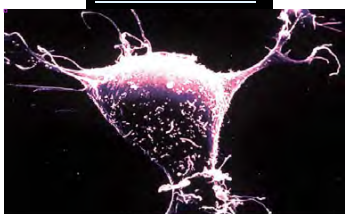
BIO 211:
ANATOMY & PHYSIOLOGY I

FIBROBLAST:



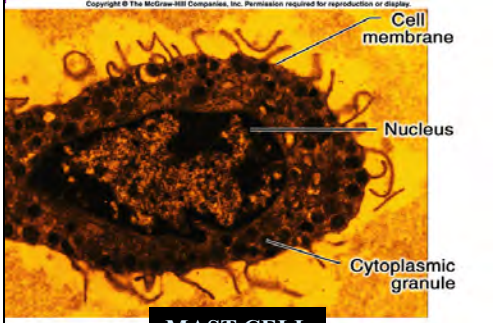
CHAPTER 05
Histology:
CONNECTIVE TISSUE

Dr. Lawrence G. Altman
www.lawrencegaltman.com
Some illustrations are courtesy of McGraw-Hill.

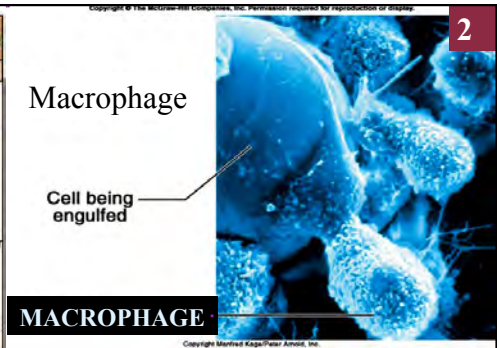
Naugatuck Valley Community College

table 5.6 Components of Connective Tissue

Component	Characteristic	Function
Fibroblast	Wdely distributed, large, starshaped cells	Secrete proteins that become fibers
Macro-phages	Motile cells sometimes attached to fibers	Clear foregin particles from tissues by phagocytosis
Mast cells	Large cells, usually located near blood vessels Think **HISTAMINE** !!	Release substances that may help prevent blood clotting and promote inflammation
Collagenous fibers (white fibers)	Thick, threadlike fibers of collagen with great tensile strength	Hold stuctures together
Elastic fibers (yellow fibers)	Bundles of microfibrils embedded in elastin	Provide elastic quality to parts that stretch
Reticular fibers	Thin fibers of collagen	For supportive network within tissues



MAST CELL



MACROPHAGE

FIBROBLAST:

OVERVIEW of CONNECTIVE TISSUE: 3

Functionally diverse, CONNECTIVE TISSUE:

binds organs
provides support
facilitates movement
protects
provides immune defense
stores energy and minerals
helps to produce heat
transports within the bloodstream.

Early embryonic tissue gives rise to mesenchyme, which in turn, produces most of the permanent connective tissue (+ muscle).

A *second* embryonic connective tissue is mucous connective tissue that is limited to Wharton's jelly that fills and supports tissues of the umbilical cord. It is a temporary tissue.

OVERVIEW of CONNECTIVE TISSUE: 4

Components of Fibroconnective Tissue:

CELLS

a. **Fibroblasts** are the most common cells of connective tissue. They are large, flat, branching cells that produce fibers and ground substance.
b. **Histiocytes** are the macrophages of connective tissue.
c. **Leukocytes**, esp. neutrophils, reside in connective tissue/react against bacteria, toxins, & foreign matter.
d. **Plasma cells** produce antibodies and are only found in inflamed tissue and the wall of the digestive tract.
e. **Mast cells,** found near blood vessels, produce heparin and histamine.
f. **Adipocytes** (fat cells) appear in some types of fibroconnective tissues.

OVERVIEW of CONNECTIVE TISSUE: 5

Components of **Fibroconnective** Tissue:

FIBERS

Fibers are made of **protein**. **Three types** are found in CT:

1. **Collagenous fibers** are tough, flexible, and resist stretching. Collagen constitutes 25% of the body's protein. These are also called ***white fibers.***
2. **Reticular fibers**: **thin collagen fibers** in reticular CT.
3. **Elastic fibers** are made of the stretchy protein **elastin.** These are also called ***yellow fibers.***

Ground Substance

Components: **tissue fluid, minerals, and proteoglycans**, the especially large colloidal particles that form a viscous tissue gel.
In **bone**, tissue gel is made up of **chondroitin sulfate**;
In **fibroconnective tissue**, **hyaluronic acid** comprises the gel tissue.

OVERVIEW of CONNECTIVE TISSUE: 6

There are **two** broad types of **FIBROCONNECTIVE Tissue:**

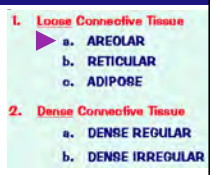
1. **Loose Connective Tissue**
   - a. **AREOLAR**
   - b. **RETICULAR**
   - c. **ADIPOSE**
2. **Dense Connective Tissue**
   - a. **DENSE REGULAR**
   - b. **DENSE IRREGULAR**

LOOSE CONNECTIVE TISSUE: AREOLAR

7

"loose" = relatively scarce fiber distribution.

ATLAS: Figure 12b (Morton & Perry, 1998)



Gel – like matrix with *all 3 fiber types:*

- reticular — reticulin = non–banded form of collagen
- elastic — often referred to as yellow fibers
- collagen — often referred to as white fibers

Cells:

- *fibroblasts* — production of connective tissue proper, matrix- i.e., all CT except cartilage, blood and bone
- *macrophages* — phagocytize bacteria
- *Mast cells* — histamine release; increased capillary permeability
- *WBCs* — a few

LOOSE CONNECTIVE TISSUE: AREOLAR

8

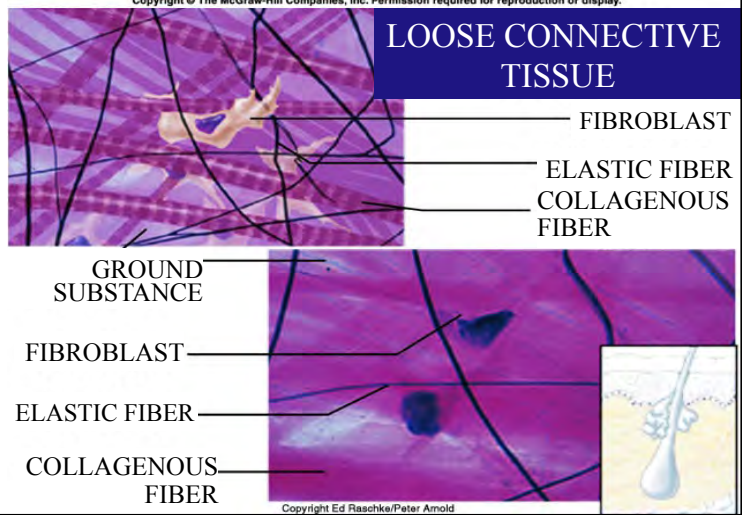
"loose" = relatively scarce fiber distribution.

ATLAS: Figure 12b (Morton & Perry, 1998)

Sites
wide distribution, organ packaging, surrounds capillaries

Functions
wrap/surround organs

additional: See Cells



LOOSE CONNECTIVE TISSUE: AREOLAR

9

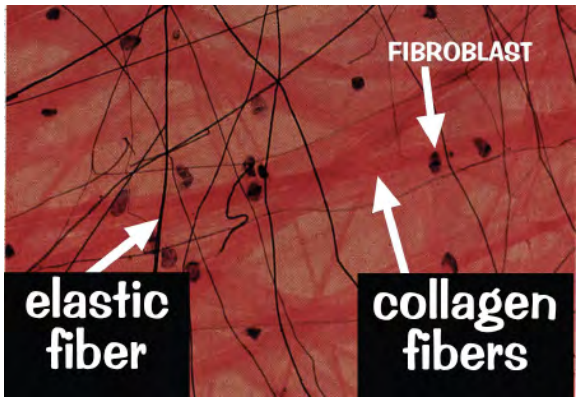
"loose" = relatively scarce fiber distribution.

ATLAS: Figure 12b (Morton & Perry, 1998)

Another View:

Bands of collagen and elastic fibers run in all directions through intercellular spaces of subcutaneous tissue; permit flexible resistance to mechanical stress. (x100)

Lab Atlas of A&P
Eder *et al.*
Mosby, 1994



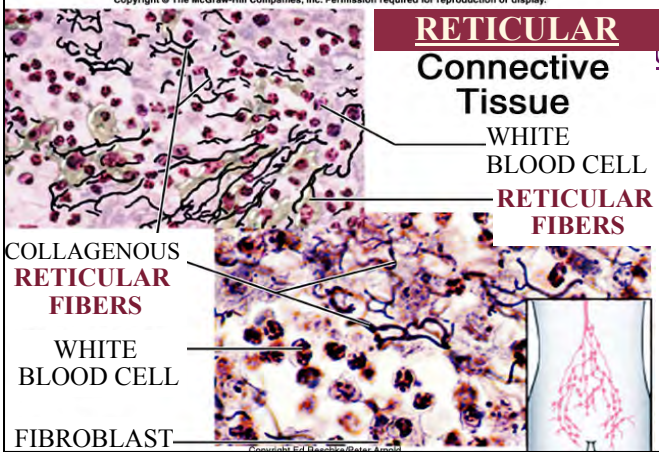
LOOSE CONNECTIVE TISSUE: RETICULAR

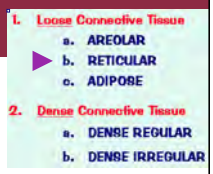
10

"loose" = relatively scarce fiber distribution.

ATLAS: Figures 14 b, c and d (Morton & Perry, 1998)

Distinctive *fiber type:* reticular NOTE: fibers may branch !
reticulin = non–banded form of collagen; sometimes called "fine collagen."





Cells: *reticular* predominate

Functions:

fibers form a soft, internal skeleton that support other cell types.

Sites:

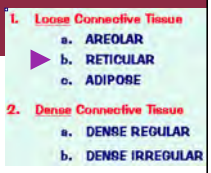
hematopoeitic; lymphoid tissues: spleen, lymph nodes, and bone marrow.

LOOSE CONNECTIVE TISSUE: RETICULAR

11

"loose" = relatively scarce fiber distribution.

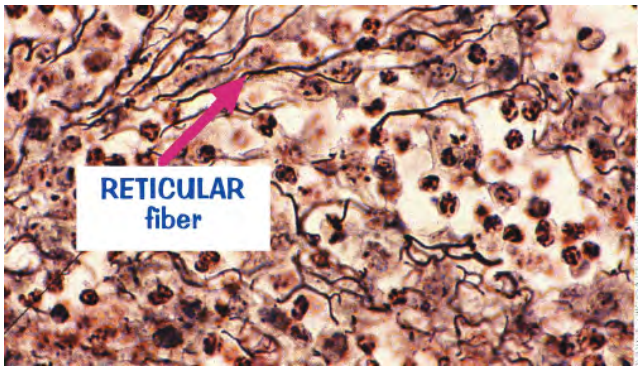
ATLAS: Figures 14 b, c and d (Morton & Perry, 1998)



Another View:

Mesh of reticular fibers appear as dark lines; provides scaffold for cellular organization.

From lymph node (X250)



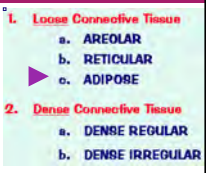
Lab Atlas of A&P
Edet *al.*
Mosby, 1994

LOOSE CONNECTIVE TISSUE: ADIPOSE

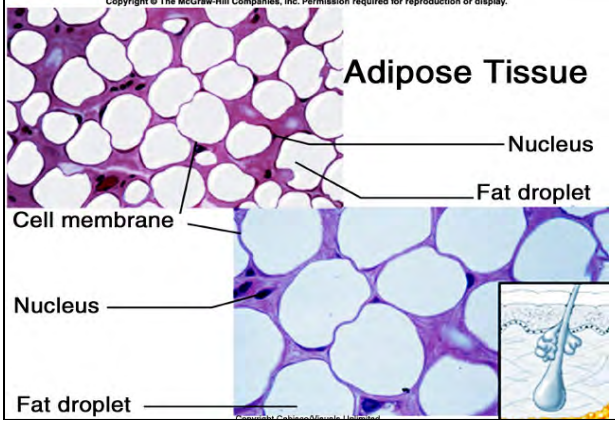
12

"loose" = relatively scarce fiber distribution.

ATLAS: Figures 13 c, d and e (Morton & Perry, 1998)
Brown adipose + description: Figure 14 a



Adipocytes: matrix as in areolar but sparse;
Cells tightly packed fat cells (adipocytes)
show **nuclei pushed to side of a large fat droplet !**



Functions:
Reserve fuel
Organ support/protection
Insulation against heat loss

Sites:
under skin
around kidneys/eyeballs
in bones
within abdomen
in breasts

LOOSE CONNECTIVE TISSUE: ADIPOSE

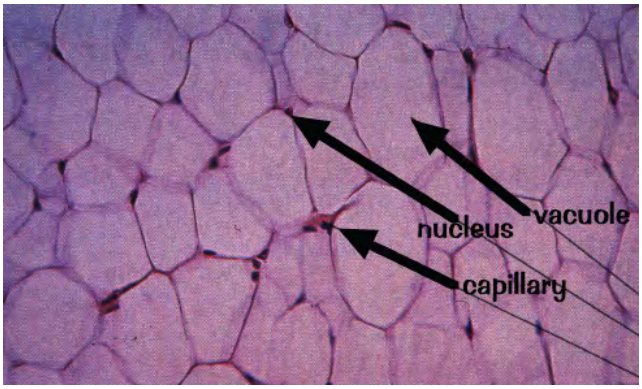
13

"loose" = relatively scarce fiber distribution.

ATLAS: Figures 13 c, d and e (Morton & Perry, 1998)
Brown adipose + description: Figure 14 a

Another View:

Large, polyhederal vacuoles dominate small, displaced nuclei of adipocytes. Fine capillaries run through tissue (x100)



Lab Atlas of A&P
Eder *et al.*
Mosby, 1994

DENSE CONNECTIVE TISSUE: REGULAR

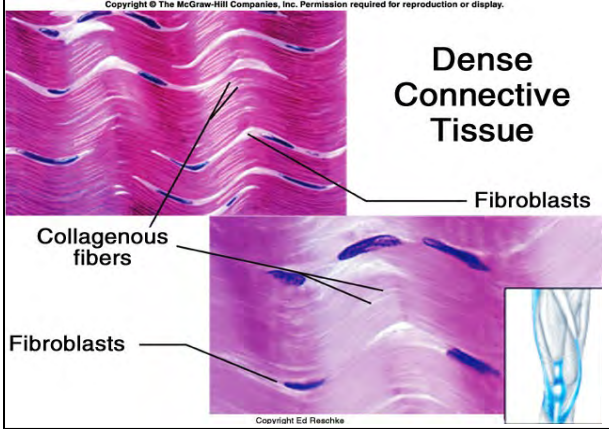
14

DENSE = high fiber distribution;
dense connective tissues are also known as "fibrous"
fibrous usually denotes mostly collagen fibers

1. Loose Connective Tissue
   a. AREOLAR
   b. RETICULAR
   c. ADIPOSE
2. Dense Connective Tissue
   ▶ a. DENSE REGULAR
   b. DENSE IRREGULAR

ATLAS: ▶**Dense Regular White: Figure 12 d (Morton & Perry, 1998)**
Dense Regular Elastic: Figure 13 a (Morton & Perry, 1998)

Major Arrangement: **parallel collagen fibers**, some elastic; **many fibroblasts**



Functions:
increased tensile strength when force applied in one direction.

Sites:
Tendon: muscle to bone
Aponeuroses: muscle to muscle
Ligaments: bone to bone across a joint (most)

NOTE: ***dense regular elastic:***
same arrangement but elastic fibers predominate: some ligaments, arterial wall and the larynx (voicebox).

DENSE CONNECTIVE TISSUE: REGULAR

15

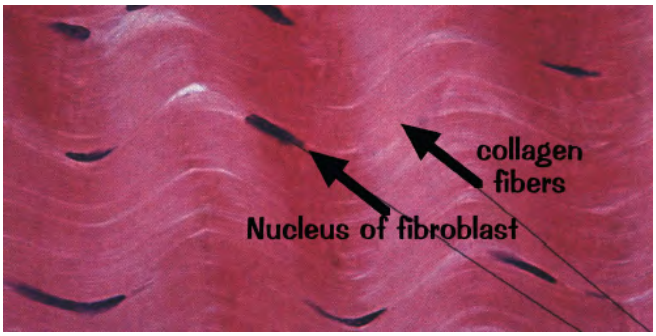
DENSE = high fiber distribution;
dense connective tissues are also known as "fibrous"
fibrous usually denotes mostly collagen fibers

1. Loose Connective Tissue
   a. AREOLAR
   b. RETICULAR
   c. ADIPOSE
2. Dense Connective Tissue
   ▶ a. DENSE REGULAR
   b. DENSE IRREGULAR

ATLAS: ▶Dense Regular White: Figure 12 d (Morton & Perry, 1998)
Dense Regular Elastic: Figure 13 a (Morton & Perry, 1998)

Another View:

Thicker bands of collagen running in regular, parallel rows resist mechanical stress mainly along course of fibers.
Monkey tendon (x250)



Lab Atlas of A&P
Eder *et al.*
Mosby, 1994

NEXT 2 Slides: Dense Regular ELASTIC >>>

DENSE CONNECTIVE TISSUE: REGULAR

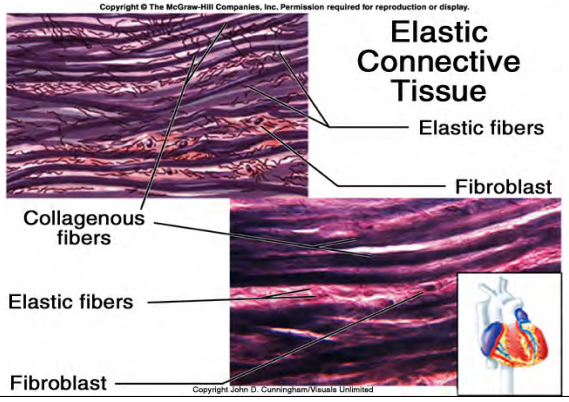
16

DENSE = high fiber distribution;
dense connective tissues are also known as "fibrous"
fibrous usually denotes mostly collagen fibers

1. Loose Connective Tissue
   a. AREOLAR
   b. RETICULAR
   c. ADIPOSE
2. Dense Connective Tissue
   ▶ a. DENSE REGULAR
   b. DENSE IRREGULAR

ATLAS: ▶Dense Regular White: Figure 12 d (Morton & Perry, 1998)
Dense Regular Elastic: Figure 13 a (Morton & Perry, 1998)

NOTE: *dense regular ELASTIC:* same arrangement but **elastic fibers** predominate
SITES: some **ligaments**, **arterial wall** and the **larynx** (voicebox).



DENSE CONNECTIVE TISSUE: REGULAR

17

1. Loose Connective Tissue
   a. AREOLAR
   b. RETICULAR
   c. ADIPOSE
2. Dense Connective Tissue
   ▶ a. DENSE REGULAR
   b. DENSE IRREGULAR

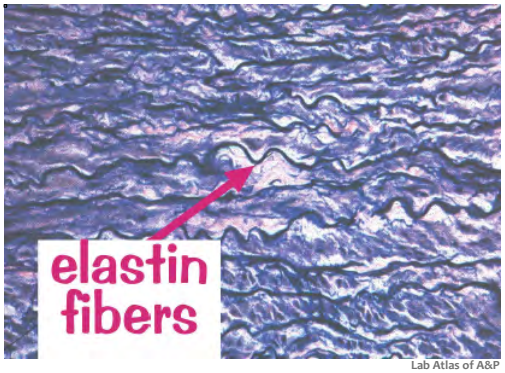
*DENSE = **high** fiber distribution;*
dense connective tissues are also known as "fibrous"
*fibrous **usually** denotes **mostly** collagen fibers*

ATLAS: **Dense Regular White: Figure 12 d (Morton & Perry, 1998)**
Dense Regular Elastic: Figure 13 a (Morton & Perry, 1998)

NOTE: ***dense regular ELASTIC:*** same arrangement but **elastic fibers** predominate
SITES: some **ligaments**, **arterial wall** and the **larynx** (voicebox).

Another View:

Extracellular elastin fibers running parallel In a plane. Structure permits tissue elasticity and recoil.



From aorta (X100)

Lab Atlas of A&P

DENSE CONNECTIVE TISSUE: IRREGULAR

18

1. Loose Connective Tissue
   a. AREOLAR
   b. RETICULAR
   c. ADIPOSE
2. Dense Connective Tissue
   a. DENSE REGULAR
   ▶ b. DENSE IRREGULAR

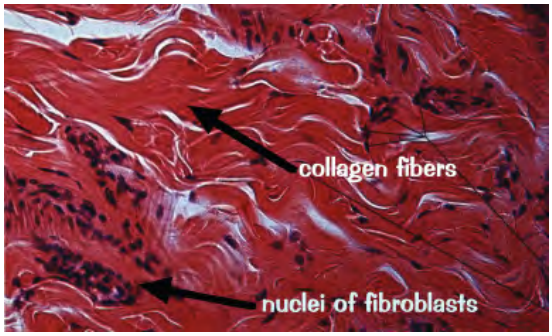
*DENSE = **high** fiber distribution;*
dense connective tissues are also known as "fibrous"
*fibrous **usually** denotes **mostly** collagen fibers*

ATLAS: **Dense Irregular: Figure 12 c (Morton & Perry, 1998)**

Major Arrangement: *non - parallel collagen fibers*, many fibroblasts

Thicker bands of collagen running in irregular rows give multidirectional *tensile* strength. Collagen - secreting fibroblasts appear throughout.
from Aponeurosis (x100)

Lab Atlas of A&P
Eder *et al.*
Mosby, 1994



Functions:
structural strength able to withstand tension from many directions

Sites:
fibrous capsules: organs/joints
dermis of the skin
submucosa of the digestive tract

CONNECTIVE TISSUE: CARTILAGE

19

There are **three** major types of **CARTILAGE:**

1. **HYALINE CARTILAGE**
2. **ELASTIC CARTILAGE**
3. **FIBROCARTILAGE** (one word)

CARTILAGE: HYALINE (smooth, glassy)

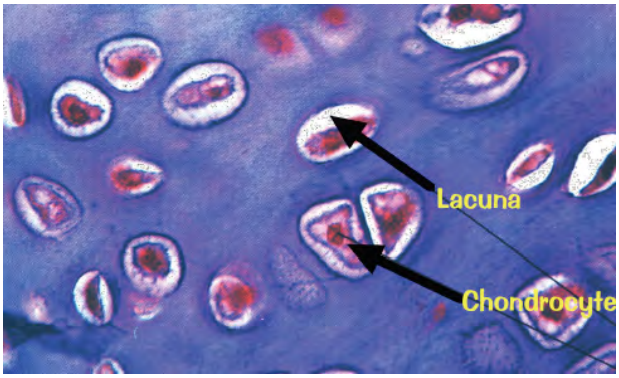
20

1. HYALINE CARTILAGE
2. ELASTIC CARTILAGE
3. FIBROCARTILAGE (one word)

unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

ATLAS: Hyaline cartilage: Figure 15 a and b (Morton & Perry, 1998)

collagen fiber network, while present, is ***often imperceptible***
firm but amorphous matrix
chondroblasts -----> chondrocytes (found in lacunae)
secrete the matrix



Functions:
resilient cushioning properties
resists compressive stress
support

Sites:
most of the embryonic skeleton
ends of long bones
in joint cavities
costal cartilage of the ribs
(between sternum and bony rib)

Cartilage of the:
Nose, Trachea (windpipe)
Larynx (voicebox)

CARTILAGE: HYALINE (smooth, glassy)

21

1. HYALINE CARTILAGE
2. ELASTIC CARTILAGE
3. FIBROCARTILAGE (one word)

unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

ATLAS: Hyaline cartilage: Figure 15 a and b (Morton & Perry, 1998)

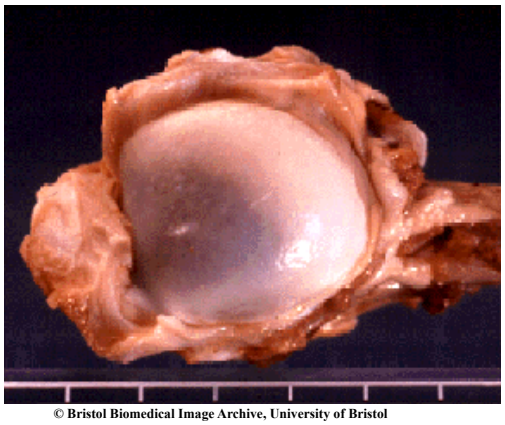


Image donated by: Dr Peter Brown
Donor organisation: University of Bristol, Department of Pathology & Microbiology
Identifier: BRISBIO-CLV00184
Summary: Fibrillation, finely granular articular surface

Speciality (UMLS): Pathology, Veterinary
Body system (UMLS): Musculoskeletal System
Disease (UMLS): Osteoarthritis Joint Diseases
Body part (UMLS): Cartilage, Articular

CARTILAGE: ELASTIC

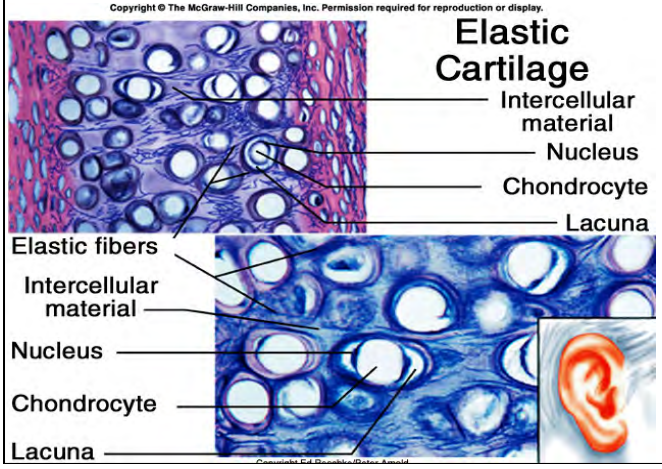
22

1. HYALINE CARTILAGE
2. ELASTIC CARTILAGE
3. FIBROCARTILAGE (one word)

unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

ATLAS: Elastic cartilage: Figure 15 c (Morton & Perry, 1998)

Similar to hyaline cartilage but with a **higher amount of elastic fibers** in the matrix



Functions:
shape maintenance while allowing great flexibility

Sites:
supports the
PINNA:
(external ear)
EPIGLOTIS:
(flap over the trachea)

CARTILAGE: ELASTIC

23

1. HYALINE CARTILAGE
2. ▶ ELASTIC CARTILAGE
3. FIBROCARTILAGE (one word)

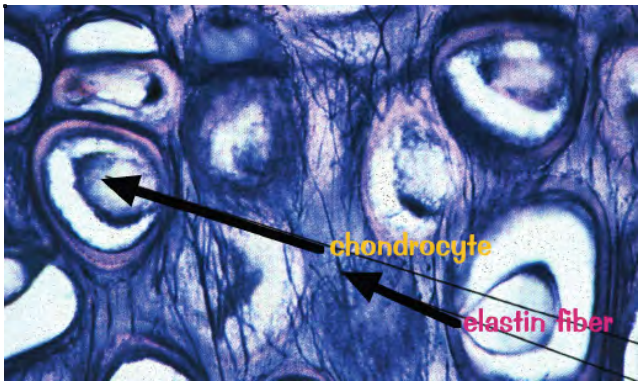
unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

ATLAS: Elastic cartilage: Figure 15 c (Morton & Perry, 1998)

Another View:

Extracellular matrix contains elastic fibers that confer elastic recoil to the tissue. (x250)

Lab Atlas of A&P
Eder *et al.*
Mosby, 1994



CARTILAGE: FIBROCARTILAGE

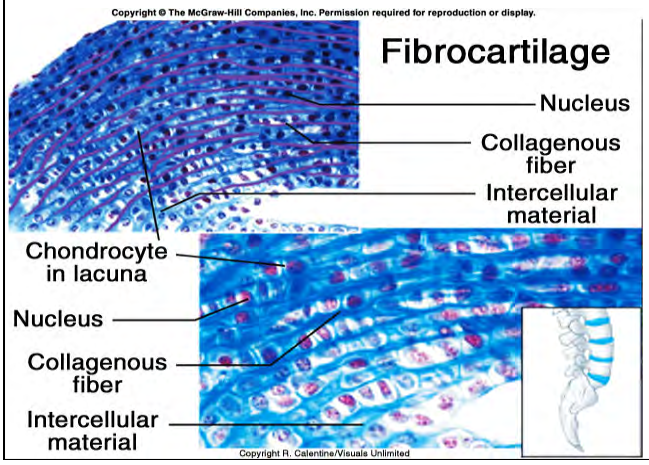
24

1. HYALINE CARTILAGE
2. ELASTIC CARTILAGE
3. ▶ FIBROCARTILAGE (one word)

unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

ATLAS: Fibrocartilage: Figure 15 d (Morton & Perry, 1998)

Similar to hyaline cartilage but matrix is less firm thick collagen fibers predominate



Functions:
shape maintenance while allowing great flexibility

Sites:
intervertebral discs
pubis symphysis
discs of the knee joint

25

CARTILAGE: FIBROCARTILAGE

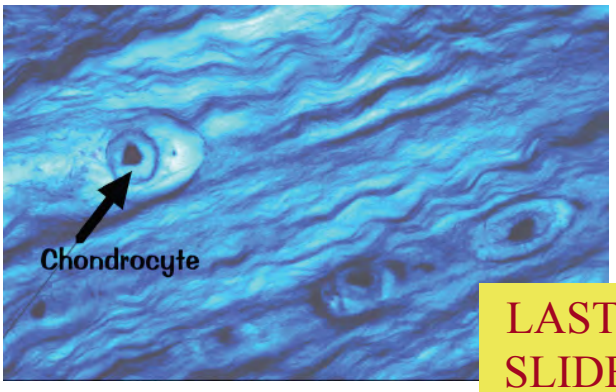
unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by chondroblasts

1. HYALINE CARTILAGE
2. ELASTIC CARTILAGE
3. FIBROCARTILAGE (one word)

ATLAS: Fibrocartilage: Figure 15 d (Morton & Perry, 1998)

Another View:

Cell nest of chondrocytes in territorial matrix surrounded by coarse extracellular fibers. (x250)



Lab Atlas of A&P
Eder *et al.*
Mosby, 1994

LAST SLIDE