HISTOLOGY OF FIBROUS CONNECTIVE TISSUE

Obimbo MM,

PRACTICAL OBJECTIVES

- At the end of this practical session, you should be able to:
  - Define and classify connective tissue types
  - Explain the functions of connective tissue
  - Describe the histogenesis of connective tissue fibres
  - Recognize the different types of connective tissue under a light microscope
  - State the applied anatomy aspects of connective tissue types

Definition and classification

- Tissue responsible for support, connects or separates different types of tissues and organs
- Composition
  - Cells
  - Extracellular matrix (abundant)
    - Protein fibres
    - Amorphous ground substance
    - Tissue fluid (constant)

Functions

- Structural support
  - Connective tissue capsules surrounding organs (such as the kidney, lymph nodes).
  - The loose connective tissue acts to fill the spaces between organs.
- Metabolic function
  - Nutritive, excretory, thermal
- Hematopoietic
  - Myeloid, lymphoid
- Immunity
  - plasma cells, lymphocytes, neutrophils, eosinophils
- Wound repair / inflammatory response –
  - Fibroblast, Scar tissue

Cell type	Chief function
Mesenchyme	Embryonic source of all connective tissue cells, stellate shaped and migratory Has various sources- mesodermal Ectodermal, special characteristics
Fibroblasts Chondroblasts Osteoblasts	Structural support
Plasma cells, Lymphocytes Neutrophils, Eosinophils, Basophils Mast cells, Macrophages	Defense and immune
Adipocytes	Metabolic Energy storage Thermal insulation

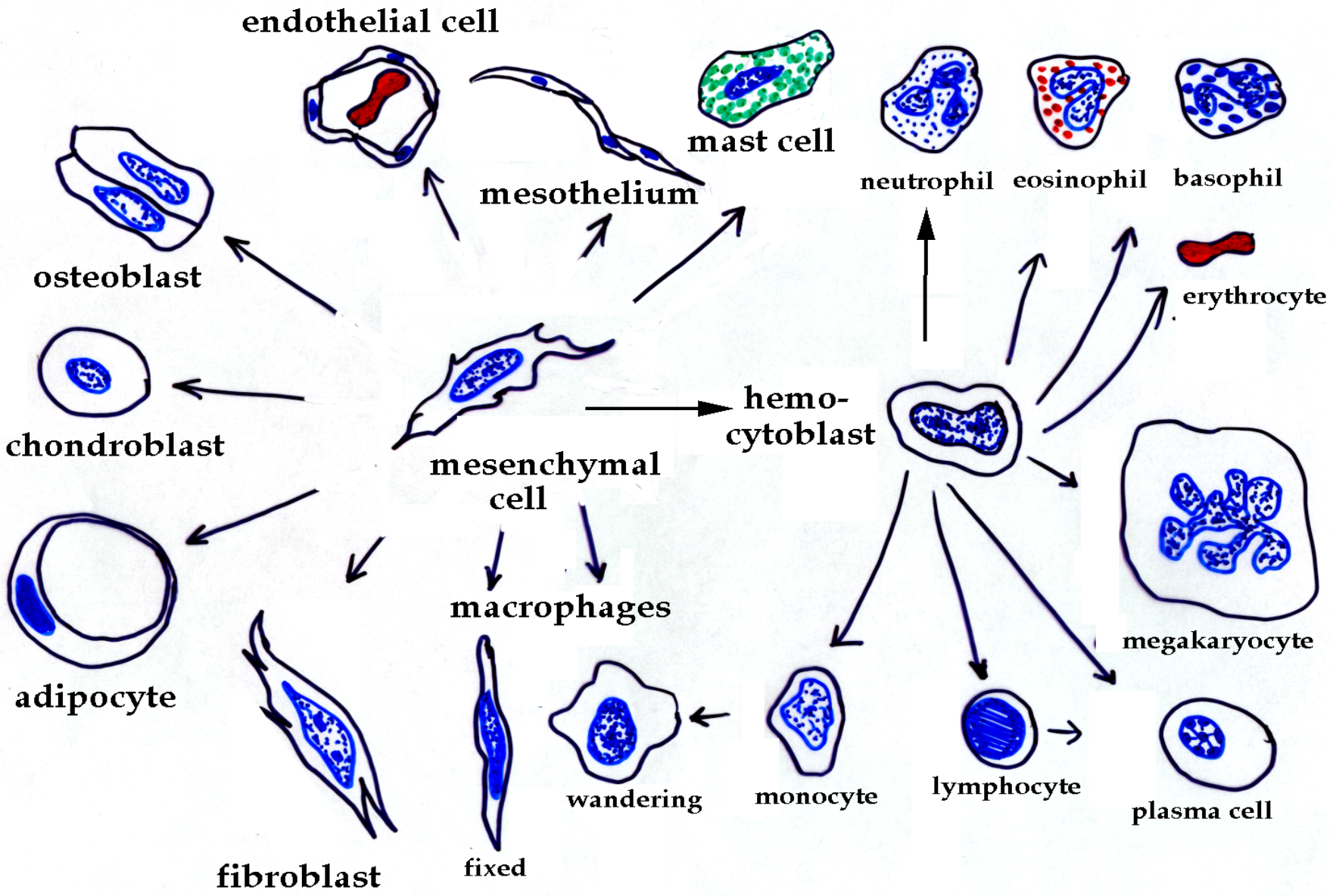
Resident

Fibroblast, adipocytes and tissue macrophages

Wandering/Transient;

Immune and inflammatory cells

Cell Lineage from Mesenchymal Cells



Amorphous ground substance

- Amorphous gelatinous material, transparent, colourless, and fills the spaces between fibres and cells
- Composed of glycosaminoglycans which link up to form proteoglycans, High capacity for water absorption
- GAGS
  - Made of polysaccharide chains
  - Negatively charged, inflexible, hydrophilic
  - Four types: Hyaluronic acid, Chondroitin sulfate, Keratan sulfate, heparan sulfate
- Proteoglycans
  - GAGs attached to core protein eg perlecan in basal lamina, aggrecan
- Multiadhesive glycoproteins – laminin, fibronectin, integrin

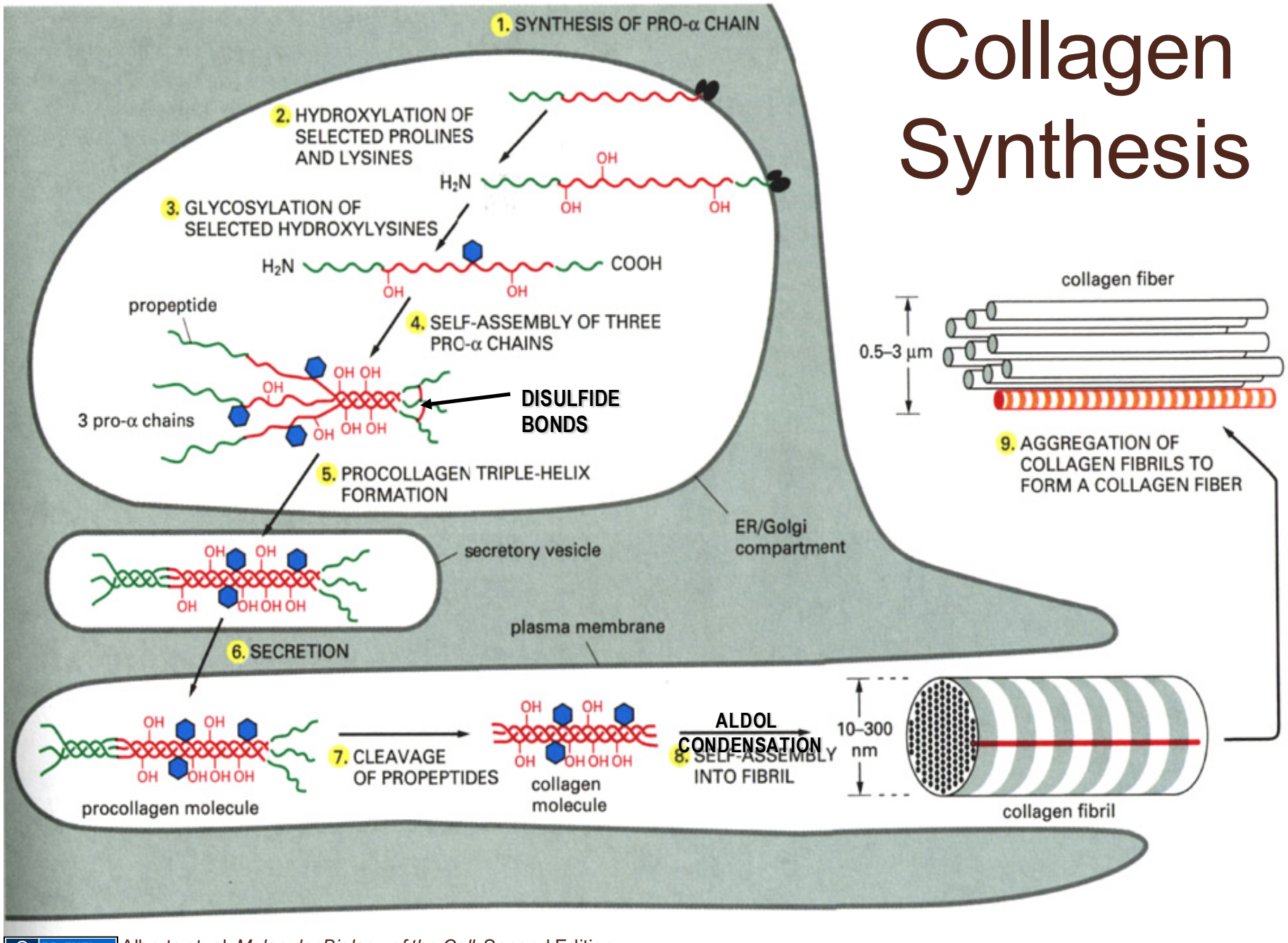
Connective tissue fibres - Collagen

- Most abundant protein in human body (up to 30% dry weight)
- Multiple types: fibril-forming or fibril-associated (in skin, tendon, cartilage, bone, dentin, blood vessels); cross-linked networks (in all basement membranes)
- Synthesized by various cells

- Main amino acids are
  - Glycine, Proline and Hydroxyproline
  - Unique AA, hydroxyproline and hydroxylysine

Collagen type	Main sites	Special features
Type I	Bones, tendons, organ capsules, dentin	Most abundant, Typical collagen fibers (64nm banding) Resist tension
Type II	Hyaline cartilage Elastic cartilage	Very thin fibrils Resist pressure
Type III	Reticular fibers	Often associated with Type I Structural support in expansible organs
Type IV	Basal lamina associated with epithelial and endothelial cells	Amorphous (non-fibrous)
Type V	Basal lamina associated with muscle	Amorphous (non-fibrous)

Collagen Synthesis



 Alberts et. al. *Molecular Biology of the Cell*. Second Edition.

Medical application

- Osteogenesis Imperfecta= A mutation in a single amino acid for example in glycine in collagen type I. Patients show spontaneous fractures and cardiac insufficiency
- Progressive systemic sclerosis= over accumulation of collagen (fibrosis).
- keloid= local swelling in the place of scars of the skin
- Scurvy= Deficiency of Vit C is characterized by degeneration of connective tissue. In Vit C deficiency the fibroblasts synthetize defective collagen (In the hydroxylation of proline)

Reticular fibres

- Made of collagen type III
- Forms thin and extensive network around the parenchymal cells of various organs for example liver and endocrine gland

Elastic fibres

- Elastic and stretch under tension
- Main protein is elastin
  - AA rich in glycine and proline
  - Unique AA, desmosine, valine and isodesmosine
- Name structures with elastic fibres

- Marfan syndrome: mutation in the fibrillin gene, the protein that produce the scaffolding necessary for elastin. Patients are lanky with inelastic tissues. Aortic aneurysms are common.

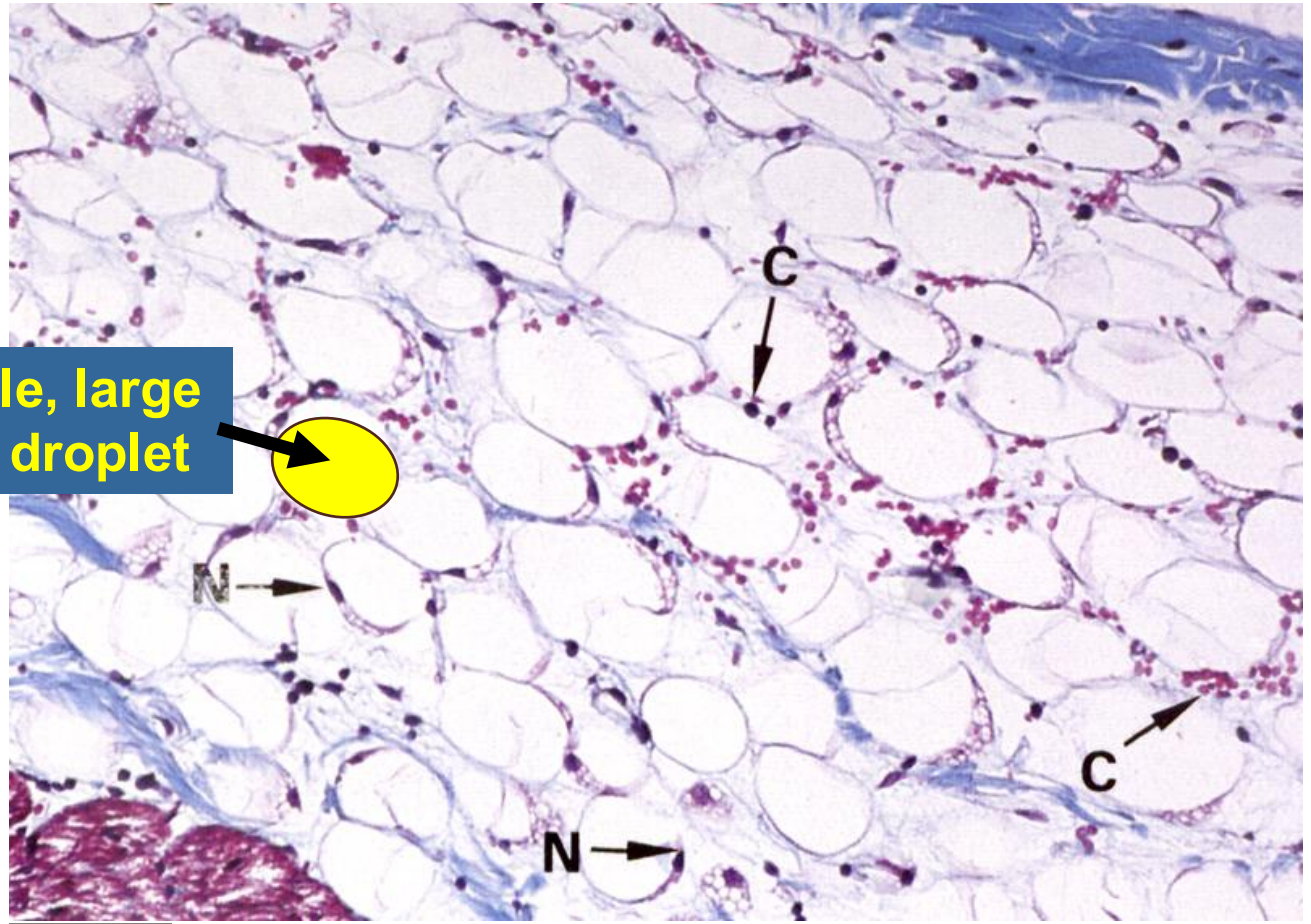
Fibroblasts are the most common cells in connective tissue

- Synthesize and secrete components of the ECM: fibers and ground substance.
- Active and quiescent stages (when quiescent sometimes called fibrocytes or mature fibroblasts).
- Synthesize growth factors.
- Rarely undergo cell division unless tissue is injured, which activates the quiescent cells.
- Play a major role in the process of wound healing and respond to an injury by proliferating and enhanced fiber formation.

Adipocytes predominate in adipose tissue

Very active cells with **many** functions:

- Triglyceride storage and glucose metabolism (insulin and glucagon receptors)
- Secretion of many bioactive molecules:
  leptin (regulates satiety) **angiotensinogen** (blood pressure) **steroids** (glucocorticoids & sex hormones)
  growth factors (e.g. insulin-like growth factor, tumor necrosis factor α) **cytokines** (e.g. interleukin-6)

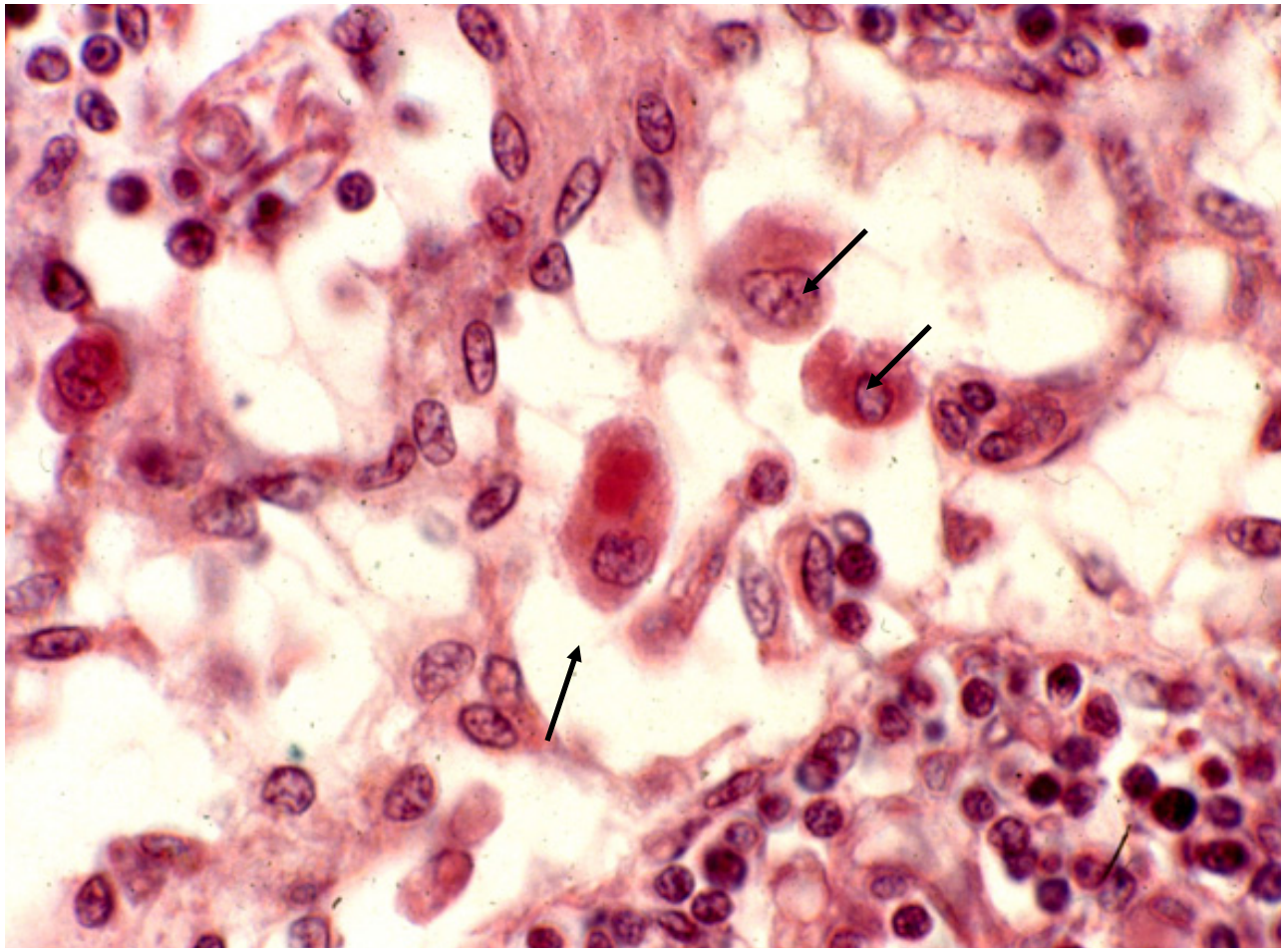


PD-INEL Ross, M. Pawlina, W. *Wheater's Functional Histology: A Text and Atlas*. Fifth Edition. 2006.

White (common, yellow, unilocular) adipose tissue stained with Masson's trichrome

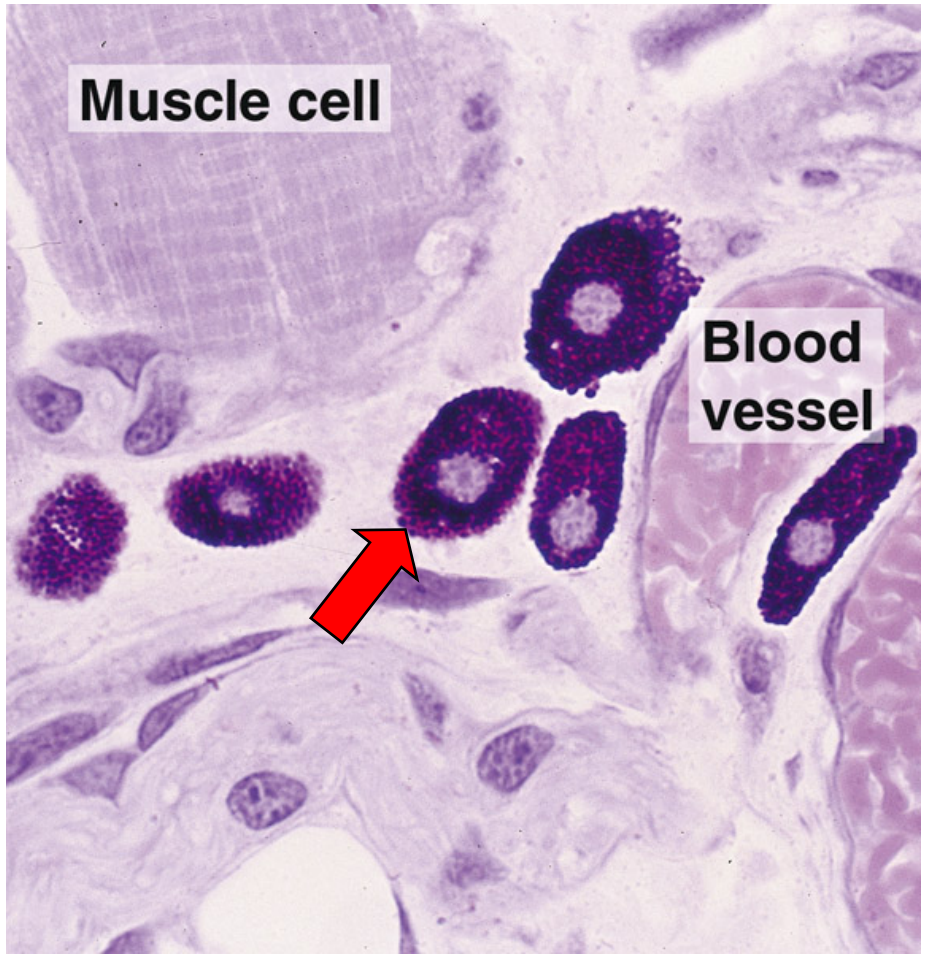
Monocytes escape from blood vessels into connective tissue where they differentiate into

Macrophages



Primary function: phagocytosis and antigen presentation

Mast Cells



PD-INEL Junqueira and Carneiro. *Basic Histology*. Tenth Edition. 2003. Figure 5.10.

Metachromasia – when stained with toluidine blue, the granules bind the dye and change its color to red.

- **Principal function is storage in secretory granules and REGULATED release (degranulation) of histamine and other vasoactive mediators of inflammation.**
- **Responsible for the immediate hypersensitivity response characteristic of allergies, asthma and anaphylactic shock.**
- **Connective tissue mast cells are found in skin (dermis) and peritoneal cavity mucosal mast cells are in the mucosa of the digestive and respiratory tracts.**

Classification of connective tissue

- Connective tissue proper
- Connective tissue with special properties
- Embryonic connective tissue

Types of Connective Tissue Proper

Loose (areolar) connective tissue – delicate, vascularized, *cellular*; supports the epithelia of the major organs and glands and fills the space between muscle tissue. - not very resistant to stress

Dense connective tissue *(many more fibers than cells)*

- Dense irregular: meshwork of coarse fibers; dermis of skin, organ capsules, fascia - resists multi-directional forces

- Dense regular:
  - collagenous: fibers aligned in defined pattern; tendons, ligaments, etc. - resists linear mechanical stresses
  - elastic: elastin and microfibrils (fibrillin) - elasticity

Special connective tissue

- Bone
- Cartilage
- Adipose
- Hemapoietic

Slides

- Loose areolar tissue
  - Abundant cells, few fibres
  - Fibres in loose random web, active and quiscent fibroblasts
- Dense regular connective tissue (Tendon)
  - Large number of fibres in parallel bundles
  - Little ground substance, flattened cells
- Dense irregular connective tissue (dermis)
  - Haphazard arrangement of fibres

- Elastic fibres
  - Predominant in elastic connective tissue
  - Wavy form appearance with special stains
  - Check aorta and muscular arteries,at IEL
- Reticular fibres
  - In bone marrow or lymphatic systems
  - Special stains
  - Appear black and threadlike with silver impregnation

- Unilocular adipose
  - Single lipid droplet occupying most of the cell
  - After preparation lipid is dissolved
  - Signet ring appearance