



الجمهورية العربية السعودية
جامعة الملك سعود

جامعة الملك سعود

كلية العلوم

قسم الكيمياء الحيوية

الكيمياء الحيوية للأنسجة المتخصصة

Biochemistry of Specialized Tissues

BCH 443

Biochemistry of specialized Tissues

- Course Symbol & No. : BCH 443
- Credit Hours : 2 (2+0)
- Prerequisite : BCH 347
- Class schedule : Sunday and Tuesday,
1 pm to 2pm.
- Class location : AA35-1 building No. 5
- Examinations : First (25 Marks) Tues, 25/11/1431h – 2/11/2010
Second (25 Marks) Tues, 29/1/1432h – 4/1/2011
Final (50 Marks)

- **This course aims to study chemical composition, proteins, biosynthesis and biochemical role of the following tissues:**
- 1- Connective tissues in bone, cartilage, teeth,
- 2- Epithelial tissue,
- 3- Muscle tissue and basis of contraction,
- 4- Nerve tissue and brain,
- 5- Kidney and liver.

<u>Lecture</u> <u>No</u>	<u>Topics</u>
1-7	<p>Connective Tissue: definitions, classification, components of connective tissues-cell types.</p> <p>Collagen, tropocollagen structure, the synthesis of collagen, Maturation of collagen. Biochemical basis of other collagen-associated diseases e.g. Ehlers-Danlos syndromes. Collagenases, tissue and bacterial, role in health and disease.</p> <p>Elastin, occurrence, physiochemical properties, amino acid composition, cross-links. Ground substance: composition and function.</p> <p>Cartilage, occurrence and composition.</p> <p>Bone, composition and structure of mineral of mineral phase, hydroxyapatite, organic constituents. Calcium metabolism: Forms of blood calcium. Physiological functions of calcium. Regulation of blood calcium by 1,25-dihydroxycholecalciferol, parathyroid hormone and calcitonin. Blood phosphate.</p> <p>Teeth, brief structure. Composition of enamel, dentine and cementum. Dental caries and role of fluorides.</p>

<u>Lecture</u> <u>No</u>	<u>Topics</u>
8	Epithelial Tissue , Definition and cellular structure. Melanin location and structure. Synthesis of melanin. Albinism, biochemical basis of the various types.
9-13	Muscle Tissue: Classification of muscles. Skeletal muscle cell structure in detail, internal membrane systems, e.g. sarcoplasmic reticulum. Myofibril structure, sarcomere structure in detail. Thick and thin filaments, their arrangement as the physical basis for the striated appearance of skeletal muscle. Sliding filament hypothesis. Proteins of striated muscles, myosin, structure and properties, enzymic cleavage, heavy and light myosin and their properties. Arrangement of myosin in thick filaments. Actin, structure and properties, G-actin and F-actin. Molecular basis of contraction, ATP cycle.

Lect No**Topics**

14-19

Nerve Tissue: Brief introduction to anatomy of central and peripheral nervous systems. Neuron morphology, dendrites, axons etc. Sensory and motor nerves. Definitions of sympathetic and parasympathetic nervous systems, ganglia, synapses etc. Membrane potentials, role of Na⁺-K⁺ ATPase. Effects of inhibitors e.g. Ouabain. Action potentials, Sodium and potassium “channels”. Molecular basis and action of inhibitors e.g. tetrodotoxin etc.

Neurotransmitters: definition and characteristics. Acetylcholine synthesis, storage, release, mechanism of action and catabolism in detail. Role of monoamine oxidase (MAO). Other neurotransmitters in brief, e.g. Dopamine, serotonin. Brain: composition. Grey matter, white matter. Blood-brain barriers, physical basis. Energy sources, respiratory quotient and oxygen consumption in normal state, hypoglycaemia and insulin shock. Ketone bodies and their role in starvation. Amino acid metabolism of brain and ammonia toxicity.

20-23

Kidney: Brief introduction to kidney structure and function. Kidney metabolism in brief. Definitions of “clearance” “renal threshold” and “transport maximum”. Mechanism of excretion of various non-electrolytes and electrolytes. Role of kidney in maintenance of acid-base balance.

24-26

Liver: Metabolic profile of the liver- an overview. Role of the Liver in the integration of metabolism

Recommended references

- Essentials of human anatomy and physiology – E. N. Marieb. 7th ed
- Principles of biochemistry, Mammalian biochemistry –E.L Smith & R.L Hill
- Biochemistry – L. Stryer

Tissues and tissue types

- **Tissues are:**
 - Collections of specialized cells and cell products organized to perform a limited number of functions
- **The four tissue types are:**
 - Connective
 - Epithelial
 - Muscular
 - Nervous or Neural

Functions of Connective Tissue

1. Connects tissues
2. Establishes a structural framework
3. Transports fluids and dissolved materials
4. Protects delicate organs
5. Stores energy
6. Defends the body from microorganisms

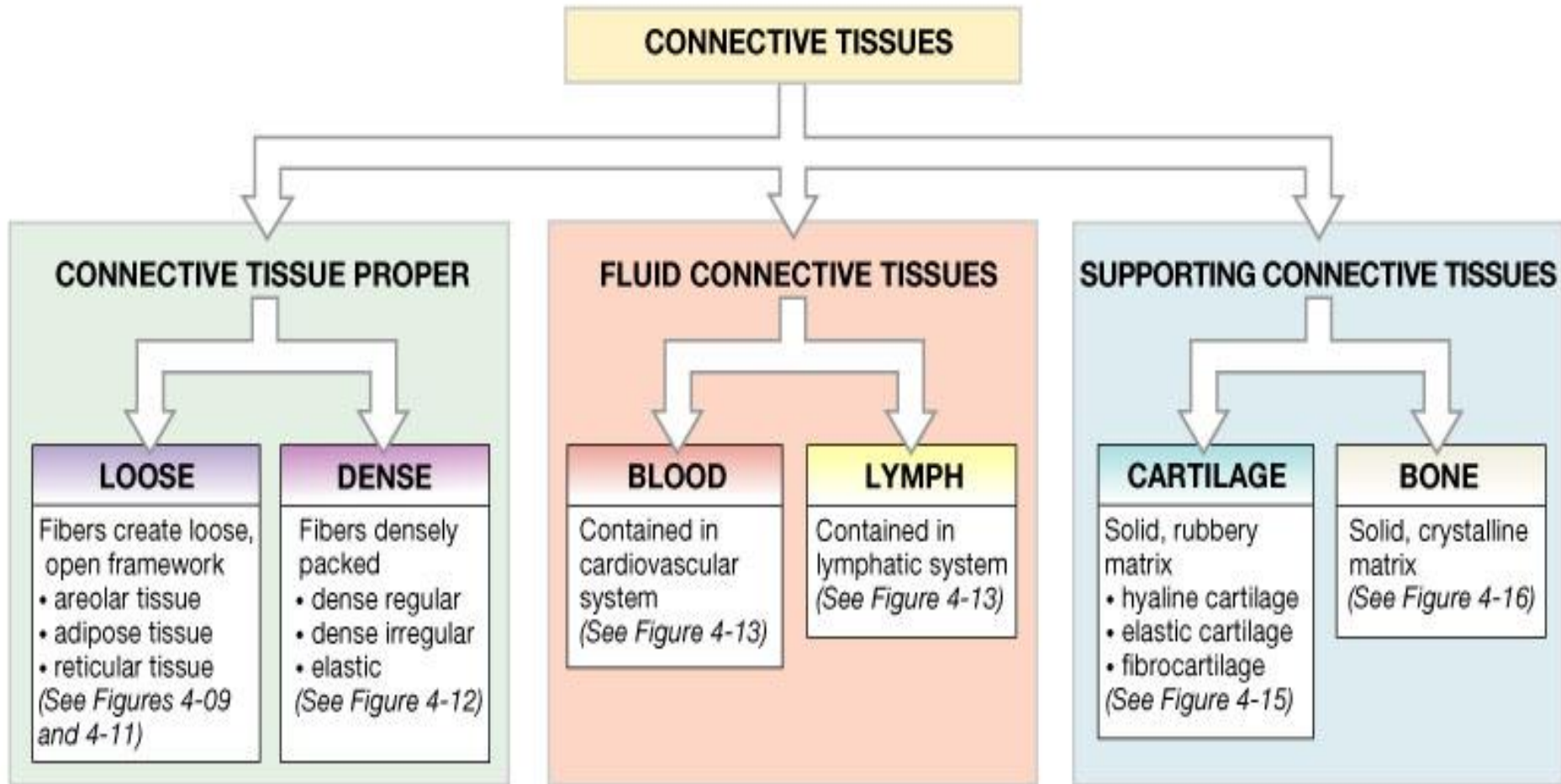
Connective tissues contain

- **All connective tissues share three basic components:**
 1. Specialized cells
 2. Extracellular protein fibers
 3. Fluid known as a ground substance

} Matrix
- The matrix represents most of the volume of connective tissues

Classification of Connective Tissues

We can identify three main types of connective tissues



Connective tissue proper

- Contains varied cell populations
- A syrupy ground substance
- Contains various fiber types
- It is composed of two types:
 - loose
 - dense

Fluid connective tissue

- Contains a distinctive cell population
- Watery ground substance with dissolved proteins
- It is composed of two types:
 - Blood
 - Lymph

Supporting connective tissues

- Less diverse cell population
- Dense ground substance
- Closely packed fibers
- It is composed of two types:
 - Cartilage
 - Bone

Connective Tissue Proper

Connective tissue proper

- **Contains fibers, a viscous ground substance, and a varied cell population.**

Cell Population

- It is composed of various types:
 - Fibroblast
 - Macrophages
 - Adipocytes
 - Lymphocytes
 - Mesenchymal cells
 - Microphages
 - Melanocytes
 - Mast cells

Connective tissue proper

Contains three main types of fibers,

- Collagen fibers
- Reticular fibers
- Elastic fibers

Connective tissue proper

Classified as loose or dense

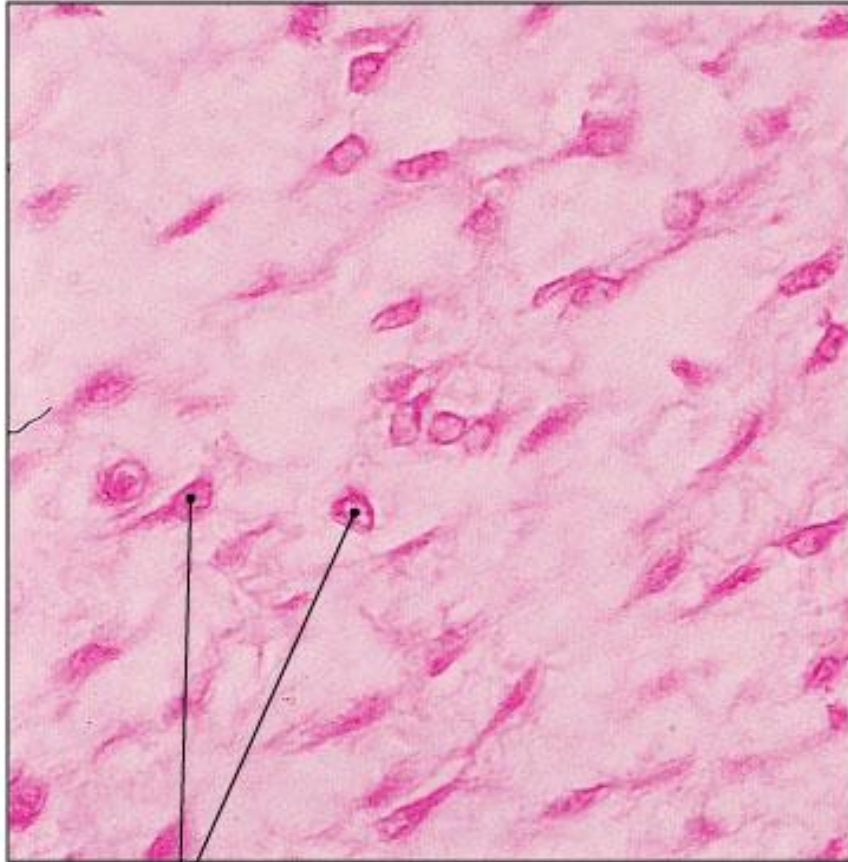
- **LOOSE:**

1. Embryonic mesenchyme, mucous connective tissues.
2. Areolar Tissue.
3. Adipose Tissue.
4. Reticular Tissue.

- **DENSE:**

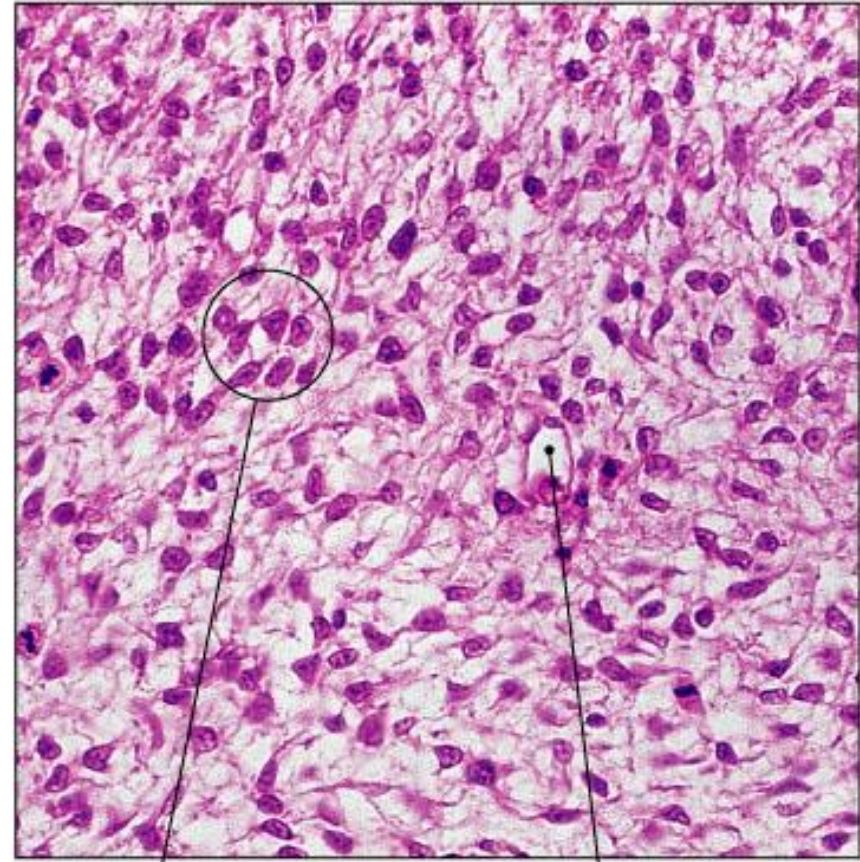
1. Dense regular connective tissue.
2. Dense irregular connective tissue

Connective Tissue in Embryos



Mesenchymal cells

(a) Mesenchyme (LM × 136)

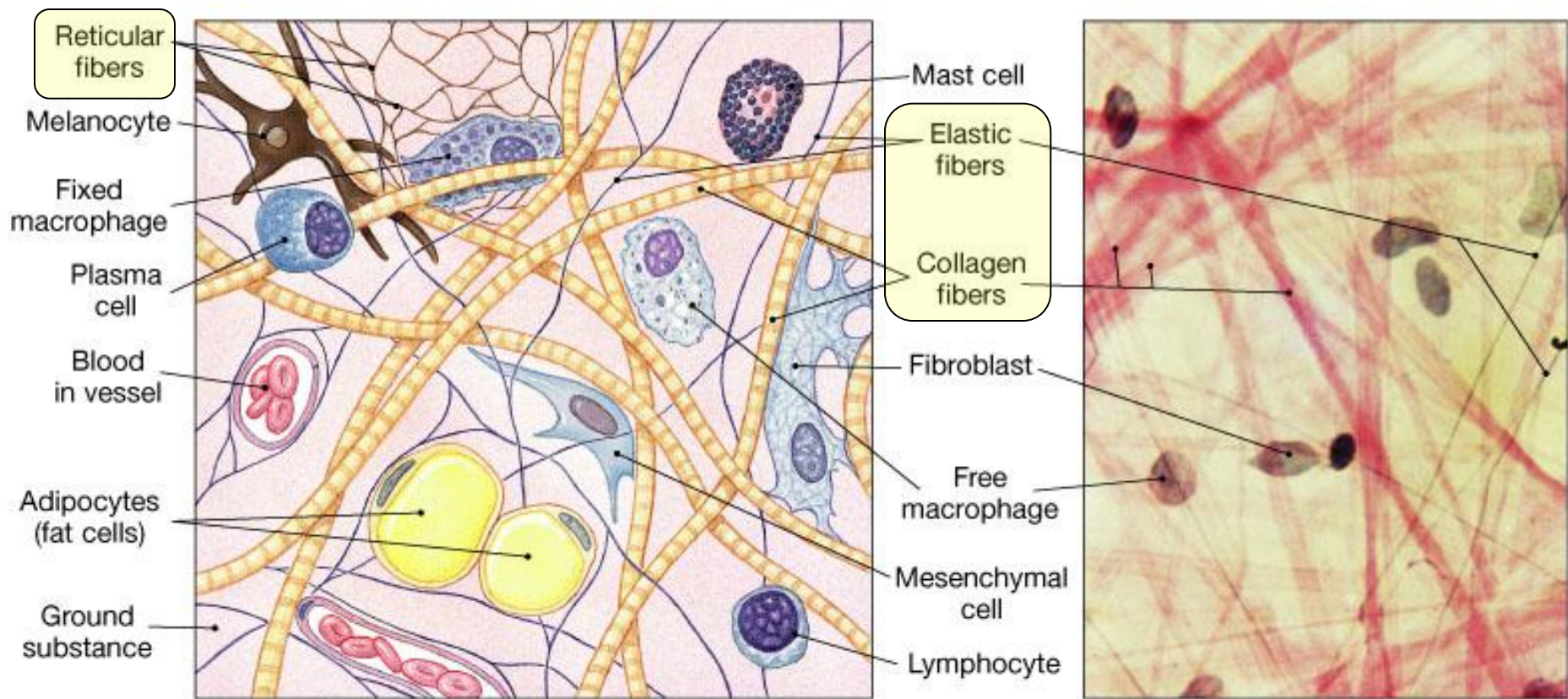


Mesenchymal cells

Blood vessel

(b) Mucous connective tissue (LM × 136)

The Cells and Fibers of Areolar Connective Tissue Proper



Connective tissue proper (areolar tissue)

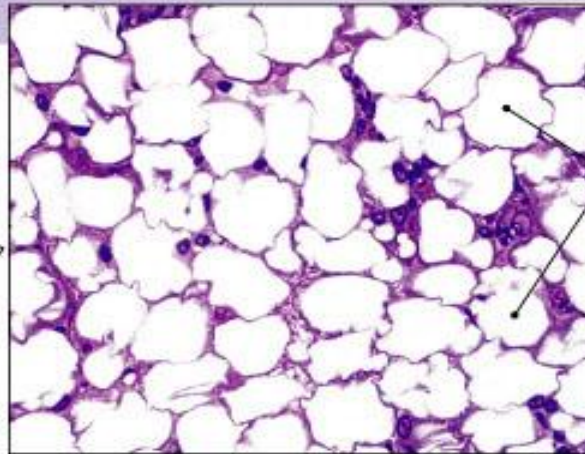
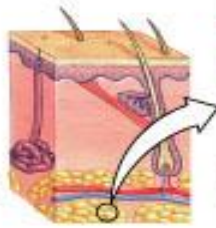
LM × 384

Adipose and Reticular Tissues

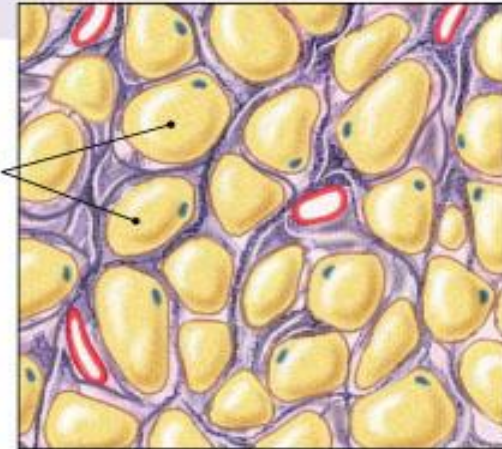
ADIPOSE TISSUE

LOCATIONS: Deep to the skin, especially at sides, buttocks, breasts; padding around eyeballs and kidneys

FUNCTIONS: Provides padding and cushions shocks; insulates (reduces heat loss); stores energy reserves



LM \times 133



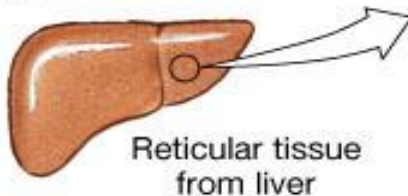
Adipocytes

(a) Adipose tissue

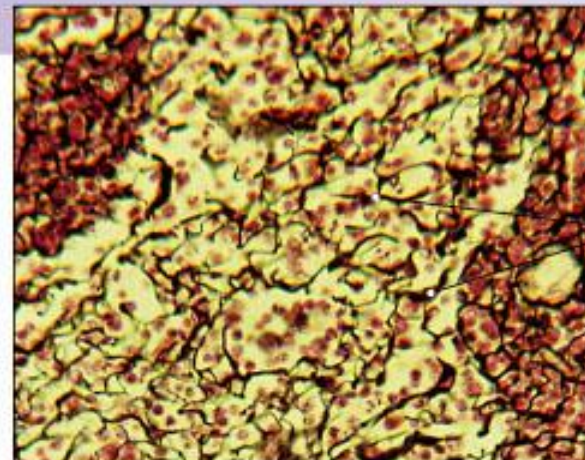
RETICULAR TISSUE

LOCATIONS: Liver, kidney, spleen, lymph nodes, and bone marrow

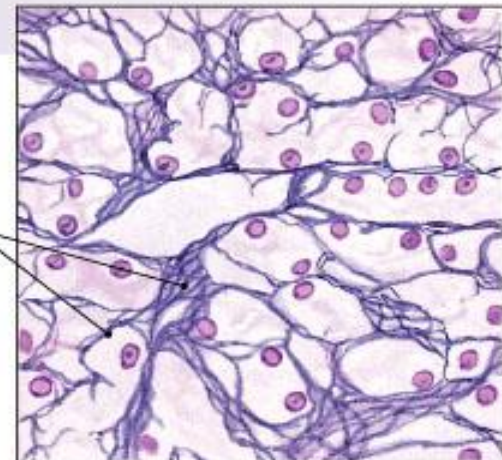
FUNCTIONS: Provides supporting framework



Reticular tissue from liver



LM \times 375



Reticular fibers

(b) Reticular tissue

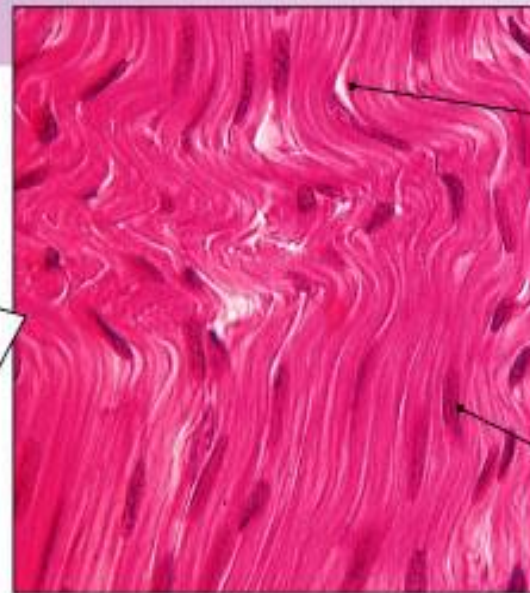
Dense Connective Tissues

a- Regular

DENSE REGULAR CONNECTIVE TISSUE

LOCATIONS: Between skeletal muscles and skeleton (tendons and aponeuroses); between bones or stabilizing positions of internal organs (ligaments); covering skeletal muscles; deep fasciae

FUNCTIONS: Provides firm attachment; conducts pull of muscles; reduces friction between muscles; stabilizes relative positions of bones



LM × 440

Collagen fibers

Fibroblast nuclei

(a) Tendon

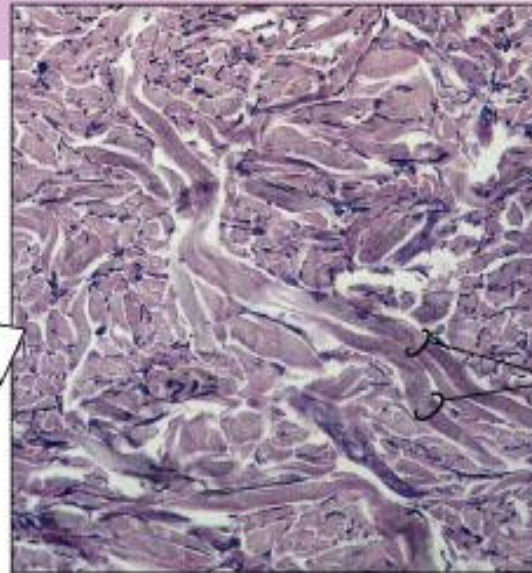
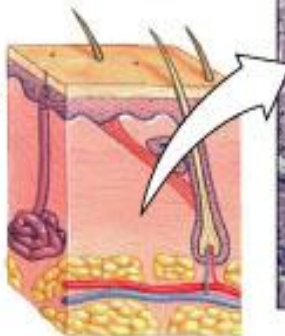
Dense Connective Tissues

b- Irregular

DENSE IRREGULAR CONNECTIVE TISSUE

LOCATIONS: Capsules of visceral organs; periosteum and perichondria; nerve and muscle sheaths; dermis

FUNCTIONS: Provides strength to resist forces applied from many directions; helps prevent overexpansion of organs such as the urinary bladder



LM × 111



Collagen
fiber
bundles

(b) Deep dermis

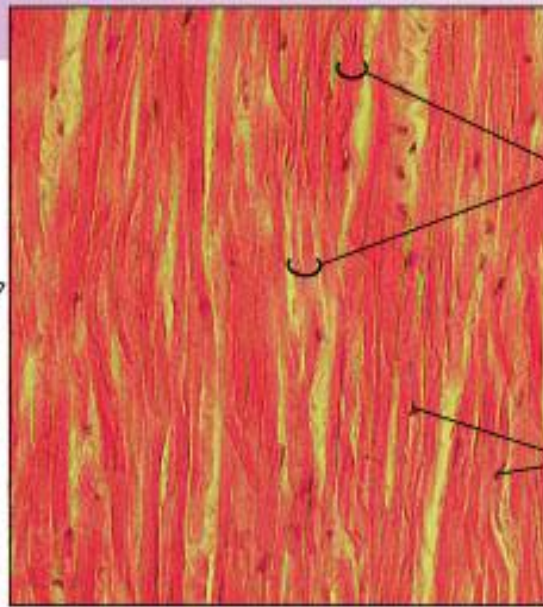
Dense Connective Tissues

c- Elastic tissue

ELASTIC TISSUE

LOCATIONS: Between vertebrae of the spinal column (ligamentum flavum and ligamentum nuchae); ligaments supporting penis; ligaments supporting transitional epithelia; in blood vessel walls

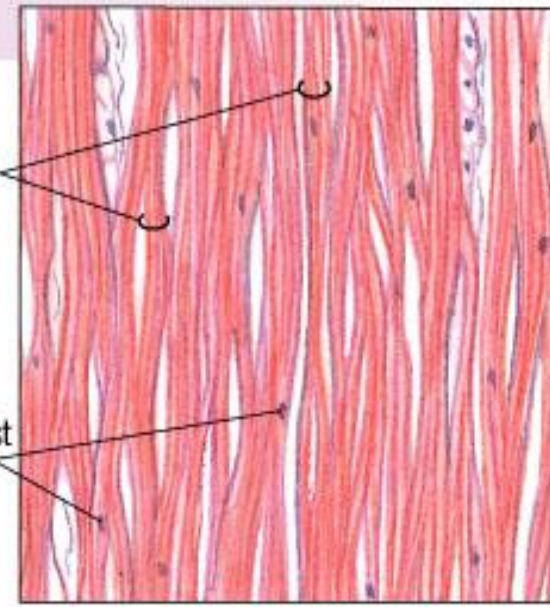
FUNCTIONS: Stabilizes positions of vertebrae and penis; cushions shocks; permits expansion and contraction of organs



LM × 887

Elastic fibers

Fibroblast nuclei



(c) Elastic ligament

Fluid

Connective Tissues

Fluid connective tissues

- **Distinctive collections of cells in a fluid-watery matrix**

It consists of:

- **Blood**

- is formed from elements and plasma

- Red blood cells, white blood cells and platelets

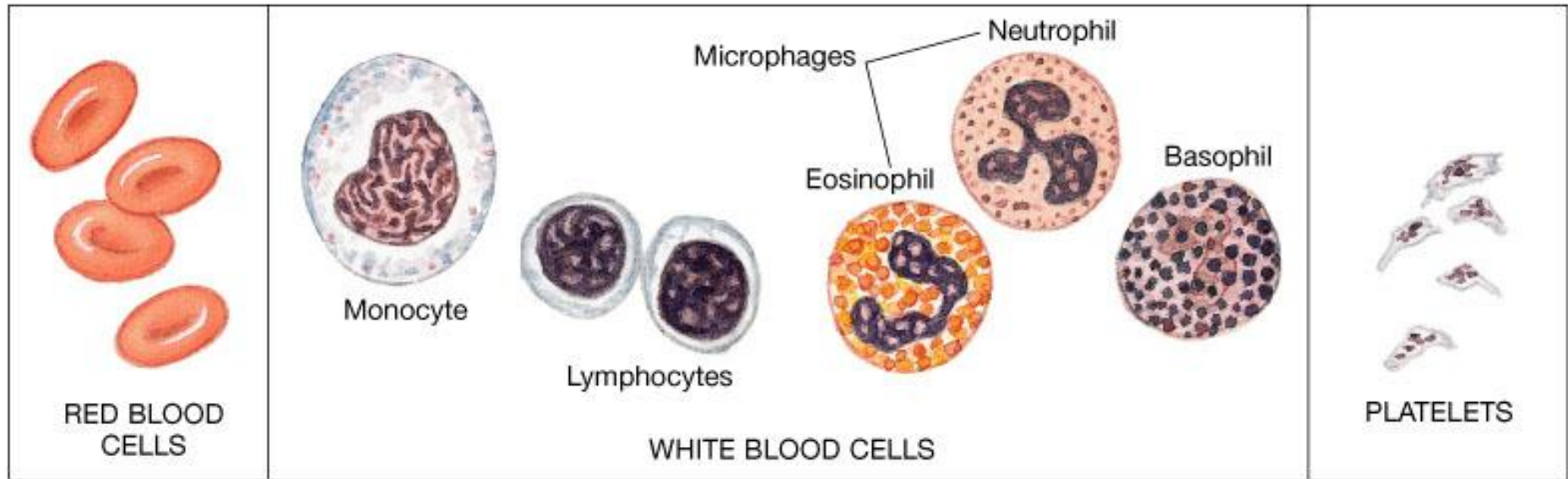
- moves in arteries (carry blood from heart) and veins (carry blood to the heart)

- capillaries allow diffusion into the interstitial fluid

- **Lymph**

- Interstitial fluid entering the lymphatic vessels

Formed Elements of the Blood

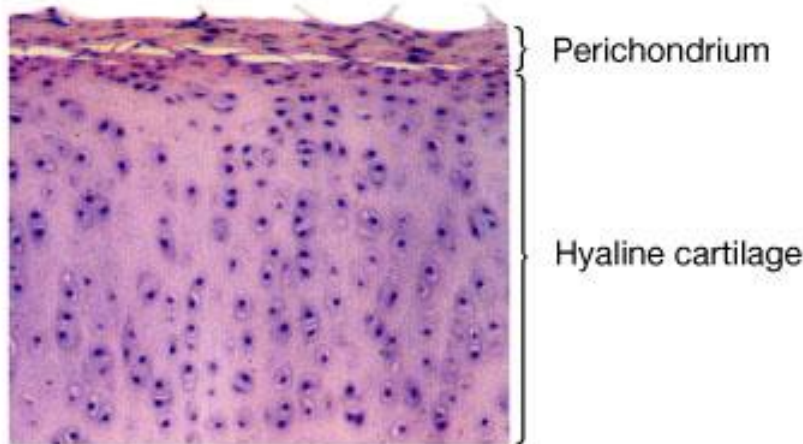


Supporting Connective Tissues

Supporting connective tissues

- Cartilage and bone support the rest of the body
- **Cartilage**
 - Matrix is a firm gel containing chondroitin sulfate
 - Cells are called chondrocytes
 - Cells occupy small chambers called lacunae
 - There are three types of cartilages:
 - 1- hyaline
 - 2- elastic
 - 3- fibrocartilage

The Perichondrium and Types of Cartilage



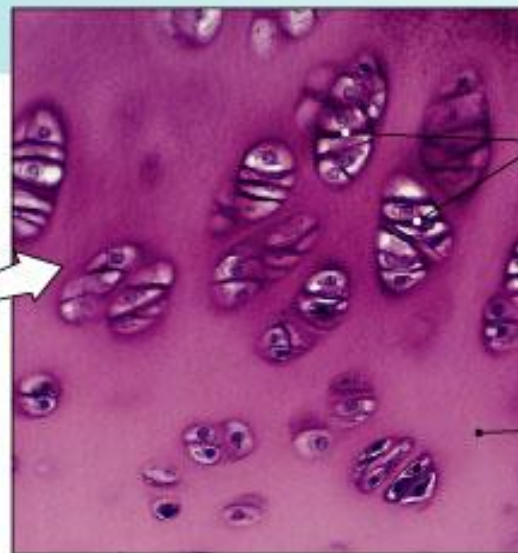
(a)

Hyaline Cartilage

HYALINE CARTILAGE

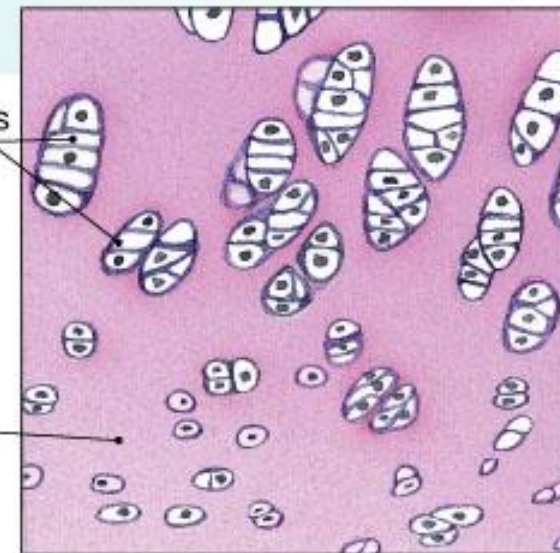
LOCATIONS: Between tips of ribs and bones of sternum; covering bone surfaces at synovial joints; supporting larynx (voice box), trachea, and bronchi; forming part of nasal septum

FUNCTIONS: Provides stiff but somewhat flexible support; reduces friction between bony surfaces



LM \times 500

(b) Hyaline cartilage



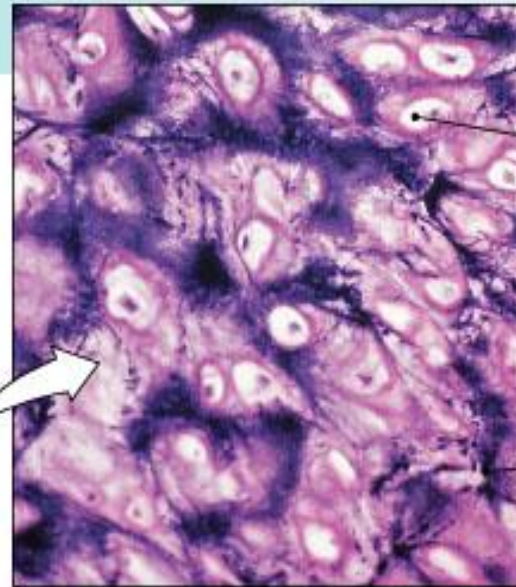
The Perichondrium and Types of Cartilage

Elastic Cartilage

ELASTIC CARTILAGE

LOCATIONS: Auricle of external ear; epiglottis; auditory canal; cuneiform cartilages of larynx

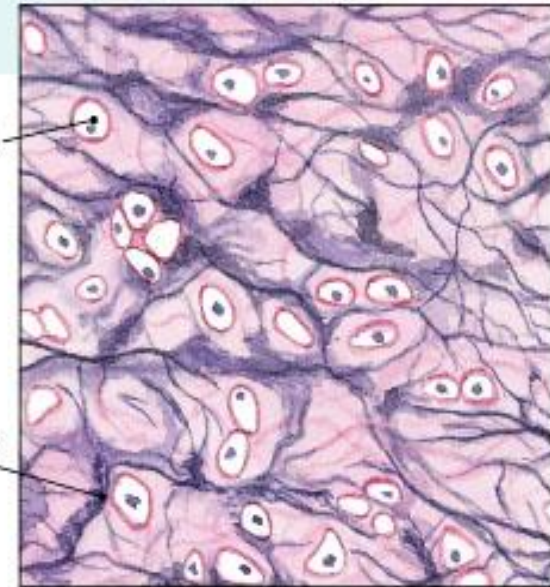
FUNCTIONS: Provides support, but tolerates distortion without damage and returns to original shape



LM \times 358

Chondrocyte
in lacuna

Elastic fibers
in matrix



(c) Elastic cartilage

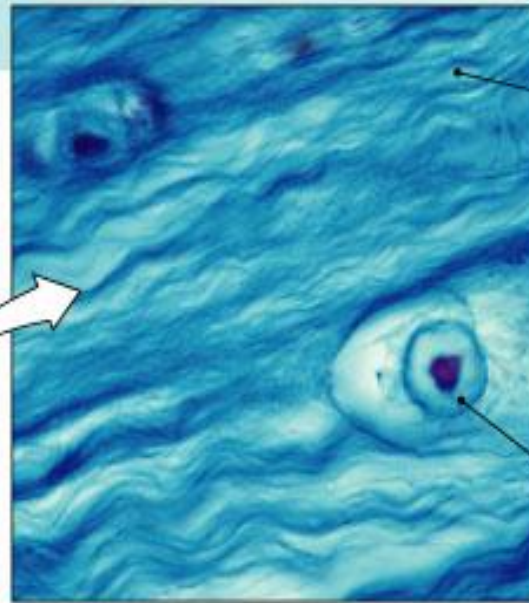
The Perichondrium and Types of Cartilage

Fibro Cartilage

FIBROCARTILAGE

LOCATIONS: Pads within knee joint; between pubic bones of pelvis; intervertebral discs

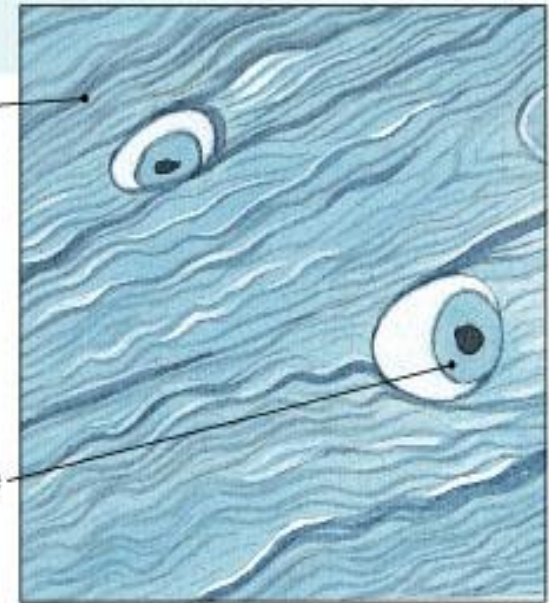
FUNCTIONS: Resists compression; prevents bone-to-bone contact; limits relative movement



LM × 750

Collagen fibers in matrix

Chondrocyte in lacuna



(d) Fibrocartilage

Bone, or osseous tissue

- **It has osteocytes**
 - The nutrients diffuses through canaliculi to reach the bone
- **Little ground substance**
- **Dense mineralized matrix**
- **Surrounded by periosteum**

Bone

