

Connective Tissue Proper

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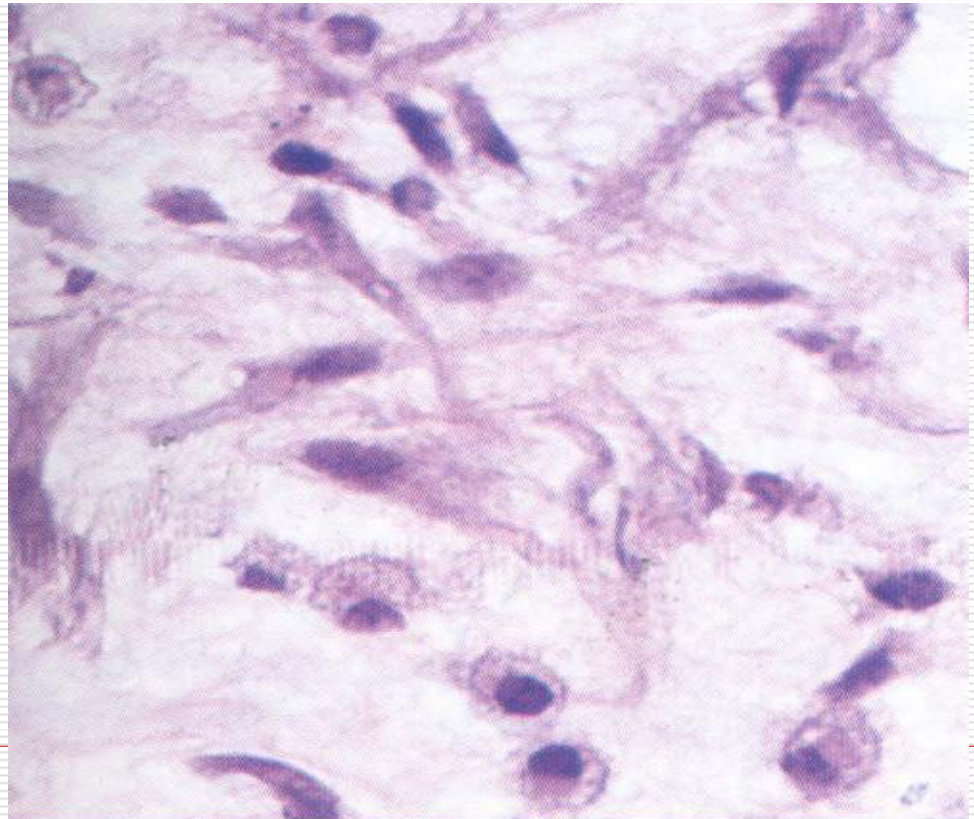
Department of Histology & Embryology

I. General characteristics

- **Structural components**
 - **Cells,**
 - **Extracellular matrix: fibers, ground substance and tissue fluid**
 - **Classification**
 - **Features**
 - **A small number of cells**
 - **A large amount of matrix**
 - **The cells have no polarity.**
 - **Be filled with blood and lymphatic vessels**
 - **Originate from mesenchyme**
 - **Connect, hold, support other tissue**
 - **Involved in nutrition, defense and repair**
-

I. General characteristics

- ❑ **Origin: mesenchyme**
- ❑ **Mesenchymal cell: stellate or fusiform, undifferentiated , multiple developmental potentialities**
- ❑ **Functions**
 - **Connection**
 - **Support**
 - **Nutrition**
 - **Defence**
 - **Repair**



Classification of connective tissue

Connective tissue proper

- Loose connective tissue

- Dense connective tissue

- Adipose tissue

- Reticular tissue

- Mucous tissue

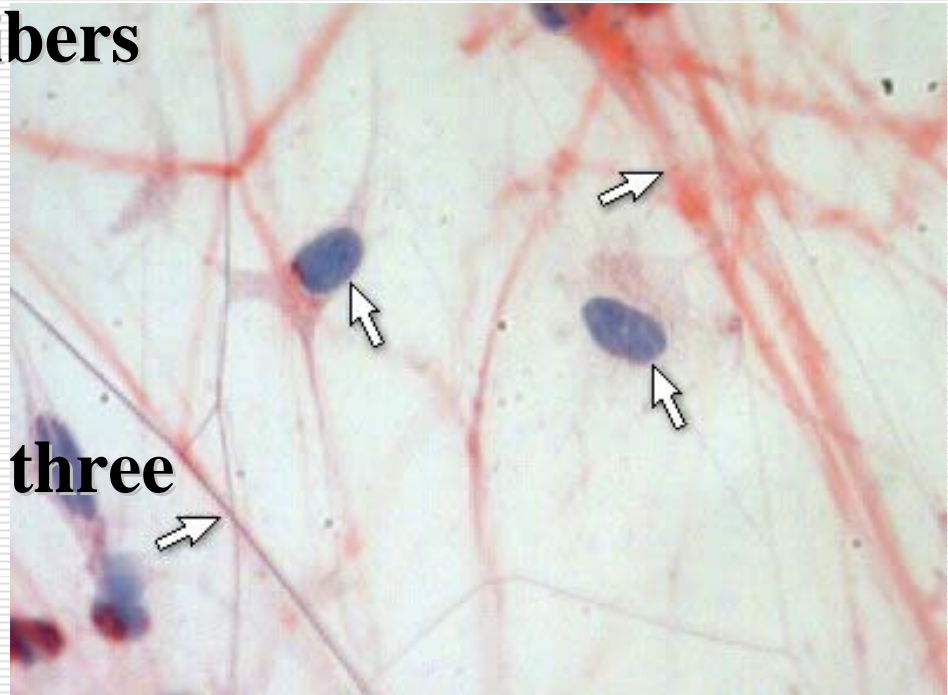
Cartilage

Bone

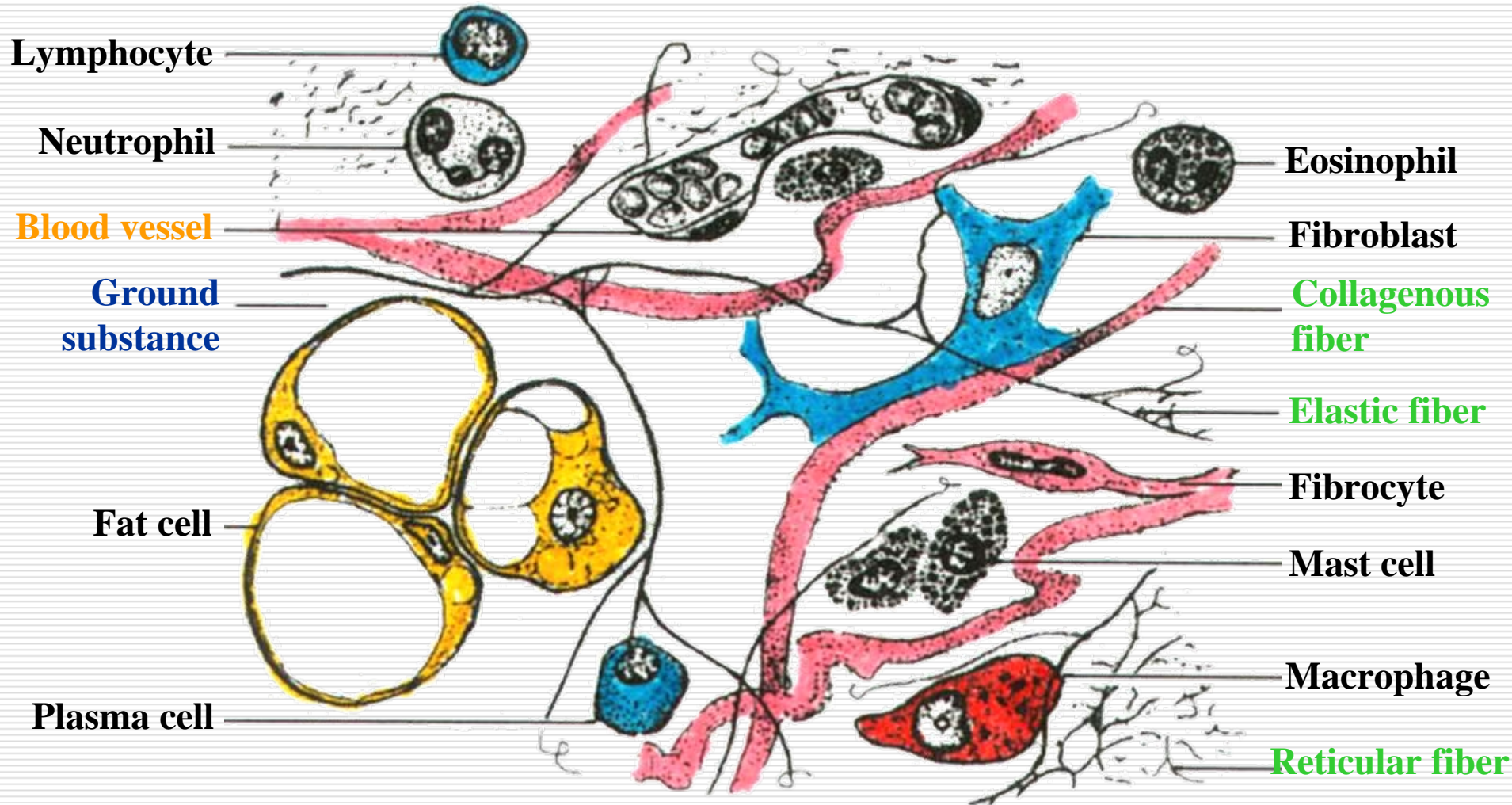
Blood

II. Loose connective tissue (Areolar tissue)

- **Distribution: common and widely**
- **Structural characteristics**
 - **Many types of cells**
 - **A small number of fibers**
 - **Sponge-like**
- **Components**
 - **Cells: seven**
 - **Intercellular fibers : three**
 - **Ground substance**



Loose connective tissue



1. Cells 2. Intercellular fibers 3. Ground substance

1. Cells

- Fibroblasts
 - Macrophages
 - Plasma cells
 - Mast cells
 - Fat cells
 - Undifferentiated mesenchymal cells
 - Leukocytes
-

1.1 Fibroblasts

□ Structure

- **LM**: large flat , branching processes, stellate; large, ovoid and pale staining nucleus; prominent nucleoli; weakly basophilic cytoplasm
- **EM**: rich in RER , free ribosomes and Golgi apparatus

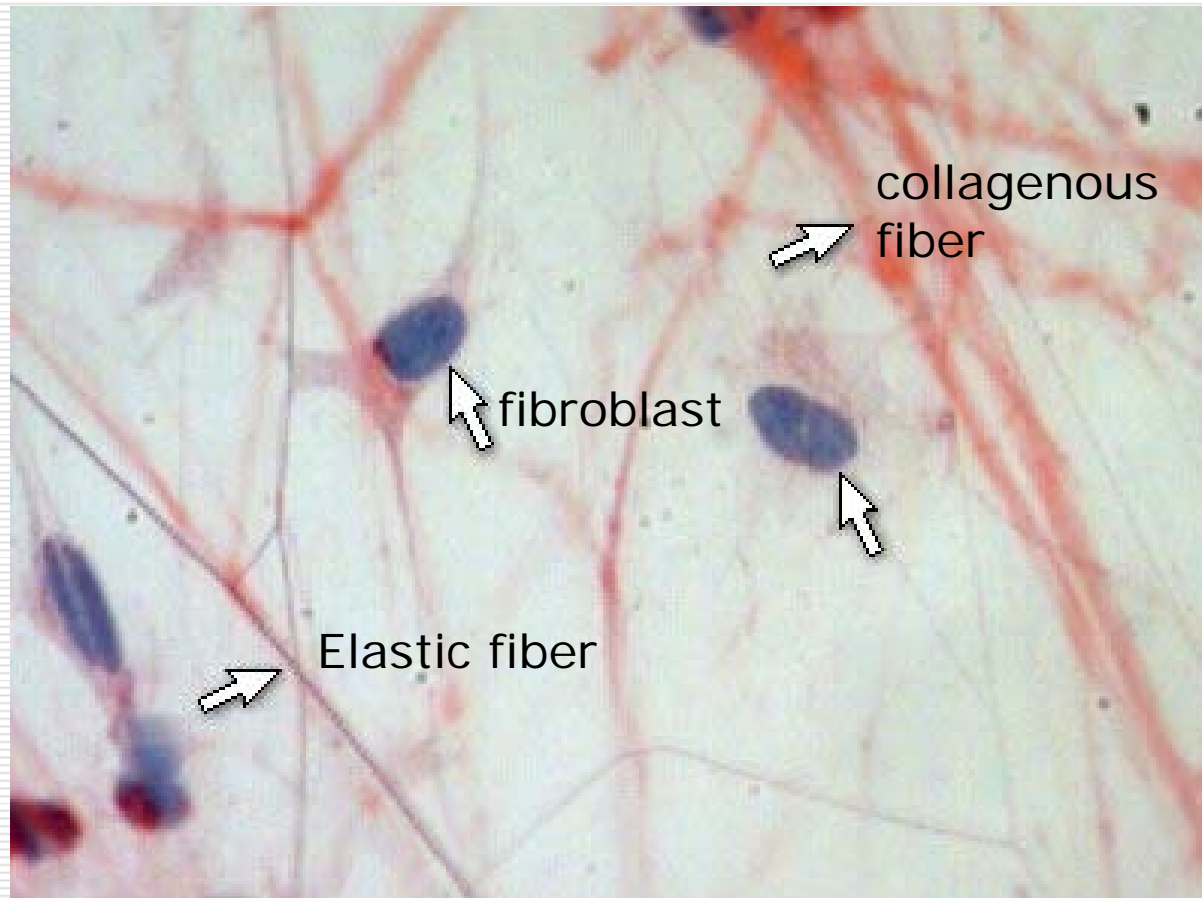
□ Function

- Synthesis of fibers and amorphous ground substance
-

Fibrocytes

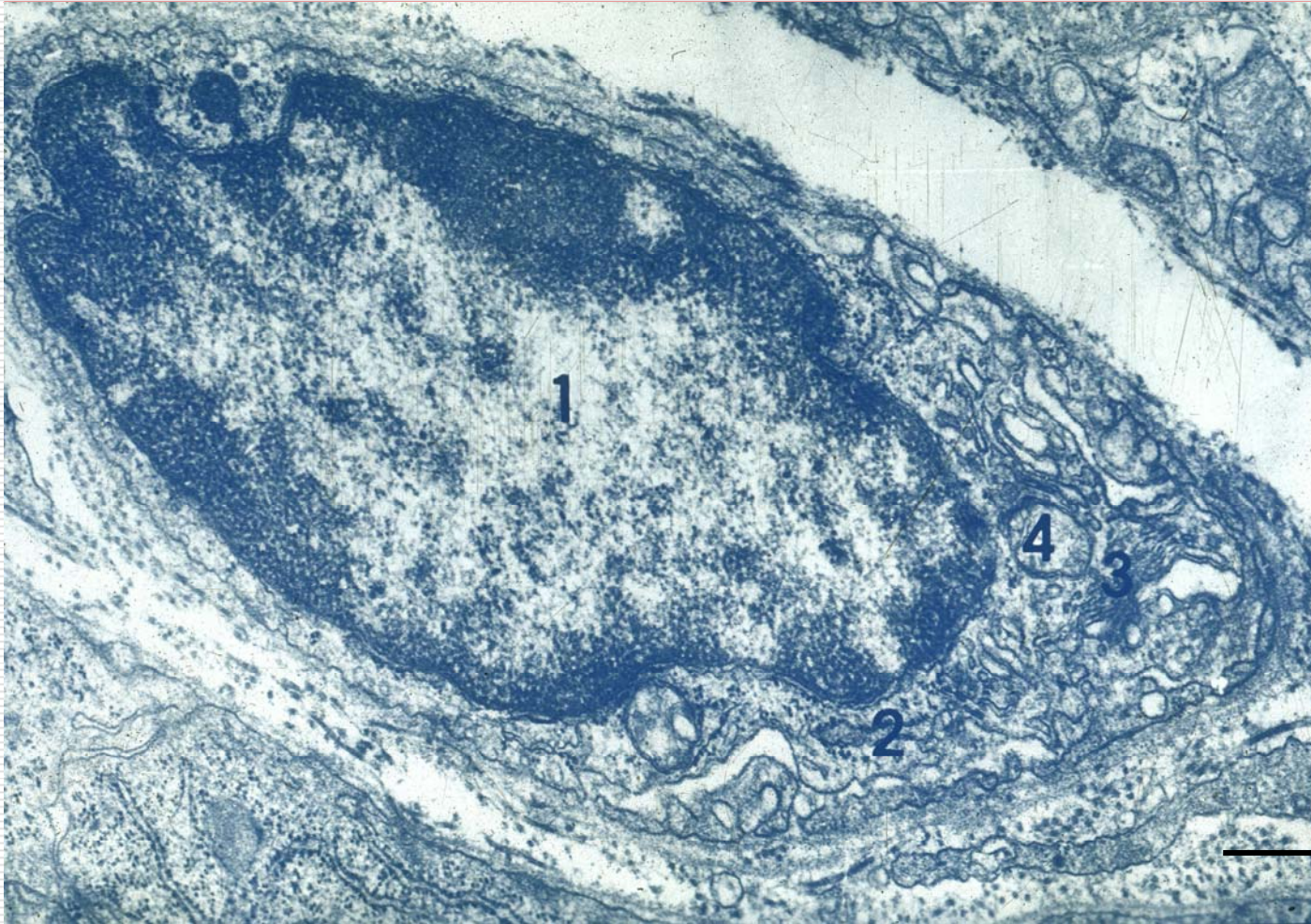
- **Fibrocytes : quiescent fibroblasts**
 - **LM: spindle-shaped ;**
 - a smaller, darker nucleus;**
 - an acidophilic cytoplasm;**
 - **EM: less rough endoplasmic reticulum**
 - undeveloped Golgi apparatus appear**
-

Fibroblast



**large flat , branching processes, stellate;
large, ovoid and pale staining nucleus; prominent nucleoli;
weakly basophilic cytoplasm HE and aldehyde-fuchsin staining**

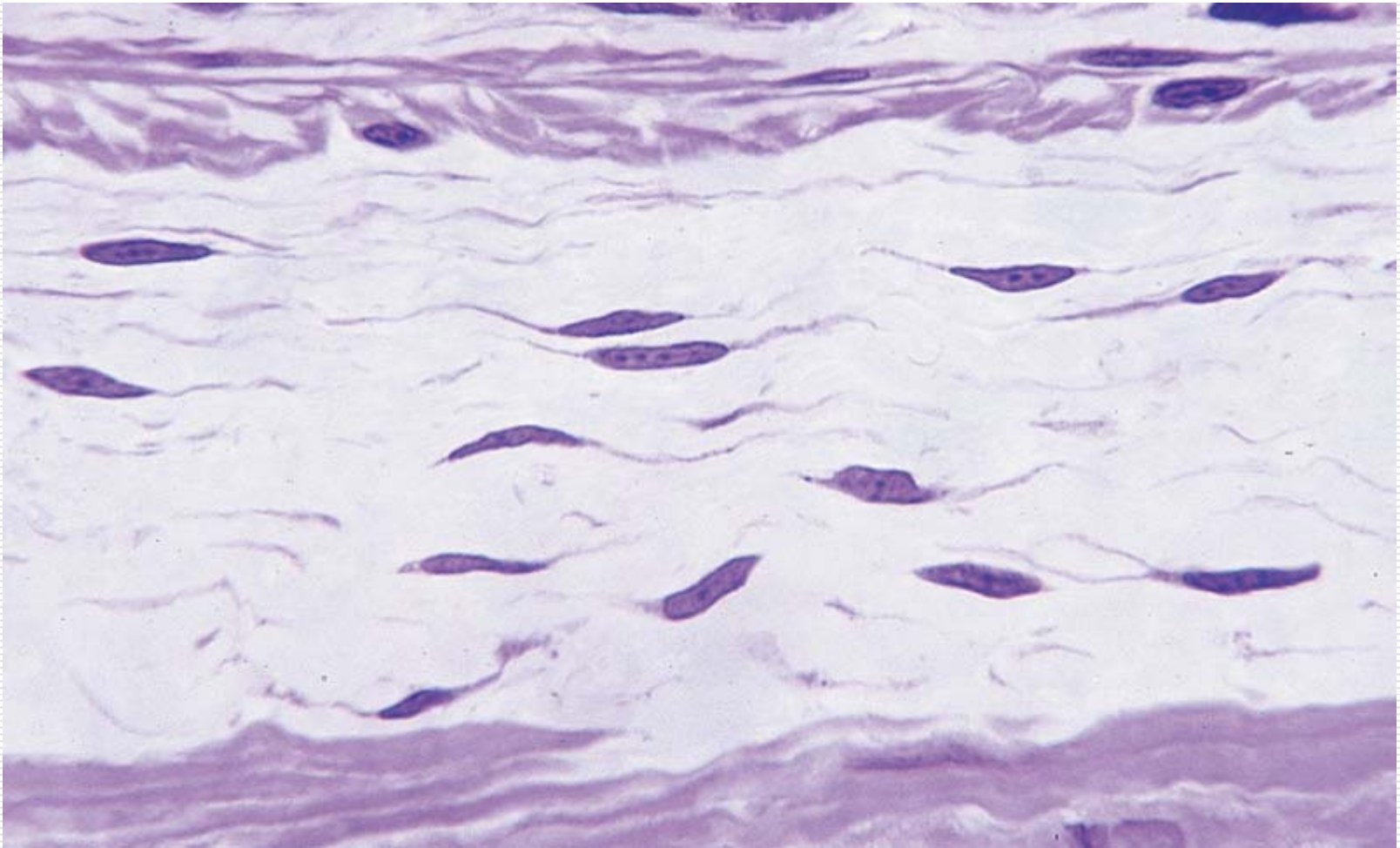
Fibroblast



cross-sectional collagen fibrils

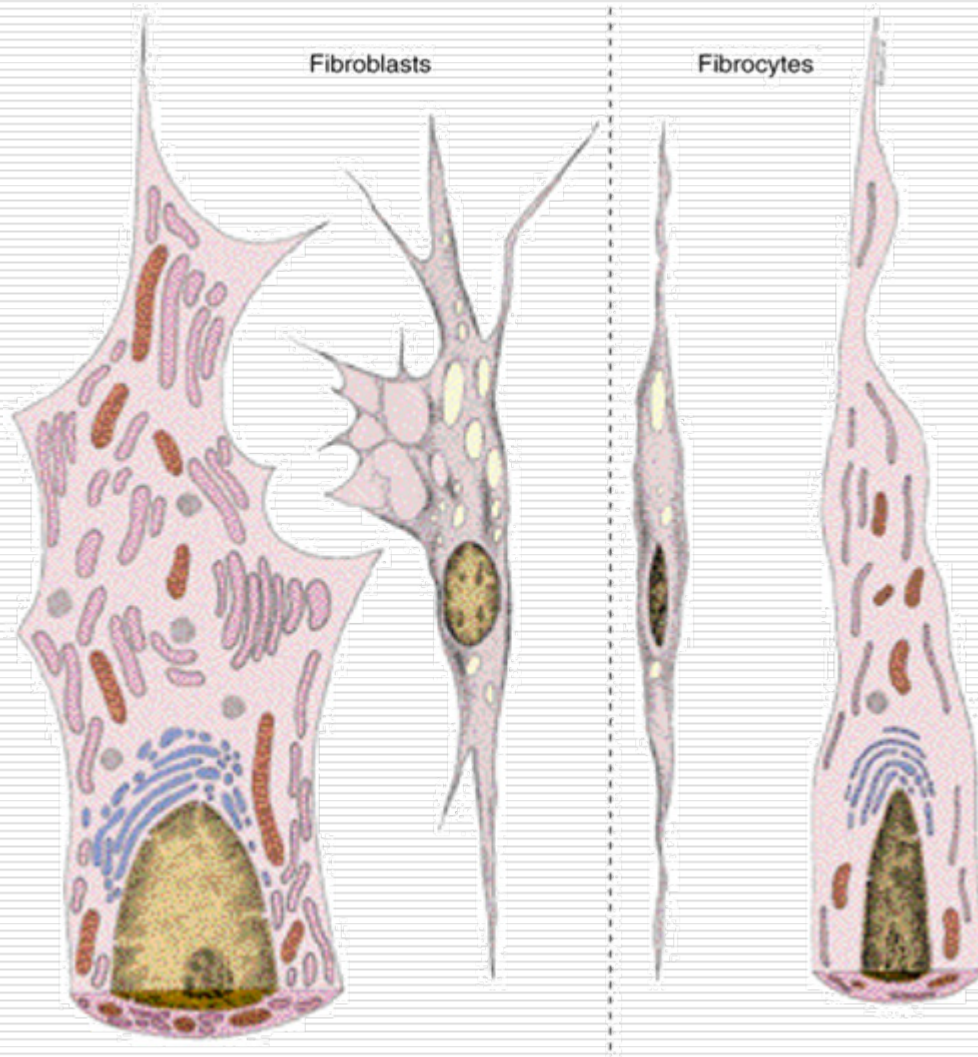
1. Nucleus ; 2. rough endoplasmic reticulum;
3. Golgi complex apparatus; 4. mitochondrion

Fibrocytes



Fibrocytes are elongated cells with thin cytoplasmic extensions and condensed chromatin.

Fibrocytes and fibroblasts



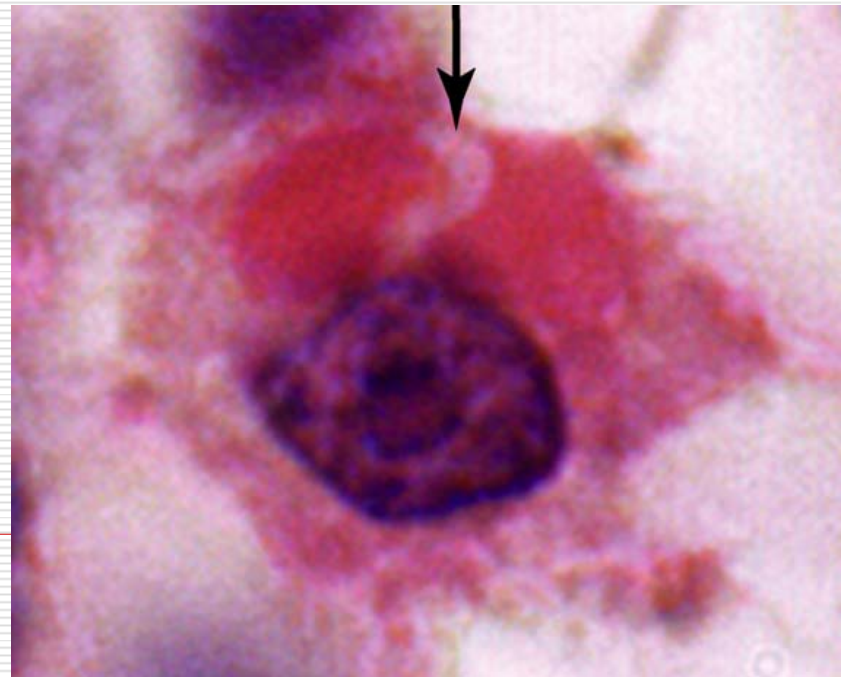
Fibroblasts and fibrocytes are different developmental or functional states of the same cells and involved in tissue repair.

1.2 Macrophages

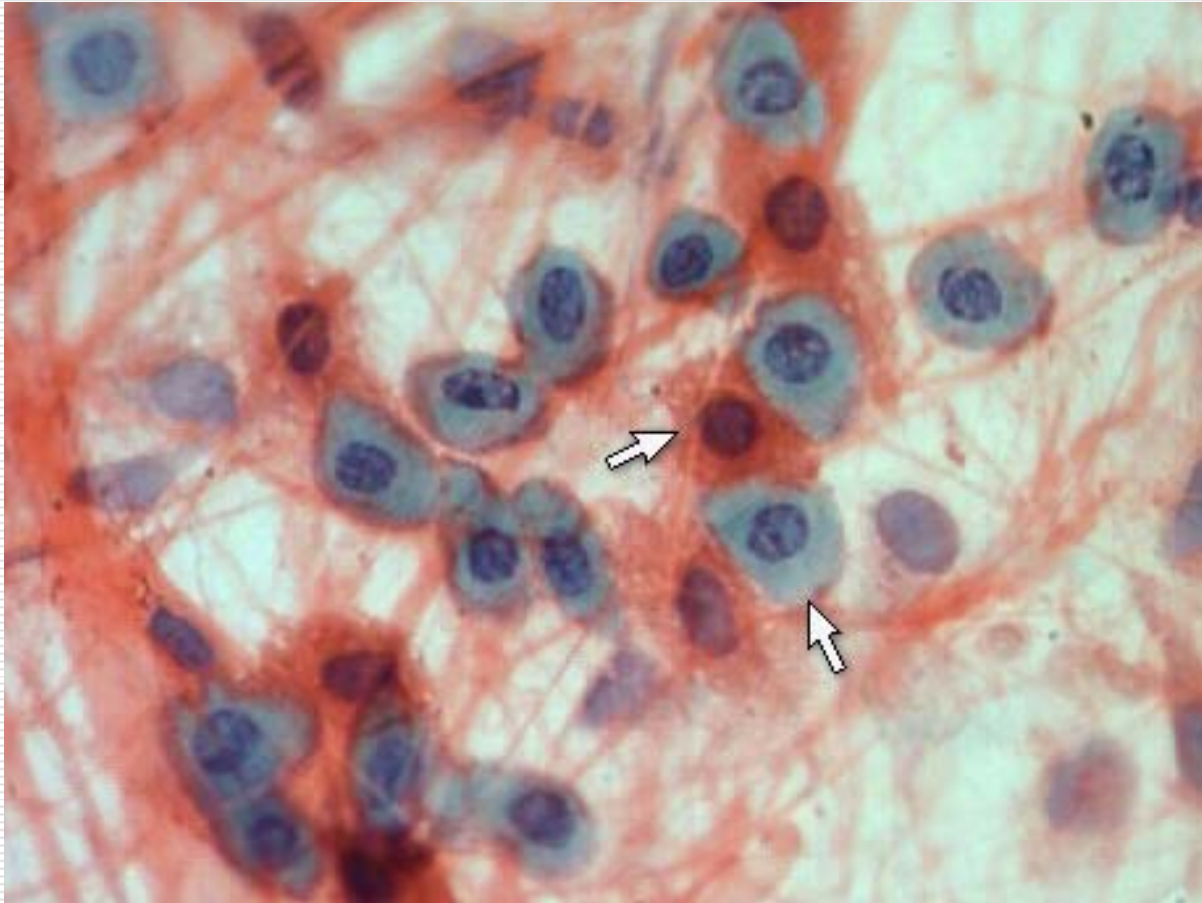
□ Structure

- **LM**: irregular; short, blunt processes;
dark, oval or kidney-shaped nucleus
acidophilic cytoplasm
phagocytosed particles

- **EM**: pseudopod(ium);
lysosomes,
Pinosomes
phagosomes
microtubules
microfilements



Macrophages



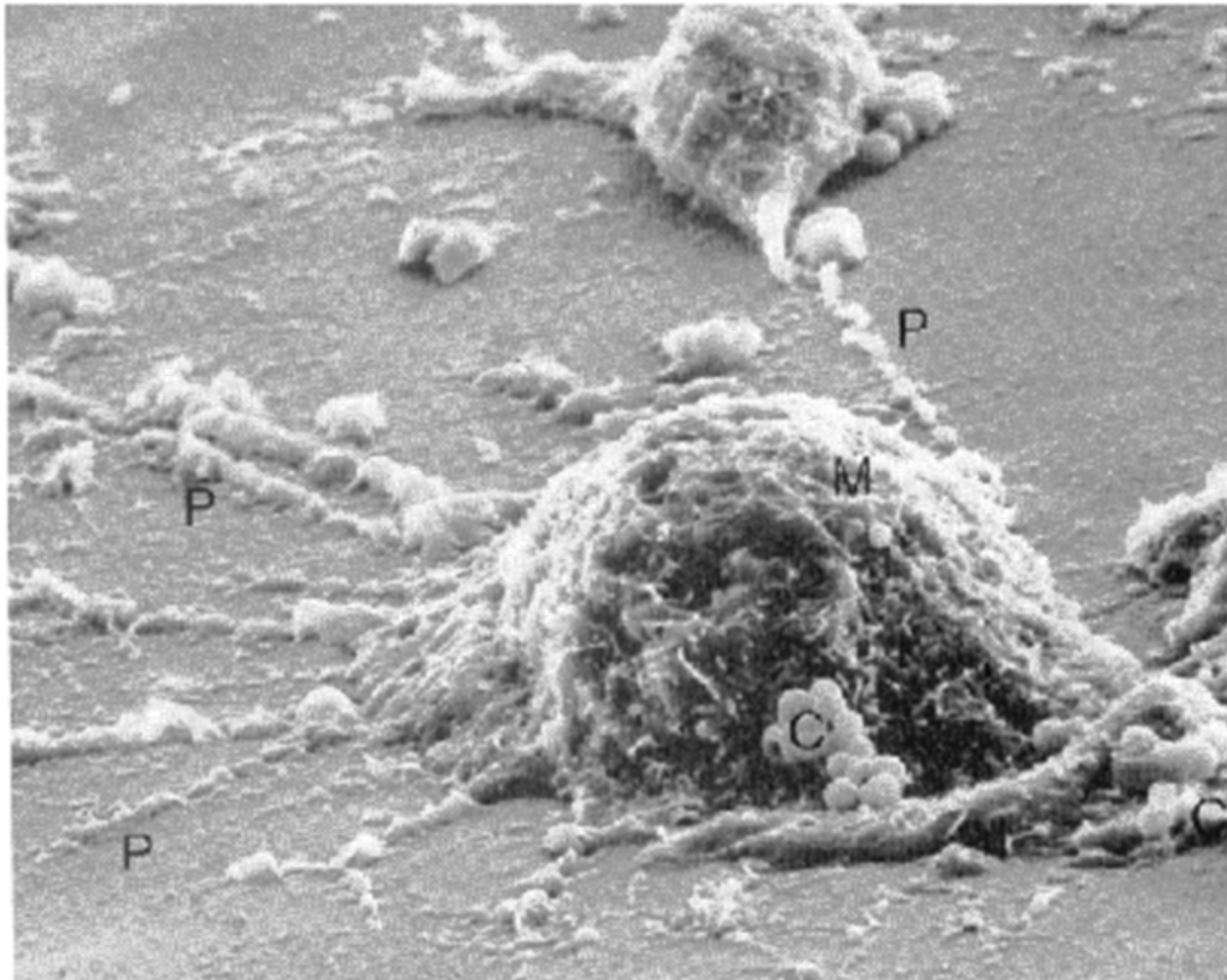
irregular; short, blunt processes; dark, oval or kidney-shaped nucleus; acidophilic cytoplasm; phagocytosed particles or vesicles.

Macrophages

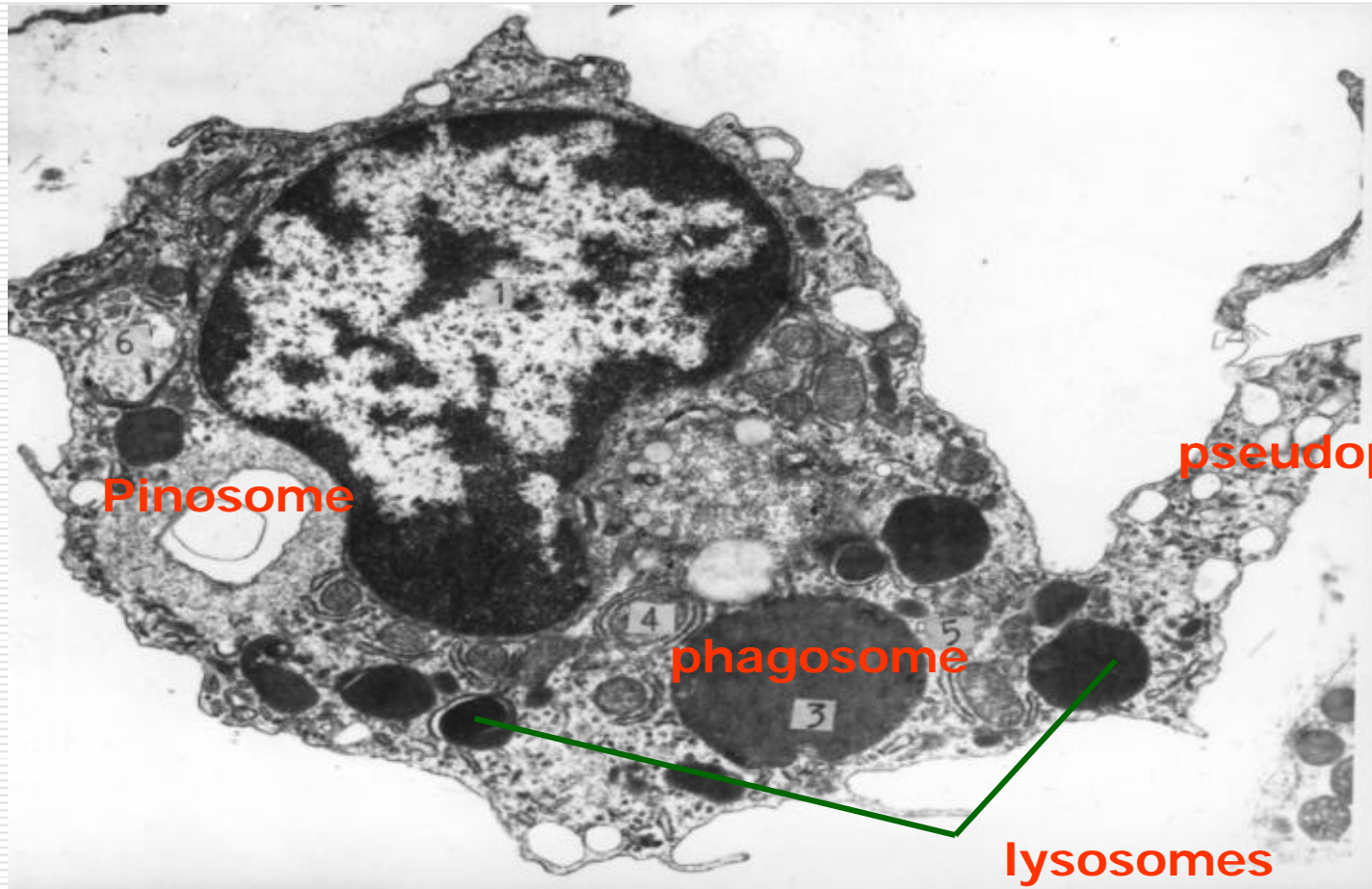


Macrophages ingest the dye (trypan blue) and store it in their cytoplasm.

Macrophages



Macrophages

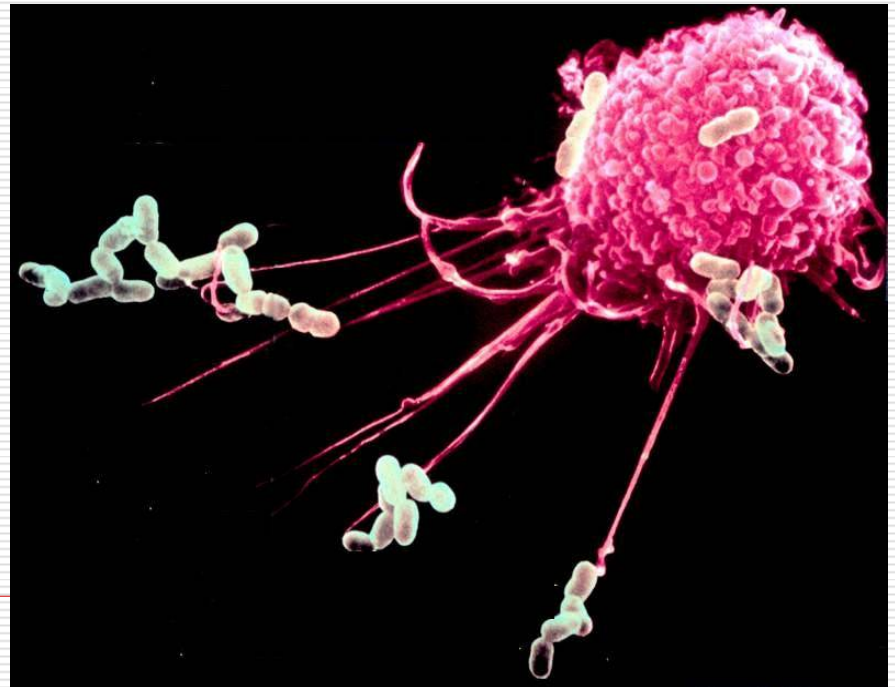


macrophages show an irregular surface and pseudopod.

Functions of macrophages

- ❑ **mobility: chemotaxis , chemotaxin**
- ❑ **phagocytic activity : phagocytosis & pinocytosis**
- ❑ **secretion: lysozyme, interferon, complement.**
- ❑ **Immune reaction**

A macrophage is capturing the bacteria by pseudopodia and processes.



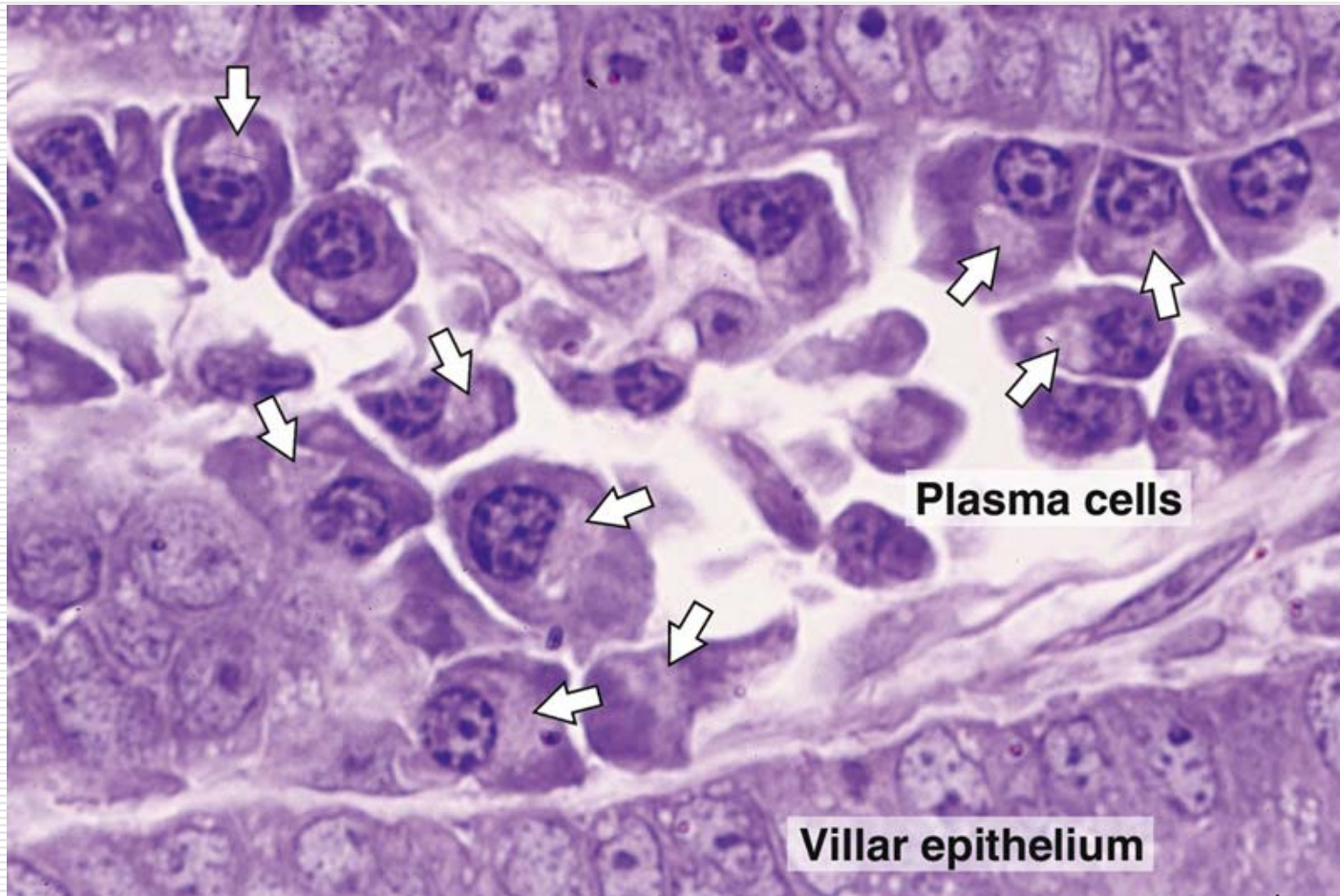
Mononuclear phagocyte system

- ❑ **Macrophages derive from monocytes.**
 - ❑ **Mononuclear phagocyte system**
 - **Kupffer cells in liver**
 - **microglial cells in nervous system,
Langerhans cells of the skin**
 - **osteoclasts in bone tissue**
-

1.3 Plasma cells

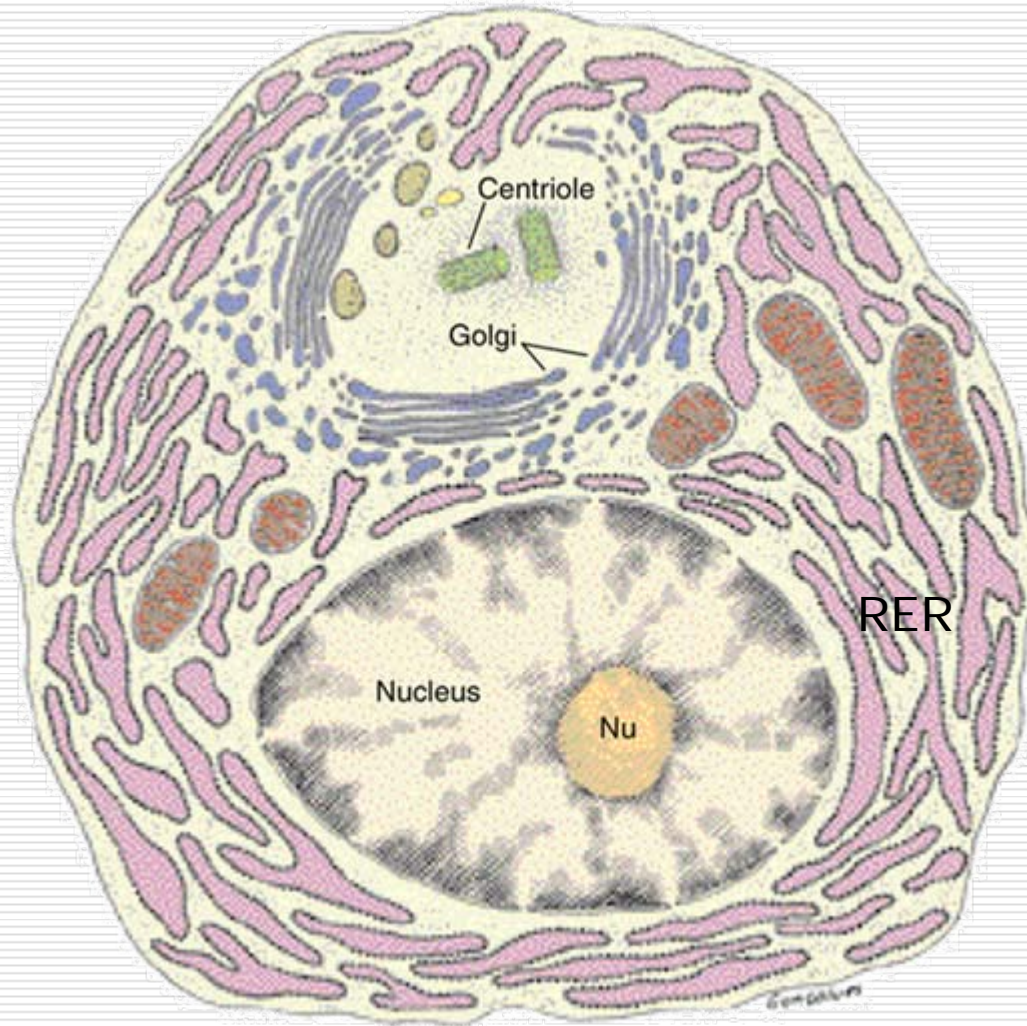
- ❑ **Distribution: digestive and respiratory tract ; serous membrane**
 - ❑ **Structure**
 - **LM: ovoid or round in shape**
 - eccentric nucleus like a clock-face;**
 - basophilic cytoplasm;**
 - lightly-stained area near nucleus**
 - **EM: well-developed Gc; a pair of centrioles;**
 - RER; free ribosome**
 - ❑ **Origin: B-lymphocytes**
 - ❑ **Function: produce immunoglobulin/ antibody**
-

Plasma cell

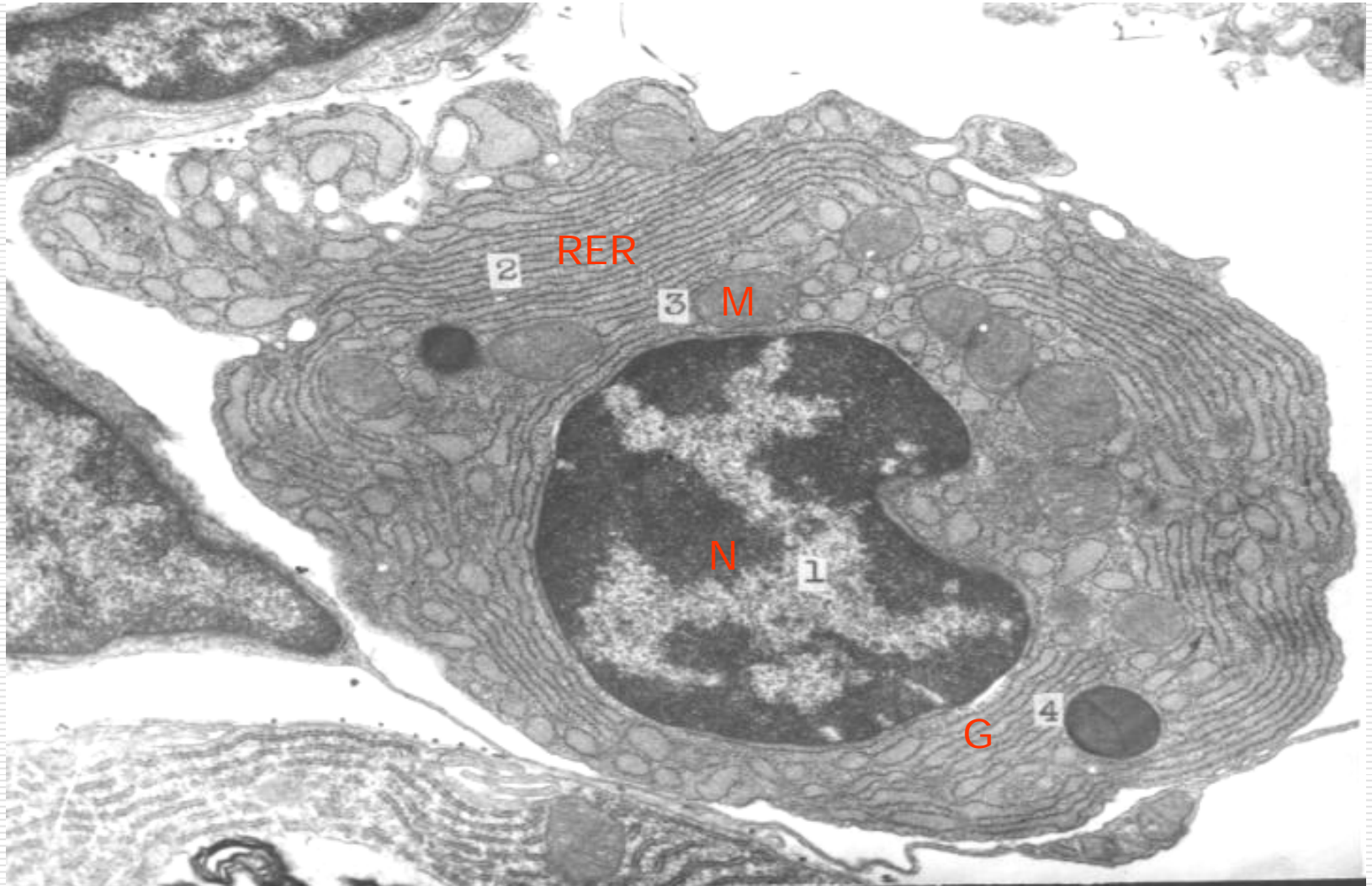


ovoid or round ; eccentric nucleus like a clock-face;
basophilic cytoplasm; lightly-stained area near nucleus

Plasma cell



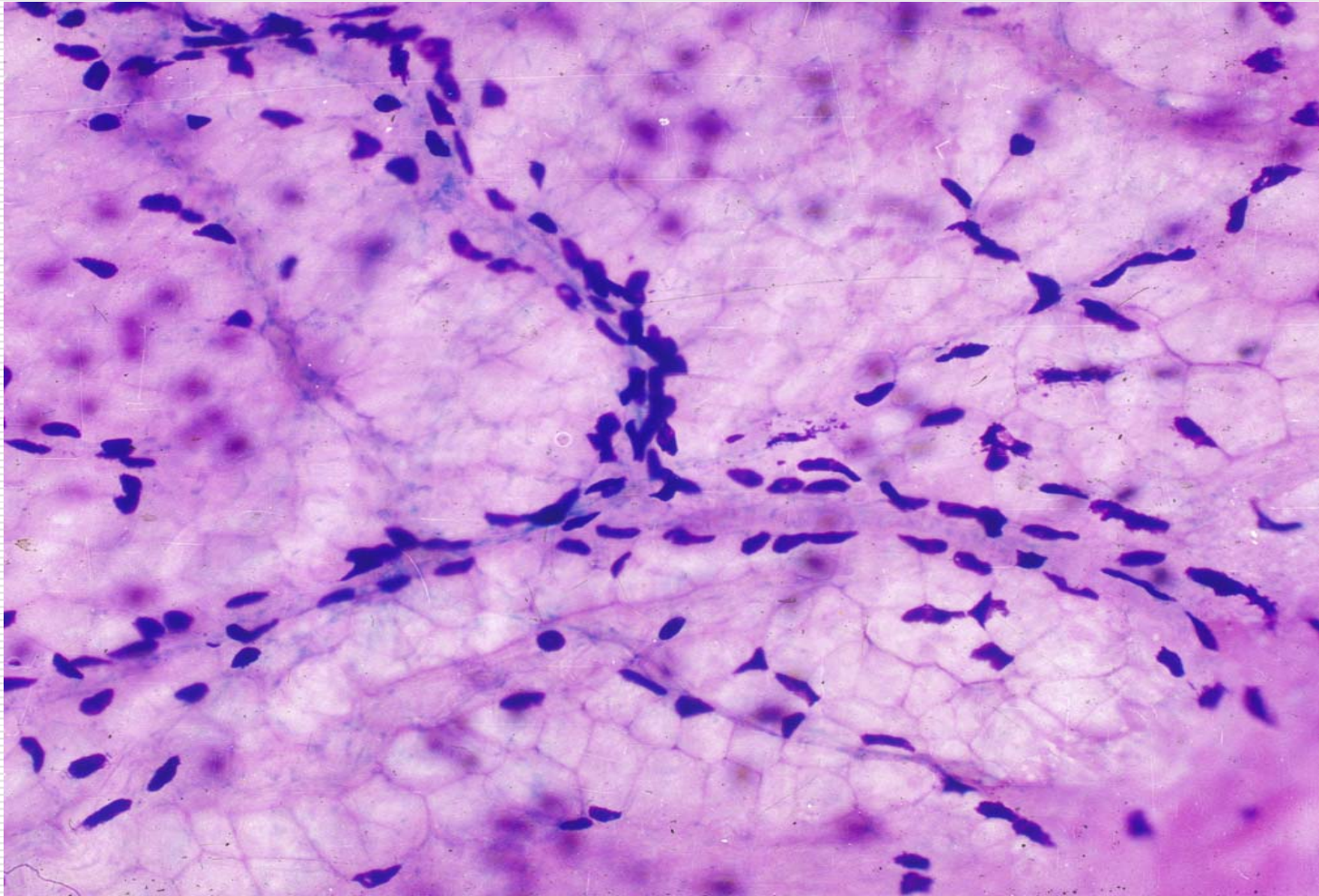
Plasma cell



1.4 Mast cells

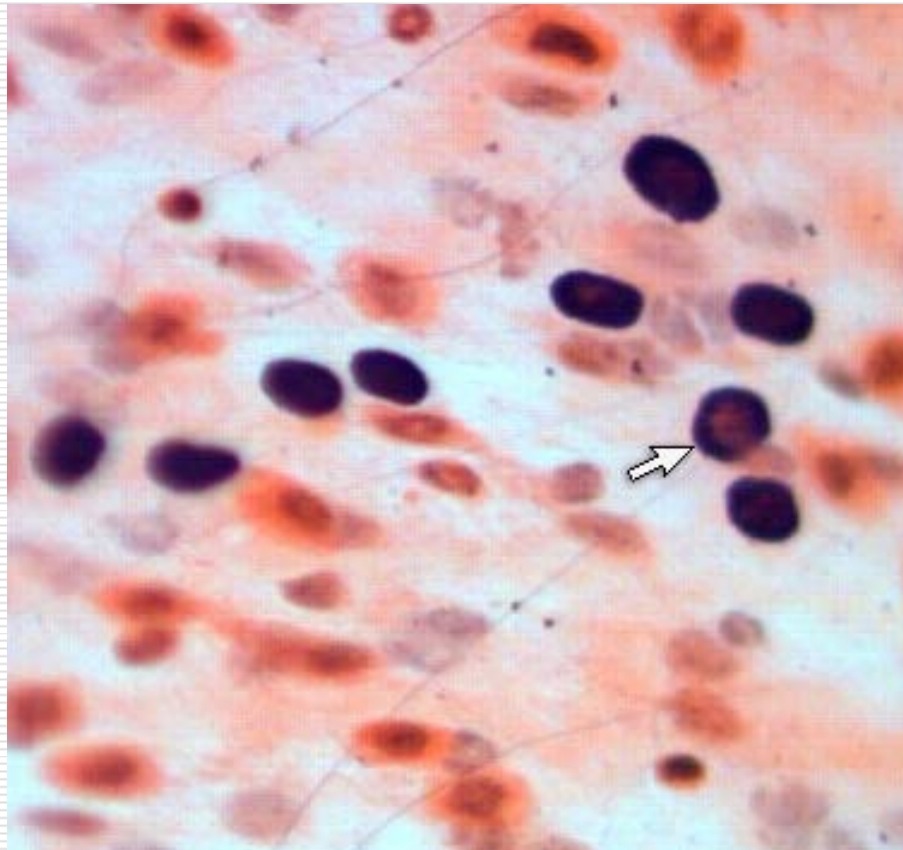
- ❑ **Distribution:** along small blood vessels
 - ❑ **Structure**
 - **LM:** large, ovoid or round;
small and pale nucleus;
coarse basophilic granules
 - **EM:** membrane-limited granules; scroll-like thin lamellae
heparin, eosinophil chemotactic factors (ECF), histamine;
leukotriene, slow-reacting substance(SRS)
 - ❑ **Function:** allergic reactions
-

Mast cells



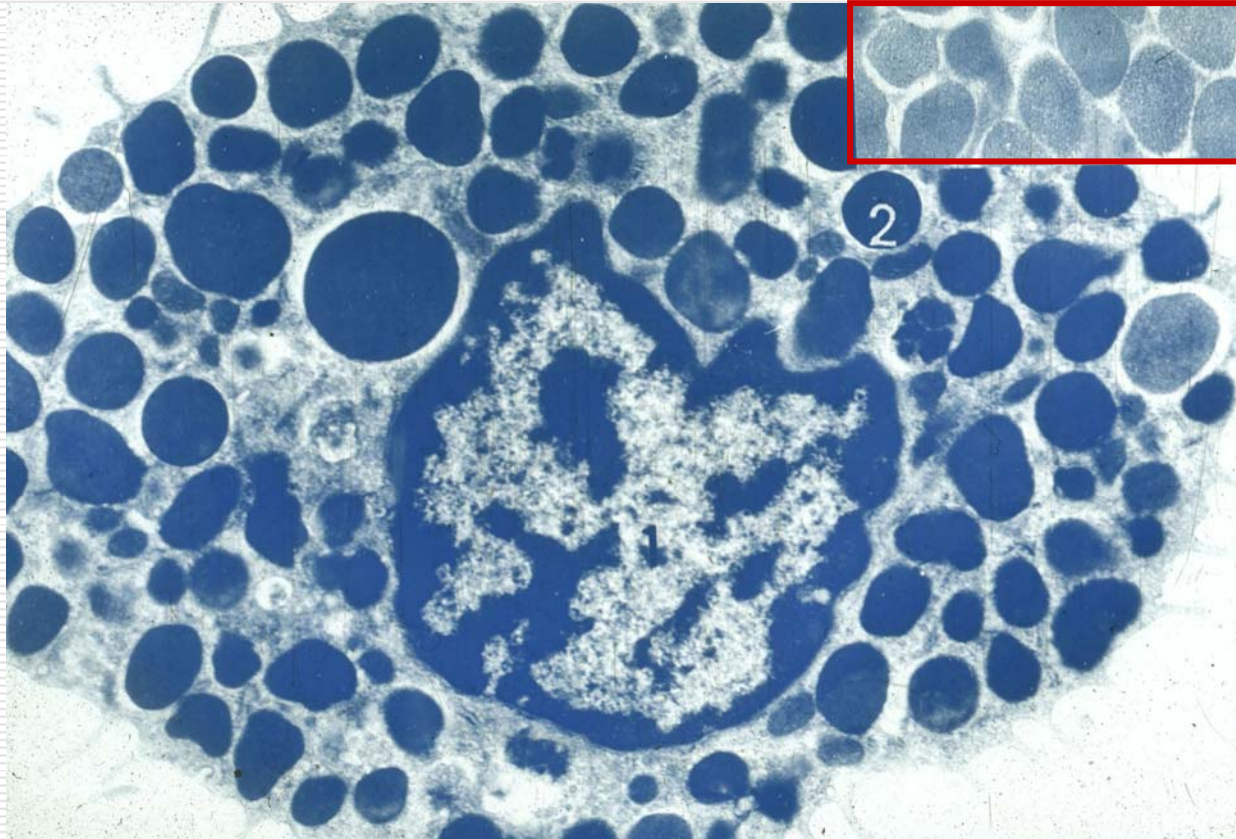
Many mast cell walk along the capillaries like fish.

Mast cells



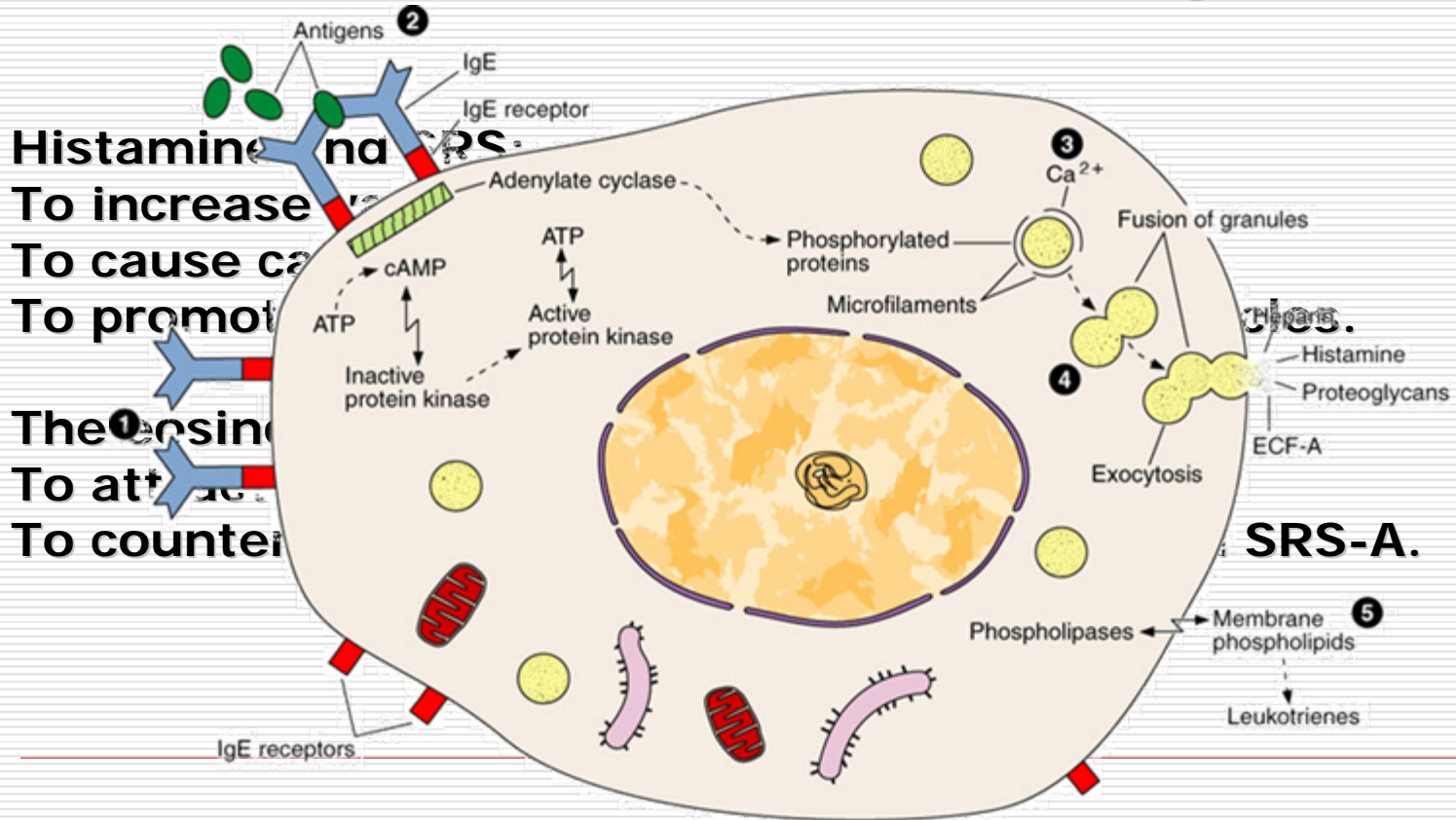
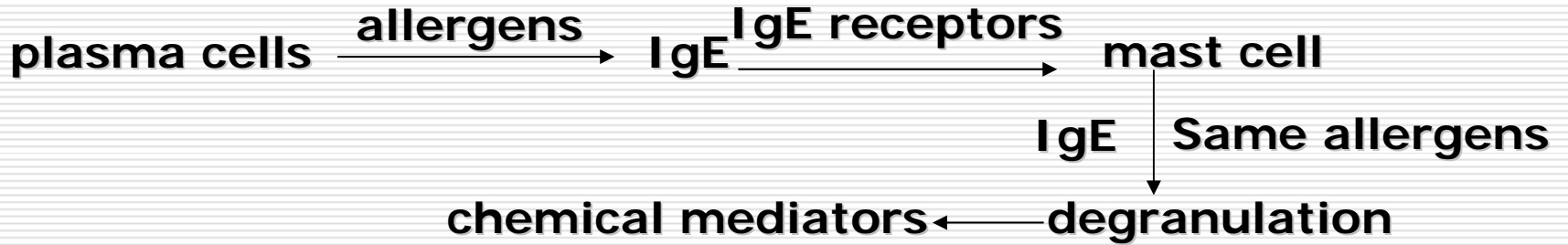
large, ovoid or round in shape;
small and pale nucleus covered by coarse basophilic
granules

Mast cell



The rectangle show one magnified granule with many scroll- like subunits inside.

Function of mast cells



Histamine
To increase
To cause ca
To promot
The binding
To att
To counter

ECF-A
SRS-A.

Mast cells



Degranulated mast cell presents basophilic cytoplasm and small round nucleus.

1.5 Fat cells (Adipose cells)

□ Distribution

- Along blood vessels
- Singly or in groups

□ Structure

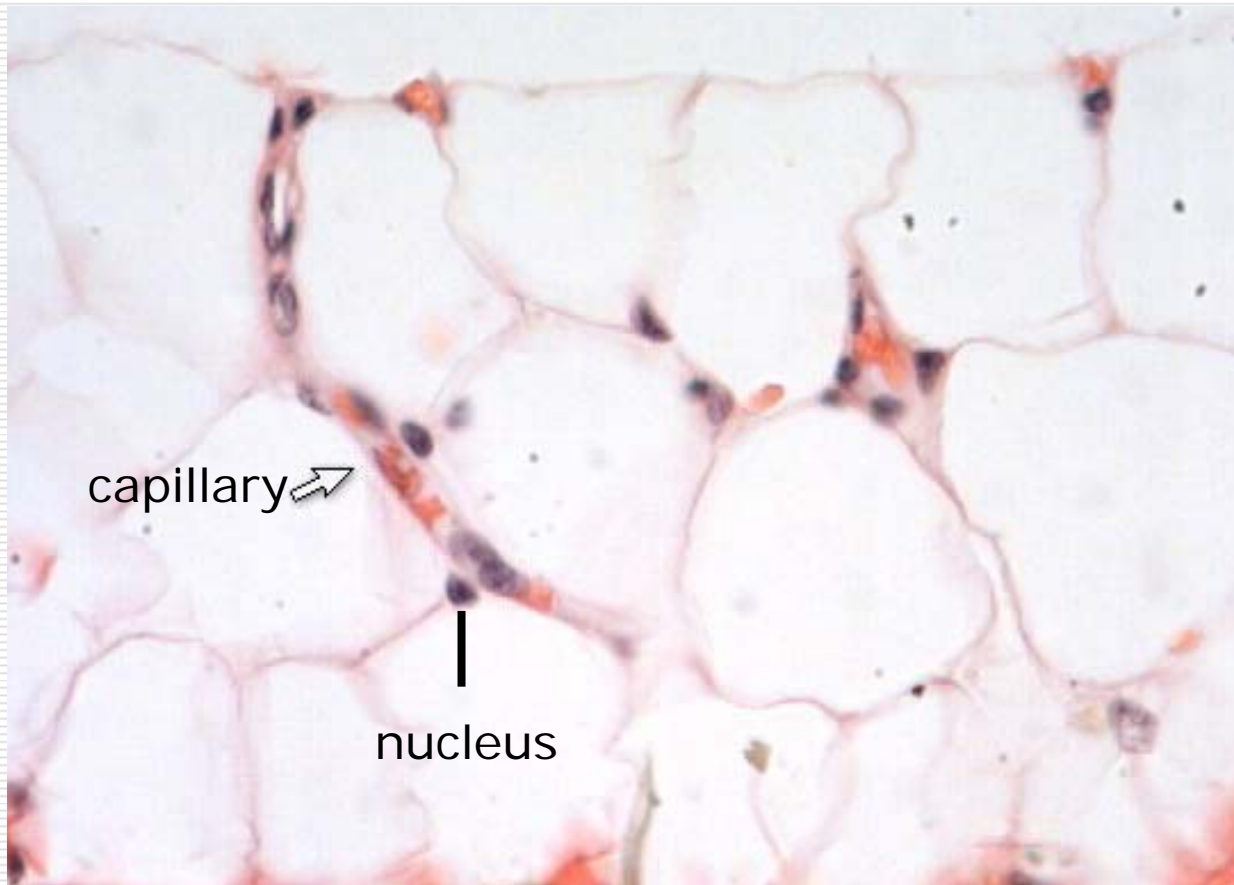
- A single large lipid droplet
- Nucleus appears flattened
- Cytoplasm becomes a thin rim

□ Function

- Synthesis and storage of lipid

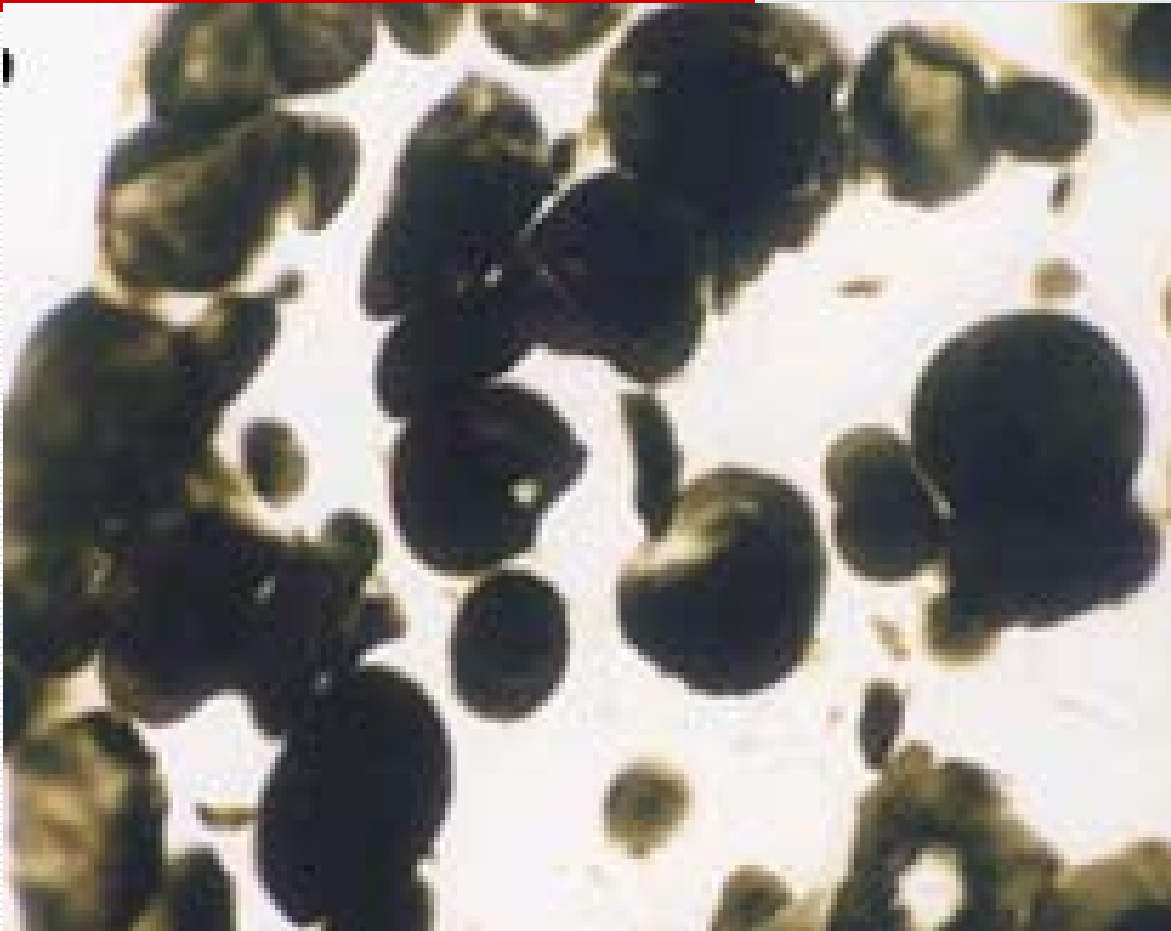


Fat cells



A single large lipid droplet
Nucleus appears flattened
Cytoplasm becomes a thin rim HE

Fat cells

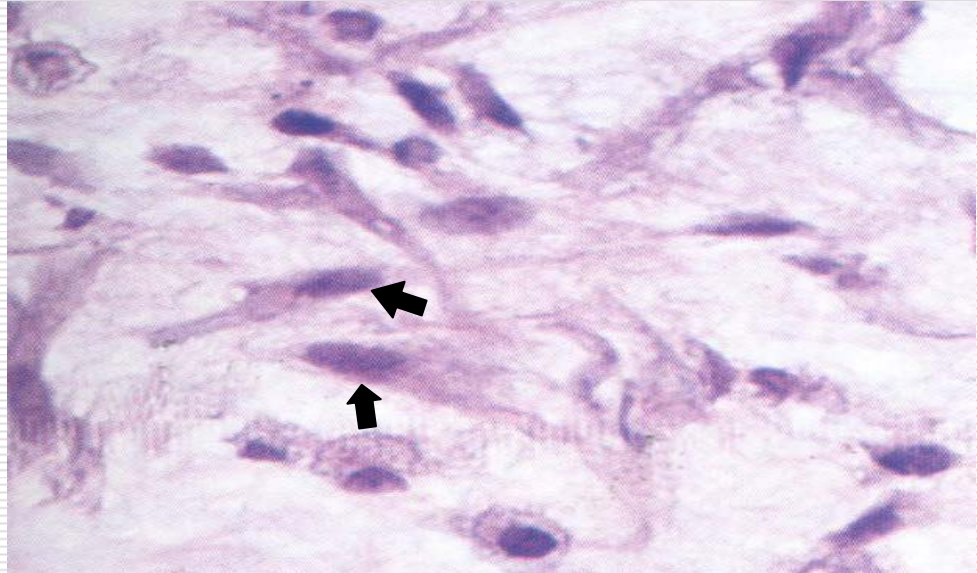


If the specimens are fixed and stained with osmic acid, the fat drop appears as black or brown globules,

1.6 Undifferentiated mesenchymal cells

□ Structure

- Stellate
- fusiform



□ Function

- developmental multipotentiality of embryonic mesenchymal cells
 - Differentiate into various cells of connective tissue
-

1.7 Leukocytes

Cell-types

- Neutrophils
- Eosinophils
- Lymphocytes
- Monocytes

Functions

- Defense and protection
-

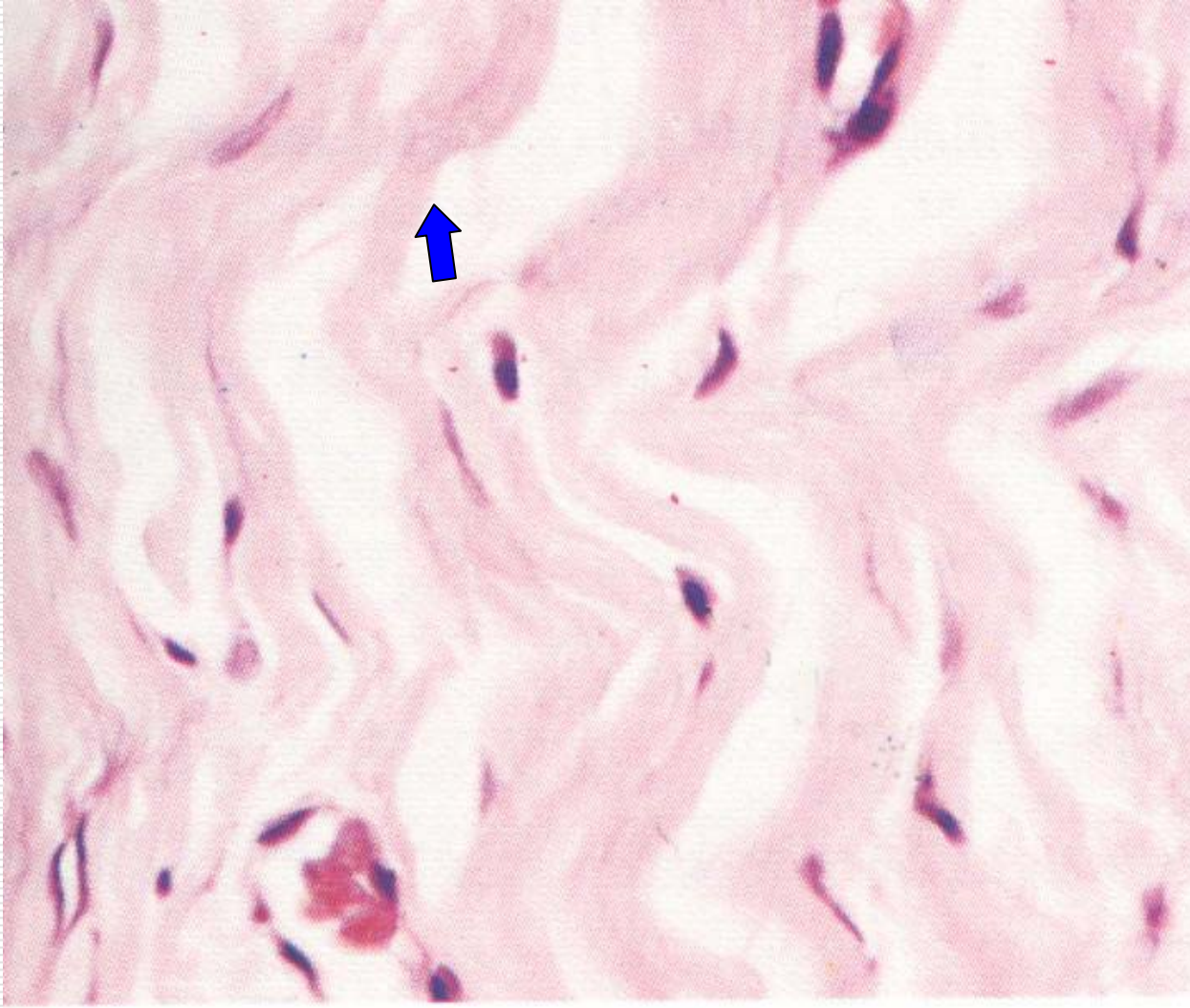
2. Fibers

- Collagenous fibers
 - Elastic fibers
 - Reticular fibers
-

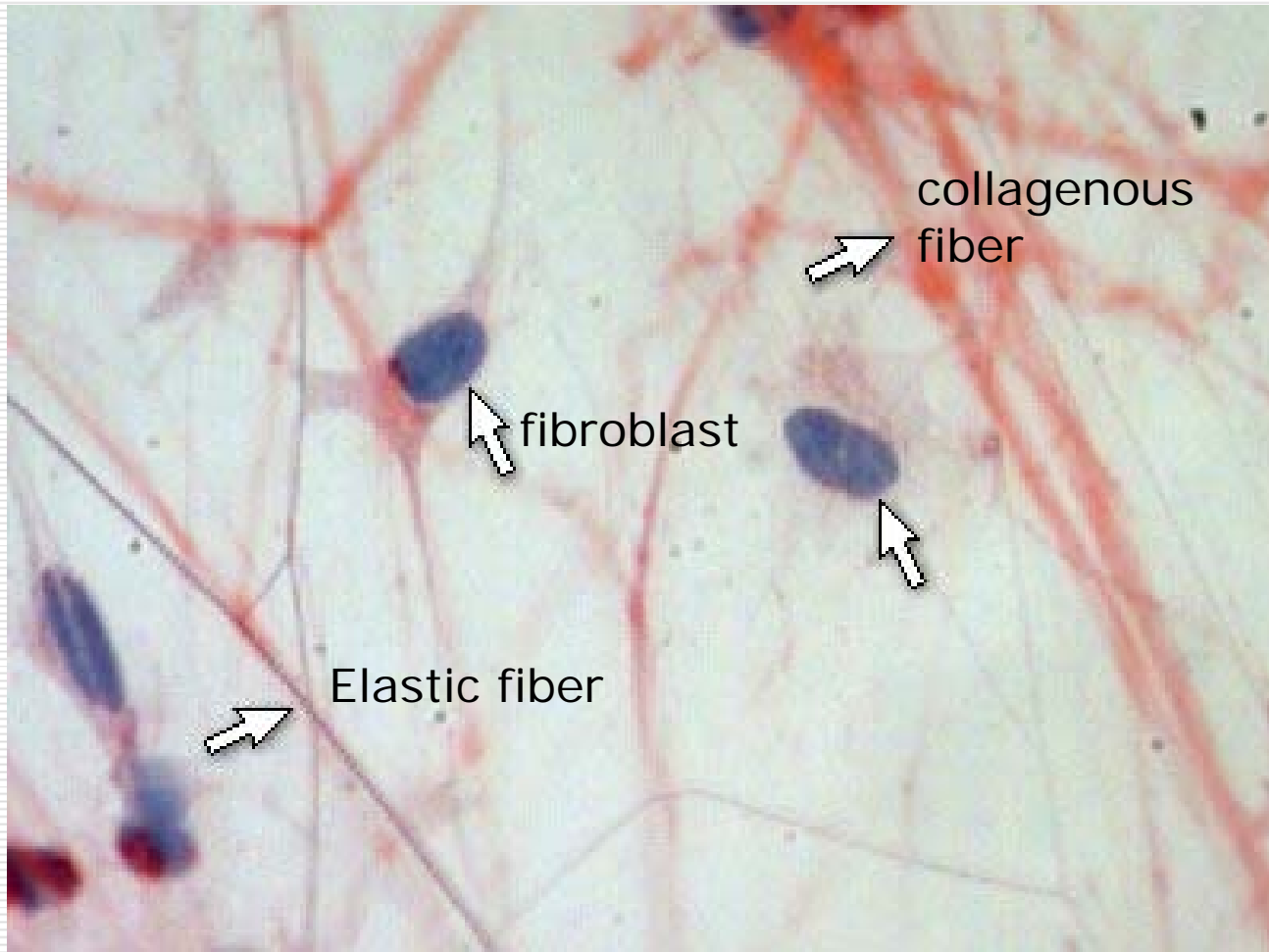
2.1 Collagenous fibers

- **White fibers, bundles, branches, interlace**
 - **Structure**
 - **LM: pink; collagenous fibrils**
 - **EM: periodic transverse striations**
fibrils aligned in a parallel direction
 - **Chemical component**
 - **Collagen (type I , II and III)**
 - **produced by fibroblasts**
 - **Function**
 - **Resistance to tension**
 - **To keep the shape of the organs**
-

Collagenous fibers

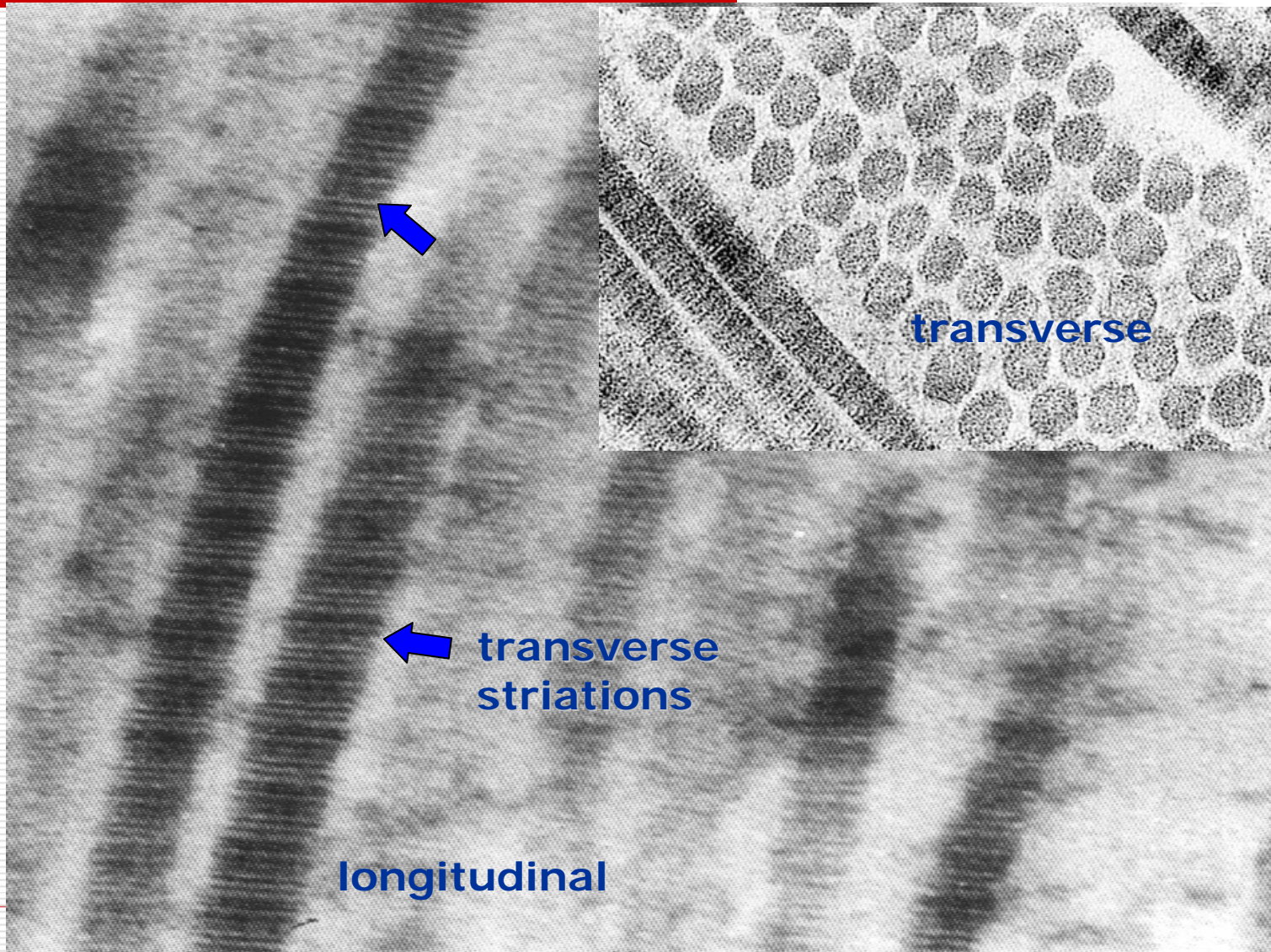


Collagenous fibers



HE and aldehyde-fuchsin staining

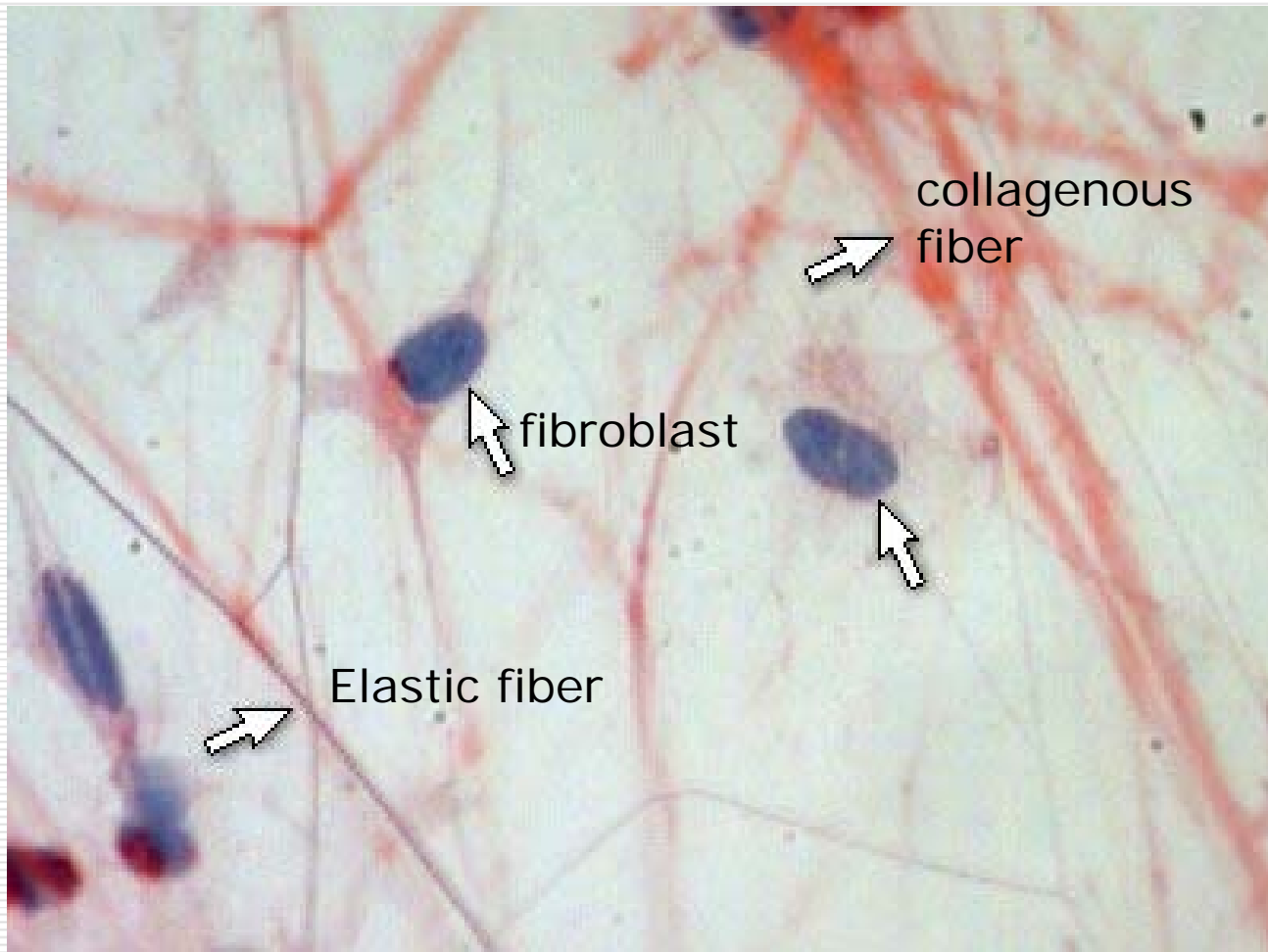
Collagenous fibers



2.2 Elastic fibers

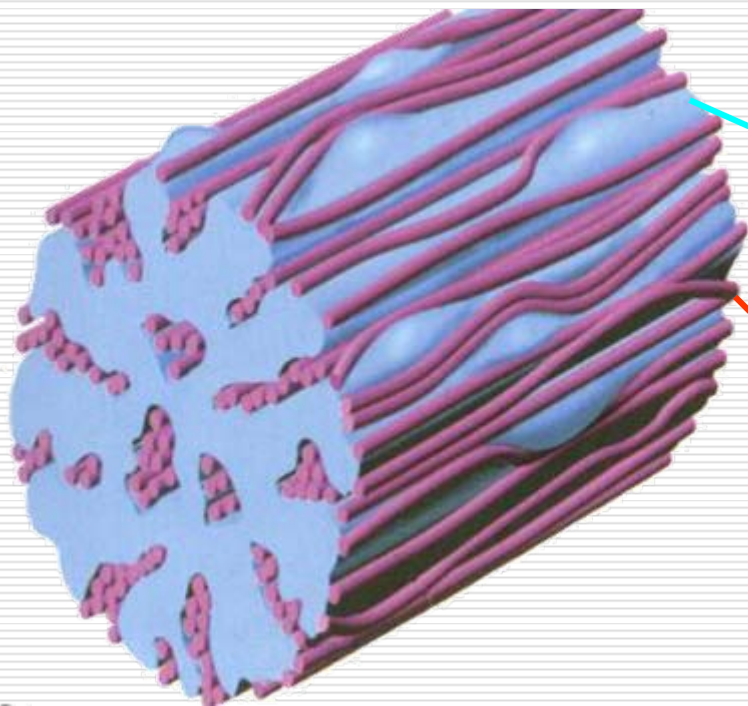
- **Yellow fibers**
 - **Structure**
 - **LM**
 - **Solitary; irregular network;**
 - **weak pink, refractive threads (HE);**
 - **purple (aldehyde-fuchsin)**
 - **EM**
 - **Elastin and Microfibrils**
 - **Function**
 - **Maintenance of elasticity**
-

Elastic fibers

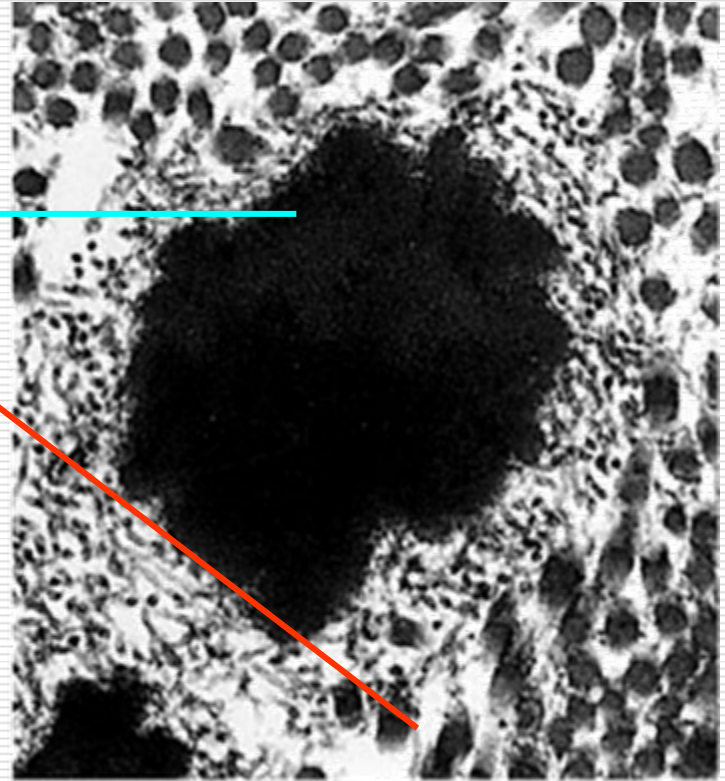


HE & aldehyde-fuchsin staining

Elastic fibers



ideograph

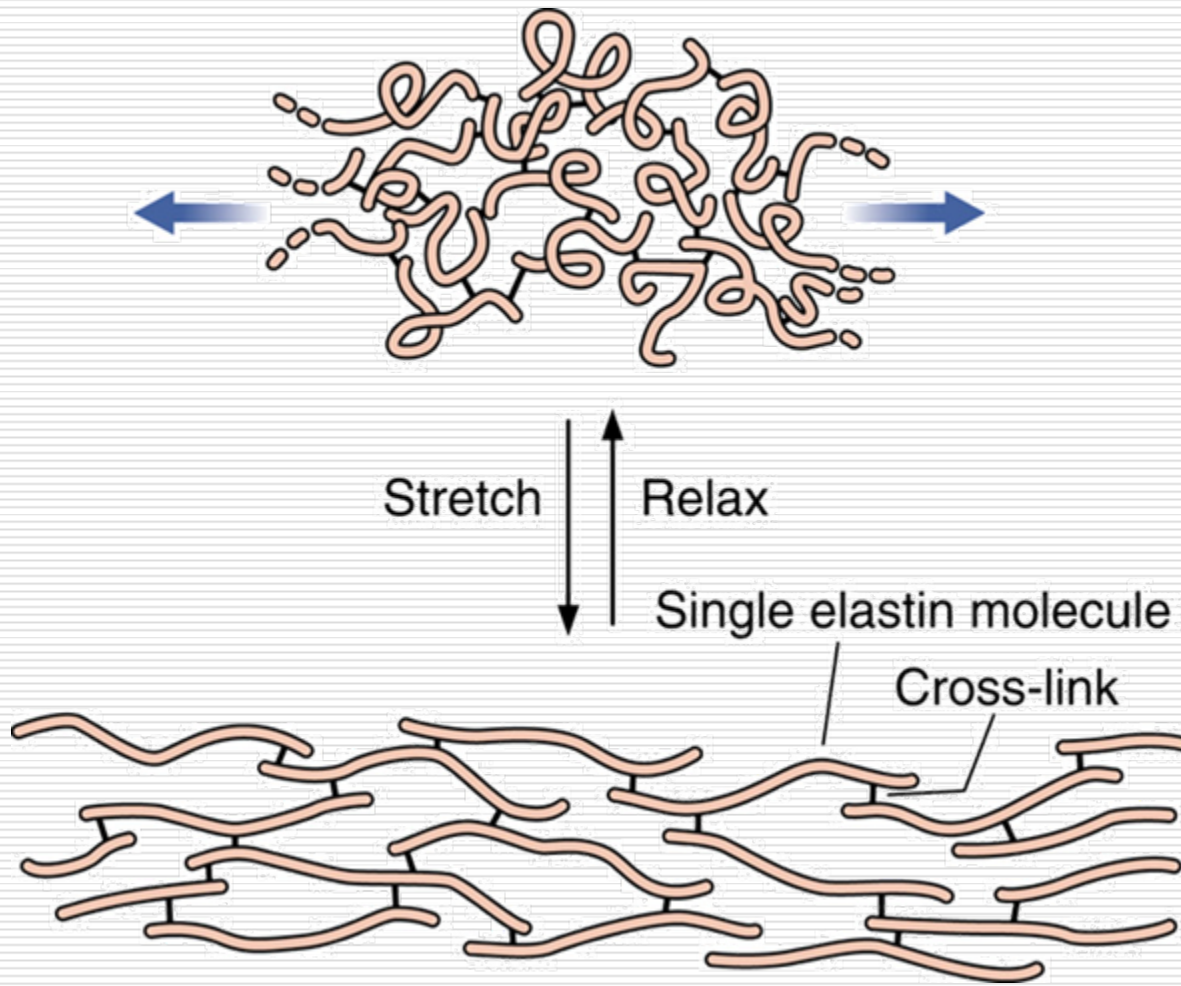


C. Elastic fibers

EM

Elastin is an amorphous substance of varying electron-density, and microfibrils gather in small bundles at the periphery of each fibre.

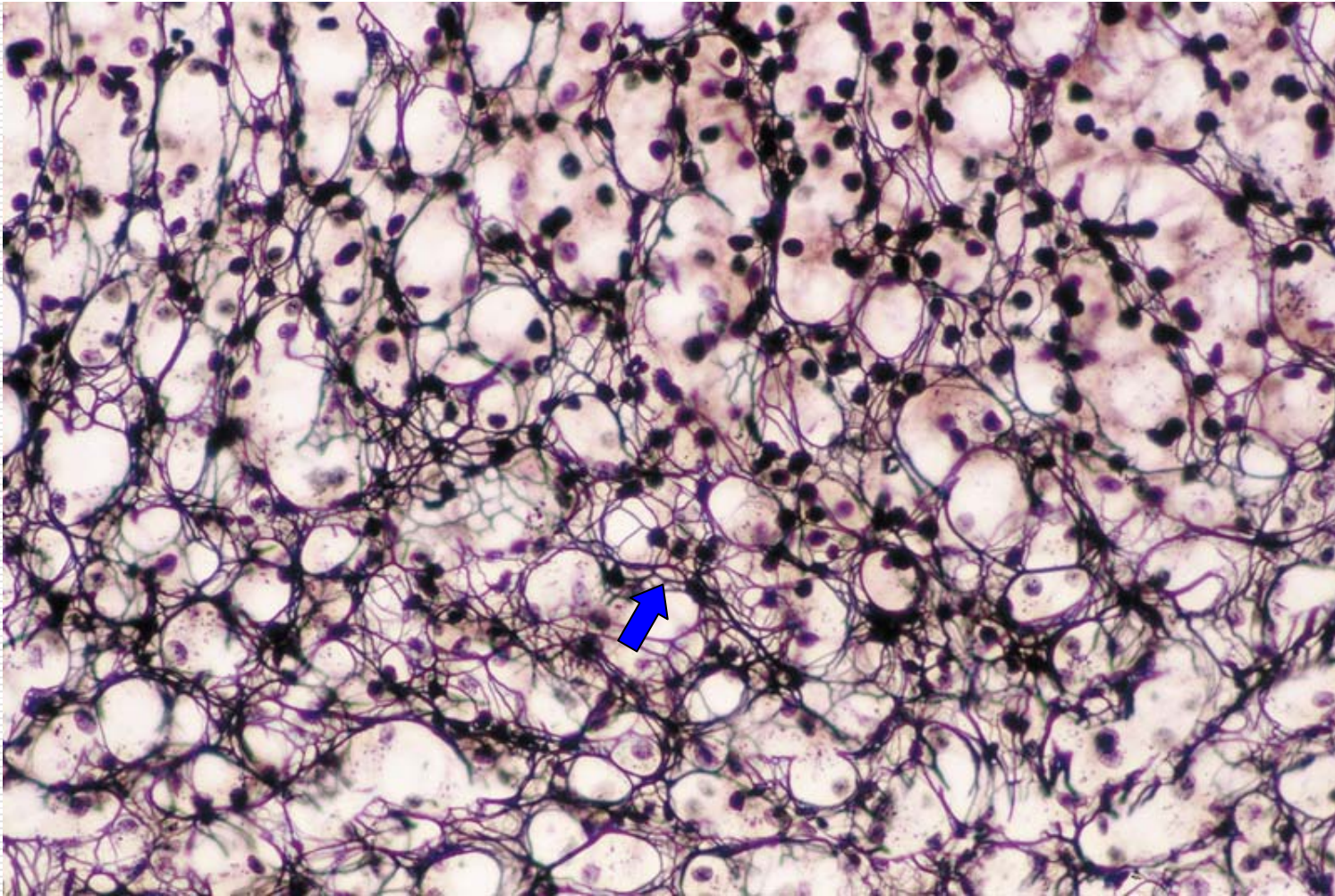
Function of elastic fibres



2.3 Reticular fibers

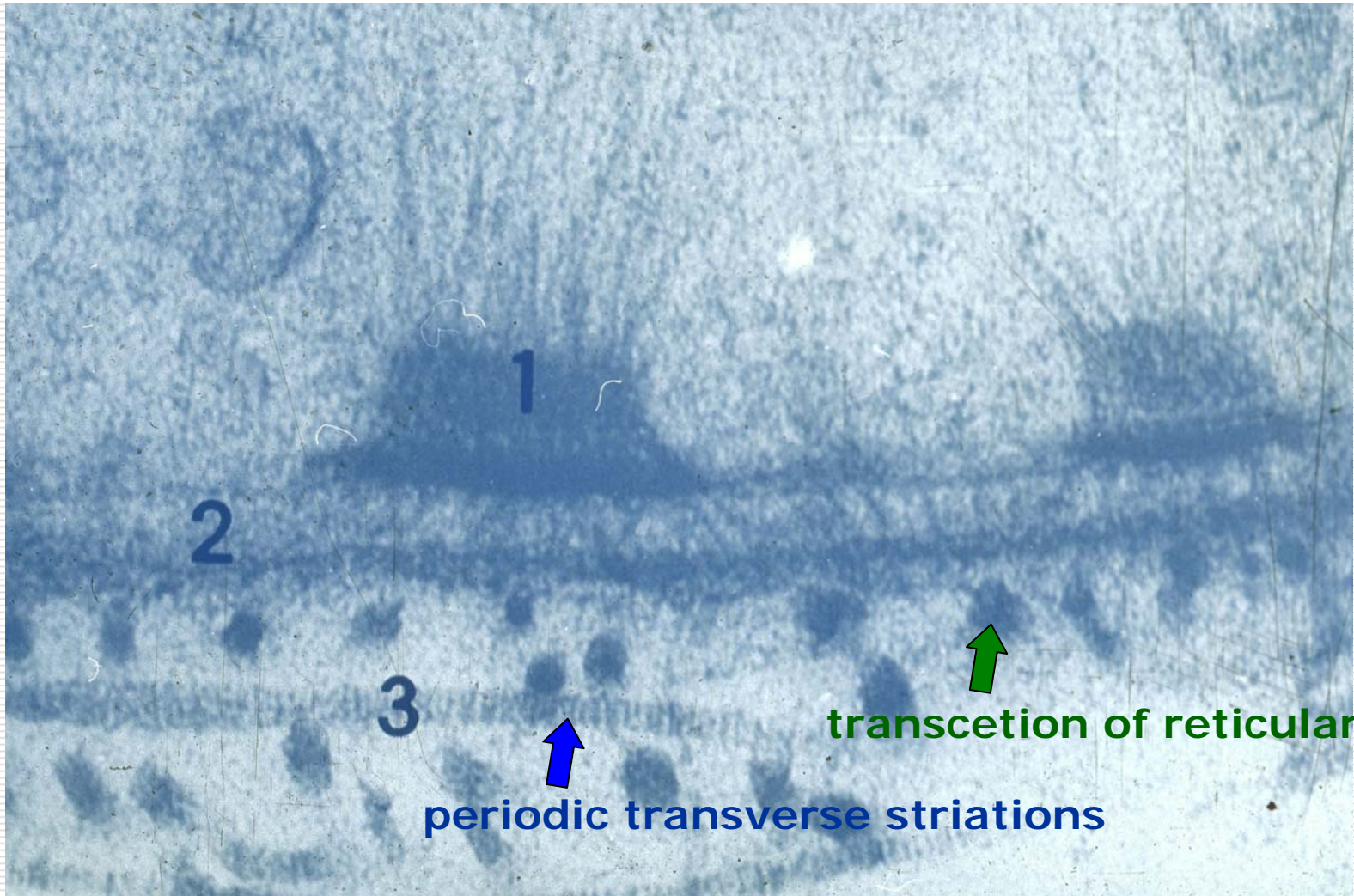
- ❑ **Argyrophil fibers**
 - ❑ **Structure**
 - **LM**: thin collagenous fibers ; delicate net;
black threads (silver slats)
 - **EM**: periodic cross-banding
 - ❑ **Chemical component**
 - Collagen (type III)
 - Carbohydrate
 - ❑ **Function**
 - To create a flexible network in organs that are subjected to changes in form or volume
-

Reticular fibers



Section of an adrenal cortex, silver stained to show reticular fibers.

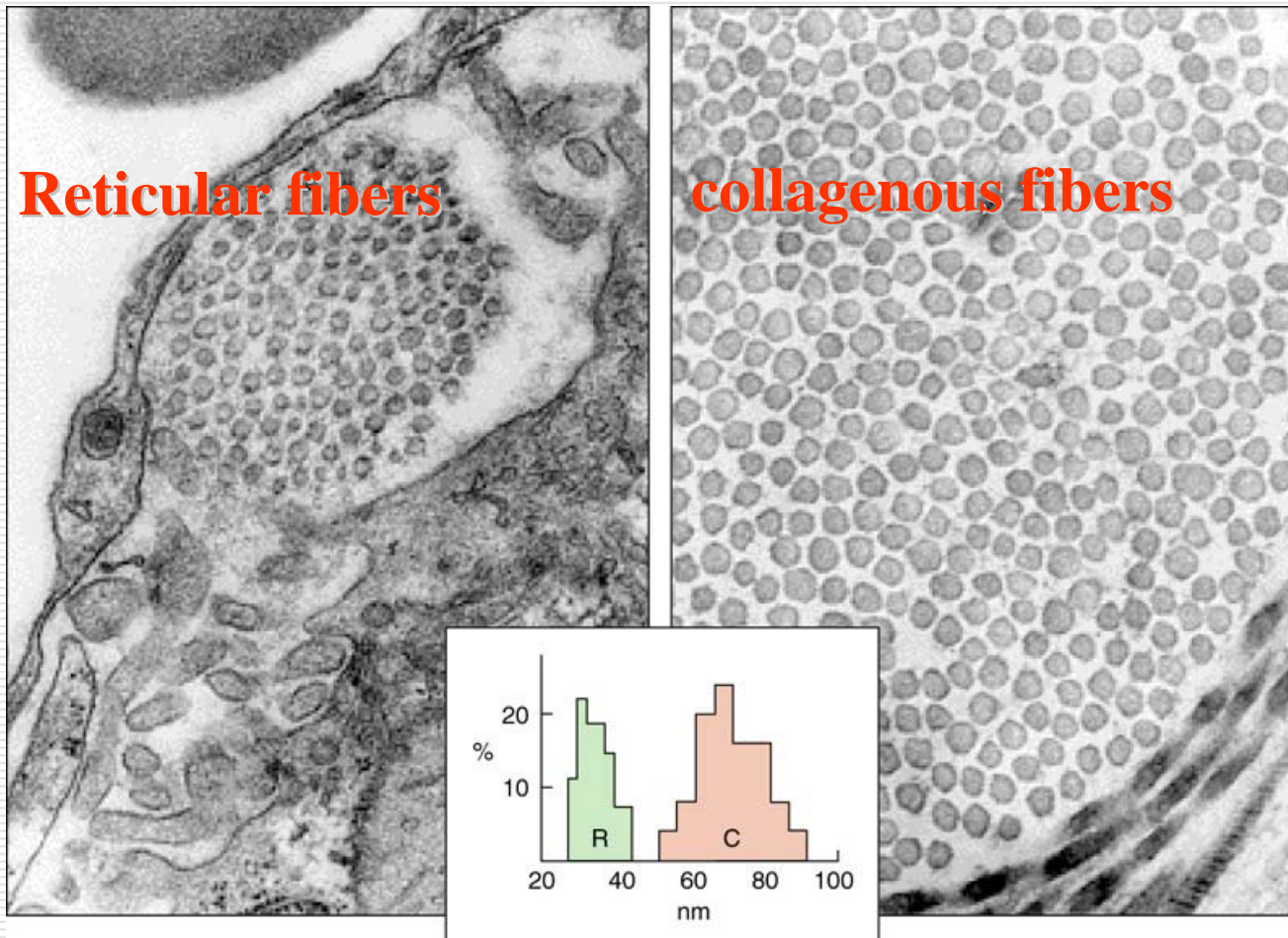
Reticular fibers



periodic transverse striations

transcetion of reticular fiber

Reticular fibers & collagenous fibers



Each fiber type is composed of numerous smaller collagen fibrils. Reticular fibrils are narrower in diameter than collagen fibrils of collagen fibers.

3. Ground substance

- ❑ **jelly-like amorphous homogenous substance**
 - ❑ **lie between the cells and fibres**
 - ❑ **component**
 - **Proteoglycan**
 - **Glycoprotein**
 - **Tissue fluid**
 - ❑ **Function:**
 - **lubricant**
 - **a barrier to the penetration of invaders**
-

3.1 Proteoglycan

□ Structure

- Linear polysaccharide

- Component:

core protein, link protein,

glycosaminoglycans (GAG) : hyaluronic acid,

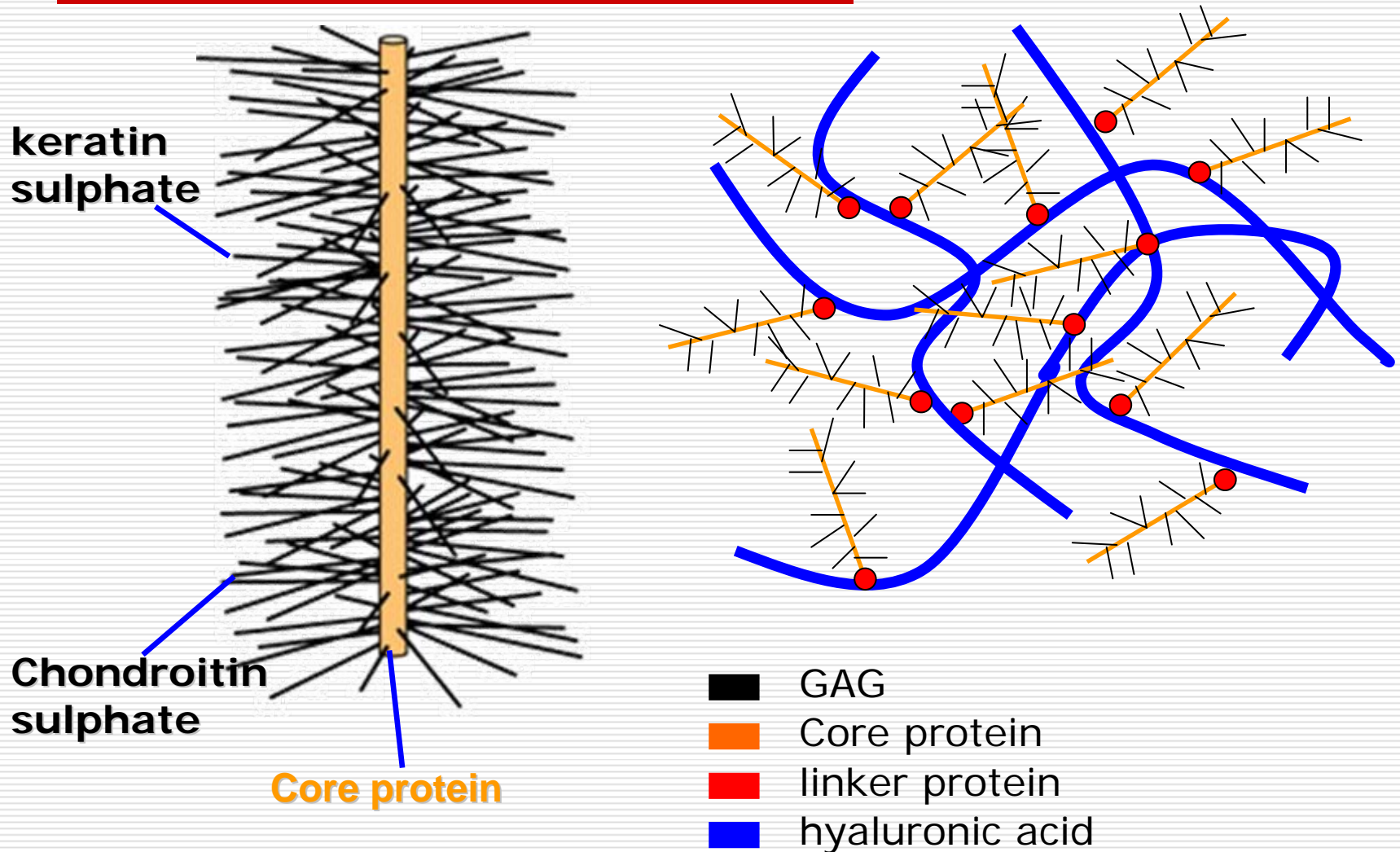
chondroitin sulfate, keratin sulfate, heparan sulfate and dermatan sulphate

□ Functions

- a molecular sieve to exclude or entrap molecules of different sizes

- a physical barrier to prevent the spread of bacteria and other microorganisms.

Structure of proteoglycan and molecular sieve



Proteoglycan unit

molecular sieve

3.2 Glycoprotein

Structure

- **Globular protein**
- **Branched chains of monosaccharides**

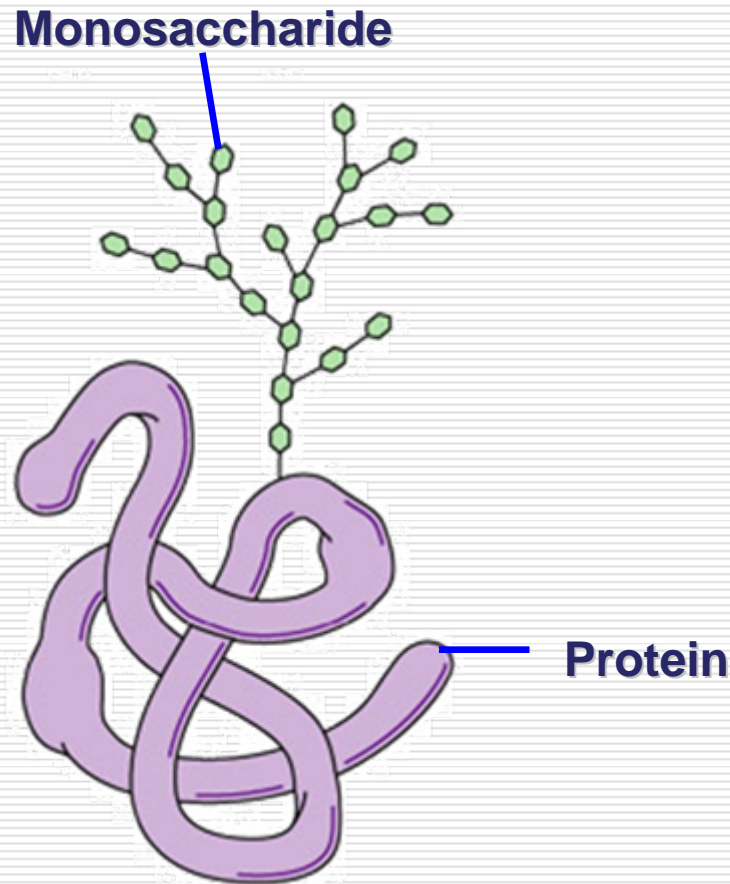
Type

- **Fibronectin**
- **Laminin**

Functions

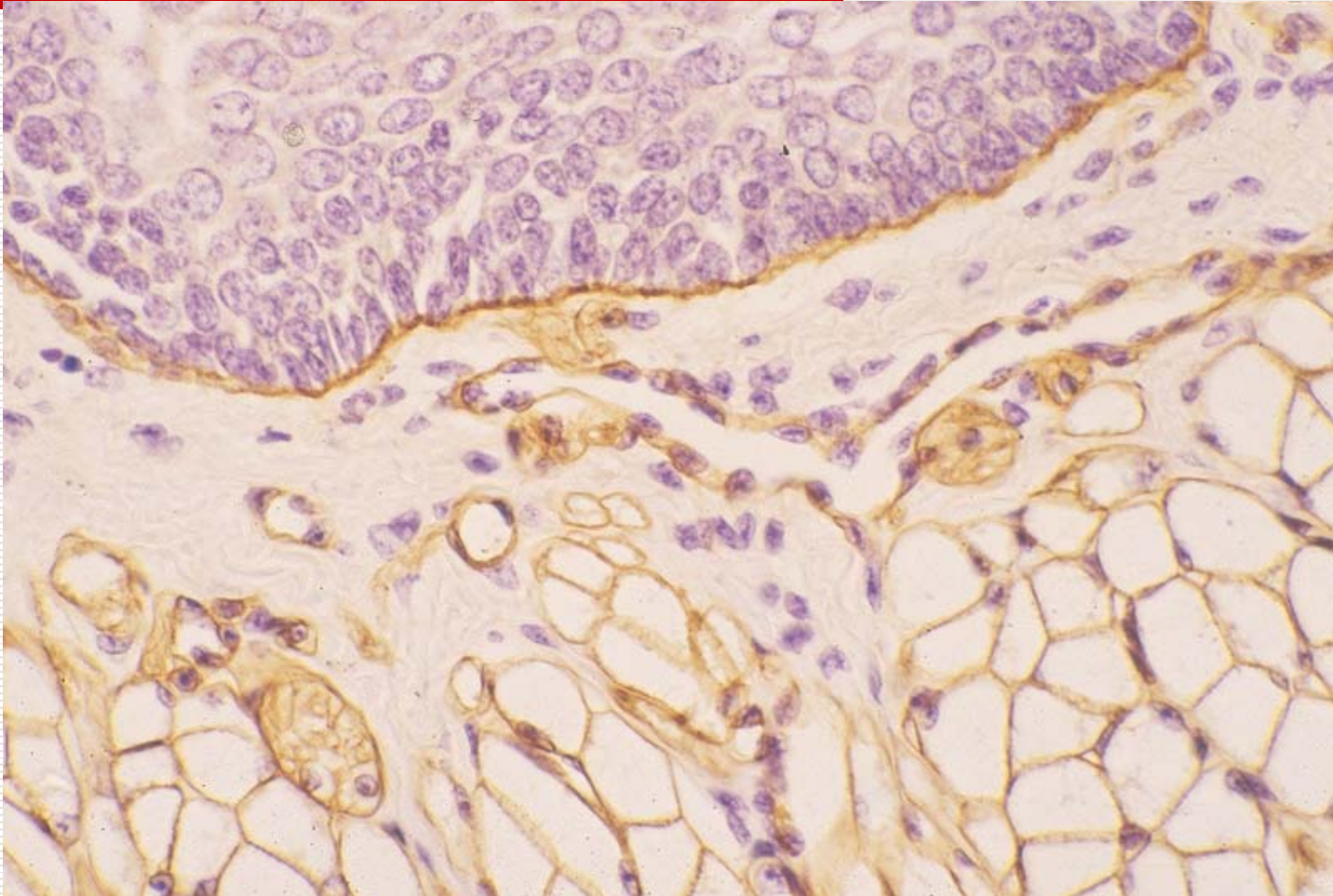
- **Interaction between cells**
 - **Adhesion of cells to their substrate (e.g. laminin)**
-

The molecular structure of glycoproteins



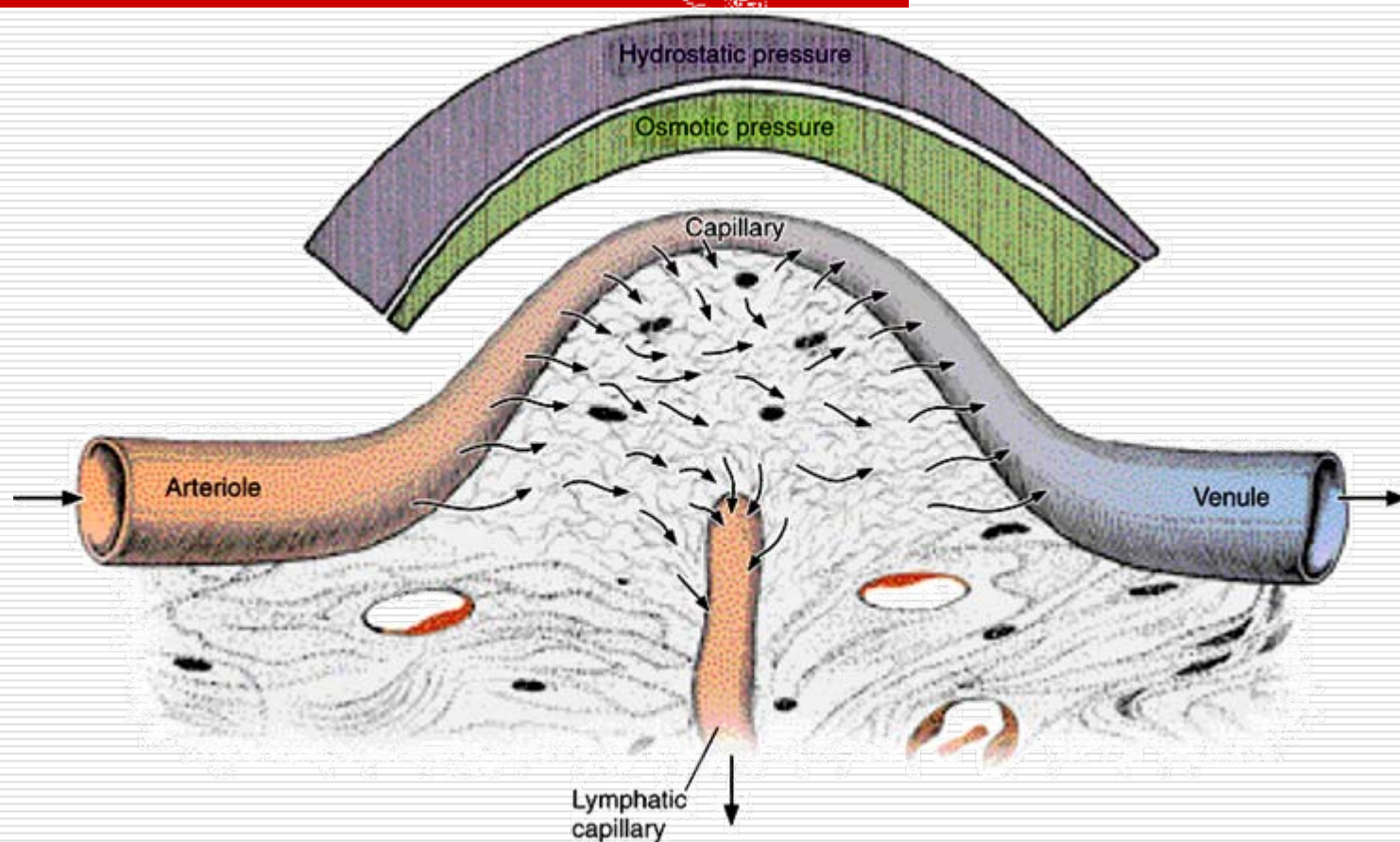
Glycoproteins are globular protein molecules to which branched chains of monosaccharides are covalently attached.

Laminin



Laminin participates in the adhesion of epithelial cells to the basal lamina. Immunocytochemical staining shows laminin in basement membranes.

3.3 Tissue fluid



There is a decrease in hydrostatic pressure and an increase in osmotic pressure from the arterial to the venous ends of blood capillaries.

Fluid leaves the capillary through its arterial end and reenters the blood at the venous end. Some fluid is drained by the lymphatic capillaries.

III. Dense connective tissue

□ Structural characteristics

- Fewer cells
- More collagenous fibers
- Some elastic fibers

□ Classification

- Dense regular connective tissue
- Dense irregular connective tissue
- Elastic tissue

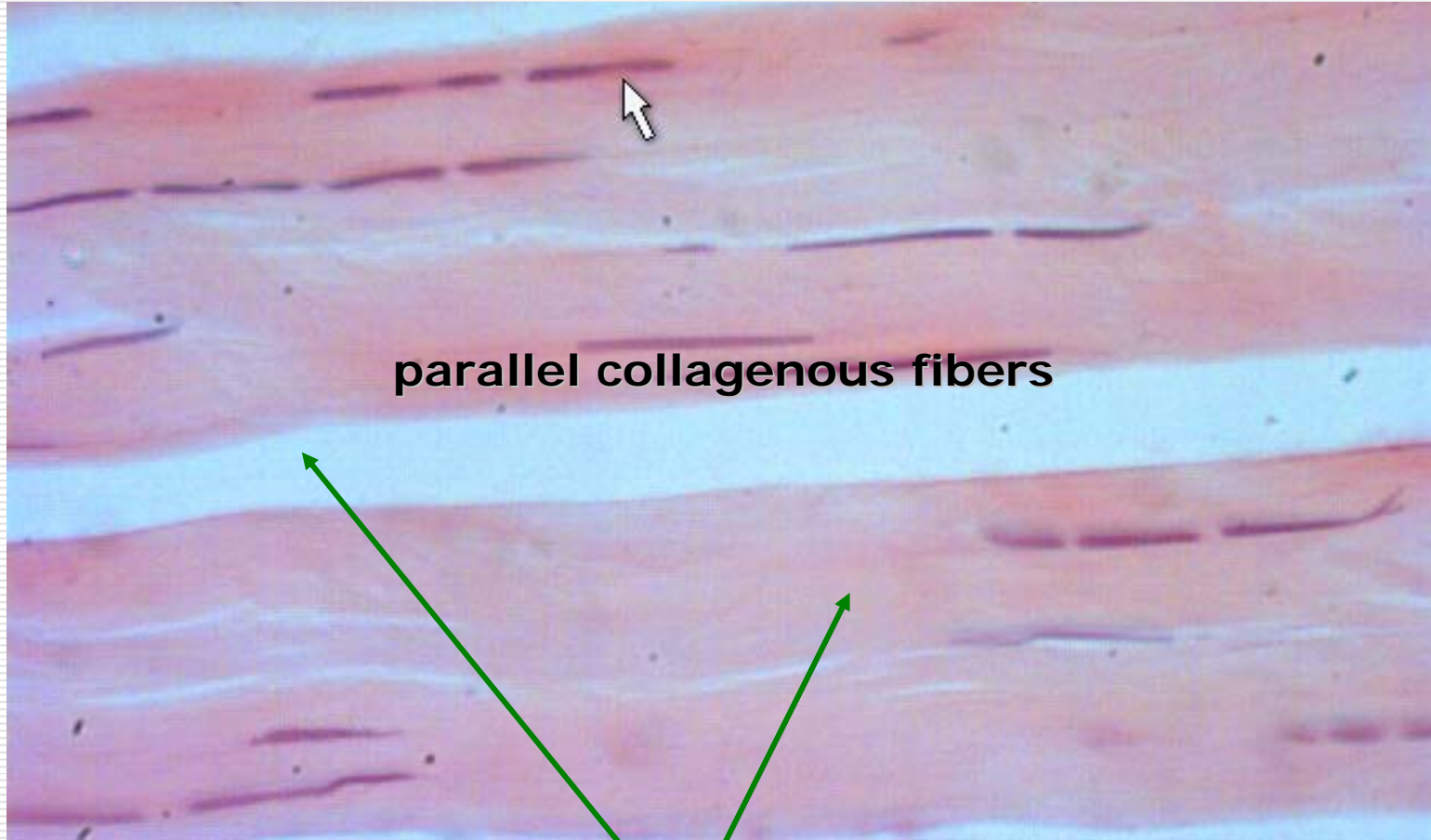
□ Functions

- Resistance and protection
-

1. Dense regular connective tissue

- ❑ **Distribution: tendons, ligaments, cornea.**
 - ❑ **Structural characteristics**
 - **Bundles of parallel collagenous fibers**
 - **A small quantity of ground substance**
 - **Fibroblasts**
 - ❑ **Function**
 - **Resist stresses in the same direction**
 - **Offer resistance to traction forces**
-

Dense regular connective tissue



parallel collagenous fibers

tendon cells

2. Dense irregular connective tissue

□ Distribution:

- Dermis, capsules surrounding organs,
- Periosteum, perichondrium.

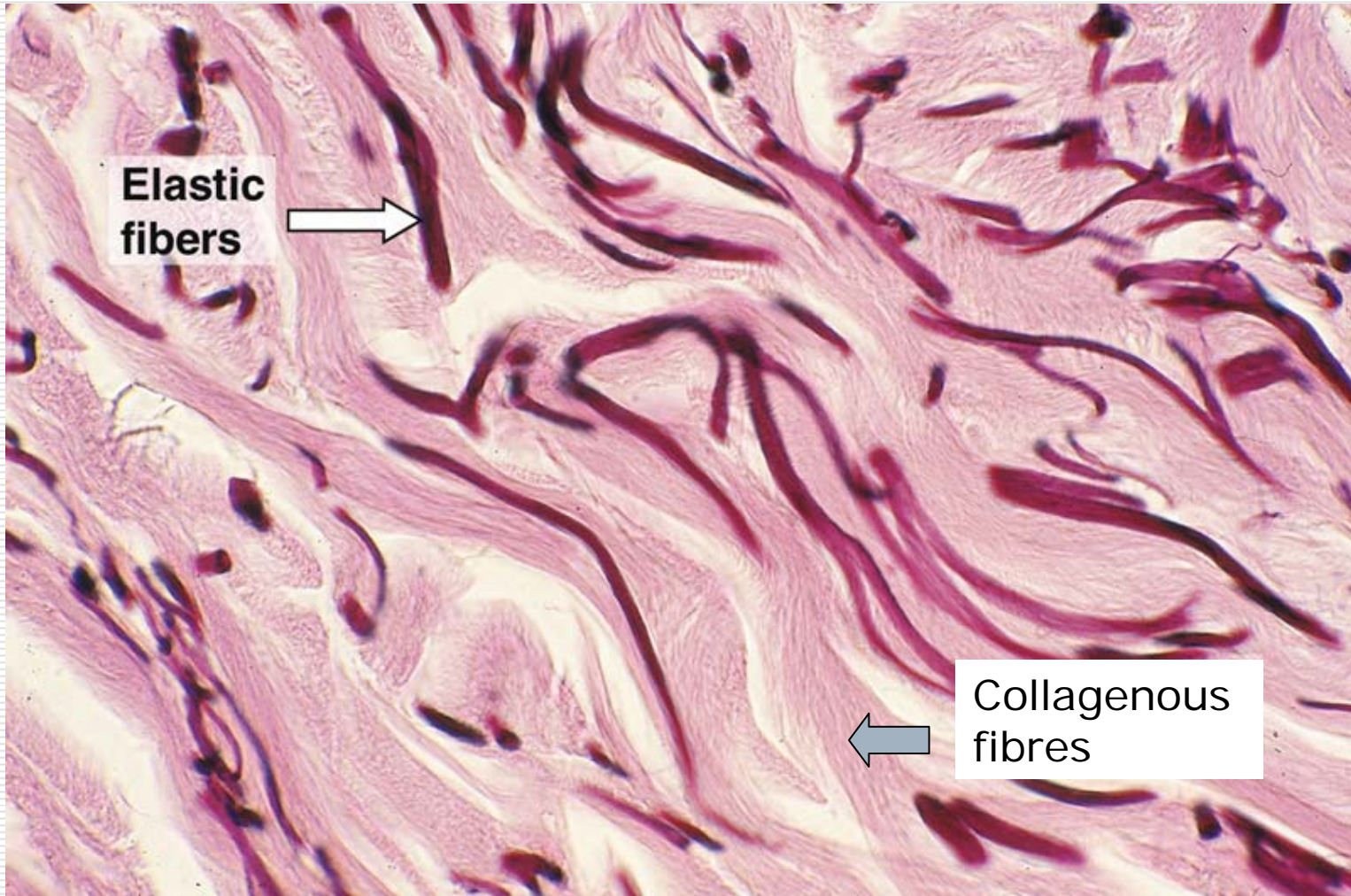
□ Structural characteristics

- Collagenous fibers facing different directions
- 3 -dimensional network

□ Function

- Resist stress from all directions
-

Dense irregular connective tissue



Dermis

HE and aldehyde-fuchsin staining

3. Elastic tissue

□ Distribution:

- yellow ligaments of the vertebral column
- suspensory ligament of the penis

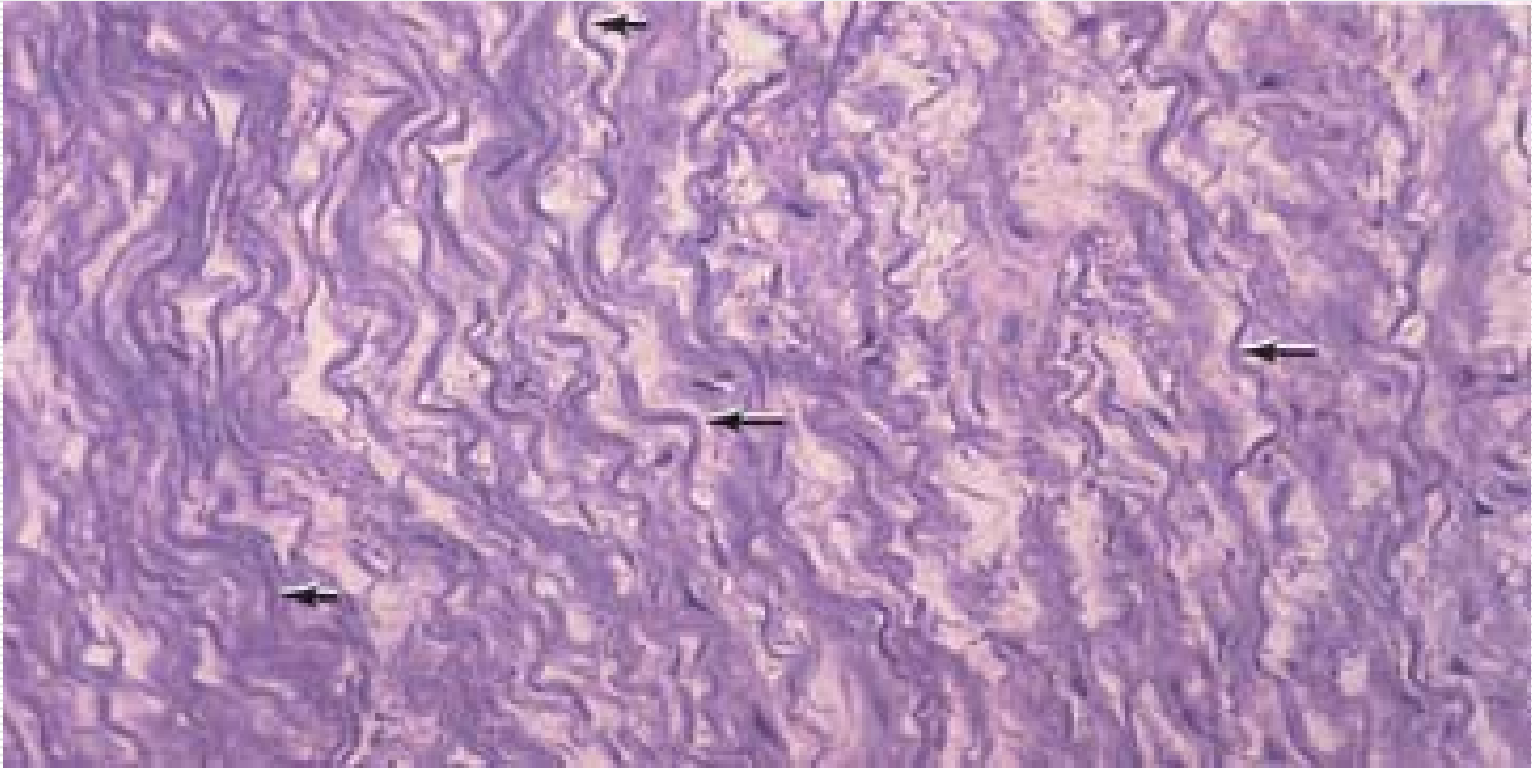
□ Structural characteristics

- Thick, parallel elastic fibers
- Thin collagen fibers
- Flattened fibroblasts

□ Function

- Elasticity
-

Elastic tissue



Elastic tissue

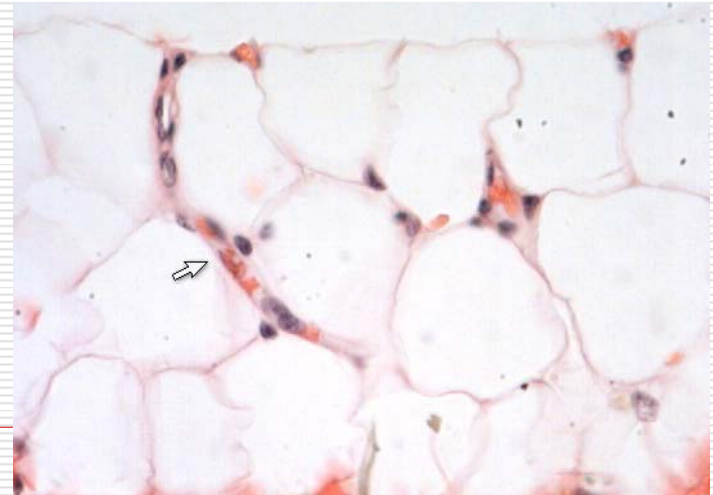
aldehyde-fuchsin staining

IV. Adipose tissue

- **Structural characteristics**
 - Fat cells form large aggregations
 - Lobule, septa, rich in blood supply
 - **Distribution**
 - mesentery, hypodermis, perirenal region
 - **Classification**
 - Unilocular (common or yellow) adipose tissue
 - Multilocular (brown) adipose tissue
 - **Functions**
 - Metabolic energy reservoir
 - Shock-absorbent padding
 - Insulating layer to conserve body heat
-

Unilocular(yellow or common) adipose tissue

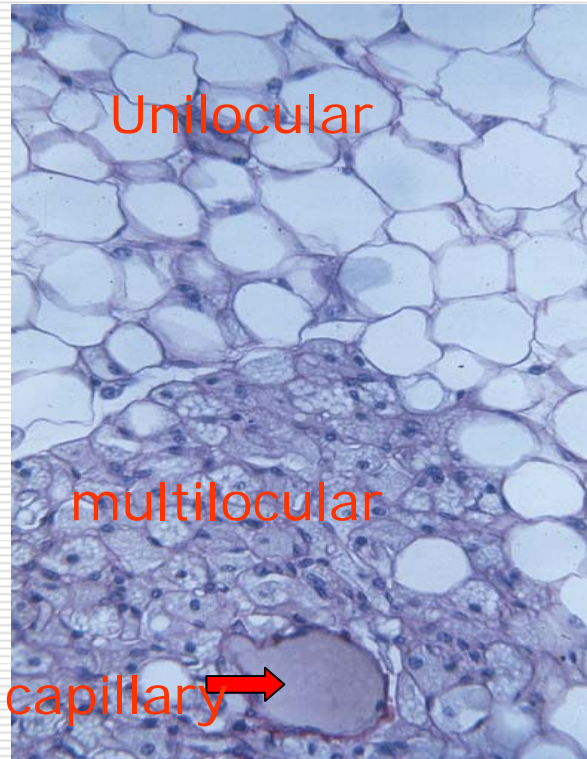
- Distribution : adults**
- Fat cells**
 - One large central lipid droplet**
 - A thin ring of cytoplasm**
 - Eccentric and flattened nucleus**
- Function**
 - large depot of energy**



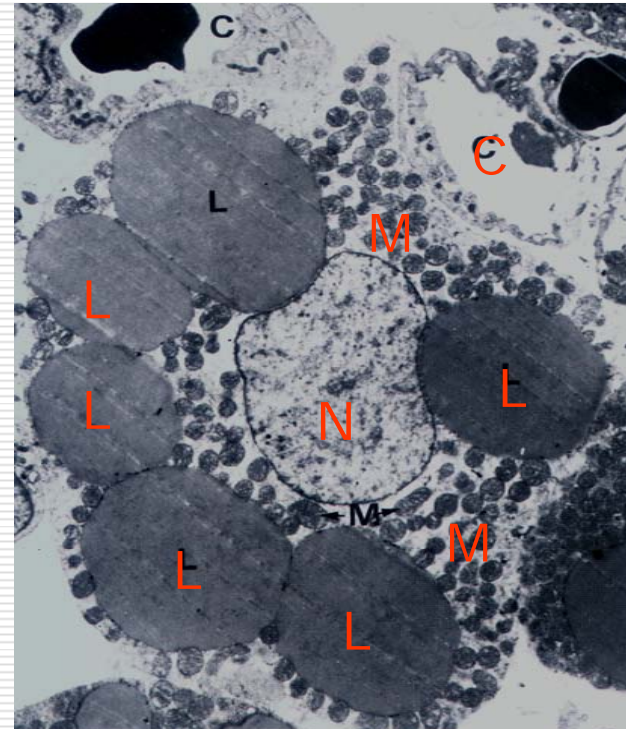
Brown (multilocular) adipose tissue

- Distribution: human embryo and newborn**
 - Fat cells**
 - Numerous small lipid droplets**
 - Abundant brown mitochondria (containing colored cytochromes)**
 - Spherical and central nucleus**
 - Functions**
 - produce heat**
-

Brown adipose tissue



PT stain



EM

many small lipid droplets;
Abundant mitochondria;
 round central nucleus

V. Reticular tissue

Distribution:

- lymphatic organs
- bone marrow

Reticular cells

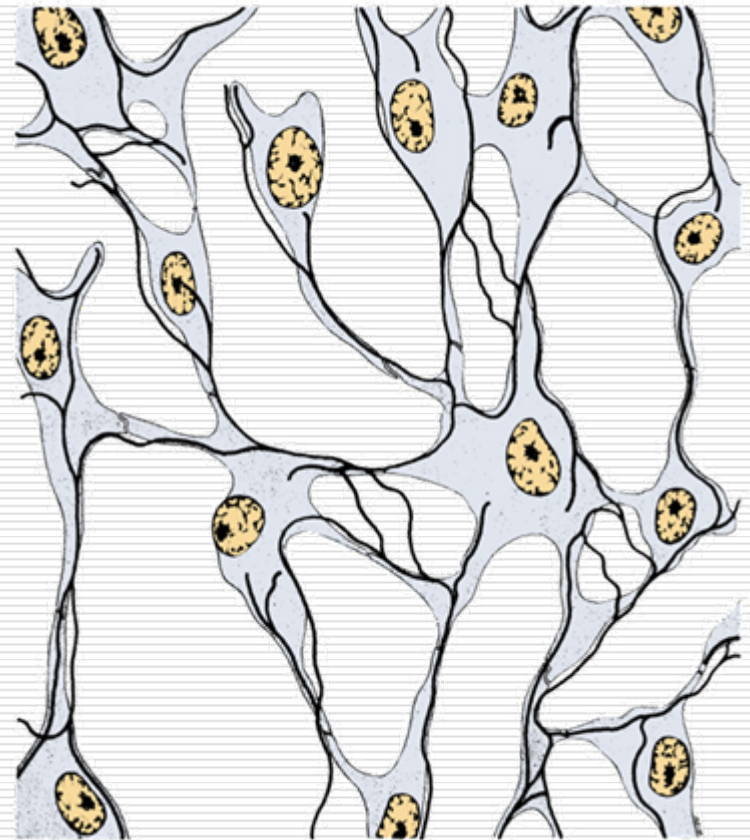
- Stellate

Reticular fibers

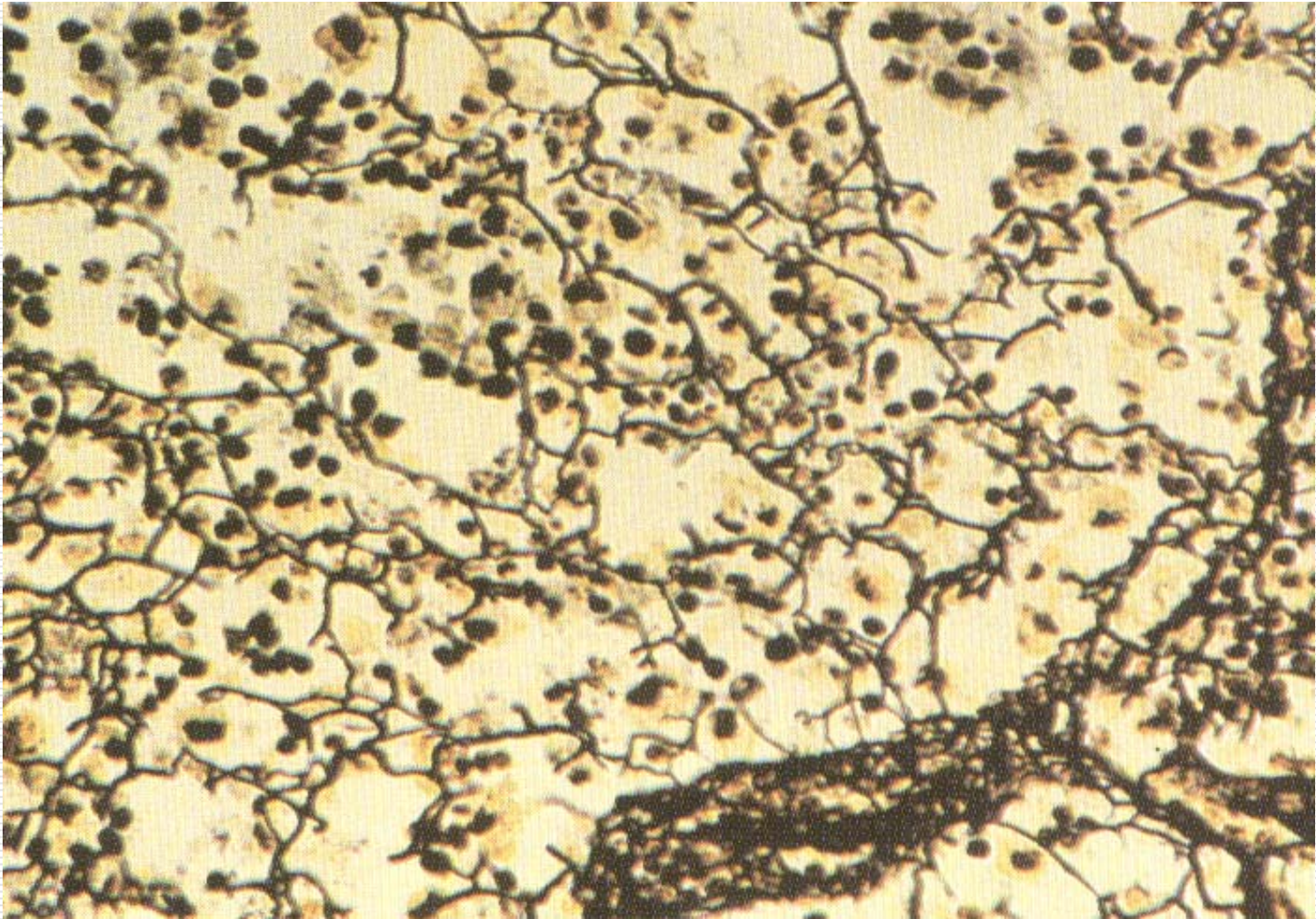
- Fibrillar network

Function

- architectural framework
- a special microenvironment for



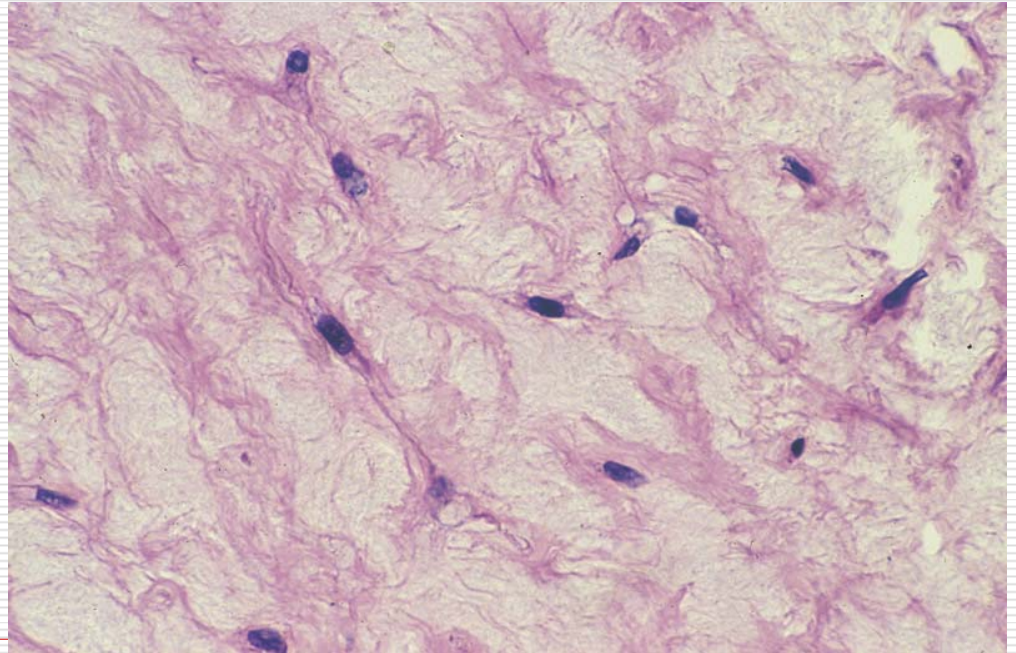
Reticular tissue



Section of an lymphatic tissue, silver stained to show reticular tissue

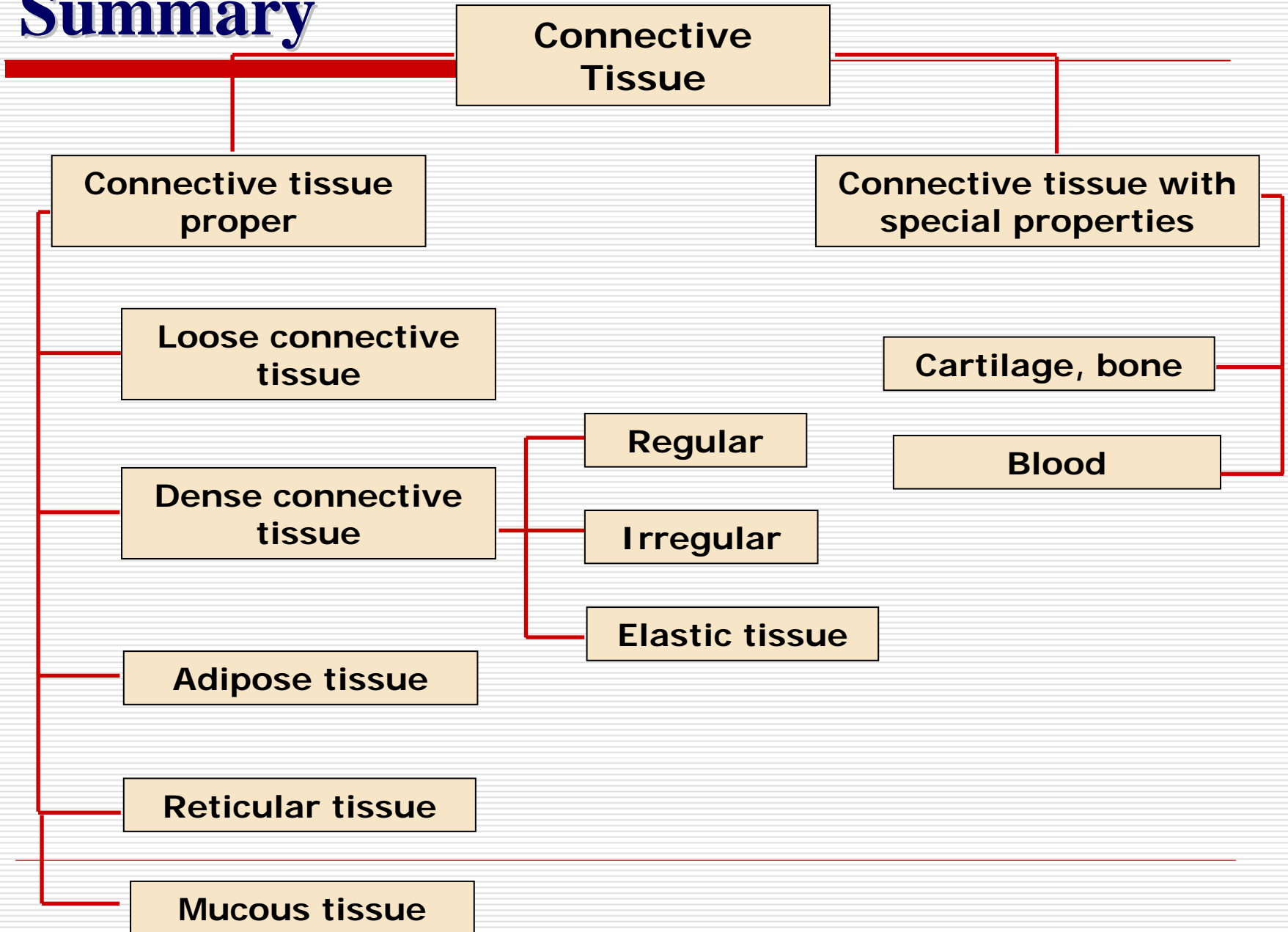
Mucous tissue

- ❑ **Distribution: umbilical cord**
- ❑ **Component**
 - **abundant ground substance hyaluronic acid**
 - **few fibres**
 - **Fibroblasts**



Fibroblasts immersed in a very loose extracellular matrix.

Summary



Summary

- Master the structure and functions of main cells in loose connective tissue.**
 - Understand the structure and functions of fibers and ground substance in connective tissue.**
 - Understand the features and classification of connective tissue.**
 - Know the structural characteristics and functions of dense connective tissue, adipose tissue and reticular tissue.**
-