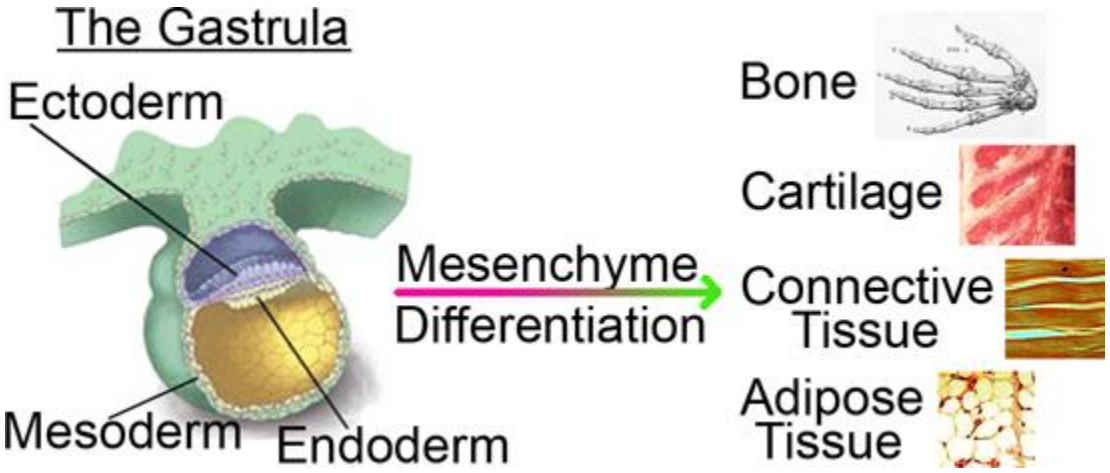
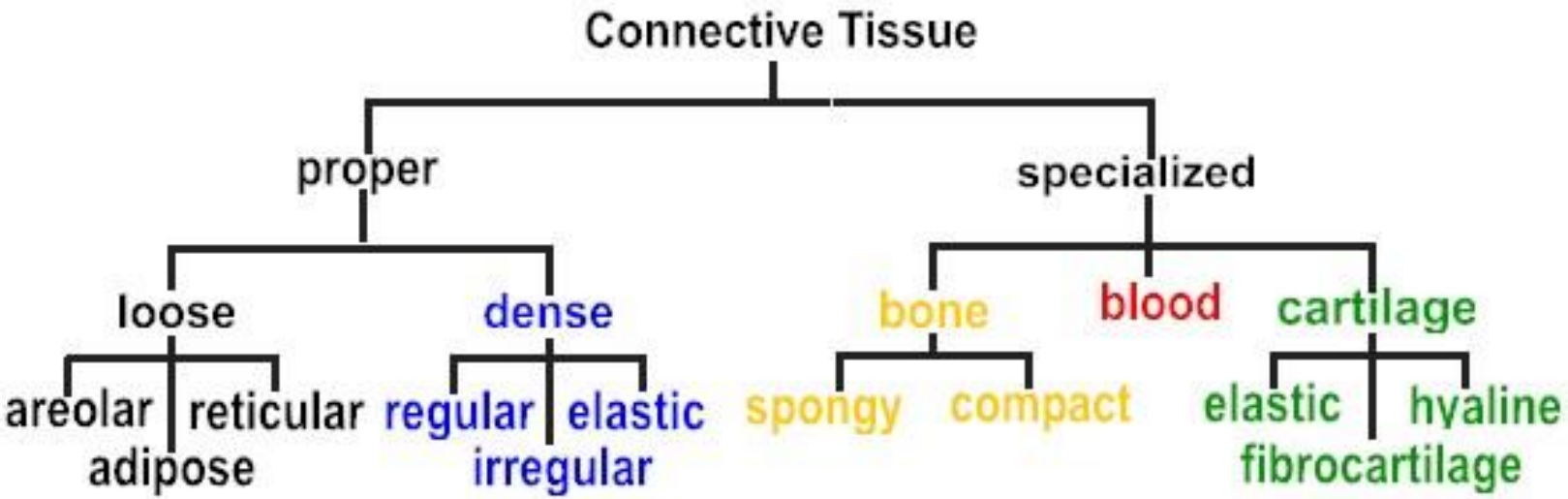
CONNECTIVE TISSUE PROPER

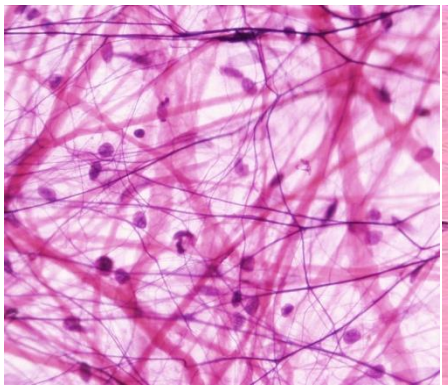
FUNCTION OF CONNECTIVE TISSUE

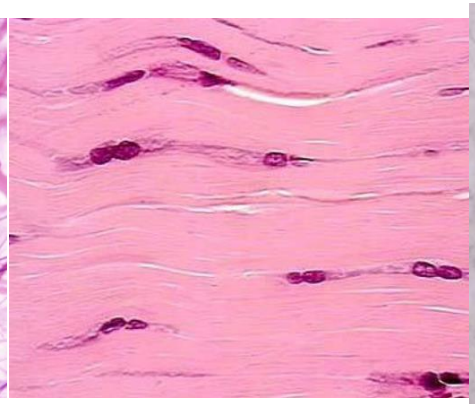
-maintaining an integrity of the body by forming a continuum with the other tissues (epithelial tissue, muscle, nervous tissue) and with other elements of connective tissues.
- providing structural support
- serving as a medium for exchange
- forming a site for storage of fat

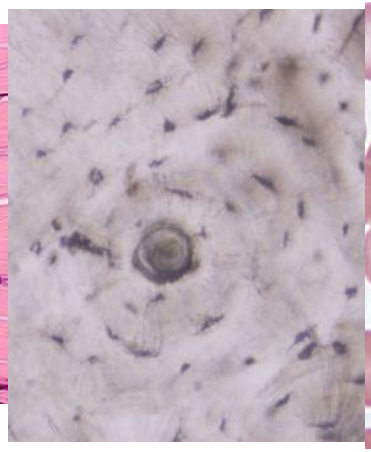


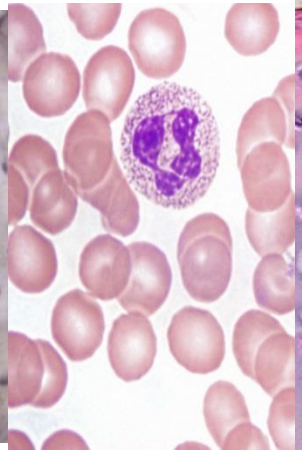
Connective tissue classification

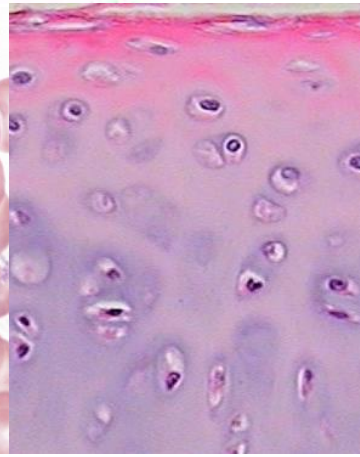












Connective tissue proper

Extracellular matrix (ECM)

Fibers → **Collagen**

Elastic

Reticular

Ground substance → **Proteoglycans (PGs)**

Glycosaminoglycans (GAGs)

Glycoproteins

Fixed cells:

Fibroblasts

Adipose cells

Histiocytes (macrophages)

Mast cells

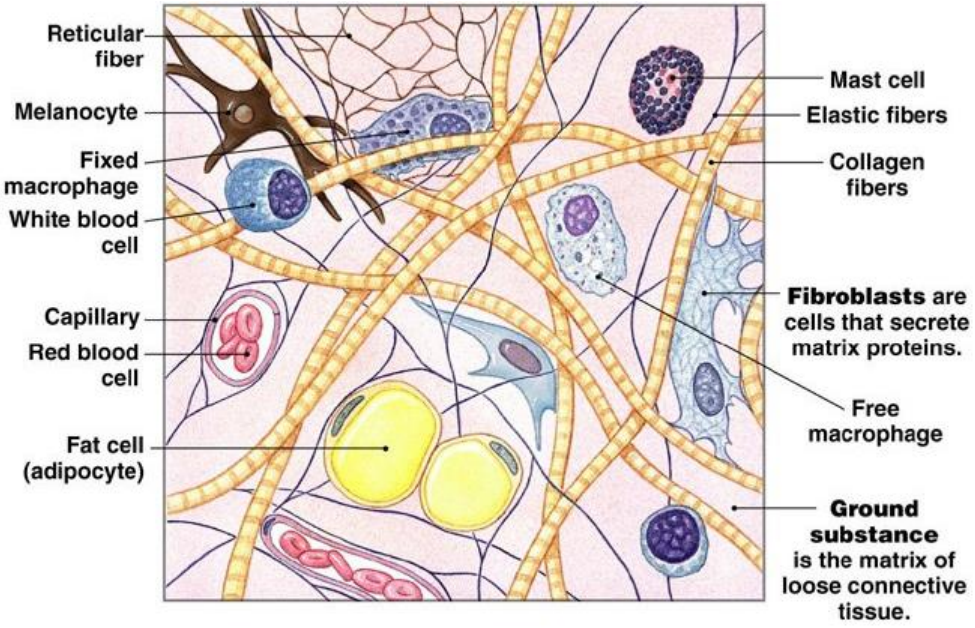
Pericytes

Transient cells:

Plasma cells

Migratory leukocytes

Macrophages

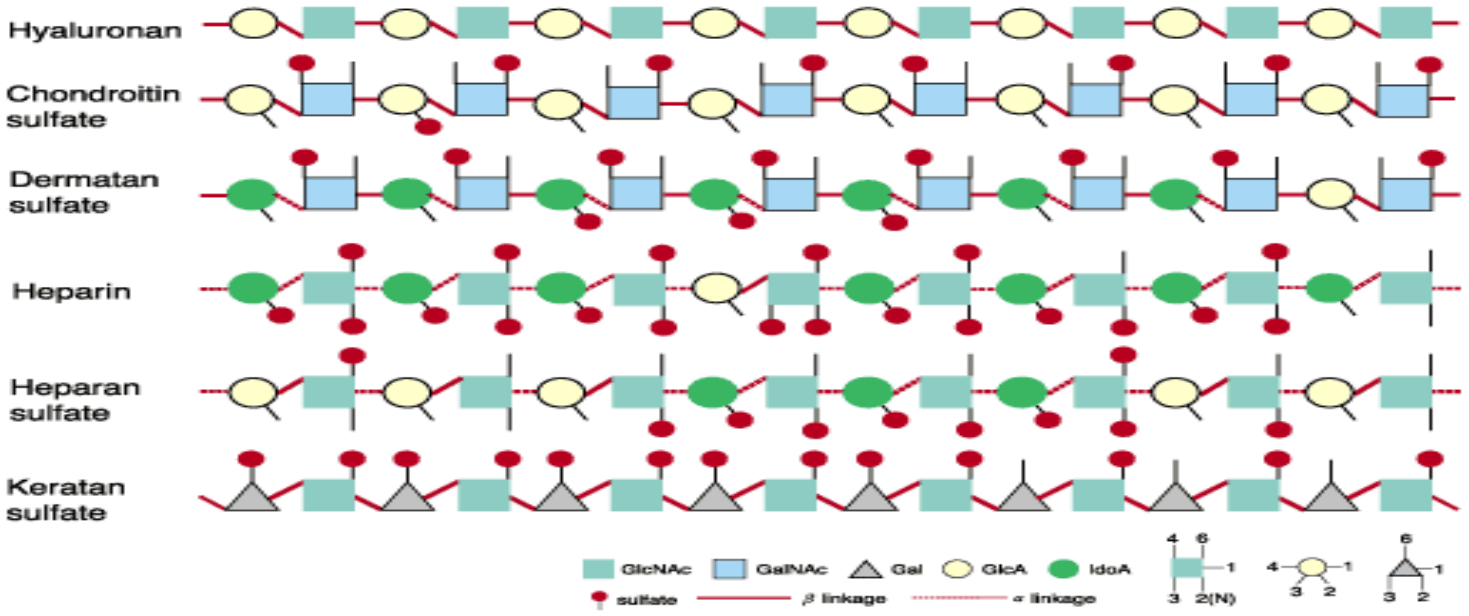


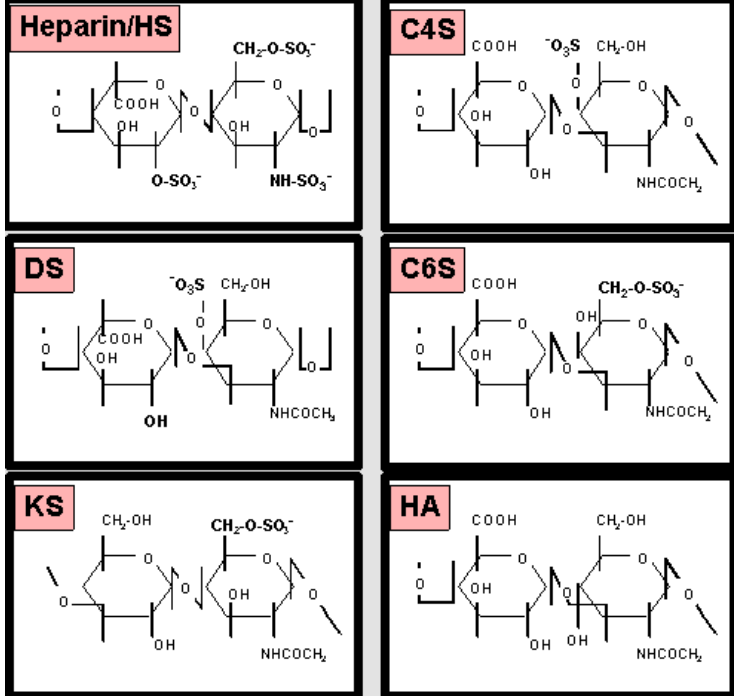
GROUND SUBSTANCE

Glycosaminoglycans (GAGs), proteoglycans and glycoproteins.

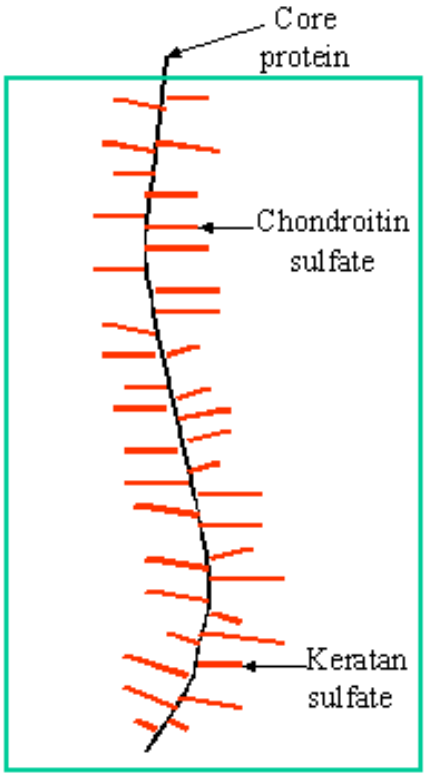
GLYCOSAMINOGLYCANS

– negatively charged, long unbranched polysaccharides consisting of a repeating disaccharide units.

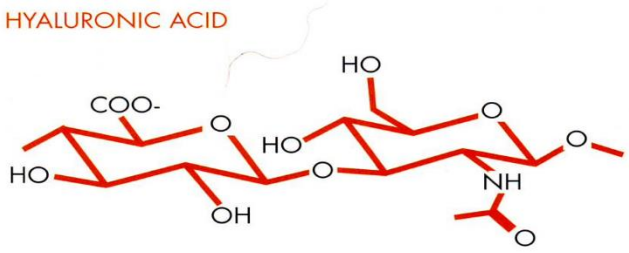




These GAGs are covalently linked to protein molecules to form proteoglycans.



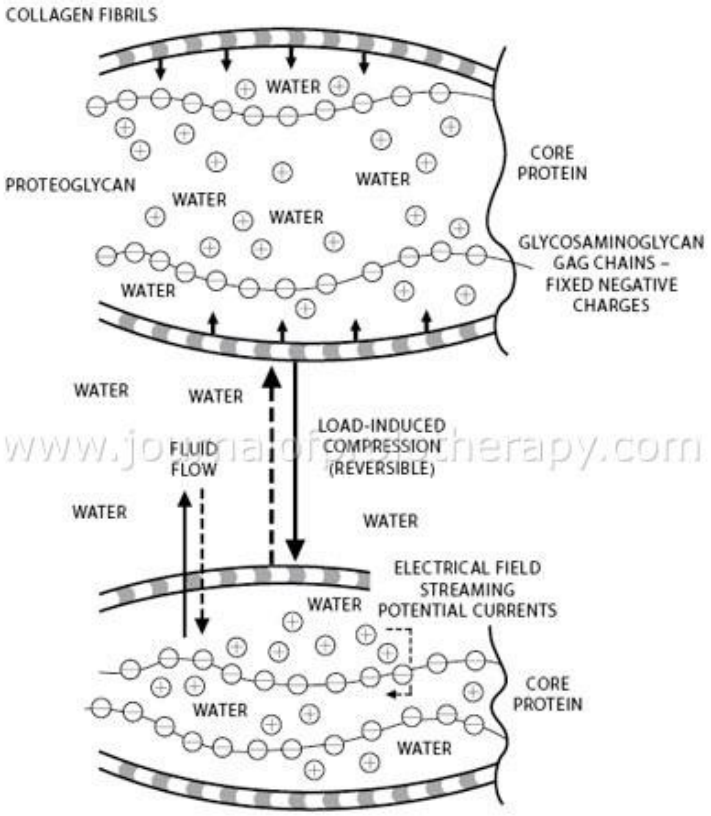
Only nonsulfated GAG is hyaluronic acid (HA) – very large (10 000 disaccharide units) macromolecule.



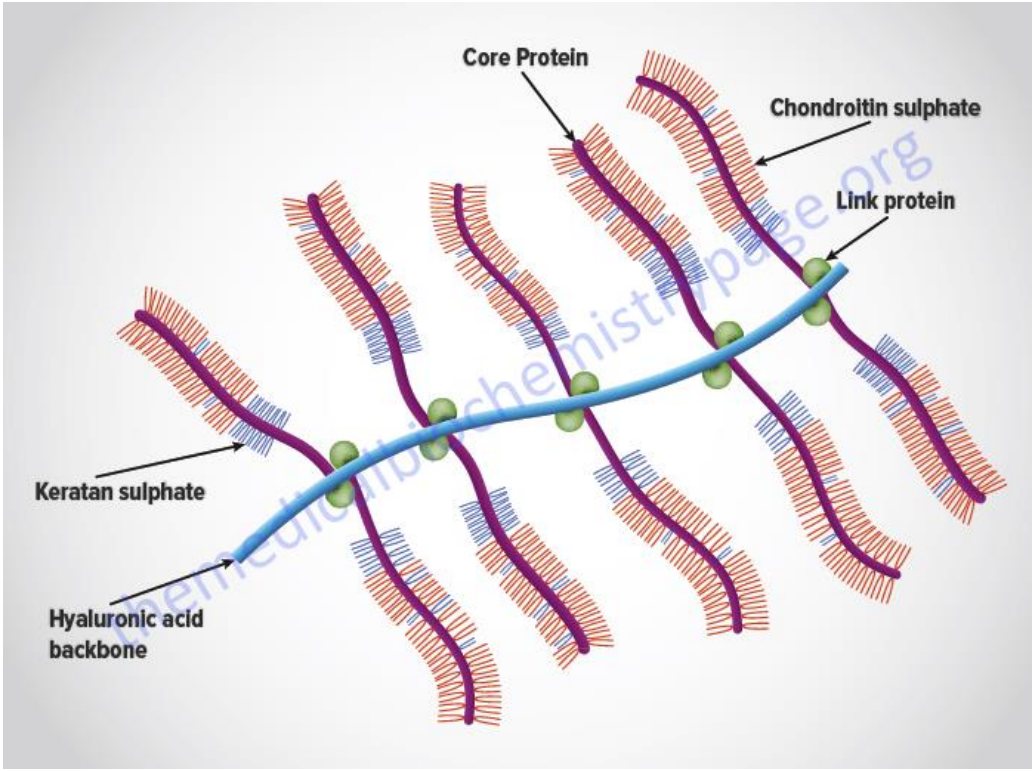
Proteoglycans (PGs)

Proteoglycans contain protein core with covalently bonded glycosaminoglycans (GAGs).

- bind large quantities of water
- resistance to forces of compression



Proteoglycans

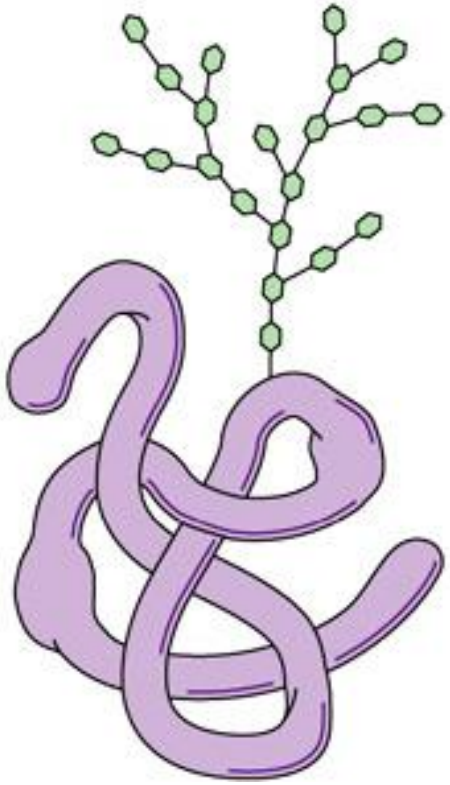


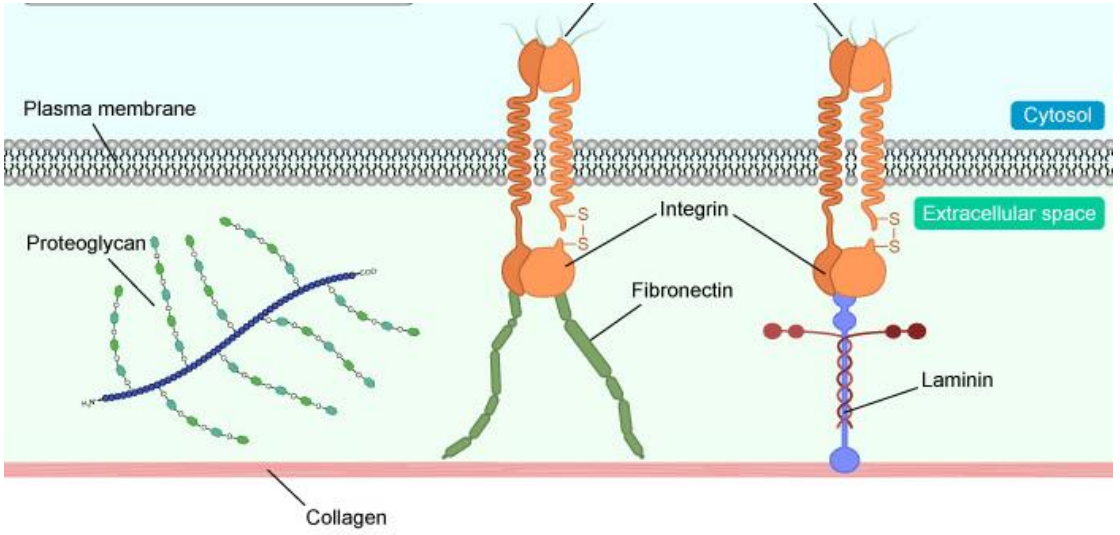
Many proteoglycans (**aggrecan, versican**) attach to hyaluronic acid with small link proteins that form bonds between the core protein of proteoglycan and hyaluronic acid.

Glycoproteins

-contain globular protein molecule with attached branched chains of monosaccharides.

-have binding sites extracellular matrix - allows the attachment of cells to the extracellular matrix

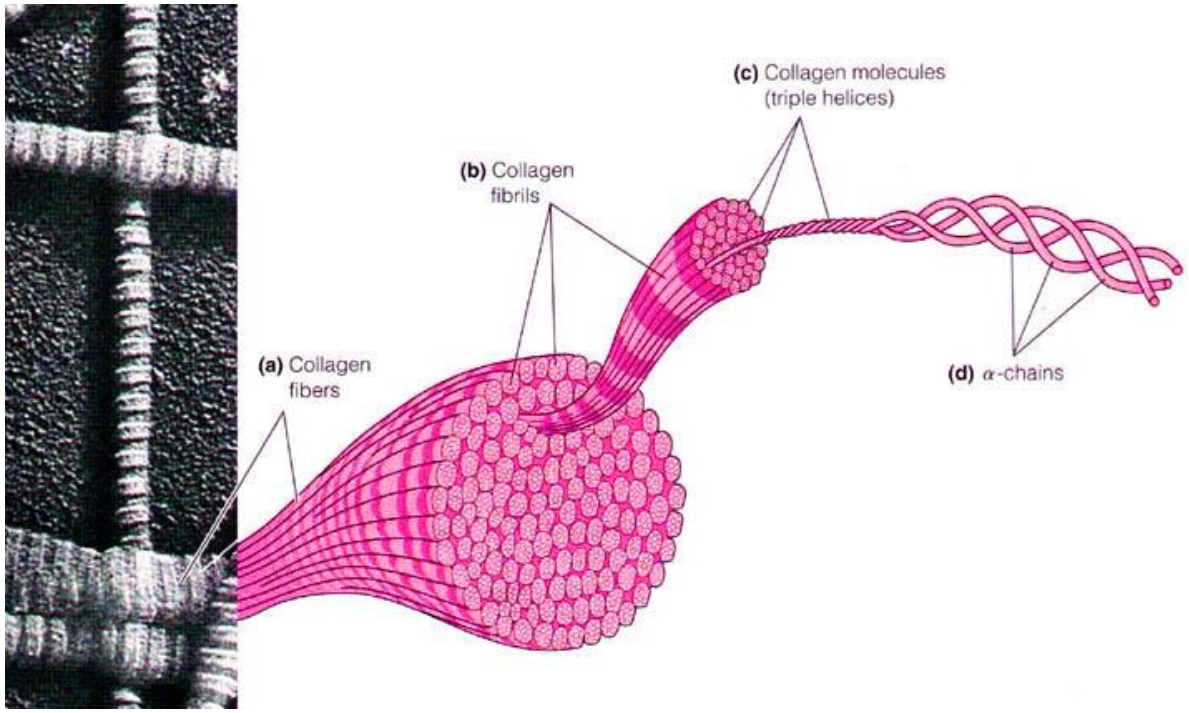




- **Fibronectin** –connective tissue and blood
- **Laminin** - basal lamina
- **Entactin (nidogen)-** connects laminin and collagen IV
- **Tenascin** –embryonic tissues
- **Chondronectin** –cartilage
- **Osteonectin** –bone

COLLAGEN FIBERS -

Inelastic fibers possessing great tensile strength.

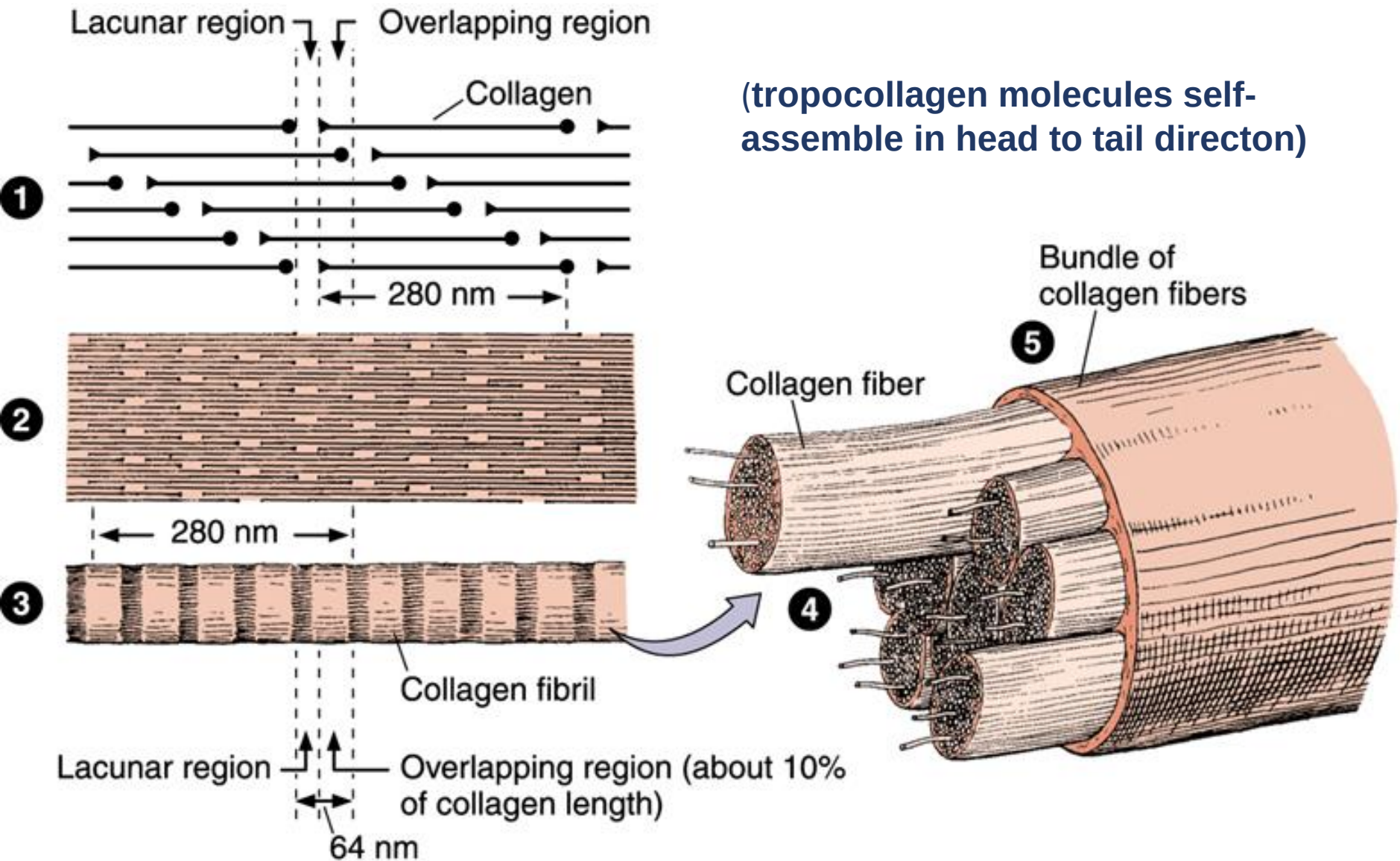


The main amino acids characteristic for collagen **hydroxyproline and hydroxylysine**

Collagen type I - dermis, tendons, ligaments and capsules of organs.

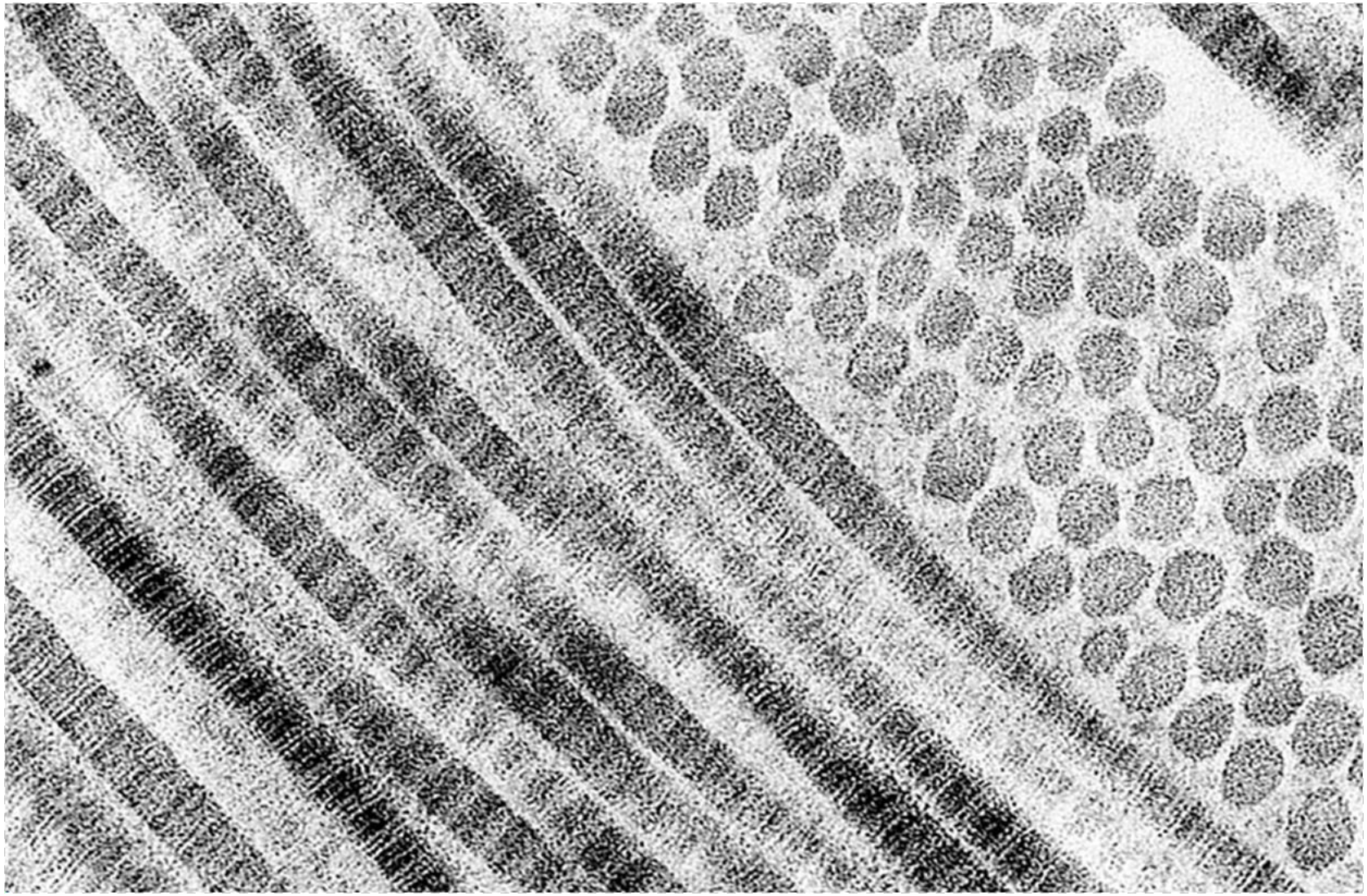
Collagen type III - reticular fibers in framework of spleen, liver, lymph nodes, smooth muscles, adipose tissue, in cardiovascular system, lung and skin.

Organization of tropocollagen, formation of collagen fibrils, fibers and bundles

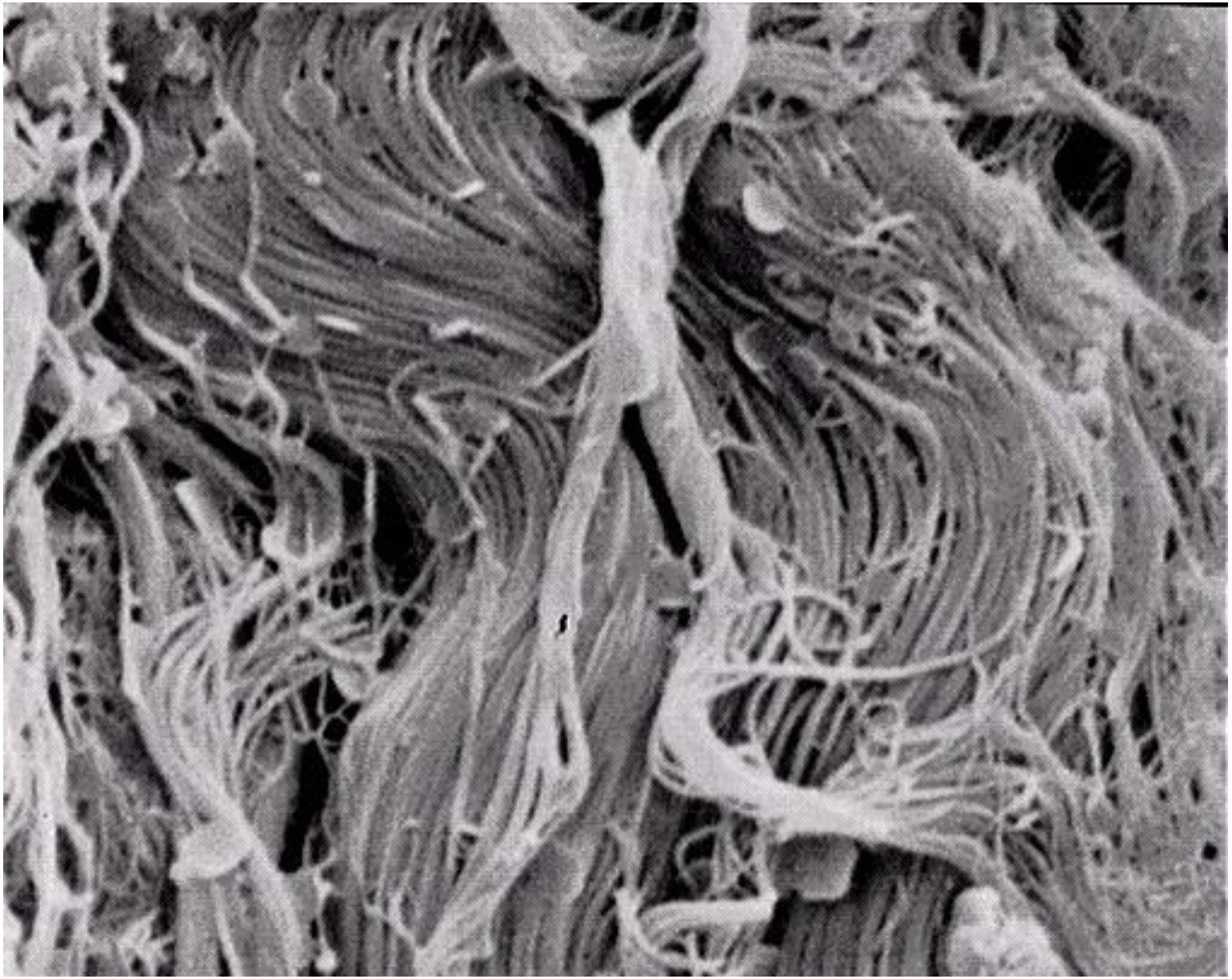


(**tropocollagen molecules self-assemble in head to tail directon)**

Collagen fibers (EM)



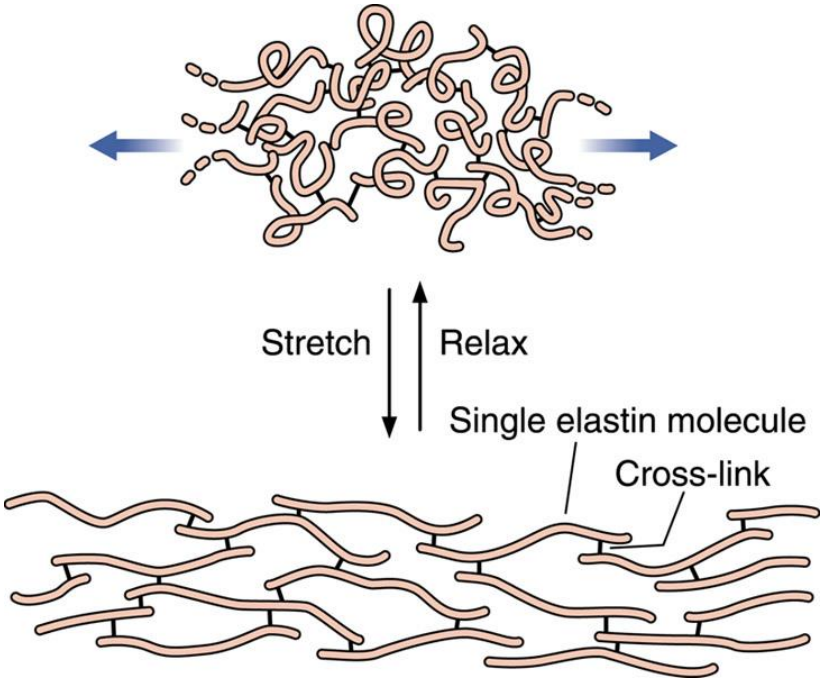
Visible cross-striations with 67 nm periodicity



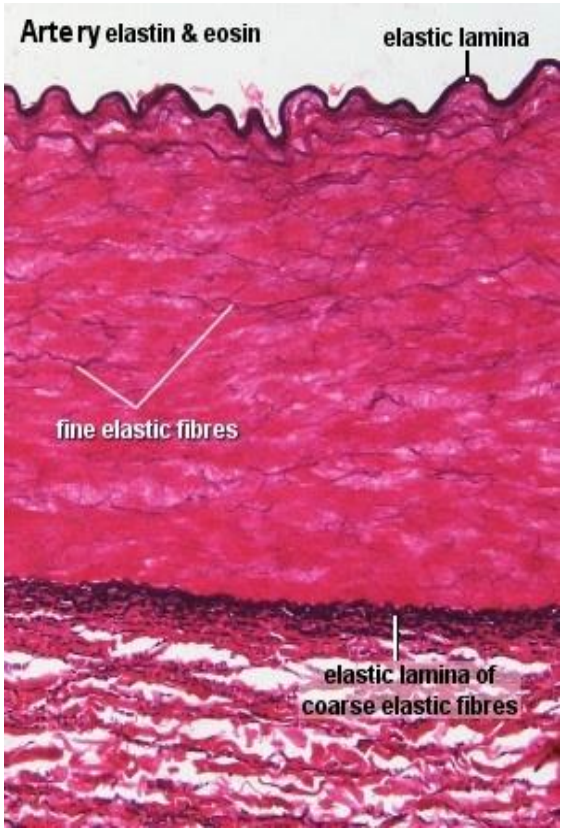
A bundle of collagen fibers, scanning electron microscope

ELASTIC FIBERS

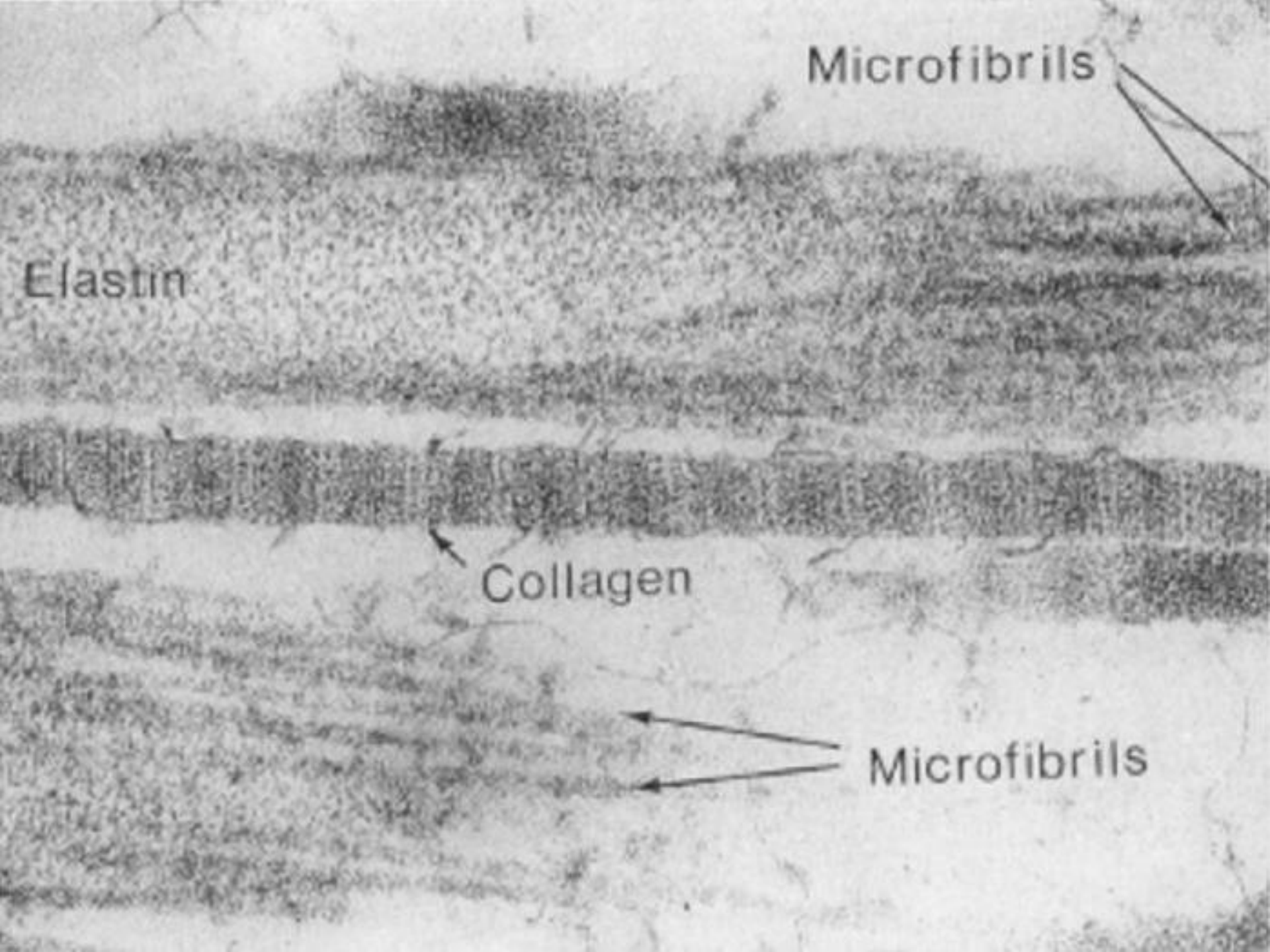
formed from the elastic microfibrils and amorphous elastin



Elastin molecules are joined by covalent bonds forming a network. Each elastin molecule can expand and contract like a random coil; thus the whole network can stretch and recoil like a rubber band.

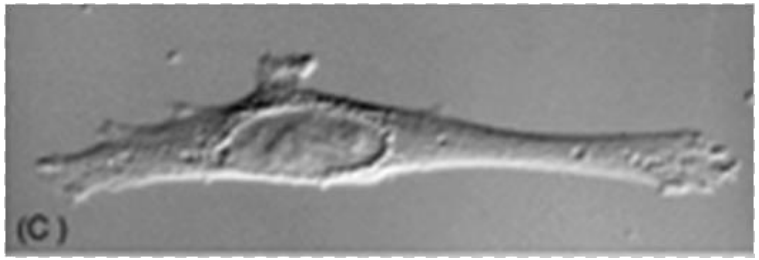


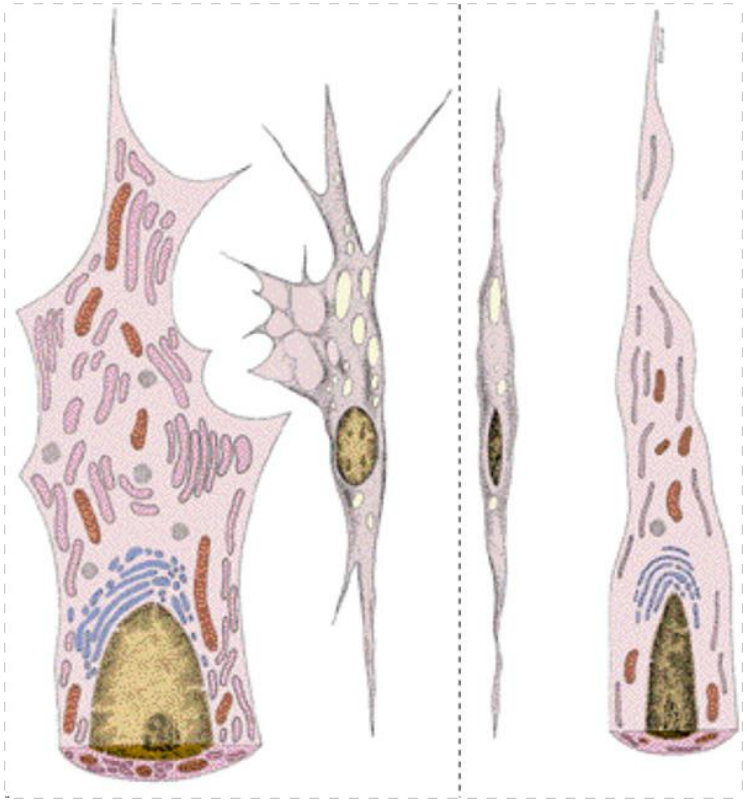
Elastic fibers are usually slender (in loose connective tissue) but may form bundles (e. g. in ligaments), and concentric sheets in the walls of larger blood vessels


Microfibrils
Elastin
Collagen
Microfibrils

Fibroblasts (fibrocytes – quiescent fibroblasts)

the most abundant cell type

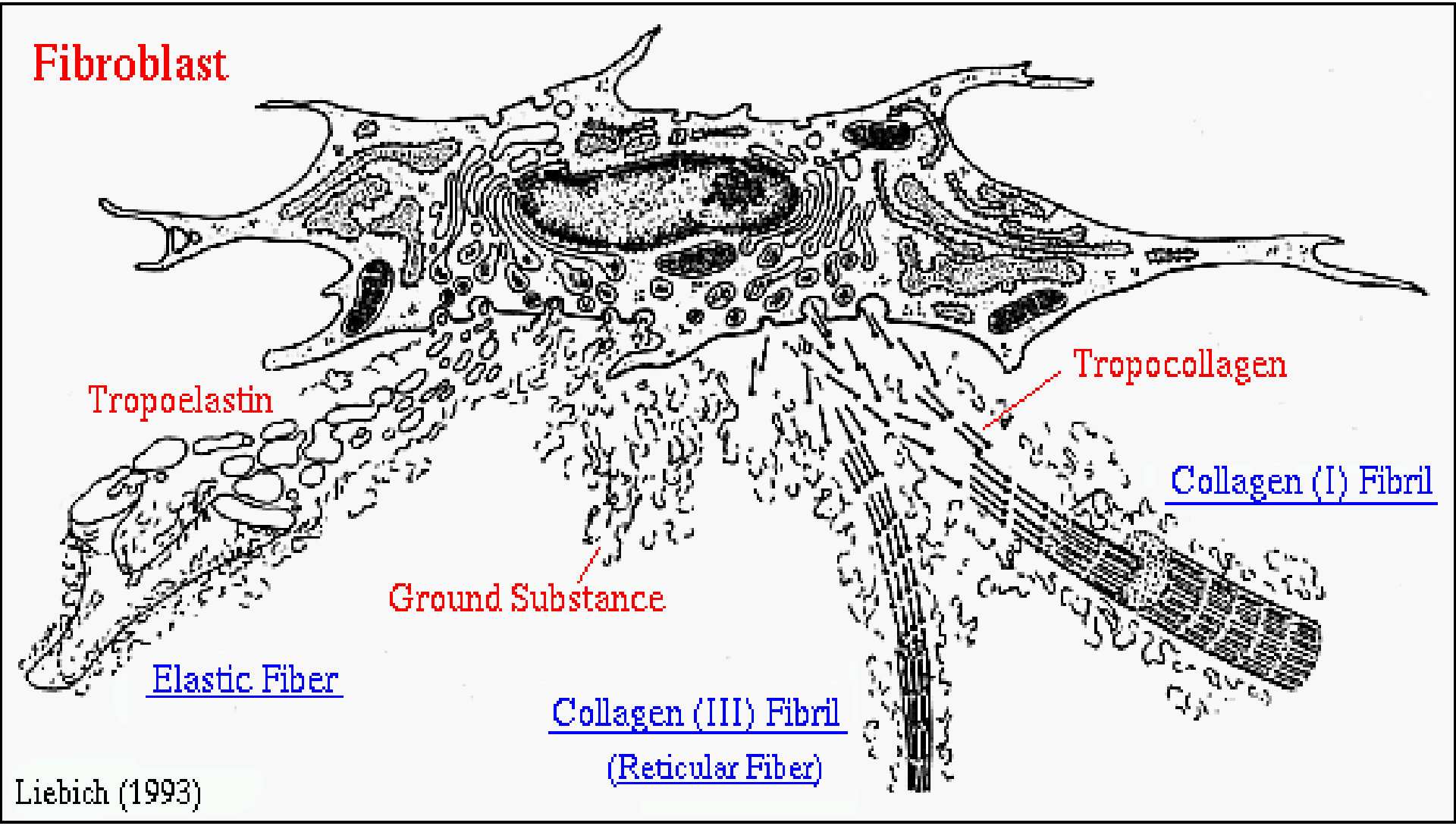


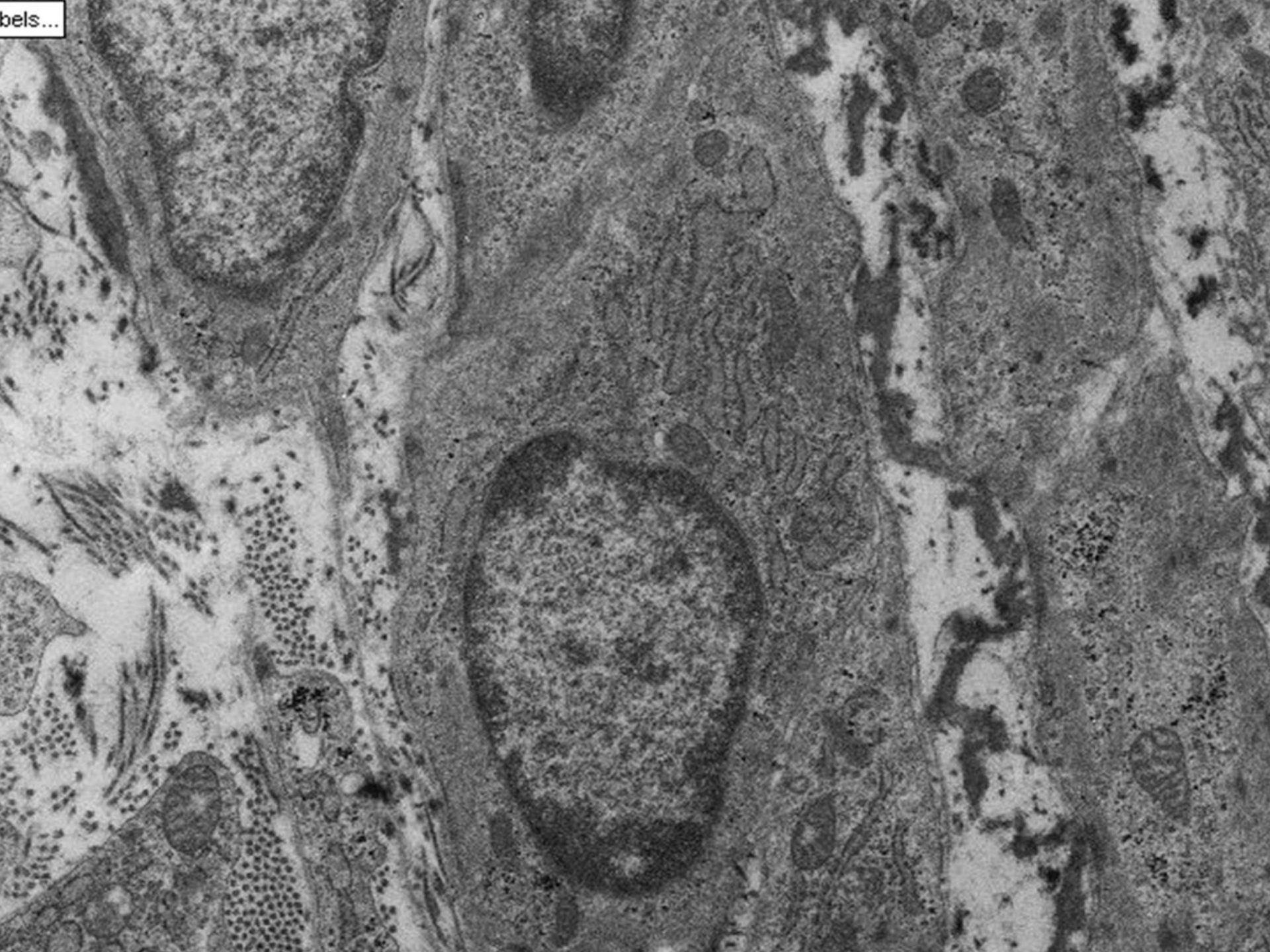


Produce fibers, ground substance and proteolytic enzymes.

Special form: myofibroblasts - contractile elements, wound healing (wound contraction)

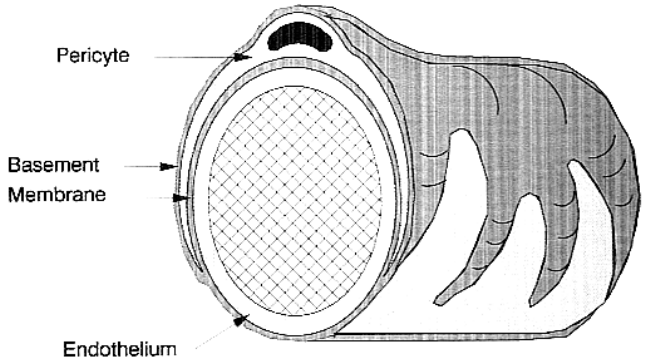
FUNCTIONS OF FIBROBLASTS

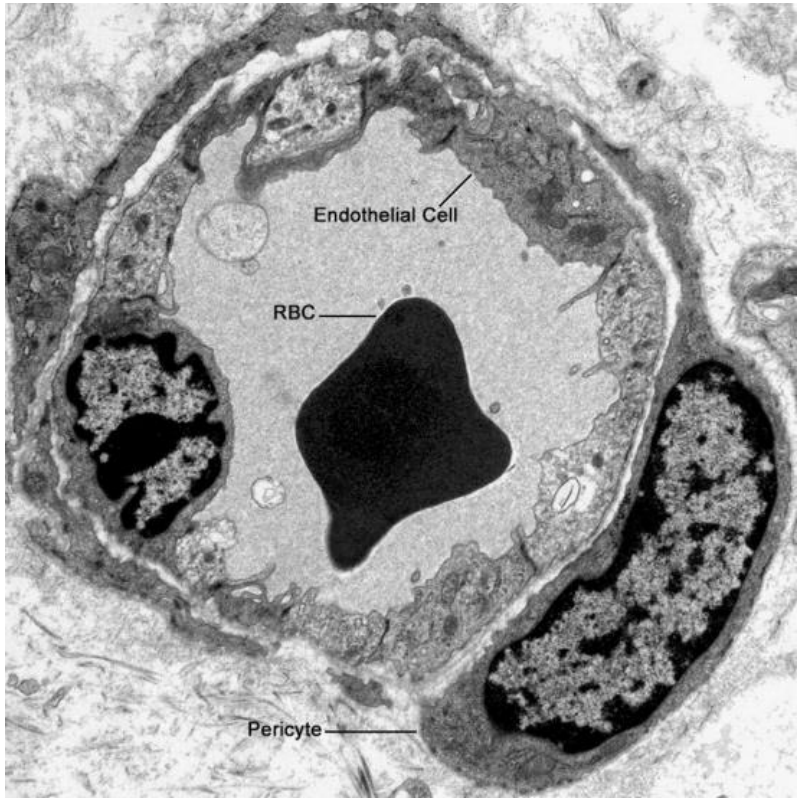




PERICYTES

surround endothelium of capillaries and small venules, possess their own basal lamina, contain actin, myosin and tropomyosin, may function in contraction.





MAST CELLS

CTissue mast cells

In various organs

along blood vessels

in fluid of body cavities

Mucosal mast cells

In mucosa of alimentary

and respiratory tract

Granules (metachromatic):

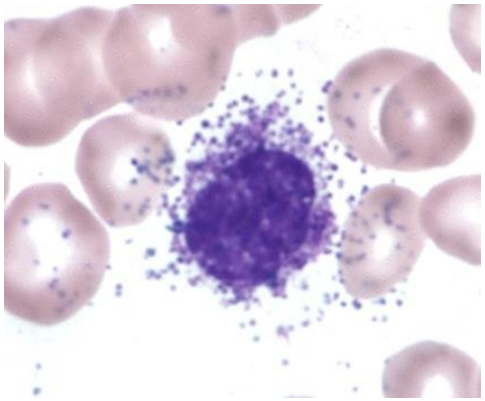
Heparin (anticoagulant, inactivate histamine)

Histamine (vascular permeability, vasodilation, bronchiospasm)

Neutrophil chemotactic factor (NCF)

Eosinophil chemotactic factor(ECF)

Proteolytic enzymes

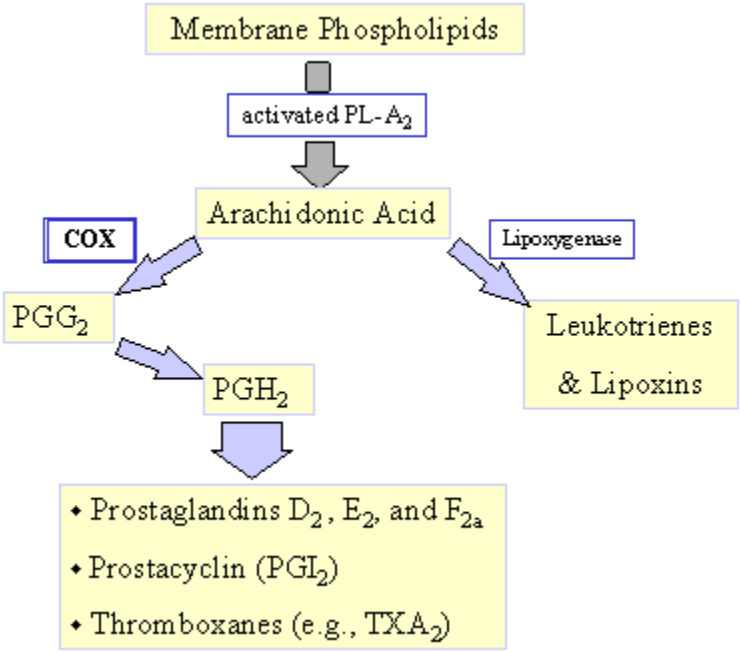


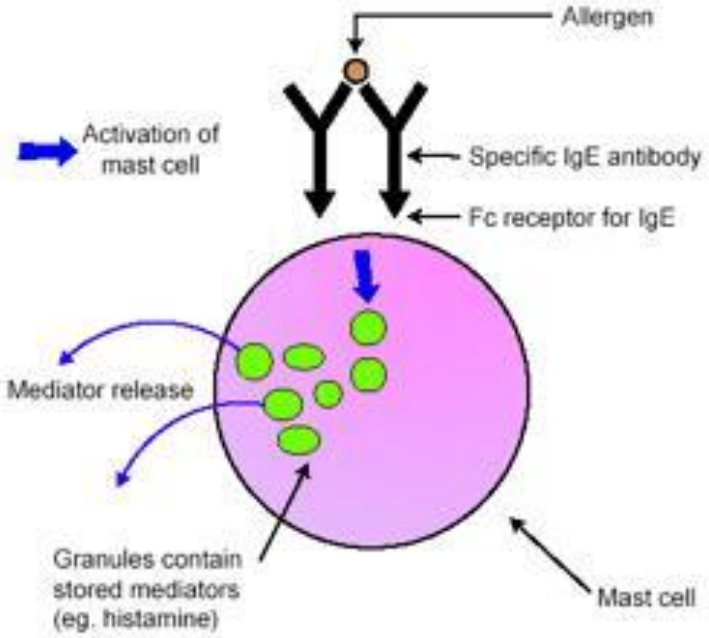
MAST CELLS

Release also **leukotrienes, prostaglandins and thromboxanes**

Contain specific receptors for immunoglobulin E

Mediate allergic reaction known as immediate hypersensitivity reactions, in most developed form leading to anaphylactic shock





ADIPOSE CELLS

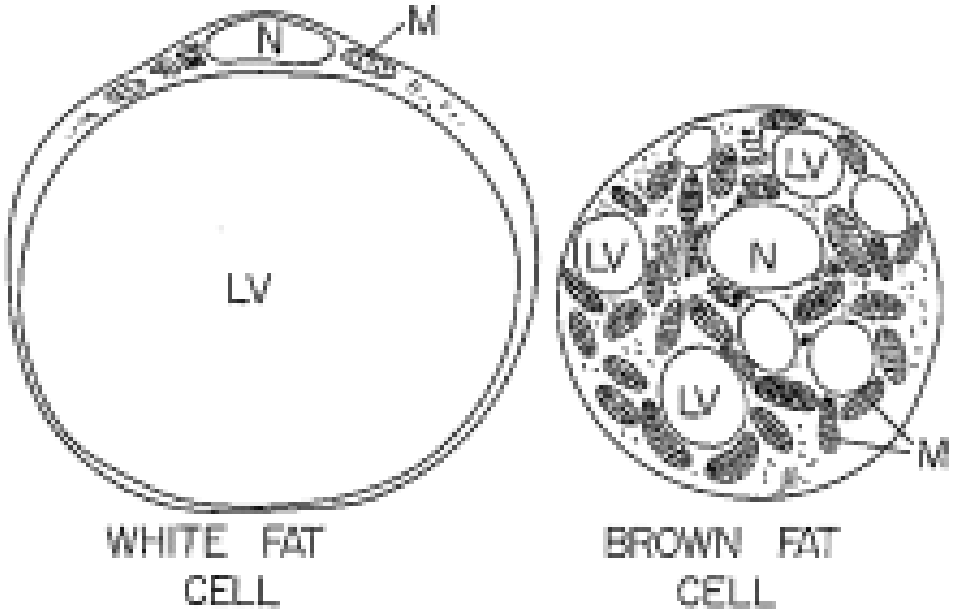
Fully differentiated cells that function in the synthesis, storage and release of fat. There are two types of fat cells.

UNILOCULAR FAT CELLS

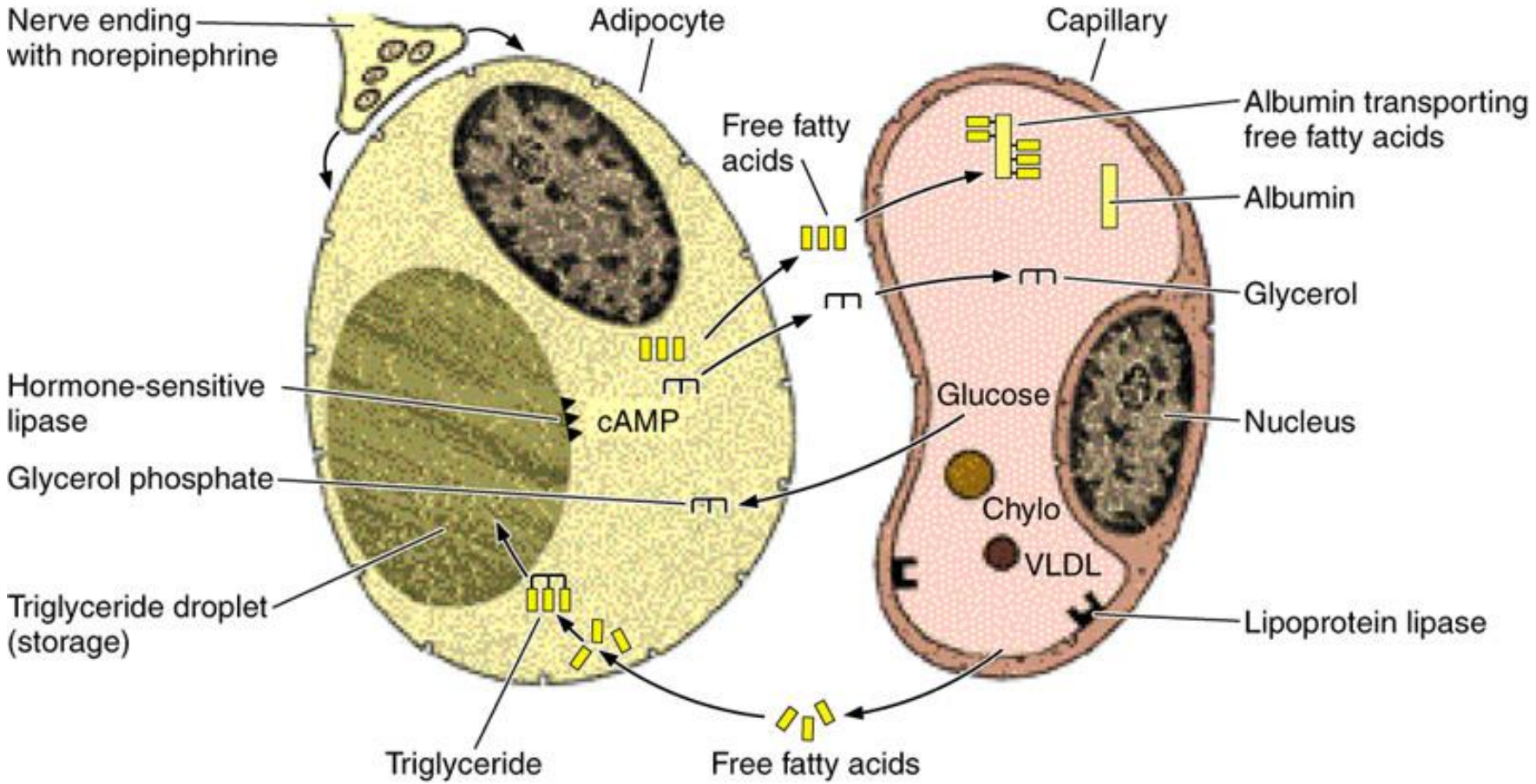
-Large, spherical cells forming white adipose tissue
-Storing of fat in a single droplet
-Cytoplasm and nucleus peripherally displaced (signet ring)

MULTILOCULAR FAT CELLS

-Smaller, more polygonal cells forming brown adipose tissue
-Storing of fat in several small droplets
-Spherical nucleus
-More mitochondria then unilocular cells
-Brown fat occurs mainly in children



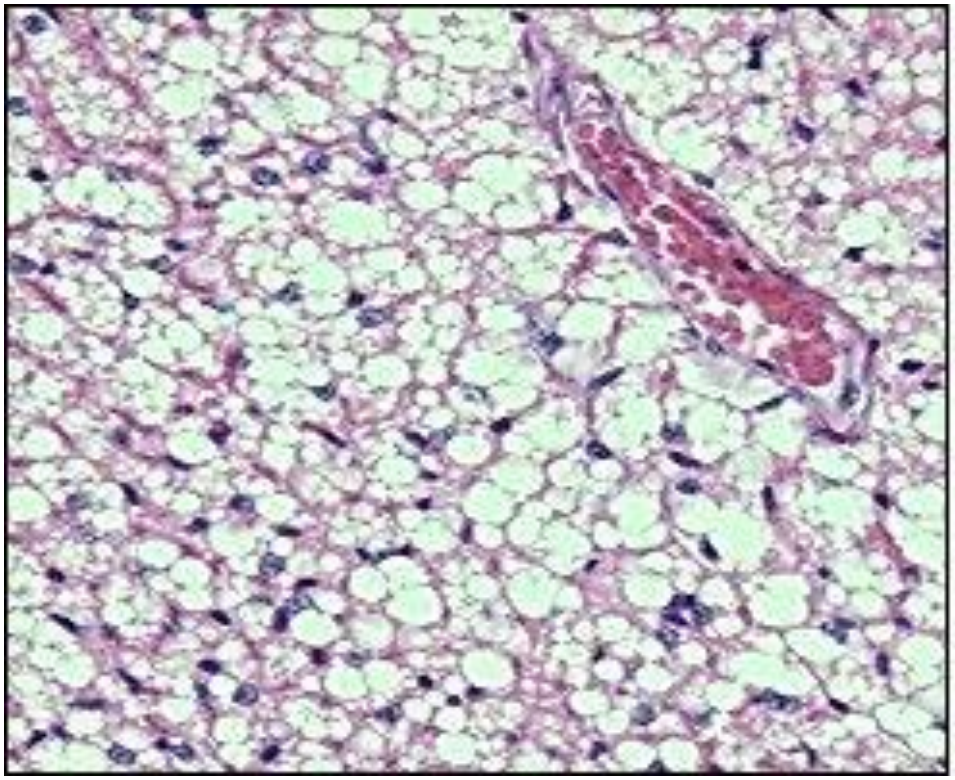
UNILOCULAR FAT CELL (WHITE ADIPOSE TISSUE)



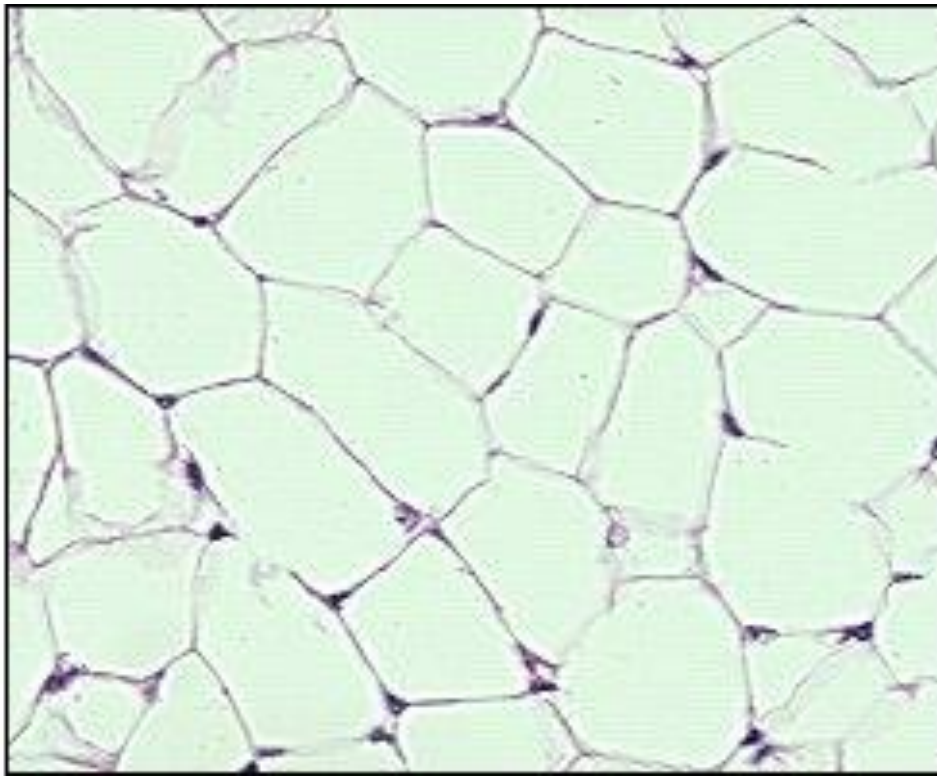
Lipoprotein lipase hydrolyze fats into free fatty acids and glycerol. They diffuse into adipocytes, are converted into triglycerides and stored in fat droplets

Norepinephrine from nerve endings stimulates the cyclic AMP system which activates hormone-sensitive lipase. This enzyme hydrolyzes triglycerides and fatty acids are released from cells.

The function of white adipose tissue is storage of fat. Brown adipose tissue is responsible for providing of heat;

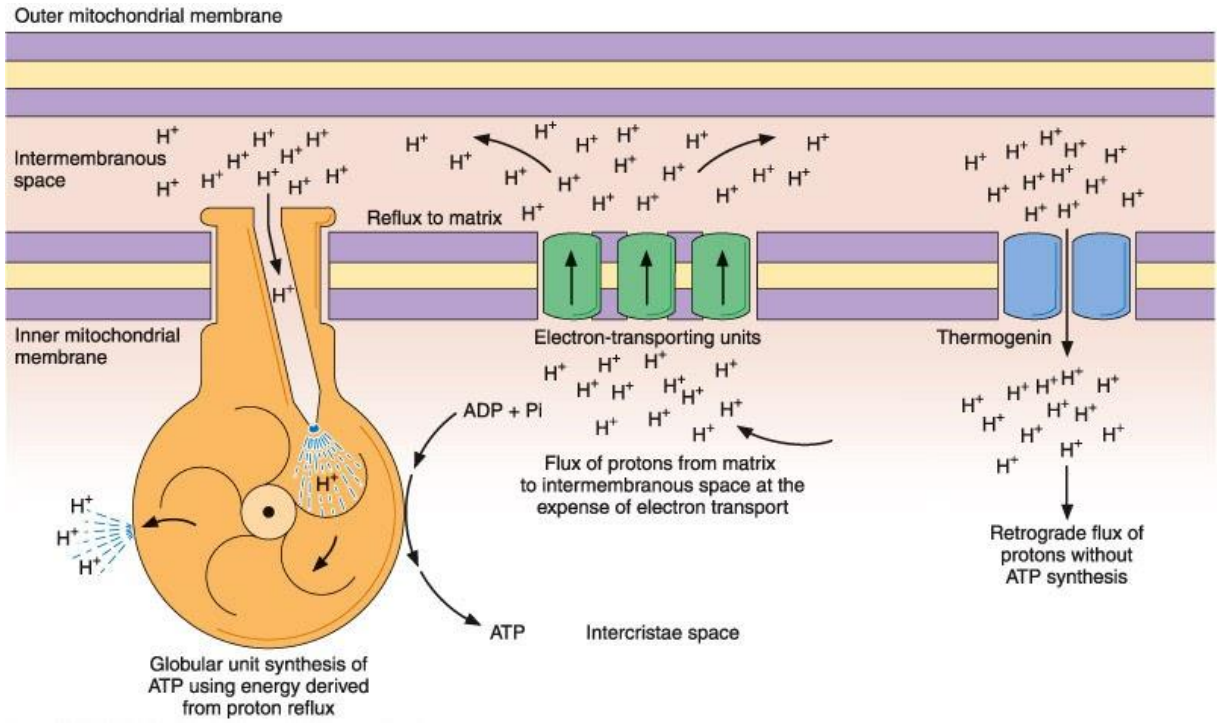


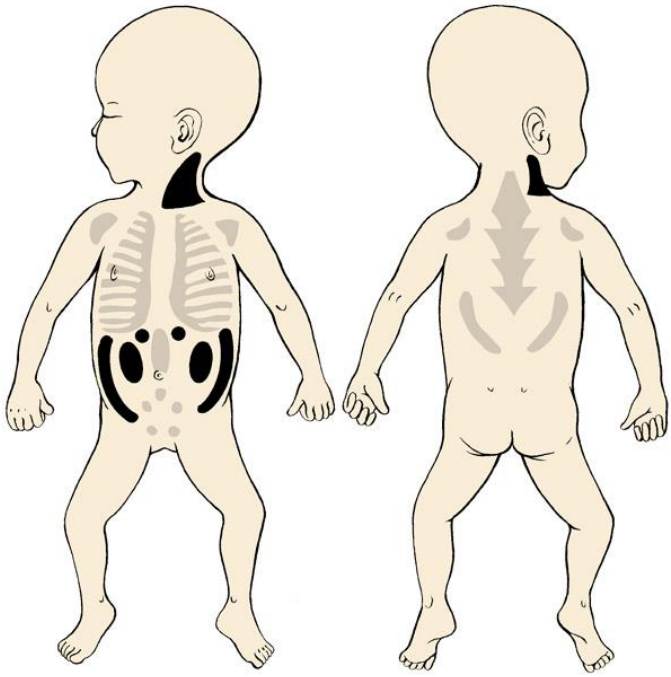
brown adipose tissue



white adipose tissue

Multilocular cells (brown adipose tissue).

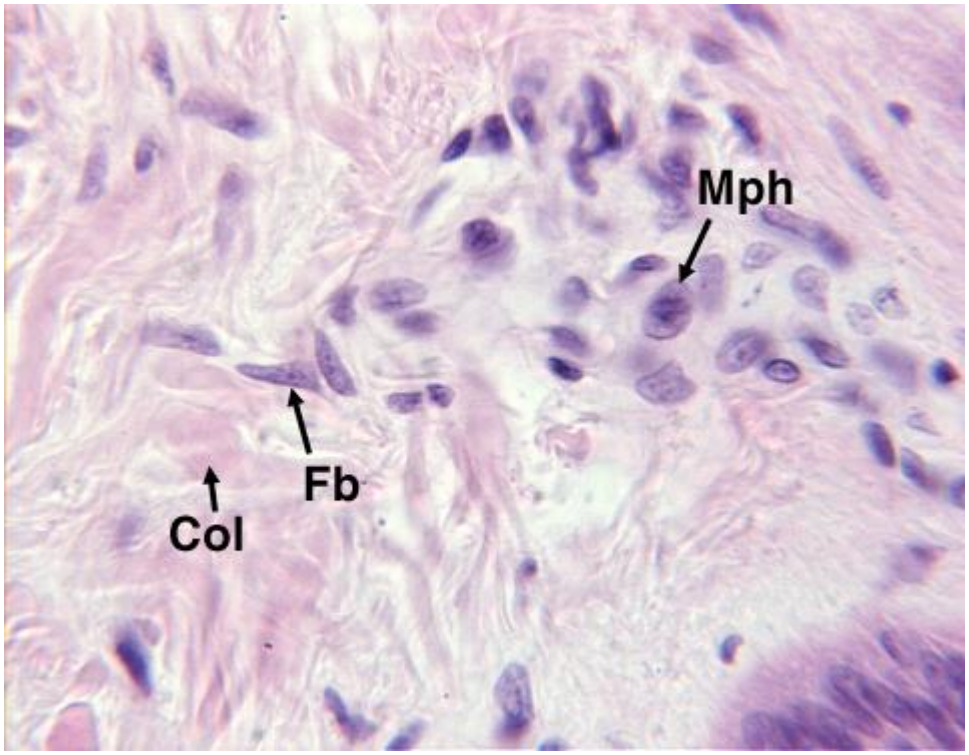




- abundant in newborns

Thermogenin is a inner-membrane **mitochondrial protein** exclusive to brown adipocytes in mammals that functions as a proton transporter, allowing the dissipation as heat of the proton gradient generated by the respiratory chain. ATP in not produced and energy is dispersed as heat.

Macrophages (histiocytes)



Originate from monocytes passing into blood from bone marrow. Tissue macrophages survive for several months.

Functions:

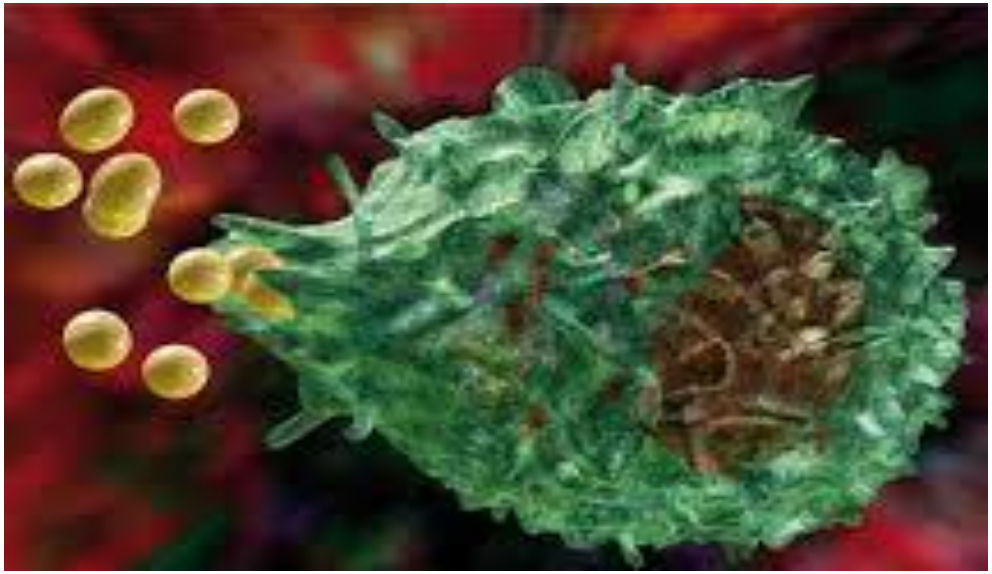
Phagocytosis of microorganisms, foreign substances, cell debris and senescent cells

Immunophagocytosis

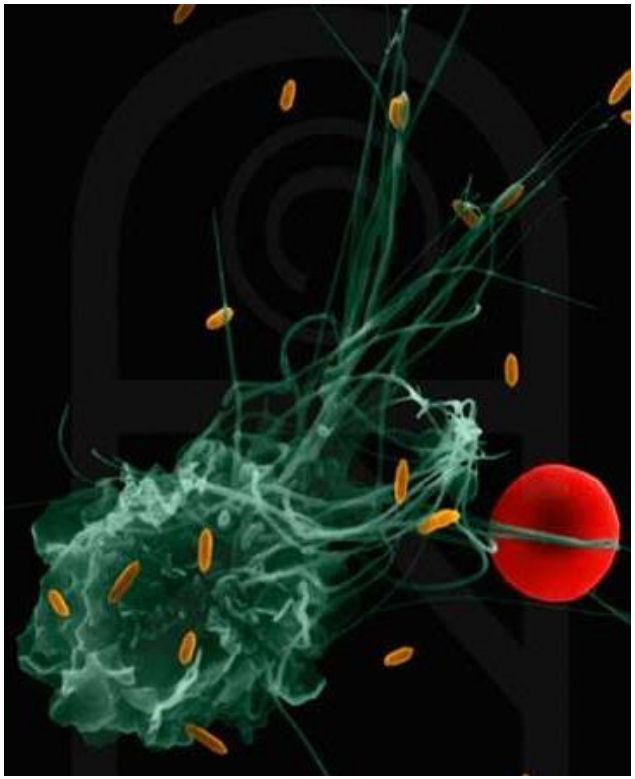
Participation in initiation of immune response

Produce: hydrolytic enzymes, interleukins and other cytokines (TNF, PDGF, TGF-beta).

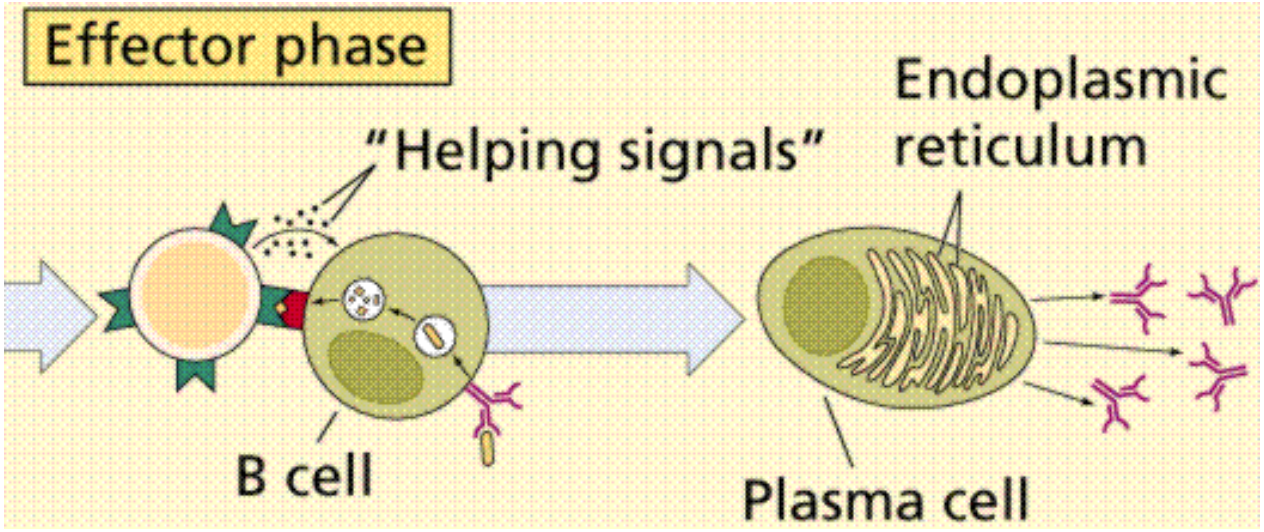
Contain receptors for Fc end of antibody.



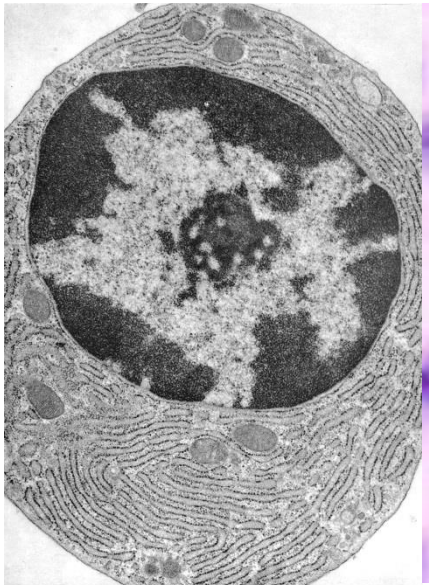
Macrophages and bacteria

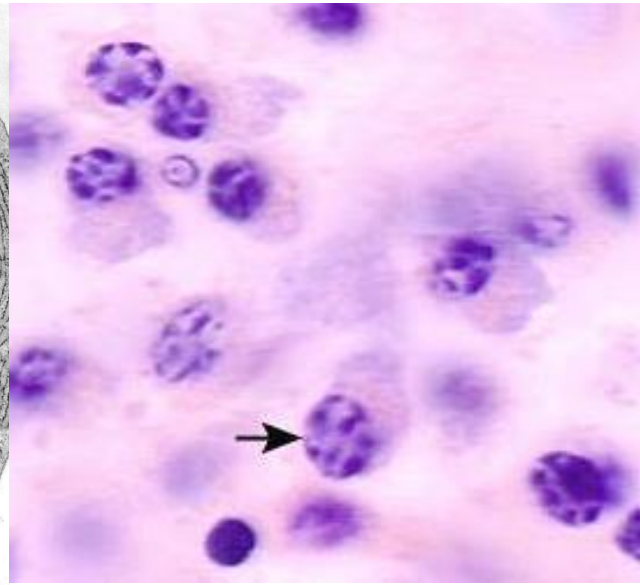


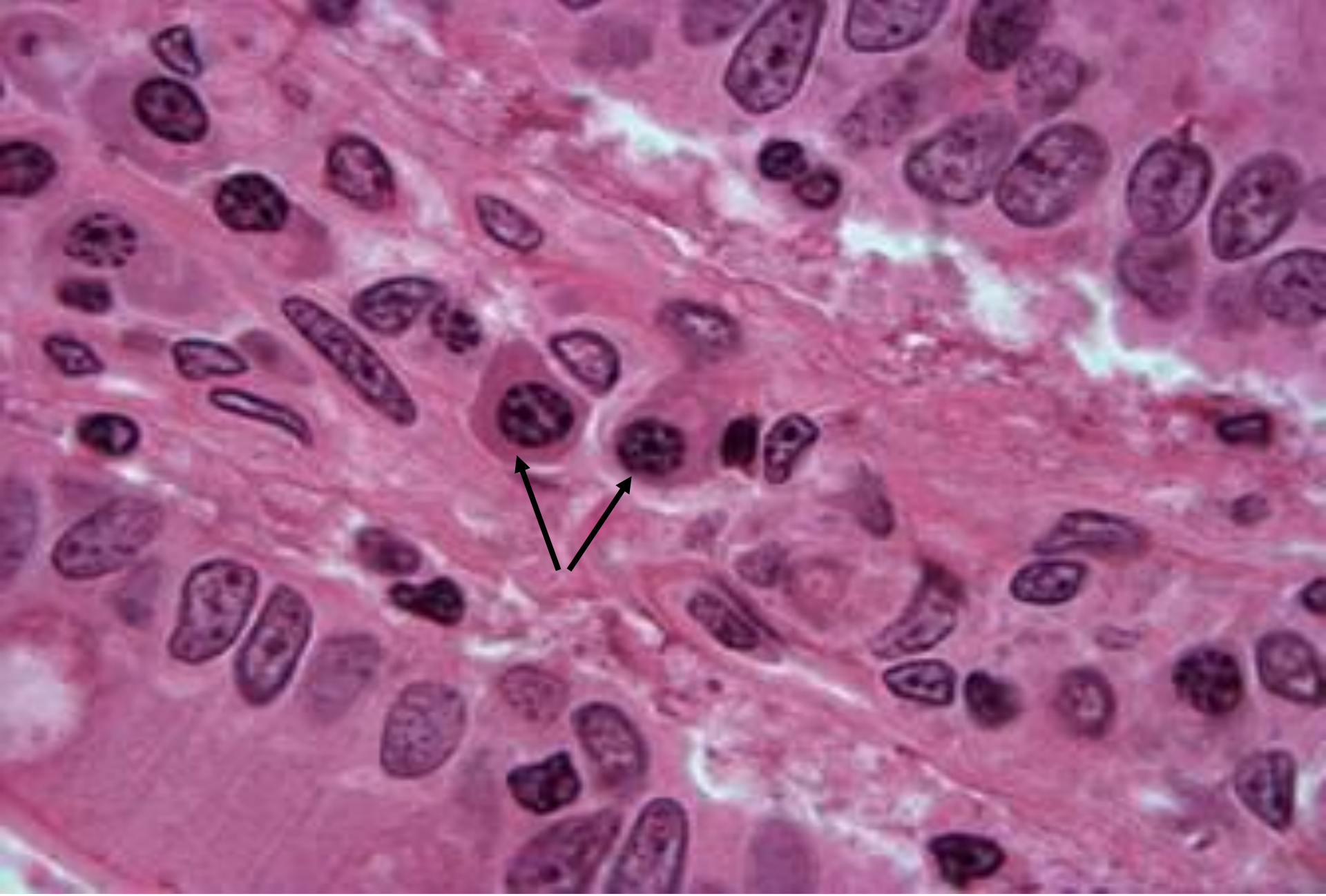
PLASMA CELLS - differentiate from B lymphocytes. Produce and secrete immunoglobulins (antibodies) **IgA; IgD; IgE, IgG, IgM** and are responsible for humorally mediated immunity.



Dilated cisternae of RER filled with immunoglobulins which are not stored in granules, clock face or spoked nucleus.







Intestinal villous – plasma cells

LEUKOCYTES

White blood cells migrating to the connective tissues during inflammation to perform various functions connected with the immune response.

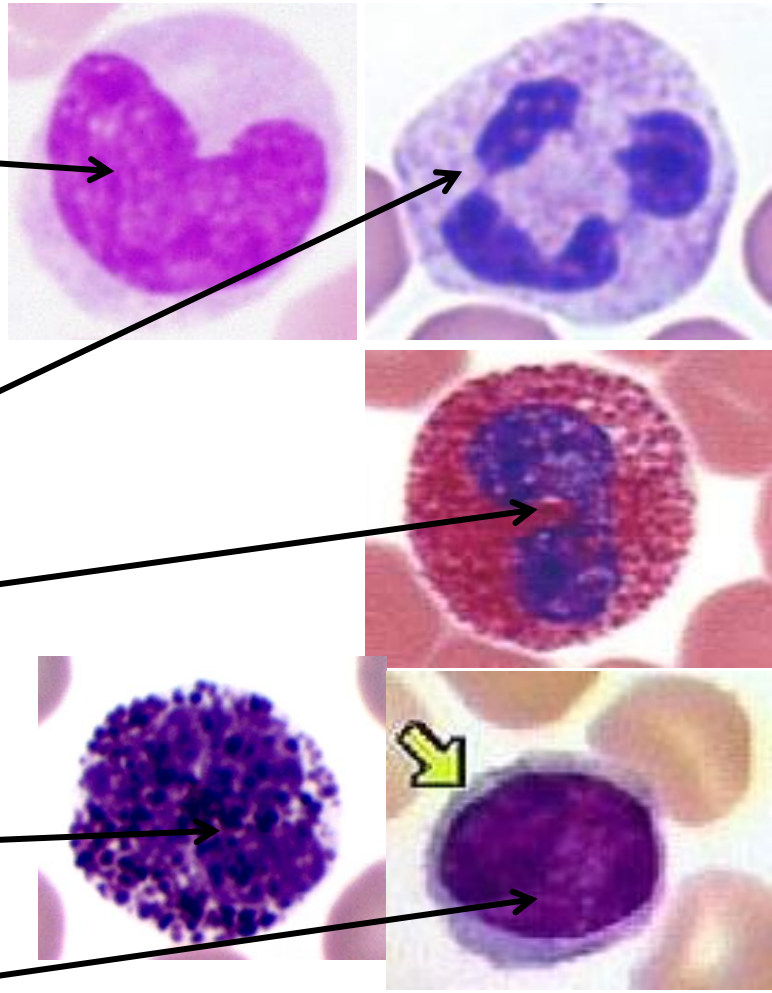
MONOCYTES – they transform into macrophages

NEUTROPHILS – phagocytose and digest bacteria in areas of inflammation, it can cause formation of pus – accumulation of dead neutrophils and debris.

EOSINOPHILS – combat parasites, moderate the allergic reactions, phagocytose the antibody-antigen complexes.

BASOPHILS – similar to mast cells

LYMPHOCYTES – humoral and cellular mediated immunity.



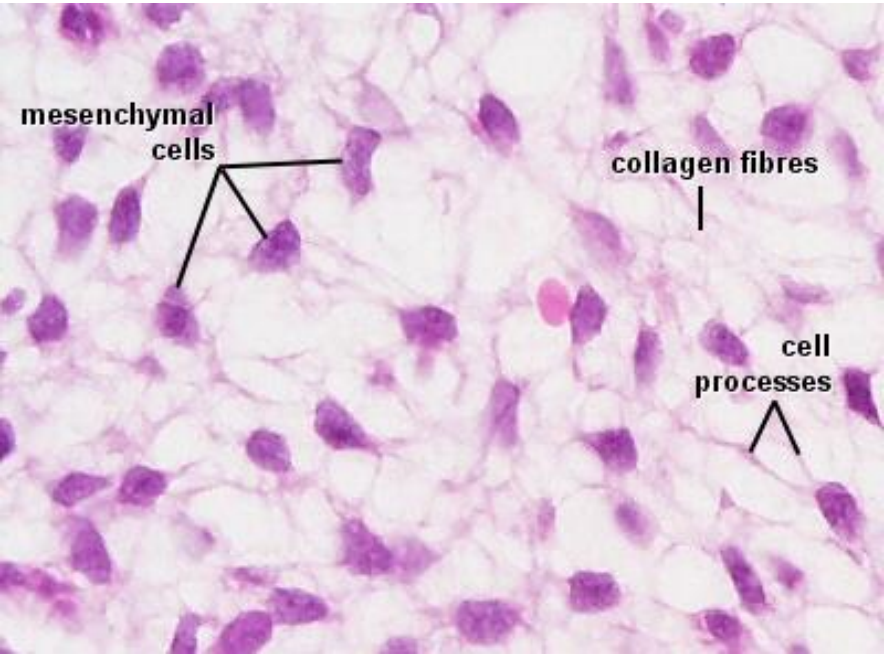
EMBRYONIC CONNECTIVE TISSUE (CT)

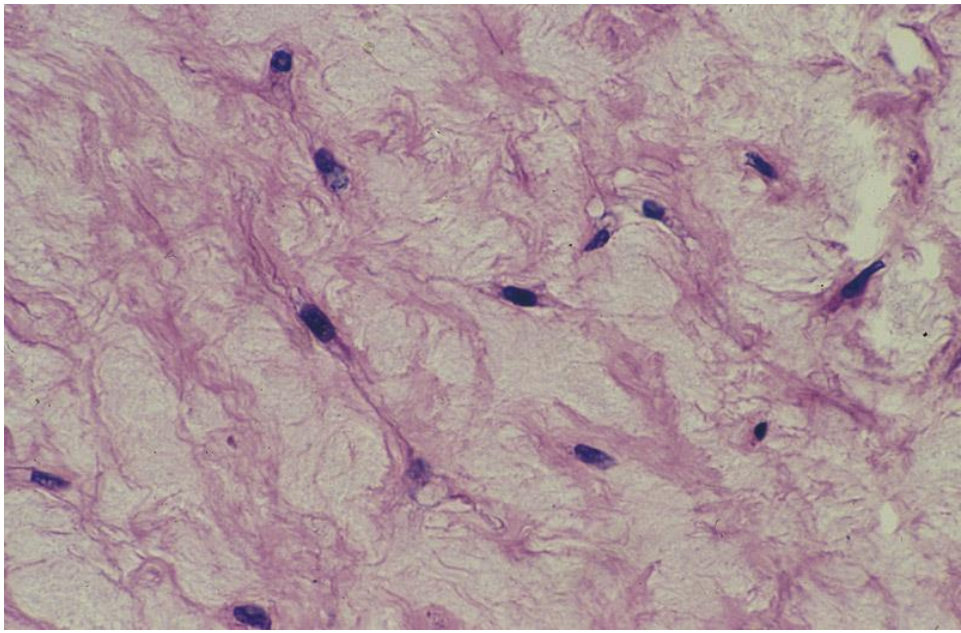
MESENCHYMAL CT

-Present in embryo and in pulp of teeth
-Mesenchymal cells
-Amorphous ground substance
-Scattered reticular fibers
-High mitotic activity

MUCOUS CT

-Present in umbilical cord (Wharton's jelly)
-Fibroblasts
-Amorphous, jelly-like ECM (HA)
-Few type I and III collagen fibers

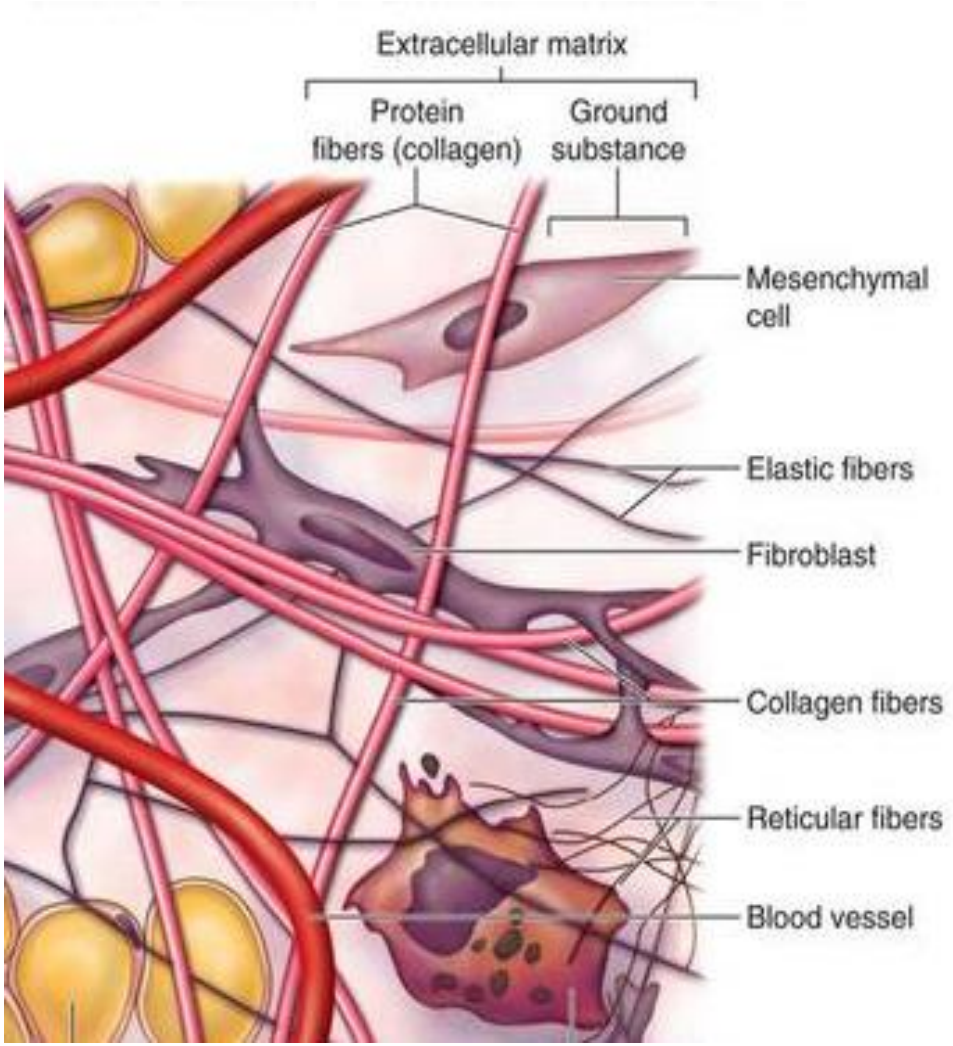




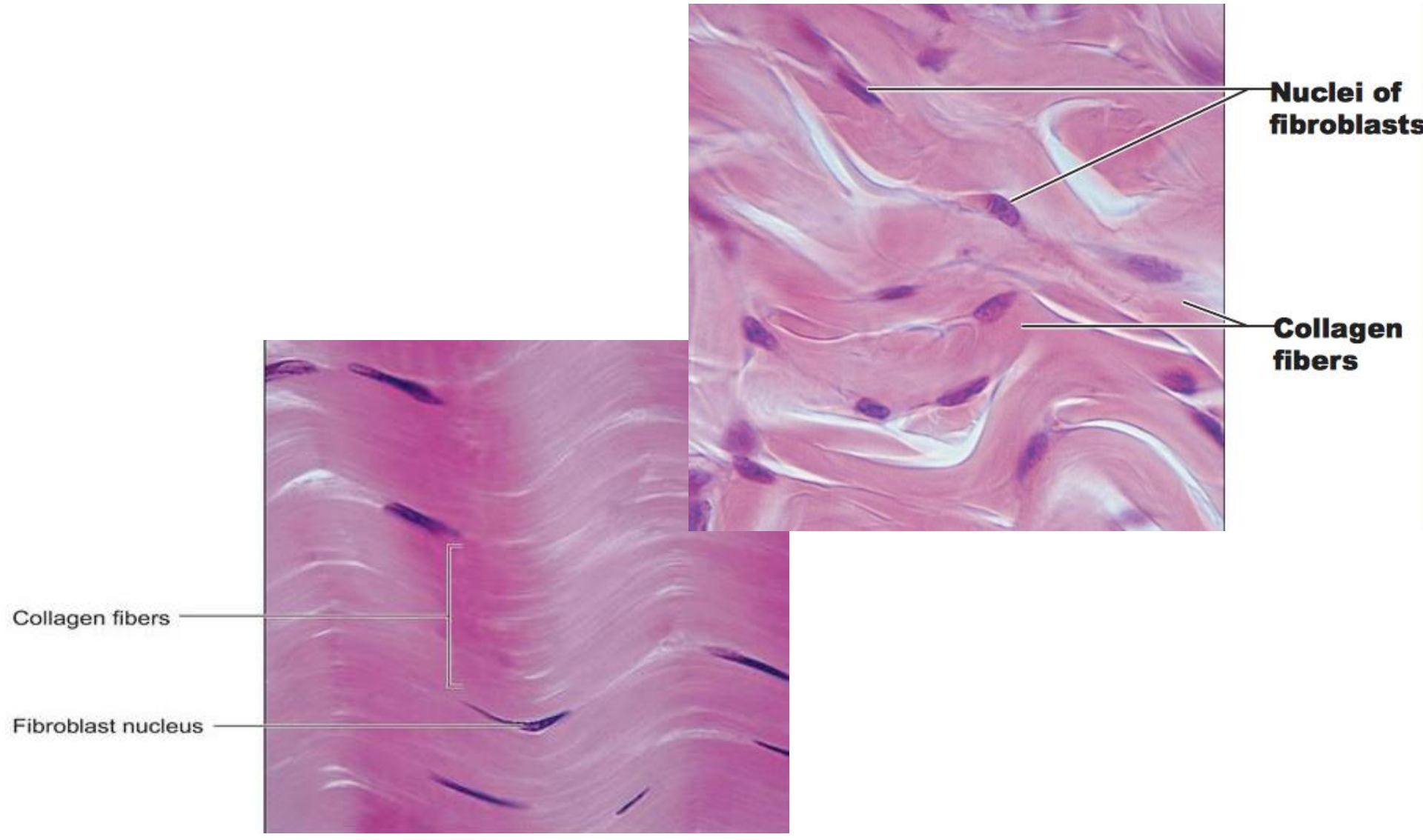
CLASSIFICATION OF CONNECTIVE TISSUE PROPER

LOOSE CONNECTIVE TISSUE (Areolar CT)

- fills the spaces in the body, forms lining of internal body cavities, adventitia of blood vessels, surrounds parenchyma of glands

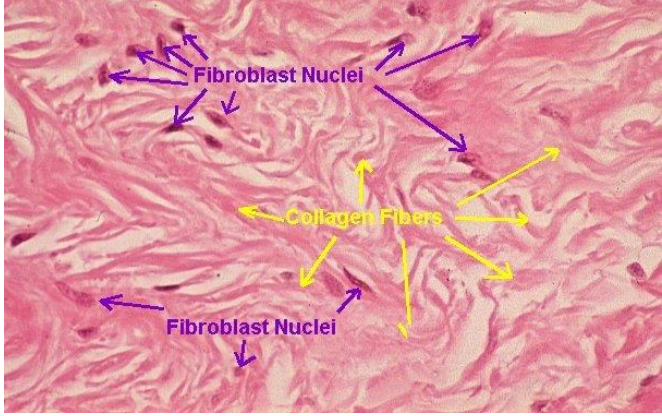


DENSE CONNECTIVE TISSUE - abundance of fibers, few cells

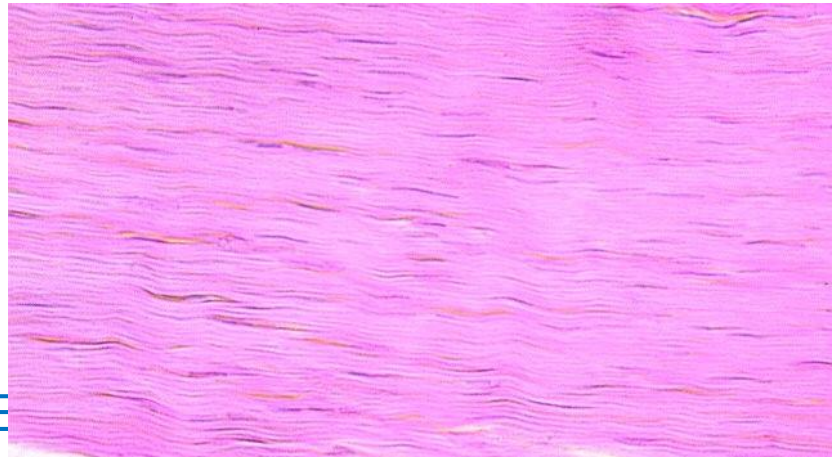


a) DENSE IRREGULAR CONNECTIVE TISSUE

Dermis of the skin, the sheaths of nerves, capsules of the spleen, testes, ovary, kidneys, lymph nodes



b) DENSE REGULAR CONNECTIVE TISSUE

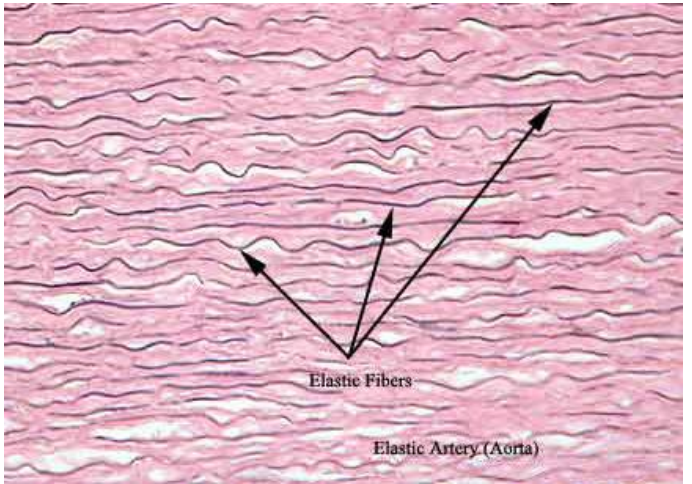


DENSE REGULAR COLLAGENOUS CONNECTIVE TISSUE

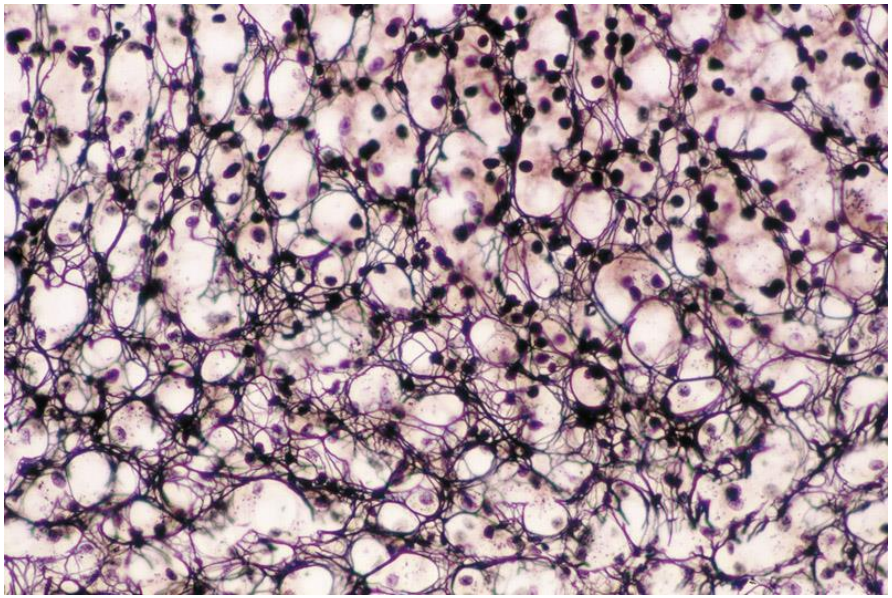
Tendons, ligaments, aponeuroses

DENSE REGULAR ELASTIC CONNECTIVE TISSUE

Walls of large blood vessels, ligamenta flava in vertebral column

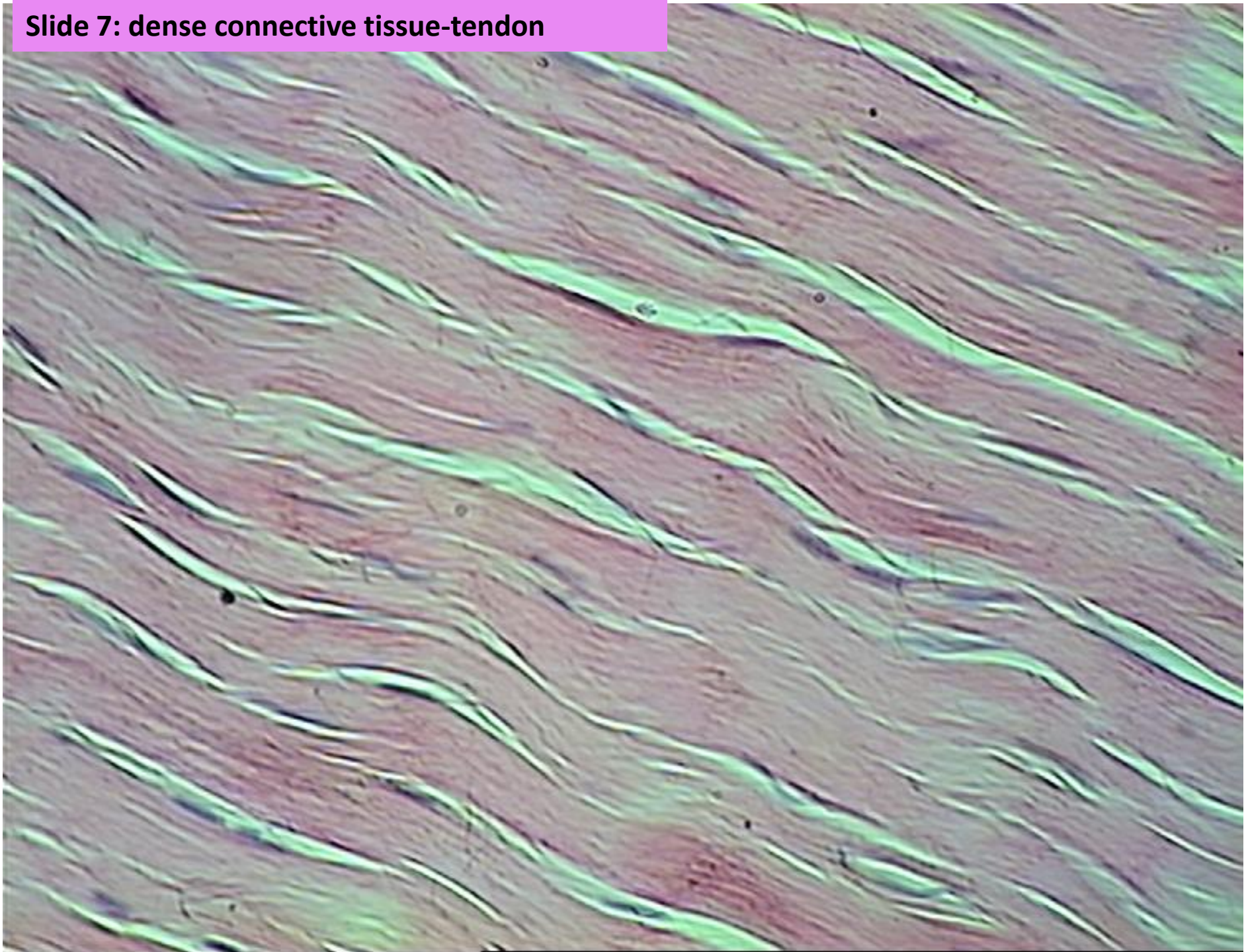


RETICULAR TISSUE major component - fibers is type III collagen
Framework of liver sinusoids, adipose tissue, bone marrow, lymph nodes, spleen, smooth muscles, islets of Langerhans



Reticular fibers – silver impregnation

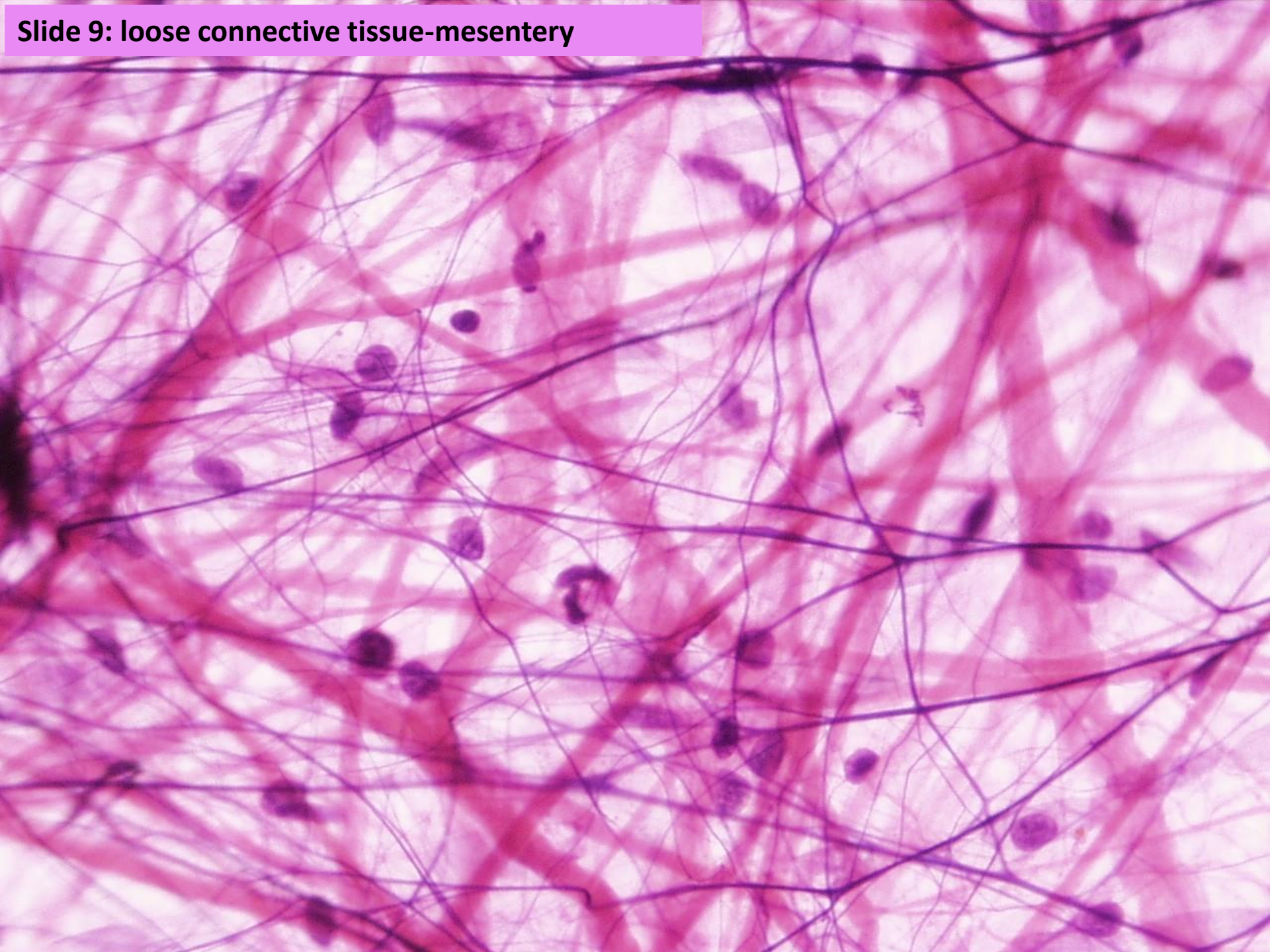
Slide 7: dense connective tissue-tendon



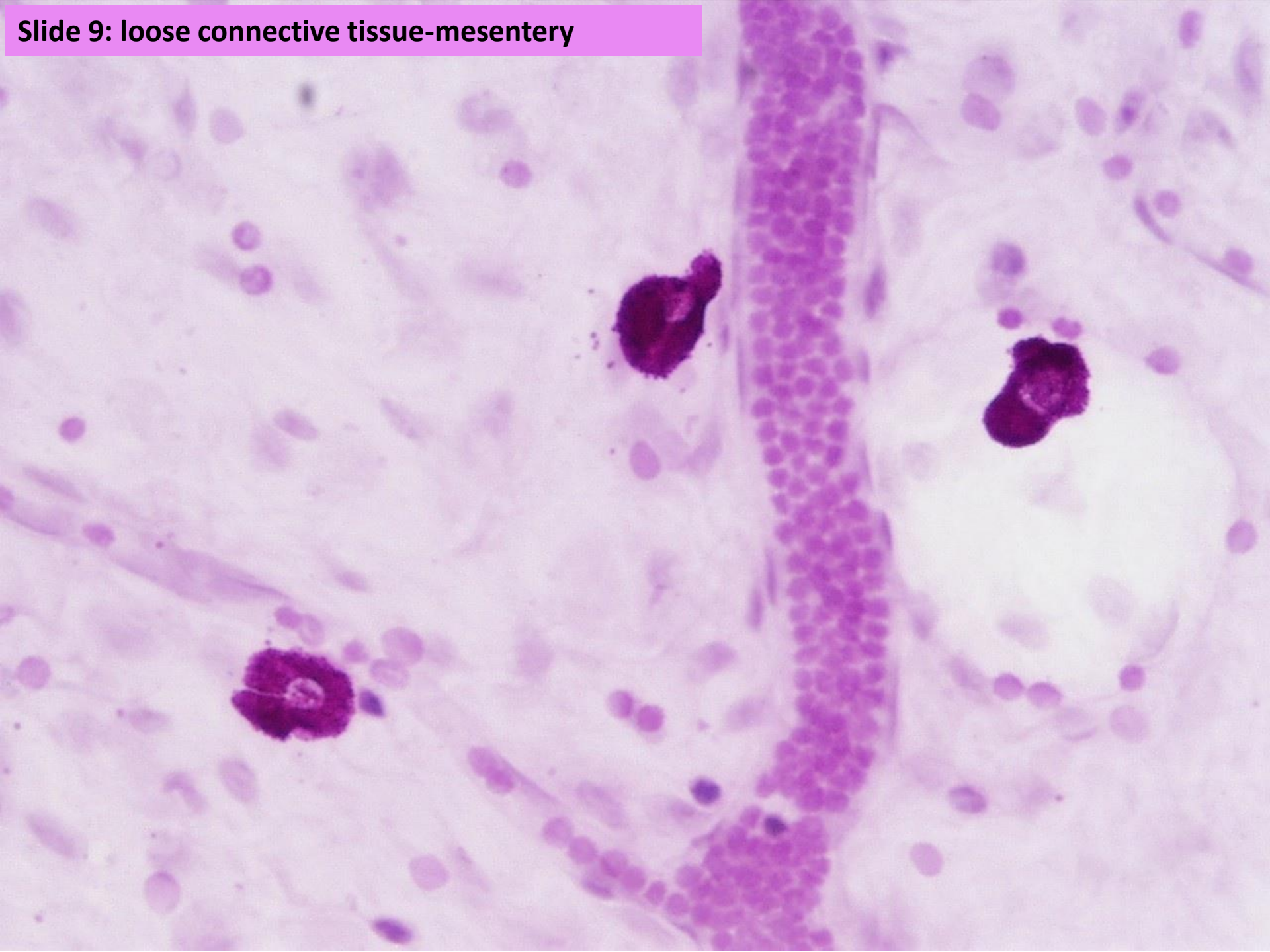
Slide 7: dense connective tissue-tendon

Slide 7: dense connective tissue-tendon

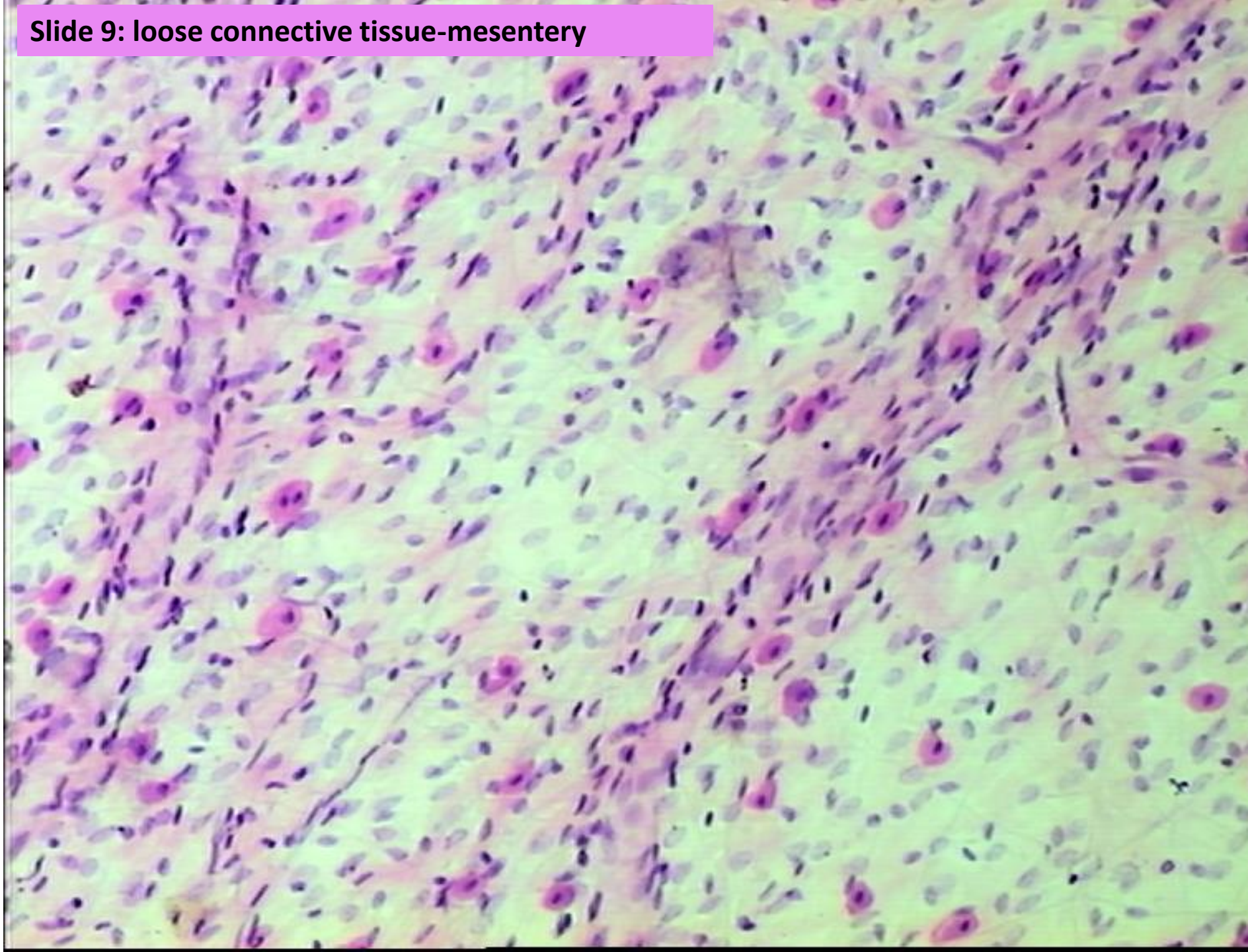
Slide 9: loose connective tissue-mesentery



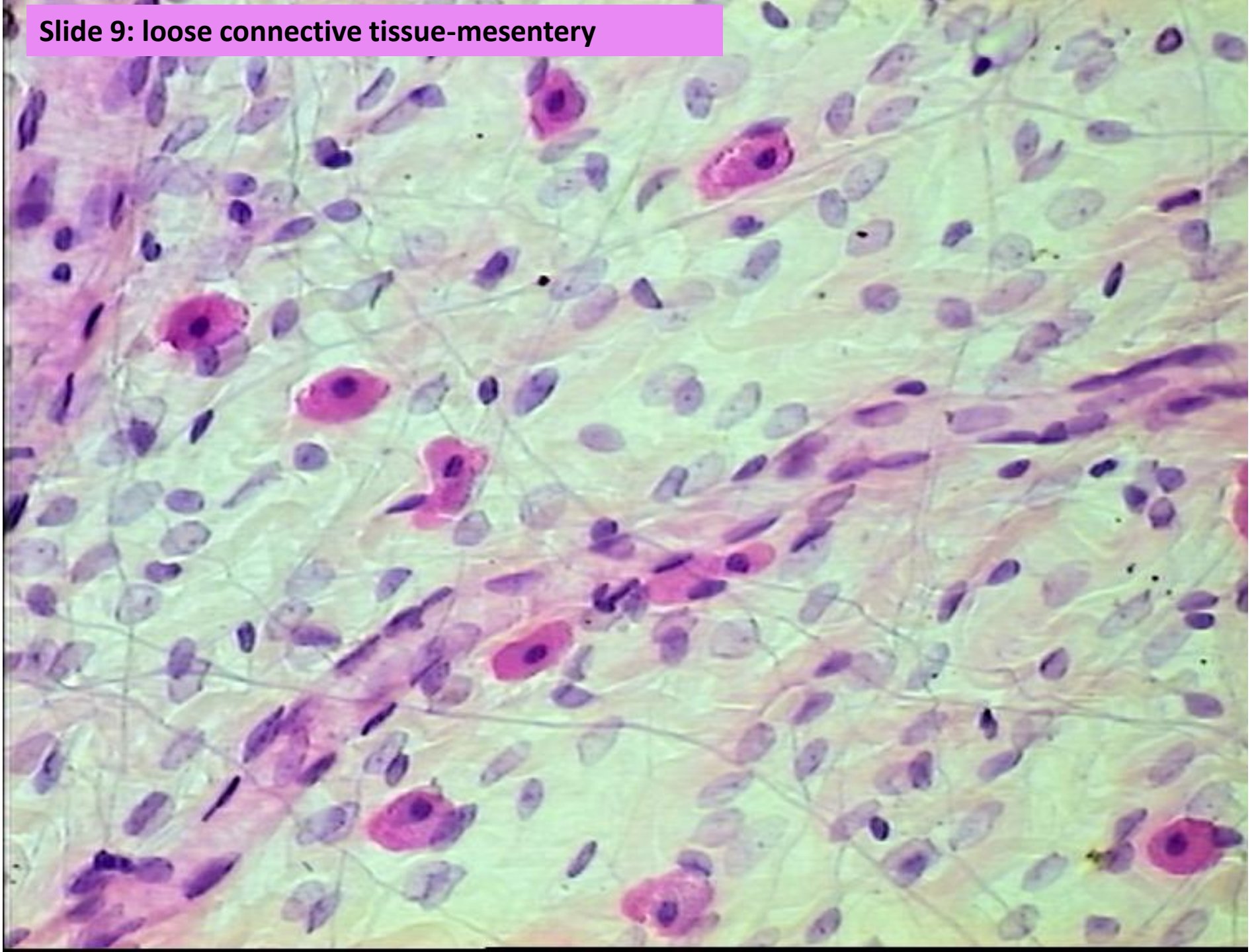
Slide 9: loose connective tissue-mesentery



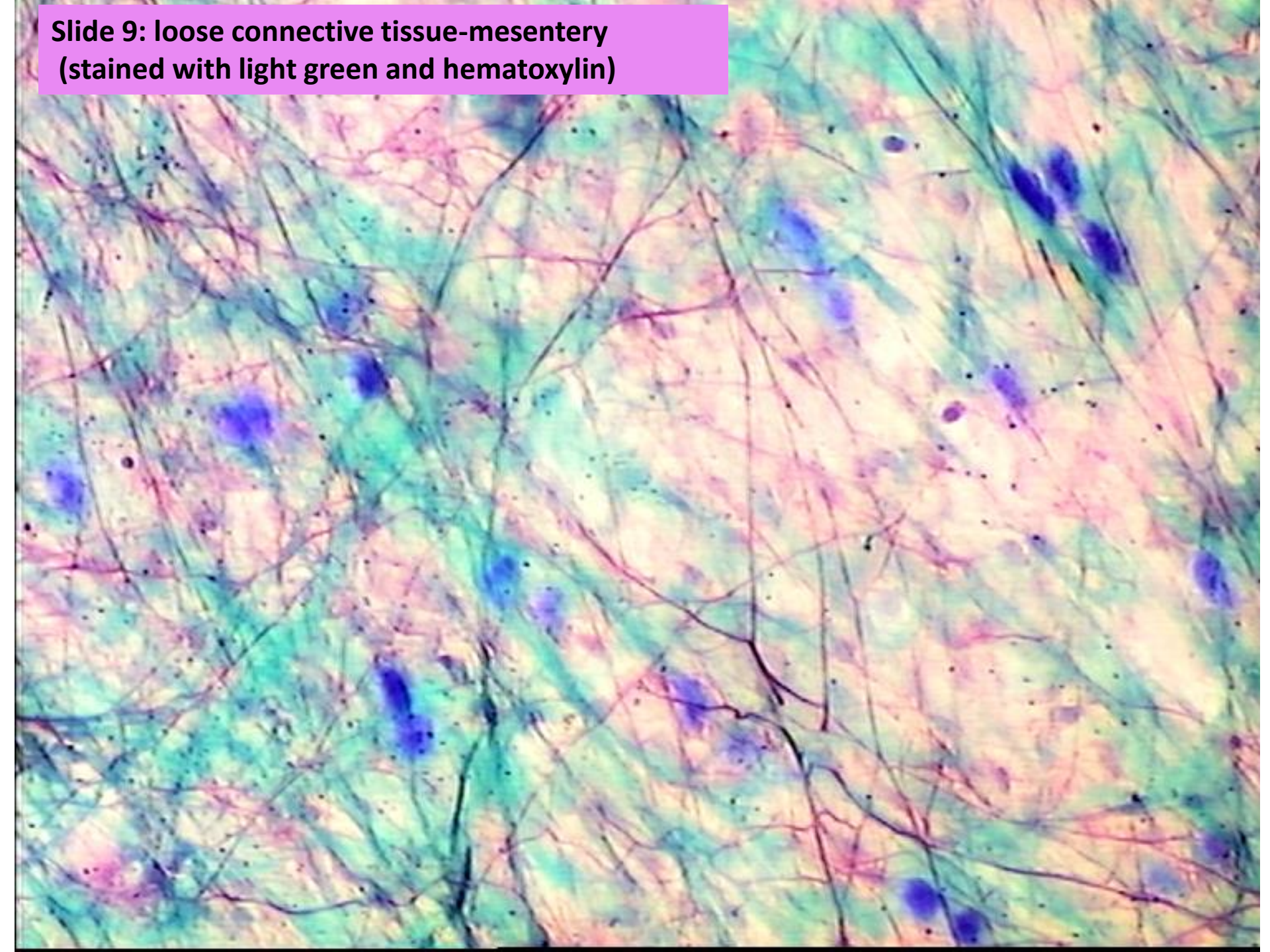
Slide 9: loose connective tissue-mesentery



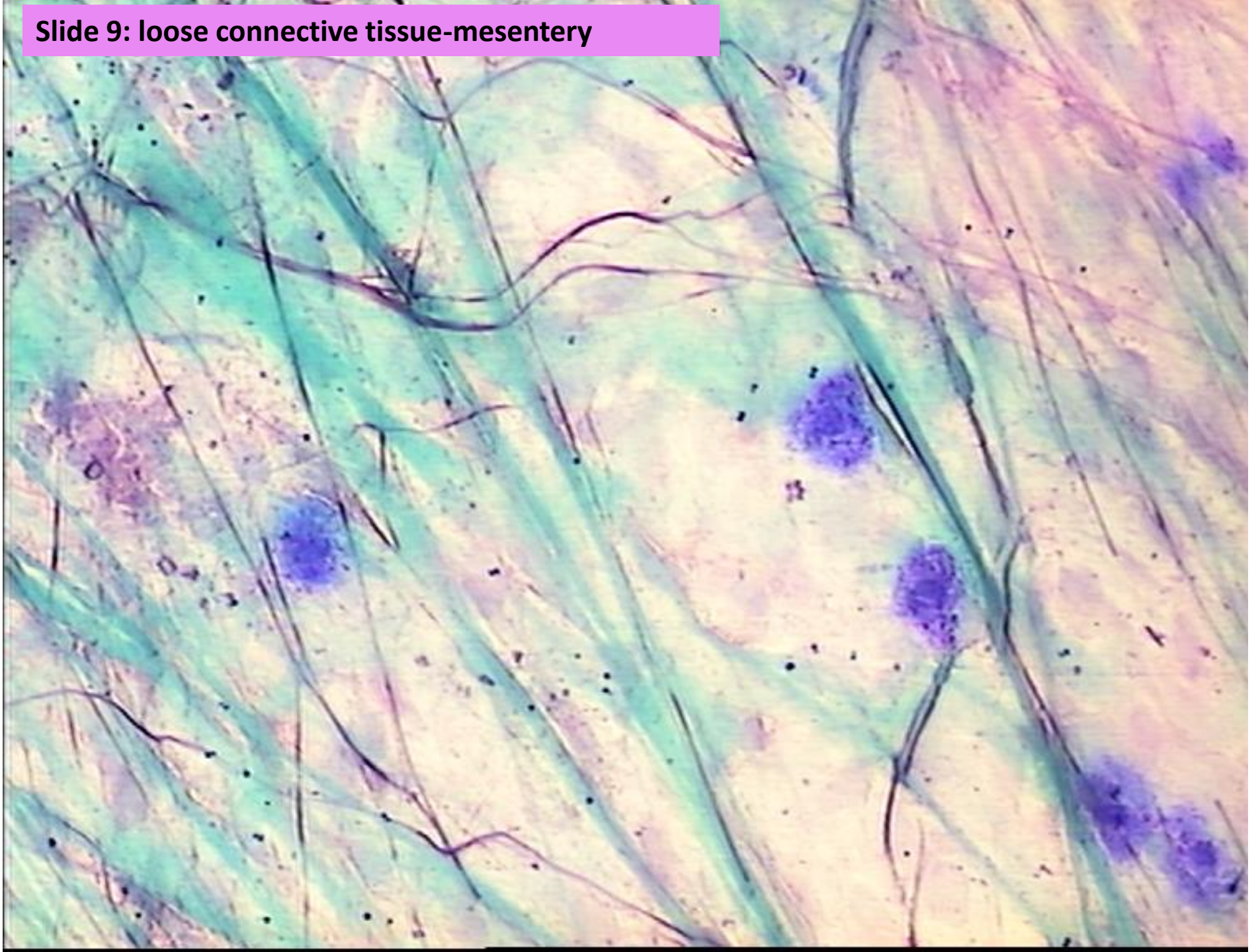
Slide 9: loose connective tissue-mesentery



Slide 9: loose connective tissue-mesentery

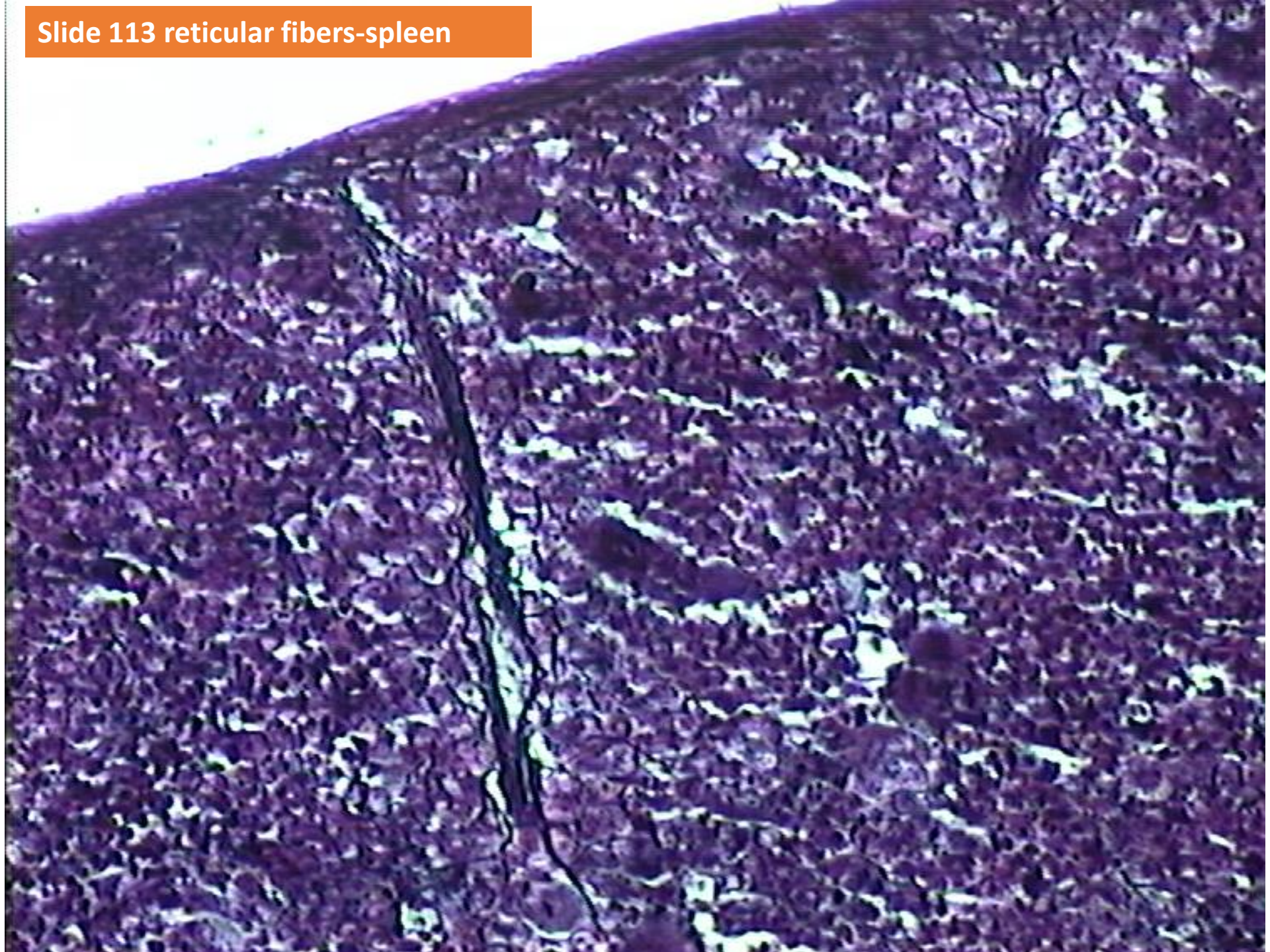

Slide 9: loose connective tissue-mesentery
(stained with light green and hematoxylin)

Slide 9: loose connective tissue-mesentery

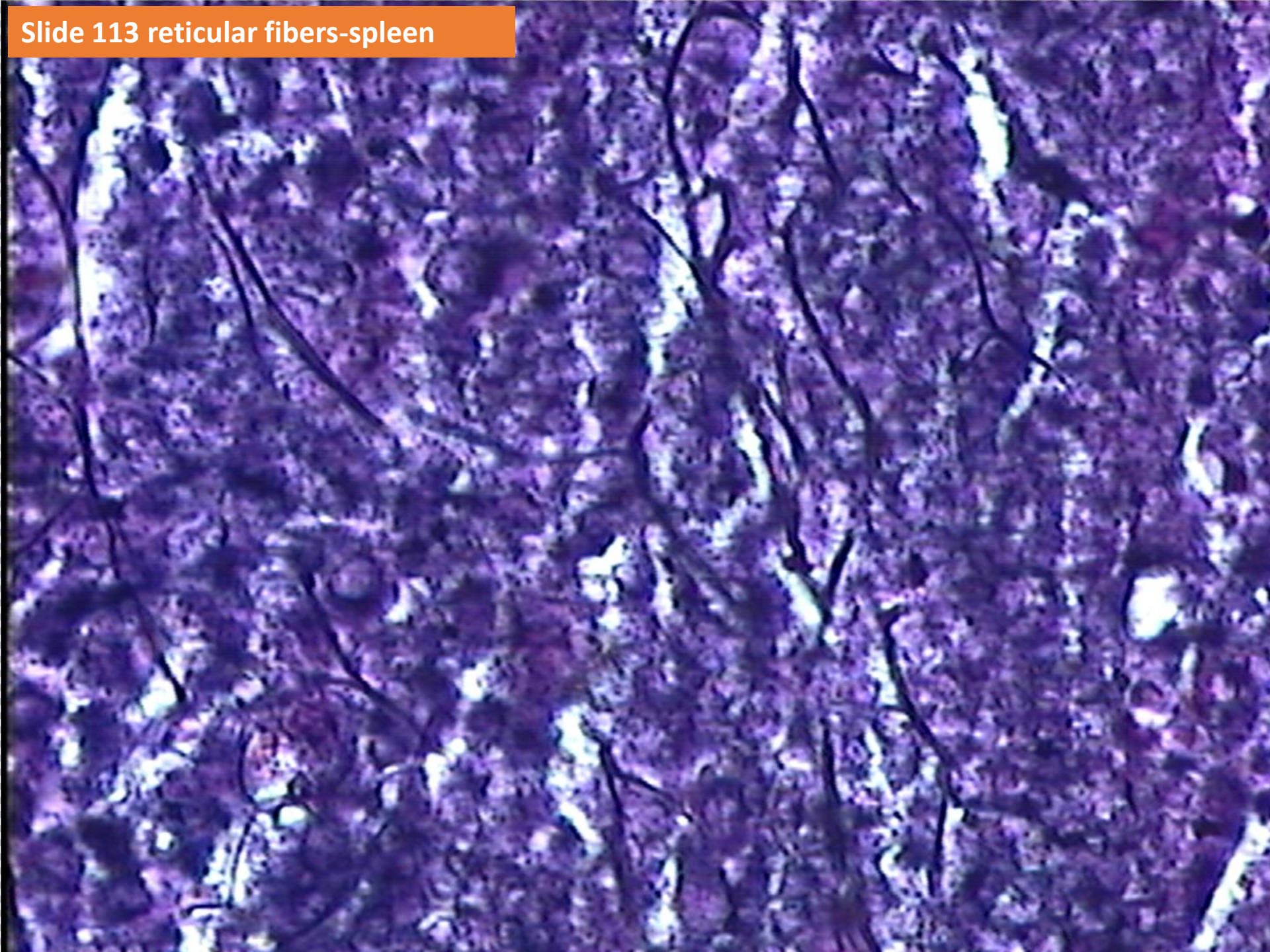


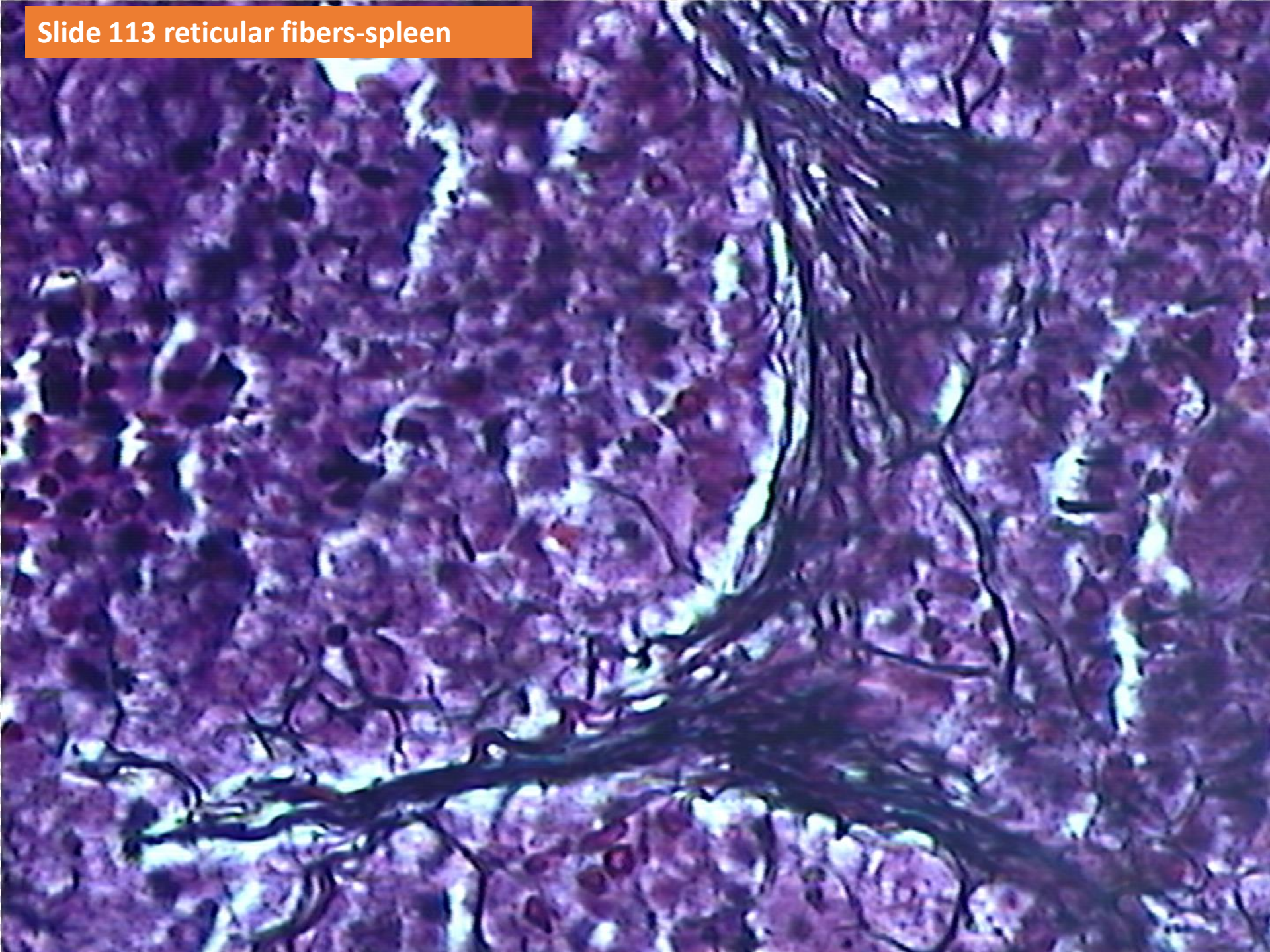
Slide 9: loose connective tissue-mesentery

Slide 113 reticular fibers-spleen

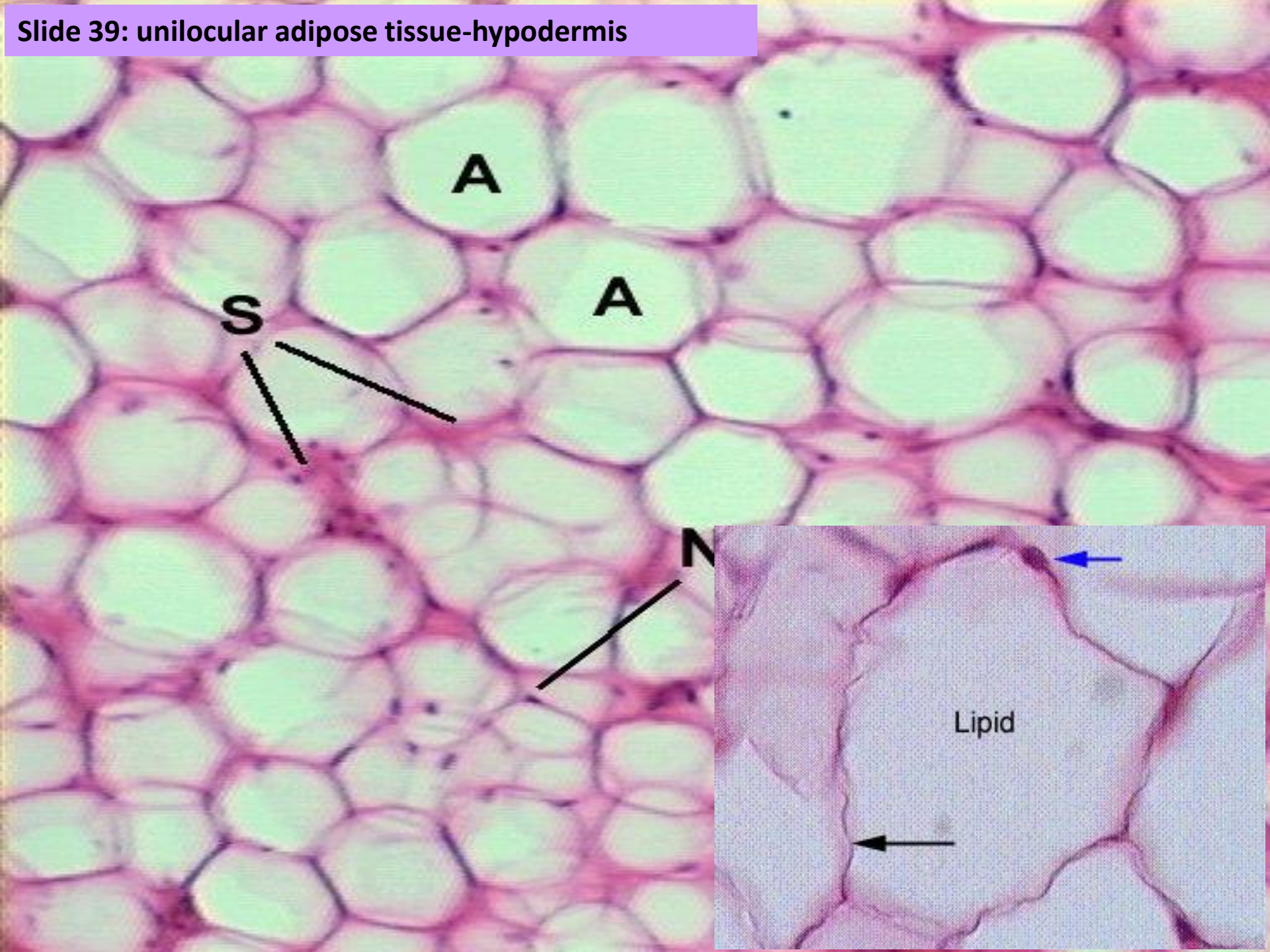


Slide 113 reticular fibers-spleen



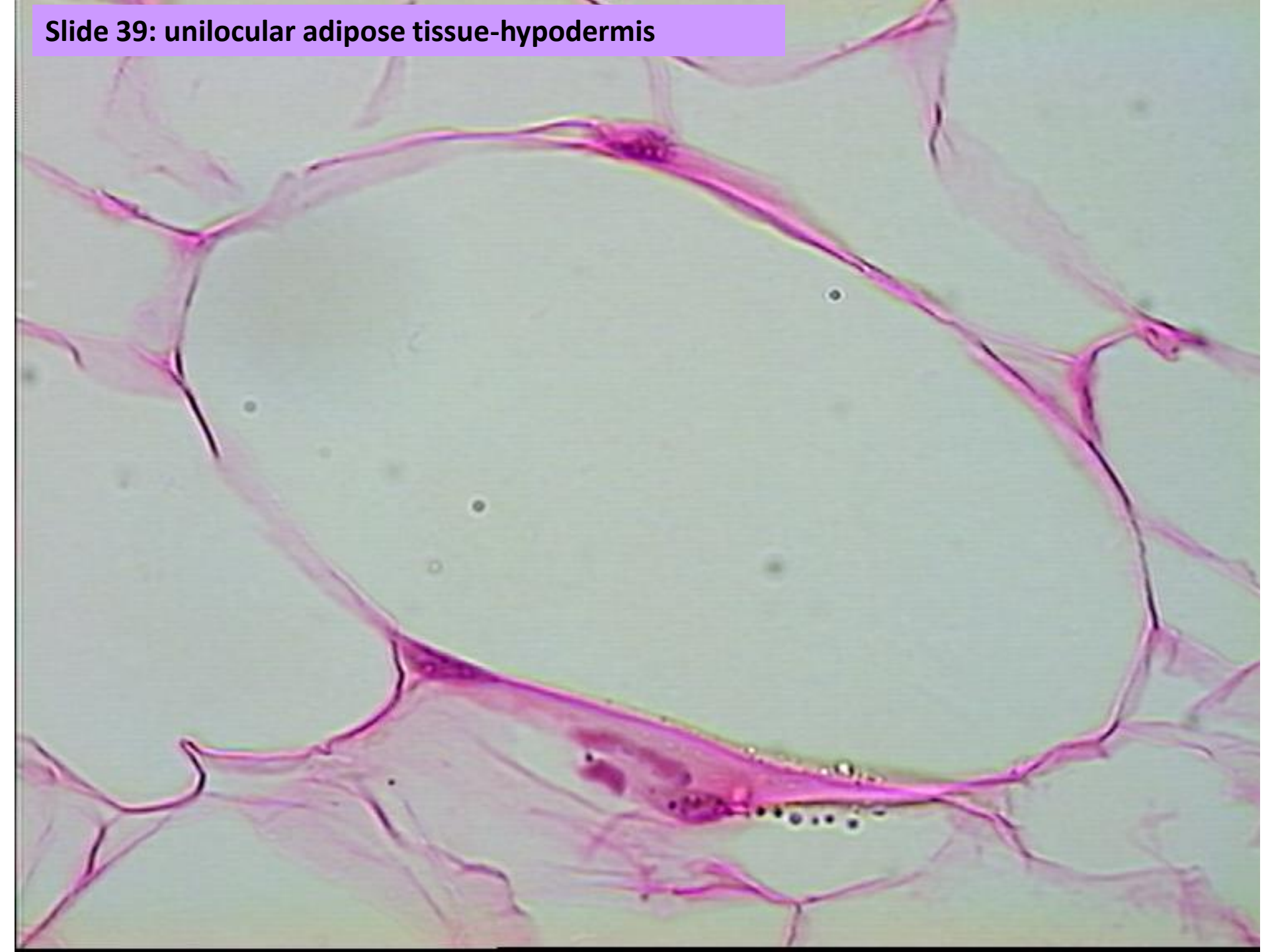

Slide 113 reticular fibers-spleen

Slide 39: unilocular adipose tissue-hypodermis

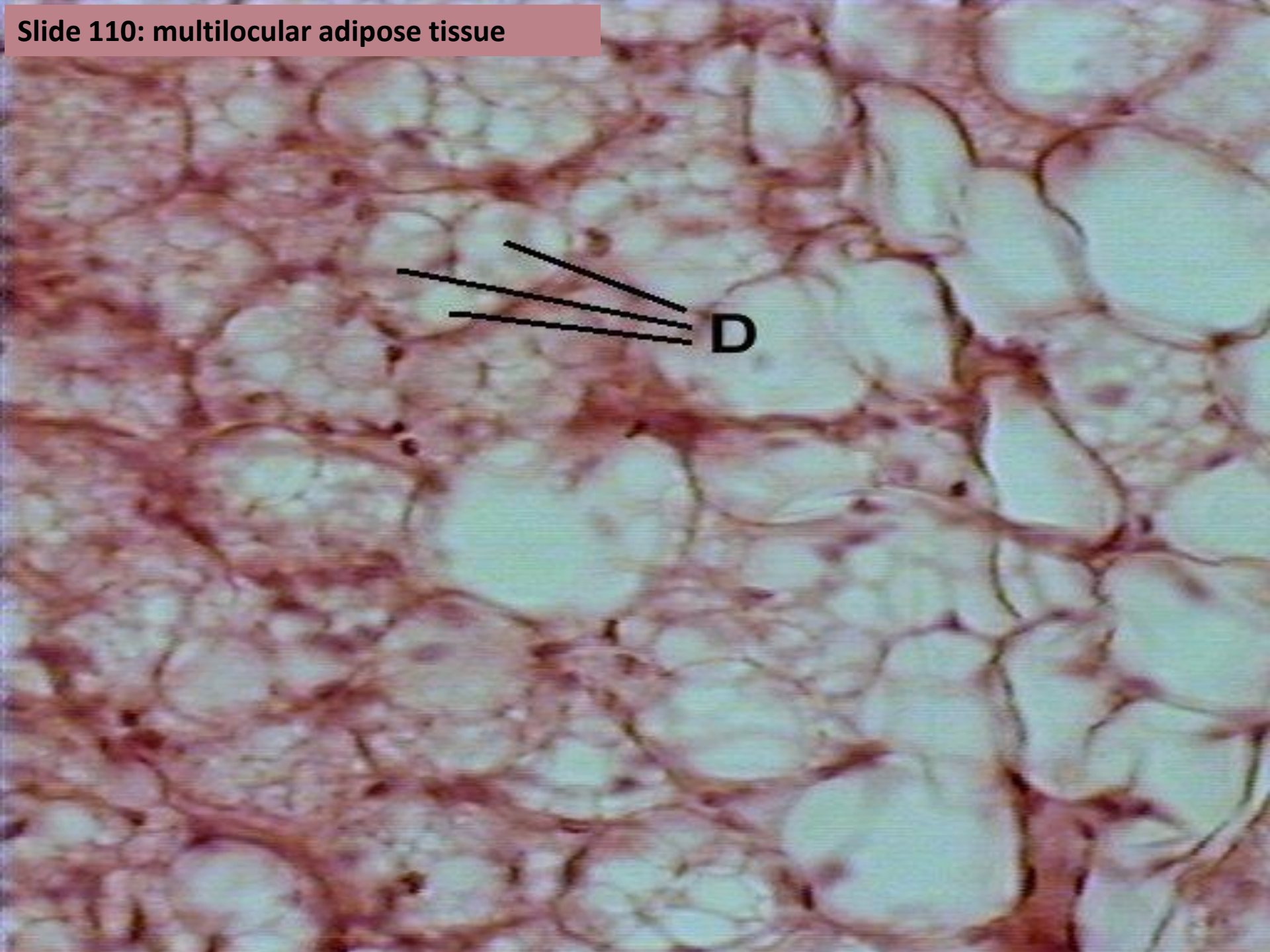


Slide 39: unilocular adipose tissue-hypodermis

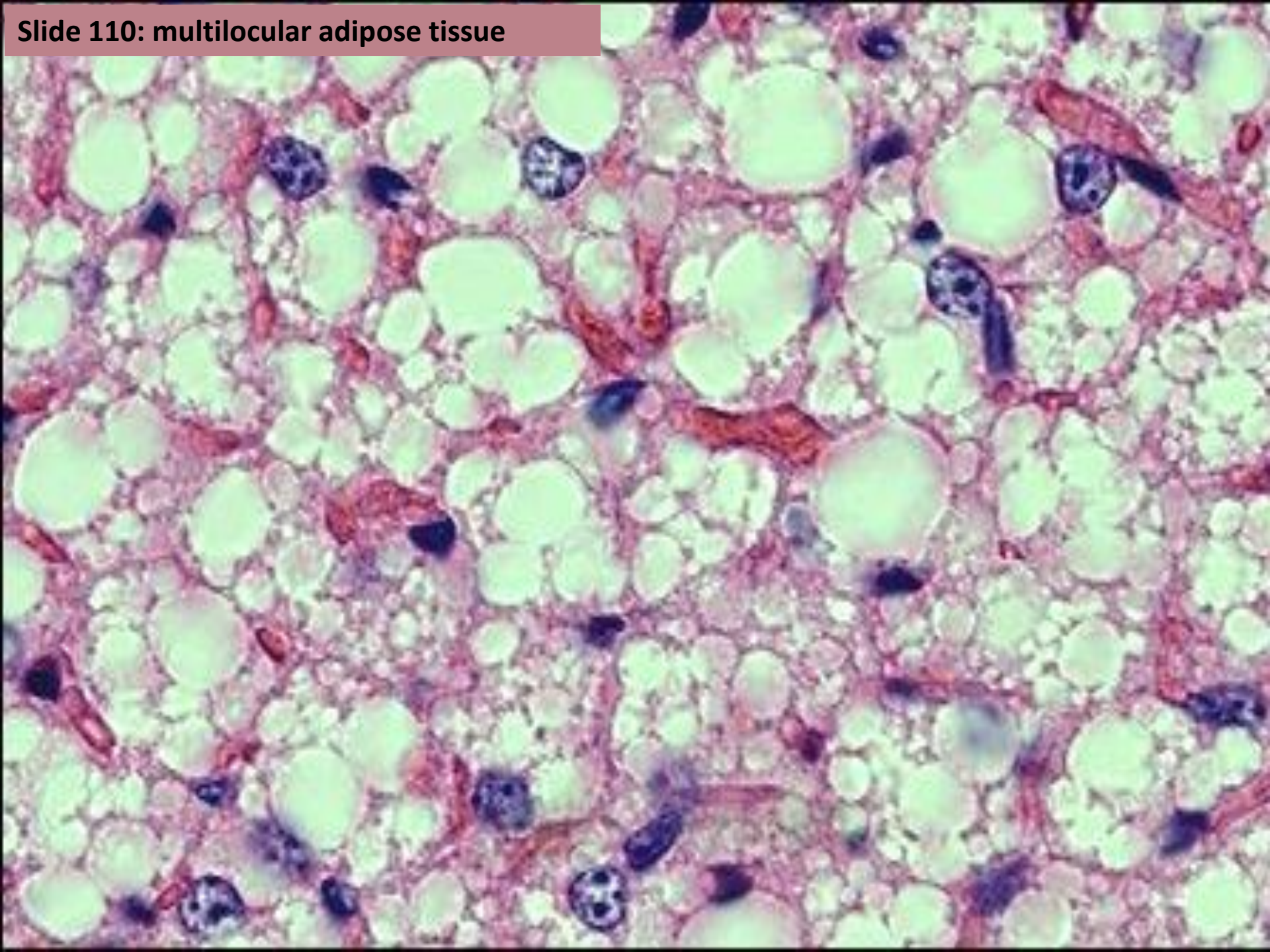
Slide 39: unilocular adipose tissue-hypodermis



Slide 110: multilocular adipose tissue

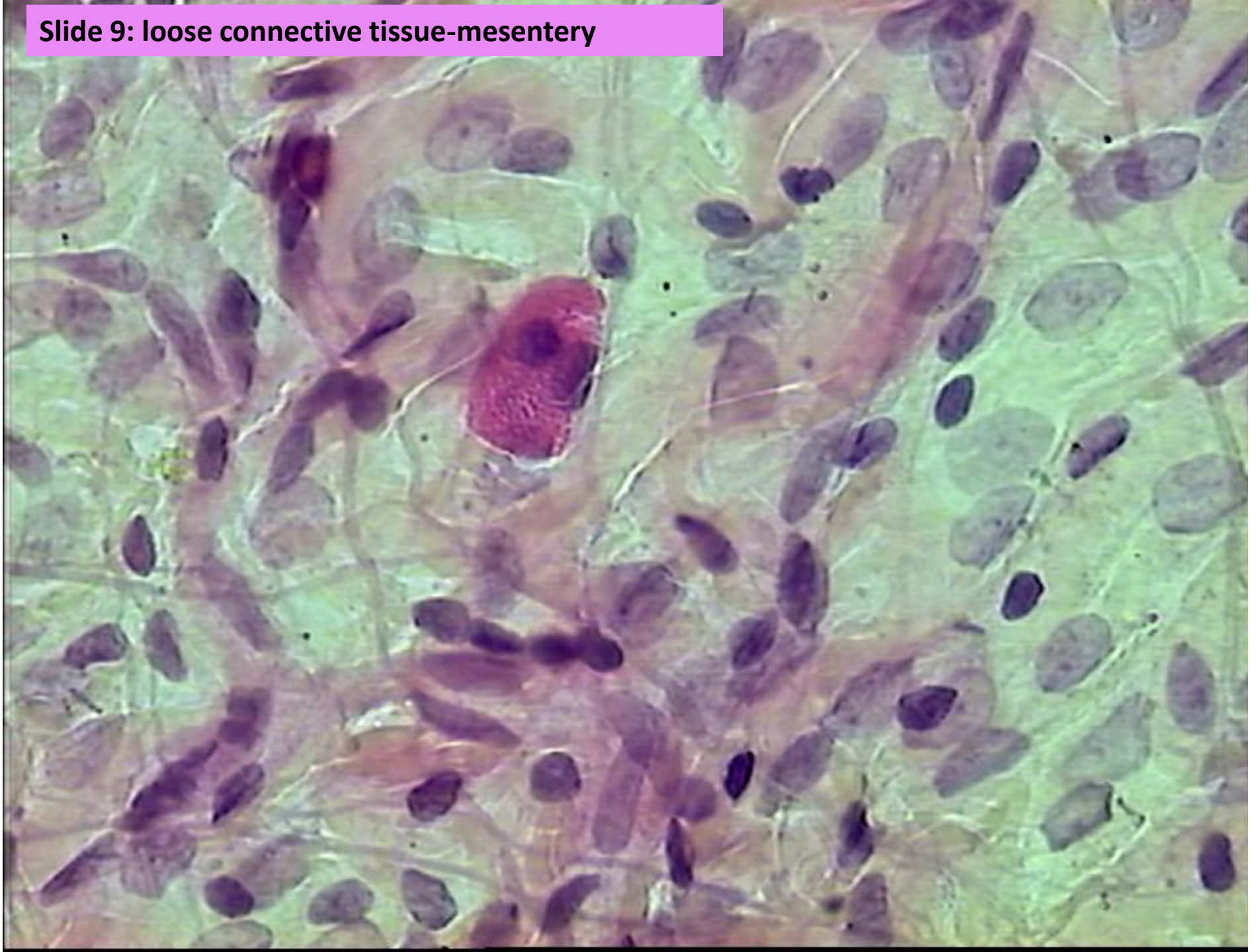


Slide 110: multilocular adipose tissue

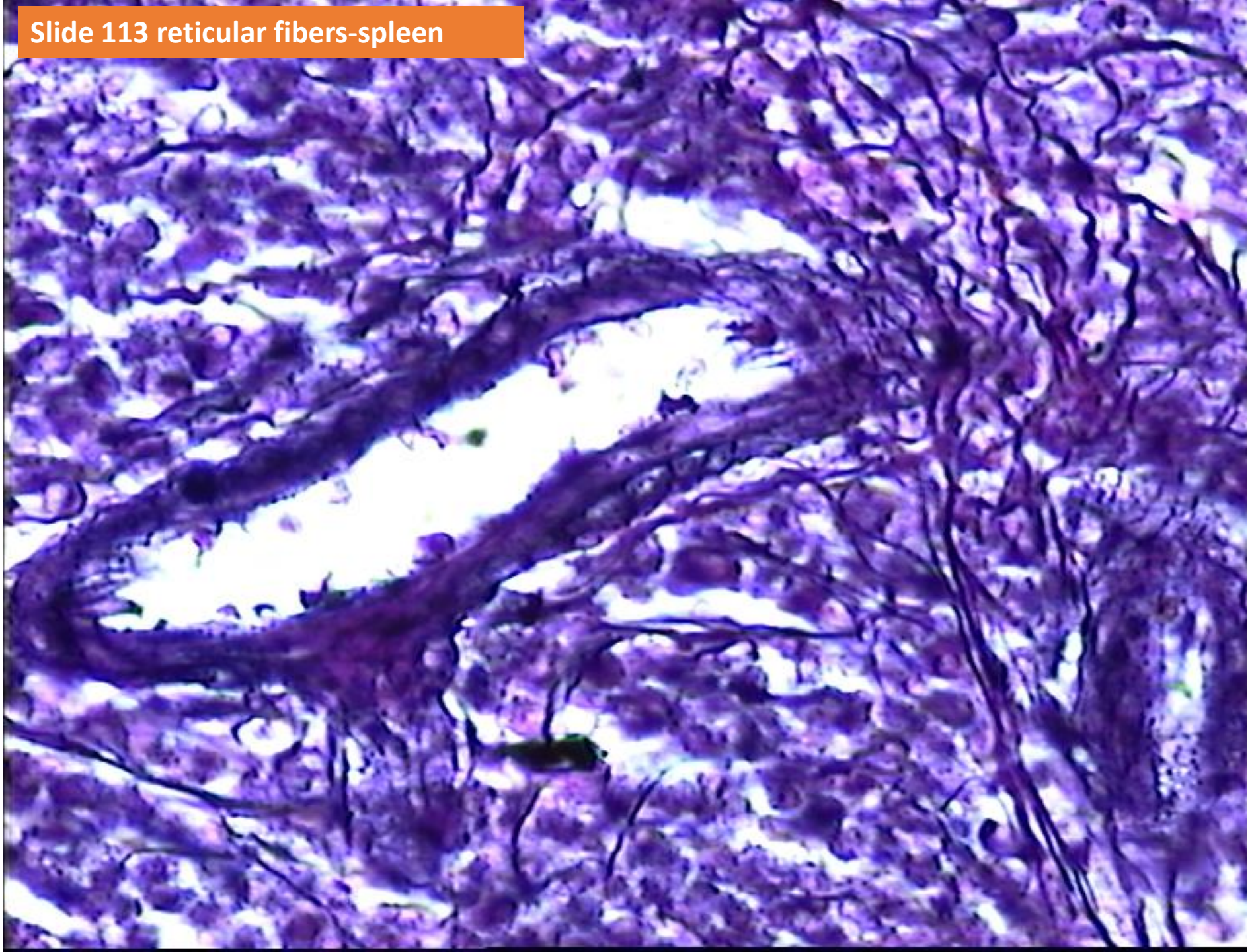


Next chapter –
Cartilage and bone, No 7

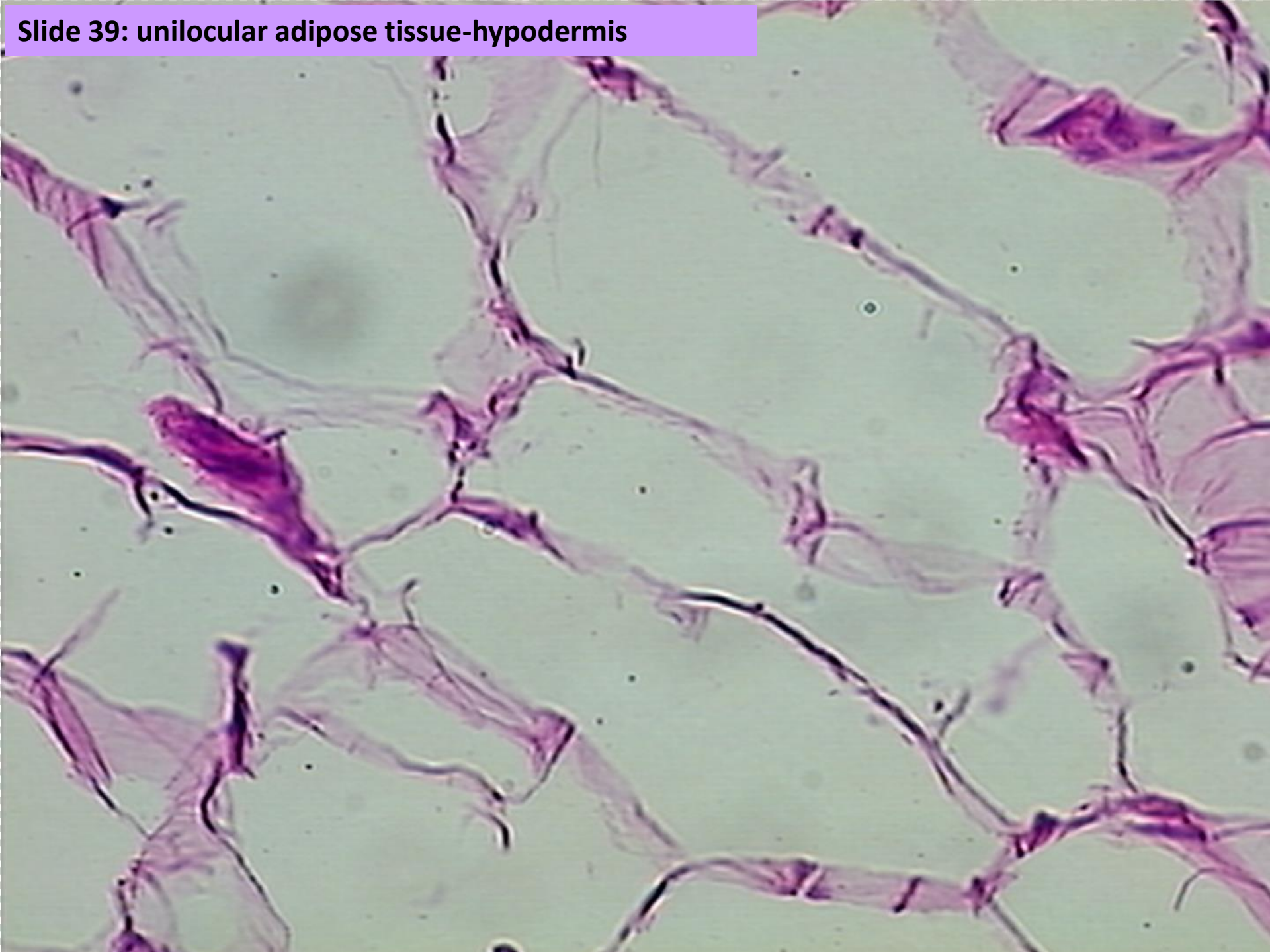
Slide 9: loose connective tissue-mesentery

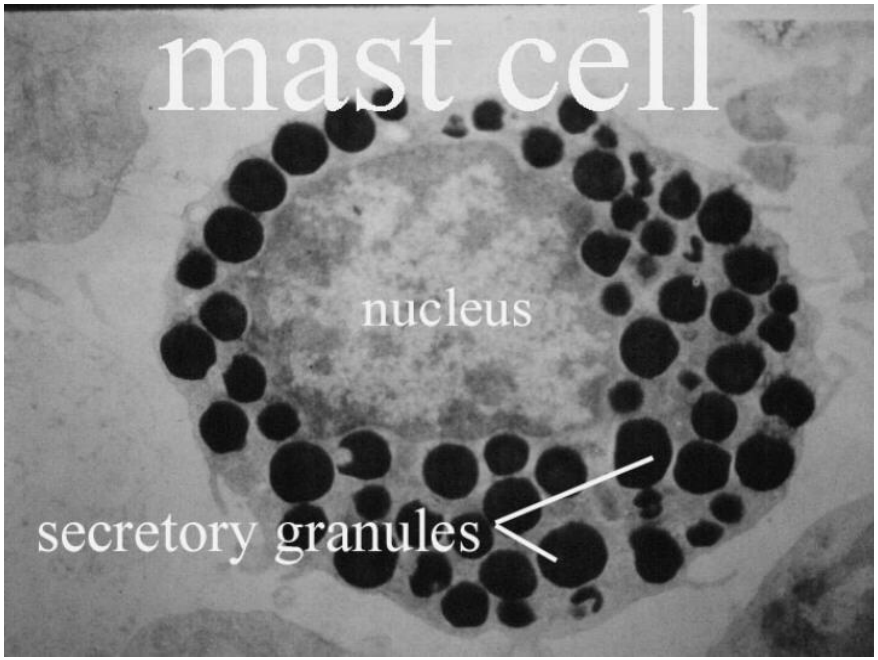


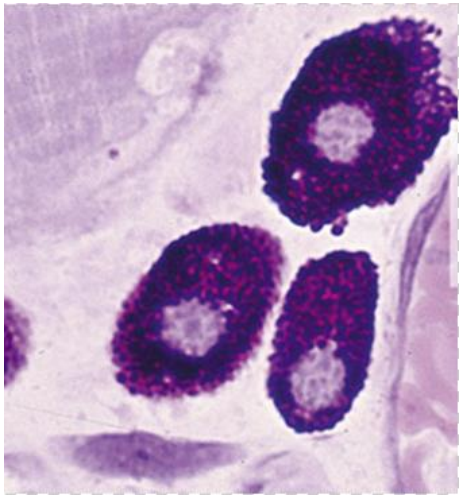
Slide 113 reticular fibers-spleen



Slide 39: unilocular adipose tissue-hypodermis







METACHROMASIA

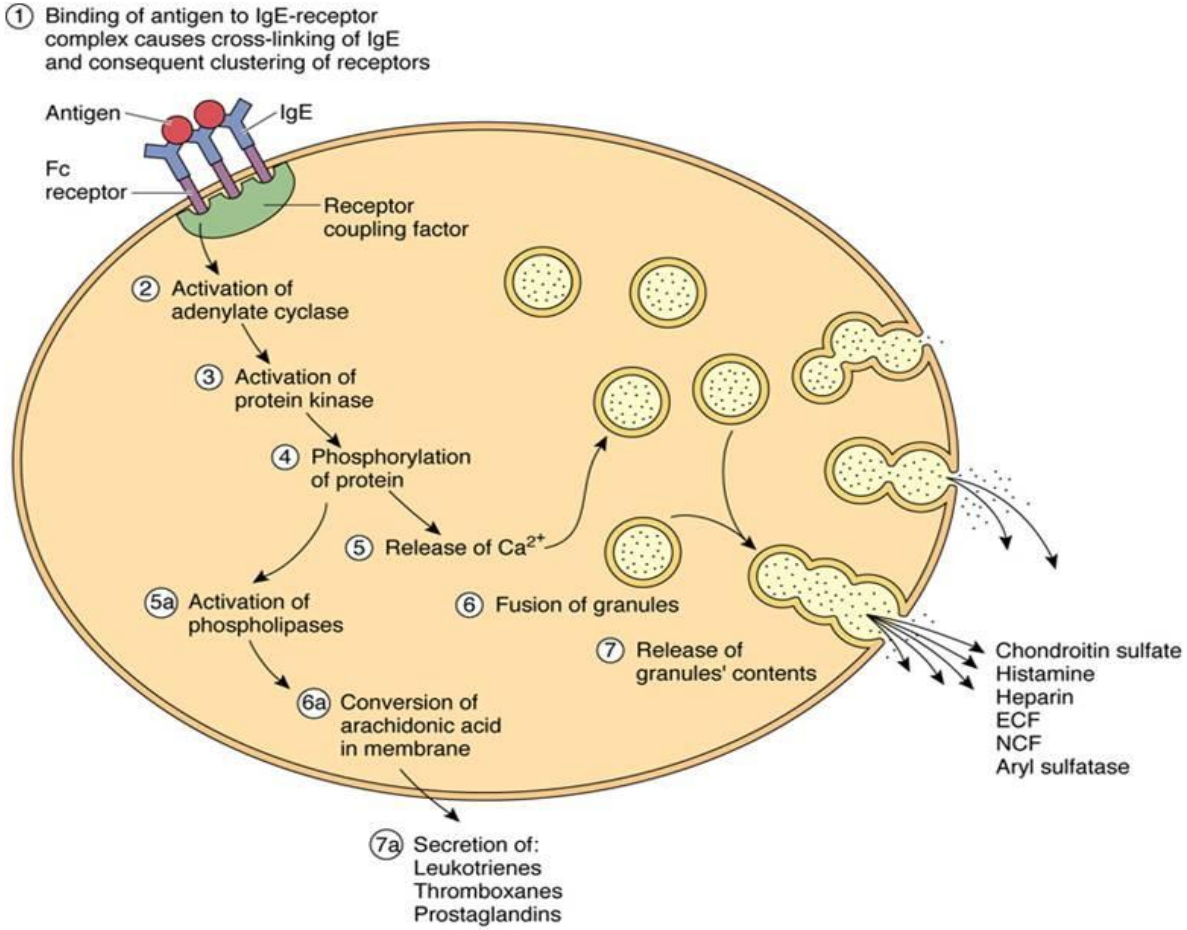
Characteristic change in the color of staining carried out in biological tissues, exhibited by e. g. toluidine blue when it binds to particular substances.

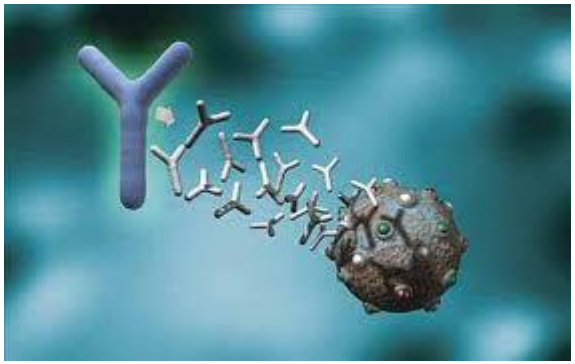
The molecules of concentrated basic dye polimerize in the presence of polyanions within the tissue. The absorption properties of these aggregations differ from those of the individual dye molecules.

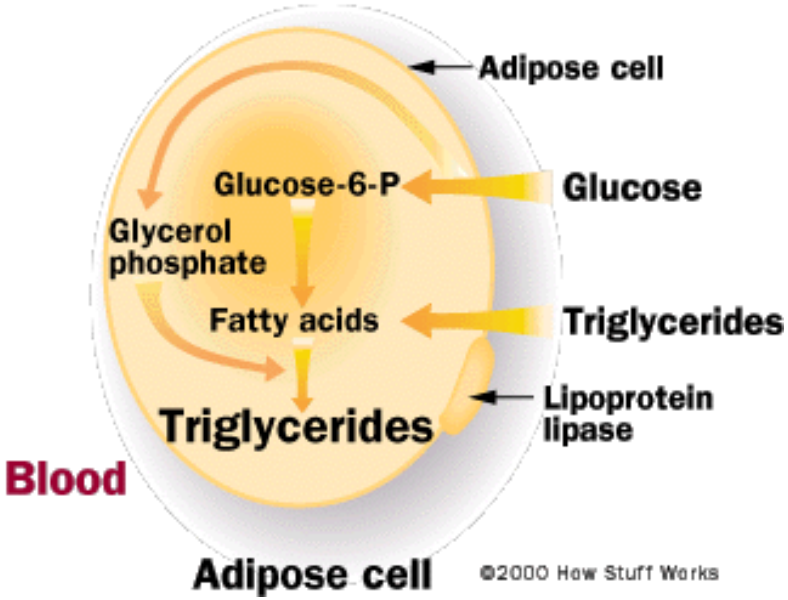
Cell and tissue structures that have high concentrations of ionized sulfate and phosphate groups-such as the ground substance of cartilage, heparin-containing granules of mast cells, exhibit metachromasia.

Mast cell activation and degranulation.

When the first exposure to the antigen elicits formation of IgE antibodies, the inflammatory response termed immediate hypersensitivity reaction or their systemic form an anaphylactic reaction develop.






Adipose cell
Glucose-6-P
Glucose
Glycerol phosphate
Fatty acids
Triglycerides
Triglycerides
Lipoprotein lipase
Blood
Adipose cell
©2000 How Stuff Works