Oral Histology

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Alveolar bone(process)

Alveolar process is defined as the parts of the maxilla and mandible that form and support the tooth sockets. Forms with eruption of tooth to provide osseous attachment to forming pdl. Disappears with loss of tooth

Because the alveolar processes develop and undergo remodeling with tooth formation and eruption, they are tooth-dependent bony structures

Gross histology of bone

Characteristics of all bone are dense outer sheet of compact bone and central medullary cavity. Medullary cavity filled with red or yellow bone marrow

Trabecular/spongy bone present in extremities of long bone.

Periosteum: The tissue that covers the outer surface of bone and composed of 2 layers I. outer (fibrous) layer rich in blood vessels and nerves o composed of collagen fibers and fibroblasts. II. inner layer composed of osteoblasts surrounded by osteoprogenator cells

Endosteum: tissue that lines the internal bone cavities . The endosteum is composed of a single layer of osteoblasts and sometimes a small amount of connective tissue

Components of bone

Cellular:- osteoprogenator(stem cells), osteoblast, osteocyte and osteoclast .

Matrix components:- Inorganic components and Organic components (Collagenous protein Non-collagenous protein)

Matrix component of Bone:-Organic 33% Collagen type I(90%) and Non-collagenous protein like bone sialoprotein, osteocalcin, osteonectin, osteopontin, proteoglycans, growth factors serum protein .

Inorganic 67% -Calcium and phosphate, along with hydroxyl, carbonate, Citrate - mineral salts are in the form of hydroxyapatite crystals

Cellular components of bone

1-Osteoblast: Plump, cuboidal, mononuclear cell that synthesize collagenous and non collagenous bone matrix proteins Origin: Differentiated from pluripotent follicle cells. Osteoblast contains high level of alkaline phosphatase on the outer surface of their plasma membrane. Cytoplasm is intensely basophilic. Abundant and well developed protein synthetic organelles such as rough endoplasmic reticulum. Osteoblasts also secret number of cytokines, Growth factors (RANKL, osteoprotegerin (OPG), and growth factors including bone morphogenetic protein).

2-Osteocytes: As osteoblast form bone, some become entrapped within the matrix they secrete, these cell become osteocytes. The more rapid the bone formation, the more osteocytes are present per unit volume. Embryonic (woven) and repair bone have more osteocyte compared to lamellar bone.

Osteocytic lacunae and Canaliculi of Osteocyte maintain contact with adjacent osteocyte and osteoblast or bone lining cell with osteocytic processes

Canaliculi penetrate bone matrix and permit diffusion of nutrients, gases, waste products between osteocytes and blood vessels. Sense the change in the environment and send signals that affect the other cells involved in remodeling of bone. Failure of this interconnecting system between osteoblast and osteocytes leads to sclerosis and death of bone.

Osteocytes posses an ellipsoid cell body with long axis parallel to surrounding bone lamellae. Oval nucleus with narrow rim of faintly basophilic cytoplasm and Few organelles but sufficient RER & golgi apparatus.

3-Osteoclasts:- Lie in Howship's lacunae, Large cell (40-100 um) , contain 15 to 20 closely packed nuclei. More the nuclei the more resorbing capacity. Shape variable due to motility. Acid phosphatase containing vesicles & vacuole Mitochondria and golgi complex extensive, RER sparse.

Osteoclast derived from hematopoitic cells of monocyte- macrophage lineage. Their proliferation and differentiation requires cell - cell interaction with osteoblast and osteoprogenator cells.

Regulation of osteoclast activity Osteoprotegerin: RANKL antogonist Estrogen: suppresses the production of bone resorbing cytokines

Osteogenesis/ ossification :

The process of bone formation is called osteogenesis . Two type of bone formation 1. Intramembranous ossification 2. Endochondral bone formation

Bone remodeling:

Bone is a dynamic tissue and is always undergoing changes to adapt for functional forces, mesial drift, and eruption of teeth. There is constant formation and resorption of bone. Periods of resorption alternate with periods of rest and repair by action of osteoblasts (bone formation) and osteoclasts(bone resorption).

Bone resorption:

Sequence of event in bone resorption :

1-Attachment of osteoclast to mineralized surface

2- Creation of sealed acidic environment through action of proton pump which dimenarilizes bone and exposes the organic matrix

3-Degradation of exposed organic matrix to its constituent amino acids by action of enzymes such as acid phosphatase and cathepsin

4-Sequestering the mineral ions & amino acid with in osteoclast

Development of alveolar process :

At the end of 2nd month of fetal life ,the maxilla as well as mandible forms a groove that open to surface of oral cavity, tooth germs contained in these groove (alveolar vessels & nerve). Gradually bone septa develops between this germs Later primitive mandibular canal is separated from dental crypts by horizontal plate of bone. Alveolar process in strict sense , develops only during eruption of the teeth and diminishes in height after the loss of teeth.

Functions of alveolar bone :-

1- Houses the roots of teeth
2- Anchors the roots of teeth to the alveoli, which is achieved by the insertion of Sharpey's fibers into the alveolar bone proper.
3- Helps to move the teeth for better occlusion.
4- Absorbs and distribute occlusal forces (tooth contact).
5- Supplies vessels to pdl.
6- Houses & protect developing permanent teeth while supporting primary teeth.
7- Organizes eruption of primary and permanent teeth

Structures of alveolar bone:

The alveolar process consists of the following:

1. An external plate of cortical bone is formed by haversian bone and compacted bone lamellae called supporting alveolar bone.
2. The inner socket wall of thin, compact bone called the alveolar bone proper

Alveolar bone proper:

It surrounds the root of the tooth and gives attachment to the periodontal ligament fibers . It consists of Lamellated bone and Bundle bone. Lamellated bone consists of osteons. Concentric lamellae along with a central blood vessel form an osteon.

Bundle bone:

Part of the alveolar bone where periodontal ligament fibres are inserted (attached). Bundle mean bundles of fibers that include Sharpeys fibres – principal fibres of the periodontal ligament that are embedded in the bone or cementum. Sharpeys fibers are seen perpendicular to the bundle bone. Other fibrils are less and are arranged parallel to the bundle bone surface

Radiographically is more radioopaque due to presence of thick bone without trabeculations and is called as "lamina dura" . Alveolar bone proper has many openings for blood vessels and nerves is perforated and is called as "cribriform plate" . Interdental and interradicular septa have canals known as canals of " zukerkandl and hirschfeld"

Supporting alveolar bone

It consists of two parts 1- Cortical plates (Outer and inner) and 2- Spongy bone

Cortical plates: these are made up of compact bone & form the outer and inner plates of alveolar bone. Cortical bone varies in thickness in different areas – it is thicker in the mandible than in the maxilla and thicker in the premolar-molar region than in the anteriors.

Spongy bone: it fills the area between the cortical plates and the alveolar bone proper. It contains trabaculae of bone and marrow spaces.

Types of spongy bone (spongiosa) :-

Type I: the trabaculae are regular and horizontal like a ladder. This is seen most commonly in the mandible.

Type II: irregularly arranged delicate and numerous trabaculae. This is seen most commonly in the maxilla.

The spongy bone is very thin or absent in the anterior regions of both the jaws.

Alveolar crest:

Alveolar bone proper meets cortical plates at the alveolar crest. In healthy mouths the alveolar crest is around 1.5 to 2 mm below the cementoenamel junction.

Incremental Lines in bone:

• **Resting line:** these lines correspond to the resting period in the process of continous bone formation.

• **Reversal line**: when a period of bone resorption is followed by bone formation, a dark line is seen which seperates the new bone from old bone, this resembles the shape of howships lacunae of osteoclasts.

Age changes in alveolar bone:

• Brittleness due to decreased water content

• Sponge bone become thin trabecula , wide marrow spaces

• Red bone marrow become fatty

• Osteoporosis

• Alveolar crest slope distally due to mesial tilting of teeth

• With loss of teeth and resorption of alveolar ridge mental foramen become very close to the ridge in mandible also maxillary sinus in upper jaw.