Connective Tissue

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Connective tissue Objectives

- The structural characteristics and classification of the connective tissue.
- The structural characteristic and function of loose connective tissue.
- The morphological structure and function of 3 fiber types (collagenous, elastic and reticular fibers).
- The structure and function of several main cell types in connective tissue (fibroblast, macrophage, plasma cell, mast cell, fat cell and mesenchymal cell).
- The structural characteristics and function of dense connective tissue, adipose tissue and reticular tissue.
Tissues of the Body: An Introduction

Tissues and tissue types

- Tissues are:
  - Collections of specialized cells and cell products organized to perform a limited number of functions
- The four tissue types are:
  - Epithelial
  - Connective
  - Muscular
  - Nervous
Connective Tissue

- Found everywhere in the body
- Includes the most abundant and widely distributed tissues

**Functions** of CT
- **Binds body tissues together** *(Binding of organs -- Ex. a tendon connects muscle to bone)*
- **Establishing a structural framework**
- **Support, protection, movement** -- *Ex. Bones*
- **Storage** -- *(energy, electrolytes) -- Ex. Fats/bones*
- **Ability to absorb large amount of water** *(Water reservoir)*
- **Transport** -- *Ex. Blood*
Connective Tissue Characteristics

- Variations in blood supply
  - Most C.T are well vascularized
  - Tendons and Ligaments have a poor supply
  - Cartillages are avascular

- Connective Tissues are made of:
  - Different types of Cells
  - Fibers
  - Non-living substance that surrounds living cells (The Extracellular matrix)
Connective Tissue Overview

- Most abundant and variable tissue type

- Consists mostly of 3 structural elements –
  - (a) **Ground substance**; (b) Fibers and (c) widely spaced **cells**
The Cells and Fibers of Connective Tissue Proper

Reticular fibers
Melanocyte
Fixed macrophage
Plasma cell
Blood in vessel
Adipocytes (fat cells)
Ground substance

Mast cell
Elastic fibers
Collagen fibers
Fibroblast
Free macrophage
Mesenchymal cell
Lymphocyte

Connective tissue proper (areolar tissue)
LM × 384
Ground Substance of C.T. (Matrix)

- It is produced by C. T. cells

- Gelatinous or rubbery material found in between cells – Function?

- Consists of 3 classes of large molecules
  - Glycosaminoglycans (GAGs) –
    - Polysacharides that attract sodium & hold water
  - Proteoglycan is bottlebrush-shaped molecule
    - Forms thick gel that slows the spread of pathogens
  - Cell adhesive glycoproteins
    - Allow themselves bind to matrix elements
Fibers of C.T.

- **Collagen fibers--called white fibers**
  - Most abundant protein of the body
  - Thick, tough, resist stretch yet flexible
    - Ex. tendons, ligaments & dermis

- **Elastic fibers--called yellow fibers**
  - Made of **Elastine, Recoil** like rubberband (elasticity)
    - Ex. skin, lungs & arteries; ability to recoil

- **Reticular fibers**
  - **Thin** collagen fibers coated with Glycoprotein
    - Ex. form framework for spleen & lymph nodes
Collagen

Tendons (collagen)
Cells of C.T.

- Connective tissue cells are usually divided into two groups based on their ability to move within the connective tissue.
  - **Fixed cells**
    - **Adipocytes or fat cells** -- are that store triglycerides
    - **Fibroblasts (Fibrocytes)** - produce fibers & ground substance
  - **Wandering cells**
    - **WBCs** -- wander (mostly in CT) in search of bacteria
    - **Macrophages** – large phagocytic cells-- arise from monocytes (WBC); function? Phagocytosis
    - **Plasma cells** -- arise from lymphocytes; antibody-producing cells
    - **Mast cells** – oval shaped; clustered along blood vessels; secrete heparin and histamine
Adipocytes

- Fat cells are fixed cells in loose connective tissue.
- Their main function is the storage of lipids.
- The cytoplasm only forms a very narrow rim around a large central lipid droplet.
- Flattened nucleus may be found in a slightly thickened part of this cytoplasmic rim.
- Adipocyte (up to 100 µm) is considerable larger than the thickness of typical histological sections.
- A "starving" adipocyte may contain multiple small lipid droplets and gradually comes to resemble a fibrocyte.
Fibroblasts or Fibrocytes

- **Fibrocytes (inactive)** are the most common cell type in connective tissues.
- Fibrocytes do not usually leave the connective tissue.
- They are the "true" connective tissue cells.
- With oval, sometimes flattened nuclei are visible in LM sections.
- The cytoplasm of a resting (i.e. inactive) fibrocyte does not contain many organelles.
- When stimulated, this situation changes (by damage to the surrounding tissue). In this case the fibrocyte is transformed into a **fibroblast (active)**,
  - With branched cytoplasm, it contains large amounts of the organelles which are necessary for the synthesis and excretion of proteins needed to repair the tissue damage (wound healing)
  - Synthesis of extracellular matrix and collagen
The “Fabulous” Fibroblast

- Fibroblast: synthesizes the extracellular matrix and collagen, the structural framework (stroma) for animal tissues, and play a critical role in wound healing.

- They are the most common cells of connective tissue
Reticular cells

- Reticular cells are usually larger than an average fibrocyte.
- They are the "fibrocytes" of reticular connective tissue and form a network of reticular fibres, in the lymphoid organs.
- Their nuclei are typically large and lightly stained (H&E) and the cytoplasm may be visible amongst the cells which are housed within the network of reticular fibres.
A Classification of Connective Tissues

C.T. differ in their fibers present in the matrix.
Connective tissue proper
Loose CT, or Fibrous C.T.

Divided into 2 broad categories:

- **Loose CT**
  - contains MORE gel-like ground substance between cells
  - Fibers create loose or open network

- 3 types:
  - A: Areolar
  - B: Reticular
  - C: Adipose tissue

- **Dense CT**
  - FIBERS fill the spaces between cells
  - 2 types varying in fiber orientation:
    - D: Dense regular
    - E: Dense irregular
Areolar Connective Tissue

- Loose arrangement of collagenous and elastic fibers
- Scattered cell types and Abundant ground substance
- Use: Cushion, support, and allow movement
- Locations-- Underlying all epithelia; surrounding nerves, blood vessels, esophagus, trachea
Reticular Tissue

- Loose network of Reticur fibers and cells
- Forms **structural supportive stroma** for lymphatic organs
- **Locations**-- liver, kidneys lymph nodes, spleen, thymus & bone marrow

Reticular fibers work like spider webs, allowing leukocytes to attach and sample lymph or blood as it flows through lymphoid organs.
Adipose : Loose Connective

- Large, empty-looking cells dominate with thin margins
- Nucleus pressed against cell membrane; often very pale
- Functions -- Energy storage, insulation, space filled as cushioning
- Locations -- Subcutaneous fat beneath skin, breast, heart surface, surrounding organs Made alof Fat cells = Adipocytes
- They shrink during weight loss
- Function: cushion, insulator and energy storage
Dense Regular CT

- This connective tissue is usually easy to identify.
- Coarse collagen fibers are aligned with each other with only very narrow open spaces between them.
- Only a few cells between the fibers. Their cytoplasm is difficult to identify but the nuclei can be seen scattered among the collagen fibres.
- Nuclei are often elongated, and their long axis runs parallel to the course of the collagen fibres.

Tendon: Connect muscle to bone
Ligament: Connect bone to bone
Dense Connective Tissues

**DENSE REGULAR CONNECTIVE TISSUE**

**LOCATIONS:** Between skeletal muscles and skeleton (tendons and aponeuroses); between bones or stabilizing positions of internal organs (ligaments); covering skeletal muscles; deep fasciae

**FUNCTIONS:** Provides firm attachment; conducts pull of muscles; reduces friction between muscles; stabilizes relative positions of bones
The connective tissue contains thick bundles of collagen fibers arranged in an irregular fashion, and is found in the dermis and fibrous capsules of joints and some organs.
Dense Connective Tissues

**DENSE IRREGULAR CONNECTIVE TISSUE**

**LOCATIONS:** Capsules of visceral organs; periosteum and perichondrium; nerve and muscle sheaths; dermis

**FUNCTIONS:** Provides strength to resist forces applied from many directions; helps prevent overexpansion of organs such as the urinary bladder

LM × 111

(b) Deep dermis
Cartilage

- Supportive CT with rubbery matrix
- Cells: **Chondroblasts** produce matrix, surround themselves, and become **Chondrocytes**
- **No blood vessels**; so diffusion must bring in nutrients & remove wastes.
- Cartilage lacks nerve fibers.
- **There are three types of cartilage:**
  - **Hyaline** - most common, found in the ribs, nose, larynx, trachea. Is a precursor of bone.
  - **Fibro** - is found in invertebral discs, joint capsules, ligaments.
  - **Elastic** - is found in the external ear, epiglottis and larynx.
Chondroblasts

- The progenitors of these cells arise in the bone marrow, in a form of stem cell. Stem cells are capable of differentiating into several different types of cell, depending on the need. When they differentiate into cartilage cells.
- They start out as chondroblasts, actively producing secretions of chondrin, the primary substance in cartilage, to build and repair the tissue.
- Once a chondroblast becomes totally surrounded, it is a mature chondrocyte.
- These cells can be found in small gaps within the cartilage known as LACUNAE.
CHONDROBLAST

- Progenitor of chondrocytes
- Lines border between perichondrium and matrix
- Secretes type II collagen and other ECM components
- Chondroblasts build
Chondrocytes

- Are mature cells found in cartilage.
- Are not capable of cell division.
- They can produce secretions to support and repair the cartilage matrix.
- They facilitate the exchange of materials between the cartilage and the surrounding material (including facilitating the exchange of fluids through the gelatinous layers).
- Depending on what type of cartilage a cell is in, it may have a slightly different composition; elastic, hyaline, and fibrocartilage are all unique, designed to meet various needs within the body.
- Because cartilage lacks blood supply, it relies on this exchange to receive nutrients and express waste materials.
- Fully mature chondrocytes tend to be round, and they may cluster together in small groups within the network of the cartilage.
Hyaline Cartilage

- **Clear, glassy** matrix; **invisible fine dispersed collagen fibers**; chondrocytes in small clusters enclosed in **lacunae**
- Supports airway, eases joint movements
- **Locations:** Over ends of bones at movable joints; sternal ends of ribs; supportive material in larynx, trachea, bronchi and fetal skeleton
Fig. Fetal skeleton

Perichondrium
Chondrocytes
Matrix
Elastic Cartilage

- Hyaline cartilage with weblike mesh of elastic fibers amid the lacunae; always has perichondrium (a sheath of C.T.)
- A specialized, fibrous connective tissue present in adult and forming most of the temporary skeleton in the embryo,
- Providing a model in which most of the bones develop, and constituting an important part of the organism's cartilage in which the cells are surrounded by a territorial matrix outside of which is an imatrix containing elastic fiber networks in addition to type II collagen fibers and ground substance.
- Synonym(s): yellow cartilage
- Locations— Ear + Epiglottis
Elastic Cartilage (Epiglottis)
Cartilage: fibrocartilage

**Description:** Matrix similar to but less firm than that in hyaline cartilage; thick collagen fibers predominate.

**Function:** Tensile strength with the ability to absorb compressive shock.

**Location:** Intervertebral discs; pubic symphysis; discs of knee joint.

**Photomicrograph:** Fibrocartilage of an intervertebral disc (200x).
Fibrocartilage
White Fibrocartilage
Cartilages in the Adult Body

(a) Hyaline cartilage (180x)

- Chondrocyte in a lacuna
- Matrix
- Lacuna
- Perichondrium

(b) Elastic cartilage (470x)

- Chondrocyte in a lacuna
- Elastic fibers
- Gelatinous ground substance

(c) Fibrocartilage (285x)

- Chondrocyte in a lacuna
- Collagen fibers