



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.

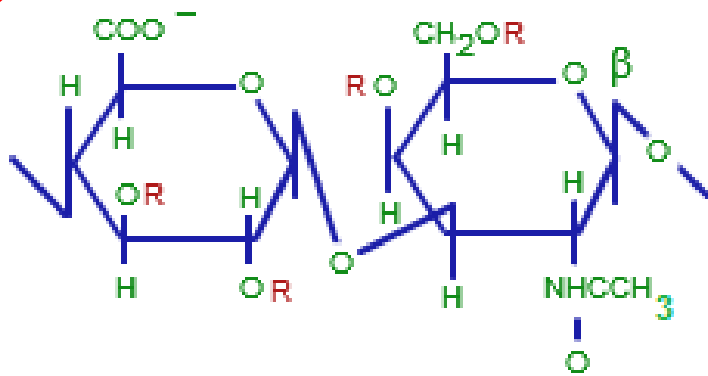
GAGs

- 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)

Types of GAGs

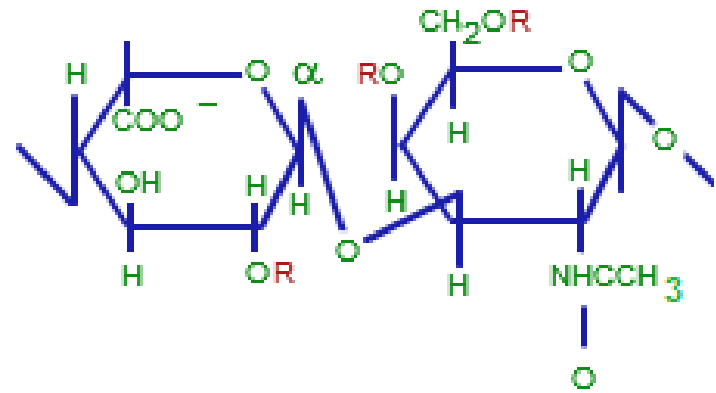
GAG	Distribution
Hyaluronic acid	Most connective tissue , cartilage, dermis, synovial fluid.
Keratan sulfate	Cartilage , cornea, intervertebral disc.
Heparan sulfate	Blood vessels, lung, basal lamina
Chondroitin 4-sulfate	Cartilage , bone, blood vessels
Chondroitin 6-sulfate	Cartilage , blood vessels, umbilical cord.
Dermatan sulfate	Skin , heart valves, blood vessels
Heparan sulfate (Heparin)	Mast cell granules , basophils, liver lung, skin.

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D - Glucuronic acid (GlcA)

N-Acetyl-D-Galactosamine (GalNAc)

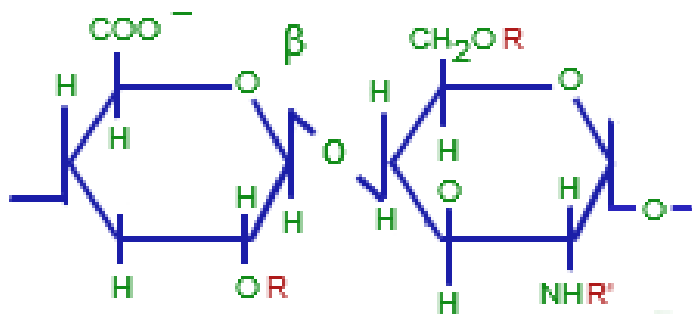


L-Iduronic acid (IdoA)

N-Acetyl-D-Galactosamine (GalNAc)

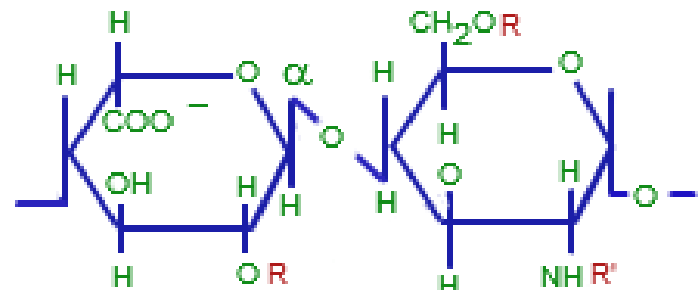
Chondroitin Sulfate

Dermatan Sulfate



D - Glucuronic acid (GlcA)

D - Glucosamine (GlcNH₂)

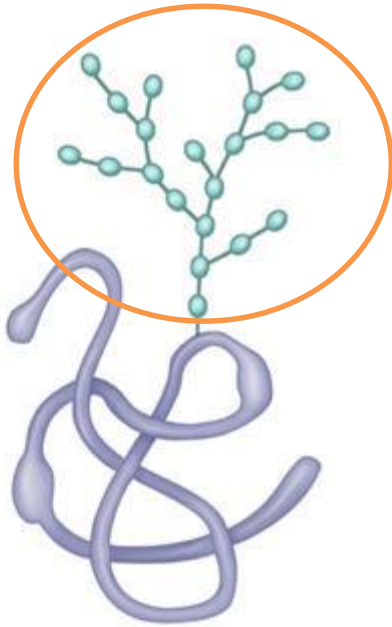


L - Iduronic acid (IdoA)

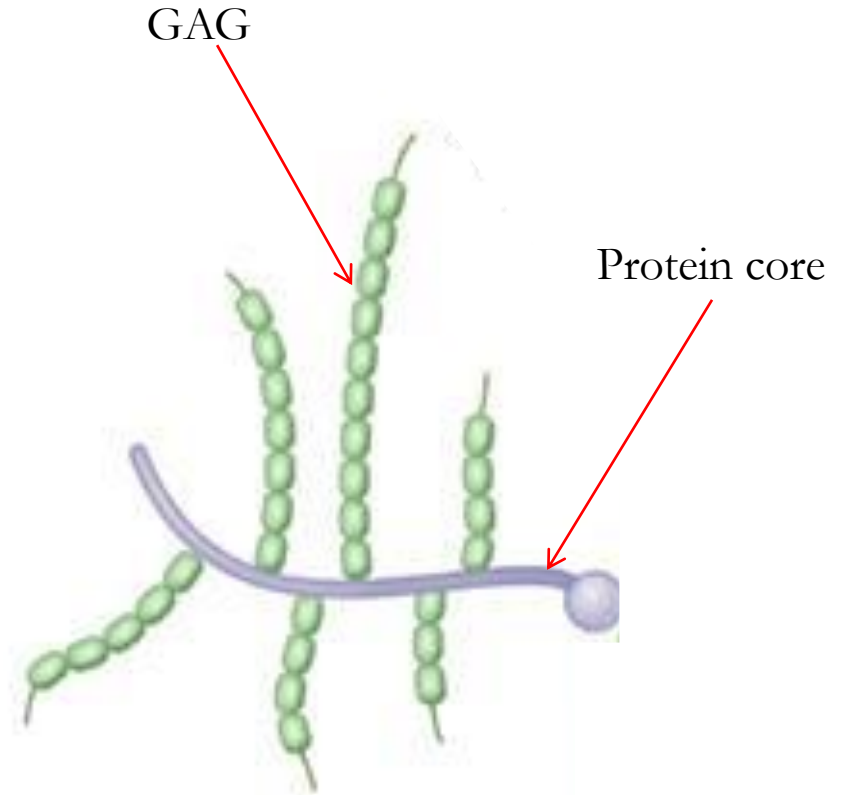
D - Glucosamine (GlcNH₂)

Heparan Sulfate

Heparin

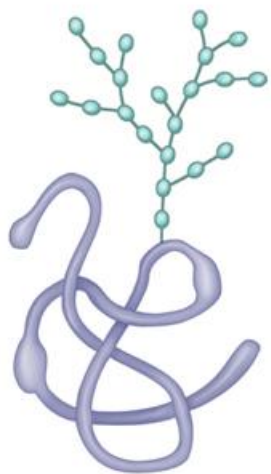


Glycoprotein

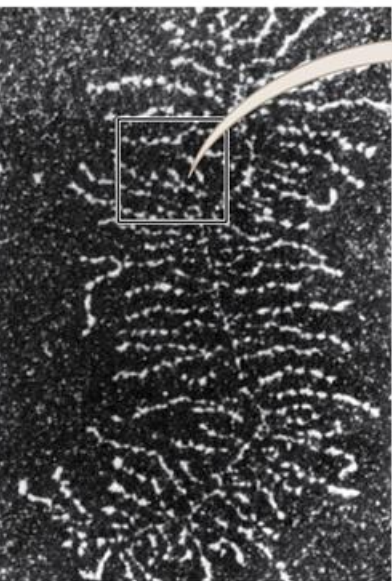


Proteoglycan

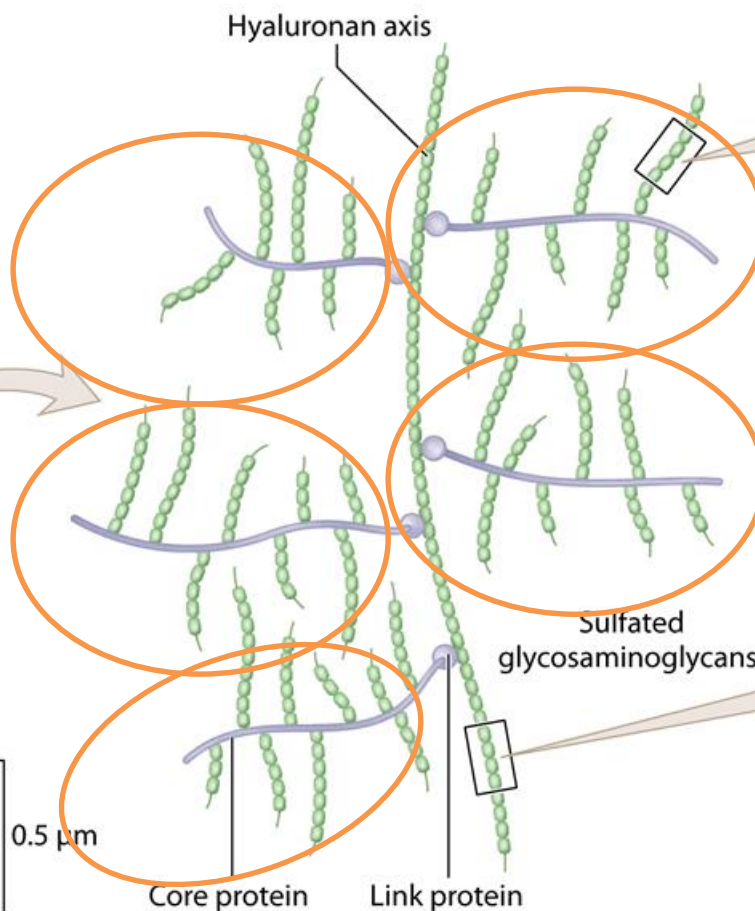
Proteoglycans are proteins that are covalently attached to one or more GAG



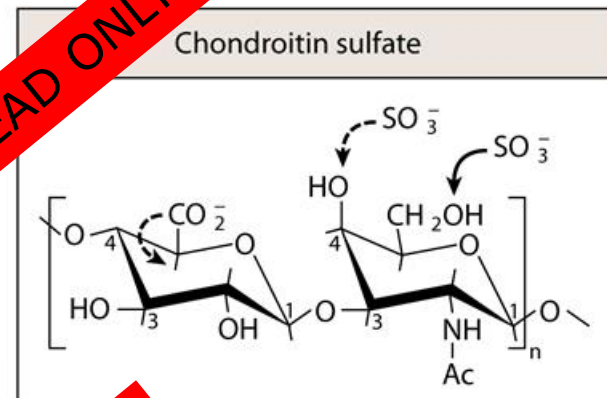
A typical glycoprotein



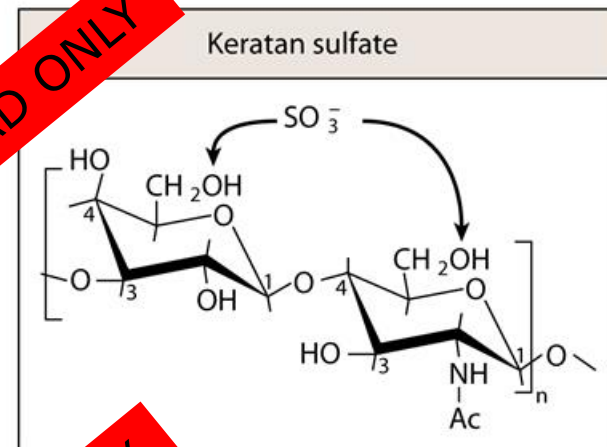
Proteoglycans linked to hyaluronan



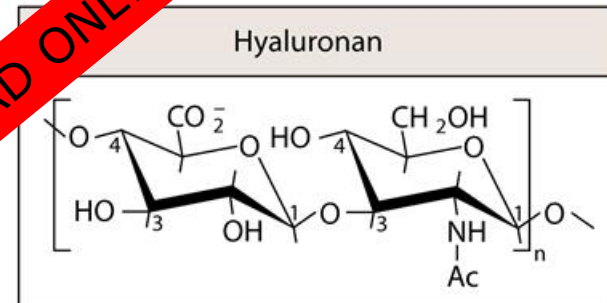
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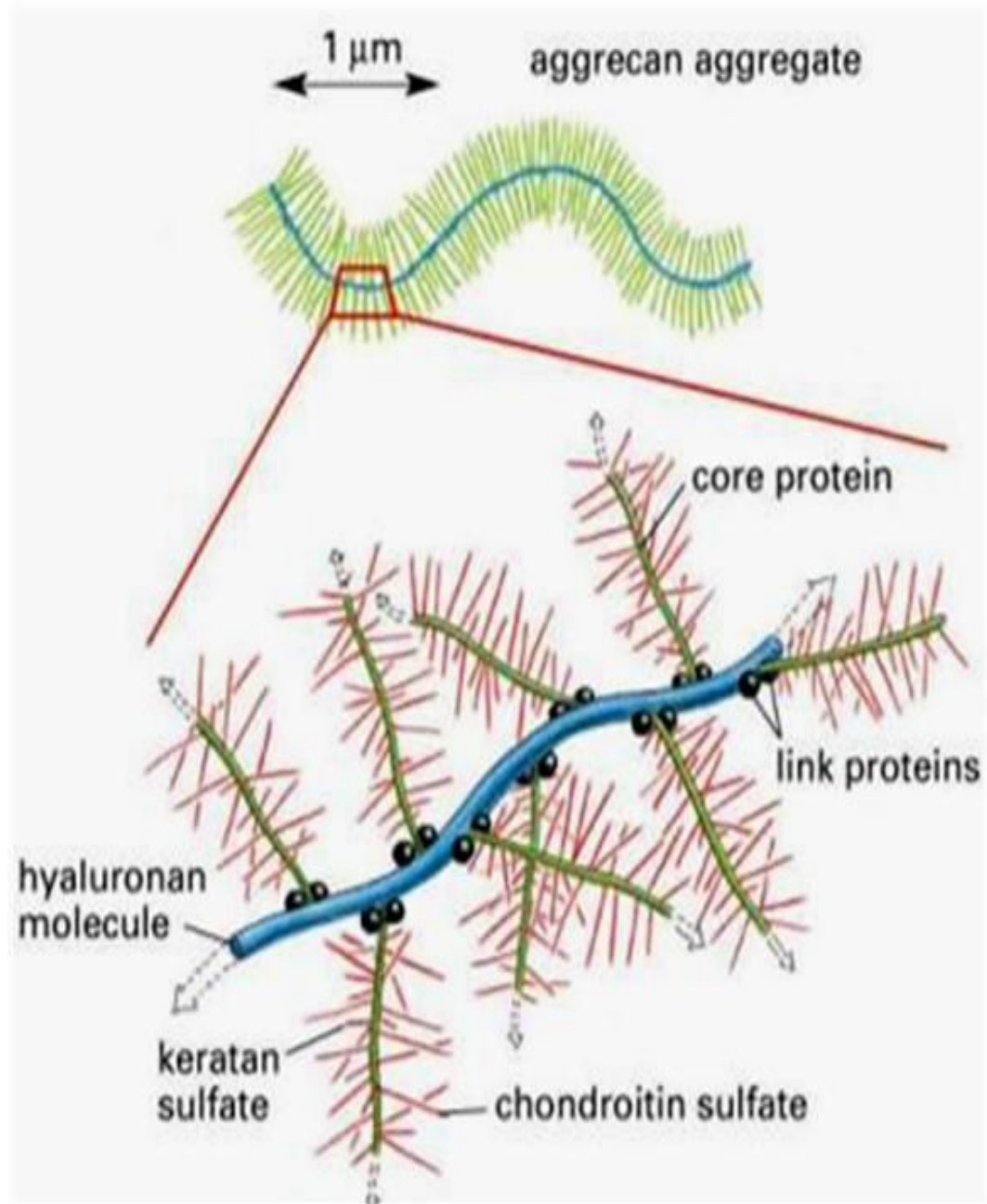
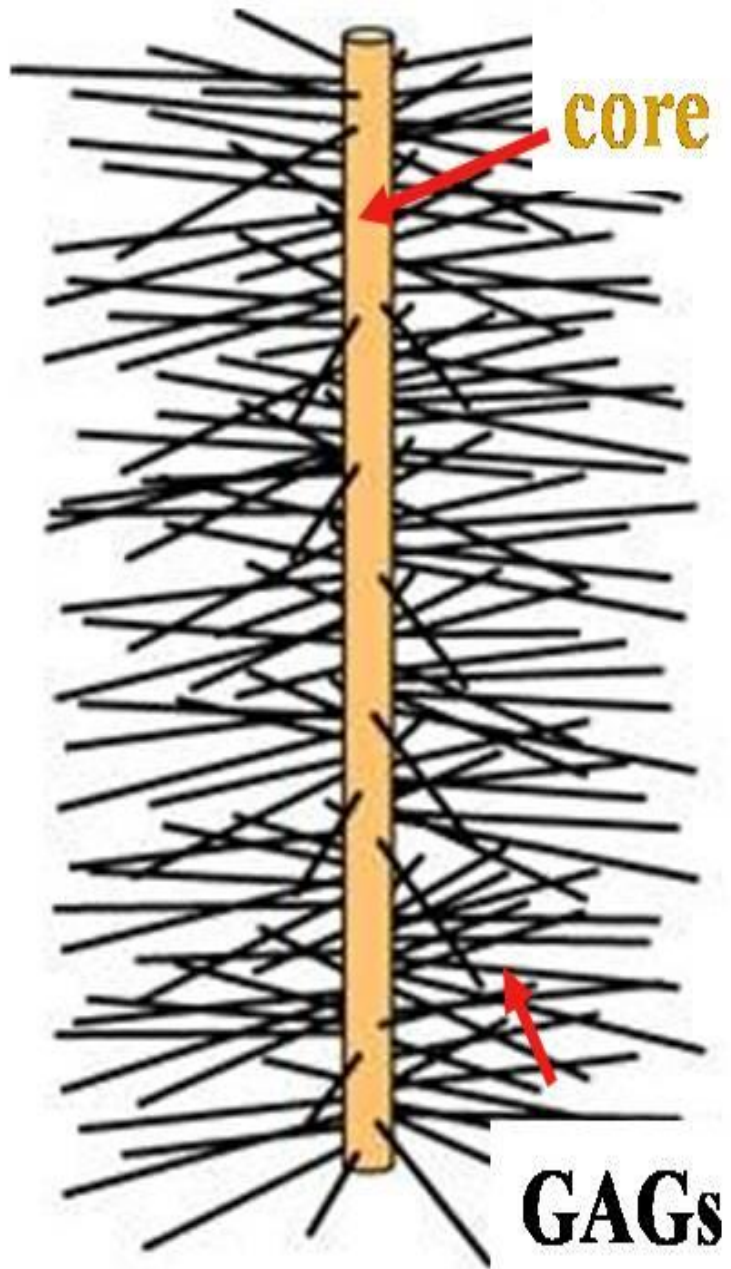


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Functions of Proteoglycans

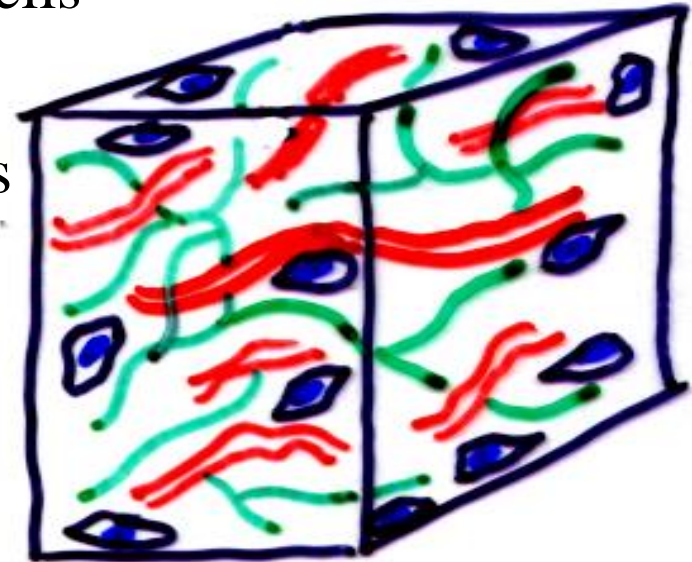
- Resistance of compression.
- Retardation of movement of microorganisms.
- Act as a filter

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

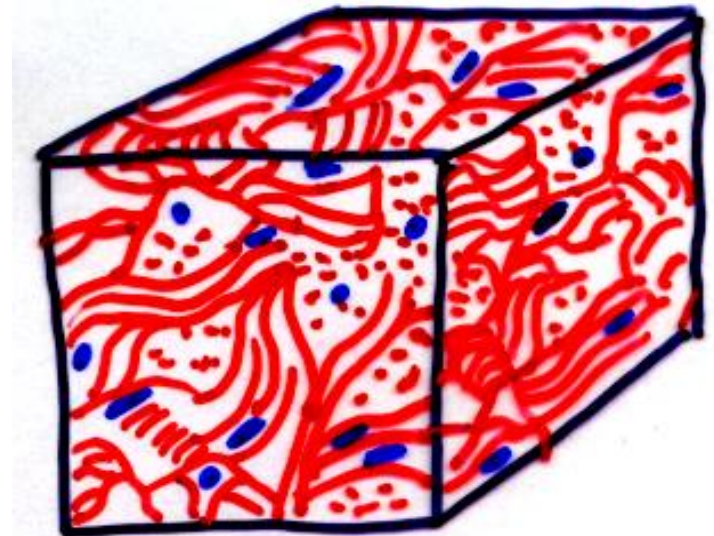
Loose connective tissue

- 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



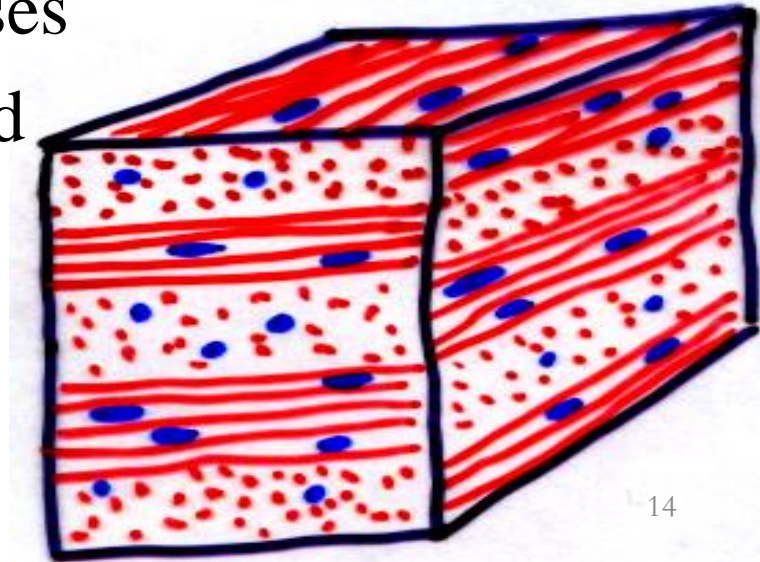
Dense irregular connective tissue

- 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

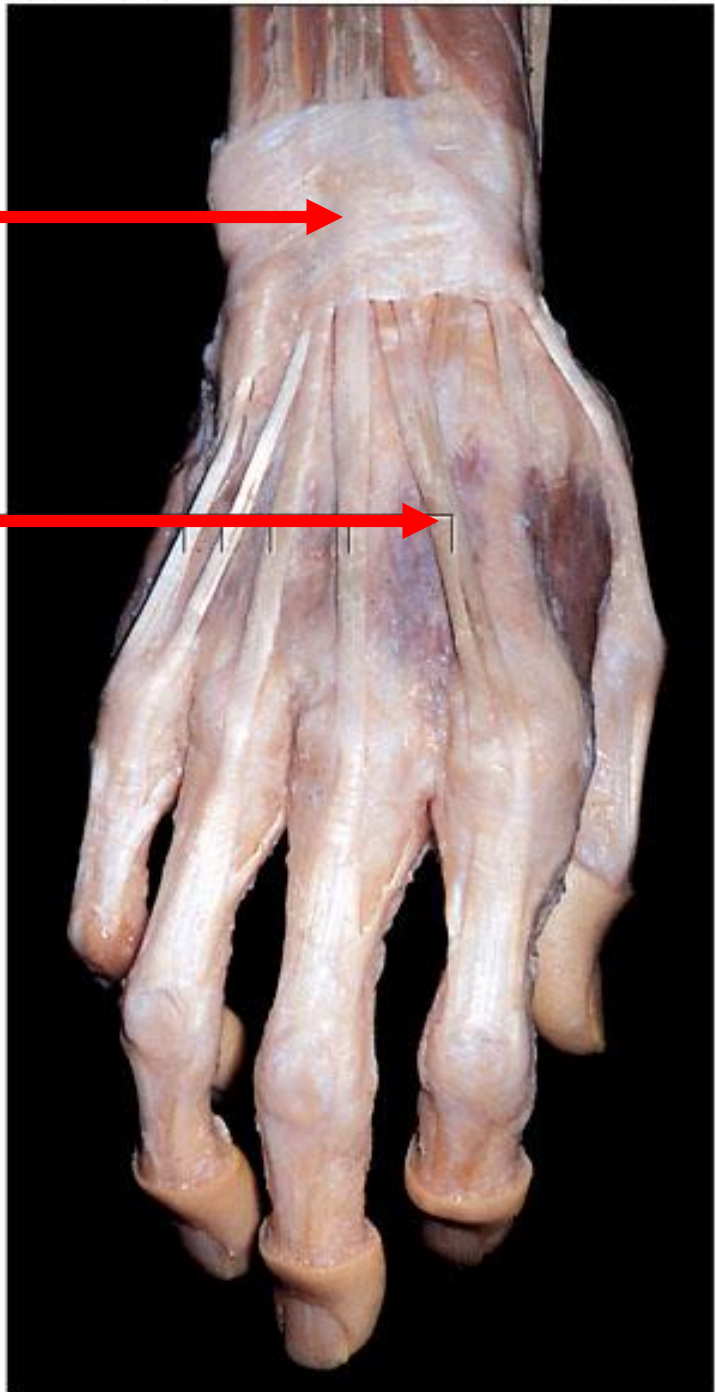
- Parallel bundles of collagen fibers with few fibrocytes aligned with collagen and separated by very little ground substance
- Provides resistance to prolonged or repeated stresses exerted in the same direction
- Ligaments , tendons, aponeuroses
- Tendons are poorly vascularized and repair of damaged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

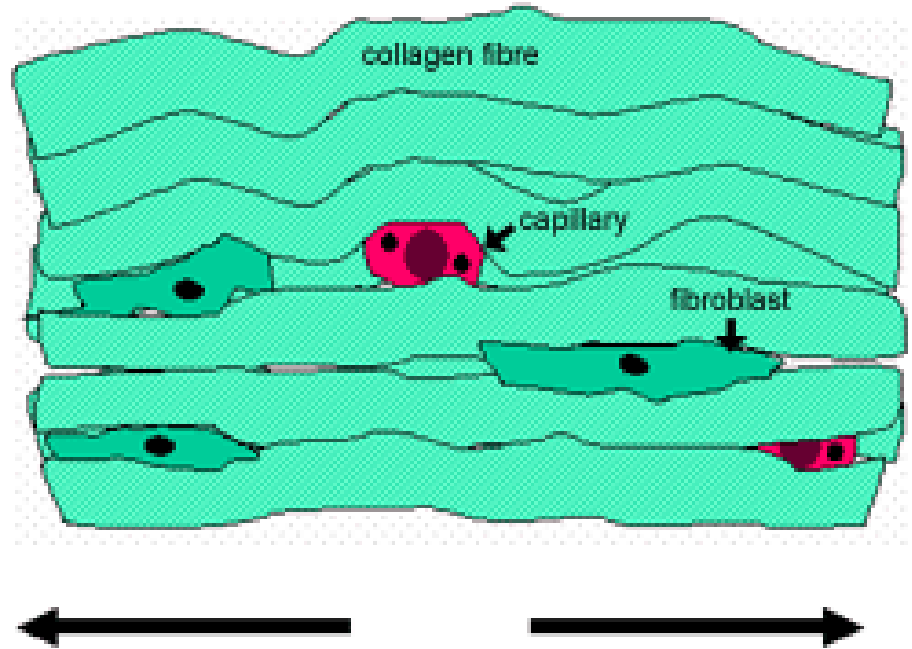
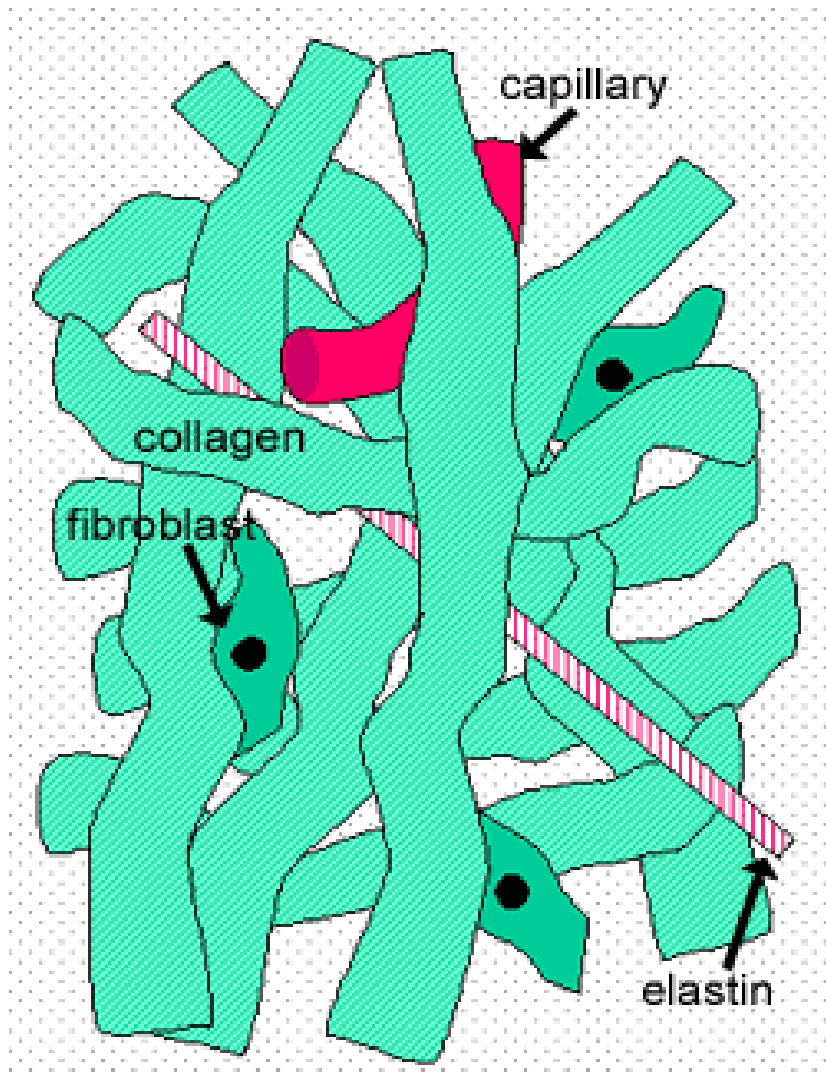


Collagen



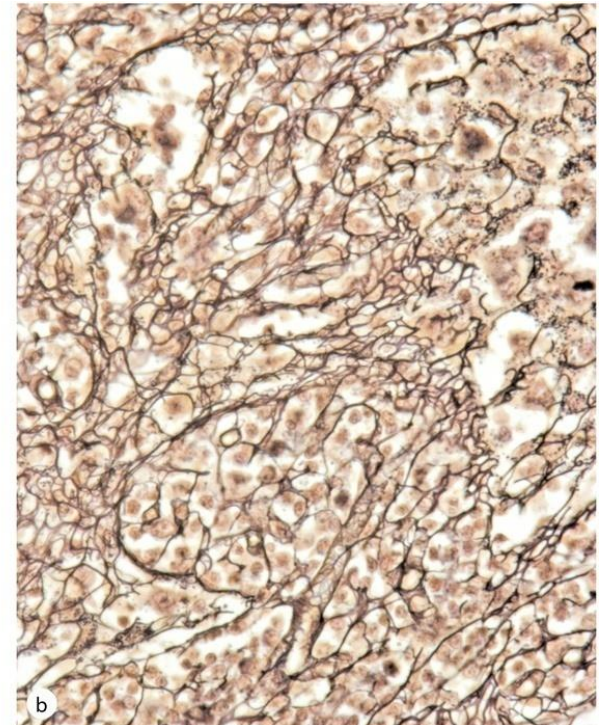
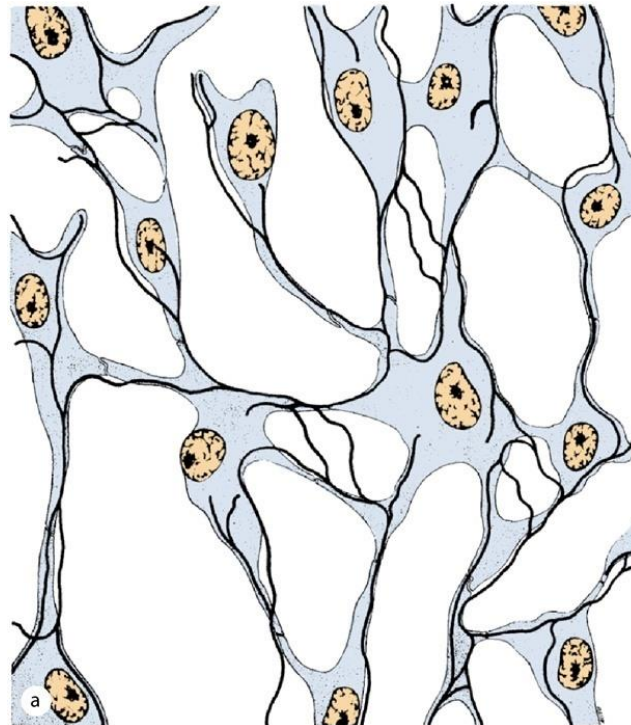
**Tendons
(collagen)**





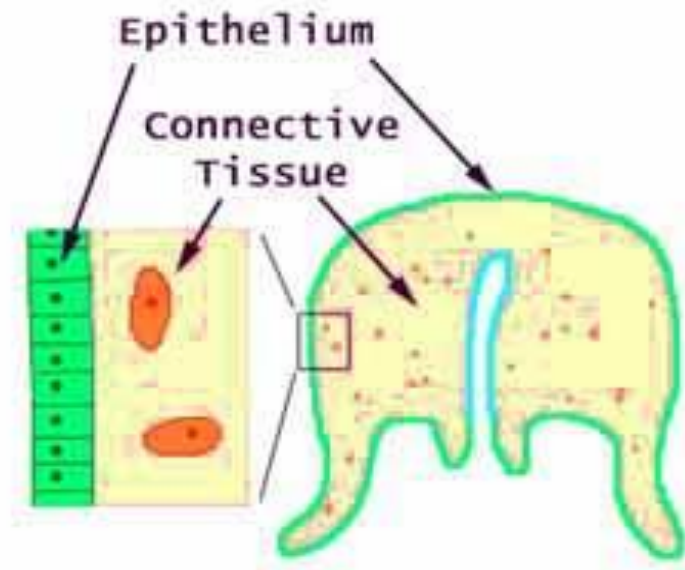
Reticular connective tissue

- 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 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

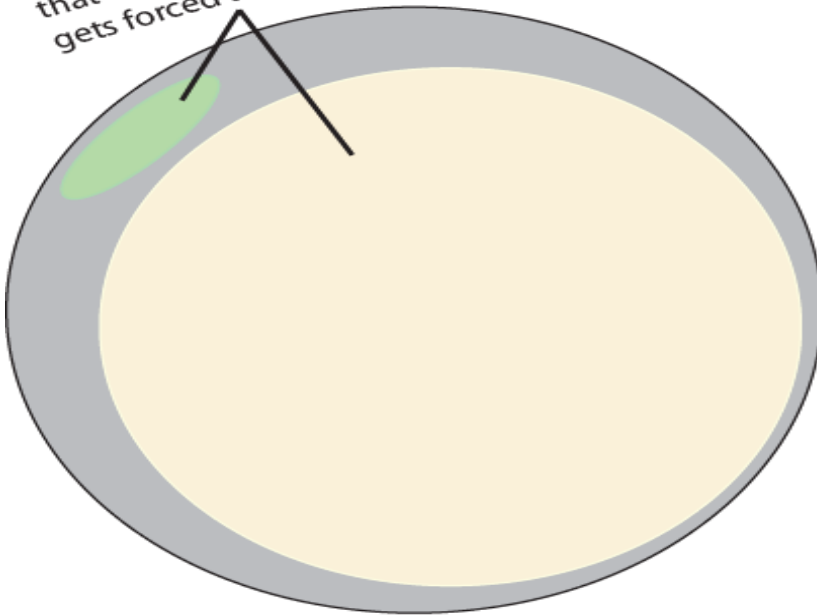
Adipose tissue is a highly specialized loose connective tissue designed to store large quantities of triacylglycerols (triglycerides) and fat-soluble substances

Is derived from embryonic mesenchyme

Each adipose cell, or adipocyte, stores lipid in cytoplasmic inclusions called **lipid droplets**

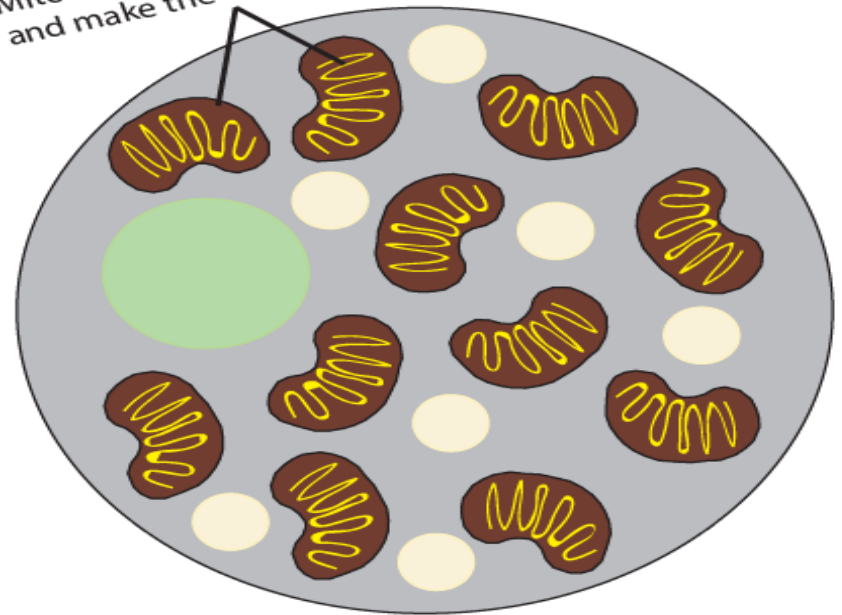
Two types of adipose tissue are found:
white adipose tissue and brown adipose tissue

The fat drop is so large
that everything else
gets forced to the edge



White Fat Cell

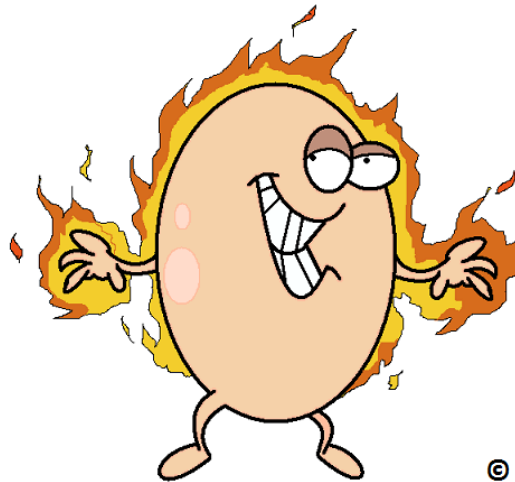
Mitochondria generate heat
and make the cell brown



Brown Fat Cell

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

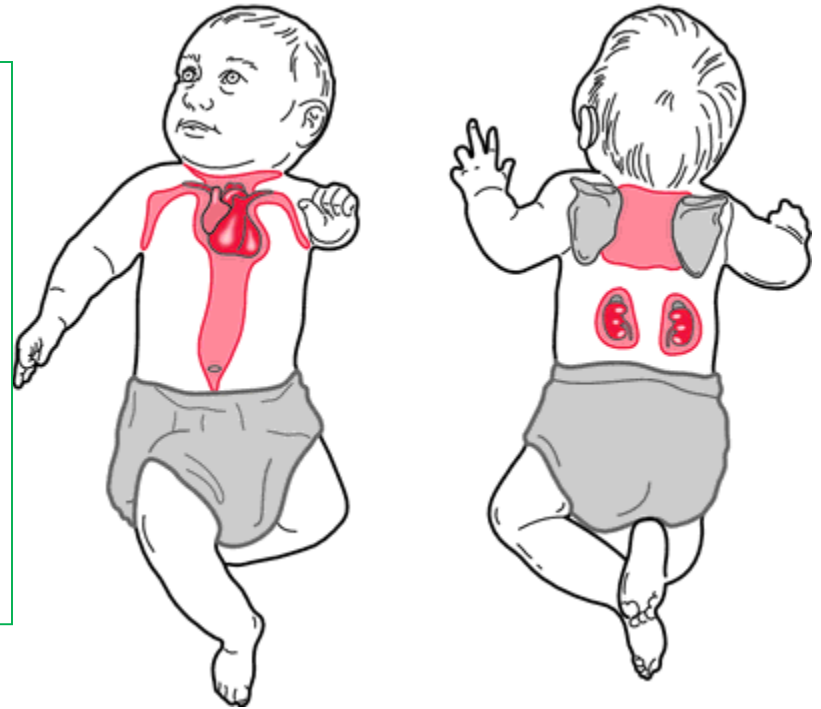


Account for 2-5 % of the body weight in a newborn

It is greatly reduced during childhood and adolescence

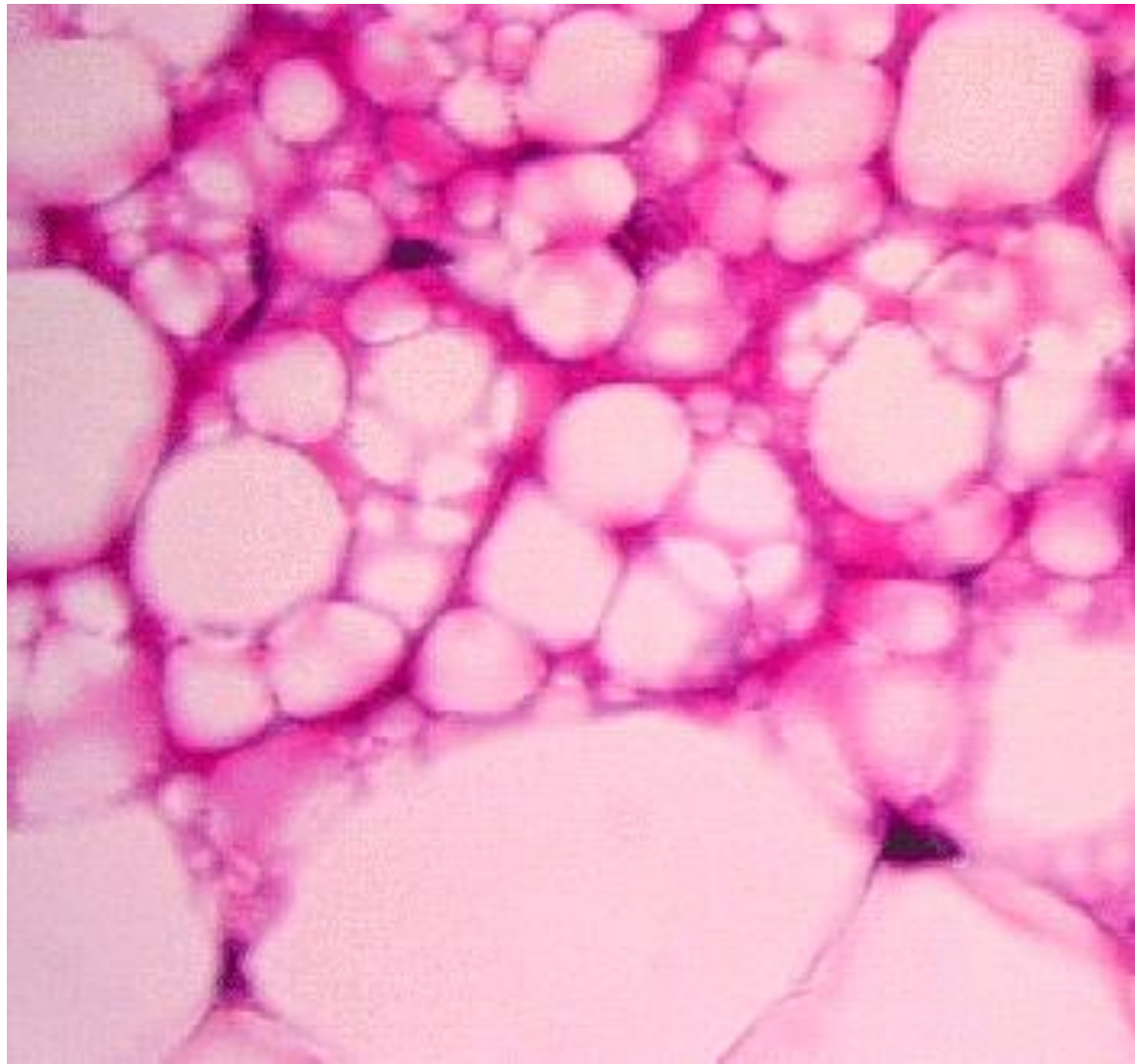
In adults it is found only in scattered areas , around kidneys and aorta

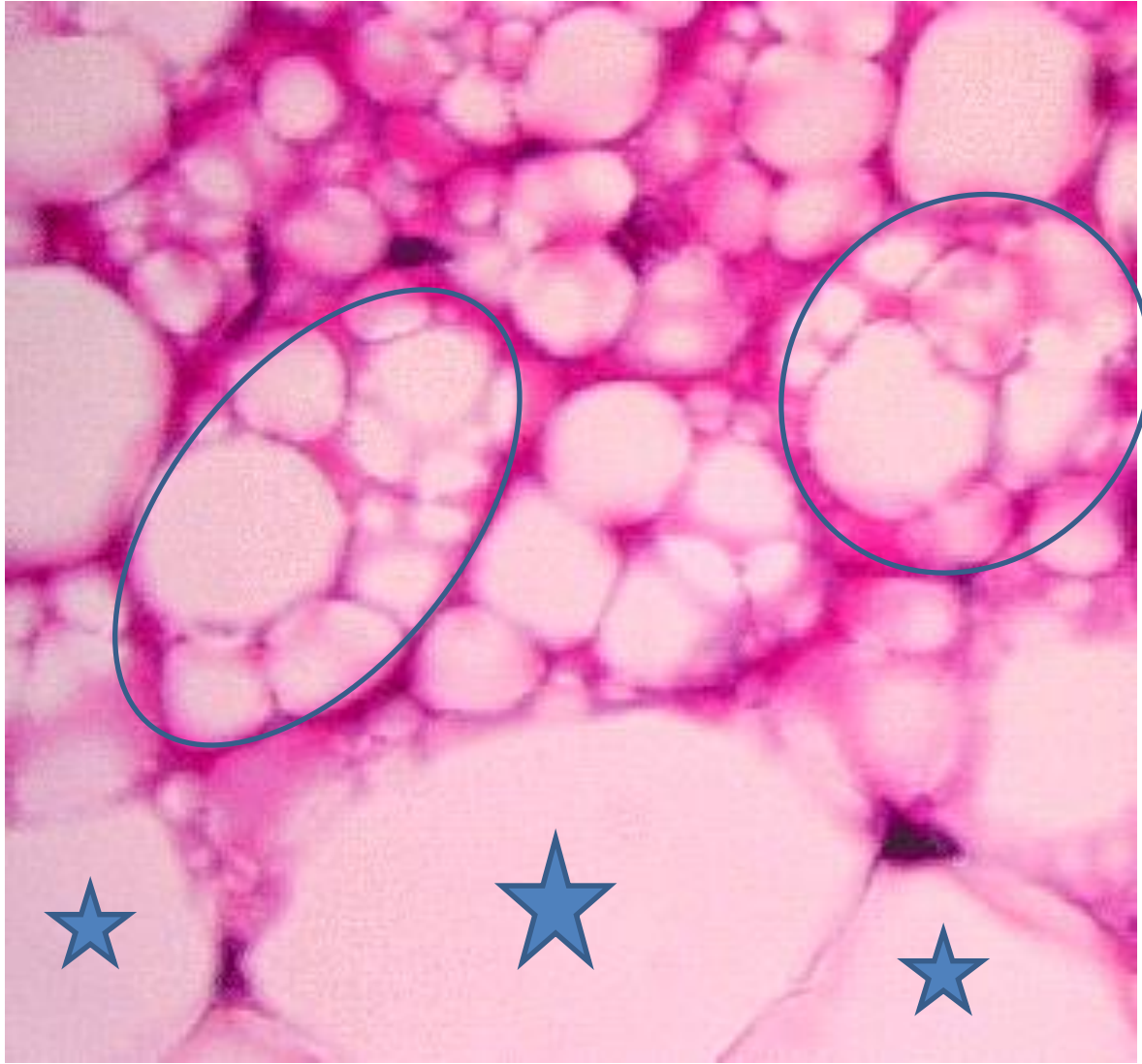
It is found in the mediastinum, the subcutaneous tissue between the scapulae, the area around the kidney and the area along the aorta.



Histologic characteristics

- 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

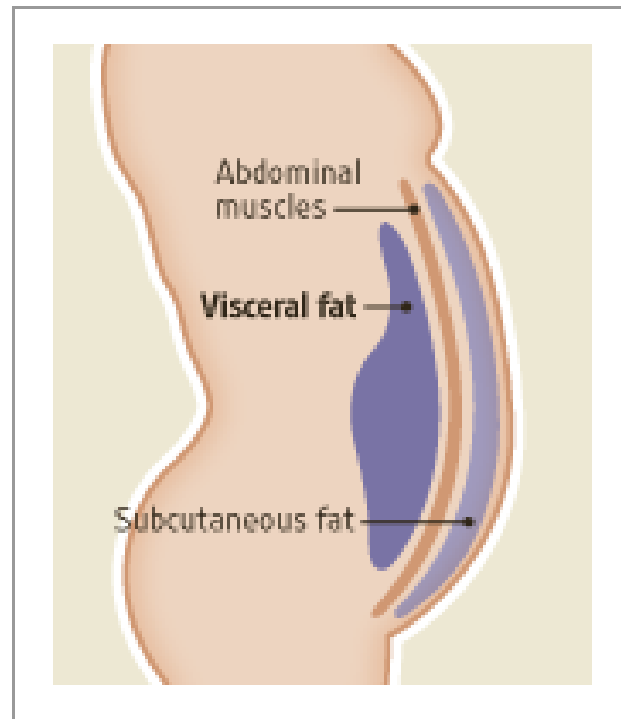




White Adipose Tissue (WAT)

- 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

