Connective Tissues

connect and support other tissues

**cells + matrix**

matrix  

stuff between cells

- **ground substance** = gel-like fluid
- **protein fibers**
  - **collagen**  
    - strength
  - **elastin**  
    - stretch and recoil
connective tissues vs epithelia

epithelia
functions based on cells

connective
functions based on matrix
connective tissue cells

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

fibroblast produces fibers
adipocyte fat cell
osteocyte bone cell
osteoblast bone producing cell
chondrocyte cartilage cell
chondroblast cartilage producing cell
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.
    elastic c.t.
    dense irregular c.t.

cartilage

bone

blood
Areolar c.t.

cells  fibroblast
mast cells  (inflammation)
macrophages  (phagocytosis)

matrix  loose arrangement of collagen and elastin

function
  support other tissues
  defense, fight infections

location
  under all epithelia
  most organs
# Connective tissues

## (a) Connective tissue proper: loose connective tissue, areolar

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

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

**Location:** Widely distributed under epithelia of body, e.g., forms lamina propria of mucous membranes; packages organs; surrounds capillaries.

![Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (340x).](image)
(a) Connective tissue proper: loose connective tissue, areolar

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**Photomicrograph:** Areolar connective tissue, a soft packaging tissue of the body (300x).
areolar c.t.
Adipose c.t.

cells adipocytes

matrix slight amount of ground substance

function
   store energy
   cushion
   insulation

location
   skin
   around kidney, eye
   around active organs – heart, muscle
Figure 4.8b: 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.
cells  fibroblasts
matrix  loose arrangement of reticular fibers
function
  form a soft network to hold other cells
location
  liver
  lymph nodes
  spleen
  bone marrow
(c) 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 (350x).
reticular c.t.
dense regular c.t. = fibrous c.t.

cells  fibroblasts
matrix  mostly collagen, in parallel arrangement
function
  strength
  prevent tearing
location
  ligament
  tendon
  blood vessel wall
**Connective tissue proper: dense connective tissue, dense regular**

**Description:** Primarily parallel collagen fibers; a few elastic 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 (430x).
elastic c.t.

cells     fibroblasts
matrix    mostly elastin
function
    stretch and recoil
location
    lung
    blood vessel wall
**Connective tissue proper: dense connective tissue, elastic**

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

**Function:** Allows tissue to recoil after 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 (250x).
elastic c.t.
dense irregular c.t.
cells fibroblasts
matrix mostly collagen, not parallel
function
  strength
  prevent tearing
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:** Fibrous capsules of organs and of joints; dermis of the skin; submucosa of digestive tract.

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

- Collagen fibers
- Fibroblast nuclei
- Dense irregular connective tissue
dermis

dense irregular ct
dense irregular c.t.
cartilage

cells      chondrocytes in lacuna
matrix     collagen + water
function
  support
  decrease friction
location
  trachea
  ear
  nose
  IVD    intervertebral disc
  joints articular cartilage
Figure 4.8g  Connective tissues.

(G) 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; serves as resilient cushion; 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 a costal cartilage of a rib (470x).
hyaline cartilage  smooth matrix
trachea:
cilia epith
areolar

hyaline cart

fib ct

adipose
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<th>Description</th>
<th>Locations</th>
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<td>Smooth collagen matrix</td>
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<td>Cartilage + collagen fibers</td>
<td>Intervertebral disc (IVD), pubic symphysis</td>
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**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.

**Photomicrograph:** Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (800x).
### Cartilage: Fibrocartilage

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

**Function:** Tensile strength allows it to absorb compressive shock.

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

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**Photomicrograph:** Fibrocartilage of an intervertebral disc (125x). Special staining produced the blue color seen.
bone

cells  osteocytes in lacuna
matrix  collagen + calcium, other minerals
function
  support
  protect organs
location  bone
(j) **Others: bone (osseous tissue)**

**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 (125x).

Haversian systems
blood

cells  RBC          erythrocyte
       WBC          leukocyte
       platelet    thrombocyte

matrix  =  plasma          water + chemicals

function          transport
### (k) Connective tissue: blood

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

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

**Location:** Contained within blood vessels.

**Photomicrograph:** Smear of human blood (1670x); shows two white blood cells surrounded by red blood cells.
erythrocyte

leukocyte

thrombocyte
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. 440x). Notice the obvious banding pattern and the fact that these large cells are multinucleate.
cardiac muscle

= myocardium

involuntary

short, branching cells

intercalated discs
(b) Cardiac muscle

**Description:** Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).

**Function:** As it contracts, it propels blood into the circulation; involuntary control.

**Location:** The walls of the heart.

**Photomicrograph:** Cardiac muscle (900x); notice the striations, branching of cells, and the intercalated discs.
**Smooth muscle**

= involuntary

small, flat cells

walls of organs and blood vessels

**Description:** Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.

**Function:** Propels substances or objects (foodstuffs, urine, baby) along internal passageways; involuntary control.

**Location:** Mostly in the walls of hollow organs.
smooth muscle
smooth muscle  artery wall
2 types of cells:

neuron
  cell body
  dendrites
  axon

sends “messages”

neuroglia
  supporting cells
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 nonexcitable supporting cells.

**Function:** Neurons transmit electrical signals from sensory receptors and to effectors (muscles and glands) which control their activity; supporting cells support and protect neurons.

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

**Photomicrograph:** Neurons (350x).
(b) Motor neuron

Dendrites
Cell body
Neuroglia
Axon

LM 430x
neuron
Membranes

continuous sheets of epithelial + connective tissues

cutaneous membrane    skin
mucous membrane        lines tracts
serous membrane        lines closed cavities
Figure 4.11 Classes of membranes.

(a) Cutaneous membrane
The cutaneous membrane (the skin) covers the body surface.

(b) Mucous membranes
Mucous membranes line body cavities that are open to the exterior.

(c) Serous membranes
Serous membranes line body cavities that are closed to the exterior.
mucous membranes

lines tracts (hollow organs)
  digestive
  respiratory
  urinary
  reproductive
also called  mucosa
serous membranes

lines closed cavities

simple squamous epith. secretes serous fluid

function lubrication around organs

2 layers:

parietal

visceral
serous membranes

Pleura

parietal pleura
visceral pleura
Pericardium

parietal pericardium
visceral pericardium
Peritoneum

parietal peritoneum

visceral peritoneum