

Histology Lecture (1)

Histology of Cartilage and Bone

Histology Team 432

Teams

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Lecture Objectives:

- By the end of this lecture, the student should describe the microscopic structure, distribution and growth of the different types of:
 - **Cartilage.**
 - **Bone**

Additional notes are in green

Cartilage

Features of Cartilage:

- It is a special type of connective tissue with a rigid (rubbery) matrix
- It is usually avascular (nonvascular)

For this reason:

- There is poor blood supply to the cartilage and so its healing is hard
- It gets nutrients by diffusion from the vascular perichondrium

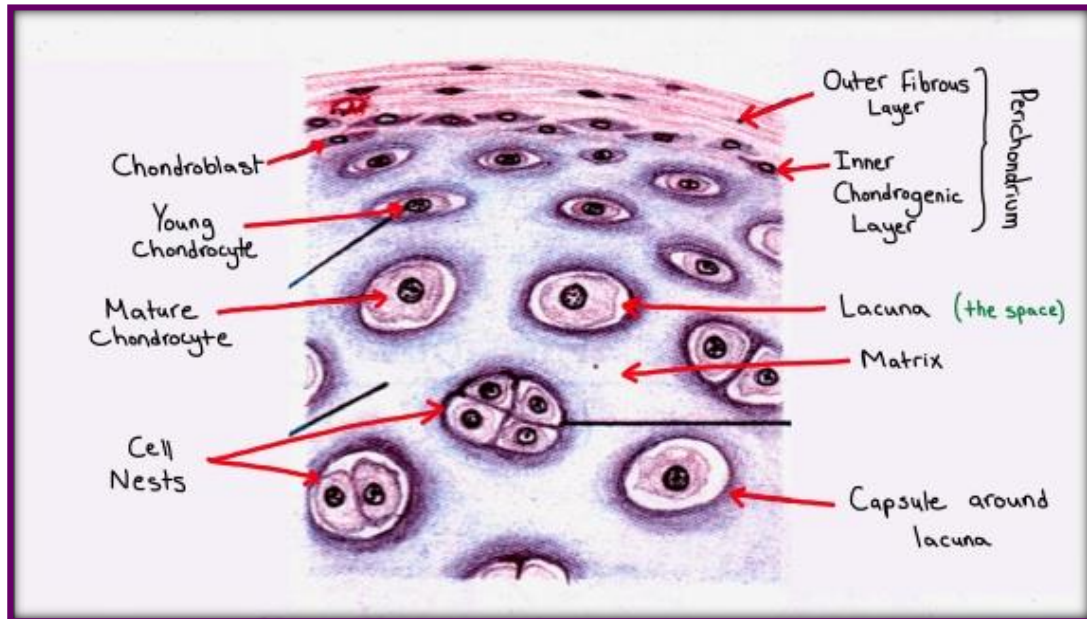
Types of Cartilage:

- Hyaline Cartilage
- Elastic Cartilage
- Fibrocartilage

1) Hyaline Cartilage:

Hyaline = glassy

<p>Perichondrium Peri = around Chondro=cartilage Perichondrium = Capsule around cartilage <u>Vascular</u> C.T. membrane formed of 2 layers:</p>	<p>Outer Fibrous Layer: Dense fibrous connective tissue (which is irregular dense collagenous connective tissue)</p>	<p>Functions of perichondrium:</p> <p>a. Nutritive function (by diffusion from its blood vessels). b. Chondrogenic function. c. Gives attachment to muscles & tendons.</p>
<p>Cartilage</p>	<p>Inner Chondrogenic Layer: Contains chondroblasts (flat cells with flat nuclei) (no lacunae)</p> <p>Cells: found in spaces called lacunae Two types of cells:</p> <ul style="list-style-type: none"> • Young Chondrocytes: Small and present singly in their lacunae (only one cell in each lacuna) • Mature Chondrocytes Large and are found: singly, in groups of 2, 4, 6 cells in their lacunae (<u>cell nests</u>) (cell nests are capsules containing multiple chondrocytes) <p>Note:</p> <ul style="list-style-type: none"> • When a cell is present singly in a lacuna: If it is small then it is young chondrocyte If it is large then it is mature chondrocyte • The capsules around chondrocytes are formed from the condensation of the ground substance . • Mature chondrocyte can divide , while mature osteocyte can not divide . So the lacunae in cartilage may contain one chondrocyte or more (2 – 8) chondrocytes . But in the bone the lacunae only contain one osteocyte . 	
	<p>Matrix:</p> <ul style="list-style-type: none"> • Homogenous • Basophilic (because of chemical compound , not because of ribosomes) . • Contains collagen type II (it cannot be seen in the figure below because it does not form bundles; it is scattered in the matrix) 	



Function of Chondroblasts:

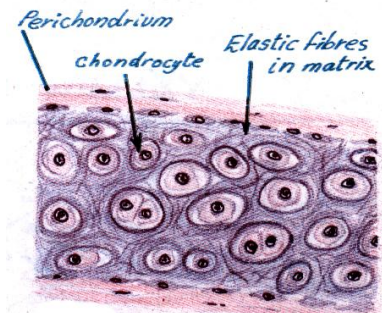
- Secrete of cartilage matrix (ground substance + fibers)
- Give rise to chondrocytes (Chondroblast -- capsule--> Chondrocyte)
- **Note: -blast = active cell**

Function of hyaline cartilage:

- Forms the skeleton of the foetus.
- Protection of bony surfaces, at joints.
- Keeps the respiratory tract open.

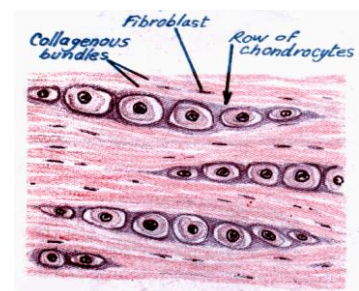
2) Elastic Cartilage:

- Similar to hyaline cartilage
- Has elastic fibers in the matrix (they are the light lines we can see in the matrix)



3) Fibrocartilage:

- No perichondrium (Devoid of nutrients except from surrounding tissue such as muscle..etc. so there is no healing)
- Rows of chondrocytes (with very little ground substance that contains collagen type II) in lacunae separated by parallel bundles of collagen fibers type I (no space to form cell nests)



Note: the dots in the collagen bundles are fibroblasts

Comparisons:

<u>Type of Cartilage:</u>	<u>Rich in:</u>
Hyaline Cartilage	Collagen type II
Elastic Cartilage	Elastic Fiber
Fibrocartilage	Collagen type I

Note: These are the types of fiber they are rich in but remember that they all contain Collagen type II in different amounts because it is the characteristic fiber of cartilage in general.

Sites where these types of cartilage are found:

Hyaline Cartilage	Elastic Cartilage	Fibrocartilage
<ul style="list-style-type: none">•Foetal skeleton•Costal Cartilage•Articular surfaces of bones•Nose, trachea & bronchi	<ul style="list-style-type: none">•Extrenal ear•Epiglottis	<ul style="list-style-type: none">•Intervertebral disks

Bone

Features of Bone:

- It is a special type of connective tissue with a hard matrix
- Rich in blood supply (blood vessels running longitudinally in canals)

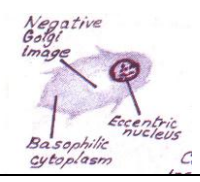
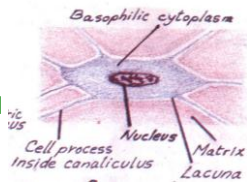
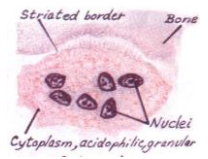
Types of Bone:

- Compact (cortical) bone
- Spongy (cancellous) bone

Functions of Bone:

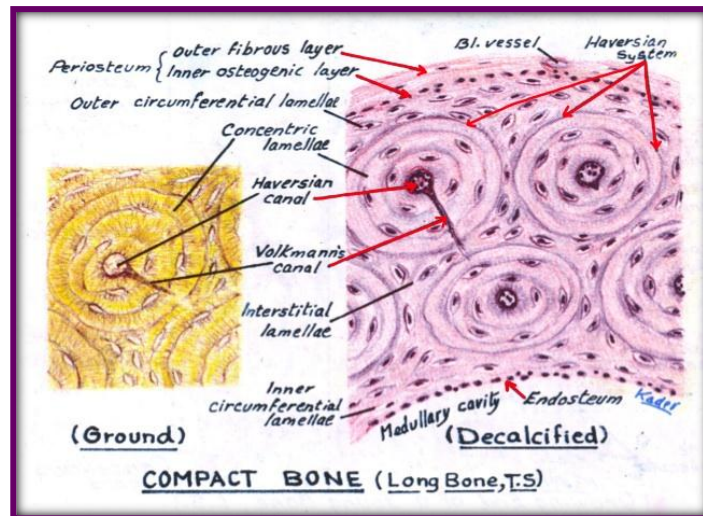
- Body support
- Protection of vital organs such as brain and bone marrow
- Storage of calcium

Components of Bone:

Bone Cells	Bone forming cells	Osteogenic cells: <ul style="list-style-type: none"> • Found in periosteum and endosteum • Fate: Gives rise to osteoblasts
		Osteoblasts: <ul style="list-style-type: none"> • Found in periosteum and endosteum • Origin: Osteogenic cells • Function: Secrete bone matrix and deposit Ca salts in it. • Fate: Change to osteocytes 
		Osteocytes: <ul style="list-style-type: none"> • Branched cells • Present <u>singly</u> in <u>lacunae</u> (non-continuous lacunae) • Their branches run in the canaliculi (to reach nearby blood vessels in the bone for nutrients because the hard matrix does not permit diffusion of nutrients through it) • Origin: osteoblasts • Function: Maintain the bone matrix, They maintain the bone matrix by continuous deposition of calcium salts. 
		Osteoclasts: (clast = destruct) <ul style="list-style-type: none"> • Large multinucleated cells on bony surfaces, in <u>Howship's Lacunae</u> • Striated or ruffled border (to increase surface area) • Cytoplasm is rich in lysosomes (because it secretes acids to decalcify the bone) • Origin: Blood monocytes (monocytes fused together) • Function: Bone resorption (destruction of bone to release calcium) 
Bone Matrix		<ul style="list-style-type: none"> • Hard because it is calcified (calcium salts) • Contains <u>type I collagen fibers</u> (gives it its pink colour); ((Acidophilic)) • Forms bone <u>lamellae</u> and <u>trabeculae</u>
Periosteum		<ul style="list-style-type: none"> • Outer fibrous layer • Inner osteogenic layer
Endosteum (lining of bone marrow cavities)		<ul style="list-style-type: none"> • Osteogenic layer only (it doesn't need fibrous layer because the fibrous layer is for protection from the outside)

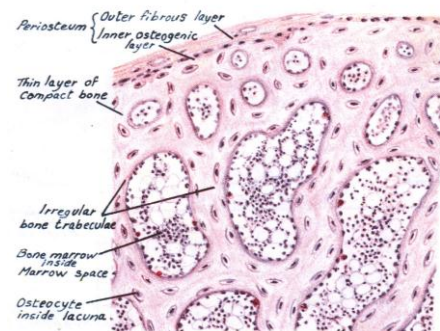
1) Compact Bone:

- Found in: Diaphysis of long bones
- Consists of:
 1. **Periosteum:**
 - a. Outer fibrous layer
 - b. Inner osteogenic layer
 2. **Endosteum**
 3. **Bone Lamellae:**
 - a. Haversian Systems (Osteons) (it is the unit of compact bone):
 - Longitudinal Cylinders
 - Each is formed of concentric bone lamellae (containing osteocytes) & a Haversian canal running in the center (with blood vessel and nerves running inside it)
 - Volkman's canals: connect the Haversian canals together (connects the blood vessels and nerves of haversian systems). They run obliquely or transversely
 - b. External Circumferential Lamellae
 - c. Internal Circumferential Lamellae
 - d. Interstitial Lamellae: Between osteons
 4. **Bone Cells**



2) Spongy (Cancellous) Bone:

- In flat bones & epiphysis of long bones
- Consists of:
 1. **Periosteum**
 2. **Endosteum**
 3. **Irregular bone trabeculae** (bone plates)
 4. **Many irregular bone marrow spaces** (it is the source of nutrients) (endosteum lines all these spaces)
 5. **Bone cells**
- Does not have Haversian systems (no osteons)



Growth of Cartilage and Bone:

Cartilage

Appositional growth:

- Produced by the activity of Chondroblasts in the inner chondrogenic layer of the perichondrium (from outside)
- Leads to an increase in width

Interstitial growth:

- Produced by division and activity of mature chondrocytes (from inside)
- Leads to increase in length

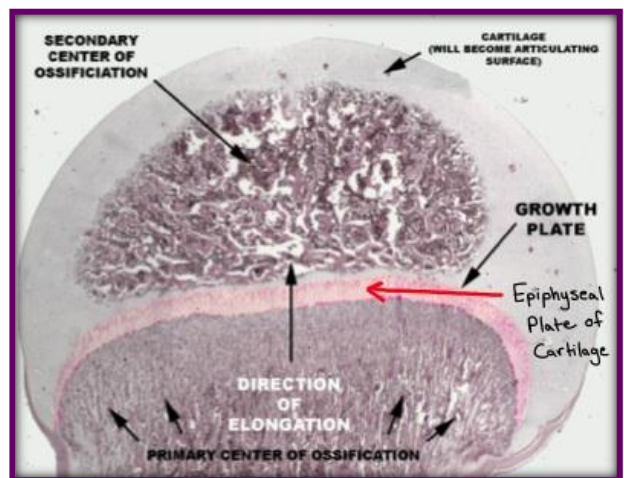
Bone

Appositional growth:

- Produced by the activity of Osteoblasts
- Leads to an increase in width

Growth in length:

- Produced by the activity of Epiphyseal plate of Cartilage (hyaline cartilage)



Additional notes:

- All -blasts have basophilic cytoplasm because their main function is secretion of proteins so they need a lot of ribosomes which make the cytoplasm basophilic
- The area surrounding osteoclasts is devoid of calcium and it appears pale so seems like a lacuna. This is Howship's lacunae.
- Interstitial growth never happens in bone because there are no cells nests (Bone can not increase in length by is self)