Bone tissue

The bone tissue supports and protection of the vital organs such as those in the cranial and thoracic Cavities. Bone also serves as a reservoir of calcium, phosphate and other ions that can be released or stored in a controlled fashion to maintain constant concentrations of these important ions in body fluid.

In addition to these functions bones form a system that multiply the forces generated during skeleton muscle contraction and movement of the body.

The bone tissue composed of cells and predominantly collagenous extracellular matrix called (osteoid), which become mineralized by deposition of calcium and phosphates.

The cells of the bone tissue:

1- Osteoblasts : which synthesis osteoid and mediate its mineralization, found lined up along bone surface. They are located at the surface of bone tissue, side by side, in a way that resembles simple epithelium. Osteoblasts have cuboidal to columinar shape. Osteoblast have cytoplasmic processes that bring them into contact with neighboring osteoblasts.

2- osteocytes: which derive from osteoblasts, lie in the lacunae situated between lamellae . only one osteocyte is found in one lacunae.

3- osteoclasts: phagocyte cells which are multinucleated cells responsible of remodeling bone tissue. Osteoclasts are very large extensively branched cells .

The bone tissue lined on both internal and external surfaces by layers of tissue containing osteogenic cells called (endosteum on the inner surface and periosteum on the outer surface.

Bone matrix:

Inorganic matter represents about 50% of the dry weight of bone matrix. Calcium and phosphorus are specially abundant, but bicarbonate, citrate, magnesium, potassium, and sodium are also found. The organic matter is type 1 collagen and amorphous ground substance, which contains proteoglycan aggregates. Several specific glycoproteins have been isolated from bone. The association of hydroxyapatite with collagen fibers is responsible for the hardness and resistance that are characteristic of bone.

Periosteum and endoosteum :

External and internal surface of bone are covered by layers of bone –forming cells and connective tissue called periosteum and endosteum.

The periosteum consist of an outer layer of collagen fibers and fibroblasts. Bundles of periosteal collagen fibers penetrate the bone matrix, binding the periosteum to bone. The inner, more cellular

layer of the periosteumis composed of flattened cells called osteoprogenitor cells which differentiation by mitosis divide into osteoblasts. These cells play a prominent role in bone growth and repair.

The endosteum lines all internal surface of cavities within bone and is composed of a single layer of flattened osteoprogenitor cells and a very small amount of connective tissue. The endosteum is therefore considerably thinner than the periosteum.

Types of bone:

The microscopic examination of bone shows that two types of bone (primary, immature or woven bone) and (secondary, mature or lamellar bone). Primary bone is the first bone tissue to appear in embryonic development and in fracture and other repair processes. It is characterized by random disposition of fine collagen fibers. Secondary bone is the variety usually found in adults. It characteristically shows collagen fibers arranged in lamellae.

Gross observation of bone in cross section shows dense areas without cavities, called compact bone, and areas with numerous interconnecting cavities called cancellous(spongy bone).

Compact bone :

The compact bone is made up of parallel bony columns. Each columns is made of concentric bony layers or lammelae disposed

around a central channel containing blood, lymphatic vessels and nerves. These channels are known (haversian canals). Lacunae containing osteocytes are found between and occasionally within the lamellae. In each lamellae, collagen fibers are parallel to each other. Surrounding each haversian system is a deposit of amorphous material called cementing substance that consists of mineralized matrix with few collagen fibers.

Each lamellae extended fine cytoplasmic extention consisting canalculi.

Volkmanns canals : by which transport nutrition and pass neurovascular bundles for each space of bone and connection with periosteum and endosteum.

Spongy bone:

The spongy bone is composed of a network of bony trabeculae separated by interconnection space containing bone marrow. Trabeculae are thin and composed of irregular lamellae of bone with lacunae containing osteocytes. Spongy bone dose not contain haversian system, by the canaliculi osteocytes exchanges metabolic material via the sinusoid in the bone marrow. The trabeculae lined by layer of endosteum which contain osteoprogenitor cells, osteoblasts, and osteoclasts.

Ossification of bone occurs by two ways:

A- Endochondral ossification:

1- Zone of reserve cartilage:

Consist of typical cartilage (hyaline cartilage) with chondrocyte arranged in small clusters surrounded by large amount of matrix.

2- Zone of proliferation :

The clusters of cartilage cells undergo successive mitotic division to form columns of chondrocytes separated by matrix rich in proteoglycans.

3- Zone of maturation:

The chondrocytes have increase in their size .

4- Zone of hypertrophy and calcification:

Chondrocytes become greatly enlarged and vacuolated and the matrix become calcified.

5- Zone of cartilage degeneration:

The chondrocytes degenerated and the lacunae of the calcified matrix are invaded by osteogenic cells during the capillaries from marrow cavity of diaphysis.

6- Zone of osteogenic:

The osteogenic cells differentiation in to osteoblasts which accumulation on the surface of the calcified matrix lead to bone formation .

Intramembranous ossification:

- The ossification occurs within membranes of condensed primitive msenchymal tissue.
- Mesenchymal cells differentiate into osteoblasts and begin synthesis and secretion of osteoid at multiple centers of ossification .
- Osteoblasts are trapped in lacunae to become osteocytes.
- Osteoprogenitor cells at the surface of the center ossification undergo mitotic division to produce further osteoblasts which important in bone formation.
- Progressive formation results in the fusion of ossification centers.
- The collagen fibers of developing bone are randomly arranged in interlacing bundles, formation woven bone then remodeling into lamellar bone.