

HUMAN ANATOMY AND PHYSIOLOGY- 1(BP101T)

UNIT: 1 TISSUE LEVEL OF ORGANIZATION

CLASS: 9

TOPIC: CLASSIFICATION OF TISSUES, STRUCTURE, LOCATION AND FUNCTIONS OF CONNECTIVE TISSUES

Connective tissue consists of **two basic elements**: **extracellular matrix** and **cells**. A connective tissue's extracellular matrix is the material located between its **widely spaced cells**. The extracellular matrix consists of **protein fibers** and **ground substance**, the material between the cells and the fibers.

Connective tissue **cells** vary according to the type of tissue and include the following:

1. **Fibroblasts** are large, flat cells with branching processes. They are present in all the **general connective tissues**, and usually are the most numerous.
2. **Macrophages** are phagocytes that develop from monocytes, a type of white blood cell.
3. **Plasma cells (plasmocytes)** are found in many places in the body, but most plasma cells **reside** in connective tissue, especially in the gastrointestinal and respiratory tracts.
4. **Mast cells (mastocytes)** are involved in the inflammatory response, the body's reaction to **injury** or infection and can also bind to, ingest, and kill bacteria.
5. **Adipocytes** are fat cells or adipose cells, connective tissue cells that store triglycerides (fats). They are found deep to the skin and around organs such as the heart and kidneys.

6. **Leukocytes (white blood cells)** are not found in significant numbers in normal connective tissue.

CONNECTIVE TISSUE EXTRACELLULAR MATRIX:

Each type of connective tissue has unique properties, based on the specific extracellular materials between the cells.

The extracellular matrix consists of two major components.

- **GROUND SUBSTANCE:** Ground substance is the component of a connective tissue between the cells and fibers.
- The ground substance may be fluid, semi-fluid, gelatinous.
- It supports cells, bind them together, stores water and provides a medium for exchange of substance between the blood and cells.
- It plays an active role in how tissues develop, migrate, proliferate and change shape, and metabolic functions.
- Ground substance contains water and large organic molecules (which are complex combination of poly saccharides and proteins).
- **FIBERS:** Three types of fibers are embedded in the extracellular matrix between the cells: collagen fibers, elastic fibers, and reticular Fibers. They function to strengthen and support connective tissues.
- **Collagen fibers (Pink, Thick):**
 - ✓ These are very strong and stretching, but they are not stiff, which allows tissue flexibility.
 - ✓ The properties of different types of collagen fibers vary from tissue to tissue.
 - ✓ Collagen fibers consist of the protein collagen.

- ✓ Collagen fibers are found in most types of connective tissues, especially bone, cartilage, tendons (which attach muscle to bone), and ligaments (which attach bone to bone).

- **Elastic fibers (Purple/Black):**

- ✓ Which are smaller in diameter than collagen fibers, branch and join together to form a fibrous network within a connective tissue.
- ✓ Elastic fibers made up of a glycoprotein named fibrillin, which aids strength and stability.
- ✓ elastic fibers have the ability to return to
- ✓ their original shape after being stretched, a property called elasticity.
- ✓ Elastic fibers are plentiful in skin, blood vessel walls, and lung tissue.

- **Reticular fibers (Black, fine):**

- ✓ Consisting of collagen arranged in fine bundles with a coating of glycoprotein, provide support in the walls of blood vessels and form a network around the cells in some tissues, tissues, such as areolar connective tissue, adipose tissue, nerve fibers, and smooth muscle tissue.
- ✓ Reticular forms the **STROMA** (supporting framework) of many soft organs, such as the spleen and lymph nodes.
- ✓ These fibers also help form the basement membrane.

CLASSIFICATION OF CONNECTIVE TISSUE:

I. EMBRYONIC CONNECTIVE TISSUE

A. Mesenchyme

B. Mucous (muroid) connective tissue

II. MATURE CONNECTIVE TISSUE

A. Connective tissue proper

1. Loose connective tissue

a. Areolar connective tissue

b. Adipose tissue

c. Reticular connective tissue

2. Dense connective tissue

a. Dense regular connective tissue

b. Dense irregular connective tissue

c. Elastic connective tissue

B. Supporting connective tissue

1. Cartilage

a. Hyaline cartilage

b. Fibrocartilage

c. Elastic cartilage

2. Bone tissue

a. Compact bone

b. Spongy bone

C. Liquid connective tissue

1. Blood

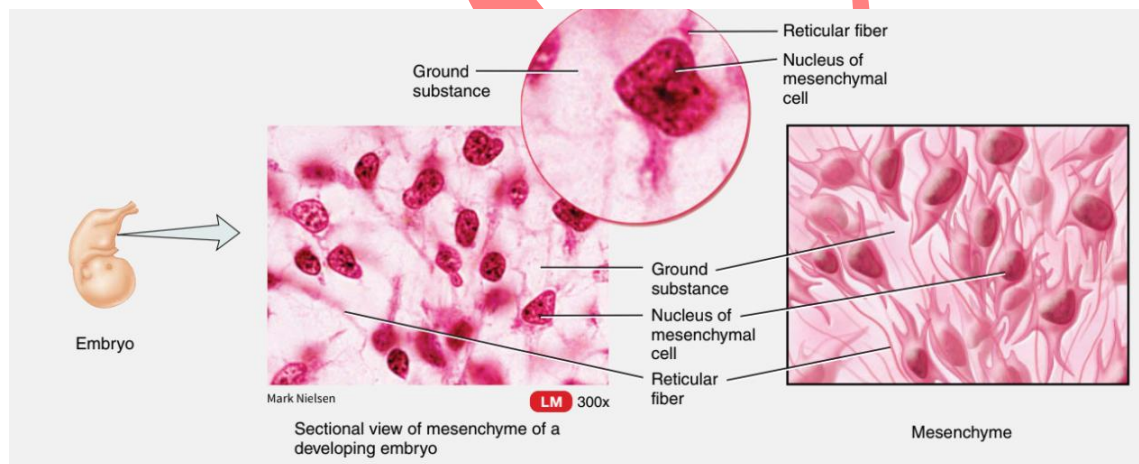
2. Lymph

I. EMBRYONIC CONNECTIVE TISSUE

A. Mesenchyme: Mesenchyme has **irregularly shaped mesenchymal cells** embedded in **semifluid** ground substance that contains **delicate reticular fibers**.

LOCATION: Skin and developing bones of embryo; some in adult connective tissue, especially along blood vessels.

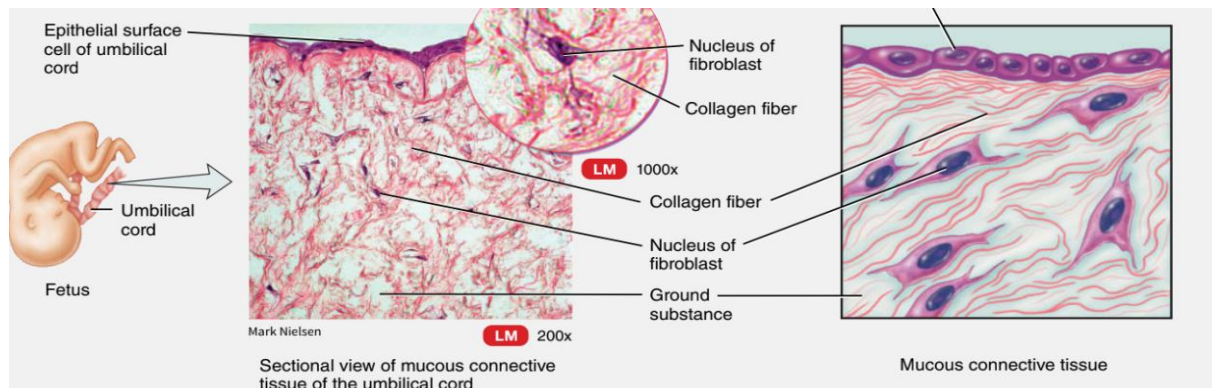
FUNCTION: Forms almost all other types of connective tissue.



B. Mucous (muroid) connective tissue: Mucous (muroid) connective tissue has widely **scattered fibroblasts** embedded in **viscous, jellylike** ground substance that contains **fine collagen fibers**.

LOCATION: Umbilical cord of fetus.

FUNCTION: Support.



II. MATURE CONNECTIVE TISSUE

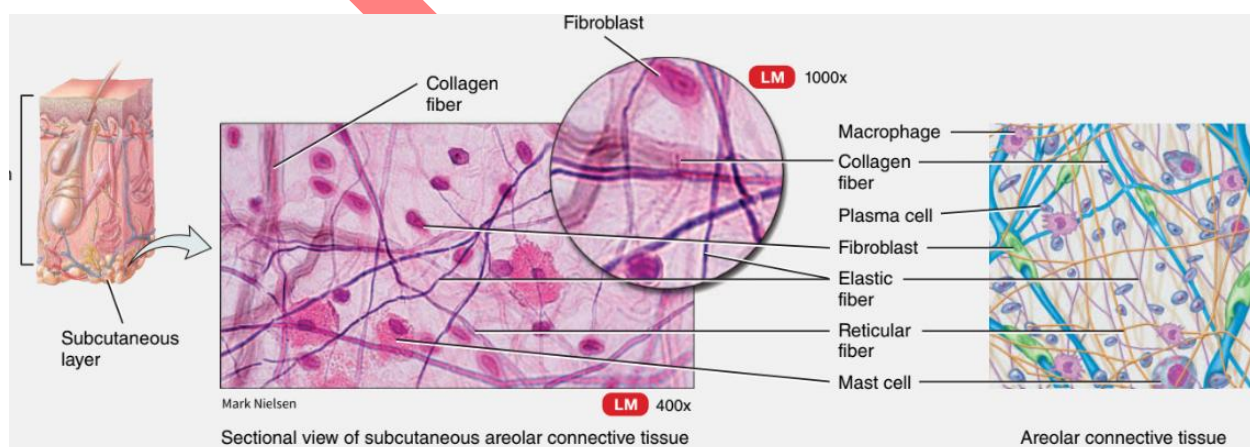
A. Connective tissue proper

1. Loose connective tissue

a. Areolar connective tissue: It is one of the most widely distributed connective tissues; consists of fibers (collagen, elastic, reticular) arranged randomly and several kinds of cells (fibroblasts, macrophages, plasma cells, adipocytes, mast cells, and a few white blood cells) embedded in semifluid ground substance (hyaluronic acid).

LOCATION: Present in subcutaneous layer deep to skin; papillary (superficial) region of dermis of skin; blood vessels, nerves, and body organs.

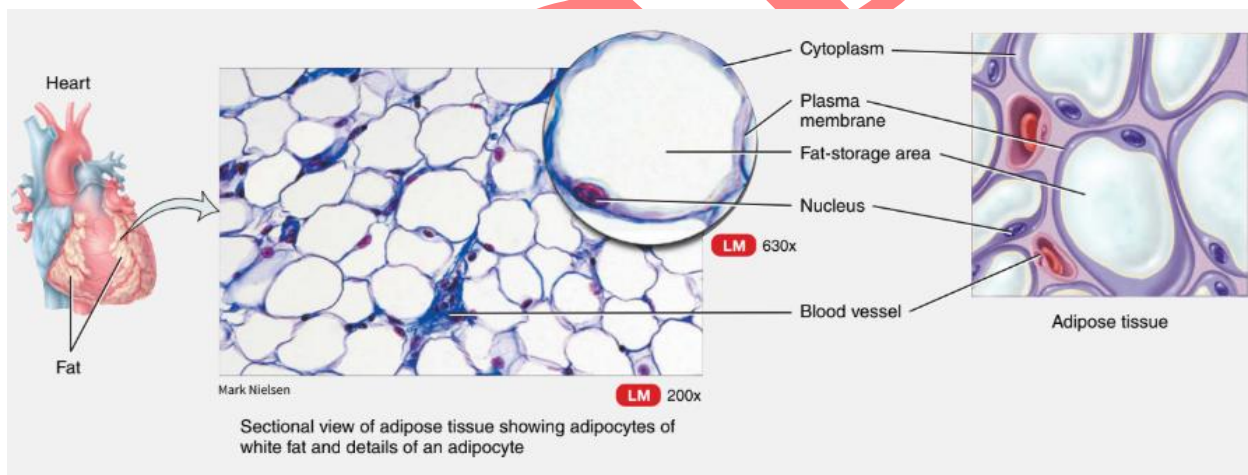
FUNCTION: Strength, elasticity, support.



b. Adipose Tissue: Adipose tissue has cells derived from **fibroblasts (called adipocytes)** that are specialized for storage of **triglycerides (fats)** as a large, centrally located droplet. Most adipose tissue in adults is **white adipose tissue**.

Brown adipose tissue (BAT) is darker due to very **rich blood supply** and **numerous pigmented mitochondria** that participate in **aerobic cellular respiration**. BAT is widespread in the fetus and infant; adults have only small amounts.

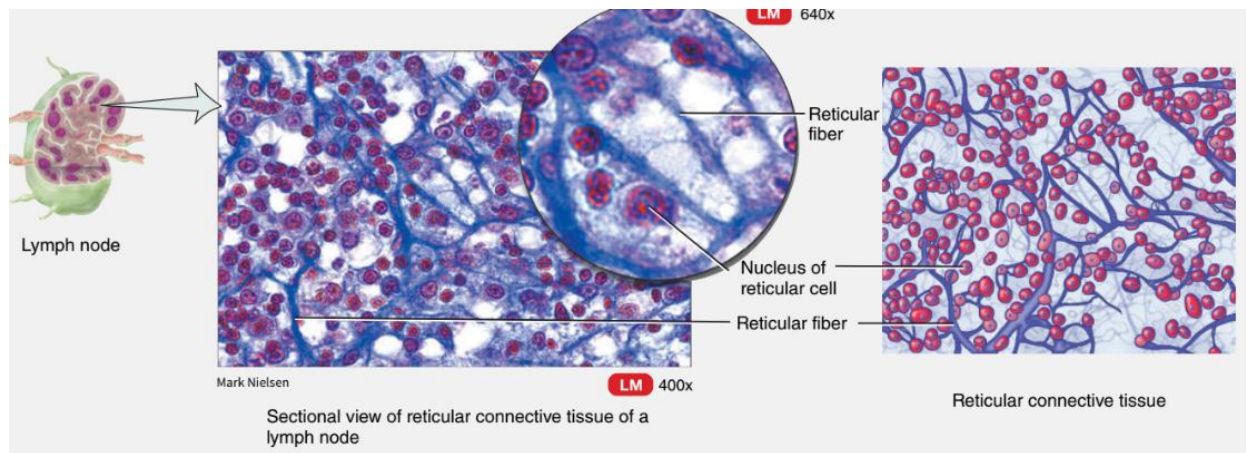
LOCATION: Subcutaneous layer deep to skin, around heart and kidneys, yellow bone marrow, and behind eyeball in eye socket.



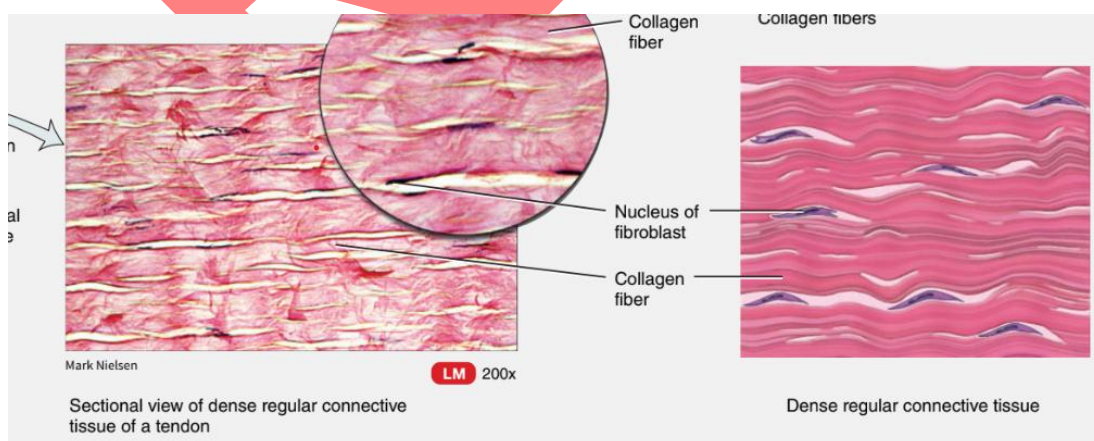
c. Reticular connective tissue: Reticular connective tissue is a fine interlacing network of reticular **fibers** (thin form of collagen fiber) and reticular cells.

LOCATION: Stroma (supporting framework) of liver, spleen, lymph nodes; red bone marrow; reticular lamina of basement membrane; around blood vessels and muscles.

FUNCTION: Forms stroma of organs; binds smooth muscle tissue cells; filters and removes worn-out blood cells in spleen and microbes in lymph nodes.



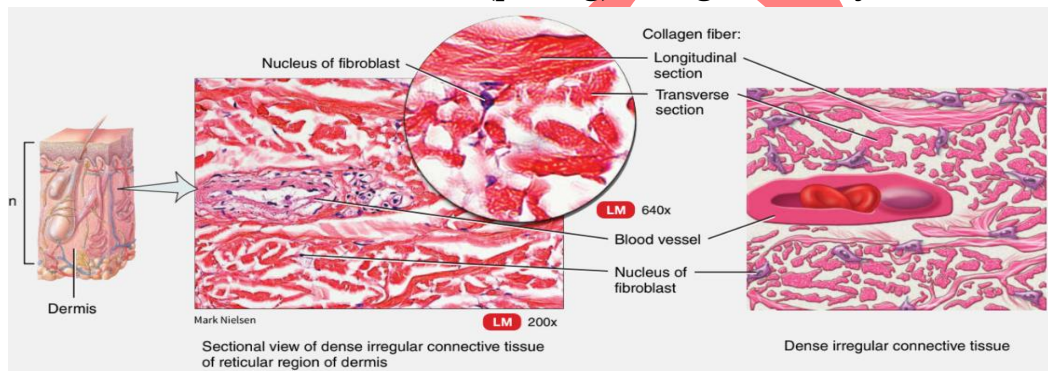
- A. DENSE REGULAR CONNECTIVE TISSUE:** Dense regular connective tissue forms shiny white extracellular matrix; mainly collagen fibers regularly arranged in bundles with fibroblasts in rows between them.
- LOCATION:** Forms tendons (attach muscle to bone), most ligaments (attach bone to bone)
- FUNCTION:** Provides strong attachment between various structures. Tissue structure withstands pulling (tension).



A.DENSE IRREGULAR CONNECTIVE TISSUE: Dense irregular connective tissue is made up of **collagen fibers**; usually irregularly arranged with a **few fibroblasts**.

LOCATION: Tissue beneath skin and around muscles and other organs, skin, heart, periosteum of bone, joint capsules, organs (kidneys, liver, testes, lymph nodes), also, in heart valves.

FUNCTION: Provides tensile (pulling) strength in many directions.

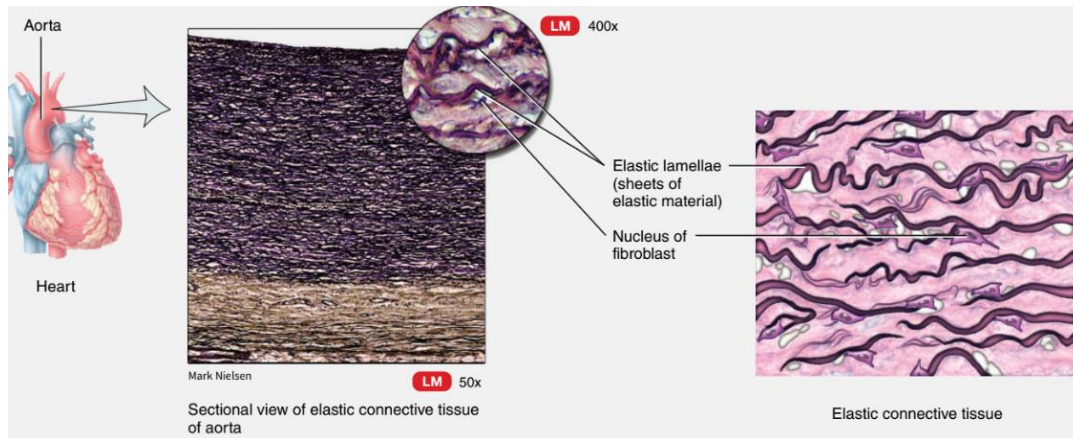


B.ELASTIC CONNECTIVE TISSUE: Elastic connective tissue contains predominantly elastic fibers with fibroblasts between them; unstained tissue is yellowish.

LOCATION: Lung tissue, walls of elastic arteries, trachea, bronchial tubes, true vocal cords, penis, some ligaments between vertebrae.

FUNCTION:

- Allows stretching of various organs;
- It is strong and can recoil to original shape after being stretched.
- Elasticity is important to normal functioning of lung tissue (recoils in exhaling) and elastic arteries (recoil between heartbeats to help maintain blood flow).



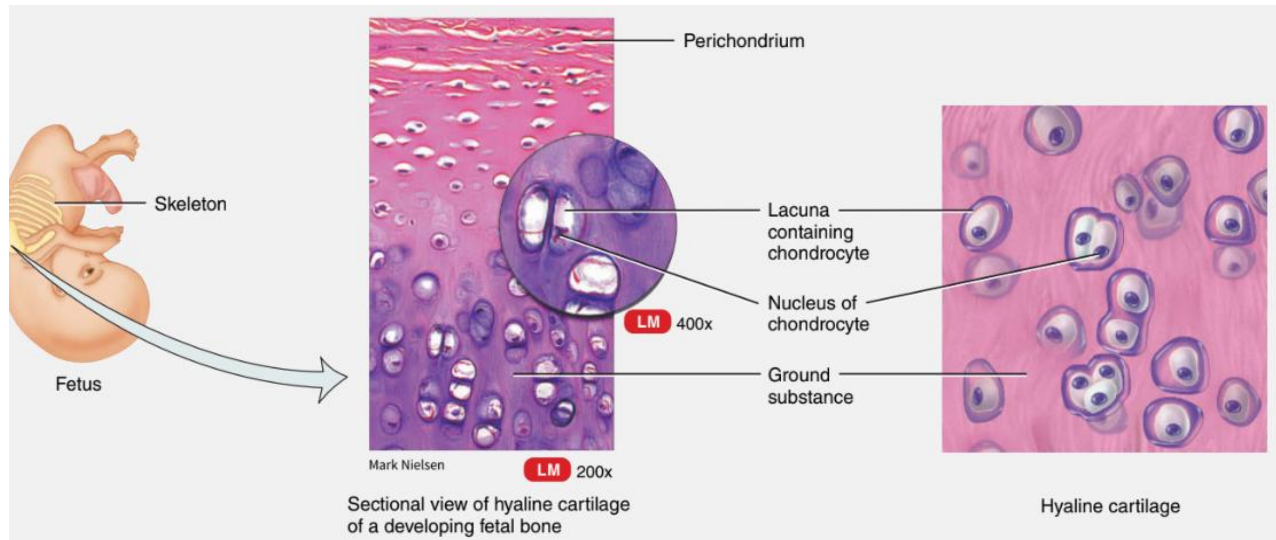
SUPPORTING CONNECTIVE TISSUE—CARTILAGE

A. HYALINE CARTILAGE: It is a type of connective tissue that **looks smooth and glassy**. It contains a **gel-like substance that helps it stay flexible and resilient**. It usually appears **bluish-white and shiny** but may **stain pink or purple** when viewed under a **microscope**.

The **collagen fibers** in this cartilage are **very fine** and typically **cannot be seen with regular staining methods**. **Chondrocytes** (cartilage cells) are housed in small spaces called **lacunae** and are often surrounded by a membrane called the **perichondrium**.

LOCATION: Most abundant cartilage in body; at **ends of long bones, anterior ends of ribs, nose, parts of larynx, trachea, bronchi, bronchial tubes, embryonic and fetal skeleton**.

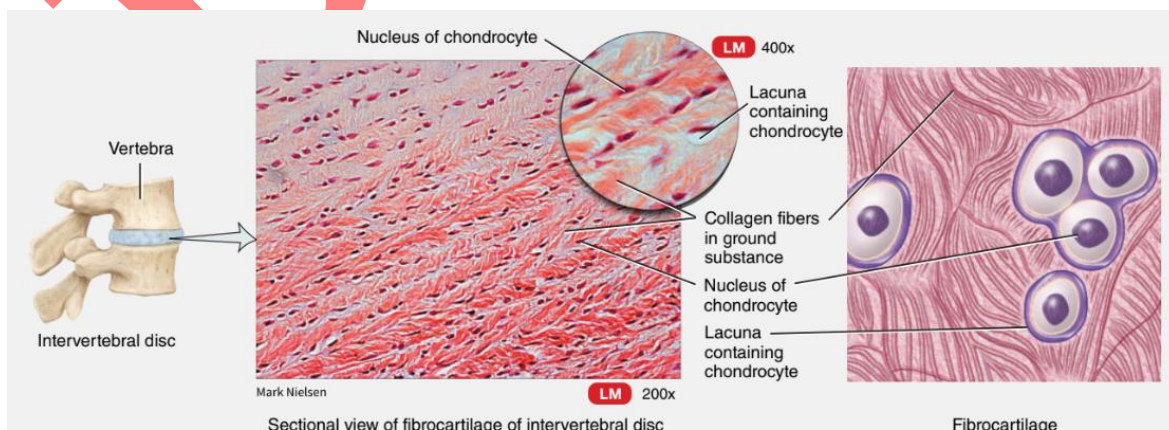
FUNCTION: Provides **smooth surfaces** for movement at **joints, flexibility, and support**.



B. FIBROCARILAGE: Fibrocartilage has **chondrocytes** among clearly visible thick bundles of **collagen fibers** within extracellular matrix; **lacks perichondrium**.

LOCATION: Hip bones, **intervertebral discs**.

FUNCTION: **Support** and **joining structures together**. Strength and rigidity make it the strongest type of cartilage.

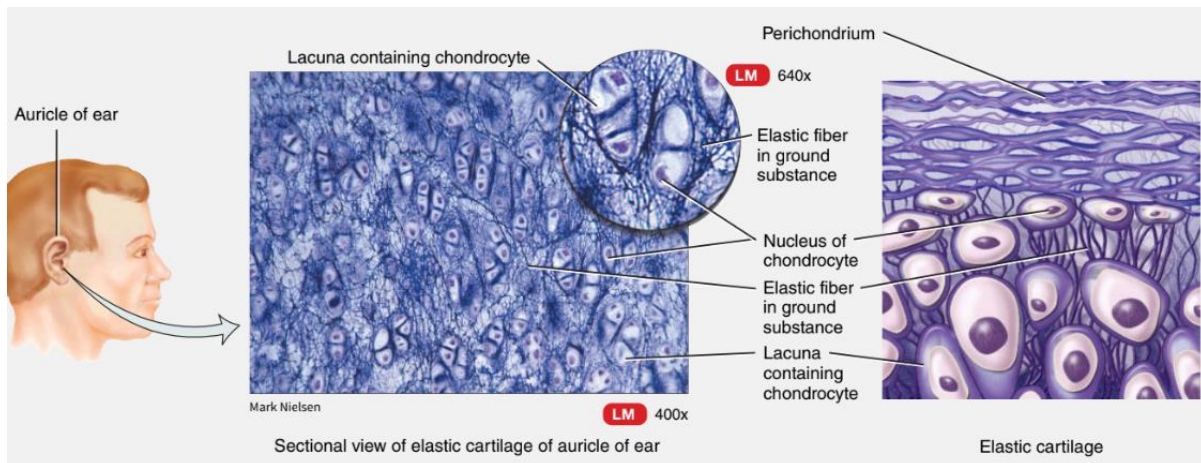


C.ELASTIC CARTILAGE:

Elastic cartilage has **chondrocytes** in **threadlike network of elastic fibers** within extracellular matrix; **perichondrium** present.

LOCATION: Larynx, part of external ear, auditory tubes.

FUNCTION: Provides strength and elasticity; maintains shape of certain structures.



BONE TISSUE:

COMPACT BONE: Tissue consists of osteons that contain lamellae, lacunae, osteocytes, canaliculi, and central canals.

SPONGY BONE: Tissue consists of **thin columns** called trabeculae; spaces between trabeculae are filled with red bone marrow.

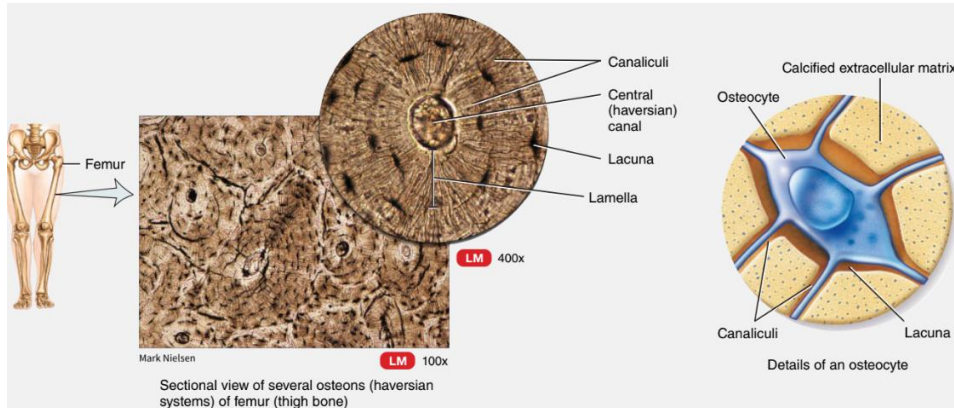
LOCATION: Both compact and spongy bone tissue make up the **various parts of bones of the body**.

FUNCTION: Support, protection, storage; houses blood-forming tissue.

Lamellae: (little plates; singular) are concentric rings of extracellular matrix that consist of **mineral salts (mostly calcium and phosphates)**, which give **bone its hardness and compressive strength**.

lacunae

Lacunae: are small spaces between lamellae that contain mature bone cells called **osteocytes**.



Canaliculi: Canaliculi provide routes for nutrients to reach osteocytes and for wastes to leave them.

Central canal or Haversian canal contains blood vessels and nerves.

LIQUID CONNECTIVE TISSUE—BLOOD: Blood consists of blood plasma and formed elements: red blood cells (erythrocytes), white blood cells (leukocytes), platelets (thrombocytes).

LOCATION: Within blood vessels (arteries, arterioles, capillaries, venules, veins), within chambers of heart.

FUNCTION: Red blood cells: transport oxygen and some carbon dioxide;

white blood cells: carry on phagocytosis and mediate allergic reactions and immune system responses;

platelets: essential for blood clotting.

LYMPH: It is a liquid connective tissue that consists of several types of cells in a clear liquid extracellular matrix that is similar to blood plasma but with much less protein. The composition of lymph varies from one part of the body to another.

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