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Connective tissue : Syllabus for foreign students

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Connective tissue

GENERAL COMPOSITION of connective tissues:

1. **Cells**
2. **Intercellular substance**
 - a. **fibers**
 - b. **amorphous ground substance**

TYPES of connective tissues:

1. **Connective tissue proper**
 - a. **loose connective tissue**
 - b. **dense connective tissue**
 - **regular**
 - **irregular**
2. **Connective tissue with special properties**
 - a. **elastic**
 - b. **reticular**
 - c. **adipose**
 - c. **embryonic – mesenchymal, mucous**
3. **Supporting connective tissue**
 - a. **cartilage**
 - b. **bone tissue**

CONNECTIVE TISSUE CELLS:

1. **fixed:** fibroblasts – fibrocytes; reticular, pigment, fat cells (adipocytes)
2. **free:** macrophages, plasma cells, mast cells, leucocytes

INTERCELLULAR SUBSTANCE composition:

1. **Fibers:** collagen, reticular, elastic

2. **Amorphous ground substance:** viscous, transparent

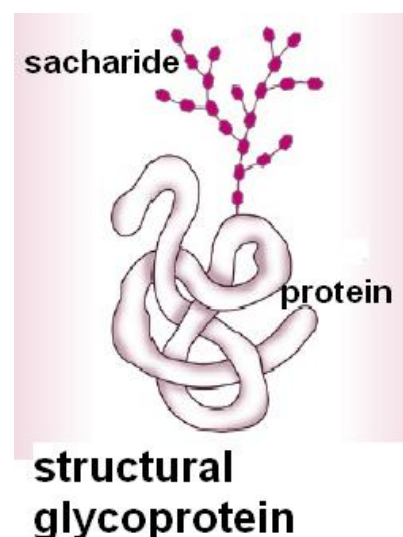
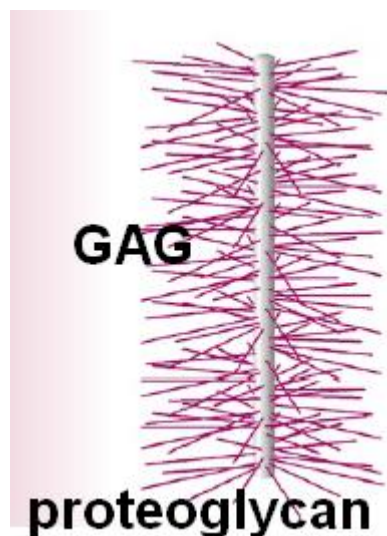
Contains: water, ions; GAG, PG, SGP

1. GAG – **glycosaminoglycans** (linear polysaccharides)

2. PG – **proteoglycans:** three dimensional structures consisting of protein core and polysaccharides (GAG)

3. SGP – **structural glycoproteins** – globular protein + branched polysaccharides
fibronectin, laminin, chondronectin, osteonectin

Function: interaction of neighbouring cells, adhesion of cells to their substrate



Fibers of connective tissue:

Connective tissue fibers are of three principal types:

Collagen fibers

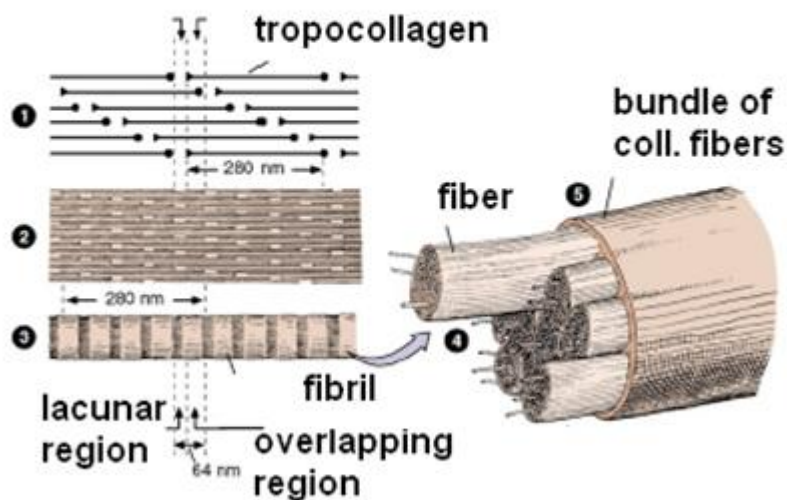
Reticular fibers

Elastic fibers

1. Collagen fibers are flexible and have a high tensile strength. In the light microscope they are stained with eosin in pink color. When examined in the EM the collagen fibers appear as bundles of fine collagen fibrils. Collagen fibrils have a 64-nm banding pattern – cross striation. This is caused by the arrangement of the tropocollagen molecules in forming the fibrils.

Collagen fiber type I formation

tropocollagen molecules – fibrils – fibers – bundle of collagen fibers



There are 15 types of collagen

Most important are:

Collagen type I: accounts for 90% of body collagen, provide resistance to

force, tension and strength

location: skin, bone, tendon, ligaments, dentine, sclera, fascia,
organ capsules, loose connective tissue

forms thick collagen fibers and bundles of fibers

In LM – eosinophilic fibers 1-20 μm in diameter

In EM – fibrils 75 nm, they have cross striation with periodicity 64 nm

Collagen typ II: in hyaline and elastic cartilage, provide resistance to pressure, forms very thin fibrils- 20 nm thick, never form fibers

Collagen typ III: forms reticular fibers with a high content of glykoproteins PAS positive, and argyrophilic
 location: in lymphoid and hemopoietic organs, liver, skin
 forms fibrils – 45 nm thick that aggregate in thin fibers
 0,2-2 µm

Collagen typ IV-V: do not form fibrils, form filamentous meshwork in basal laminae of epithelia, fat cells, muscle cells, Schwann cell

Collagen typ VII: forms anchoring fibrils connecting basal lamina to reticular lamina

Types of collagen fibers

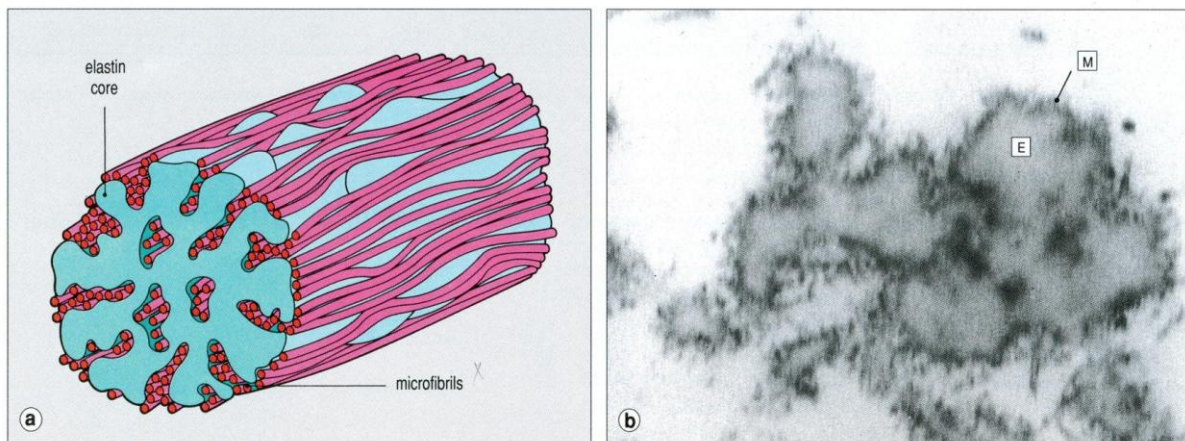
FIBRIL	FIBER	BUNDLE of FIBERS	
Type I. 75 nm	1-2 µ m	+	Skin (eosinophilic)
Type II. 20 nm	0	0	Cartilage (in LM not visible)
Type III. 75 nm	0,2-2 µ m	0	Lymphoid organs (reticular fibers)

2. Reticular fibers - 0,2-2 µm thick, composed of collagen typ III, provide a supporting framework for the cells of various tissues – lymphoid organs
 LM: argyrophilic, PAS positive

3. Elastic fibers- 1-10 µm thick, can be stretched to 150% of their original length
 LM: special staining (orcein) – dark brown in color
 EM: protein elastin in the centre – light (lucent), fibrillin microfilaments at the periphery – dark (dense)



(M) Microfibrils (glycoprotein fibrillin) at the periphery (dense), (E) – elastin (lucent)



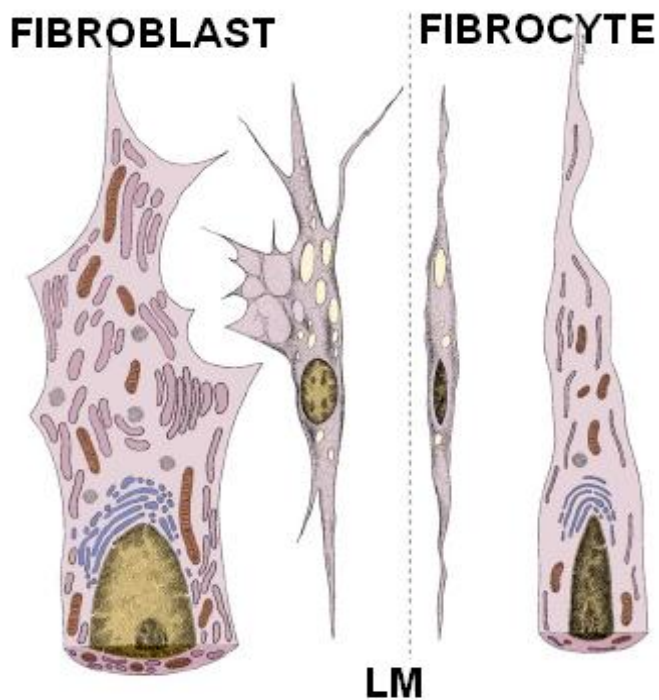
Fixed connective tissue cells:

1. Fibroblasts - active cells, synthesize fibers and AGS

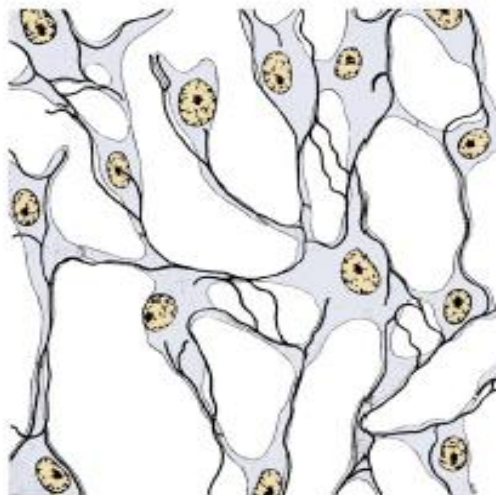
- irregular shape, many short and sharp cytoplasmic processes
- light, oval nucleus, rich in euchromatin
- prominent nucleolus
- cytoplasm rich in - GER and GA, basophilic

2. Fibrocytes – spindle shaped cells, smaller like fibroblasts

- nucleus is elongated, smaller, more basophilic
- cytoplasm is poor in organelles, acidophilic



3. Reticular cells – star shaped cells with long processes by which they are interconnected, synthesize collagen type III

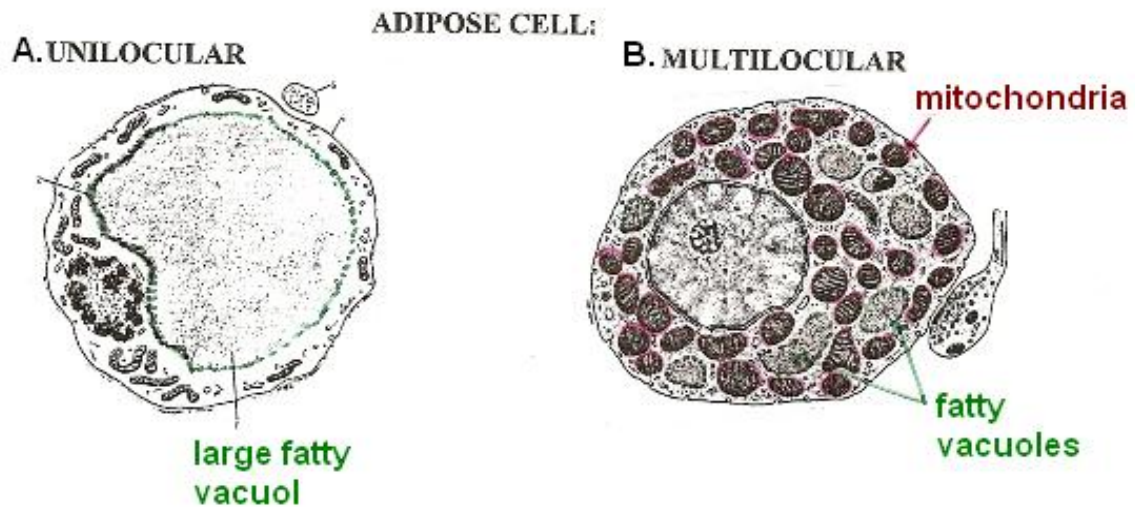


4. Adipocytes (fat cells) - unilocular

- multilocular

Function: storage of energy

- triglycerides (continuous turnover)
- adipose tissue: mechanical and thermal protection



Unilocular adipocytes

- spherical cells, 50 – 150 μm in size
- in tissues are polyhedral
- 1 fat vacuole fills the cytoplasm
- flat nucleus placed in the periphery
- EM –a thin ring of cytoplasm+ GA+GER+SER
- basal lamina surrounds the cell

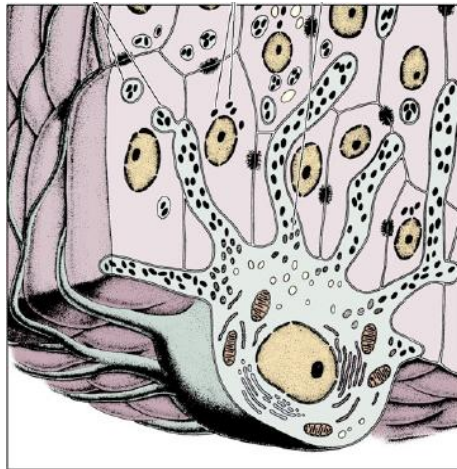
Multilocular adipocytes

- polygonal cells, smaller than unilocular
- spherical nucleus usually in the centre of the cell
- in the cytoplasm many fat vacuoles of different size
- a lot of mitochondria containing cytochrom oxidases (brown color)
- newborns and hibernating animals
- brown adipose tissue
- basal lamina surrounds the cell

During β -oxidation of fatty acids the heat is released by the brown fatt cells (not the energy in ATP form). This is because transmembrane proteins thermogenins are situated in the inner mitochondrial membrane of these brown fatt cells. Thermogenins allow back flow of protons, and the obtained energy is released in the form of heat .

5. Pigment cells – melanocytes

- Oval cell body, long cytoplasmic processes
- Granules with melanin pigment - melanosomes
- Epidermis of the skin
- Protection against UV – rays
- Neuroectodermal origin

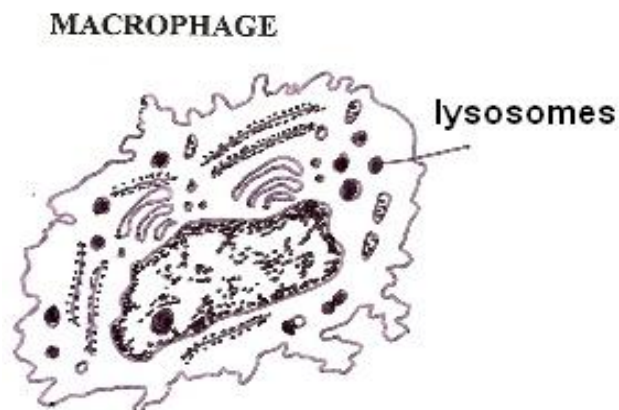


Free connective tissue cells:

1. Macrophages - histiocytes (monocytemacrophage system)

- Kupffer cells in liver, mikroglia in CNS, osteoclasts in bone tissue,
Langerhans cells in epidermis

- Oval cells with numerous folds and fingerlike projections
- spherical or oval nucleus
- many lysosomes

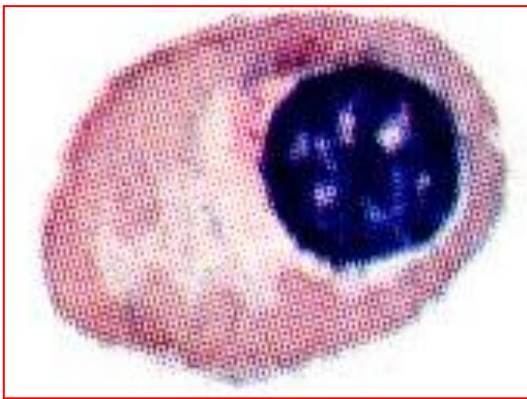


Function: - phagocytosis, defense, immunological

2. Plasma cell, derived from B lymphocytes

- large (20 μm) ovoid cell
- basophilic cytoplasm – GER, GA
- eccentrically placed spherical nucleus
- clock face arrangement of chromatin

Function: Synthesis of immunoglobulins - antibodies

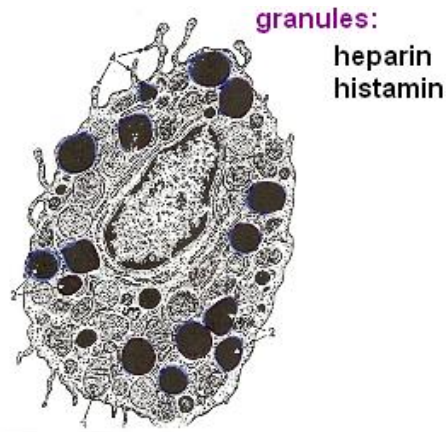


3. Mast cell

- large spherical cell with spherical nucleus
- microvilli and folds on the cell surface
- cytoplasm filled with large granules
- granules contain heparin and histamin

Function: storage of chemical mediators of the inflammatory response

- paracrine secretion (heparin – anticoagulant, histamin – increases permeability of capillaries)



Classification of connective tissue - according the amount of cells, fibers and amorphous ground substance:

1. Connective tissue proper

- a. loose connective tissue
- b. dense connective tissue
 - regular
 - irregular

2. Connective tissue with special properties

- a. elastic
- b. reticular
- c. adipose
- c. embryonic – mesenchymal, mucous

Recommended textbooks:

- 1. Adamkov: Introduction to functional histology
- 2. Junqueira: Basic histology. Text and atlas