Third lecture (3) Cartilage and Bone

Cartilage is an avascular specialized connective tissue with a firm extracellular matrix that provides flexible support depending on its location. It can bear mechanical stress without permanent deformation. Like bone, cartilage has isolated cells embedded in an extensive matrix. Most types are covered by a dense irregular connective tissue called the perichondrium, which contains blood vessels and nerve fibers. Only fibrocartilage and articular cartilage lack a perichondrium.

The perichondrium is essential for cartilage growth and maintenance. It has two layers: an outer fibrous layer with fibroblasts, collagen fibers, and blood vessels that supply nutrients by diffusion, and an inner cellular layer with chondrogenic cells that differentiate into chondroblasts. Cartilage functions include supporting soft tissues, providing smooth movement at joints, and contributing to bone growth in length.

Cartilage Cells

1-Chondrogenic cells are located in the perichondrium and differentiate into chondroblasts to participate in appositional growth of cartilage. These cellsare difficult to identify under the light microscope with H&Estain

2-Chondrocytes cells : are mature cartilage cells located in lacunae. They can divide and form isogenous groups (two or more cells derived from one parent cell), which represent interstitial growth. In most cartilage, cells appear in isogenous groups, while in fibrocartilage they are arranged in small rows or columns — also indicating interstitial growth.

3-Chondroblasts cells : are young cartilage cells derived from chondrogenic cells. They actively produce the cartilage matrix and have basophilic cytoplasm rich in

ribosomes. As the matrix accumulates, chondroblasts become trapped in small spaces called lacunae and are then called chondrocytes.

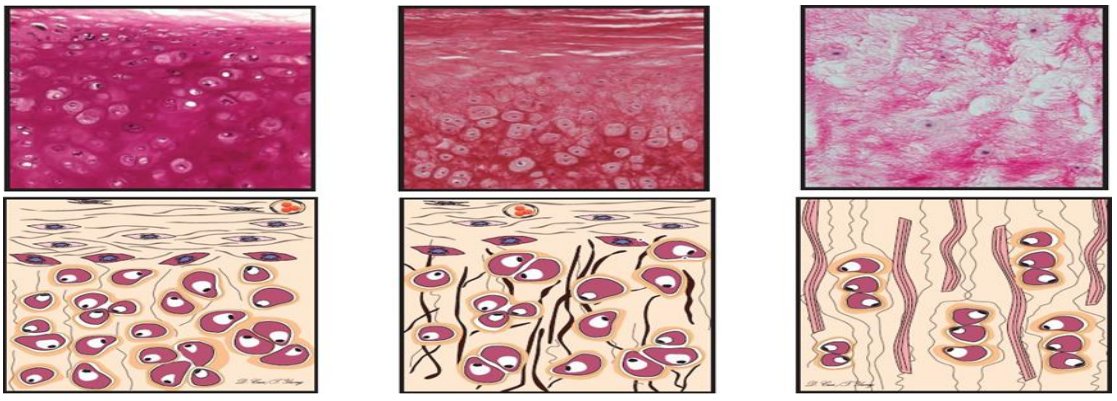
Types of Cartilage

1-Hyaline cartilage has a glassy, homogeneous matrix containing type II collagen evenly dispersed in the ground substance. It is usually covered by perichondrium except at joint surfaces. It is the most common cartilage type, found in the articular ends of long bones, nose, larynx, trachea, and bronchi, and serves as a model for endochondral bone formation and growth.

2-Elastic cartilage is similar to hyaline cartilage but has numerous thick bundles of elastic fibers in its matrix. It also contains type II collagen and is surrounded by perichondrium. Its chondrocytes are larger and more abundant. It is found where flexibility and support are needed, such as in the epiglottis and larynx.

3-Fibrocartilage lacks perichondrium and contains both type I and type II collagen. It is characterized by thick bundles of collagen fibers alternating with rows or columns of small, sparse chondrocytes. Growth occurs by interstitial expansion. Fibrocartilage resists tearing and compression and is found in areas requiring strong support and tensile strength, such as intervertebral discs.

Hyaline Elastic Fibrocartilage



Bone

Bone is a specialized connective tissue with a hard, mineralized extracellular matrix containing embedded osteocytes. Unlike cartilage, bone is calcified, harder, stronger, and highly vascularized. Bone protects internal organs, supports soft tissues, serves as a calcium reserve, provides an environment for blood cell production, detoxifies chemicals, and aids movement. The external surface is covered by periosteum, containing blood vessels, osteogenic cells, and nerves. The inner surface is lined by endosteum, a thin layer of connective tissue with osteoprogenitor cells and osteoblasts, separating bone matrix from marrow cavities. Bone cells include osteogenic cells, osteoblasts, osteocytes, and osteoclasts, contributing to growth, remodeling, and repair.

Bone Cells:

1. **Osteoprogenitor cells**: in the periosteum; differentiate into osteoblasts.

2. **Osteoblasts:** produce bone matrix; cuboidal/low columnar; responsible for mineralization via calcium, phosphate, and hydroxyapatite crystals.

3. **Osteocytes**: mature cells derived from osteoblasts, embedded in lacunae, with cytoplasmic processes in canaliculi connecting neighboring lacunae.

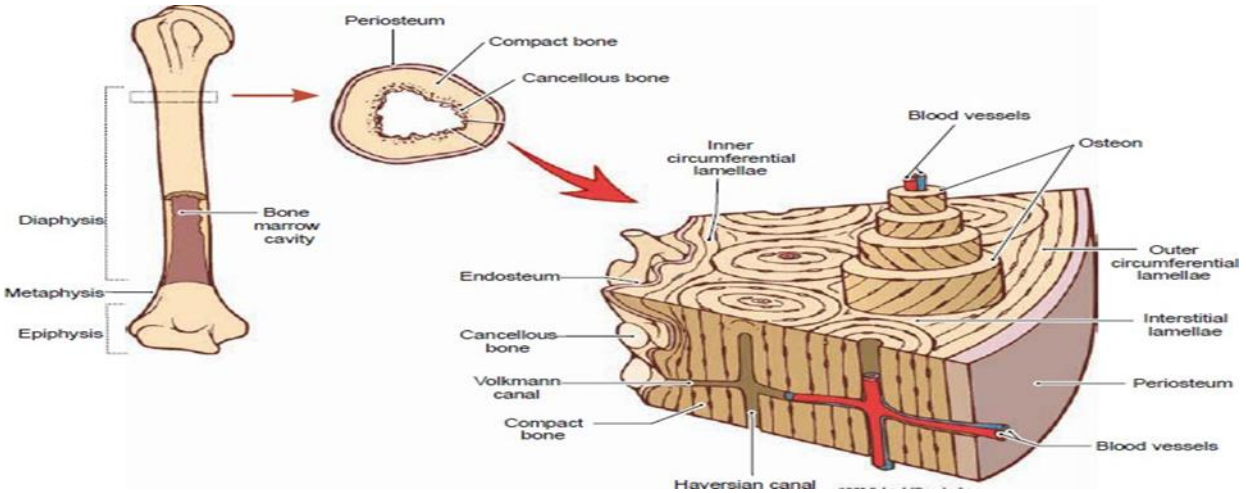
4. **Osteoclasts**: large, multinucleated cells from monocytes; resorb bone matrix and are essential for remodeling.

Bone Classification:

• By shape: long bones (longer than wide), short bones (cube-like).

• By structure: compact bone and cancellous (spongy) bone.

• Long bones: diaphysis (compact bone + medullary cavity), epiphyses (mainly cancellous, covered with articular cartilage), metaphysis (transitional zone). External surfaces covered by periosteum; internal surfaces by endosteum.



The general structure Compact Bone Lamellae:

1. Osteon: canal surrounded by concentric lamellae.
2. Interstitial lamellae: between osteons.
3. Outer circumferential lamellae: beneath periosteum.
4. Inner circumferential lamellae: beneath endosteum.

Bone Development:

• Intramembranous ossification: mesenchymal tissue → bone, no cartilage precursor; mesenchymal cells become osteoblasts and deposit bone matrix.

• Endochondral ossification: (mentioned later, similar to cartilage template).

Bone Remodeling:

Adult bone undergoes continuous internal remodeling to adapt to forces. The Haversian system is modified via osteoclastic resorption followed by osteoblastic formation.

• Resorption cavity: osteoclasts degrade bone.

• Formation: osteoprogenitor cells divide, form osteoblasts, and deposit new lamellae.

• The coordinated process of resorption and formation is called coupling.