

Bony Tissue

Bony tissue is a specialized connective tissue characterized by vascularization and hard consistency. It is the principal tissue of mature bones. The hardness of bony tissue is due to the large amount of mineral salts and collagen fibers in the extracellular matrix. Bony tissue is dependent upon good vascular supply for maintenance, bone repair and bone remodeling. Ischemia results in bone necrosis.

Types

Types of bony tissues

- Woven bone (also known as primary or immature bony tissue) has a haphazardly-arranged bone matrix. Woven bone is present in bone development and repair, and in some diseases (e.g., Paget Disease).
- Lamellar bone (also known as secondary or mature bone) has well-organized layers of bone matrix.

Types of bony tissue architecture

- Compact bone is dense, closely-packed bony tissue. Compact bone is present in the parts of a bone that appear thick and solid on cross section, for example, the cortical bone of long bone shafts. Blood vessels are present in canals within compact bony tissue, and the bony tissue forms lamellae around these canals.
- Spongy bone, also called cancellous or trabecular bone, is lighter than compact bone. Spongy bone appears like a latticework to the naked eye, and is commonly found in parts of the medullary cavity of mature bones.

Description

Bony tissue is a specialized connective tissue. It is composed of cells and extracellular fibers embedded in ground substance and interstitial fluid, like other connective tissues. Its specialization is the tissue's hardness due to the presence of a large inorganic component (mineral salts) in the bone (extracellular) matrix.

Cells

Osteoblasts are mitotically and metabolically active cells derived from mesenchyme that are located on the surfaces of bony tissue. They are large basophilic cells with large nuclei and nucleoli, and abundant RER, Golgi apparatus and secretory vesicles. Alkaline phosphatase is present on the cell membrane and in matrix vesicles. Osteoblasts produce osteoid and play a role in mineralization. They have receptors for parathyroid hormone (which stimulates the osteoblast's up-regulation of osteoclast differentiation) and for vitamin D3 (which stimulates mineralization). Once osteoblasts have surrounded themselves with bone matrix, they become osteocytes.

Osteocytes are embedded in and maintain the extracellular matrix of bone. Osteocytes are smaller than osteoblasts with smaller nuclei. They are also less mitotically and less metabolically active than osteoblasts. The space within the extracellular matrix occupied by an osteocyte is called a lacuna. Although osteocytes appear isolated, they have processes that make gap junctions with other osteocytes. The cellular processes are located in canaliculi that connect the lacunae.

Osteoclasts are multinucleated, phagocytic giant cells that resorb bone (and other mineralized tissues). Osteoclasts are derived from hematopoietic tissue; they are formed by fusion of monocytes. They can be found in depressions on the bony tissue surface called Howship's lacunae. Osteoclasts release lysosomal enzymes (including collagenase and acid phosphatase) and pump out hydrogen ions (to dissolve calcium salt crystals). Osteoclasts have receptors for calcitonin, which suppresses osteoclast activity.

Extracellular Matrix

Organic portion of bone matrix

The organic portion accounts for about **30% of the bone matrix**. Prior to mineralization, the bone matrix is called osteoid, which is roughly equivalent to the organic portion of the mineralized bone matrix.

- Fibers: Type I collagen is the major component (about 90%) of the organic part of the bone matrix
- Ground substance:
 - Glycosaminoglycans (GAGS) - hyaluronan
 - Proteoglycans: e.g., osteomodulin, osteoglycin
 - Glycoproteins: e.g., osteocalcin, osteonectin
- Water is about 25% of the wet weight of bone.

Inorganic portion of bone matrix

Mineral salts account for about **70% of the bone matrix**. The chief constituent of the inorganic portion is hydroxyapatite $[\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2]$.

- Crystalline hydroxyapatite
- Amorphous ("poorly crystalline") hydroxyapatite contains ionic contaminants. It makes up about 20% of the inorganic portion and represents a mobilizable calcium store.

External Link

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