

Tissue concept and classification

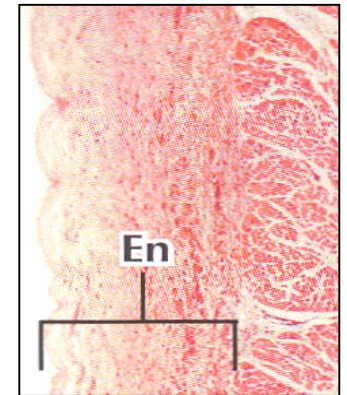
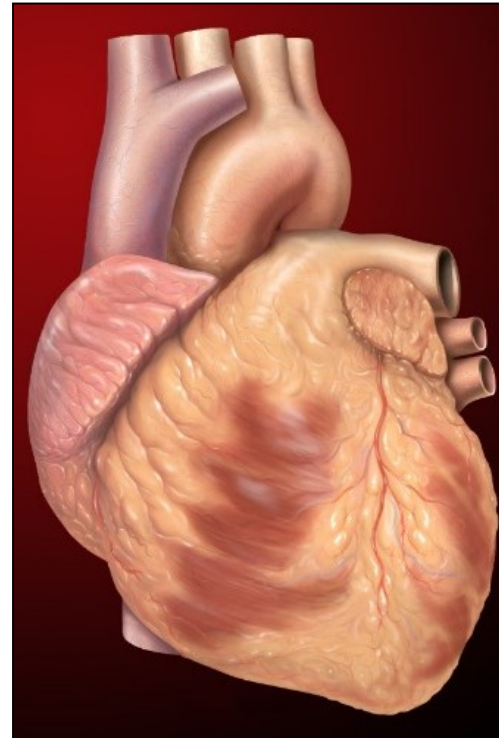
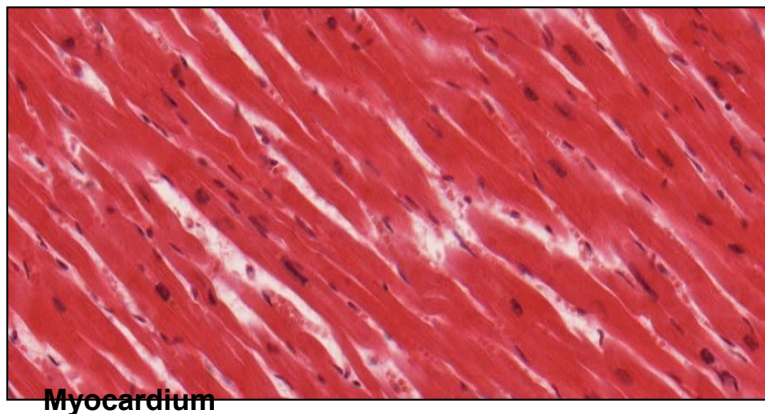
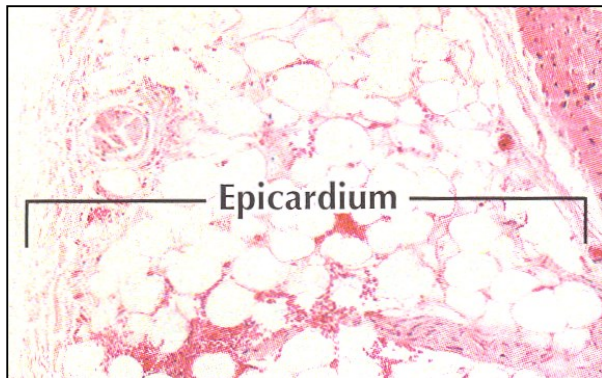
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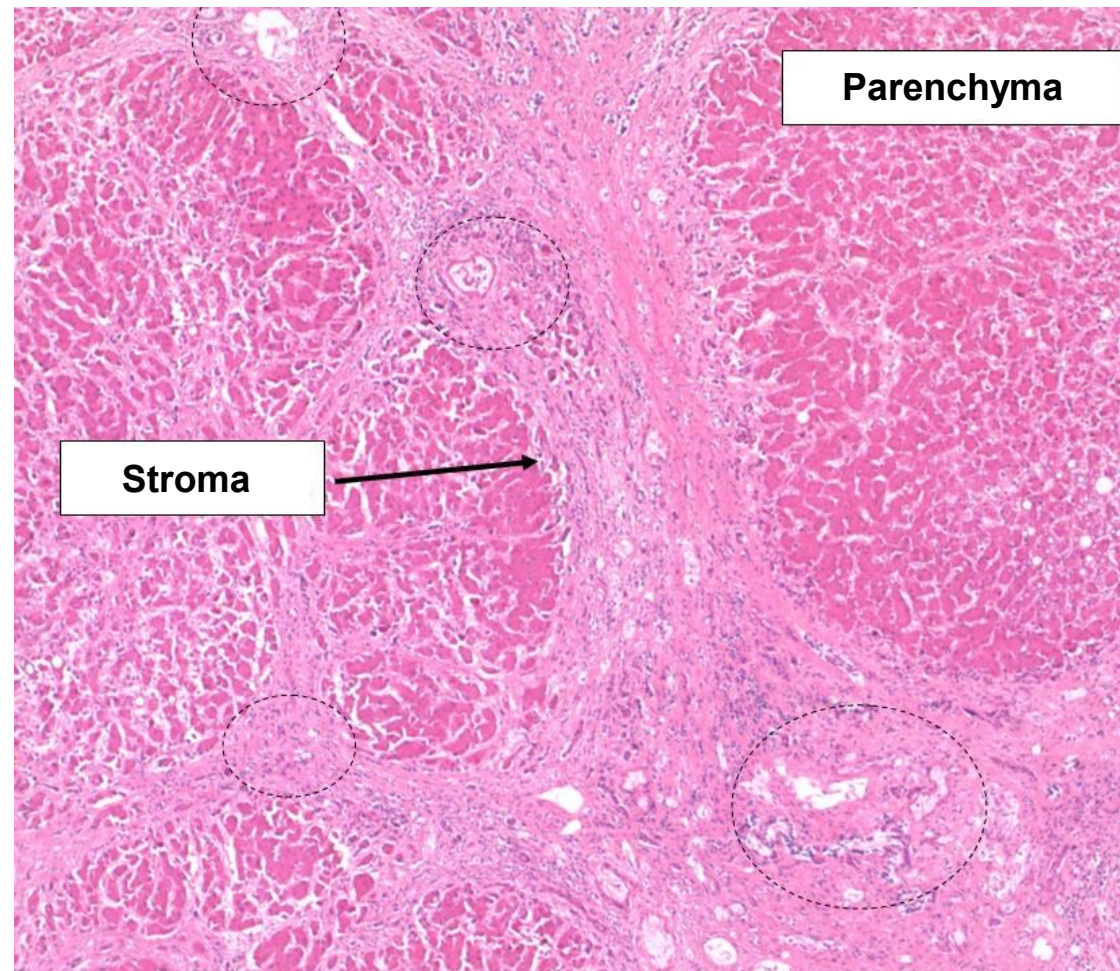
TISSUES AND ORGANS

- 6×10^{13} **CELLS** of **200** different types
- cells form **functional, three-dimensional**, organized **aggregations** of morphologically similar **cells** and their **products** and derivatives - **TISSUES**
- tissues constitute **ORGANS** and organ systems



Parenchyma: functional component of a tissue
(liver, lung, pancreatic, kidney parenchyma)

Stroma: surrounding, supportive tissue



LIVER

Parenchyma:

- Hepatocytes
- Sinusoids and adjacent structures

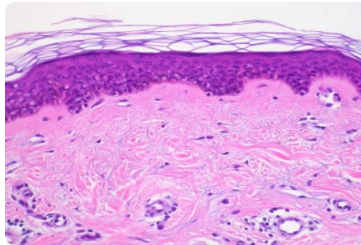
Stroma:

- Connective tissue and adjacent structures
- Vessels
- Nerves
- Bile ducts

CONTEMPORARY TISSUE CLASSIFICATION

Based on **morphology** and **function**:

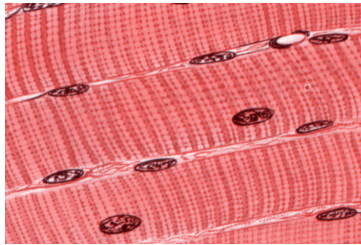
Epithelium



Continual, avascular layers of cells with different function, oriented to open space, with specific junctions and minimum of ECM and intercellular space.

Derivates of all three germ layers

Muscle

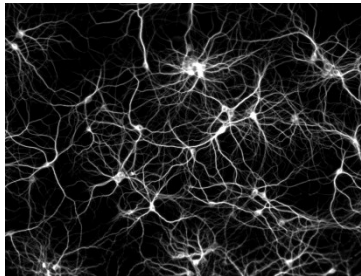


Myofibrils → contraction

Mesoderm – skeletal muscle, myocard, mesenchyme
– smooth muscles

Rarely ectoderm (eg. m. sphincter a m. dilatator pupillae)

Nerve

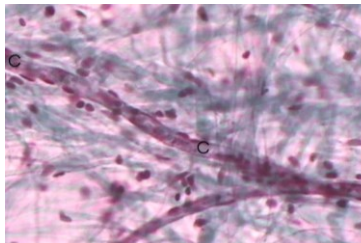


Neurons and neuroglia

Reception and transmission of electric signals

Ectoderm, rarely mesoderm (microglia)

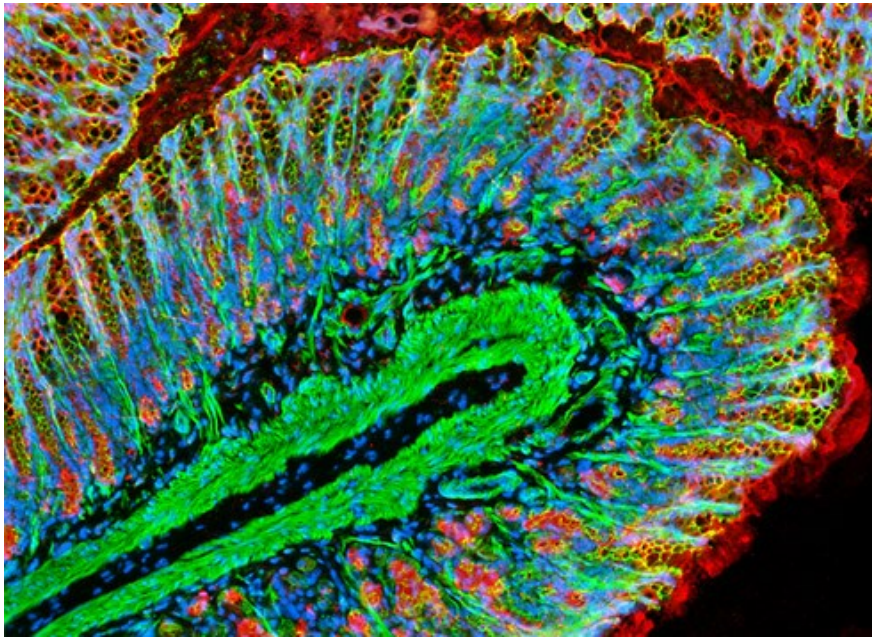
Connective



Dominant extracellular matrix

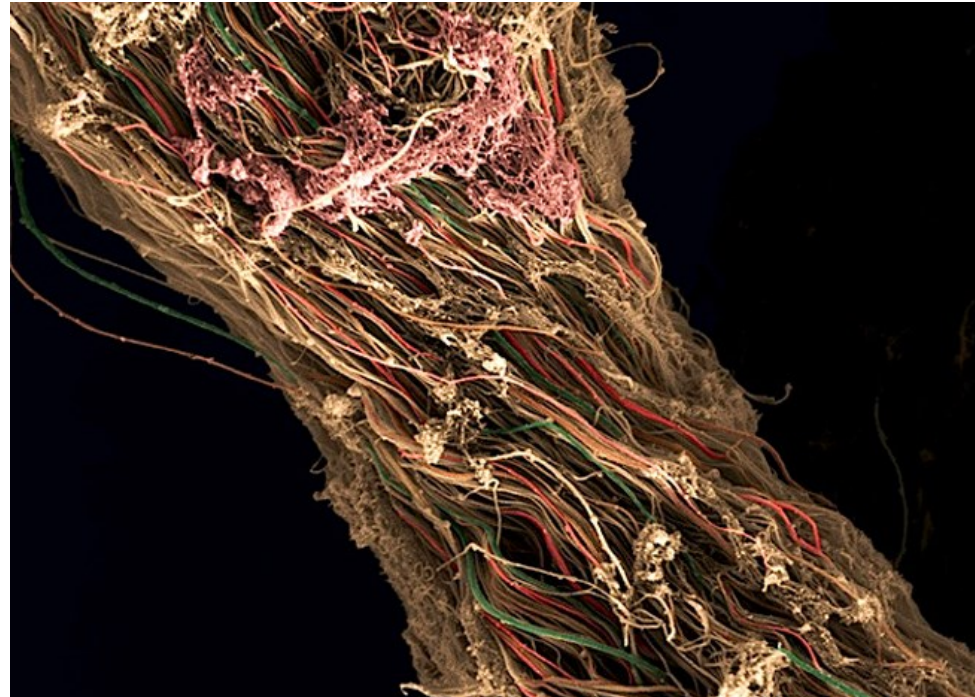
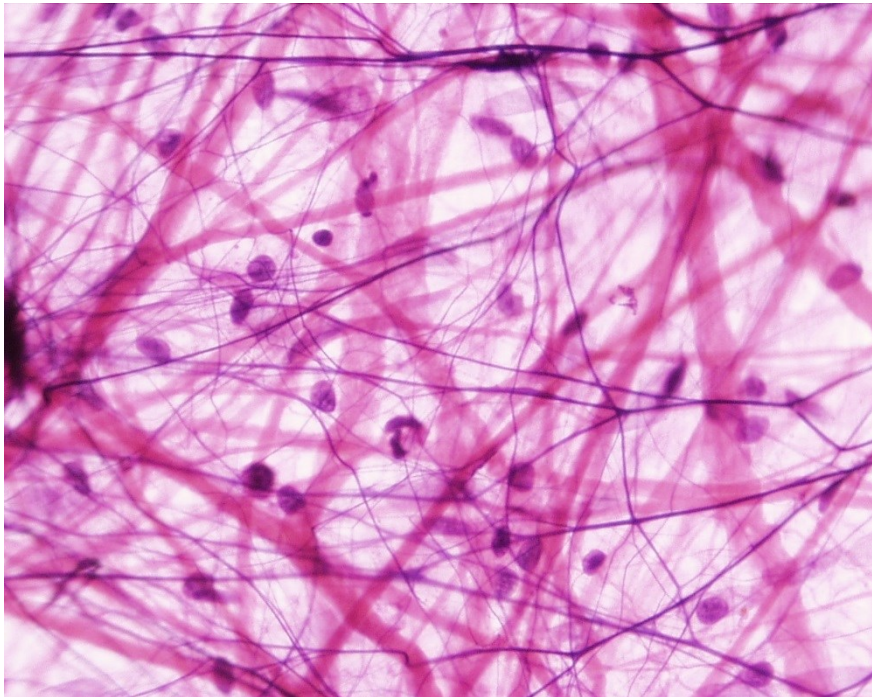
Connective tissue, cartilage, bone...

Mesenchyme



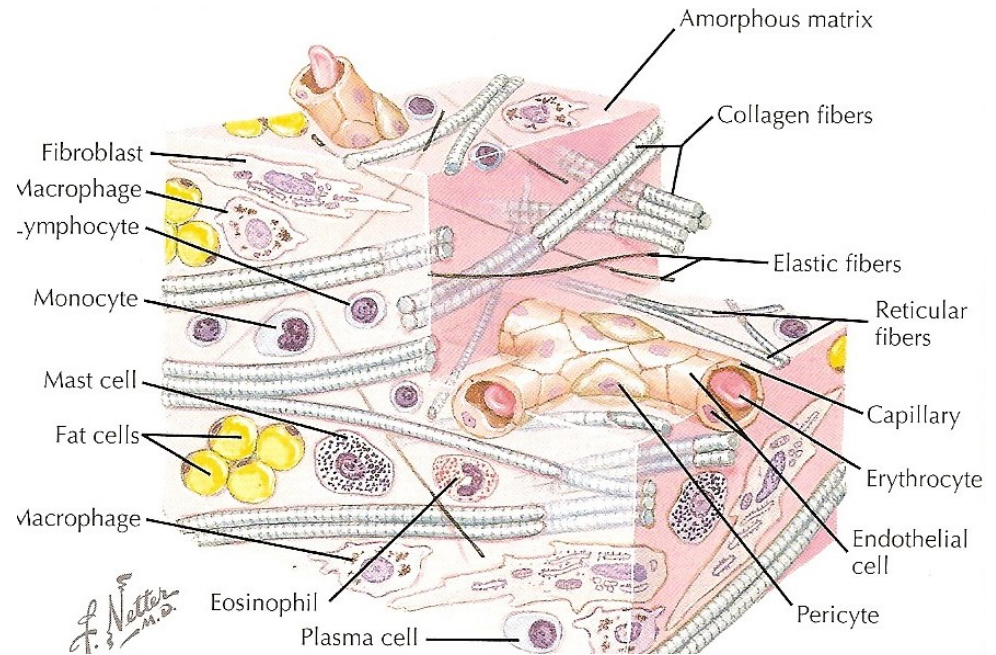
CONNECTIVE TISSUE

Not just a tissue glue...



Mechanical and biological properties

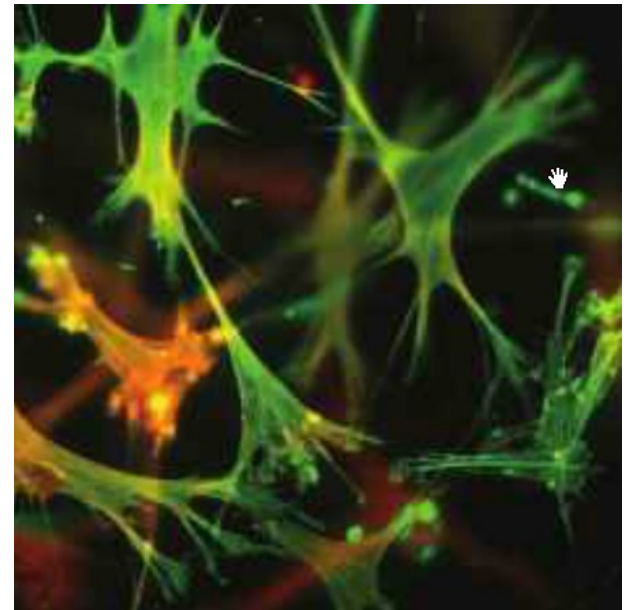
→ surrounds other tissues, allows compartmentalization, provides support, defines physico-chemical environment, brings immunological support, provides storage of energy, ...



GENERAL COMPOSITION OF CONNECTIVE TISSUE

Cells and extracellular matrix (ECM)

- **Cells**
 - **Connective tissue** – permanent and transient cell populations (e.g. fibroblasts/myofibroblasts, immune cells, adipocytes, adult stem cells)
 - **Cartilage** – chondroblasts/chondrocytes
 - **Bone** – osteoblasts/osteocytes/osteoclasts
- **Matrix** – fibrous and amorphous
 - **Fibrous component**
 - collagen
 - reticular
 - elastic
 - **Amorphous component** (amorphous ground substance)
Complex matrix consisting of
 - glycosaminoglycans
 - glycoproteins
 - proteoglycans



composition dependent on tissue type (connective × ligament × cartilage × bone)

CLASSIFICATION OF CONNECTIVE TISSUE

- **Embryonic CT**

- Mesenchyme
- Jelly-like CT (Wharton jelly, dental pulp, stroma of iris)

- **Adult CT**

- Areolar (loose, interstitial) CT
- Dense collagen irregular CT

- Dense collagen regular CT
- Fat (adipose tissue)
- Cartilage
- Bone

- Blood and hematopoietic tissue
- Lymphatic tissue

} CT

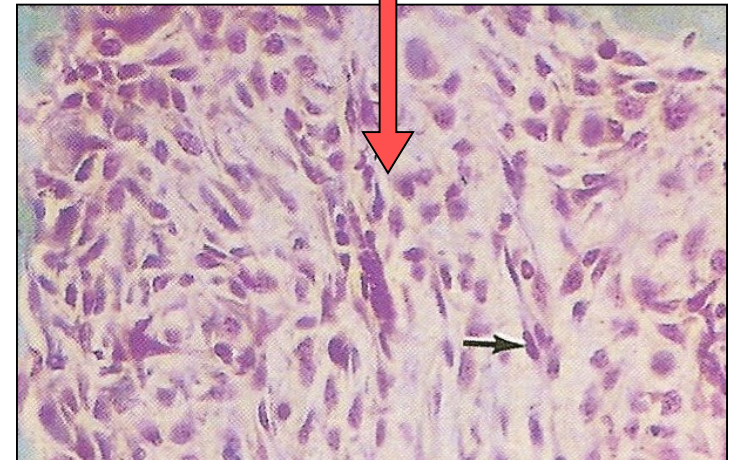
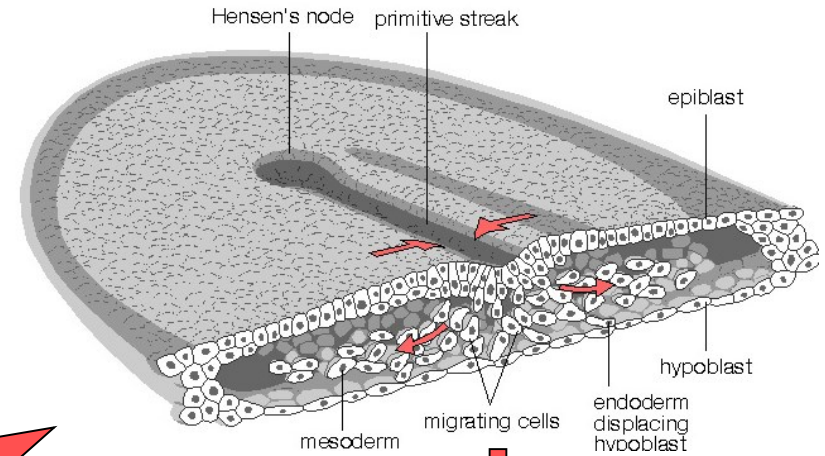
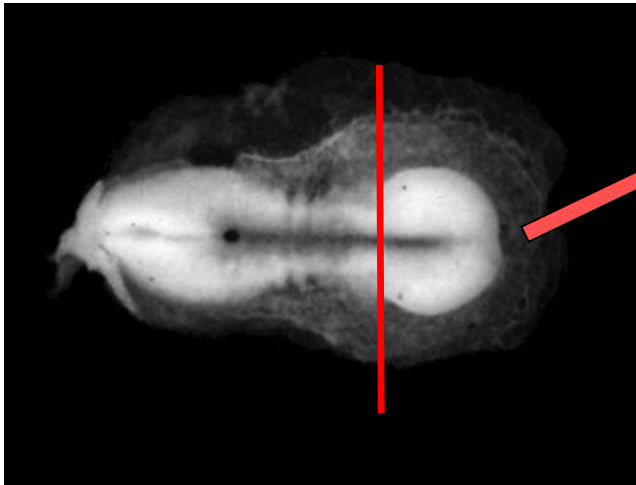
} Specialized CT

} Trophic CT (body liquids)

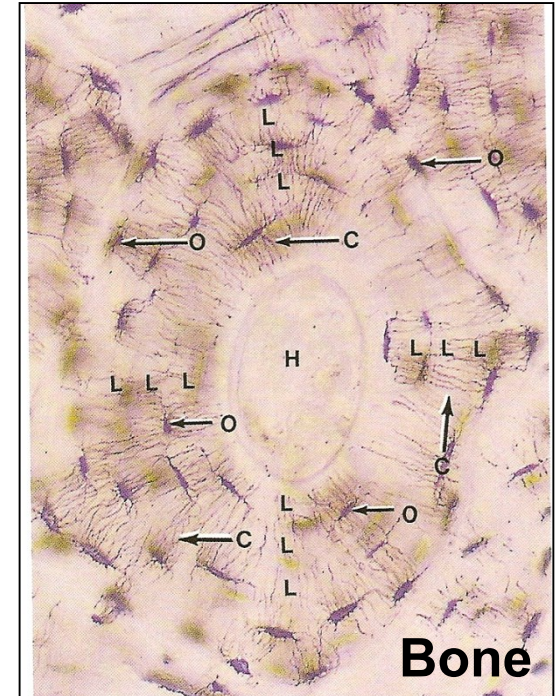
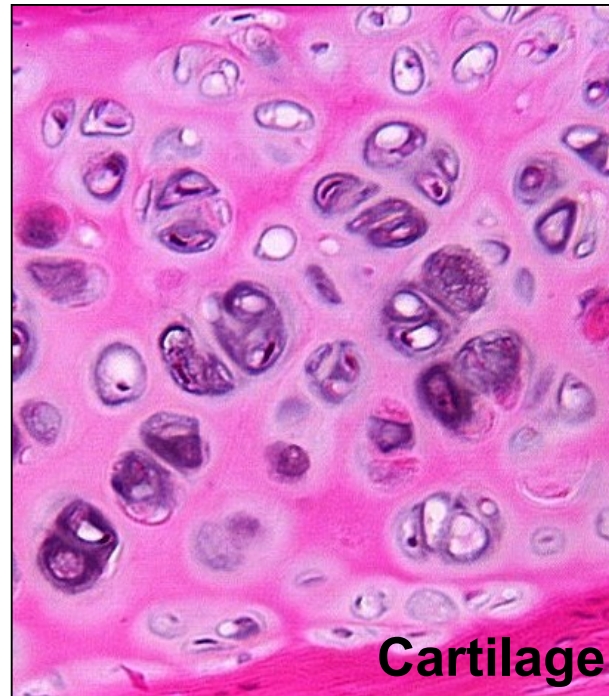
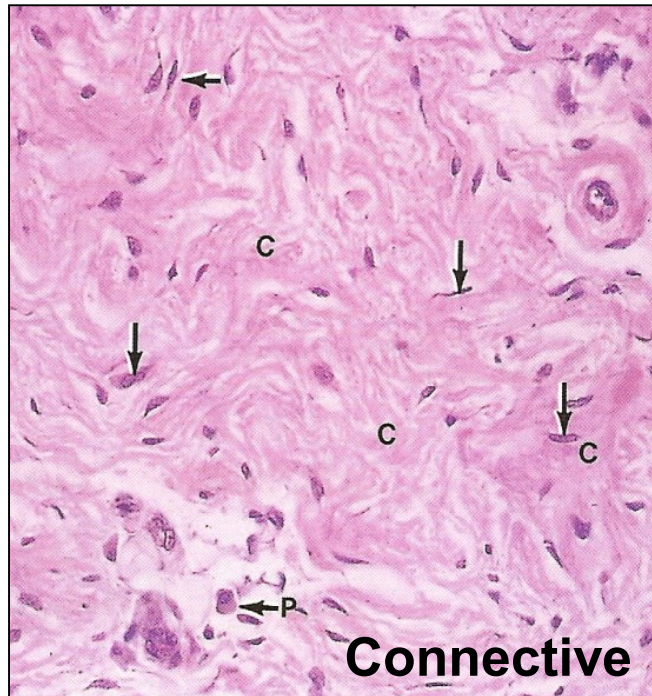
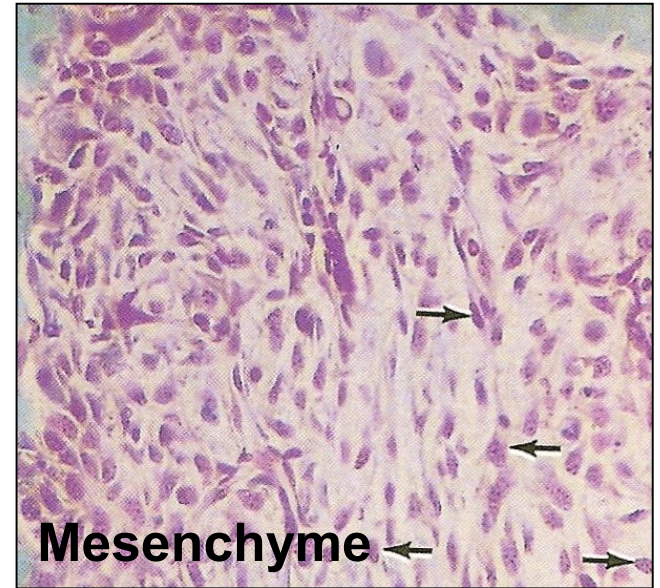
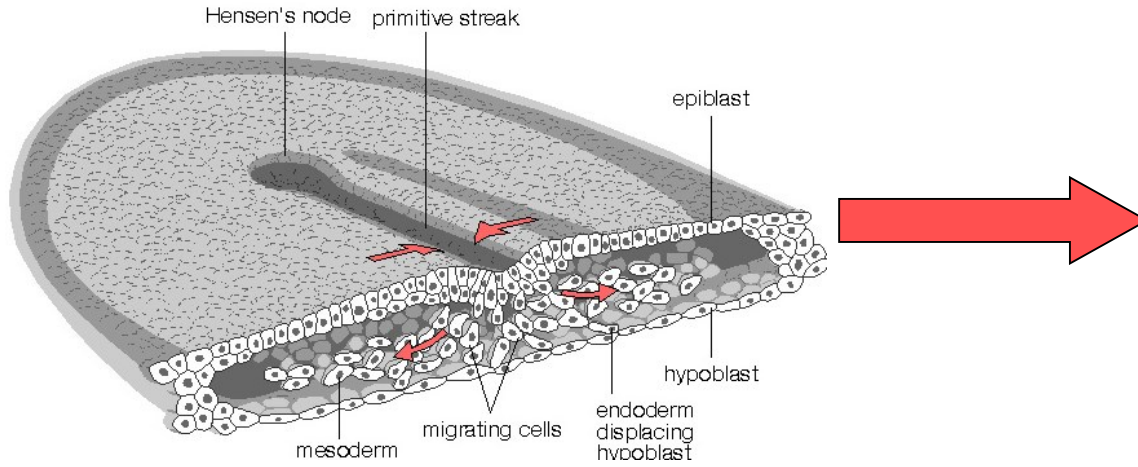
EMBRYONIC ORIGIN OF CONNECTIVE TISSUE

- Mesenchyme = loose tissue between germ layers
- Complex network of star- or spindle-shaped cells
- Jelly-like amorphous ground substance

DAY 12 of embryonic development



DERIVATIVES OF CONNECTIVE TISSUE



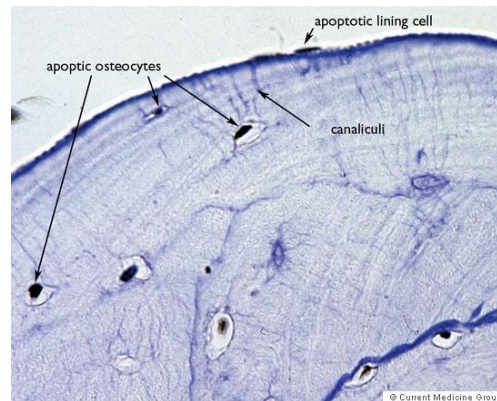
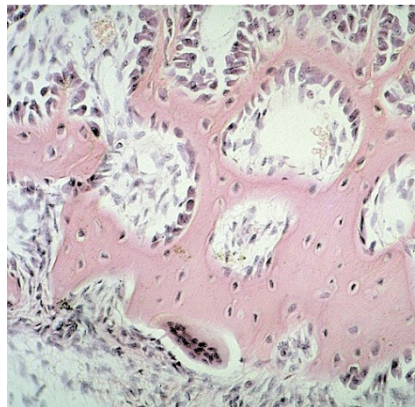
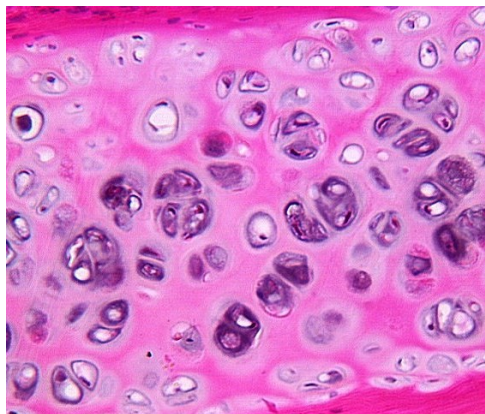
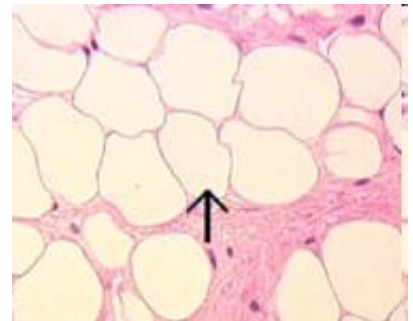
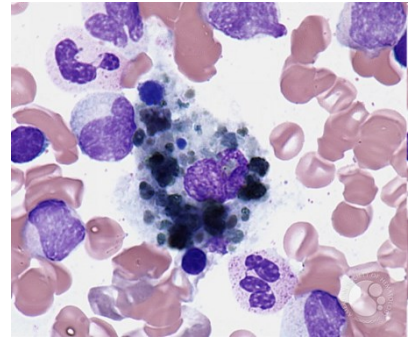
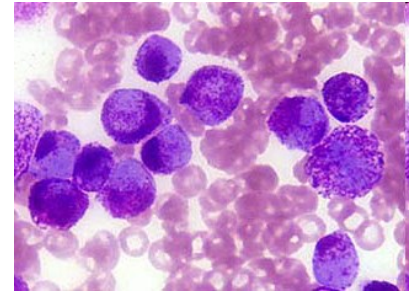
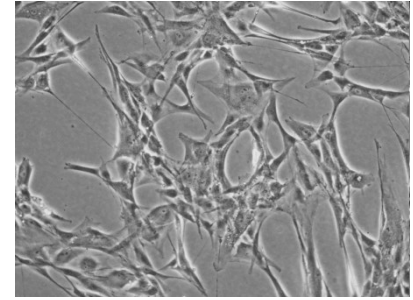
LOOSE COLLAGEN CONNECTIVE TISSUE

Cells

- Fibroblasts/fibrocytes/myofibroblasts
- Heparinocytes
- Macrophages of CT = histiocytes
- Plasma cells
- Lymphocytes
- Adipocytes
- Adult stem cells

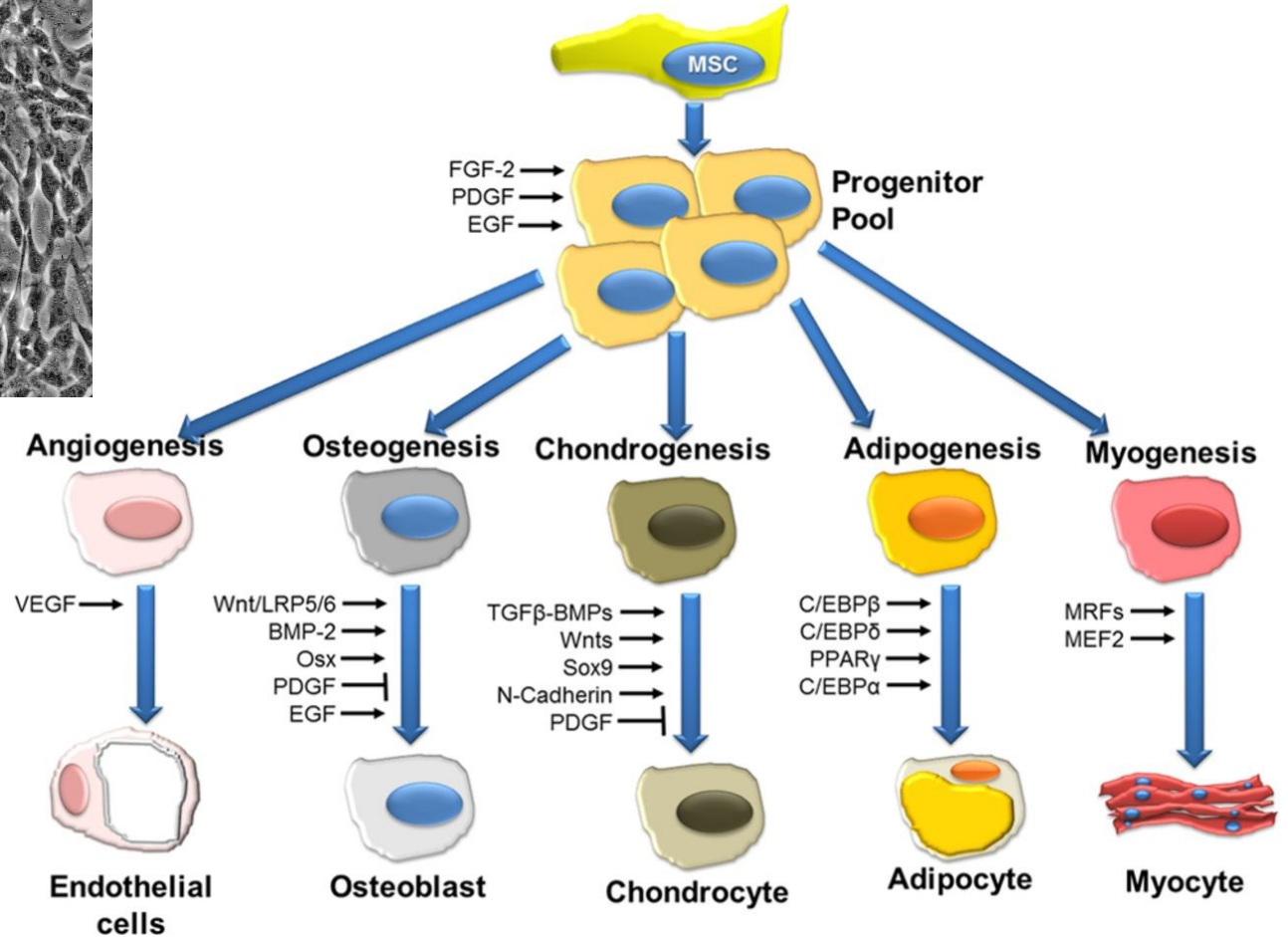
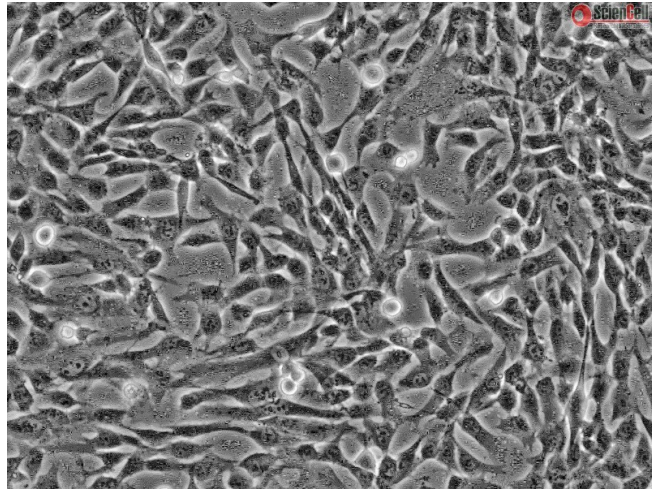
Extracellular matrix

- Fibrous compound
- Amorphous ground substance



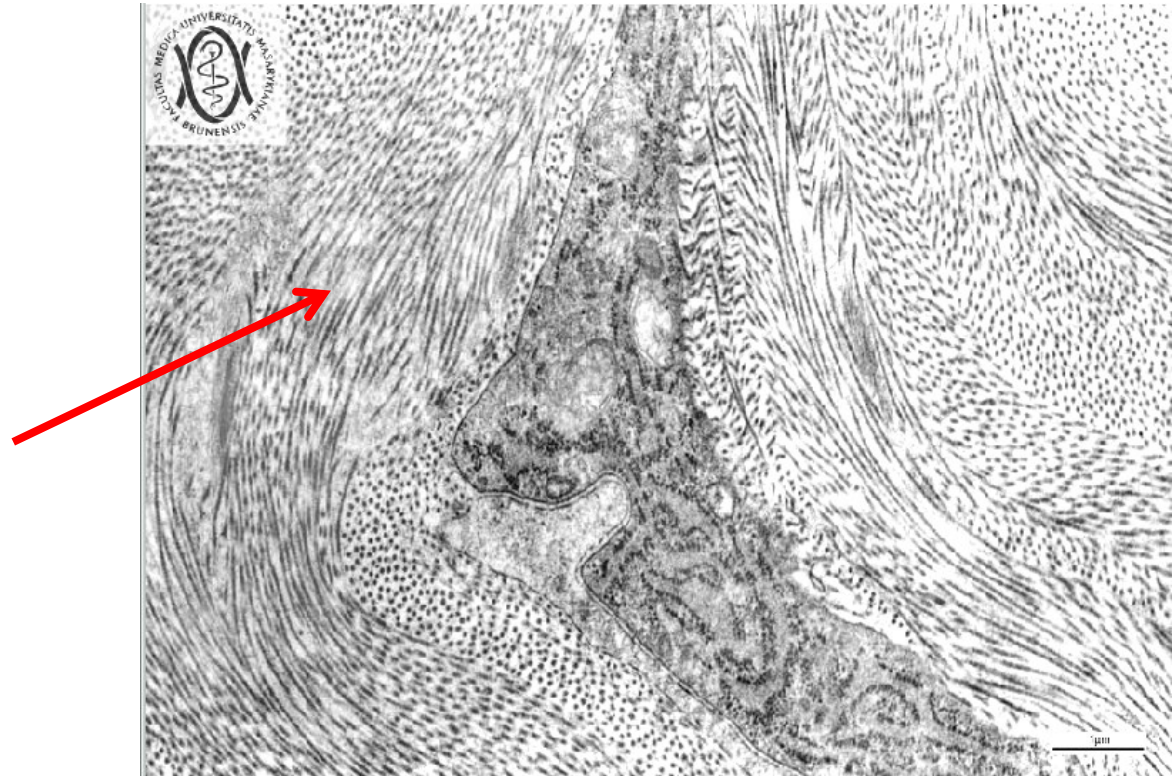
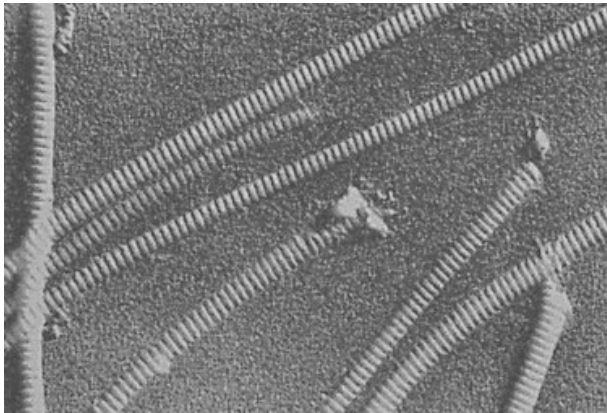
CELLS OF LOOSE COLLAGEN CONNECTIVE TISSUE

Mesenchymal (adult) stem cells

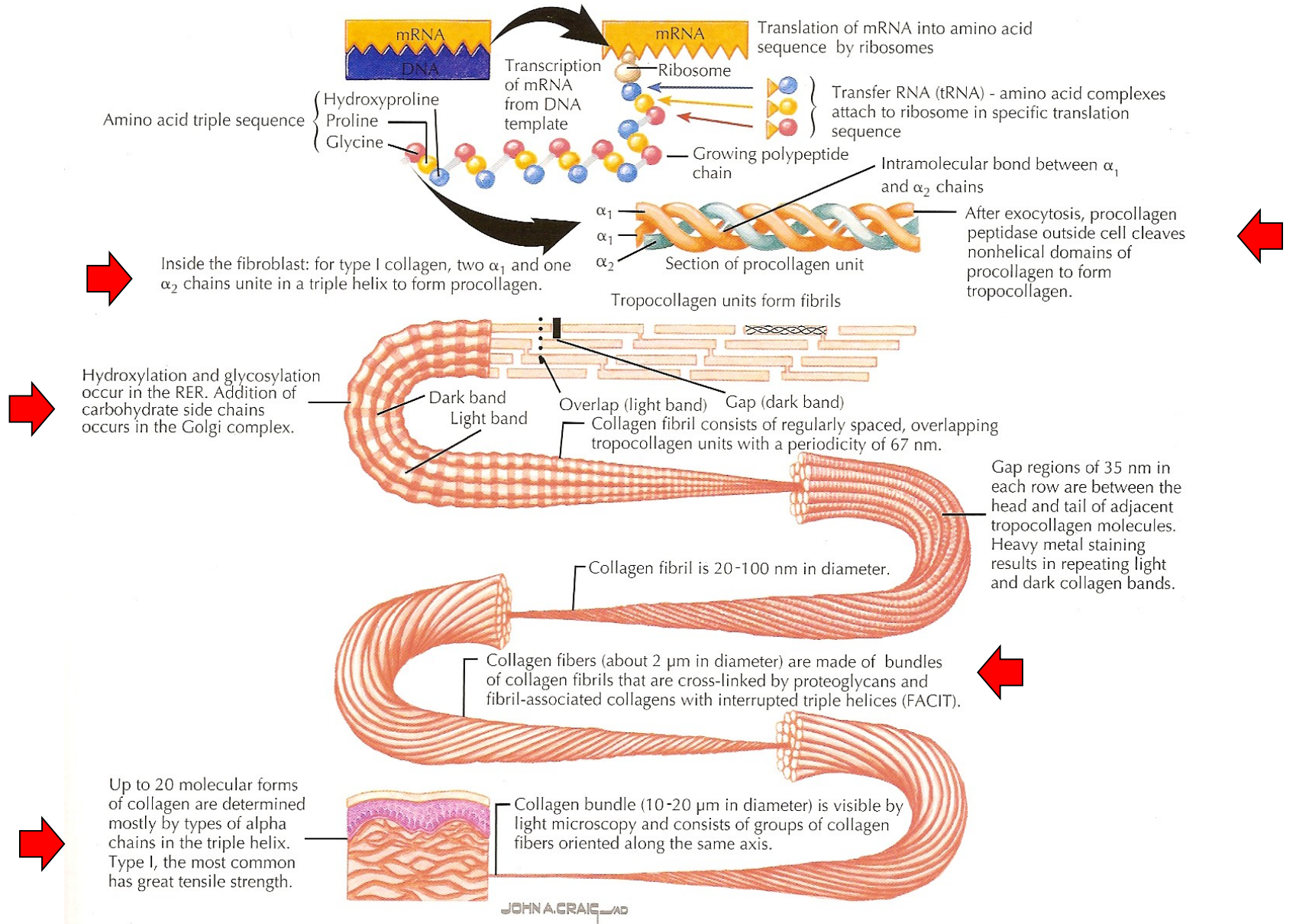


Collagen fibers

- family of fibrous proteins encoded by >35 genes (2013)
- polymer – subunit = tropocollagen; triple helix
- different structural and mechanical properties (strength, elasticity, pliability...)
- most abundant protein in human body (30% dry weight)



COLLAGEN



COLLAGEN

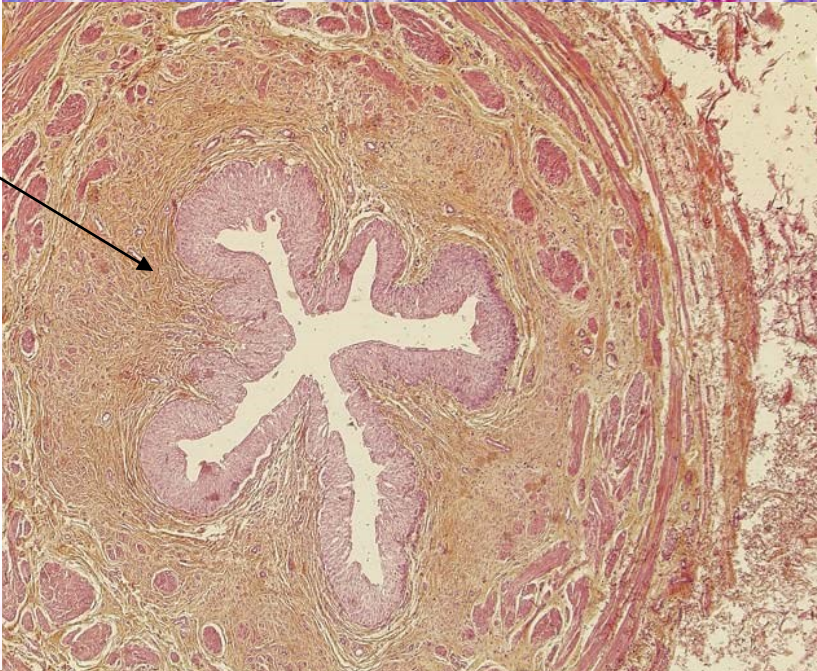
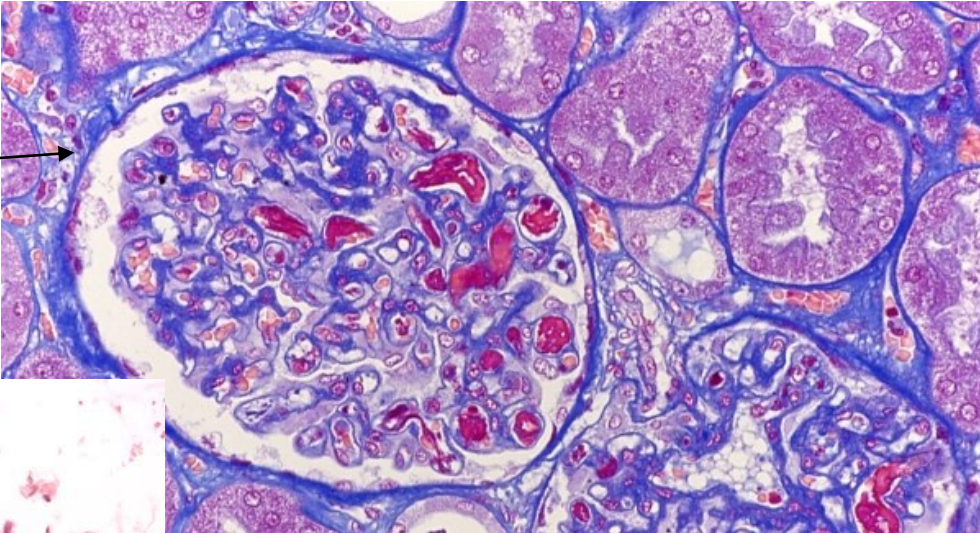
Type	Localization	Structure	Main function
I	Bone, tendons, meniscus, dentin, dermis, capsules of organs, loose CT 90% of type I	Fibrils (75nm) – fibers (1-20µm)	Resilience in pull
II	Hyaline and elastic cartilage	Fibrils (20nm)	Resilience in pressure
III	Skin, veins, smooth muscles, uterus, liver, spleen, kidney, lung	Like I, high content of proteoglycans and glycoproteins, reticular network	Shape formation
IV	Basal lamina of epithelium and endothelium, basal membranes	No fibrils or fibers	Mechanical support
V	Lamina of muscle cells and adipocytes, fetal membranes	Like IV	
VI	Interstitial tissue, chondrocytes – adhesion		Connecting dermis and epidermis
VII	Basal membrane of epithelium		
VIII	Some endothelia (Cornea)		
IX, X	Growth plate, hypertrophic and mineralized cartilage		Growth of bones, mineralization

COLLAGEN IN LIGHT MICROSCOPE

HE

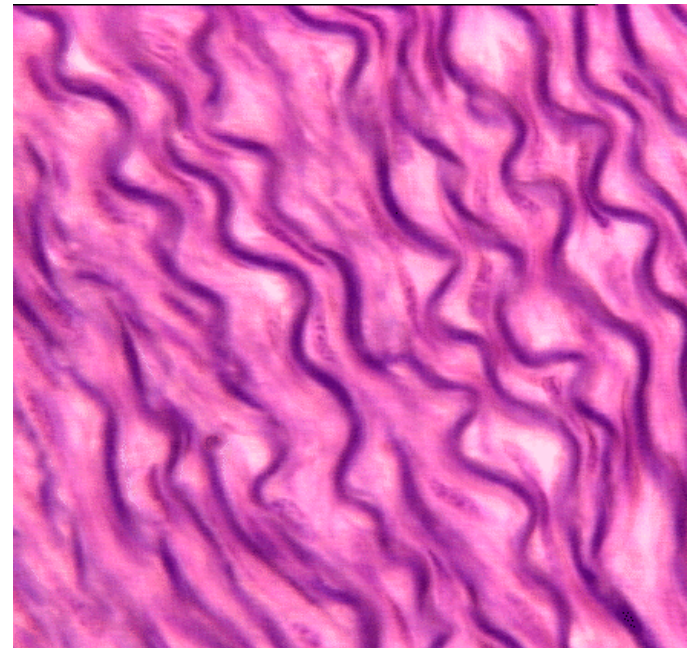
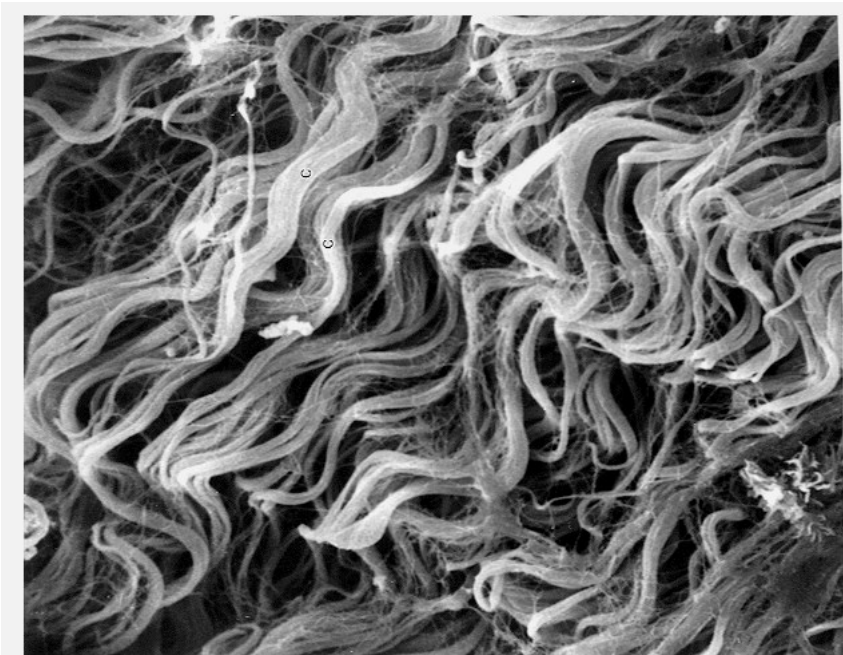
HES

AZAN



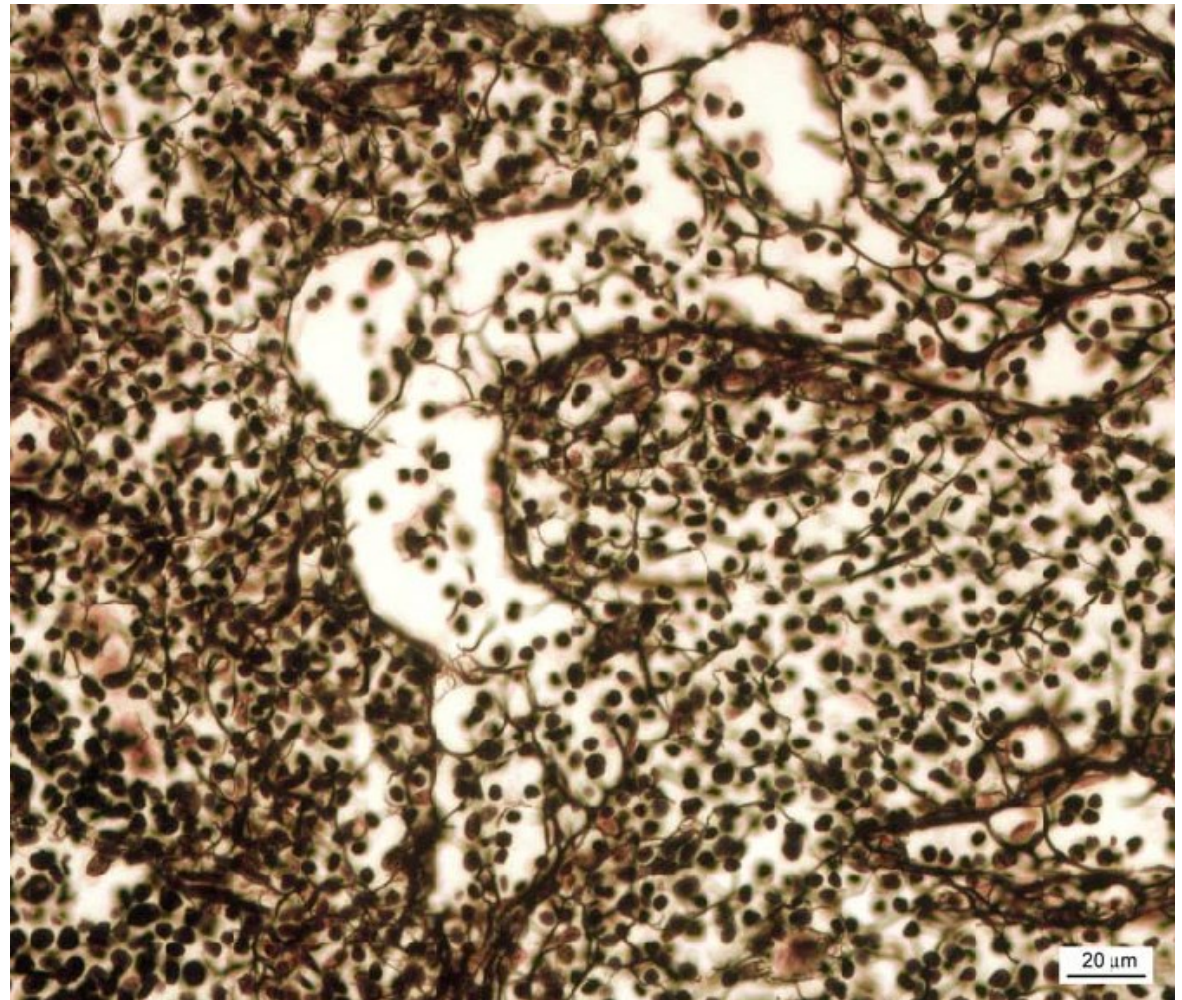
ELASTIC FIBERS

- less abundant than collagen
- polymer – tropoelastin
- minimal tensile resistance, loss of elasticity if overstretched
- reduction of hysteresis = allow return back to original state after mechanic change

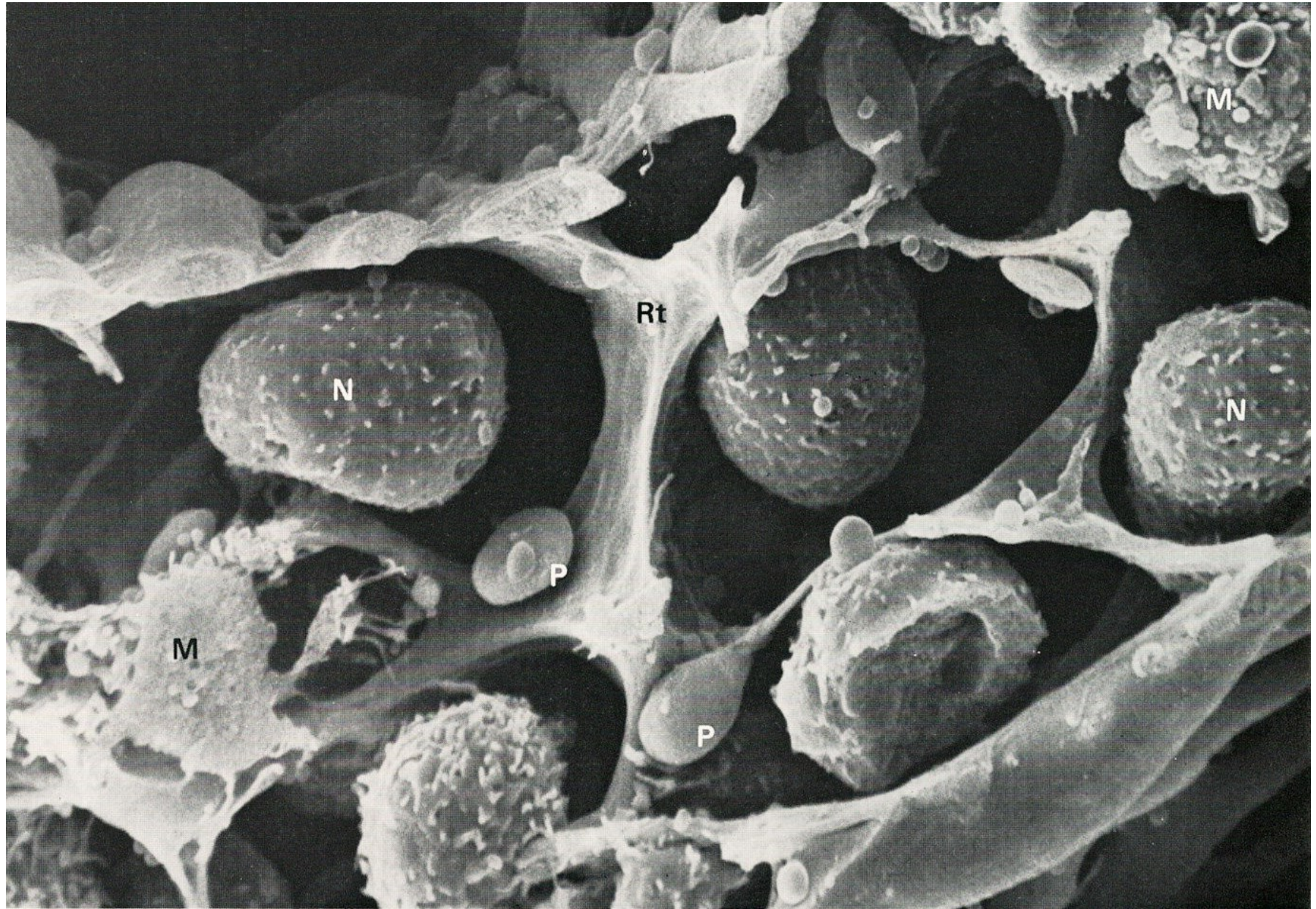


RETICULAR FIBERS

- collagen 3D meshwork
- bone marrow, spleen, lymphatic nodules
- microenvironment for e.g. hematopoietic stem cells and progenitors



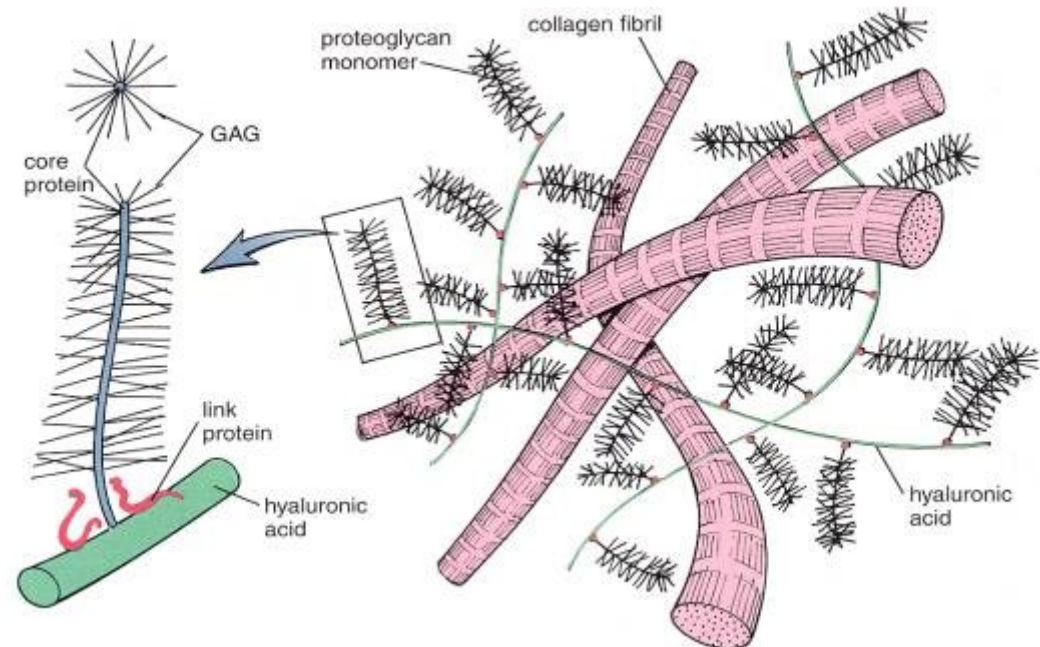
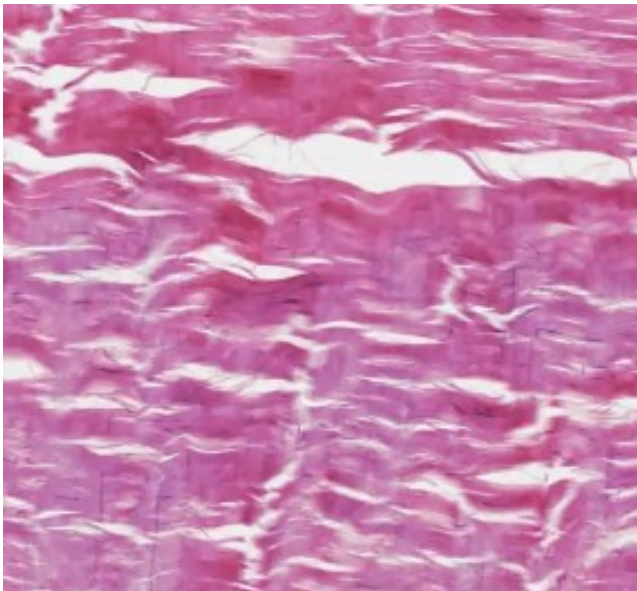
RETICULAR CONNECTIVE TISSUE



EXTRACELLULAR MATRIX – GROUND SUBSTANCE

Amorphous extracellular matrix

Colorless, transparent, homogenous substance consisting of glycosaminglycans, proteoglycans and structural glycoproteins



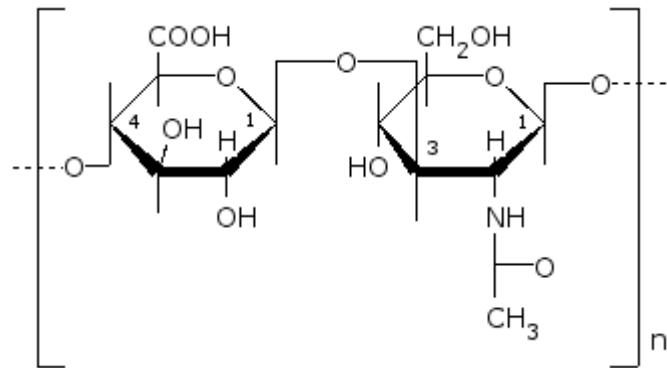
GLYCOSAMINOGLYCANS

linear polysaccharides composed of two disaccharide subunits

– **uronic acid and hexosamine**

polysaccharides rich in hexosamines = acid mukopolysaccharides

glucuronic or iduronic acid



glucosamin or galactosamin

GLYCOSAMINOGLYCANS

They bind to protein structures (except for hyaluronic acid)

Glycosaminoglycan

Hyaluronic acid

Chondroitinsulphate

Dermatansulphate

Heparansulphate

Keratansulphate

Localization

Umbilical cord, synovial fluid, fluid of corpus vitreum, cartilage

Cartilage, bone, cornea, skin, notochord, aorta

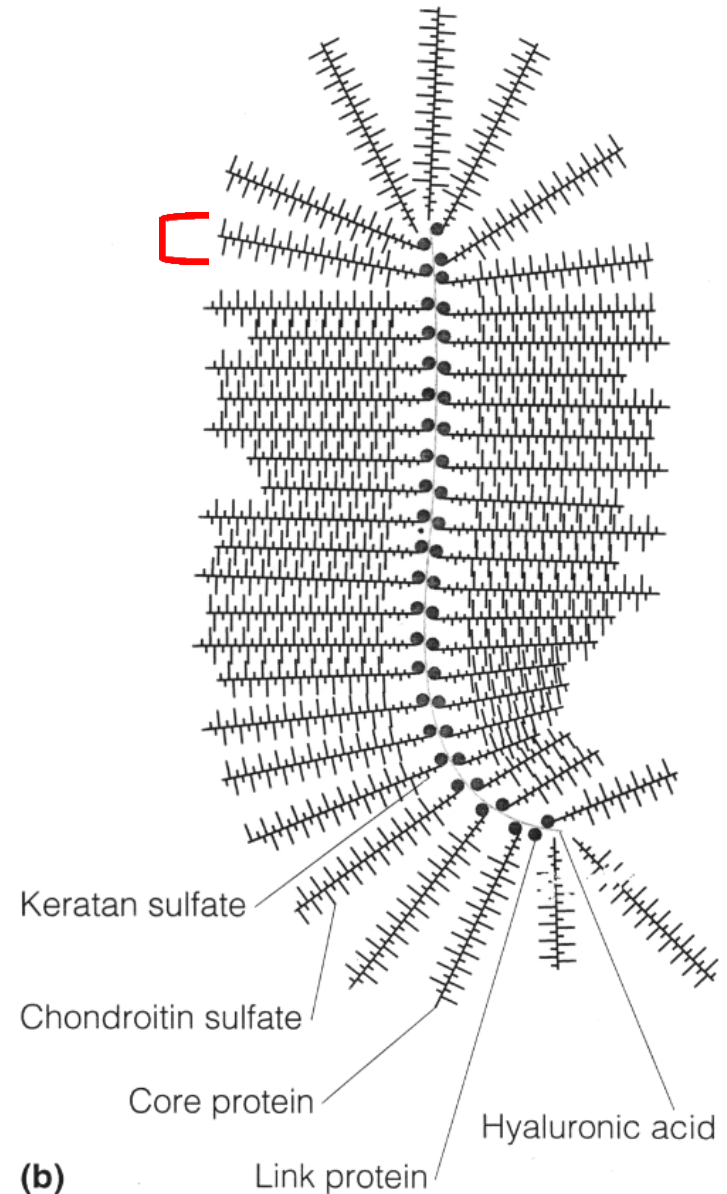
Skin, ligaments, adventitia of aorta

Aorta, lungs, liver, basal membranes

Iris, cartilage, nucleus pulposus, anulus fibrosus

PROTEOGLYCANS

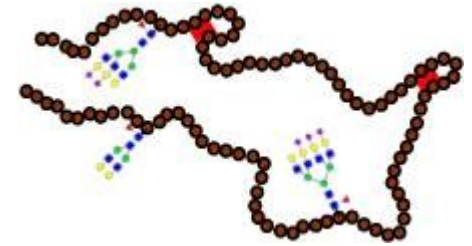
- protein + dominant linear saccharide component
- proteoglycan aggregates
- water-binding, volume dependent of hydration
- aggrecan (cartilage)
- syndecan
- fibroglycan



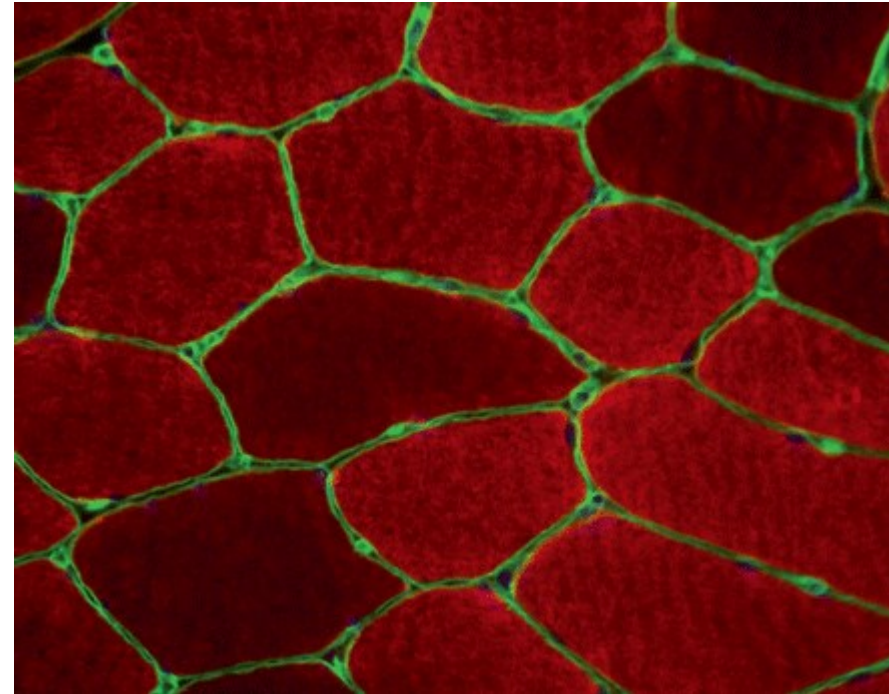
(b)

STRUCTURAL GLYCOPROTEINS

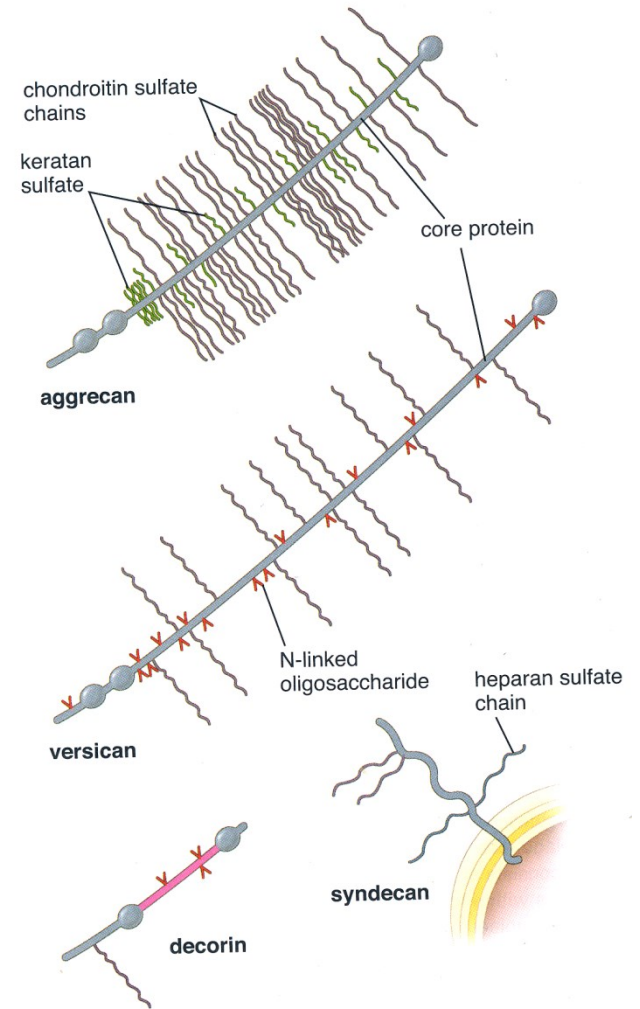
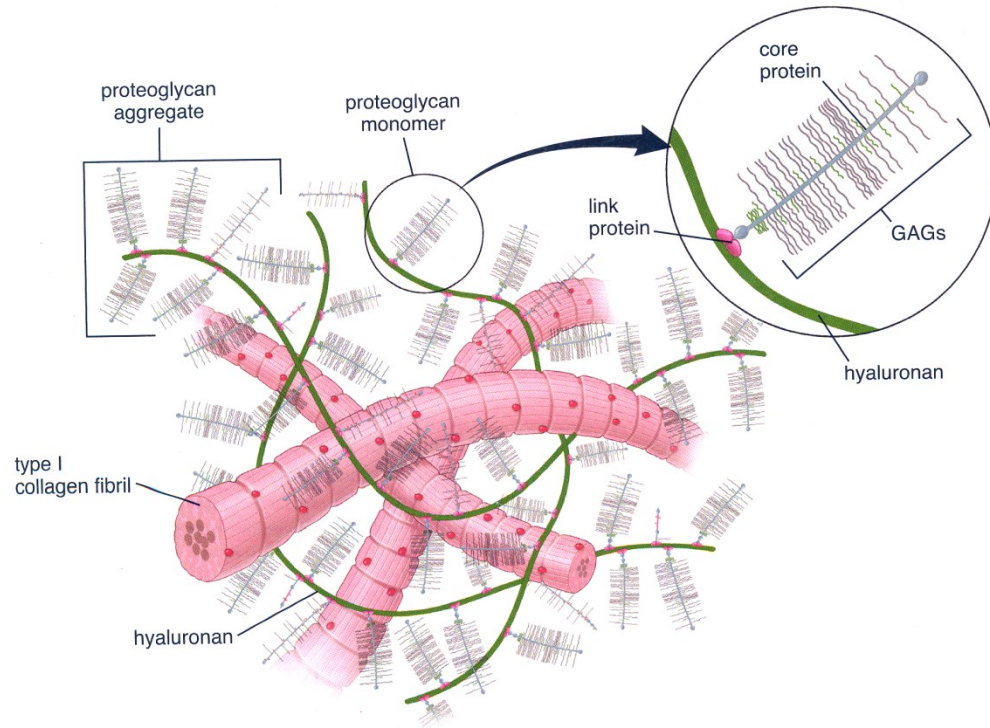
- dominant protein + branched saccharide component
- interaction between cells and ECM



- **fibronectin** – connects collagen fibers and glykosaminoglycans, cell adhesion and migration
- **laminin** – basal lamina – epithelial integrity
- **chondronectin** – cartilage – adhesion of chondrocytes to collagen



COMPOSITION OF ECM

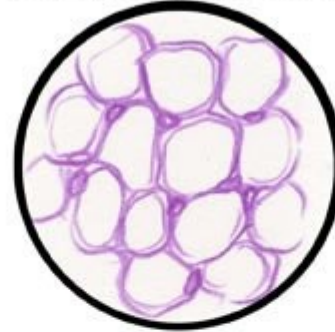


CLASSIFICATION OF SPECIALIZED CONNECTIVE TISSUE

**Dense
Connective Tissue**



**Adipose Tissue
(Connective Tissue)**



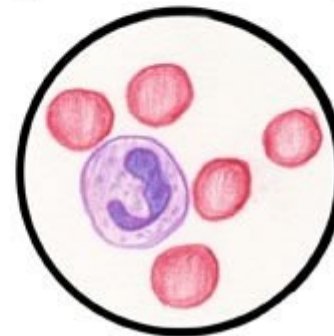
**Areolar Tissue
(Connective Tissue)**



**Compact Bone
(Connective Tissue)**



**Blood
(Connective Tissue)**



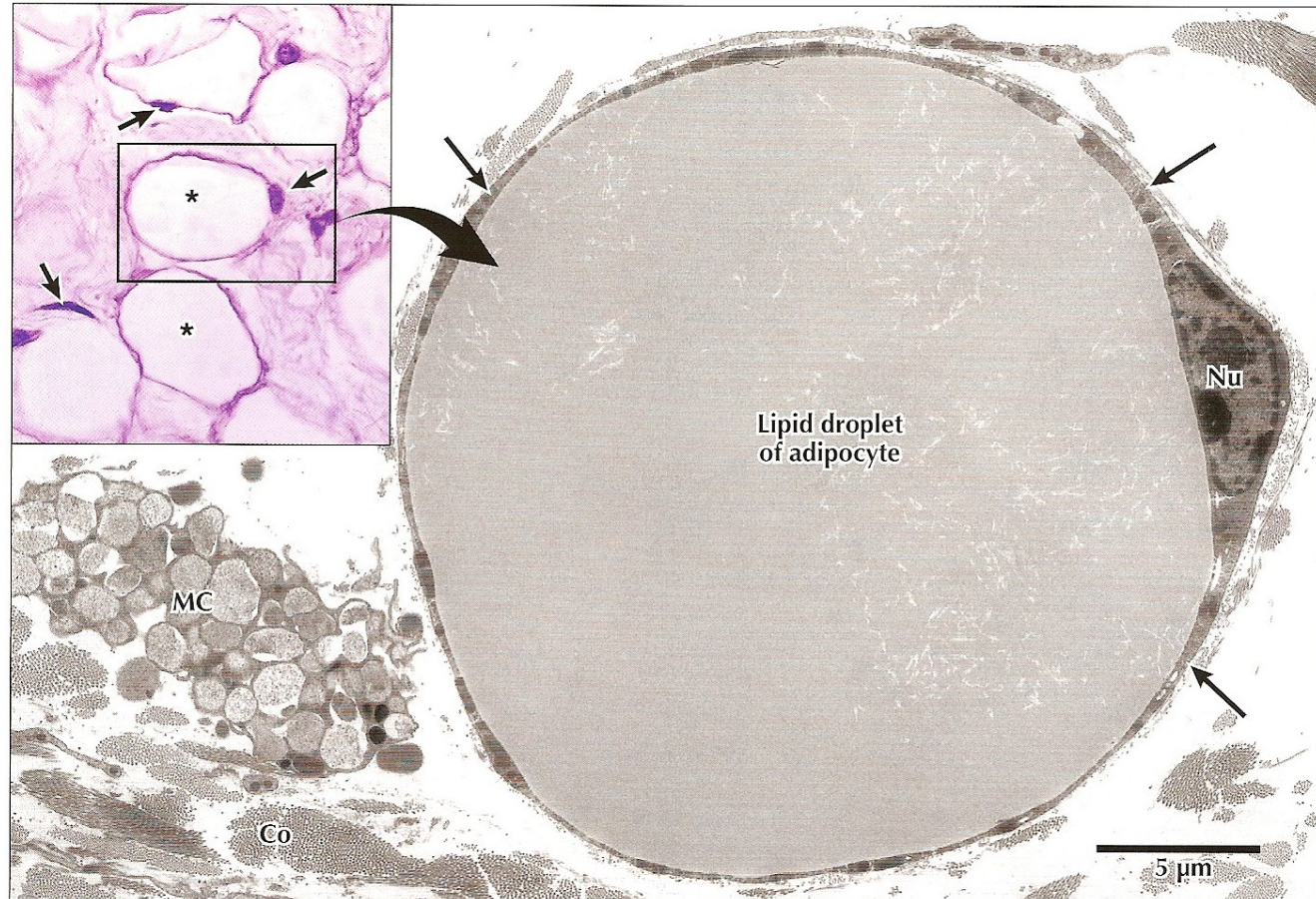
ADIPOSE TISSUE

- Adipocytes, fibroblasts, reticular, collagen and elastic fibers, capillaries
- White and brown adipose tissue



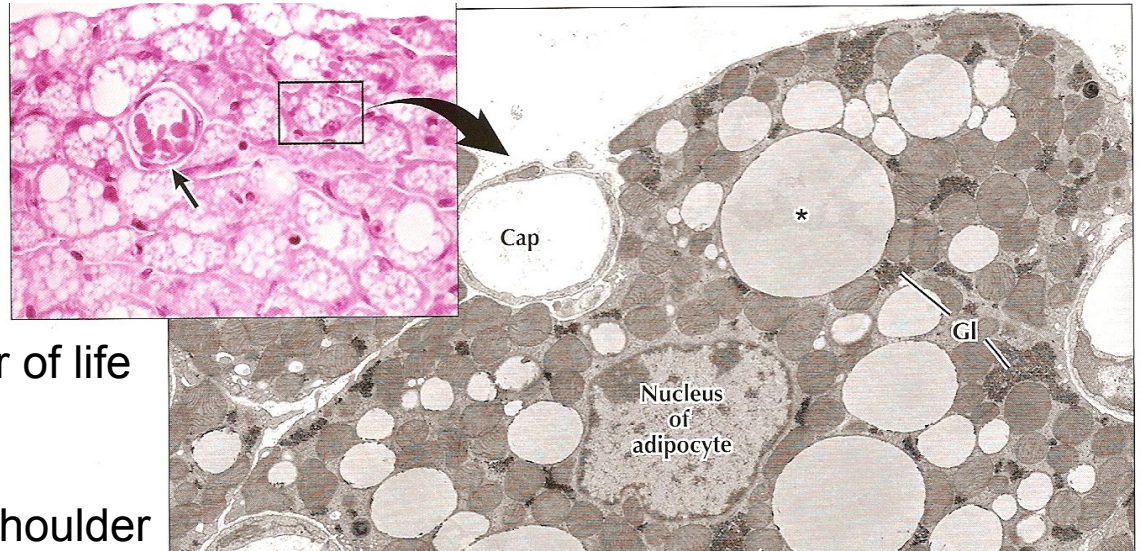
WHITE ADIPOSE TISSUE

- adipocytes are actively formed until 2nd year of life
- no innervations, but rich vascularisation
- adipocytes with only one lipid droplet
- leptin (adipokinins)

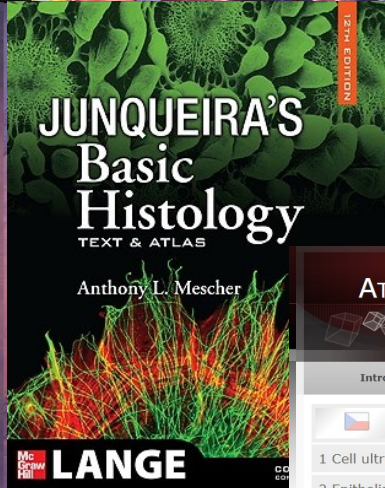
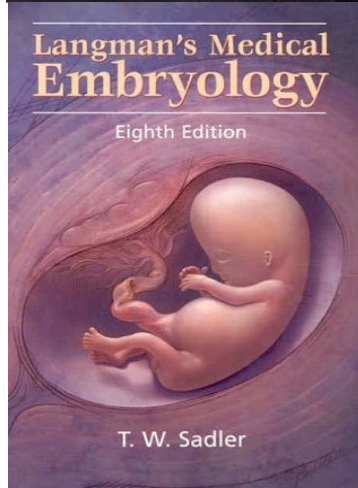
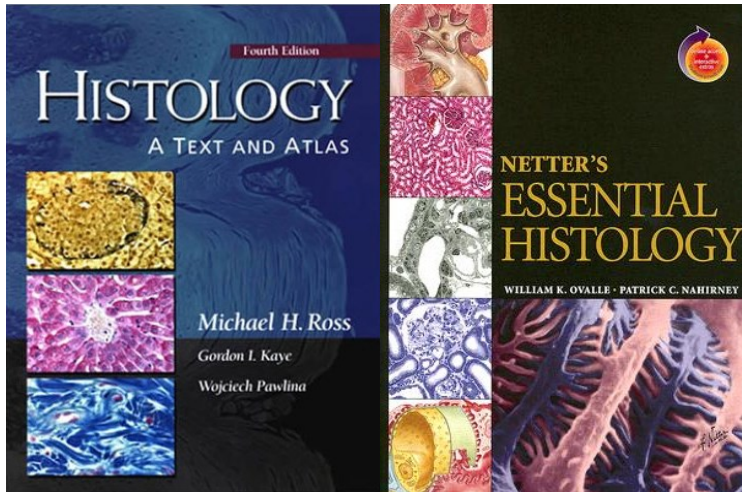


BROWN ADIPOSE TISSUE

- fetus and children up to 1st year of life
- fast source of energy
- typical localization – between shoulder blades, axilla, mediastinum, around kidneys, pancreas, small intestine
- small cells with numerous fat droplets

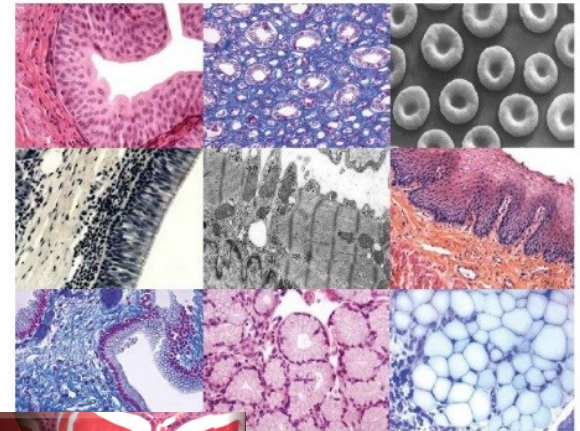


FURTHER STUDY



Guide to General Histology and Microscopic Anatomy

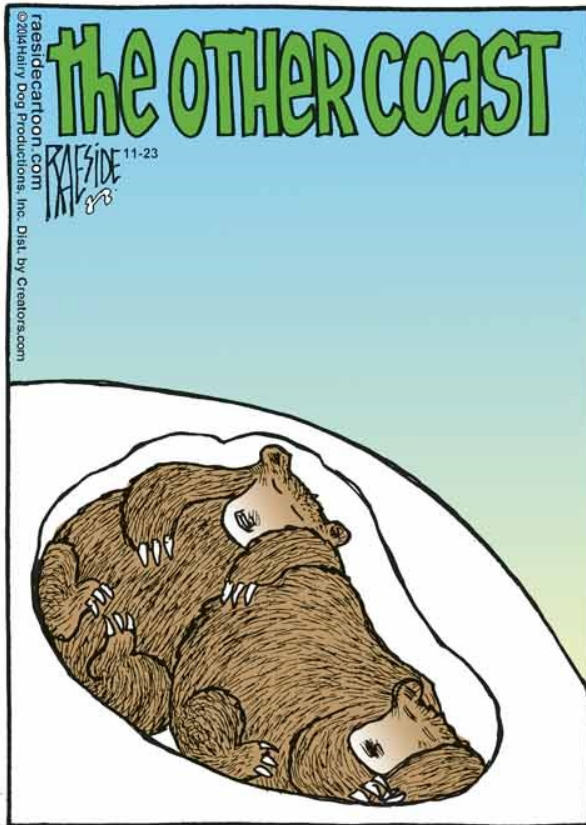
Petr Vaňhara, Miroslava Sedláčková,
Irena Lauschová, Svatopluk Čech, Aleš Hampl



ATLAS OF HISTOLOGY FM MU
DEPARTMENT OF HISTOLOGY AND EMBRYOLOGY, FACULTY OF MEDICINE, MASARYK UNIVERSITY
PETR VAŇHARA ET AL.

Introduction	General Histology	Microscopic Anatomy	Practical test
<ol style="list-style-type: none">1 Cell ultrastructure2 Epithelial tissue3 Connective tissue4 Muscle tissue5 Nerve tissue6 Blood morphology and hematopoiesis		<p>General histology explains how cells and acellular components assemble into tissues and defines the basic properties of individual tissue types. Building on morphology of cells as well as on their molecular makeup, general histology provides indispensable theoretical ground for microscopic anatomy (structure of organs and organ systems) and for embryology (body development).</p>	

<http://www.med.muni.cz/histology>



Thank you for attention

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