Connective Tissue 2

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Components

- Cells
- Protein Fibers
- Ground Substance

Extracellular matrix
Ground Substance

Composed of:

• **Glycosaminoglycans (GAGs)**
• **Proteoglycans**: Responsible for the gel state of the extracellular matrix.
• **Adhesive glycoproteins**: laminin, chondronectin, osteonectin and fibronectin.
GAGs

• Long polymers of repeating disaccharide units, usually a hexosamine and uronic acid.
• The hexosamine can be glucosamine or galactosamine, and the uronic acid can be glucuronate or iduronate.
• The largest and most ubiquitous GAG is **hyaluronan** (also called hyaluronate or hyaluronic acid)
<table>
<thead>
<tr>
<th>GAG</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyaluronic acid</td>
<td>Most connective tissue, cartilage, dermis, synovial fluid.</td>
</tr>
<tr>
<td>Keratan sulfate</td>
<td>Cartilage, cornea, intervertebral disc.</td>
</tr>
<tr>
<td>Heparan sulfate</td>
<td>Blood vessels, lung, basal lamina</td>
</tr>
<tr>
<td>Chondroitin 4-sulfate</td>
<td>Cartilage, bone, blood vessels</td>
</tr>
<tr>
<td>Chondroitin 6-sulfate</td>
<td>Cartilage, blood vessels, umbilical cord.</td>
</tr>
<tr>
<td>Dermatan sulfate</td>
<td>Skin, heart valves, blood vessels</td>
</tr>
<tr>
<td>Heparan sulfate (Heparin)</td>
<td>Mast cell granules, basophils, liver lung, skin.</td>
</tr>
</tbody>
</table>
Chondroitin Sulfate

D-Glucuronic acid (GlcA)  N-Acetyl-D-Galactosamine (GalNac)

Dermalan Sulfate

L-Iduronic acid (IdoA)  N-Acetyl-D-Galactosamine (GalNac)

Heparan Sulfate

D-Glucuronic acid (GlcA)  D-Glucosamine (GlcNH₂)

Heparin

L-Iduronic acid (IdoA)  D-Glucosamine (GlcNH₂)
Proteoglycans are proteins that are covalently attached to one or more GAG
Functions of Proteoglycans

- Resistance of compression.
- Retardation of movement of microorganisms.
- Act as a filter
Classification of Connective Tissue

• **Connective tissue proper:**
  - Loose (areolar)
  - Dense regular
    - Dense irregular
    - Dense regular

• **Special connective tissue:**
  - Reticular
  - Elastic
  - Adipose
  - Bone
  - Cartilage
  - Blood

• **Embryonic connective tissue**
  - Mesenchymal (mucoid) connective tissue
Loose connective tissue

- Called also areolar connective tissue
- Typically contains cells, fibers and ground substance in equal amounts
- Supports epithelium (lamina propria)
- Surrounds small blood vessels
- Fills spaces between muscle and nerve cells
- Mesentery
- Its flexible but not very resistant to stress
Dense irregular connective tissue

- Bundles of collagen fibers are randomly interwoven with no definite orientation
- Provides resistance to stress from all directions
- Dermis of skin, organ capsules, submucosa
Dense regular connective tissue

• Parallel bundles of collagen fibers with few fibrocytes aligned with collagen and separated by very little ground substance
• Provides resistance to prolonged or repeated stresses exerted in the same direction
• Ligaments, tendons, aponeuroses
• Tendons are poorly vascularized and repair of damaged tendons is very slow
Collagen

Tendons (collagen)
Reticular connective tissue

- Consists of reticular cells (modified fibroblasts) and the network of reticular fibers formed by them
- Forms the structural framework in which the cells of the organ are suspended
- In the liver, bone marrow, lymph nodes and the spleen
Mesenchymal connective tissue

- Mesenchyme forms the undifferentiated "filling" of the early embryo.
- It consists of mesenchymal cells, which interconnect by slender cell processes.
- Mesenchymal cells have stem cell properties, i.e. they are able to give rise to other cell and tissues types.
- The wide extracellular space between the mesenchymal cells is occupied by ground substance, which can be stained with dyes that also stain mucin - hence the alternative name of this tissue type: mucoid connective tissue.
Mesenchymal connective tissue

Mucoid connective tissue also forms a compliant cushion around the vessels of the umbilical cord, where it is also called Wharton's jelly. Included among the fibroblastic cells are many mesenchymal stem cells, which are being studied for their potential in regenerative medicine.

• Mucoid connective tissue is similar to the tissue found in the vitreous chambers of eyes and pulp cavities of young teeth.
Adipose tissue
Adipose tissue is a highly specialized loose connective tissue designed to store large quantities of triacylglycerols (triglycerides) and fat-soluble substances.

Is derived from embryonic mesenchyme.

Each adipose cell, or adipocyte, stores lipid in cytoplasmic inclusions called lipid droplets.
Two types of adipose tissue are found: white adipose tissue and brown adipose tissue.
Brown Adipose Tissue (BAT)

- Is present in significant amounts in human infants
- Its primary function is to generate body heat
- Its distribution is very limited in the adult
Account for 2-5% of the body weight in a newborn.

It is greatly reduced during childhood and adolescence.

In adults it is found only in scattered areas, around kidneys and aorta.

It is found in the mediastinum, the subcutaneous tissue between the scapulae, the area around the kidney and the area along the aorta.
Brown adipocytes are small cells that contain a centrally-placed nucleus and large numbers of mitochondria.

Brown adipocytes are multilocular cells, i.e., each cell contains multiple small lipid droplets.

Brown adipose tissue has a high metabolic rate capable of generating relatively high amounts of heat, a process that is physiologically important to infants prior to the maturation of their thermoregulatory mechanisms.
White Adipose Tissue (WAT)

• Is the principal type of adipose tissue of the adult human
  I. storage reservoir of metabolic fuel in the body
  II. thermal insulator
  III. protective cushion
• In the adult, white adipose tissue is primarily distributed subcutaneously and viscerally.
Histologic characteristics

- The adipocytes are relatively large 50-150 um in diameter, compared to brown adipocytes, and are dominated by the lipid droplet
- Non-membrane bound droplet
- Unilocular cells
- Signet ring appearance.
- The tissue is well vascularized
- Adipocytes are surrounded by a thin external lamina containing type 4 collagen