Connective Tissues

- connect and support other tissues
- **cells + matrix**
- **matrix** stuff between cells
  - fibers = proteins
    - collagen strength
    - elastin stretch and recoil
    - reticular network, thin fibers
  - ground substance = gel-like fluid
connective tissue cells

- cells produce or maintain matrix
- - cyte = cell; adult; maintain matrix
- - blast build matrix

- fibroblast produces fibers
- adipocyte fat cell
- osteocyte bone cell
- osteoblast bone producing cell
- chondroblast cartilage producing cell
connective tissues vs epithelia

• epithelia functions based on cells
• connective functions based on matrix
types of connective tissues

• connective tissue proper
  – loose connective tissue
    – areolar c.t
    – adipose c.t.
    – reticular c.t.
  – dense connective tissue
    – dense regular c.t.
    – dense irregular c.t.

• cartilage

• bone

• blood
Areolar c.t.

- **cells**: fibroblast, mast cells (inflammation), macrophages (phagocytosis)
- **fibers**: loose arrangement, collagen, elastin, reticular
- **function**: support, defense
- **where?**: under all epithelia, most organs

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**Connective tissue proper: loose connective tissue, areolar**

**Description:** Gel-like matrix with all three types; cells: fibroblasts, macrophages, cells, and some white blood cells.

**Function:** Wraps and cushions organs; its macrophages phagocytize bacteria; plays an essential role in inflammation; holds and retains tissue fluid.

**Distribution:** Widely distributed under epithelia, e.g. forms lamina propria of mucous membranes; packages organs; surrounds blood vessels.

**Photomicrograph:** Areolar connective tissue, a soft packaging tissue of the body (400×).
Adipose c.t.

- cell = adipocyte

- function:
  - energy storage
  - cushion
  - insulation

- where?
  - skin
  - kidney, eye
  - active organs: heart, muscle, kidney
Adipose connective tissue

Capillary

Adipocyte

Vacuole of fat

Nucleus
(b) Connective tissue proper: loose connective tissue, adipose

**Description:** Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

**Function:** Provides reserve food fuel; insulates against heat loss; supports and protects organs.

**Location:** Under skin; around kidneys and eyeballs; within abdomen; in breasts.

**Photomicrograph:** Adipose tissue from the subcutaneous layer under the skin (450×).
reticular c.t.

- like areolar c.t., but only reticular fibers
- holds many cells of organ
  - liver
  - lymph nodes
  - spleen
  - bone marrow
Connective tissue proper: loose connective tissue, reticular

**Description:** Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

**Function:** Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

**Location:** Lymphoid organs (lymph nodes, bone marrow, and spleen).

**Photomicrograph:** Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350×).
reticular c.t.
Dense regular c.t.

- strength
- fibroblasts
- matrix
  - fibrous ct  mostly collagen  strength
    tendons
    ligament
    artery wall
  - elastic ct  elastin > collagen  recoil
    alveoli
    artery wall
(f) Connective tissue proper: dense connective tissue, dense regular

**Description:** Primarily parallel collagen fibers; a few elastin fibers; major cell type is the fibroblast.

**Function:** Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

**Location:** Tendons, most ligaments, aponeuroses.

**Photomicrograph:** Dense regular connective tissue from a tendon (1000x).
(g) Connective tissue proper: dense connective tissue, elastic

**Description:** Dense regular connective tissue containing a high proportion of elastic fibers.

**Function:** Allows recoil of tissue following stretching; maintains pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.

**Location:** Walls of large arteries; within certain ligaments associated with the vertebral column; within the walls of the bronchial tubes.

**Photomicrograph:** Elastic connective tissue in the wall of the aorta (121×).
elastic c.t.
Dense irregular c.t.

- irregular arrangement of collagen fibers
- location: dermis, organ capsules
(e) Connective tissue proper: dense connective tissue, dense irregular

**Description:** Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast.

**Function:** Able to withstand tension exerted in many directions; provides structural strength.

**Location:** Dermis of the skin; submucosa of digestive tract; fibrous capsules of organs and of joints.

**Photomicrograph:** Dense irregular connective tissue from the dermis of the skin (400×).
dense irregular c.t.
Cartilage

- chondrocytes in lacunae
- matrix: collagen strength
  water decrease friction
- functions:
  - support
    - trachea
    - ear
    - nose
  - IVD = intervertebral disc
  - decrease friction articular cartilage
  - bone growth
**Cartilage: hyaline**

**Description:** Amorphous but firm matrix; collagen fibers form an imperceptible network; chondroblasts produce the matrix and when mature (chondrocytes) lie in lacunae.

**Function:** Supports and reinforces; has resilient cushioning properties; resists compressive stress.

**Location:** Forms most of the embryonic skeleton; covers the ends of long bones in joint cavities; forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx.

**Photomicrograph:** Hyaline cartilage from the trachea (300x).
types of Cartilage

- hyaline cartilage
  - joints
  - ribs
  - trachea, larynx

- elastic cartilage
  - cartilage + elastic fibers
  - ear
  - epiglottis

- fibrocartilage
  - cartilage + collagen fibers
  - IVD
  - some joints
hyaline cartilage

smooth matrix
trachea:
cilia epith
collagen
hyaline cart
fibrous connective tissue
adipose
### (i) Cartilage: elastic

**Description:** Similar to hyaline cartilage, but more elastic fibers in matrix.

**Function:** Maintains the shape of a structure while allowing great flexibility.

**Location:** Supports the external ear (pinna); epiglottis.

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**Photomicrograph:** Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (640×).
Elastic cartilage, ear

- Elastic fibers
- Lacuna
- Chondrocyte
(j) 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).
Bone

- cell = osteocyte
- matrix
  - collagen + Calcium
- Haversian systems = Osteons
- function: support
  protect organs
**Description:** Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.

**Function:** Bone supports and protects (by enclosing); provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).

**Location:** Bones

**Photomicrograph:** Cross-sectional view of bone (70x).
Blood

- cells
  - RBC: erythrocyte
  - WBC: leukocyte
  - platelet: thrombocyte
- matrix: plasma
(k) Others: blood

Description: Red and white blood cells in a fluid matrix (plasma).

Function: Transport of respiratory gases, nutrients, wastes and other substances.

Location: Contained within blood vessels.

Photomicrograph: Smear of human blood (1500×); two white blood cells (neutrophil in upper left and lymphocyte in lower right) are seen surrounded by red blood cells.
erythrocyte

leukocyte

thrombocyte
Muscle

• cells specialized for contraction

• 3 types:
  – skeletal
  – smooth
  – cardiac
skeletal muscle

• = voluntary muscle
  • conscious movement
• = striated muscle
  • striped appearance

• long, parallel cells
• function: moves skeleton
(a) Skeletal muscle

**Description:** Long, cylindrical, multinucleate cells; obvious striations.

**Function:** Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

**Location:** In skeletal muscles attached to bones or occasionally to skin.

**Photomicrograph:** Skeletal muscle (approx. 300×). Notice the obvious banding pattern and the fact that these large cells are multinucleate.
cardiac muscle

- myocardium
- involuntary
- short, branching cells
- intercalated discs

Photomicrograph: Cardiac muscle (800×); notice the striations, branching of cells, and the intercalated discs.

p 140
smooth muscle

- = involuntary
- small, flat cells
- walls of organs and blood vessels
smooth muscle
smooth muscle

artery wall
Nerve

• cell = neuron
  – cell body
  – processes dendrites axon
• supporting cells = neuroglia
Nervous tissue

**Description:** Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonirritable supporting cells (not illustrated).

**Function:** Transmit electrical signals from sensory receptors and to effectors (muscles and glands) that control their activity.

**Location:** Brain, spinal cord, and nerves.

**Photomicrograph:** Neurons (100x)
neuron
Membranes

- continuous sheets of epithelial + connective tissues
- cutaneous skin
- mucous lines tracts
- serous lines closed cavities
mucous membranes

- lines tracts that open to environment
  - digestive
  - respiratory
  - urinary
  - reproductive
- = mucosa

- epithelial tissue varies
- areolar c.t. = lamina propria
(b) Mucous membranes

- Mucosa of nasal cavity
- Mucosa of mouth
- Esophagus lining
- Mucosa of lung bronchi
serous membranes

• lines closed cavities
• simple squamous epith. secretes serous fluid
• 2 layers:
  – parietal
  – visceral
serous membranes

- Pleura
  - parietal pleura
  - visceral pleura
serous membranes

- Pericardium
  - parietal pericardium
  - visceral pericardium
serous membranes

• Peritoneum
  • parietal peritoneum
  • visceral peritoneum