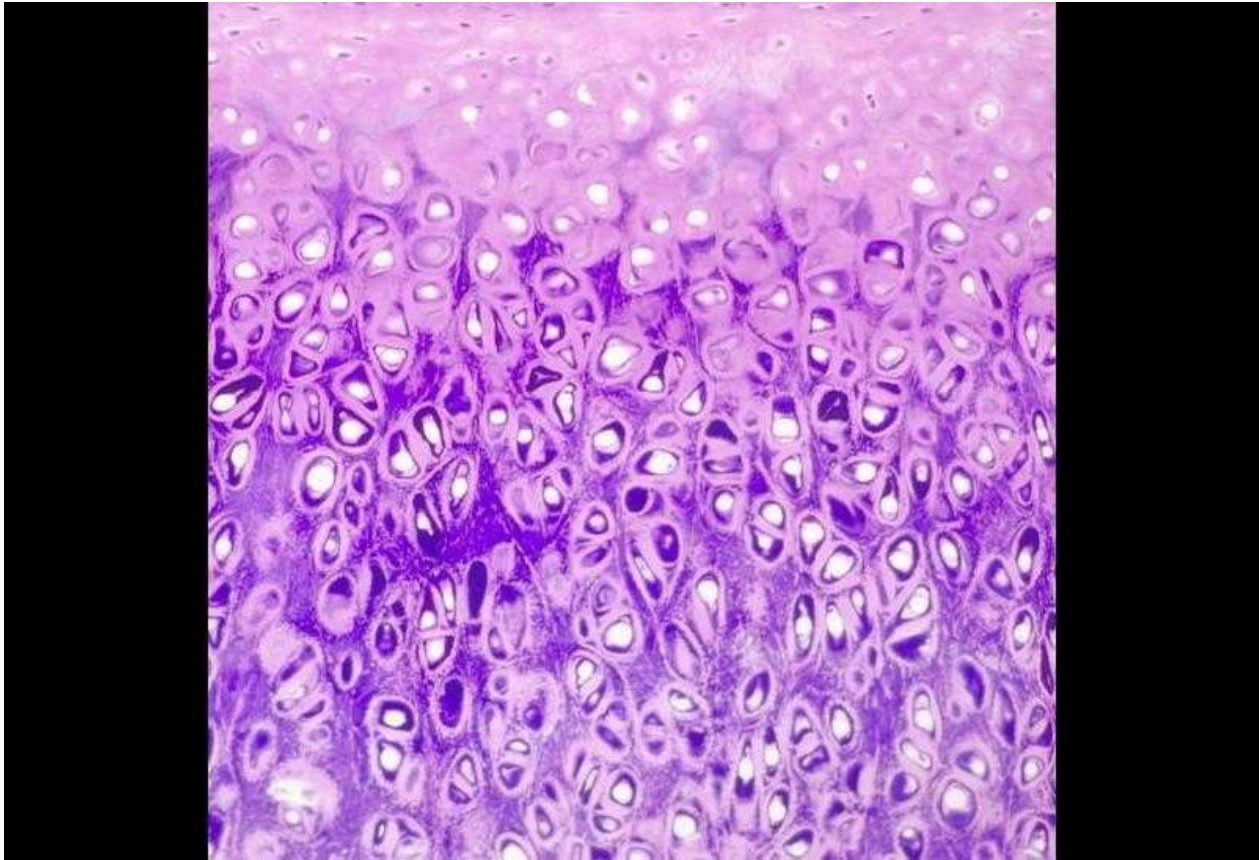
similar to hyaline cartilage ✓
except that it contains an
abundant network of
elastic fibers in addition to
type II collagen fibers.

Elastic fibers give fresh ✓
elastic cartilage a yellowish
color



All Elastic cartilages are surrounded by perichondrium.

Special stains must be used in order to see the elastic fibers.

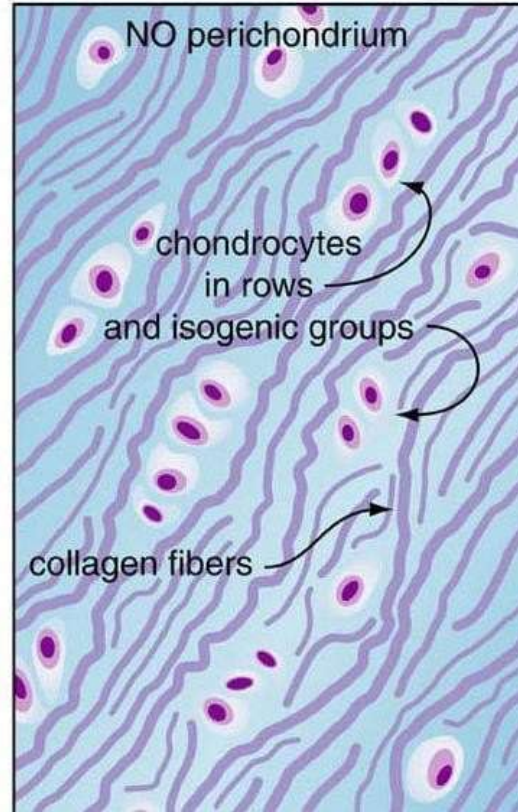


Fibrocartilage

a combination of **hyaline cartilage** and **dense CT** with gradual transitions between these tissues. ✓

Chondrocytes occur singly ✓
& in aligned isogenous aggregates or they are very sparse.

consists of small ✓
chondrocytes in a **hyaline matrix**, usually layered with larger areas of **bundled type I collagen** with scattered **fibroblasts**.

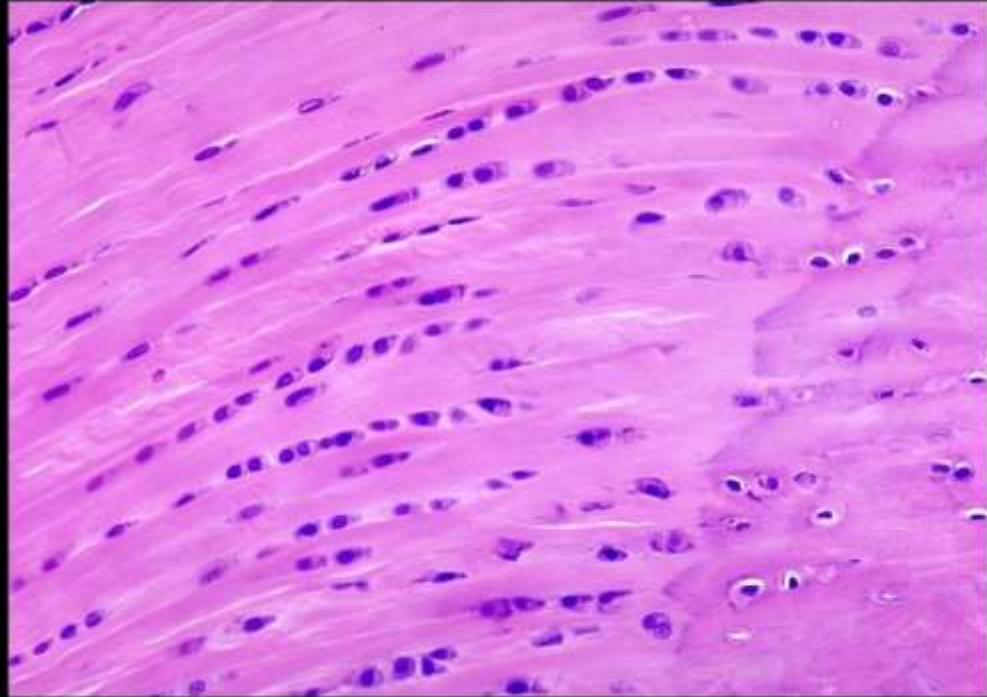


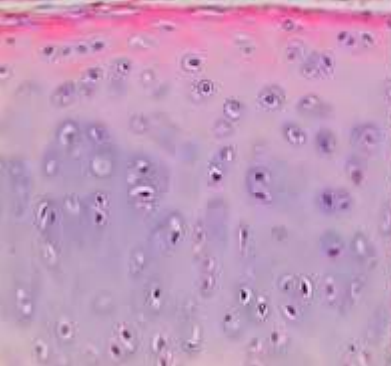
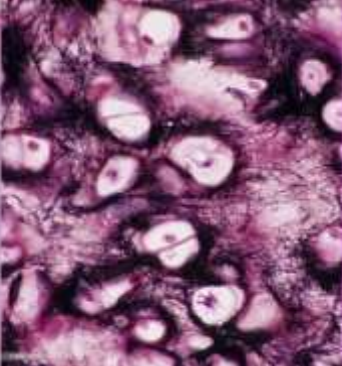
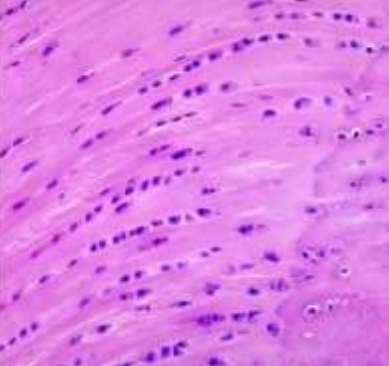
Fibrocartilage is mainly found in places of **weight bearing**.

It's the **most strong** cartilage (contains collagen type I).

In fibrocartilage collagen **type I is dominant** while type II is found in few areas.

There is **no perichondrium** surrounding the cartilage.



	Hyaline cartilage	Elastic cartilage	Fibrocartilage
			
Main features of ECM	<u>Homogeneous</u> , with type II collagen & aggrecan	<u>Darker elastic fibers</u> , Type II collagen & aggrecan	<u>Large areas of dense CT</u> type I & II collagen
Presence of perichondrium	Yes (except at articular cartilage)	Yes	No

	Hyaline cartilage	Elastic cartilage	Fibrocartilage
Major cells	Chondrocytes, chondroblasts	Chondrocytes, chondroblasts	Chondrocytes, fibroblasts
Typical arrangement of chondrocytes	isolated or in small isogenous groups	usually in small isogenous groups	isolated or in isogenous groups arranged axially
Main functions	Provides smooth, low-friction surfaces in joints, structural support for respiratory tract	Provides flexible shape and support of soft tissues	Provides cushioning, tensile strength, and resistance to tearing and compression

	Hyaline cartilage	Elastic cartilage	Fibrocartilage
Main locations	<p>In the walls of larger .1 respiratory passages (nose, larynx, trachea, bronchi).</p> <p>articular ends of .2 movable joints</p> <p>In the ventral ends of .3 ribs, where they articulate with the sternum</p> <p>epiphyseal plates of .4 long bones</p> <p>fetal skeleton .5</p>	<p>1.Auricle of ear</p> <p>2.external acoustic meatus</p> <p>3.auditory tube (eustachian)</p> <p>4.epiglottis & certain other laryngeal cartilages (cuneiforms)</p>	<p>intervertebral .1 discs</p> <p>pubic symphysis .2</p> <p>3.meniscus (knee)</p> <p>4.certain other joints (manubrio-sternal joint)</p> <p>5. insertions of tendons</p>
Flexibility	2 nd most flexible	Most flexible	Least flexible
Special features	<p>Most abundant type ✓</p> <p>Susceptible to ✓ calcification</p>		Strongest type ✓

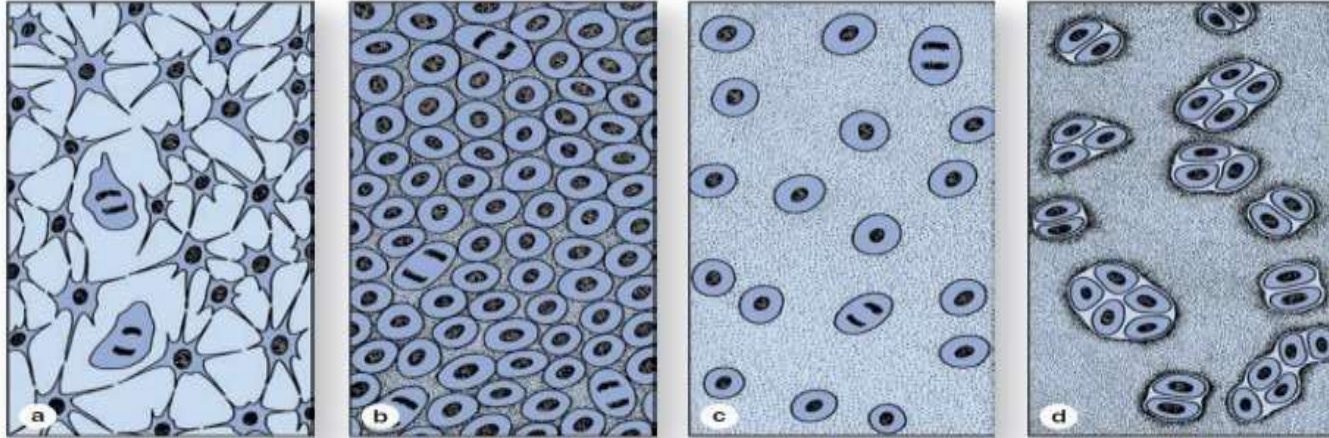
Most **abundant** type : Hyaline cartilage.

Most **flexible** type : Elastic cartilage.

Strongest type : Fibrocartilage.

*some areas of Hyaline cartilage become calcified as we get older.

Chondrogenesis (by which embryonic cartilage is formed)



Mesenchyme is the precursor for all types of cartilage.

Mitosis and early differentiation produces a tissue with condensations of rounded cells called chondroblasts.

Chondroblasts are then separated from one another again by their production of various matrix components, which collectively swell with water and form the very extensive ECM.

Multiplication of chondroblasts within the matrix gives rise to isogenous cell aggregates surrounded by a condensation of territorial matrix.

**The cartilage in the embryo is formed at the center then outward.
“from inner to outer area from where it was formed”.**

Interstitial Growth of cartilage

“Growth from within” ✓

Occurs mainly in immature cartilage, limited in mature ✓
cartilage (articular cartilage & epiphyseal plate).

It Resulting from the mitotic division of preexisting ✓
chondroblasts in **existing cartilage**, divide & form small
groups of cells “isogenous groups” which produce matrix to
become separated from each other by a thin partition of
matrix.

**Interstitial growth in the articular cartilage and epiphyseal ✓
plates of long bones is important in increasing the length of
long bones during postnatal development.**

The cartilage growth starts in embryo life and continues postnatal “after birth” life.

There is two ways of cartilage growth:

- Interstitial growth.** -
- Appositional growth.** -

interstitial growth “from within”,

occurs mainly in immature cartilage (as in embryo),

limited in mature cartilage (postnatal life) in 2 places : articular cartilage, epiphyseal plate.

This way of growth helps increasing the length of long bones from postnatal **till puberty**.

Appositional growth of cartilage

“Growth from outside” ✓

Occurs in mature & immature cartilage. ✓

it involves differentiation of new chondroblasts from the ✓
perichondrium

Chondroblasts at the periphery of cartilage secrete matrix. ✓

Appositional growth of cartilage is more important during ✓
postnatal development.

Appositional growth “from outside”

From chondrogenic cells that are on the sides of the perichondrium.

Occurs in **embryo life and postnatal life** , but it is more important in postnatal life.

Appositional growth keeps happening **even after puberty** and that's why our ears and noses keep growing as long as we're alive.