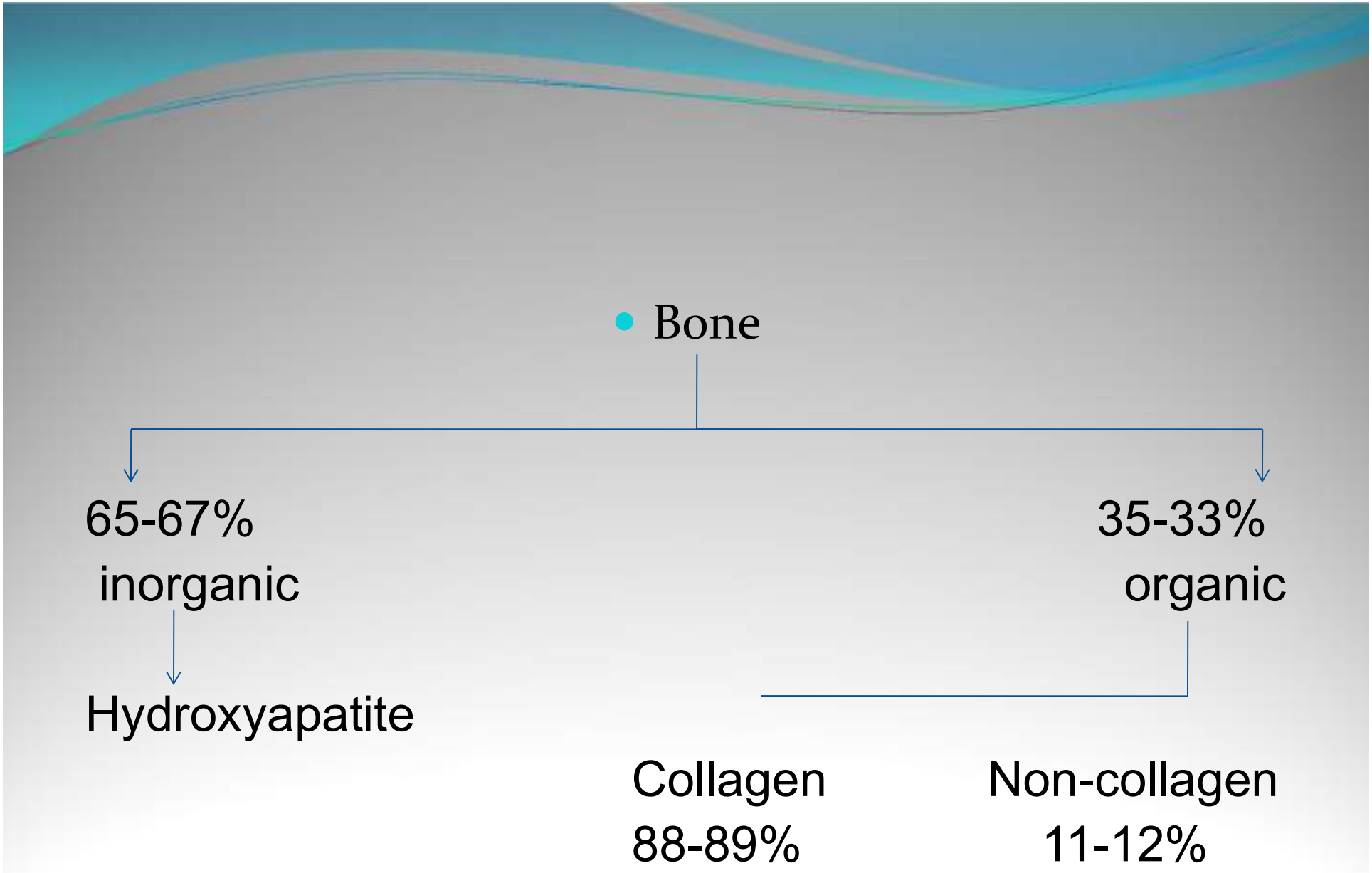
Aurobindo College of Dentistry

Indore, Madhya Pradesh

INDIA

Module plan

- Topic : Bone & Alveolar bone
- Subject: Oral Pathology
- Target Group: Undergraduate Dentistry
- Mode: Powerpoint – Webinar
- Platform: Institutional LMS
- Presenter: Dr.Shradha Jaiswal


Bone
65-67%
inorganic
Hydroxyapatite
35-33%
organic
Collagen
88-89%
Non-collagen
11-12%

Non-Collagenous:

- Glycoproteins,
- osteocalcin,
- osteonecticn,
- osteopontin,
- Bone Sialoprotein
- proteoglycans
- growth factors.

Functions

1. Support
2. Protection
3. Locomotion
4. Reservoir of minerals

Classification

Based on :

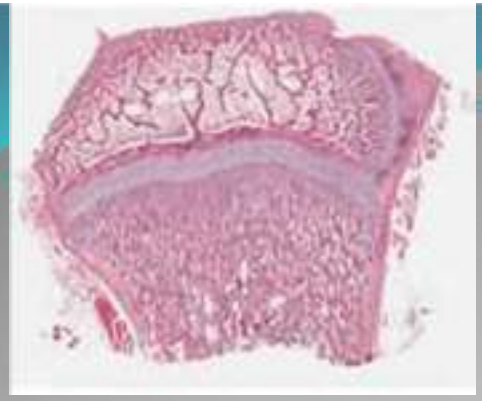
- Shape
- Structure
- Development
- Histology

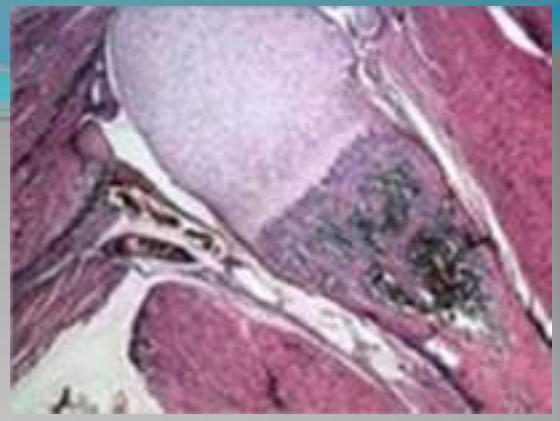
Based on: Shape

- Long
- Flat
- Irregular

Structure-

- compact
- cancellous



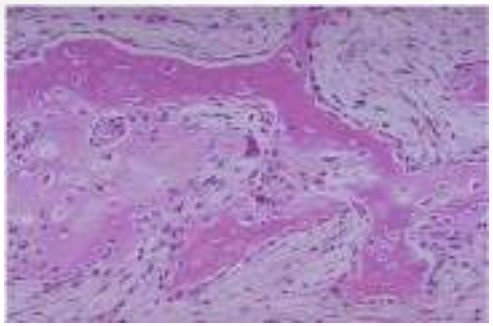


Development-

- Intramembraneous
- endochondral

Histologically

- woven (immature bone)
- mature bone



Structure

Periostium
Outside osteum/ osteon
2 layers- outer fibrous, inner cellular(endosteum)

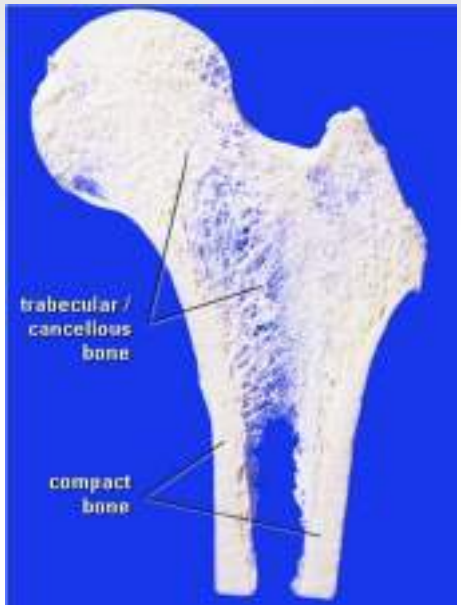
Structure-location

Compact bone

- Dense or cortical bone, solid. In long bones, compact bone forms the solid external walls of the bone

Spongy bone

- Cancellous or trabecular bone, porous, like a sponge, located internally within the epiphyses



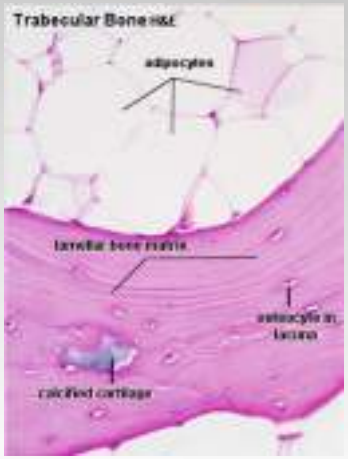
- Compact bone consists almost entirely of extracellular substance, the *matrix*. Osteoblasts deposit the matrix in the form of thin sheets which are called *lamellae*. Lamellae are**microscopical** structures. Collagen fibres within each lamella run parallel to each other. Collagen fibres which belong to adjacent lamellae run at oblique angles to each other. Fibre density seems lower at the border between adjacent lamellae, which gives rise to the lamellar appearance of the tissue. Bone which is composed by lamellae when viewed under the microscope is also called **lamellar bone**.
- In the process of the deposition of the matrix, osteoblasts become encased in small hollows within the matrix, the *lacunae*. Unlike chondrocytes, osteocytes have several thin processes, which extend from the lacunae into small channels within the bone matrix , the *canaliculi*. Canaliculi arising from one lacuna may anastomose with those of other lacunae and, eventually, with larger, vessel-containing canals within the bone. Canaliculi provide the means for the osteocytes to communicate with each other and to exchange substances by diffusion.
- In mature compact bone most of the individual lamellae form concentric rings around larger longitudinal canals (approx. 50 µm in diameter) within the bone tissue. These canals are called *Haversian canals*. Haversian canals typically run parallel to the surface and along the long axis of the bone. The canals and the surrounding lamellae (8-15) are called a*Haversian system* or an *osteon*. A Haversian canal generally contains one or two capillaries and nerve fibres.
- Irregular areas of *interstitial lamellae*, which apparently do not belong to any Haversian system, are found in between the Haversian systems. Immediately beneath the periosteum and endosteum a few lamella are found which run parallel to the inner and outer surfaces of the bone. They are the *circumferential lamellae* and *endosteal lamellae*.
- A second system of canals, called *Volkmann's canals*, penetrates the bone more or less perpendicular to its surface. These canals establish connections of the Haversian canals with the inner and outer surfaces of the bone. Vessels in Volkmann's canals communicate with vessels in the Haversian canals on the one hand and vessels in the endosteum on the other. A few communications also exist with vessels in the periosteum.
- **Trabecular Bone**

- *The matrix of trabecular bone is also deposited in the form of lamellae*. In mature bones, trabecular bone will also be lamellar bone. However, *lamellae in trabecular bone do not form Haversian systems*. Lamellae of trabecular bone are deposited on preexisting trabeculae depending on the local demands on bone rigidity.
- Osteocytes, lacunae and canaliculi in trabecular bone resemble those in compact bone.

Histology


Compact Bone
ground
Haversian systems


Compact Bone ground
lacunae
canaliculi
Haversian canal


Trabecular Bone H&E
adipocytes
lamellar bone matrix
osteocyte in lacuna
calcified cartilage

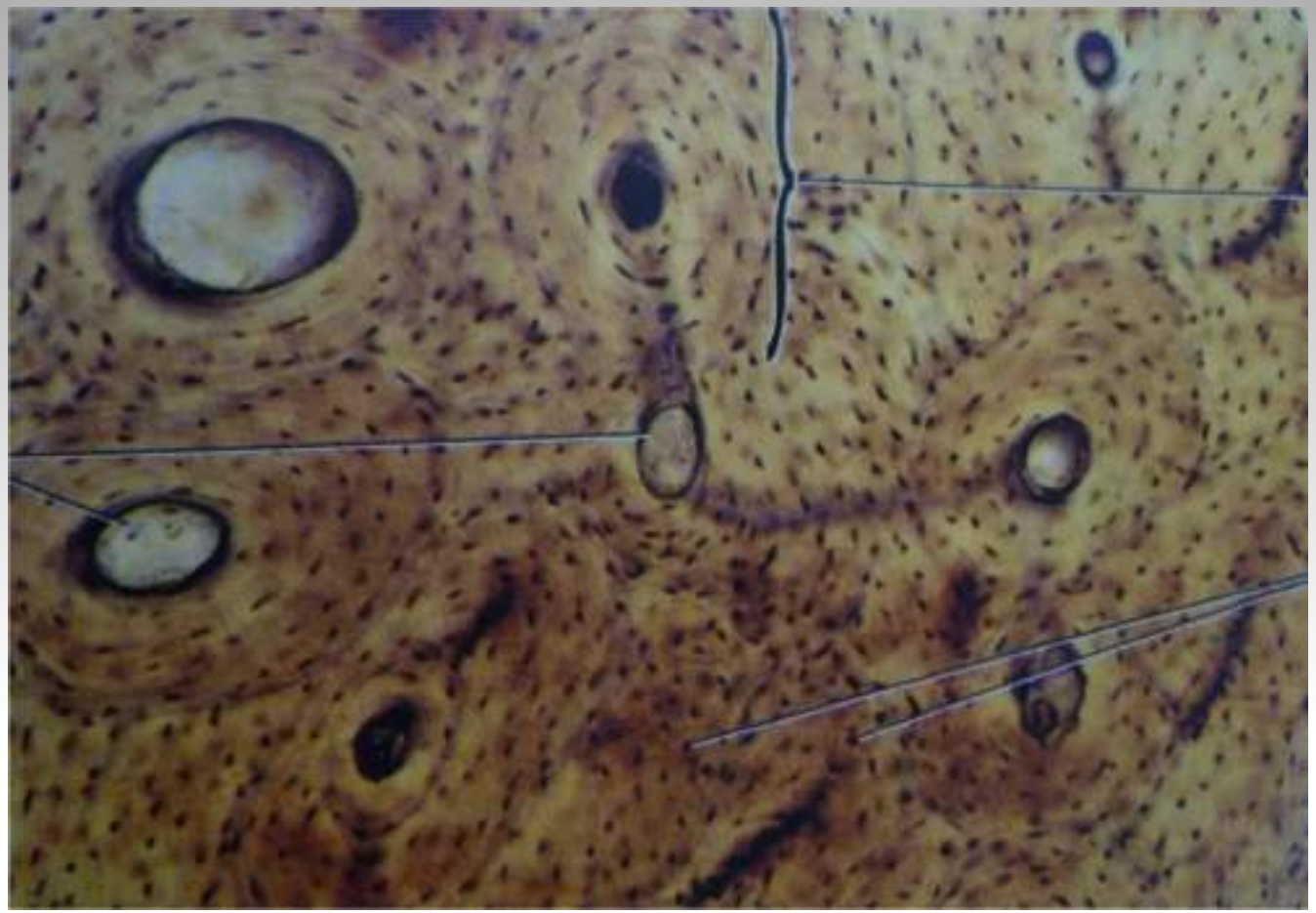

Growing Bone H&E
bone marrow
epiphysis

Histological Structure

Mature bone:

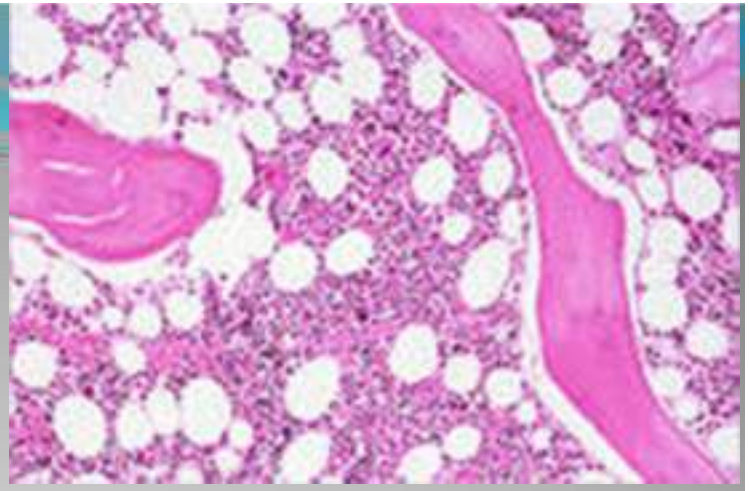
- Also called lamellar bone
- Osteon (Haversian system)
- The basic functional and structural unit of mature compact bone
- 3 lamellae- circumferential, concentric, interstitial

Histologically-



Trabecular bone:

- open lattice or narrow plates of bone, NO OSTEONS, but PARALLEL LAMELLAE
- Flat Bone of skull, the spongy bone is called diploe (double) sandwiched between two layers of compact bone



Bone marrow:

- Central cavity of bone
- Filled with red or yellow marrow
- Bones containing red marow-
- Yellow marrow can get converted to red if need arises-anemia

Development

Endochondral ossification:

- Occurs at extremities of all long bones
- During development condensation of mesenchyme
- Differentiation of mesenchyme into cartilage cells
- Formation of pericondrium around periphery
- Development & growth of chondroblasts to secrete chondroid tissue

- Mineralization begins by matrix vesicles

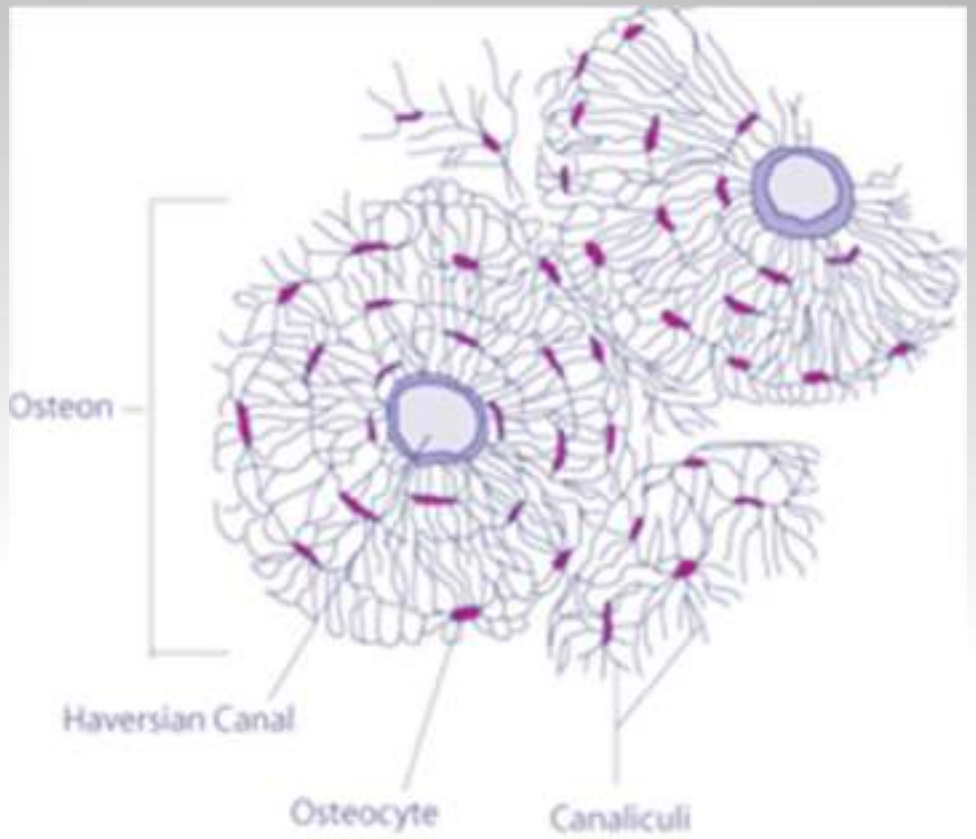
- Mineralized cartilage gets replaced by osteoid

Intramembraneous ossification:

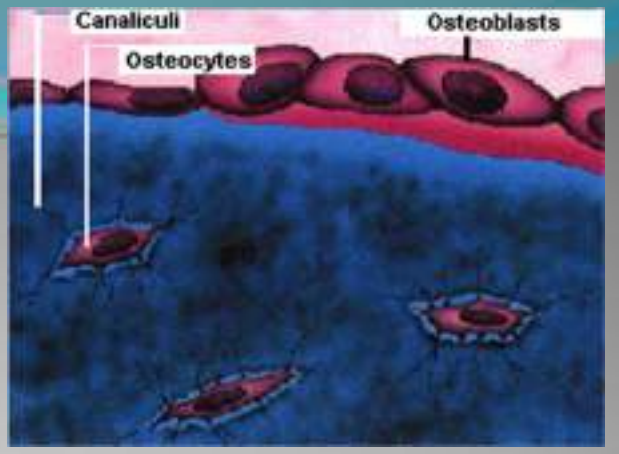
- Bone develops directly within soft connective tissue
- Mesenchymal cells condense
- Increased vascularity
- Differentiation of osteoblasts which lay down matrix
- First formed bone-woven bone

Bone cells

- Osteoblasts
- Osteoclasts
- Osteocytes



Osteoblasts

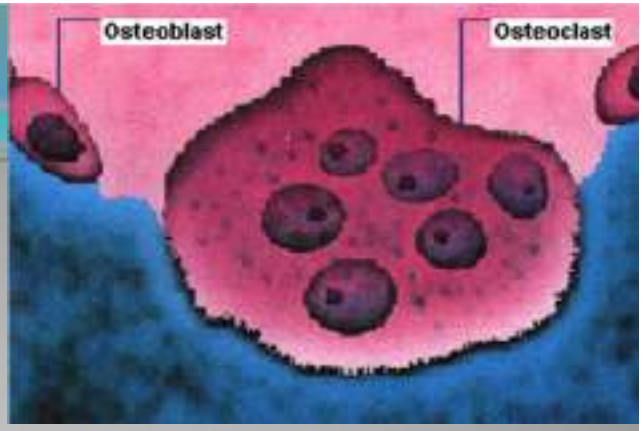


- Mono-nucleated cells
- Plump, cuboidal cells or slightely flattened cells
- Synthesize collagenous & non-collagenous bone matrix proteins
- Osteoid : uncalcified matrix, mainly collagen that acts as scaffold
- Arise from pluopotient stem cells

Osteocytes

- Osteoblasts entrapped in bone matrix
- Ostocyte number depends on the rapidity of bone formation
- Woven bone & repair bone have more osteocytes than lamellar bone
- Osteocytic lacunae-Space occupied by osteocyte
- Extensions from these lacunae form closed channels containing osteocytic processes

Osteoclasts



- Multinucleated giant cells
- Often seen in cluster
- Contain tartrate resistant acid phosphatase within vacuoles
- Present in Howships lacunae
- Ruffeled border
- Sealing zone
- Proton pump pumps H+ ions into sealed compartment

Steps in resorption

1. Attachment of osteoclasts to bone surface
2. Proton pump releases H+ ions
3. Degradation of exposed matrix
4. Endocytosis of inorganic & organic contents
5. Release of degradation products on opposite side of ruffeled border

Resting lines

- Denotes period of rest during bone formation
- Eosinophillic

Reversal line

- Basophillic
- Contains no little or no collagen, but high amount of glycoproteins & proteoglycans
- Irregular ,scalloped- coinciding with Howship's lacunae

Bone remodelling

Mediators-

- Parathyroid hormone
- Vitamine D metabolites
- Growth factors
- Mechanical factors

Parathyroid hormone

- Increases bone resorption & formation

Physiological levels :

- promote bone formation
- Increase renal absorption of calcium, decrease reabsorption of phosphate

Increased levels:

- Promote resorption

Calcitonin

- Secreted when blood calcium levels rises
- Inhibits bone resorption & promotes calcium salt deposition in bone matrix reducing blood calcium levels

Vitamin D

- Active component-1,25-dihydroxycholecalciferol
- Affects bone formation

Growth factors

- Transforming Growth Factor (TGF)
- Two classes-α & β
- Potent bone resorbing factors

Mechanical factors

- Wolff's Law- bone remodels in response to forces or stresses placed on it

Markers of bone turnover

Formation:

- Alkaline phosphatase
- Osteocalcin
- Procollagen I extension peptide

Resoption:

- Urine calcium
- Urinary hydroxy proline
- Collagen cross link fragments
- Urine N-telopeptide
- Urine C-telopeptide
- Urine total pyridinoline

Alveolar bone

- Part of maxilla & mandible that forms and supports sockets of teeth
- Functions:

1. Holds roots
2. Helps movement of teeth
3. Absorbs and distributes occlusal forces
4. Supplies vessels to PDL
5. Houses & protects developing teeth
6. Organises erruption of teeth

Structure

- Alveolar bone proper
- Lamellated bone
- Bundle bone

Bundle bone

- Bone in which principal fibers of PDL are anchored
- Scarcity of fibers in intercellular substance
- Contains fewer fibrils than lamellated bone, hence appears dark in H&E
- Radiographically called as Lamina Dura(thick bone without trabaculation, not because of increased minerals)

Alveolar bone proper

- Forms inner wall of socket
- Carries interalveolar nerves & vessels, hence also called cribriform plate
- Interdental septum: bone between the teeth
- Interdental & inter radicular septa contain perforating canals of Zurkerandle & Hirschfeld(which are nutrient canals)

Supporting alveolar bone

- Cortical plates
- Spongy bone

Clinical considerations

- Orthodontic tooth movements
- Healing of fractures/ extraction wounds
- Periodontal diseases
- Resorption of ridges after tooth loss
- Lamina dura
- Autografts
- Allograft
- Xenografts
- Synthetic bone graft

Take home message

- Bone gives form and support for all bodily movements.
- The structure of bone differs based on its location and function.
- Knowledge about structure of bone is important if any problem associated with it needs to be diagnosed.