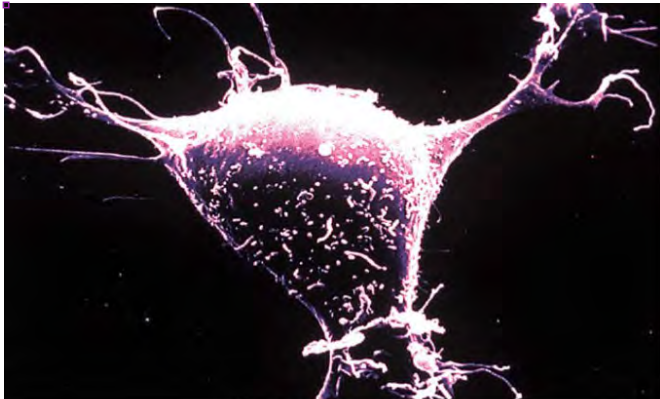


BIO 211:
ANATOMY & PHYSIOLOGY I

FIBROBLAST:



CHAPTER 05

Histology:
CONNECTIVE
TISSUE

Dr. Lawrence G. Altman

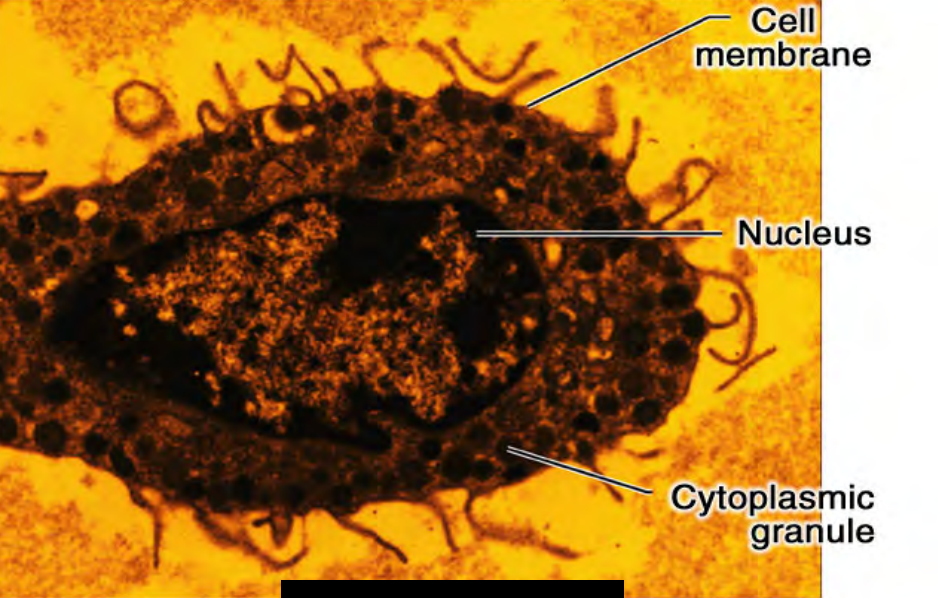
www.lawrencegaltman.com

Some illustrations are courtesy of McGraw-Hill.



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

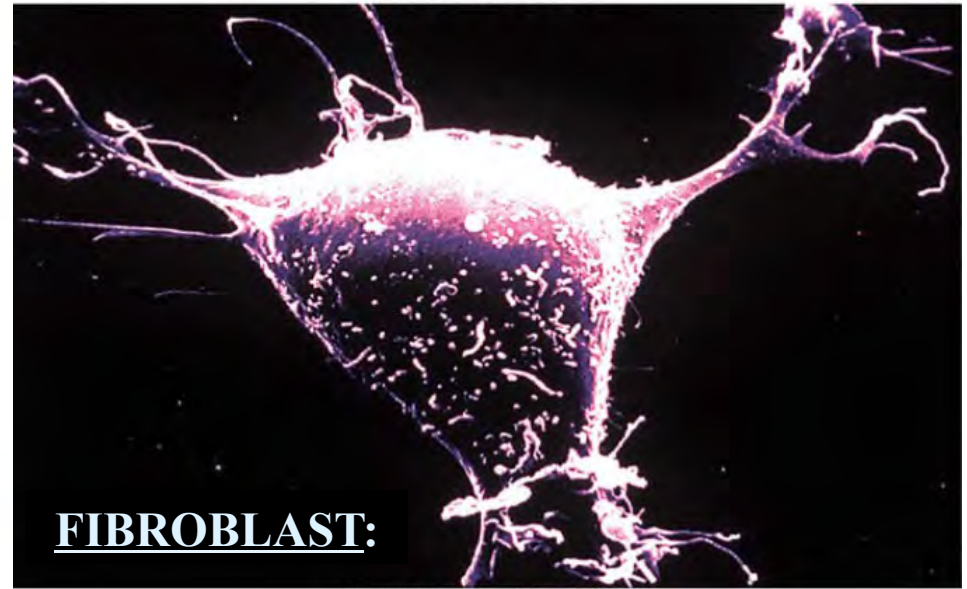
Macrophage

Cell being engulfed



MACROPHAGE

Fibroblast



FIBROBLAST:

OVERVIEW of CONNECTIVE TISSUE:

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:

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:

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.

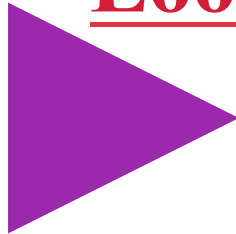
In **bone**, tissue gel is made up of chondroitin sulfate;

In fibroconnective tissue, hyaluronic acid comprises the gel tissue.

OVERVIEW of CONNECTIVE TISSUE:

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

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

LOOSE CONNECTIVE TISSUE: AREOLAR

“loose” = relatively scarce fiber distribution.

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

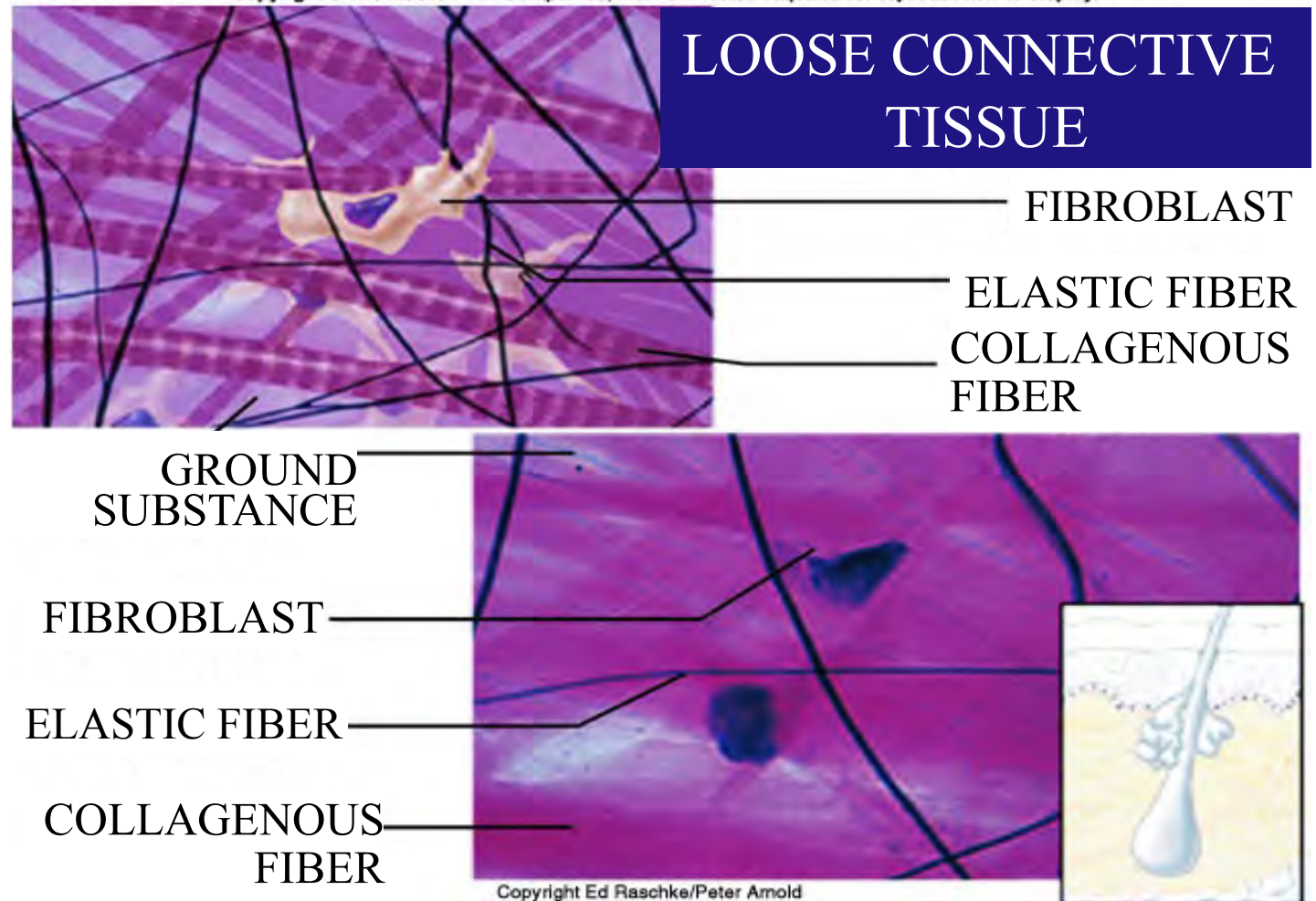
Sites

wide distribution,
organ packaging,
surrounds capillaries

Functions

wrap/surround
organs
additional:
See Cells

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LOOSE CONNECTIVE TISSUE: AREOLAR

9

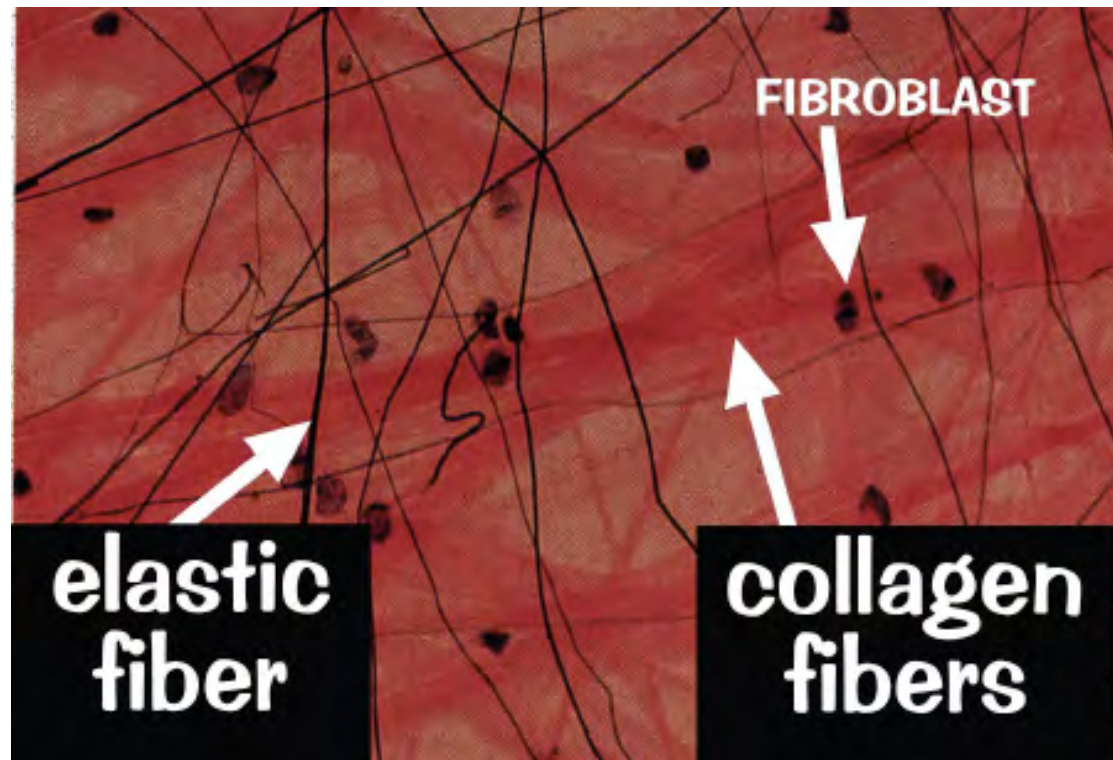
“loose” = relatively scarce fiber distribution.

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

“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.”

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

RETICULAR Connective Tissue

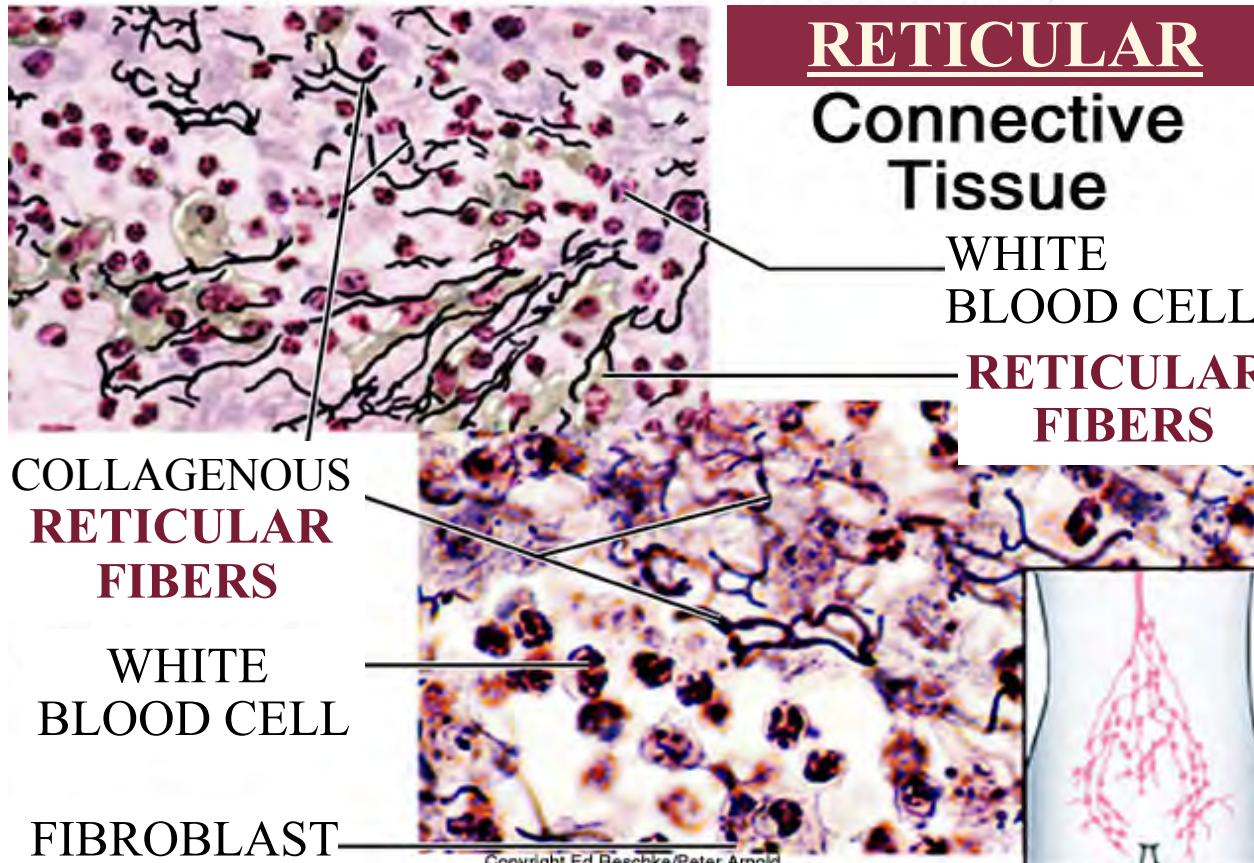
Cells: reticular predominate

Functions:

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

Sites:

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



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LOOSE CONNECTIVE TISSUE: RETICULAR

“loose” = relatively scarce fiber distribution.

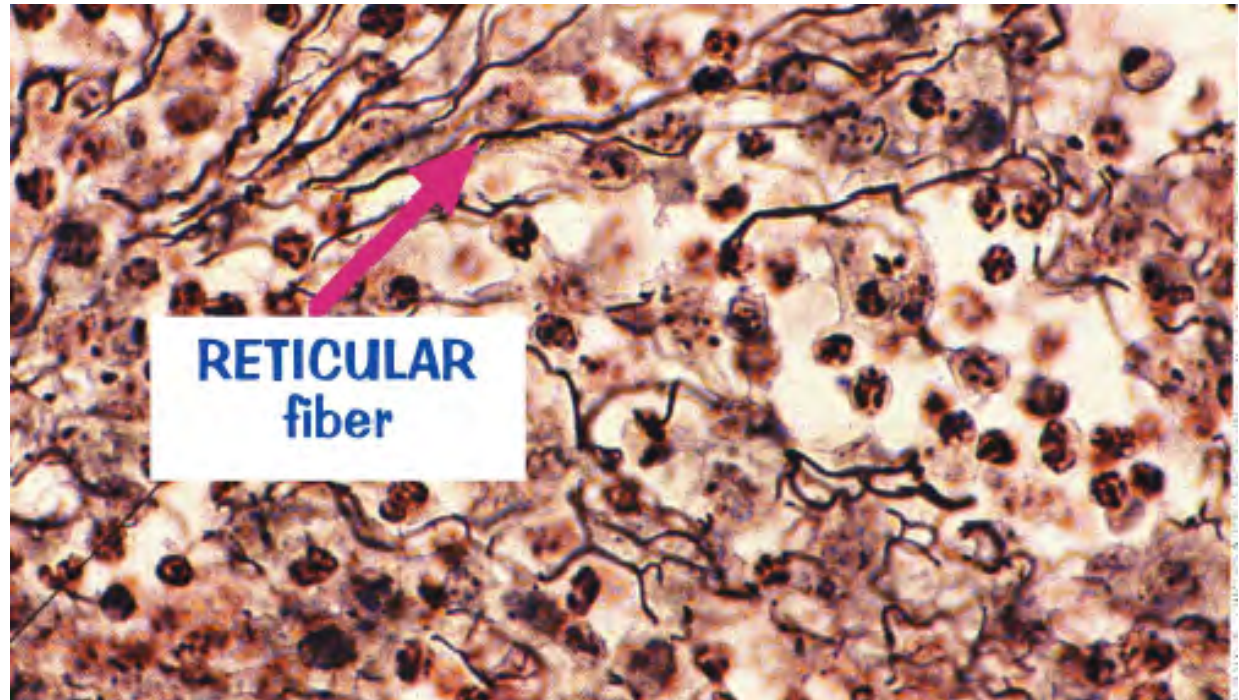
ATLAS: Figures 14 b, c and d (Morton & Perry, 1998)

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

Another View:

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

From lymph node
(X250)



LOOSE CONNECTIVE TISSUE: ADIPOSE

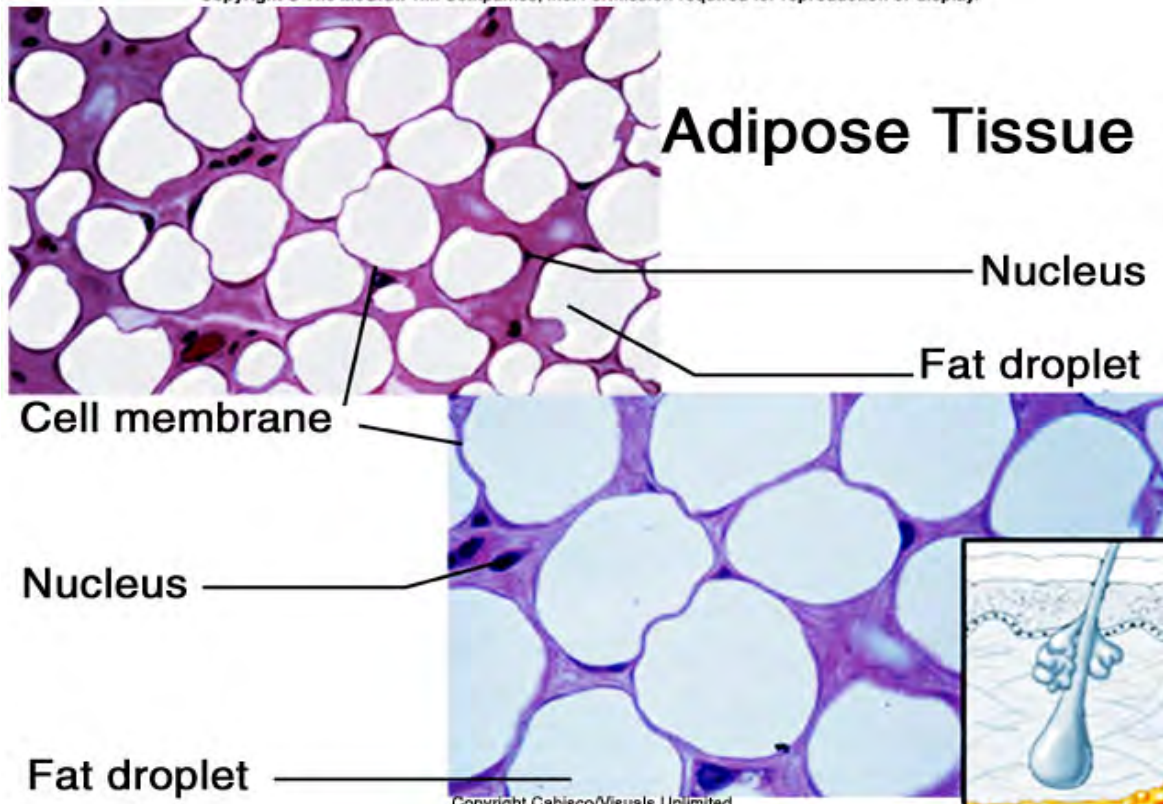
“loose” = relatively scarce fiber distribution.

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 !**

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

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

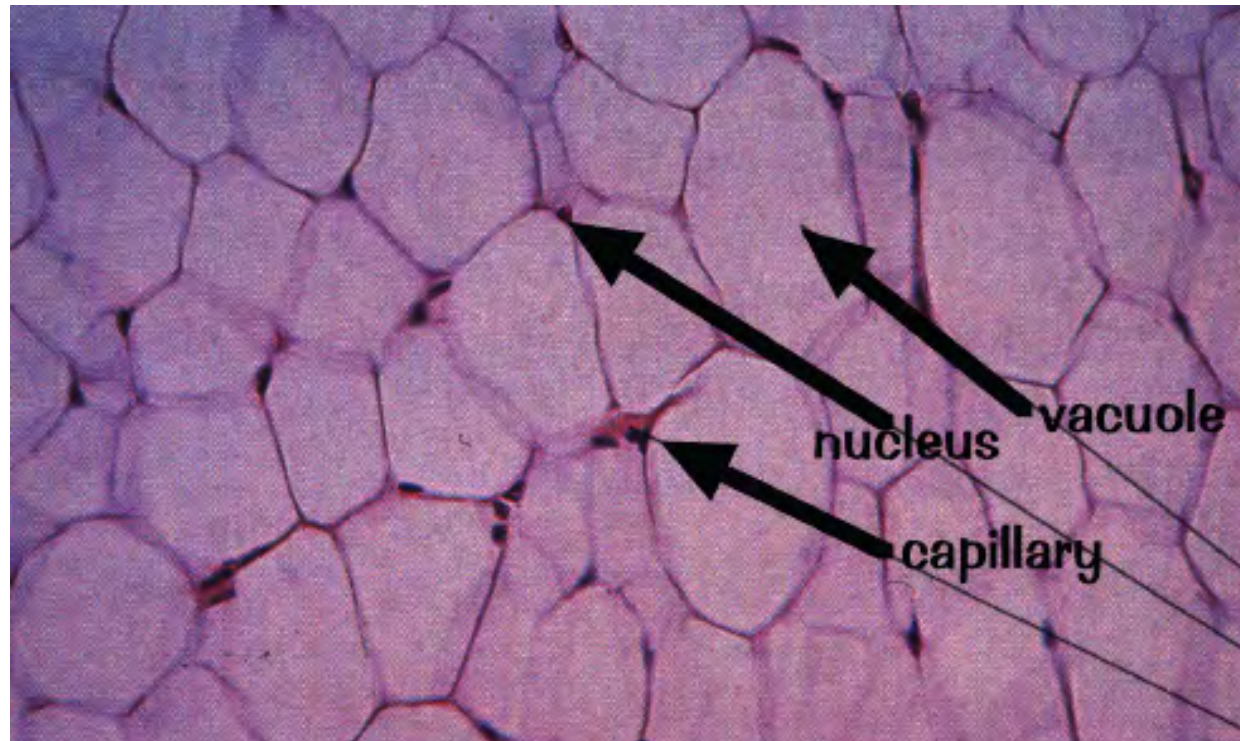
“loose” = relatively scarce fiber distribution.

ATLAS: Figures 13 c, d and e (Morton & Perry, 1998)

Brown adipose + description: Figure 14 a

Another View:

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



DENSE CONNECTIVE TISSUE: REGULAR

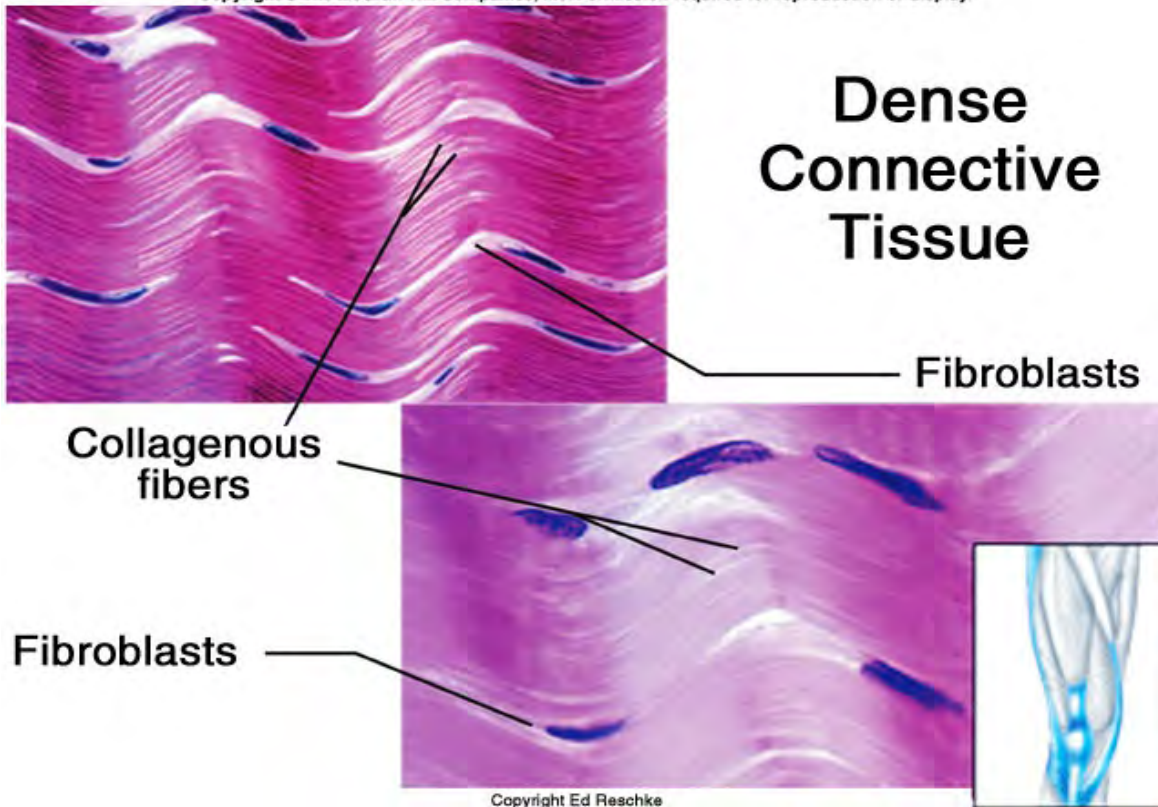
DENSE = *high fiber distribution;*
dense connective tissues are also known as “fibrous”
fibrous usually denotes mostly collagen fibers

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

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

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

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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

*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

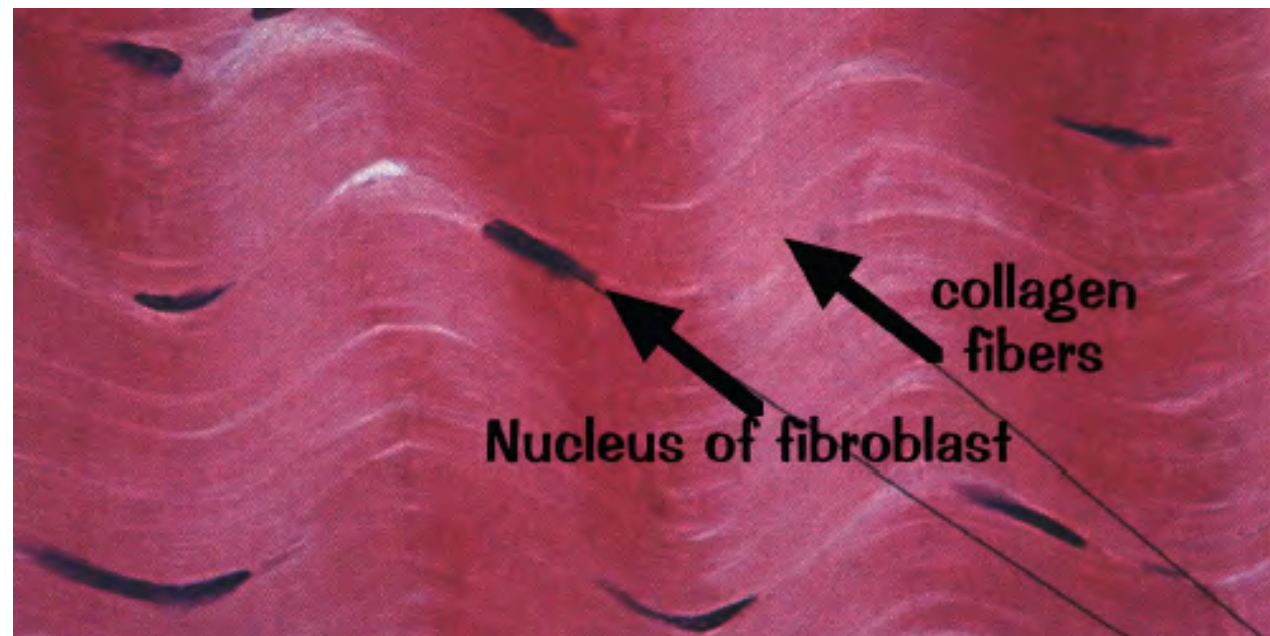
2. Dense Connective Tissue

- ▶ 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)



DENSE CONNECTIVE TISSUE: REGULAR

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)

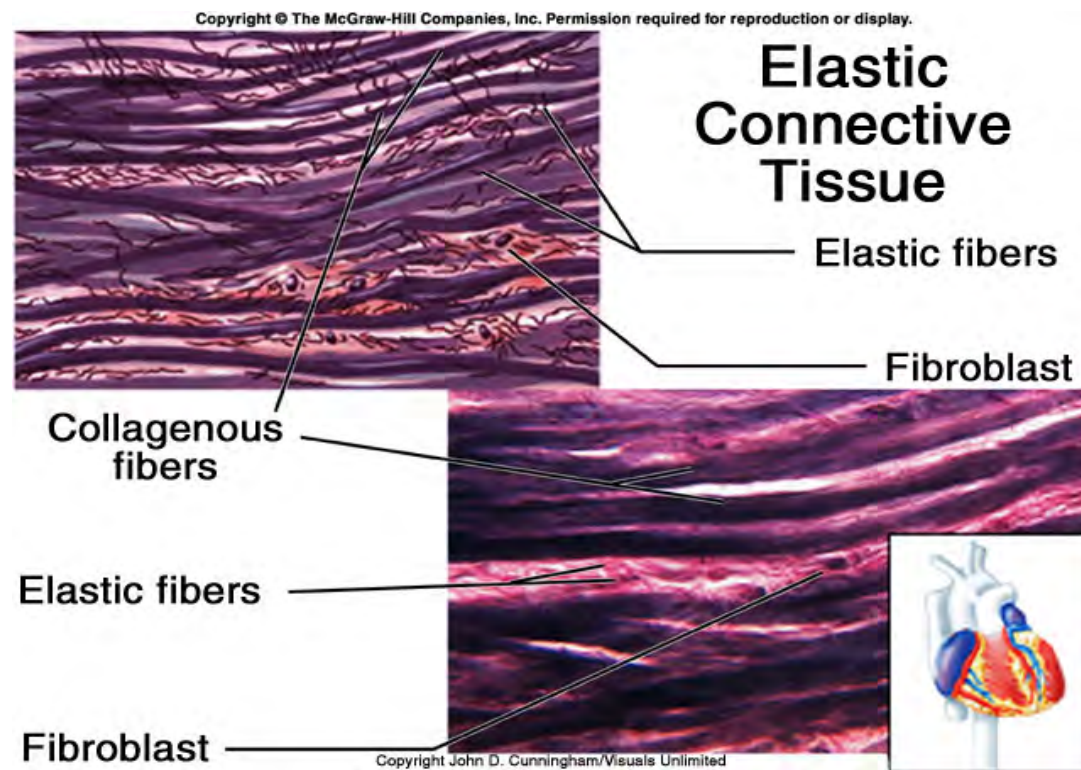
1. Loose Connective Tissue

- a. AREOLAR
- b. RETICULAR
- c. ADIPOSE

2. Dense Connective Tissue

- a. DENSE REGULAR
- b. DENSE IRREGULAR

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



DENSE CONNECTIVE TISSUE: REGULAR

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)

1. Loose Connective Tissue

- a. AREOLAR
- b. RETICULAR
- c. ADIPOSE

2. Dense Connective Tissue

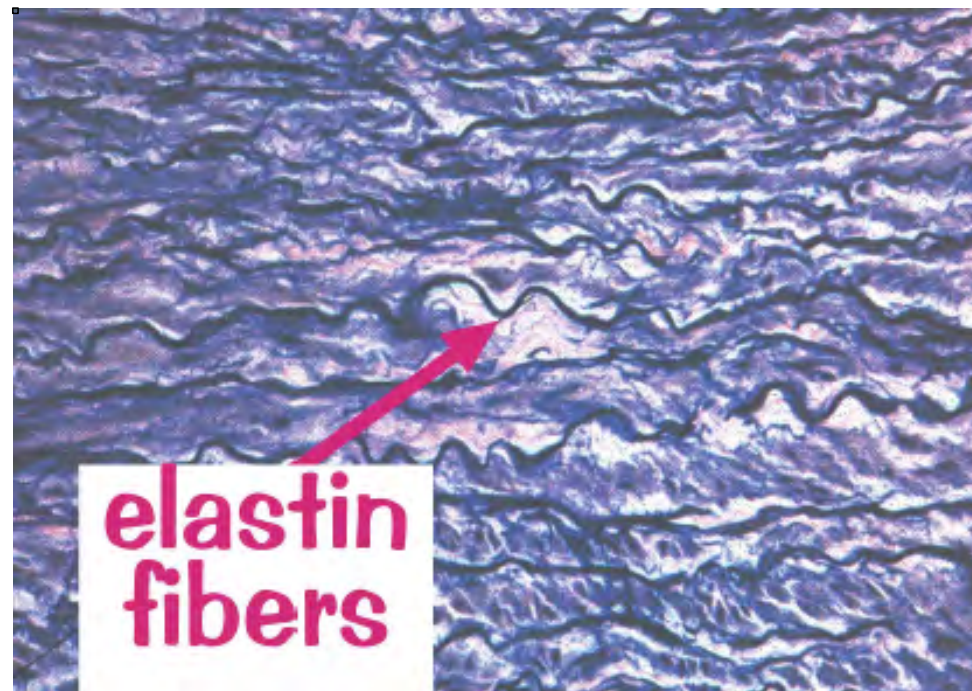
- a. DENSE REGULAR
- b. DENSE IRREGULAR

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

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

Another View:

From aorta (X100)



DENSE CONNECTIVE TISSUE: 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)

1. **Loose Connective Tissue**

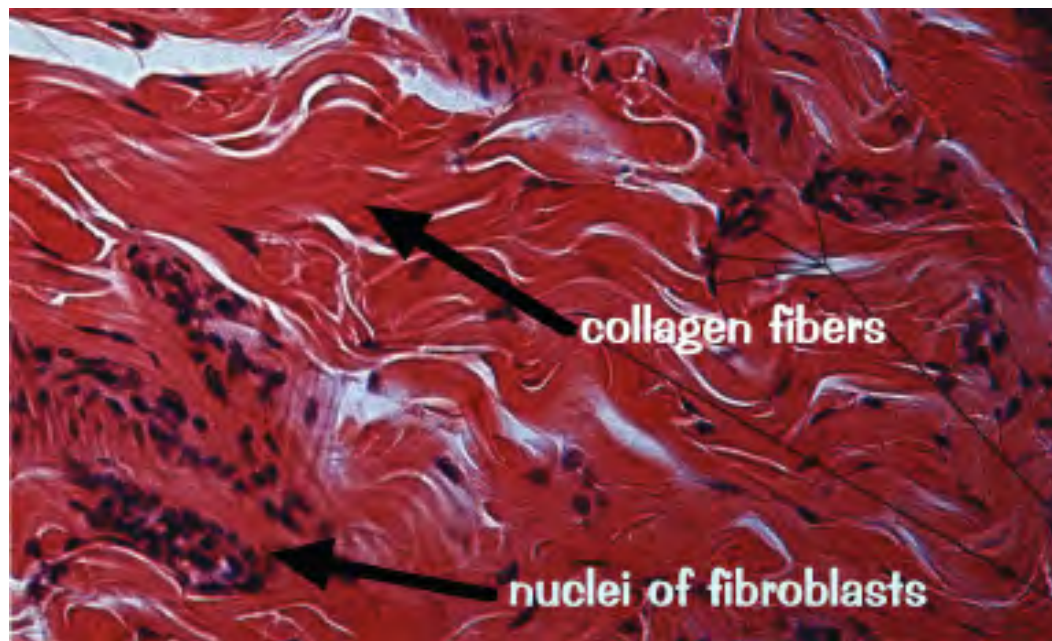
- a. AREOLAR
- b. RETICULAR
- c. ADIPOSE

2. **Dense Connective Tissue**

- a. DENSE REGULAR
- ▶ b. DENSE IRREGULAR

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:

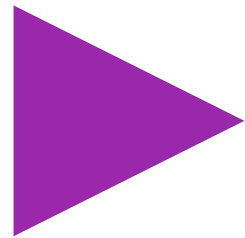
structural strength
 able to withstand
 tension from
many directions

Sites:

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

CONNECTIVE TISSUE: CARTILAGE

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



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

CARTILAGE: **HYALINE** (smooth, glassy)

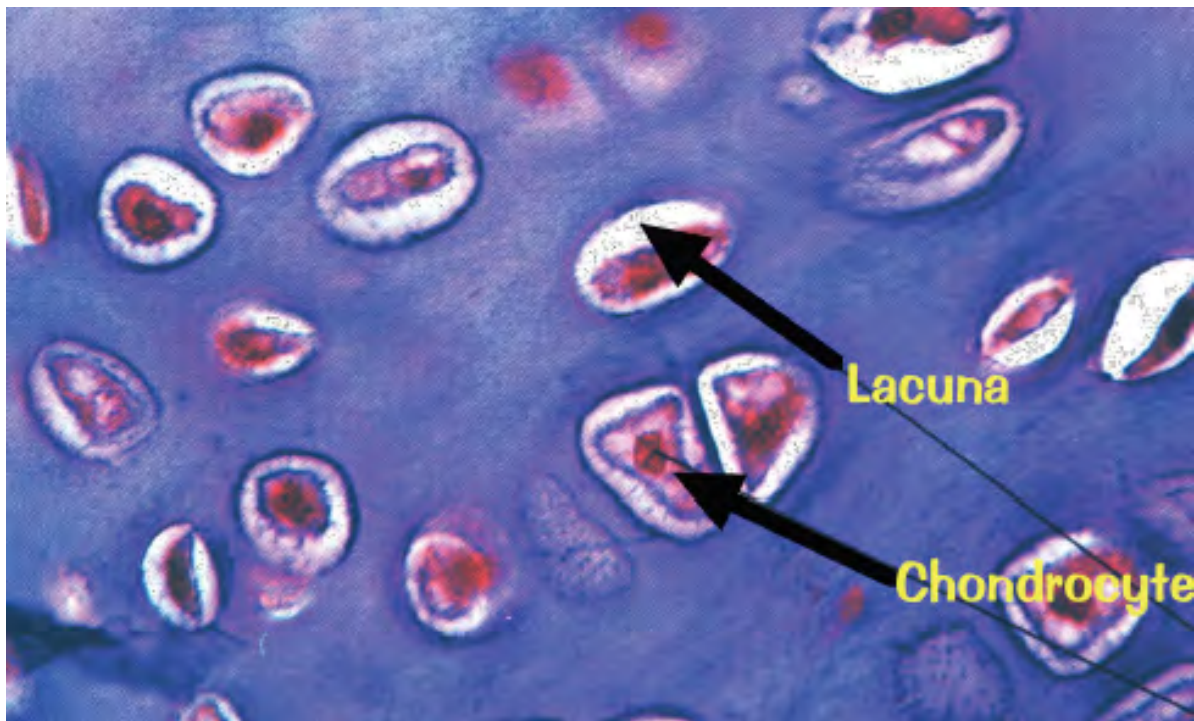
*unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by **chondroblasts***

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

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:

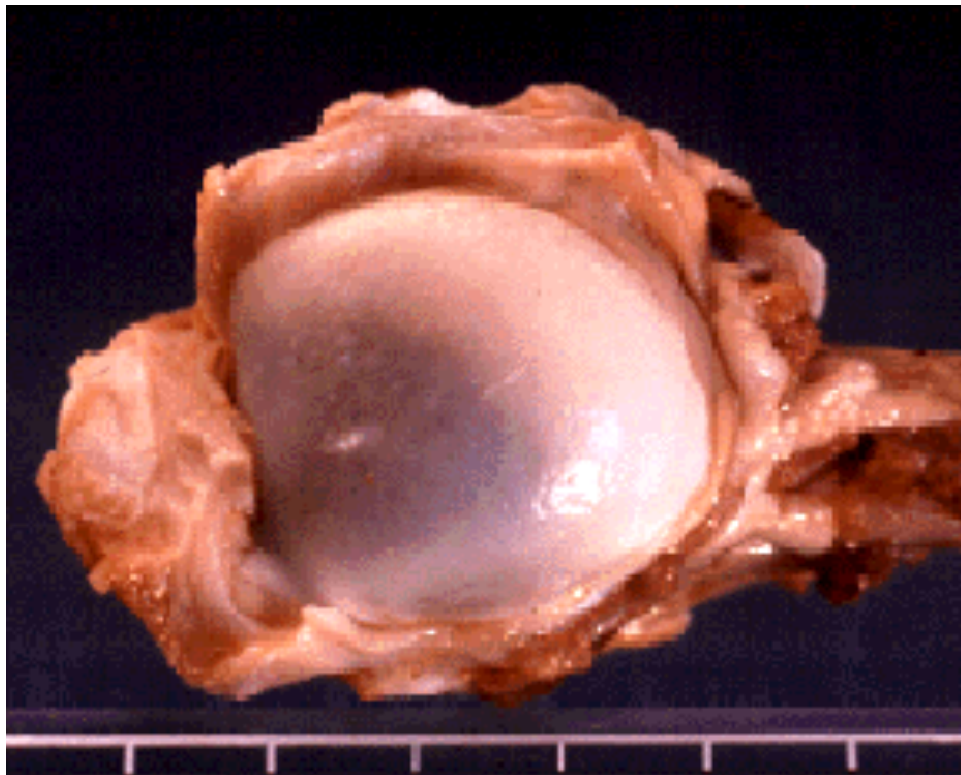
Nose, Trachea (windpipe)
Larynx (voicebox)

CARTILAGE: **HYALINE** (smooth, glassy) ▶

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

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

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



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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

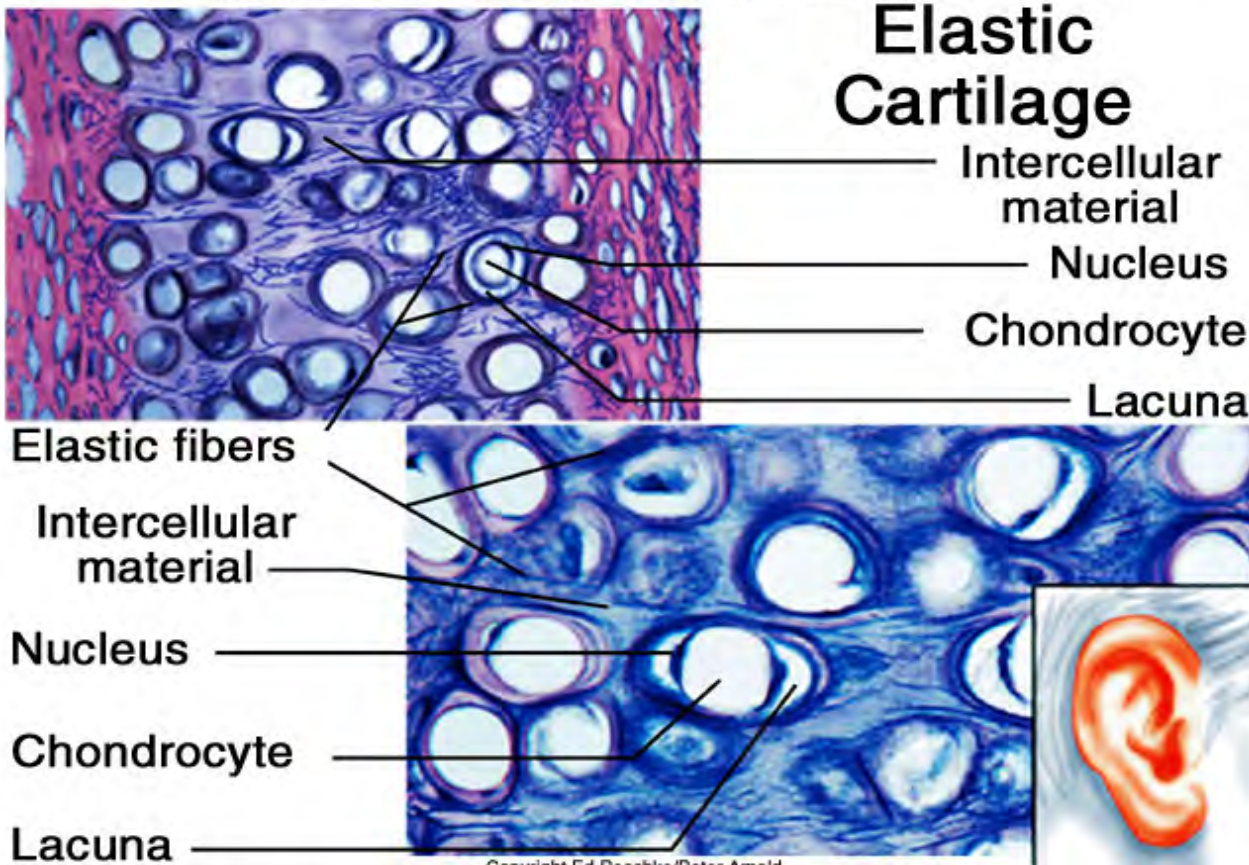
*unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by **chondroblasts***

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

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

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

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Functions:

shape maintenance while allowing great flexibility

Sites:

supports the **PINNA:**
(external ear)

EPIGLOTIS:
(flap over the trachea)

CARTILAGE: ELASTIC

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

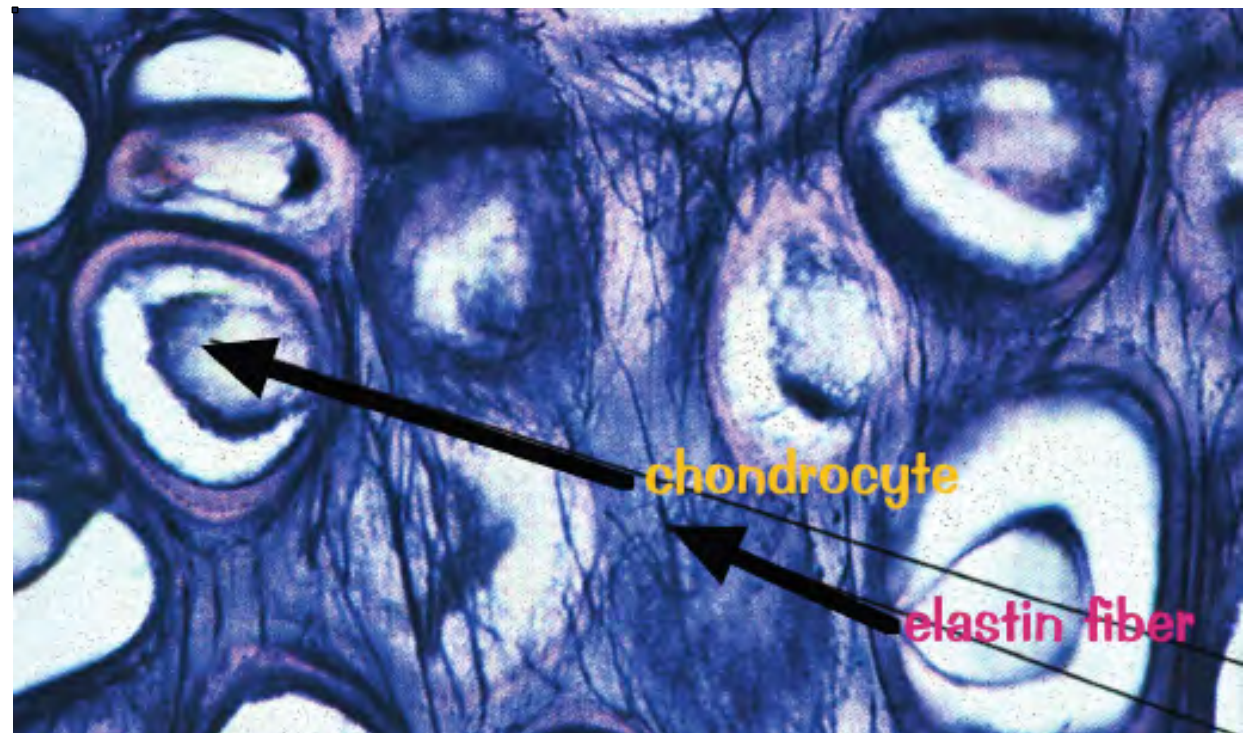
1. **HYALINE** CARTILAGE
2. **ELASTIC** CARTILAGE
3. **FIBROCARTILAGE** (one word)

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



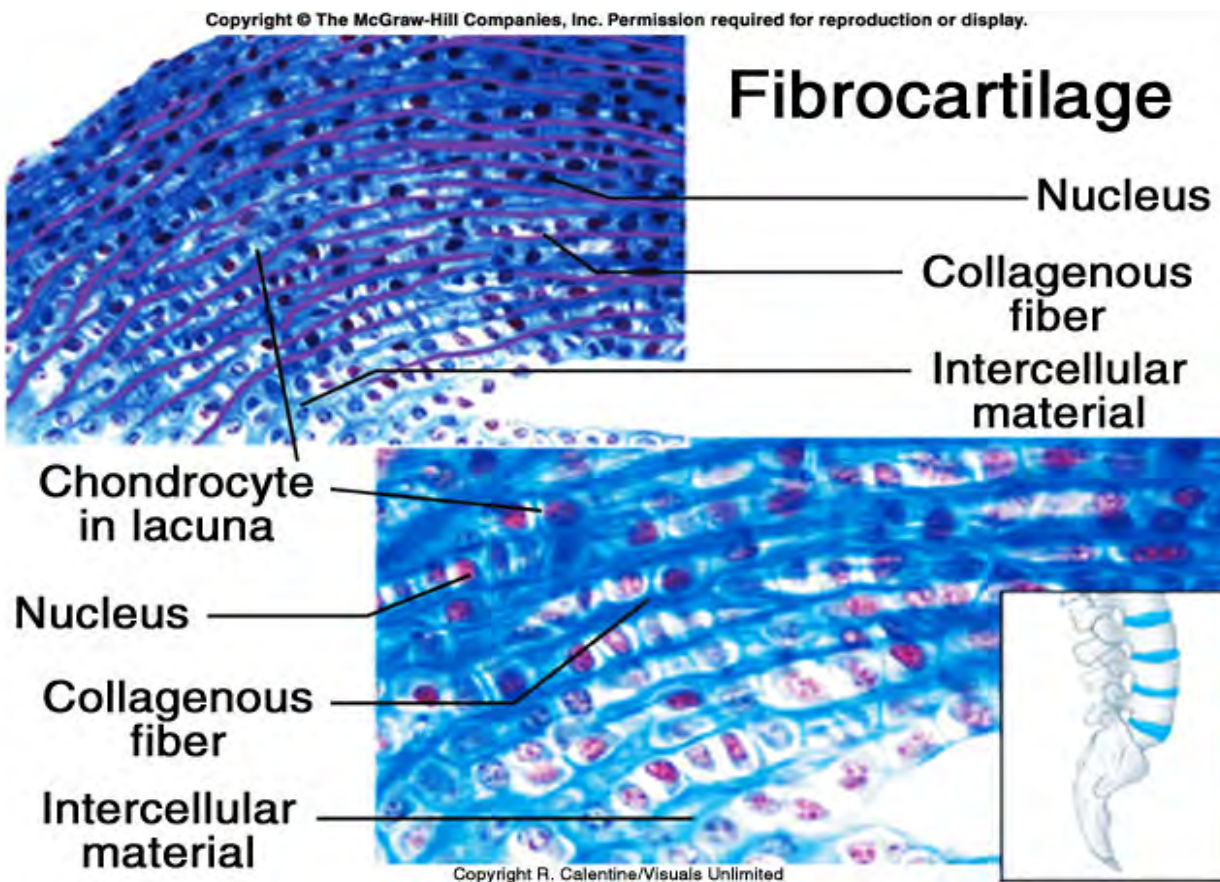
CARTILAGE: FIBROCARILAGE

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

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

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

CARTILAGE: FIBROCARILAGE

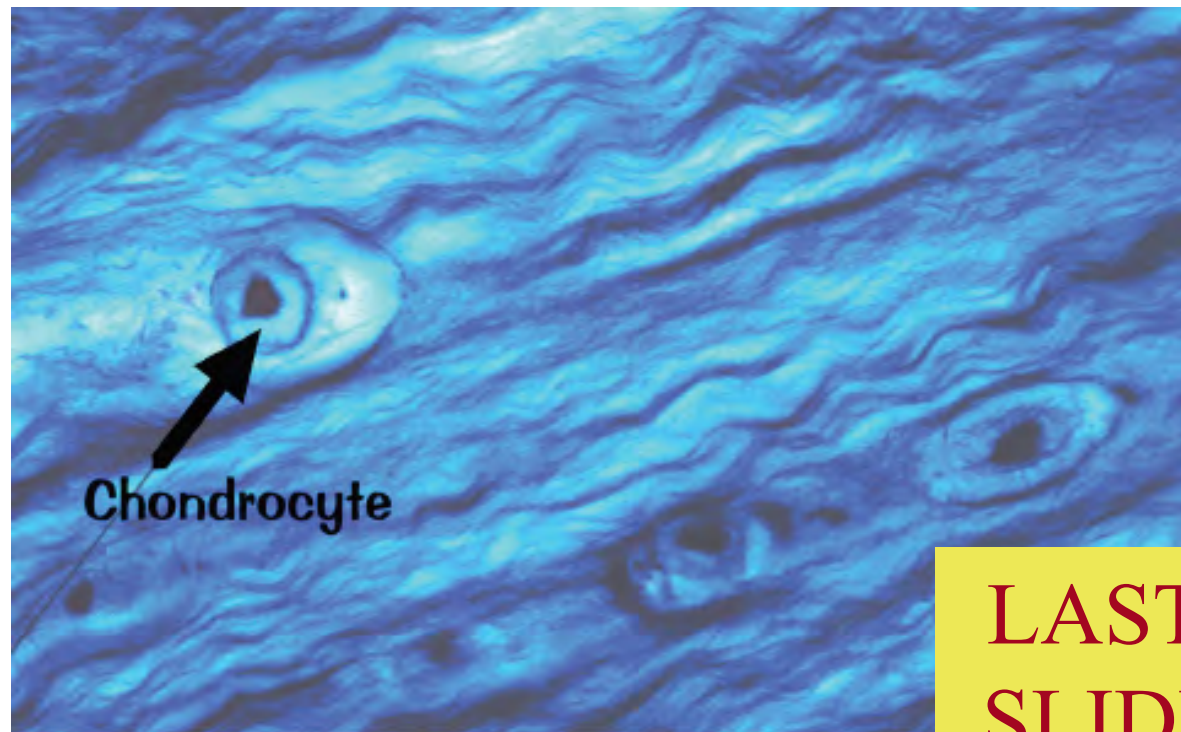
*unlike the connective tissue proper (fibroblast - derived), cartilage matrix is formed by **chondroblasts***

1. **HYALINE CARTILAGE**
2. **ELASTIC CARTILAGE**
3. **FIBROCARILAGE** (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