Connective Tissue???

- It Binds, It Supports, It Strengthens, It Protects, It Insulates, It Compartmentalizes, It helps us move, It helps transport stuff, It is a site for storing energy, It is involved in our immune system, It helps heat us when we were itty bitty babies!!

Connective Tissue – What is it?

- All Connective tissue is:
  - Living cells within a non-living extracellular matrix
- Extracellular Matrix (stuff between cells):
  1. Protein Fibers
  2. Ground substance

2. Connective Tissue

- Cells rarely touch due to extracellular matrix
- Matrix: Protein fibers & ground substance secreted by cells
- Consistency varies from liquid, gel to solid
- Good nerve & blood supply (except cartilage & tendons)
- Most abundant, widely distributed, and histologically variable of the primary tissues

Components of Connective Tissue

1. Cells
2. Non-living matrix
   - Protein fibers
   - Ground substance

   1. Cells:
      2. blast type cells = 1) can divide & 2) secrete matrix (fibroblasts, chondroblasts, & osteoblasts)
      3. cyte type cells = mature cells: reduced ability to divide or produce matrix (chondrocytes & osteocytes)

Components of Fibrous Connective Tissue

- more cells:
  - leukocytes or white blood cells
  - Macrophages (develop from WBC) – engulf bacteria & debris by phagocytosis
  - Plasma cells (develop from WBC) – produce antibodies (proteins) that help attack foreign substances
  - Mast cells produce heparine & histamine
  - Adipocytes store fat

Components Connective Tissue

2. Non-living matrix

- Types of Connective Tissue Fibers:
  1. Collagen (25% of protein in your body)
     - tough, resistant to pull, yet pliable
     - tendons, ligaments, and deep layer of the skin are mostly collagen
  2. Elastic (protein elastin)
     - can stretch and return to shape!
     - very thin fibers
  3. Reticular (spleen and lymph nodes)
     - Support and strength
     - thin collagen fibers coated with glycoprotein
2. Non-living matrix
- ground substance:
  - usually gelatinous to rubbery consistency resulting from three classes of large molecules
  - glycosaminoglycans (GAG)
  - proteoglycan
  - adhesive glycoproteins –
  - Regulate H2O balance
  - Slippery lubricant
  - Adhesive

Types of connective tissue

1. Loose connective tissue (2)
2. Dense connective tissue (2)
3. Adipose tissue
4. Cartilage (3)
5. Bone (2)
6. Blood
7. Lymph?

Loose Connective Tissues

- Loosely woven fibers throughout tissues

2 Types of loose connective tissue
1. areolar connective tissue
2. reticular tissue

Areolar Connective Tissue

- Gelatinous ground substance
- Few random protein fibers (all 3 types)
- All 6 cell types
- Below our epithelial layer!

Areolar Tissue

Figure 5.14a
Figure 5.14b,i
**Reticular Connective Tissue**

- Network of fibers & cells that produce framework to hold some organs together

**Reticular Tissue**

**Dense Connective Tissue**

- More fibers present but fewer cells
- Types of dense connective tissue:
  1. dense regular connective tissue
  2. dense irregular connective tissue

**1. Dense Regular Connective Tissue**

- Collagen fibers in parallel bundles with fibroblasts

**2. Dense Irregular Connective Tissue**

- Collagen fibers are irregularly arranged (interwoven)
- Tissues can resist tension from any direction
- Very tough tissue e.g., dermis of skin

**Dense Irregular Connective Tissue**

- Collagen fibers in parallel bundles with fibroblasts
- Tissues can resist tension from any direction
- Very tough tissue e.g., dermis of skin
Adipose Tissue

- Adipocytes (store triglycerides)
- Peripheral nuclei
- Deeper layer of skin, organ padding, yellow marrow
- Reduces heat loss, energy storage, protection
- Brown fat??!!!

Cartilage

- Network of fibers in rubbery ground substance
- Resilient and can endure more stress than loose or dense connective tissue
- Types of cartilage:
  1. hyaline cartilage (invisible fibers)
  2. fibrocartilage (thick collagen bundles)
  3. elastic cartilage (visible elastic fibers)

Hyaline Cartilage

- Chondrocytes!! sit in spaces called lacunae
- No blood vessels or nerves so repair is very slow
  - Articular cartilage

Elastic Cartilage

- Elastic fibers help maintain shape after deformations
- Ear, nose, vocal cartilages
Elastic Cartilage

- Perichondrium
- Elastic fibers
- Chondrocytes
- Lacunae

(a) © Ed Reschke

Figure 5.20a

Fibrocartilage

- Many more collagen fibers causes rigidity & stiffness
- Strongest cartilage (intervertebral discs)
- No perichondrium

(a)

Figure 5.20b.i

(b)

Figure 5.21a

(b)

Figure 5.21b.i

Fibrocartilage

- Many more collagen fibers causes rigidity & stiffness
- Strongest cartilage (intervertebral discs)
- No perichondrium

(b)

Figure 5.21b.i

Bone tissue (osseous tissue)

- Bones protect organs, allow for movement, store minerals, sites of blood cell formation

- ‘bone’ has two meanings:
  - an organ of the body: femur, mandible; composed of multiple tissue types
  - bone tissue – osseous tissue – makes up most of the mass of bone

2 types of bones: Compact and Spongy

1. Compact bone
   - solid, dense bone
   - basic unit of structure is osteon (haversian system)

Compact Bone

- Osteon = lamellae (rings) of mineralized matrix
  - calcium & phosphate—give it its hardness
  - interwoven collagen fibers provide strength
- Osteocytes surrounded by lacuna

(a)

Blood

- Connective tissue with a liquid matrix = ??
- Cell types = red blood cells (erythrocytes), white blood cells (leukocytes) and cell fragments (platelets)
- Transport things
- immune functions & clotting
Membranes

- Epithelial layer sitting on a thin layer of connective tissue (lamina propria)
- Combo of epithelial & underlying CT layer = epithelial membrane
- Types of membranes:
  1. mucous membrane
  2. serous membrane
  3. synovial membrane
  4. cutaneous membrane (skin)

(1) Mucous Membranes
- Lines cavity that open to the outside — e.g., mouth, vagina, anus, respiratory
- Tight junctions between cells
- Mucous secreted by ????

(2) Serous Membranes
- Simple squamous cells overlying CT layer
- Squamous cells secrete slippery fluid
- Internal cavities (not open to the outside)
  Examples:
  - pleura, peritoneum and pericardium
  - membrane on walls of cavity = parietal layer
  - membrane over organs in cavity = visceral layer

(3) Cutaneous membrane (skin)

(4) Synovial Membranes
- Line joint cavities of freely movable joints
- No epithelial cells -- just special cells that secrete slippery fluid

Muscle

- Cells that shorten (myocytes)
- Provide us with motion, posture and heat
- Types of muscle:
  1. skeletal muscle
  2. cardiac muscle
  3. smooth muscle
Skeletal Muscle
- Cells are long cylinders with many peripheral nuclei
- Visible banding (looks striated)
- Voluntary

Cardiac Muscle
- Cells are branched cylinders with one central nuclei
- Involuntary
- striated

Smooth Muscle
- Spindle shaped cells with a single central nuclei
- Walls of hollow organs (blood vessels, GI tract, bladder)
- Involuntary and nonstriated

Tissue Growth
- Increasing the number of cells or the existing cells grow larger
- hyperplasia - tissue growth through cell multiplication
- hypertrophy - enlargement of preexisting cells
  - muscle growth through exercise
  - accumulation of body fat
- neoplasia – development of a tumor (neoplasm)
  - benign or malignant
  - composed of abnormal, nonfunctional tissue

Tissue Repair
- regeneration - replacement of dead or damaged cells by the same type of cell as before
  - restores normal function
  - skin injuries and liver regenerate
- fibrosis - replacement of damaged cells with scar tissue
  - holds organs together
  - does not restore normal function
  - severe cuts and burns, healing of muscle injuries, scarring of lungs in tuberculosis
**Wound Healing**

- severed blood vessels bleed into cut
- **mast cells** and damaged cells release **histamine**
  - dilates blood vessels
  - increases blood flow to area
  - makes capillaries more permeable
- **blood plasma** seeps into the wound carrying:
  - antibodies
  - clotting proteins
  - blood cells

- **blood clot** forms in the tissue
  - inhibits spread of pathogens from injury site to healthy tissue
- forms **scab** that temporarily seals wound and blocks infection
- **macrophages** phagocytize and digest tissue debris

**Figure 5.33 (2)**

- deeper portions become infiltrated by capillaries and fibroblasts
  - transform into soft mass – **granulation tissue**
  - macrophages remove the blood clot
  - begins 3-4 days after injury and lasts up to 2 weeks

**Figure 5.33 (3)**

- surface epithelial cells (mitosis)
- connective tissue undergoes **fibrosis**
- scar tissue may or may not show through epithelium
- **remodeling (maturation) phase** begins several weeks after injury and may last up to two years

**Figure 5.33 (4)**

**Tissue Shrinkage and Death**

- **atrophy** – shrinkage of a tissue through a loss in cell size or number
  - senile atrophy (aging)
  - disuse atrophy (no use)
- **necrosis** – premature, pathological death of tissue (trauma, toxins, or infections)
- **apoptosis** - programmed cell death