



TATYASAHEB KORE DENTAL COLLEGE AND RESEARCH CENTRE

NEW PARGAON – 416 113

Tal.: Hatkanangale Dist.:Kolhapur (Maharashtra State)

National Dental Commission

INFORMATION REGARDING INSTITUTIONAL COMPLIANCE



4. Clinical Compliance

4.2 Student clinical work registers are updated regularly.

Mahatma Gandhi Charitable Medical Trust, Warananagar.



TATYASAHEB KORE DENTAL COLLEGE & RESEARCH CENTRE, NEW PARGAON

RECOGNISED BY DENTAL COUNCIL OF INDIA, NEW DELHI.

AFFILIATED TO MAHARASHTRA UNIVERSITY OF HEALTH SCIENCES, NASHIK.



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DENTAL HISTOLOGY RECORD BOOK

NAME: SHARAYU SHARADKUMAR SANKAPAL

PERMANENT REGISTRATION No.: _____

UNIVERSITY EXAMINATION No.: 811890 ROLL No.: 51

Mahatma Gandhi Charitable Medical Trust, Warananagar.

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**DENTAL HISTOLOGY
RECORD BOOK**

CERTIFICATE

This is to certify that *Shri/Kum. Sharayu Sharadkumar*
Sankapal Roll No. *51*

has satisfactorily carried out the Practical work in Dental Histology as
prescribed by the Maharashtra University of Health Sciences, Nashik
for the year 2023 & 2024


Staff Incharge

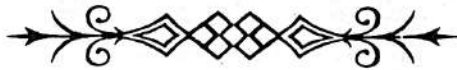
Date :- 09/09/2024



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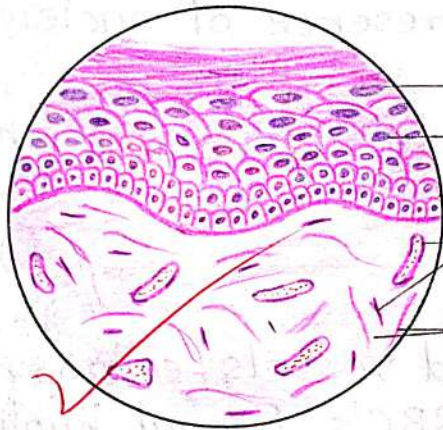

Professor & Head 9/9/24

Study of Stains



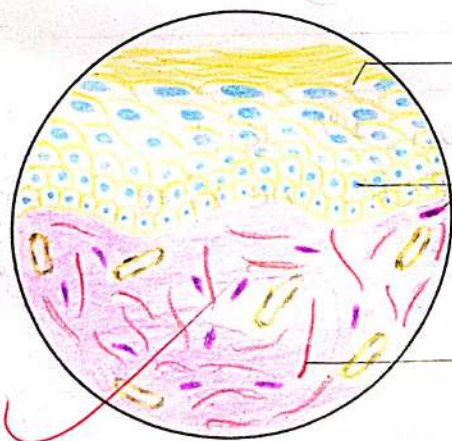
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Hematoxylin and Eosin Stain



- Cytoplasm stained with eosin
- Nucleus of epithelial cells stained with hematoxylin
- Nucleus of endothelial cell and fibroblast stained with hematoxylin
- Collagen and ground substance stained with eosin

Van Gieson Stain



- Epithelium stained yellow
- Nucleus stained blue or black
- Collagen stained red colour



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1. Haematoxylin and Eosin :

Principle

Haematoxylin is a basic dye so it stains the nucleus which is acidic because of presence of nucleic acid i.e. DNA and RNA

Eosin is acidic so it stains the cytoplasm which is basic in nature.

Result

Haematoxylin : Blue - Nucleus

Eosin : Pink - cytoplasm, blood vessels, collagen, nuclear fibres, RBC's, Fungal hyphae, connective tissue.

2. Van Gieson's Stain

Principle

Based on differential staining of collagen fibres and other tissue and size of dye molecule

Compounds

Saturated picric acid solution, 1% acid

Solute is distilled water. Celestine blue

Result

Epithelium - Yellow

Cell Nuclei - Blue/Black

Collagen - Bright red

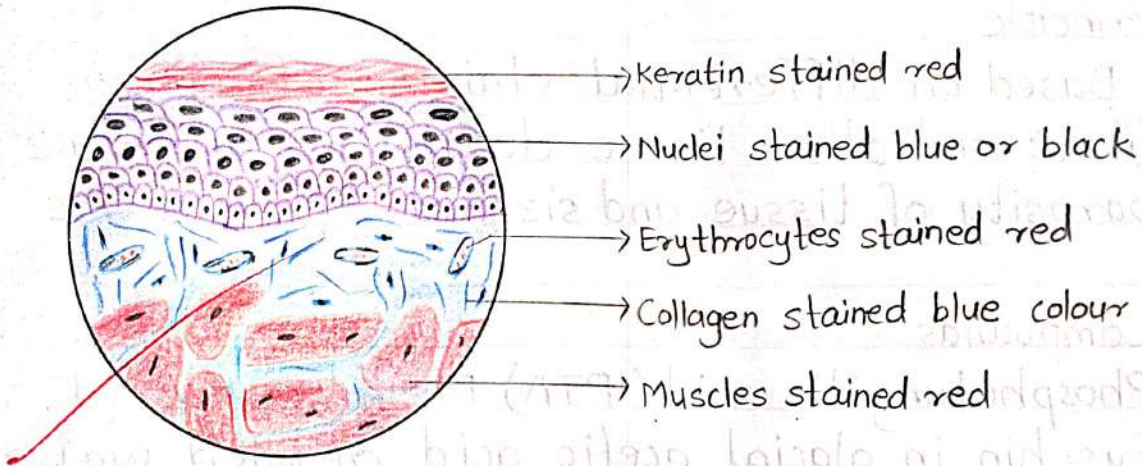
Muscle fibre - Yellow

RBC - Yellow

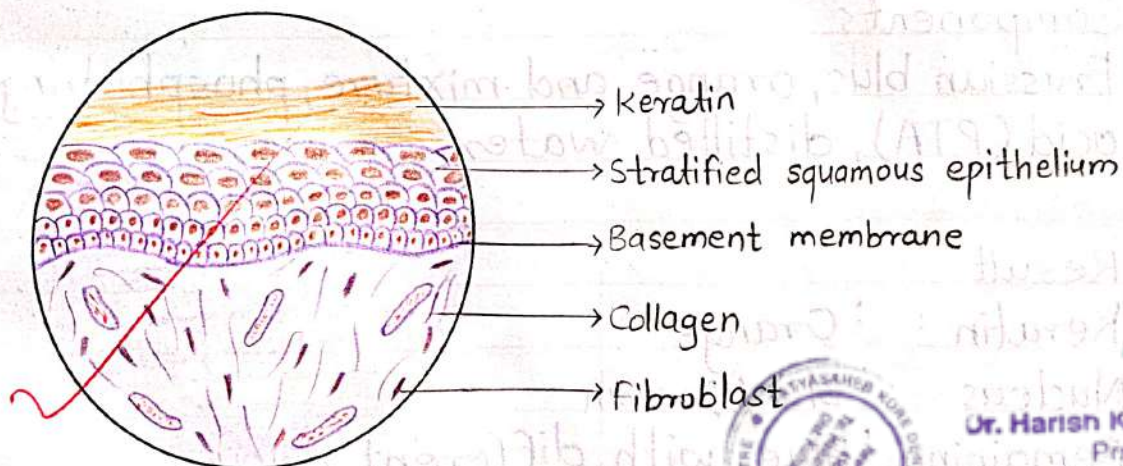


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Masson Trichrome Stain



Mallory's Stain



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3. Masson's Trichrome Stain

This stain is used for staining muscle

Principle

Based on differential staining of collagen fibres and other tissue developing upon the porosity of tissue and size of dye molecule.

Compounds

Phosphotungstic acid (PTA) Methyl blue. Acid Fuschin in glacial acetic acid, distilled water

4. Mallory's Stain

This stain is used for checking degree of keratinization and used to differentiate Kerat from epithelium

Components

Prussian blue, orange and mixture, phosphotungst acid (PTA), distilled water

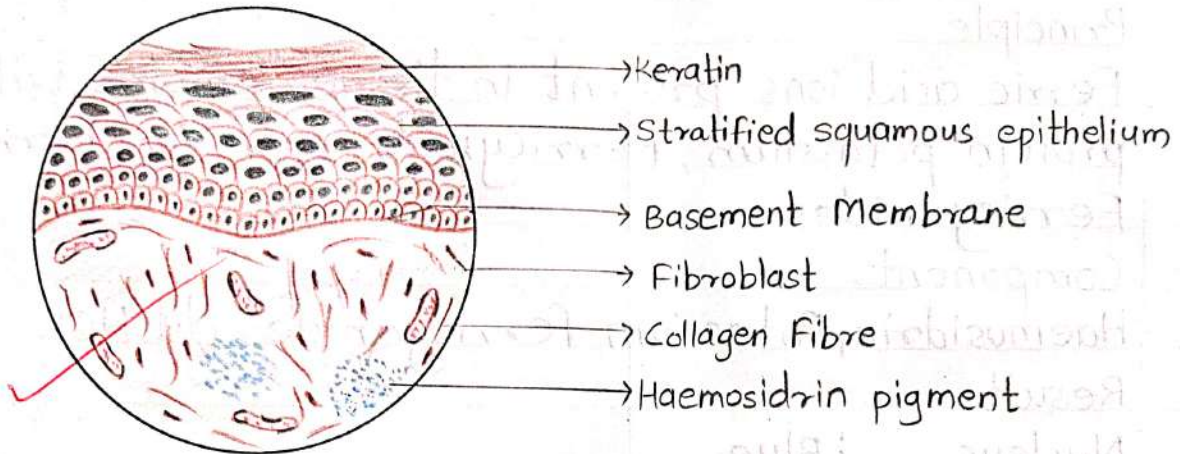
Result

Keratin : Orange

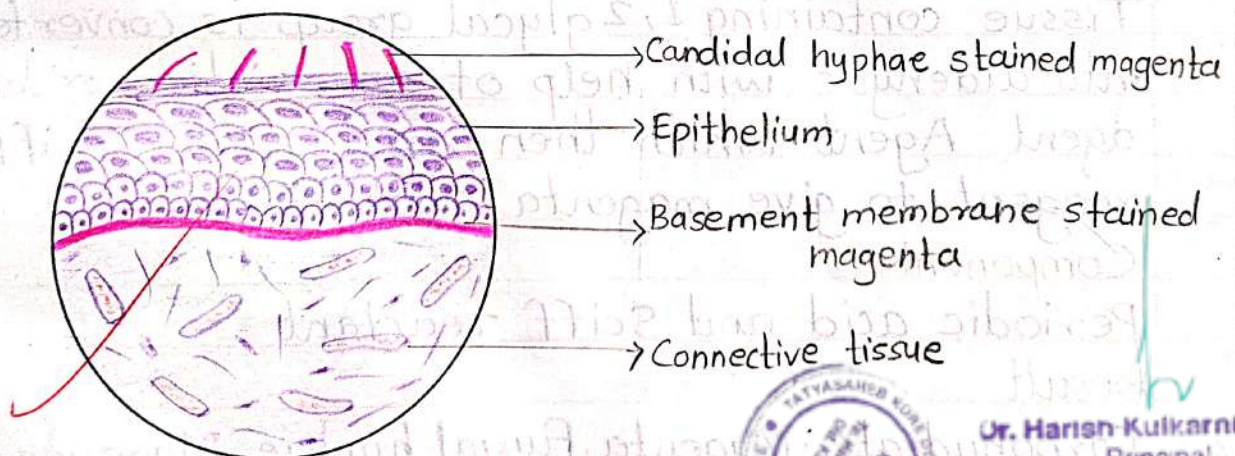
Nucleus : Blue/ Brown

Remaining : Blue with different colour
(contrast structure)

Perl's Prussian Blue



Periodic Acid-Schiff stain



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5. Perl's Prussian Blue stain

This stain is used for demonstration of iron

Principle

Ferric acid ions present in tissue combine with protein potassium, ferricyanide forming Ferricyanides.

Components

Haemosidrin, Potassium ferricyanide, dil. HCl

Result

Nucleus : Blue

Cytoplasm : Brown

Haemosidrin : Blue

6. Periodic Acid Schiff Stain

This stain is used to demonstrate the glycogen and mucosaccharides.

Principle

Tissue containing 1, 2 glycol group is converted into aldehyde with help of an existing oxidizing agent. Agent which then reacts with Schiff reagent to give magenta colour.

Components

Periodic acid and Schiff reagent

Result

Carbohydrate : Magenta, fungal hyphae : Magenta

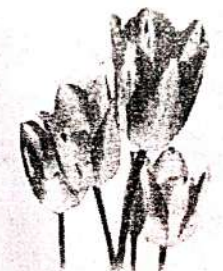
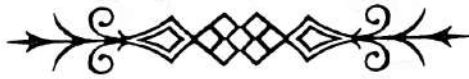
Cytoplasm : Pale blue, Nucleus : blue

Basement : Magenta membrane

Handwritten signature

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Study of Cells



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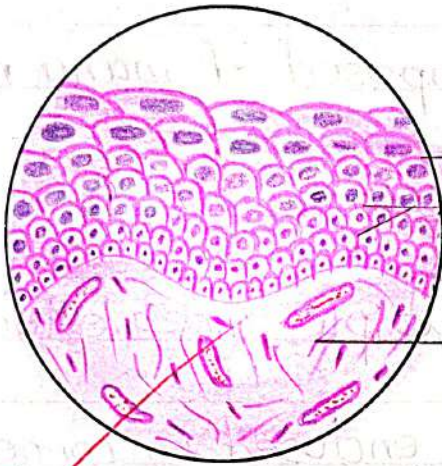
Stratified Squamous Epithelium

- In stratified squamous epithelium the cells are arranged in different layers or strata
- The basal cells are cuboidal in shape, with central nucleus, arranged in single layer on the basement membrane
- The superficial cells are squamous and polyhedral in outline with centrally placed nucleus.
- All these cells are attached to each other by desmosomal junctions

Pseudostratified Ciliated Columnar Epithelium

- The cells of the ciliated columnar epithelium are columnar in shape, of varying sizes arranged in a single layer on a basement
- The nuclei of cells are placed at different levels giving the erroneous appearance of stratification
- The cells on the superficial aspect have cilia which help in the movement of mucous secretion
- Among the columnar cells unicellular secretory organs called goblet cells are also noticed. Goblet cells are goblet shaped with a basally placed nucleus and apical cytoplasm filled with secretory products.

Stratified Squamous Epithelium



- stratified squamous epithelium
- cell arranged in different layers
- Connective Tissue

Pseudostratified Squamous Epithelium



- Goblet Cell
- Pseudostratified Squamous Epithelium
- Connective Tissue



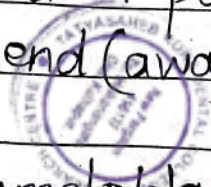
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Striated Muscle

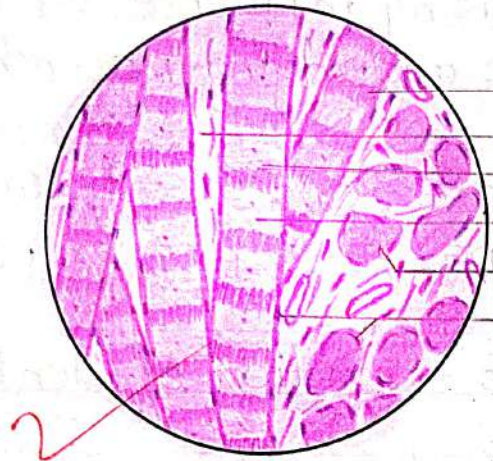
- Striated muscle is seen as highly eosinophilic cylinder like structures in a hematoxylin and eosin stained sections.
- Each muscle fiber is composed of many myofibrils
- The cytoplasm of muscle or sarcoplasm is rich in cytoplasmic organelles.
- Nuclei are flattened, multiple and are located at the periphery.
- The muscle as a whole is enclosed in connective tissue called epimysium.
- This connective tissue extends inwards dividing muscle into fasciculi. These extensions are called perimysium, from which again septa extends that invests individual muscle fibres.

Ameloblast

- Ameloblasts are enamel forming cells which differentiate from the cells of inner enamel epithelium of enamel organ.
- They are columnar in shape with approximately 40 microns in length and diameter of 4 to 5 μm .
- Ameloblasts show reversal of polarity with nucleus located at the proximal end (away from the basement membrane)
- During formative stage, ameloblasts develop a conical projection at the basal portion which is termed as Tomes process

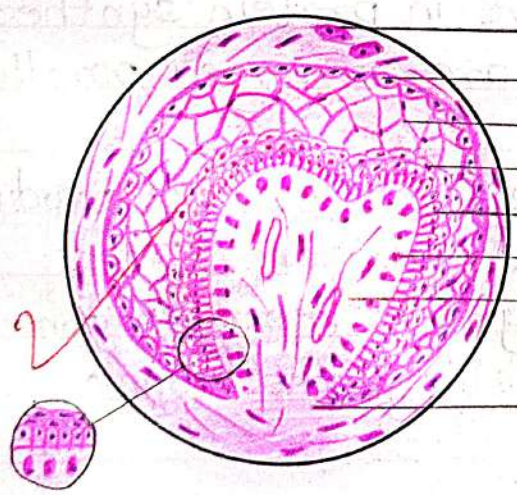


Striated Muscle



- Dark Band
- Interfascicular Connective Tissue
- Light Band
- Striated muscle in longitudinal section
- Striated muscle in transverse section
- Peripherally placed nucleus

Ameloblast



- Remnants of dental lamina
- Outer enamel Epithelium
- Stellate Reticulum
- Stratum intermedium
- Ameloblast
- Odontoblast
- Dental papilla
- Cervical loop



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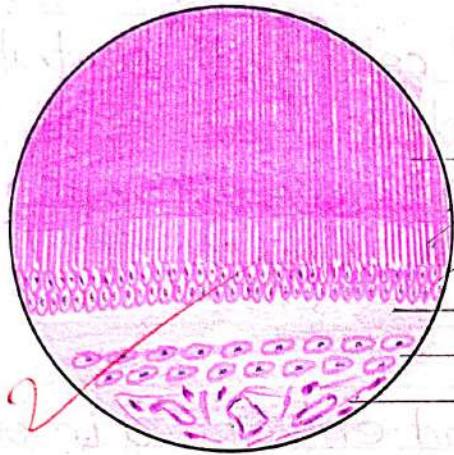
Odontoblast

- Odontoblasts are tall columnar cells located at periphery of dental pulp.
- They originate by organising influence of enamel epithelium on the underlying mesench cells of dental papilla.
- They are 5-7 μm in diameter and 25-40 μm length of different shapes, in different part of tooth.
- Its primary function is secretion of dentin during dentinogenesis.

Fibroblasts

- Fibroblasts are ovoid or star shaped cells with multiple cytoplasmic process.
- The cell has large, round and open face nucleus.
- Cytoplasm exhibiting slight basophilia indicate that they are highly active in protein synthesis.
- Fibroblast and fibrocytes are arranged parallel to the collagen fibres.
- Fibroblast are the synthetic cells that produce collagen fibres and ground substances.
- They also help to degrade these components thereby helping in remodelling the connective tissue.

Odontoblast



- Dentin
- Predentin
- odontoblastic zone
- Cell free zone
- Cell Rich zone
- Pulp core

Fibroblasts, Fibrocytes & Endothelial Cell



- Blood vessels with RBC
- Fibrocyte
- Collagen
- Ground substance
- Fibroblasts
- Endothelial cells



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Osteoblast

- Osteoblast are synthetic cells of bone that help in the formation of bone, by matrix deposition and mineralization.
- They are cuboidal or ovoid cells with centrally placed ovoid open face nucleus.
- They are arranged along the periphery of the bony trabeculae, forming a lining or rimming of the trabeculae.

Osteocytes

- They are resting cells found entrapped in bone
- They occupy spaces called lacunae.
- Osteocytes have a cell body & processes called canaliculi.
- Cells are ovoid or flat with close faced nucleus and scanty cytoplasm.

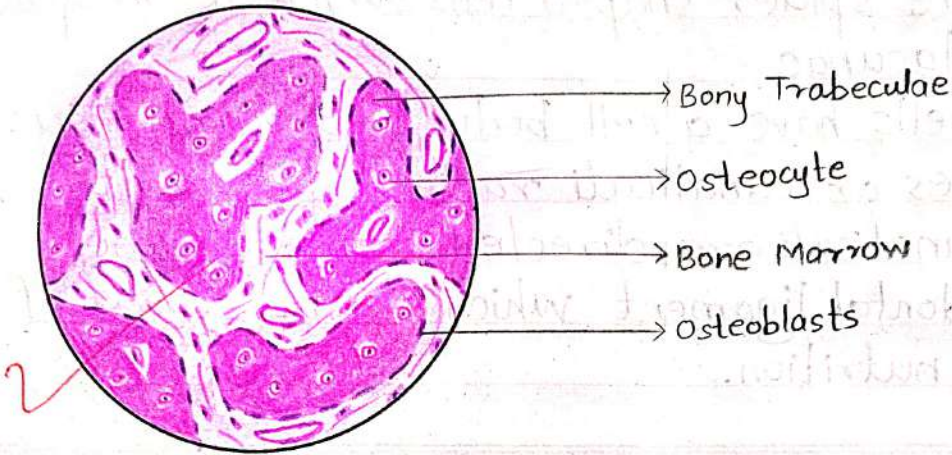
Osteoclasts

- Osteoclasts are the cells which resorb the bone
- Osteoclasts are derived from circulating monocyte
- They are large giant cells with multiple nuclei.
- These cells occupy irregular resorption bays called Howship' lacunae.

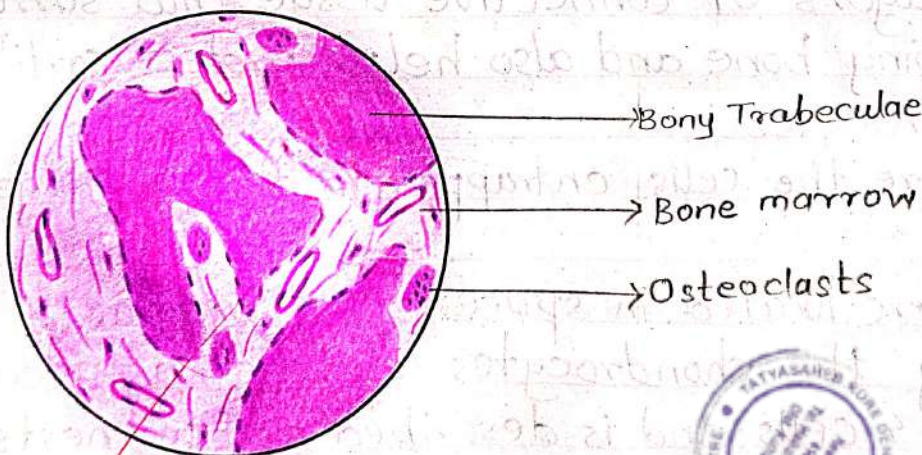


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Osteoblasts, Osteocytes



Osteoclasts



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Cementocytes

- They are the cells found entrapped in cellular cementum
- They are spider shaped cells which lie in spaces called lacunae.
- These cells have a cell body and numerous processes or canaliculi radiating from it.
- The canaliculi are directed towards the periodontal ligament which is the source of their nutrition.

Chondroblast

- They are cartilage forming cells
- They appear as flattened or elliptical cells and are located at the periphery of cartilage parallel to the surface.
- They are located in the perichondrium, which is a layer of connective tissue that surrounds developing bone and also helps protect cartilage.

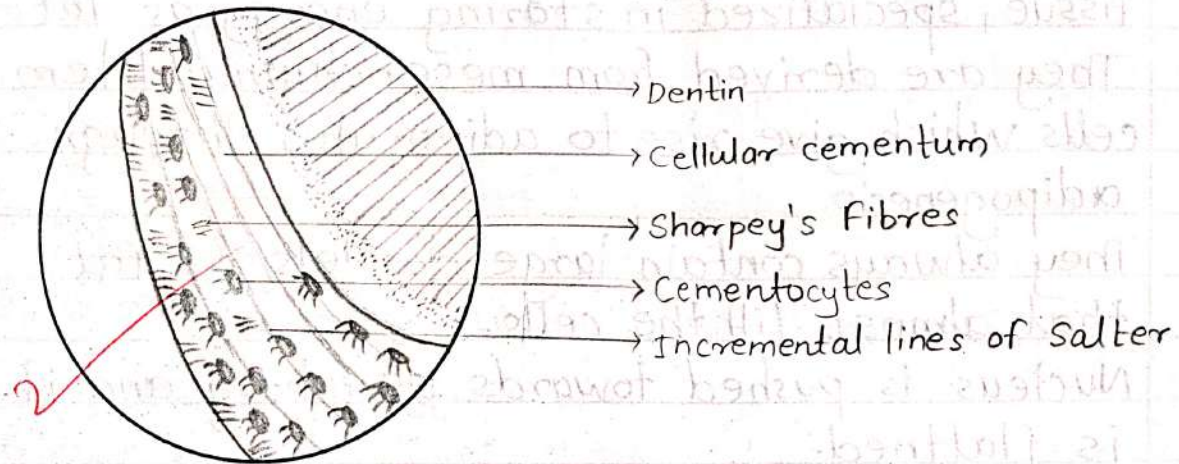
Chondrocytes

- They are the cells entrapped in the cartilaginous matrix
- They are located in space called lacunae
- Usually the chondrocytes are seen as groups of 2 to 4 cells and is described as 'cell nests'

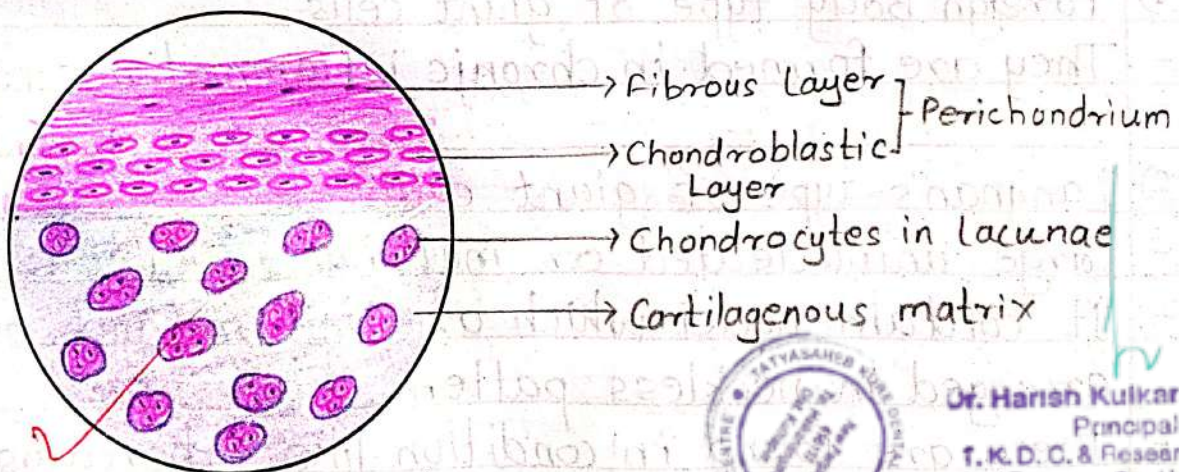
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Cementocytes



Chondrocytes & Chondroblasts



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Adipose Cells

- Fat cells also known as adipocytes and lipocytes are the cells that primarily compose adipose tissue, specialized in storing energy as fat.
- They are derived from mesenchymal stem cells which give rise to adipocytes through adipogenesis.
- They always contain large droplets of fat that almost fill the cells.
- Nucleus is pushed towards periphery and it is flattened.
- Fat cells can be stained by a special stain called sudan III.
- They are distributed in submucosal tissue.

Giant Cells

- Large/multinucleated cells are called giant cells.
3 types

1) Foreign Body type of giant cells

- They are formed in chronic inflammation condition

2) Langhan's type of giant cells

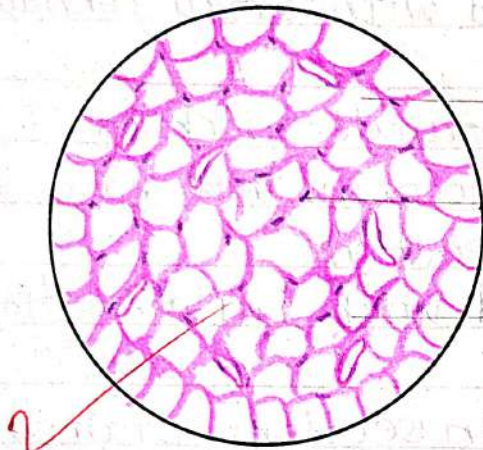
- Large uninucleated or multinucleated cells.
- It contain nuclei which are uniform and are arranged in neckless pattern.
- These are found in condition like tuberculosis.

3) Touton 'type of giant cells

- These are multinucleated cells that have vacuolate cytoplasm due to lipid. E.g In xanthoma

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Adipose Cells

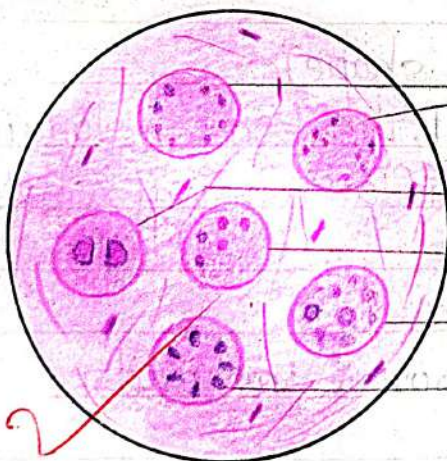


→ fat cell with empty cytoplasm

→ Eccentrically placed nucleus

→ Polygonal fat cells

Giant Cells



→ Langhan's type giant cell

→ Reed Sternberg

→ foreign body giant cell

→ Tumour giant cell

→ Touton's giant cell



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Macrophages/Mast Cells

- Mast cells are connective tissue cells which are widely distributed in the oral mucosa.
- Mast cells are round/ovoid with small centrally placed nucleus.
- The cytoplasm contains granules rich in histamine, heparin and serotonin that have important role in allergic reaction.
- Mast cells are concerned with inflammation & immune response.
- These cells can be seen in sections stained by toluidine blue as cell filled with purple/violet coloured coarse granules.

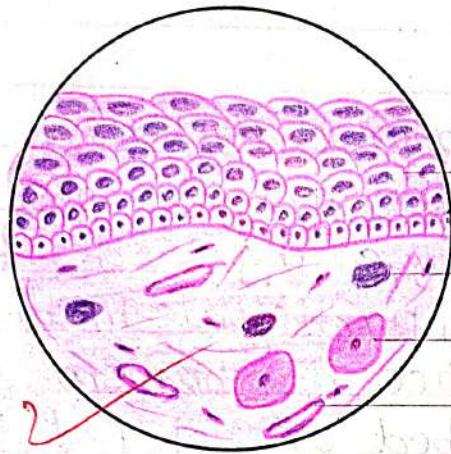
Lymphocytes/Plasma cells

- Size: 8-10 μm
- large nucleus (oval/kidney shape)
- These are defence cells of the body belonging to the group of chronic inflammatory cells.
- They are stained by blue

2 types

- 1) B-lymphocytes provide humoral immunity
- 2) T-lymphocytes provide cell mediated immunity

Macrophage, Mast cell



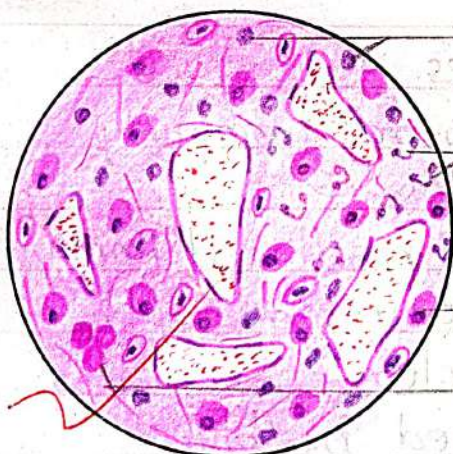
→ Epithelium

→ Mast cell granules stained violet

→ Macrophage

→ Connective tissue

Lymphocytes, Plasma cells

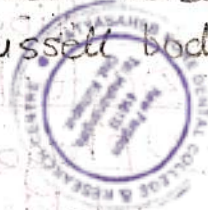


→ Lymphocytes (small & large)

→ Neutrophils

→ Plasma cells with eccentrically placed nucleus

→ Russell bodies



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Peripheral Blood Smear

1) Neutrophils: 1) Size - 10 to 12 μm , multilobed nucleus
2) In H+E staining they take up pink colour.

3) Phagocytes

2) Eosinophils: 1) 10-12 μm , bilobed nucleus
2) Large acidophilic granules in cytoplasm they stained by orange red.

3) Anti-parasite, participate in allergic reaction, defence mechanism

3) Basophils: 1) 12-15 μm , bilobed or S-shaped
2) Basophilia of granules is due to presence of heparin

3) Phagocytosis, release of enzyme histamine to dilate blood vessels heparin which is anticoagulant

4) Lymphocytes: 1) 8-10 μm , large nucleus (oval/round)
2) They are stained by blue

3) 2 type

i) B-lymphocytes

- Provide humoral immunity

ii) T-lymphocytes

- Provide cells mediated immunity

5) Monocytes: 1) 15-22 μm , Mononuclear with ellipsoidal nucleus

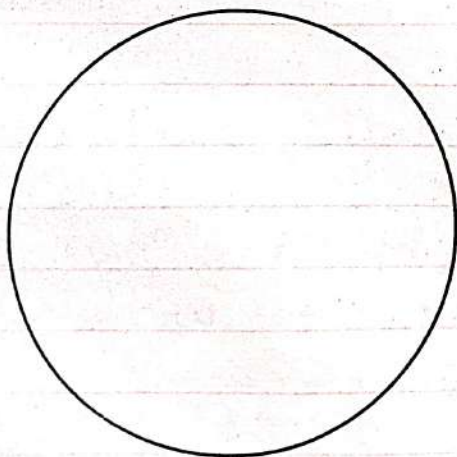
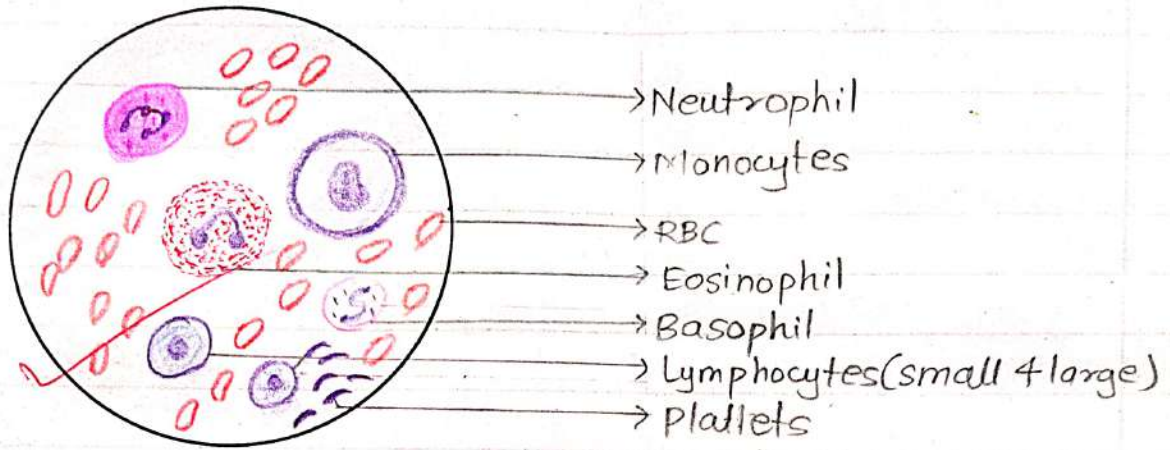
2) Cytoplasm stained by blue

3) Phagocytosis, antigen presentation, cytokine production.

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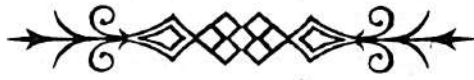
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Peripheral Blood Smear



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Study of Development of Tooth



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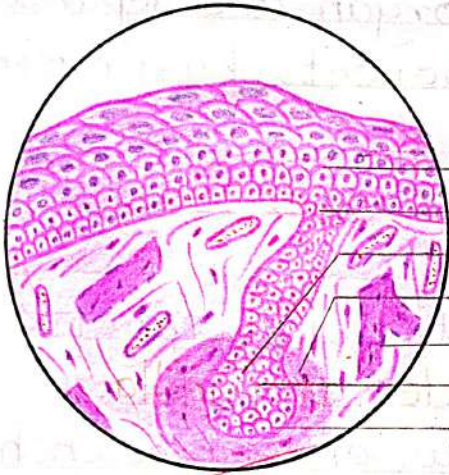
Bud Stage

- Enamel organ is bud shaped (round or ovoid) with peripheral cuboidal cells and central polyhedral cells.
- Peripheral cells of enamel organ are separated from ectomesenchymal components by a basement membrane.
- All the cells are attached to each other by desmosomal junctions.
- Ectomesenchymal condensation adjacent to enamel organ forms the dental papilla.
- Marginal condensation dental of ectomesenchymal cells closing dental papilla and enamel organ is called dental follicle or dental sac



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BUD STAGE



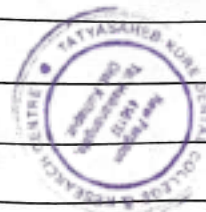
- Oral Ectoderm
- Dental Lamina
- Enamel Organ
- Condensation of Ectomesenchyme
- Developing bone
- Central Polyhedral cells
- Peripheral Cuboidal Cells



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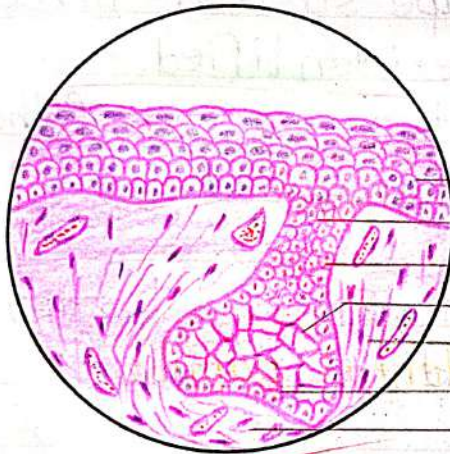
Cap Stage

- Enamel organ increases in size and attain the shape of a cap by invagination of the deep portion of the bud.
- Cells undergo change in shape so that three separate cell groups can be identified.
- Cell lining the convexity or the periphery of the cap are cuboidal in shape and are called outer enamel epithelium.
- The cells lining the concave or invaginated portion change to columnar cells named inner enamel epithelium.
- The central polyhedral cells transform into a network of star-shaped cells called stellate reticulum.
- Dental papilla gets partially enclosed by the invaginated portion of enamel organ.
- Cells of dental papilla undergo proliferation and further condensation.
- Dental follicle shows further condensation of ectomesenchymal cells.
- It becomes more fibrous and denser in cap stage.



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CAP STAGE



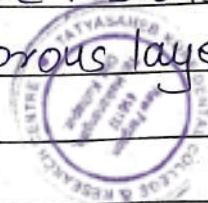
- Oral Ectoderm
- Dental Lamina
- Outer Enamel Epithelium
- Stellate Reticulum
- Dental Follicle
- Inner Enamel Epithelium
- Dental Papilla



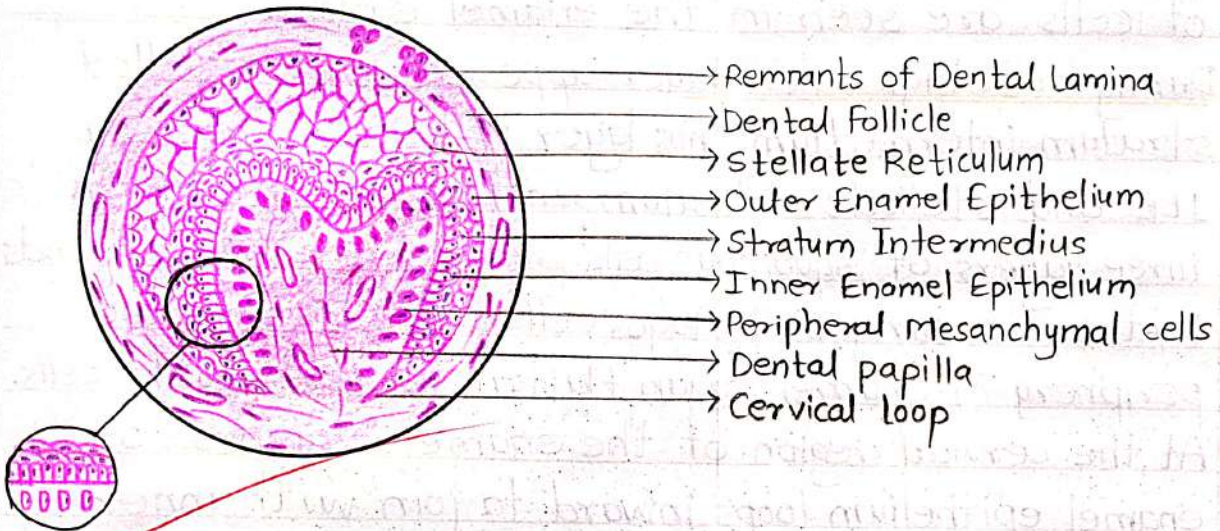
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Bell Stage: Early Bell Stage

- Enamel organ enlarges further and invagination deepens changing the shape to that of a bell in a longitudinal section. In bell stage four different layers of cells are seen in the enamel organ.
- During bell stage a new layer appears which is called stratum intermedium. This layer is located between IEE and stellate reticulum and is composed of two to three layers of squamous cells. Stellate reticulum expands further in early bell stage. Cells of OEE lining the periphery of enamel organ flatten to low cuboidal cells.
- At the cervical region of the enamel organ outer enamel epithelium loops inward to join with inner enamel epithelium. This is called cervical loop.
- During early bell stage enamel organ loses its connection to oral ectoderm due to degeneration of dental lamina. Remnants of the dental lamina are called cell rests of Serres.
- Successional lamina develops at this stage which is the primordium for the permanent successor.
- Dental papilla: The dental papilla is fully enclosed in the invaginated portion of the enamel organ in this stage. Peripheral cells of dental papilla differentiate into odontoblast under the organizing influence of IEE.
- Dental follicle becomes more fibrous, with three layers i.e. inner cellular, outer fibrous layer and middle loose connective tissue.



EARLY BELL STAGE



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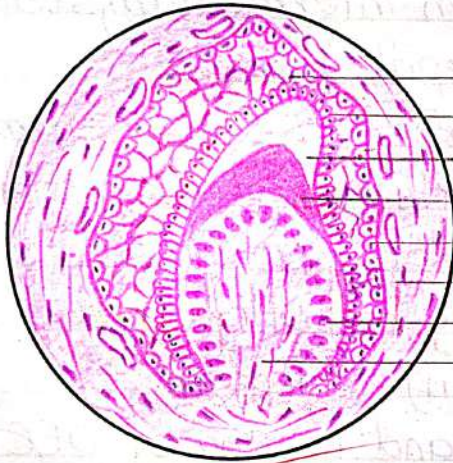
Advanced Bell Stage

- Differentiating feature between early and advanced bell stage is formation of hard tissues.
- Enamel organ shows four different layers, inner enamel epithelium (ameloblasts), stratum intermedium, stellate reticulum and outer enamel epithelium.
- Cells lining the invaginated portion, the inner enamel epithelium is composed of single layer of tall columnar cells that differentiate to ameloblasts
- Histological differences from early bell stage are
 - Hard tissue (enamel and dentin) formation.
 - Collapsed stellate reticulum and folding of OEE bringing capillaries of the dental follicle nearer to the ameloblasts.
- Ameloblasts are brought closer to the dental follicle which now becomes their source of nutrition.
- Dental papilla shows differentiated odontoblast at the periphery.
- Dental follicle is distinct enclosing enamel organ and dental papilla.



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ADVANCED BELL STAGE



- Collapsed stellate Reticulum
- Ameloblast
- Enamel
- Dentin
- Outer Enamel Epithelium
- Dental Sac
- Odontoblast
- Developing pulp



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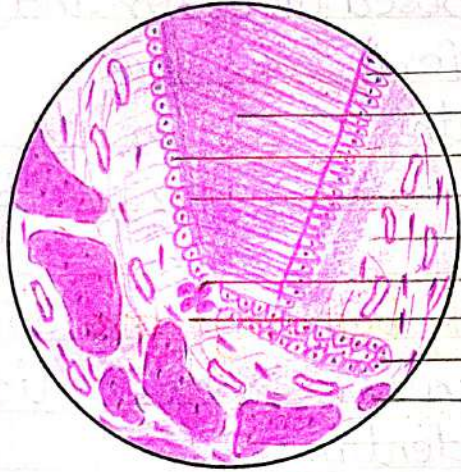
Development of Root

- Root development occurs in advanced bell stage after the enamel and dentin formation reaches the cervical region of tooth.
- The cervical loop which is composed of outer and inner enamel epithelium, proliferates to form Hertwig's epithelium root sheath (HERS) which determine the size, shape and number of roots to be formed.
- Inner cells of HERS exert an organizing influence on dental papilla cells to differentiate into odontoblasts that deposit radicular dentin.
- Once the root dentin is formed, HERS degenerates allowing the dental follicle cells to come in contact with dentin. The cells of dental follicle differentiate to form cementoblasts and lays down cementum over the root dentin. As the cementum formation progresses, the rest of the dental follicle becomes more fibrous and develops into periodontal ligament.
- The remnants of HERS remain in periodontal ligament and are called 'cell rests of Malassez'.
- Under pathological conditions these cell rests may proliferates giving rise to odontogenic cysts or tumors.



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DEVELOPMENT OF ROOT



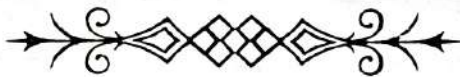
- Odontoblasts
- Dentin
- Cementoblasts
- Cementum
- Dental Papilla
- Cell Rests of Malassez
- Dental Follicle
- Hertwig's Epithelial Root Sheath
- Developing Alveolar Bone

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Study of Enamel



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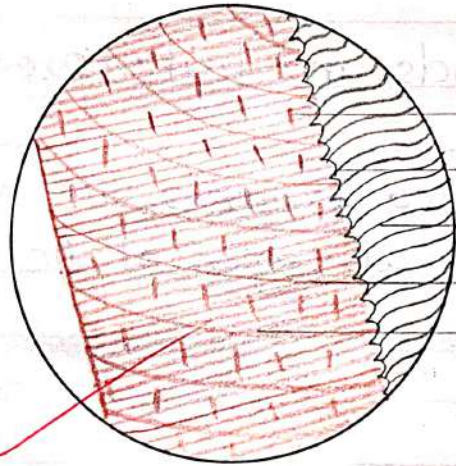
4) ENAMEL RODS: LONGITUDINAL SECTION

- Enamel rods are the basic functional structural unit of enamel.
- They run from the dentino-enamel junction to outer surface of enamel and follow somewhat tortuous course.
- In a longitudinal section, enamel rods appear to be divided into segments by dark lines.
- These dark lines across the enamel rods are called cross striations.
- These cross striations are separated by a distance of 4μ making each segment 4μ which is the increment of enamel deposit daily.



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Enamel Rods: Longitudinal Section



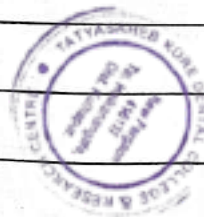
- Cross Section
- Dentino-enamel Junction
- Dentine
- Striae of Retzius
- Enamel Rods



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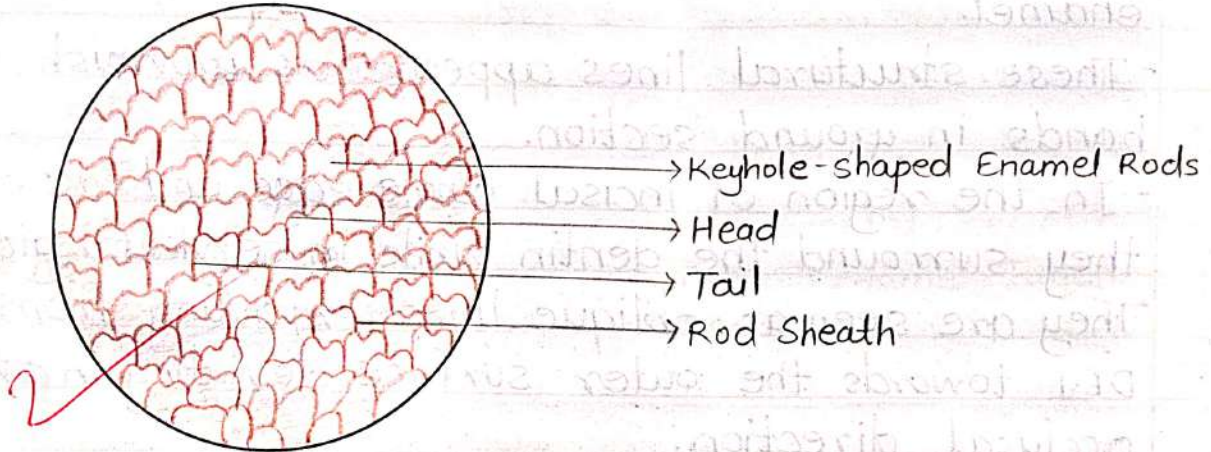
2) ENAMEL RODS : TRANSVERSE SECTION

- In cross section, enamel rods may resemble a fish scale or keyhole pattern with a head and a tail.
- Head represents the rods and tail represents the inter-rod region.
- The head portion is directed towards the occlusal aspect and tail to the cervical region of the tooth.



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Enamel Rod: Transverse Section



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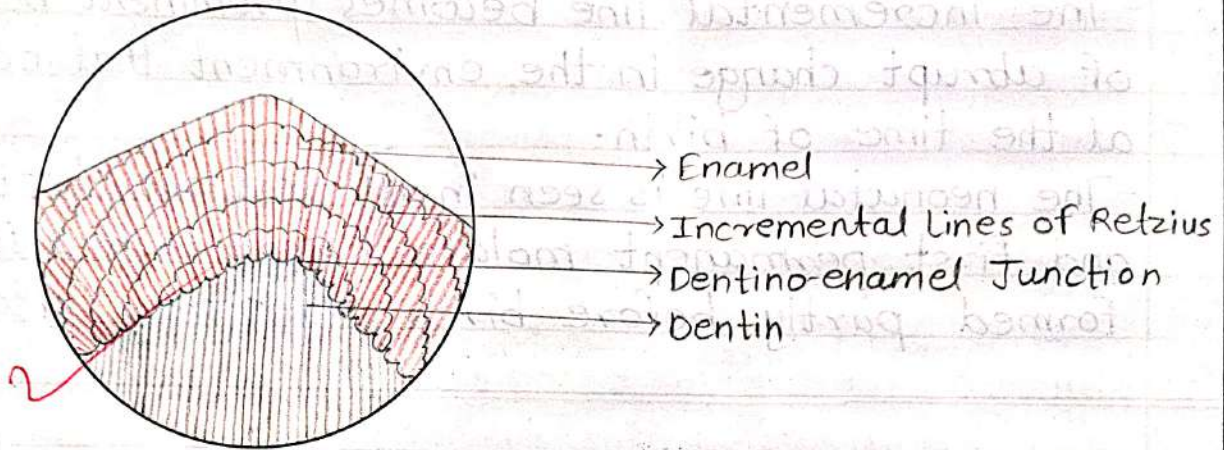
3) STRIAE OF RETZIUS

- These are the incremental lines of enamel representing the successive deposition of enamel.
- These structural lines appear as brownish bands in ground section.
- In the region of incisal angle edge and cusps they surround the dentin while in cervical region they are seen as oblique lines extending from DEJ towards the outer surface deviating in an occlusal direction.
- In transverse section of teeth incremental lines are seen as concentric rings.
- These lines are hypocalcified and reflect variation in structure and mineralisation.



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Striae of Retzius



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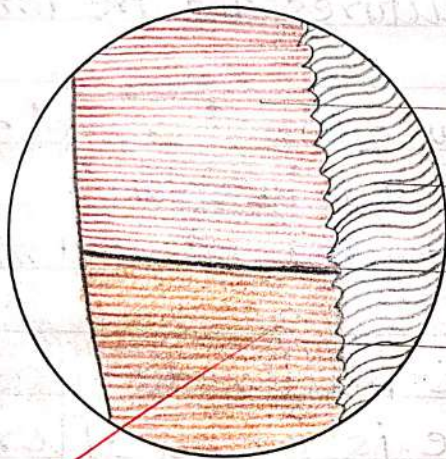
4) NEONATAL LINE

- It is a prominent incremental line that separates the enamel that is formed before birth (prenatal enamel) and after birth (postnatal enamel)
- The incremental line becomes prominent because of abrupt change in the environment that occurs at the time of birth.
- The neonatal line is seen in all deciduous teeth and first permanent molars where enamel is formed partly before birth and partly after.



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Neonatal Line



→ Prenatal Enamel

→ Dentin

→ Neonatal Line

→ Postnatal Enamel



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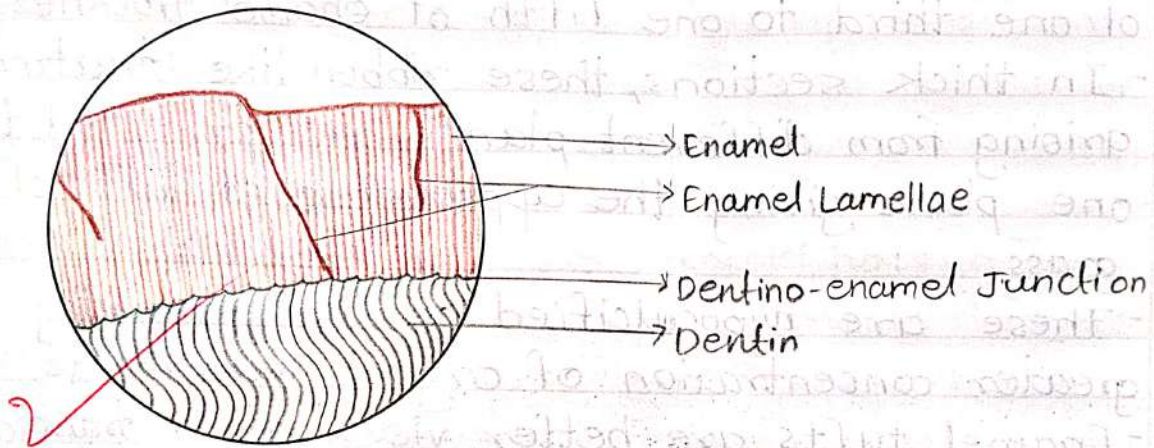
5) ENAMEL LAMELLAE

- These are leaf like structures that extend from the outer surface of enamel towards the dentin.
- These are hypocalcified structures and are formed in planes of tension.
- Type A: Composed of poorly calcified enamel rods. This type is restricted to enamel.
- Type B: Consists of degenerated cells and may extend into dentin.
- Type C: Filled with organic matter derived from saliva. This type is formed after eruption of the tooth and may be extended into the dentin.



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Enamel Lamellae



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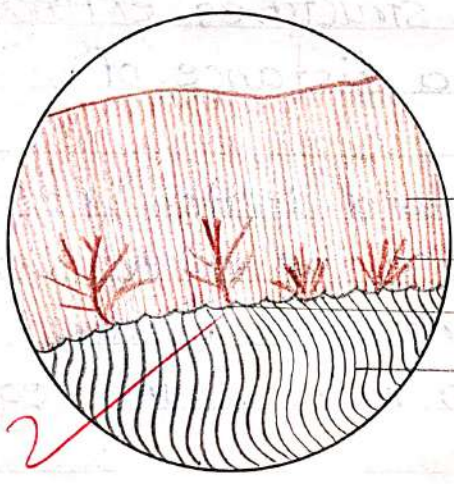
6) Enamel Tufts:

- These are ribbon like structures extending from dentinoenamel junction into enamel to a distance of one third to one fifth of enamel thickness.
- In thick sections, these ribbon like structures arising from different planes are projected to one plane giving the appearance of tufts of grass.
- These are hypocalcified sections containing greater concentration of organic components.
- Enamel tufts are better visualized in transverse section.



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Enamel Tufts



- Enamel
- Enamel Tufts
- Dentino-enamel Junction
- Dentin



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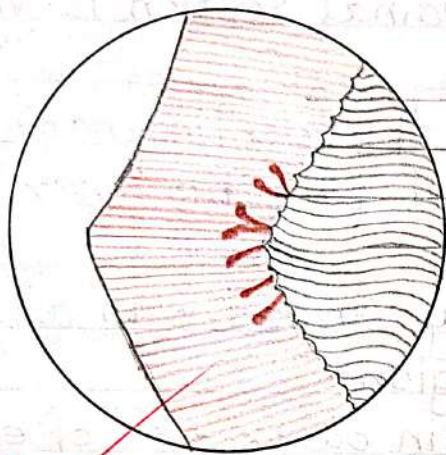
7) ENAMEL SPINDLES

- The enamel spindles are the odontoblastic processes crossing the dentinoenamel junction and extending to the enamel.
- These are spindle shaped structures extending from DEJ to enamel to a distance of approximately 10 μm .
- They appear dark in ground section under transmitted light because the organic content of spindle is lost and is replaced by air.
- Enamel spindles are seen more in the region of cusp tip.



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Enamel Spindles



→ Enamel

→ Dentino-enamel Junction

→ Enamel Spindles

→ Dentin



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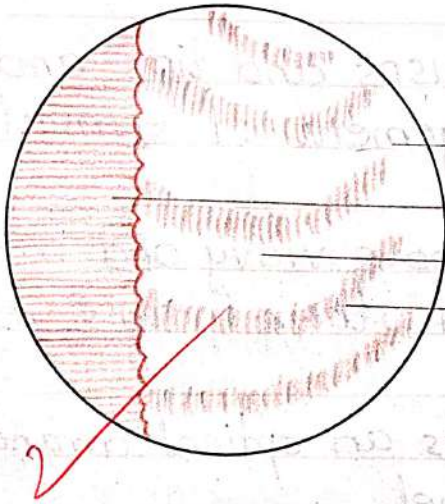
B) HUNTER-SCHREGER BANDS :

- Hunter Schreger bands (HS bands) are alternate dark and light bands of varying width observed in enamel when a longitudinal section is viewed under reflected light.
- These bands arise from the dentinoenamel junction and pass outward till the inner $\frac{2}{3}$ of enamel thickness.
- These bands are slightly curved with convex directed to the cervical region.
- HS bands are not seen in outer $\frac{1}{3}$ rd of enamel because the enamel rods are straight in this region.
- HS bands are formed due to change in direction of enamel rods.



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Hunter-Schreger Bands



→ Enamel

→ Dentin

→ Light Band

→ Dark Band



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9) GNARLED ENAMEL

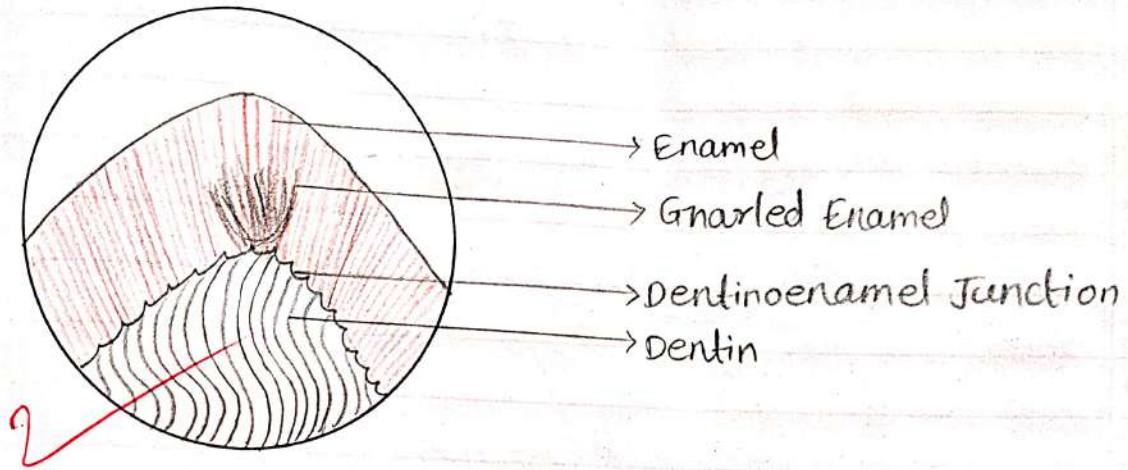
- Enamel rods follow a wavy course as they extend from dentino-enamel junction towards the outer surface.
- In the region of the cusps and tips and incisal edges the arrangement of enamel rods are more complicated.
- The enamel rods are more wavy and irregular and interwine with each other in this region especially near DEJ.
- This appearance creates an optical arrangement referred as gnarled enamel.
- This particular arrangement of rods in cuspal and incisal region makes enamel stronger to withstand masticatory stress.

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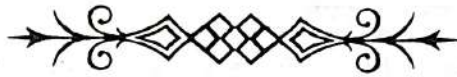
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Gnarled Enamel



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Study of Dentin



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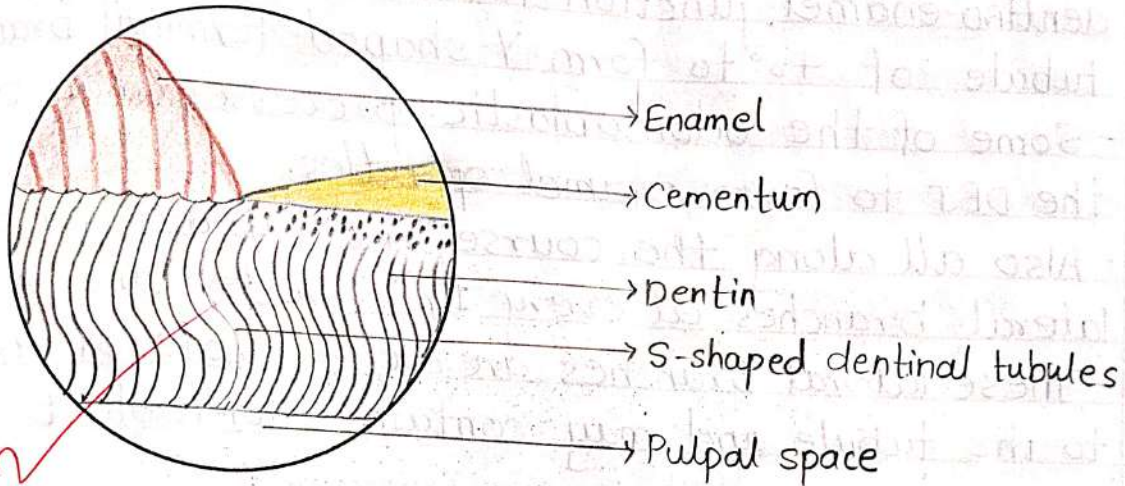
1) S-shaped dentinal tubules

- Dentinal tubules extend from pulpal surface to dentinoenamel or dentinocemental junction.
- Dentinal tubules are S-shaped or doubly curved structures and is described as primary curvature of dentinal tubules.
- The first convexity from pulpal side is directed towards the root of teeth and second convexity towards the crown
- These tubules are perpendicular to pulpal surface and dentino-enamel junction
- Along the length of primary curvature small oscillations will be found at intervals and are referred as secondary curvature.



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1) S-shaped dentinal tubules



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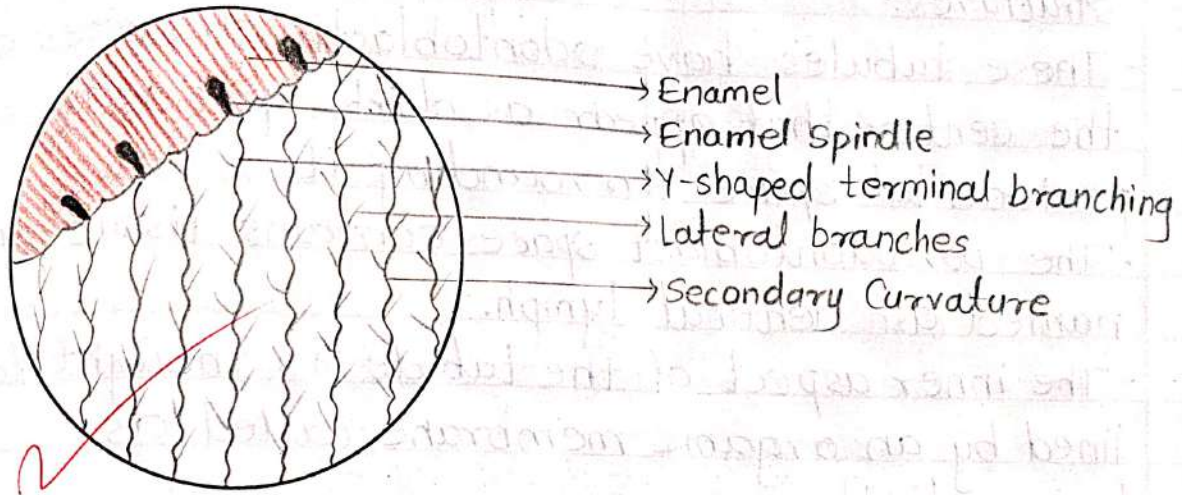
2) Terminal branches and lateral branches of Dentinal tubules

- The terminal end of dentinal tubule near dentino-enamel junction fork off from the main tubule of 45° to form Y-shaped terminal branching.
- Some of the odontoblastic processes may cross the DEJ to form enamel spindles.
- Also all along the course, the tubules have lateral branches at every 1 micrometer distance.
- These lateral branches are at an angle of 45° to the tubule and may contain odontoblast process.
- Lateral branches may communicate with those of adjacent tubules or blindly end at intertubular dentin.



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2) Terminal branches & lateral branches of Dentinal tubules



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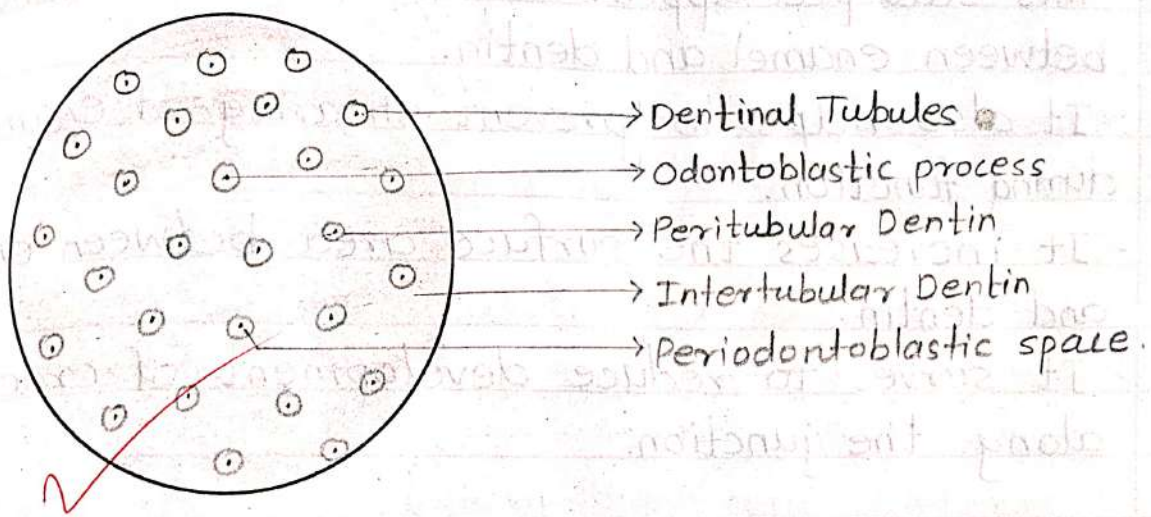
3) Transverse Section of Dentin

- Transverse or cross section of dentin shows numerous dentinal tubules appearing as circular structures.
- These tubules have odontoblastic processes at the center that appear as dark spot with peritubular space surrounding it.
- The peritubular space contains tissue fluid named as dentinal lymph.
- The inner aspect of the tubule is thought to be lined by an organic membrane called as lamina limitans.
- The dentinal tubules are surrounded by peritubular or intertubular dentin.
- In between dentinal tubules, the bulk of dentin is made up of intertubular dentin.



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3) Transverse Section of Dentin



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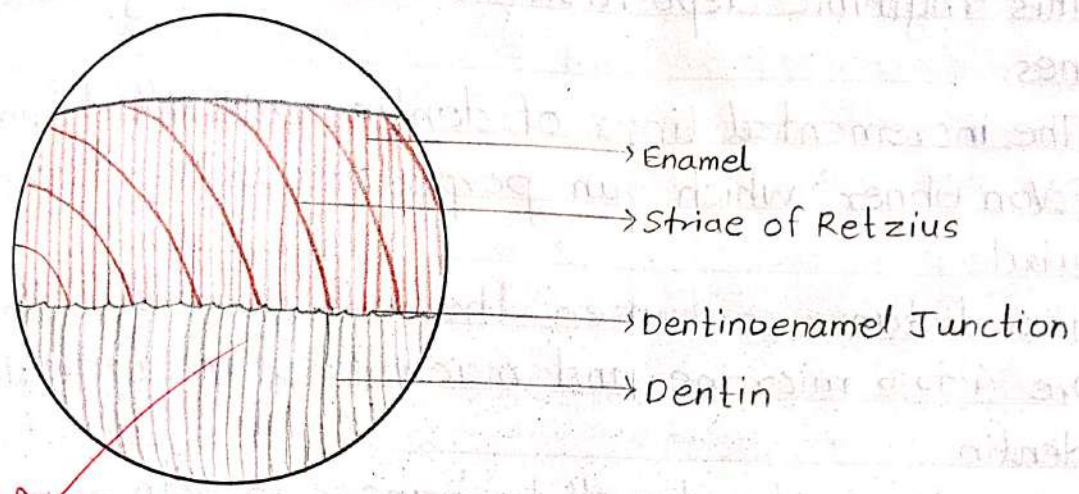
4) Dentino-enamel junction:

- Dentino-enamel junction is scalloped with convex facing the dentin.
- This scalloped appearance increases the adherence between enamel and dentin.
- It also helps to prevent shearing of enamel during function.
- It increases the surface area between enamel and dentin.
- It serves to reduce development of cracks along the junction.



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4) Dentino-enamel Junction



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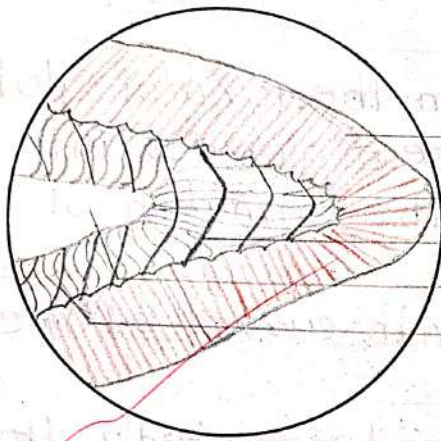
5) Incremental lines of Dentin

- Formation of dentin is a rhythmic process with alternating phases of activity and quiescence.
- This rhythmic deposition is indicated by incremental lines.
- The incremental lines of dentin are called 'lines of Von Ebner' which run perpendicular to dentinal tubule
- The distance between these incremental lines are 4 to 6 microns and much less in radicular dentin
- Sometimes due to disturbances in either matrix deposition or mineralisation these incremental lines may become accentuated and are called 'Counter lines of Owen'



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5) Incremental lines of Dentin:



- Enamel
- Dentin
- Contour lines of Owen
- Pulp space
- Incremental lines of Von Ebner



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6) Interglobular Dentin

- It is a hypocalcified area seen in coronal circum-pulpal dentin immediately below mantle dentin
- These areas appear slightly dark in a ground section under transmitted light.
- Dentin calcification occurs in the form of globules.
- For failures of fusion of these globules into a homogenous mass result in the formation of interglobular dentin.
- They appear star-shaped with curved outline of adjacent globules.
- Dentinal tubules pass uninterruptedly through this area suggesting that it results from defect in mineralisation and not matrix deposition.

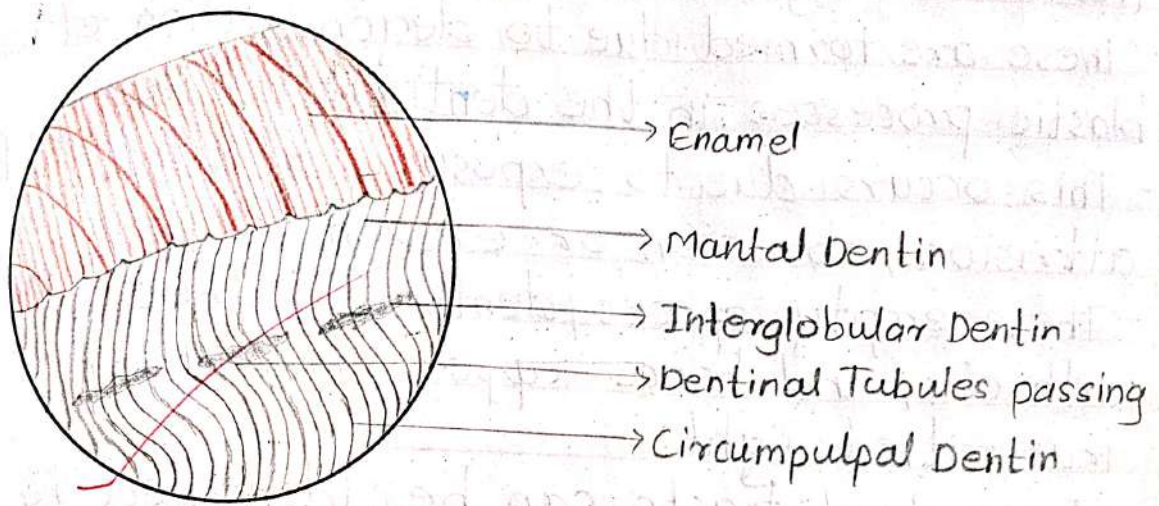
7) Granular Layer of Tomes.

- It is a structure seen only in radicular dentin adjacent to cementodentinal junction.
- This layer appears in a ground section as a dark granular structure, gradually increasing in thickness from CEJ till the apex.
- It is thought to be formed because of looping and coalescing of dentinal tubules near the dentinocemental junction.

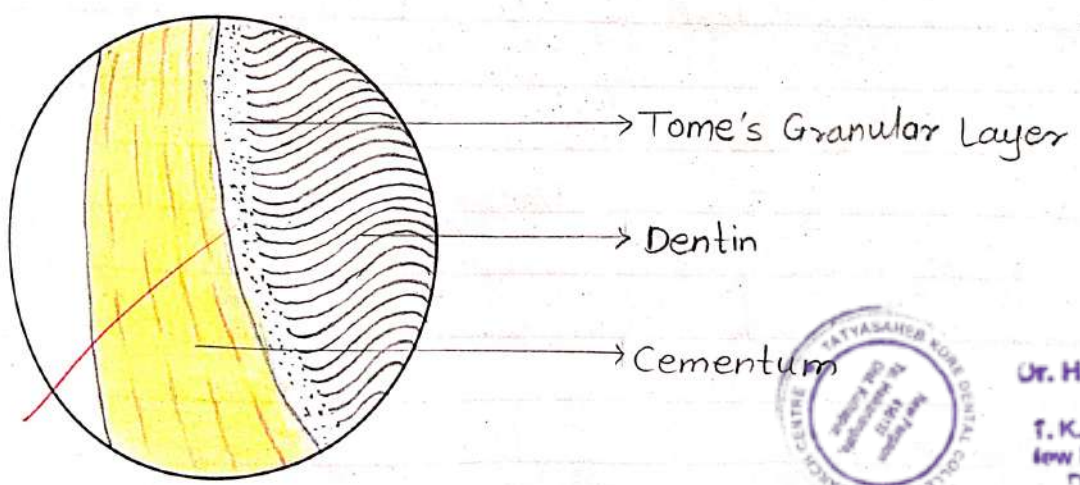


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6) Interglobular Dentin



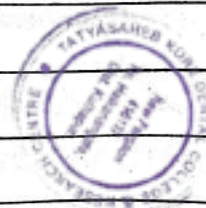
7) Granular Layer of Tome's



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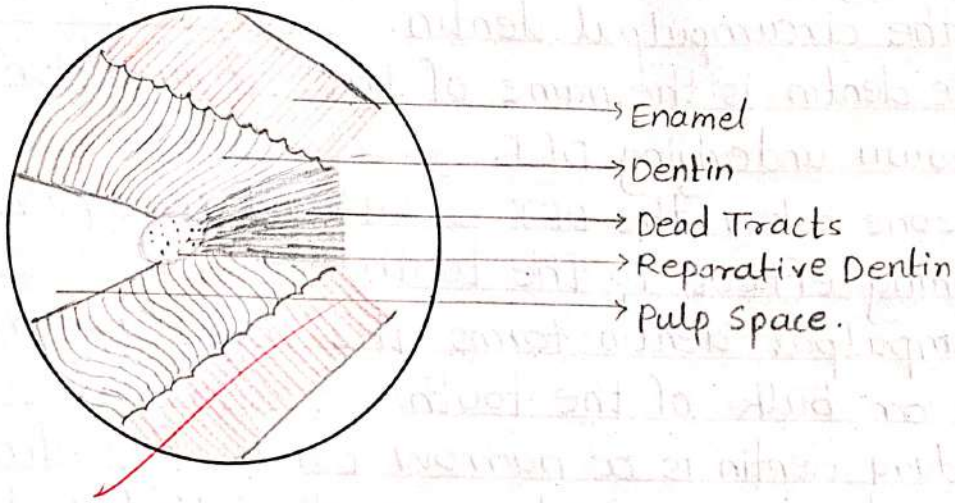
8) Dead Tracts

- These are the empty dentinal tubules those appear dark in ground section of dentin and transmitted light and white into reflected light.
- These are formed due to degeneration of odontoblastic processes in the dentinal tubules.
- This occurs due to exposure of dentin following attrition, abrasion or erosion.
- These empty spaces / dentinal tubules filled with air, and hence appear dark under transmitted light.
- True dead tracts can be identified by the presence of reparative dentin at their pulpal end.



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8) Dead Tracts



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9) Primary and Secondary Dentin

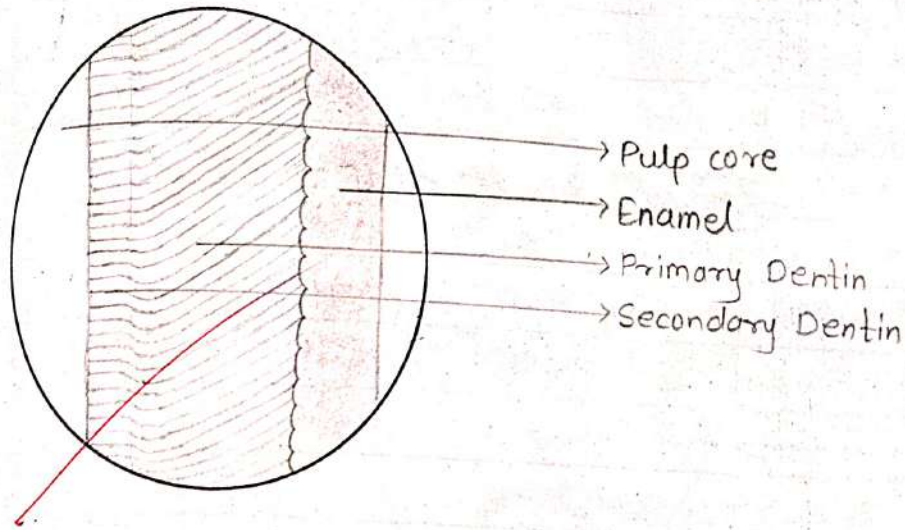
- Dentin that is formed before root completion is known as primary dentin.
- The primary dentin are of two types mantle dentin and the circumpulpal dentin.
- Mantle dentin is the name of first formed dentin in the crown underlying DEJ.
- This zone below the DEJ is soft and thus provides cushioning effect to the tooth.
- Circumpulpal dentin forms the remaining primary dentin or bulk of the tooth.
- Secondary dentin is a narrow band of dentin bordering the pulp and representing that dentin formed after the root completion.

10) Sclerotic Dentin

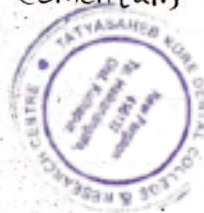
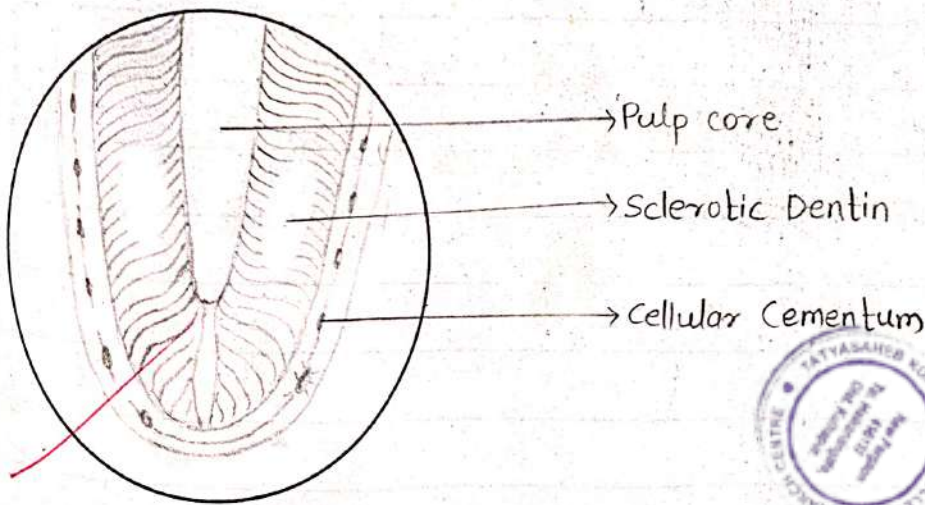
- Continuous deposition of intratubular dentin as a result of aging or in response to tooth wear or slowing progressing dental caries results in progressive reduction of lumen of dentinal tubules.
- If it continues, it may obliterate dentinal tubules.
- This dentin with obliterated tubules is called as sclerotic dentin.
- When this dentin deposition obliterates many tubules in adjacent area, the dentin assumes glassy or transparent appearance.

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9) Primary & Secondary Dentin

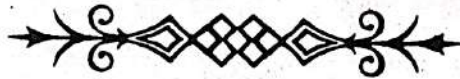


10) Sclerotic Dentin



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Study of Pulp



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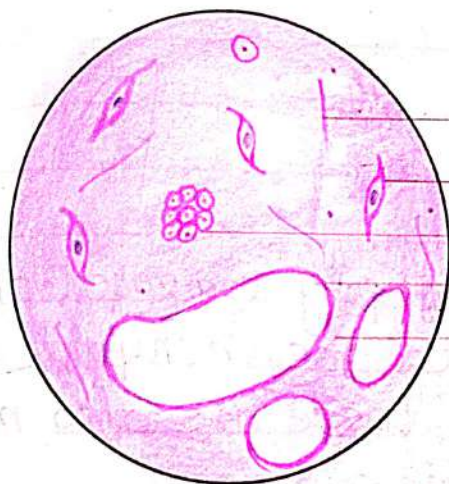
1) Pulp at Centre

- Central region of the both coronal pulp and radicular pulp contain huge nerve trunk and blood vessels.
- It is the also contain fibroblast, undifferentiated mesenchymal cell, nerve fibers and collagen fibers.
- Fibroblast are the most numerous cell type in the pulp. They form collagen fibers and ground substance. They have typical stellate shaped extensive process that connect and joined by inter-radicular junction to the process of other fibroblast.
- Undifferentiated mesenchymal cells are the primary cell in very young pulp. They appear larger than fibroblast & polyhedral in shape with peripheral process and large oval nuclei.
- Collagen fibers exhibit typical cross striation at 64 nm or more, main type of collagen fiber in pulp is type I, type II is also present.



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1) Pulp at Centre



- Collagen fibre
- Fibroblast
- Undifferentiated Mesenchymal Cell
- Blood vessels
- Pulp Core



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2) Pulp at Periphery

- Peripherally the pulp is circumscribed by the specific odontogenic region.

1) The odontoblast

2) The cell free zone

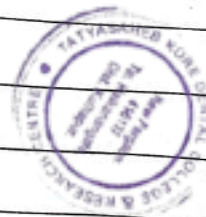
3) The cell rich zone

- The cell zone is layer principally composed of fibroblast and undifferentiated mesenchymal cells

- During early dentinogenesis these are also many young collagen fibers in this zone.

- The cell free zone in space which the odontoblast may be pulpward moved and layer to limited extent to junctional tooth.

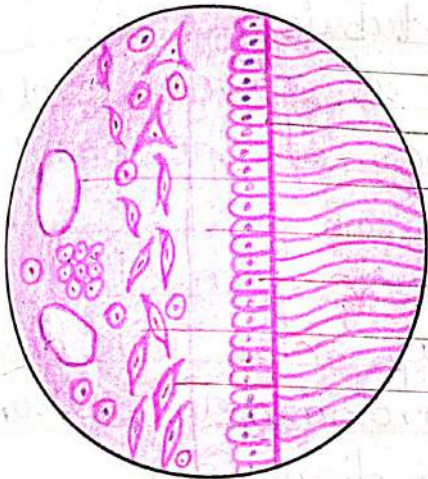
- That is why the zone is unconspeuous during early stage of rapid dentinogenesis. Odontoblast migration would be greater at that time.



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2) Pulp at Periphery



- Dentin
- Predentin
- Blood vessel
- Cell free Zone
- Odontoblastic zone
- Cell rich zone
- Fibroblast



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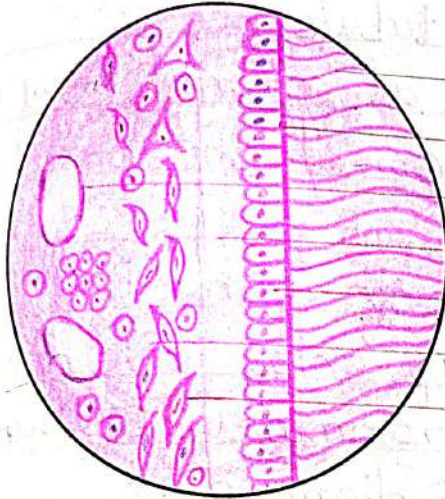
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2) Pulp at Periphery



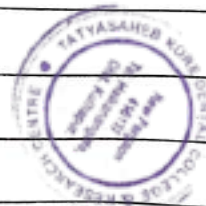
- Dentin
- Preditin
- Blood vessel
- Cell free Zone
- Odontoblastic zone
- Cell rich zone
- Fibroblast



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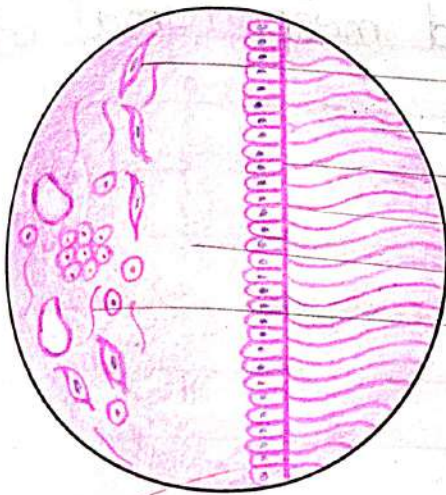
3) Odontoblast at Coronal Level

- Odontoblast are second most abundant cell bodies in the pulp beside adjacent to one another predentin and well process in dentinal tubule.
- Odontoblast appear columnar at coronal level with large oval nuclei which extends till the basal part of the cell.
- Cells are arranged very close to each other between the odontoblastic gap exist tight desmosomal junction. These are approximately 3-7 μm in diameter & 20-30 μm in diameter.



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3) Odontoblast at Coronal Level



- Fibroblast
- Dentin
- Predentin
- Odontoblastic Zone
- Cell Free Zone
- Cell Rich Zone



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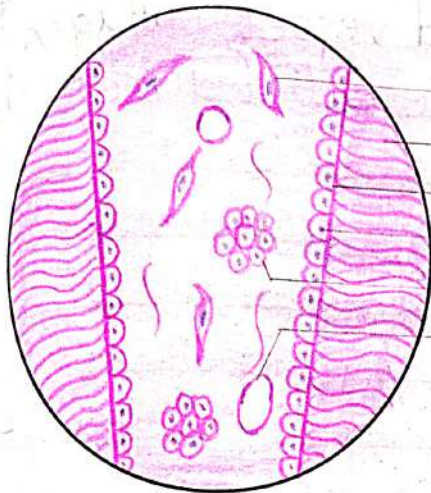
4) Odontoblast at Middle Level

Odontoblast at middle level of the pulp appear cuboidal with circular nuclei collagen fiber and fibroblast and undifferentiated mesenchymal cell are also present.



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4) Odontoblast at Middle level



- Fibroblast
- Dentin
- Predentin
- Odontoblastic Zone
- Undifferentiated Mesenchymal Cells
- Blood Vessel



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5) Odontoblast at Apical Level

- At apical level, odontoblast appear to be flattened
- The nuclei are flat odontoblast appear more like odontoblast appear blood vessel, collagen fibers, fibroblast and undifferentiated mesenchymal cells are also present.



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5) Odontoblast at Apical Level



- Fibroblast
- Dentin
- Predentin
- Odontoblastic Zone
- Blood Vessel



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e) Defence Cells of Pulp

A) Macrophages and Histocyte:

- Phagocytosis of foreign body in the junction
- They are dense irregularly bodies during inflammation they show granules and vascular in cytoplasm

B) Mast Cell

- Large, round or oval cell cytoplasm show dense granules.

C) Plasma Cells

- They are mature lymphocyte and have last their division. Their arrangement of chromatic in nucleus gives it's cost wheel like appearance.

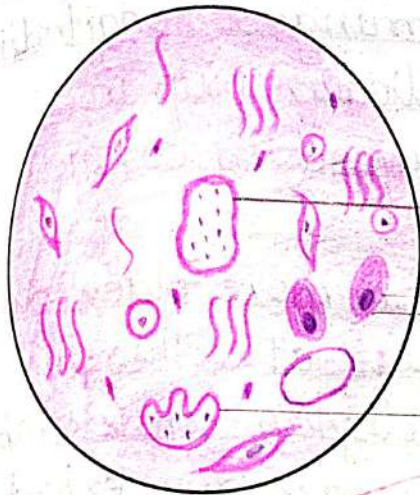
D) Lymphocyte and Eosinophils

- They are termed intravascularly in normal pulp they are members in normal pulp.



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Defence Cells



→ Macrophage

→ Plasma Cell

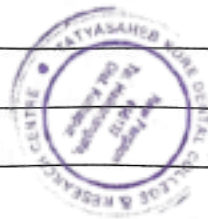
→ Mast Cell



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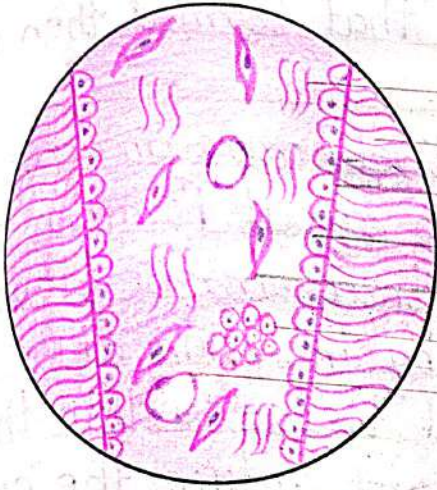
7) Pulp Fibrosis

- In the aging pulp accumulation of diffused fibrillar component of wall as well as bodies of collagen fibers may appear arranged longitudinal section in bundle in the radicular pulp in a random more diffused arranged in coronal pulp area.
- This condition is variable with more older pulp shows surprisingly small amount of collagen accumulation whereas other display considerably.
- The increase in fiber in pulp organ any extent trauma such as dental carries or deep restoration unusually cause a localised fibrosis as scarring effect.
- Collagen increase in notched in the medial and adventitial layer and blood vessel as the increase in collagen fibers may be more apparent that actual being attributory to decrease pulp size which makes the fibers present occupy less space and hence they become more concentrated without total volume.



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1) Pulp Fibrosis



- Collagen Fibres
- Dentin
- Predentin
- Odontoblast
- Fibroblast
- Undifferentiated Mesenchymal Cells
- Blood Vessel



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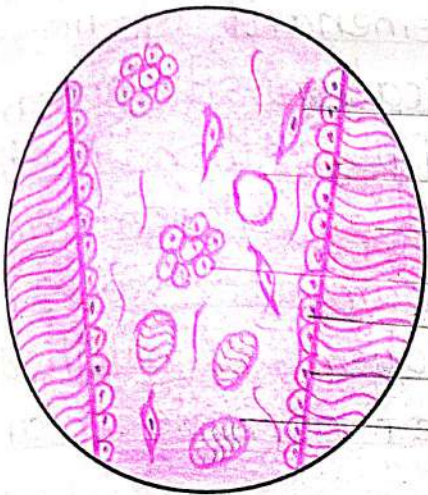
8) True Pulp Stone

- True denticles are similar in structure to dentin in that they have dentinal tubule and contain the process of odontoblast that termed them and that exist on there surface.
- True denticles are comparatively rare and are usually located their close to apical foramen at theory has been advanced that are developed of true denticles is caused by inclusion of remenant of the epithelial tissue within the pulp. These epithelial remenant induce the cells of pulp to differentiated into odontoblast which they term dentinal masses called true pulp stone



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8) True Pulp Stone



- Fibroblast
- Blood Vessel
- Dentin
- Undifferentiated Mesenchymal Cells
- Odontoblast
- Predentin
- True Pulp Stone



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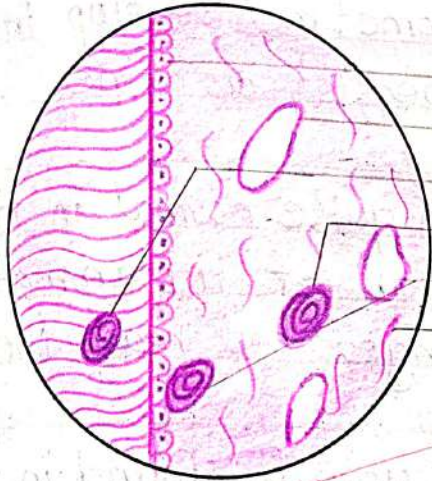
g) False Pulp Stone

- False denticles do not exhibit dentinal tubule but appears instead as concentric layer of calcified tissue, there is remnant of necrosis.
- In some case this calcification site appear within a bundle of collagen fiber other time they occur in location in pulp free of collagen accumulate some fibers false stone arises among vessel. In the center of these concentric layers of calcified tissue there is remnants of necrotic calcified cells.
- Calcified of thrombi in blood vessel called phleboliths.
- May serve as false denticles being as small nodules but increase in size by incremental growth of these surfaces.
- The surrounding pulp tissue may occur quite normal pulp stone may eventually till substantial part of pulp stone may be classified depending on their relation to the dentin of teeth as free embedded or as attached.



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g) False Pulp Stone



- Odontoblast
- Blood Vessel
- Embedded Pulp Stone
- Free Pulp Stone
- Attached Pulp Stone
- Collagen Fibre



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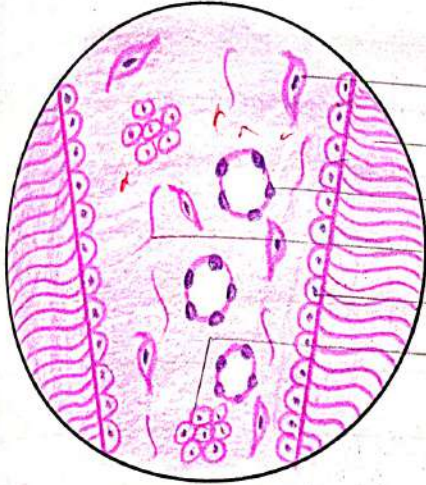
10) Diffused Calcification

- It appear or irregular calcification deposit in pulp tissue usually following collagenous fibers bundles as blood vessels sometime develop into layers masses but usually persist as fine calcification spicules.
- The pulp organ may appear quite normal in its coronal portion without sign of inflammation or other pathological changes but may these calcification in true root.
- Diffused calcification are usually found in the coronal area whereas denticle are seen more frequently in the coronal pulp. Diffused calcification surround blood vessel. May calcification surround blood vessel. May calcification as dystrophic calcification.

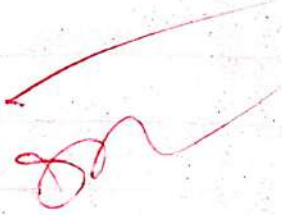


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10) Diffused Calcification

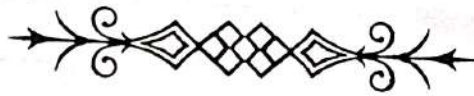


- Fibroblast
- Dentin
- Diffused Calcification
- Collagen Fibre
- Odontoblast
- Undifferentiated Mesenchymal Cells



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Study of Cementum



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1) Acellular Cementum

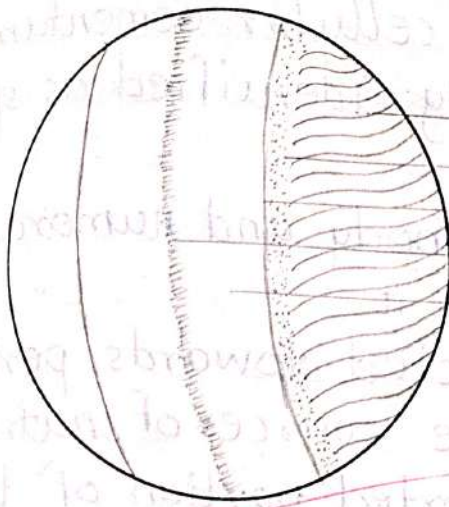
- Acellular cementum is the type of cementum that do not contain any cells.
- In a ground section under transmitted light acellular cementum is seen as structureless layer.
- Incremental lines of cementum referred to as lines of Salter are seen as dark lines parallel to root surface representing rhythmic deposition of cementum.
- Sharpey's fibres are not distinct because they are fully mineralised.
- Acellular cementum is generally located at cervical $2/3^{\text{rd}}$ of root.



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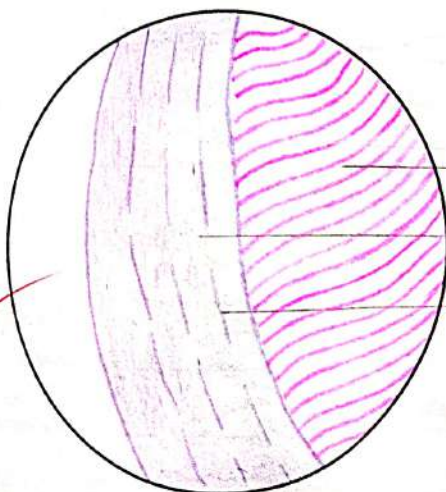
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Acellular Cementum (Ground Section)



- Dentin
- Tomes Granules
- Hyaline layer of Hopewell and Smith
- Incremental lines of Salter
- Cementum

Acellular Cementum (Decalcified section)



- Dentin
- Acellular Cementum
- Incremental Lines of Salter



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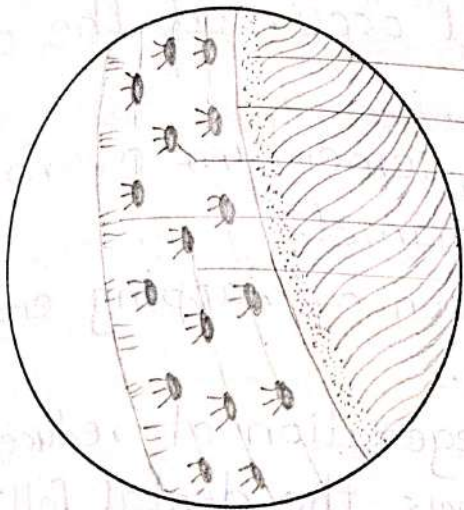
2) Cellular Cementum

- Cellular cementum is the cementum in which cementocytes are entrapped.
- In a ground section of cellular cementum cementocytes can be easily identified as spider shaped cells.
- These cells have a cell body and numerous canaliculi radiating from it.
- The canaliculi are directed towards periodontal ligament which is the source of nutrition.
- Sharpey's fibers are inserted portion of the periodontal ligament and are seen as faint black lines of an angle to the root surface.
- It is located at apical one third of roots and furcation areas of multirrooted teeth.



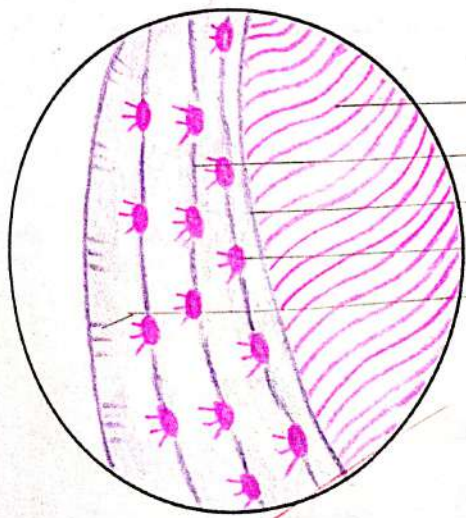
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Cellular Cementum (Ground Section)



- Tomes Granular Layer
- Hyaline Layer of Hopewell & Smith
- Cementocytes
- Sharpey's Fibres
- Incremental lines of Salter

Cellular Cementum (Decalcified Section)



- Dentin
- Incremental Lines of Salter
- Hyaline Layer of Hopewell & Smith
- Cementocytes
- Sharpey's Fibres



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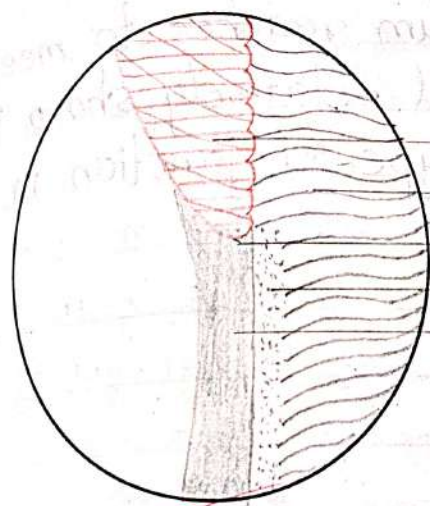
3) Cemento-enamel junction - Overlap type

- Cementoenamel junction is the junction between enamel and cementum that occur at the cervical region of tooth.
- In this type of junction, cementum overlaps the cervical region of enamel.
- The type of cementum seen overlapping enamel is acellular afibrillar cementum.
- This occurs due to early degeneration of reduced enamel epithelium which allows the dental follicle cells to come in contact with newly formed enamel.
- Then these cells differentiate into cementoblasts and lay down cementum.
- This type of junction is seen in 60% of teeth.



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Cemento-enamel junction - Overlap Type



- Enamel
- Dentin
- Cemento-enamel Junction - overlap type
- Tomes Granules
- Cementum



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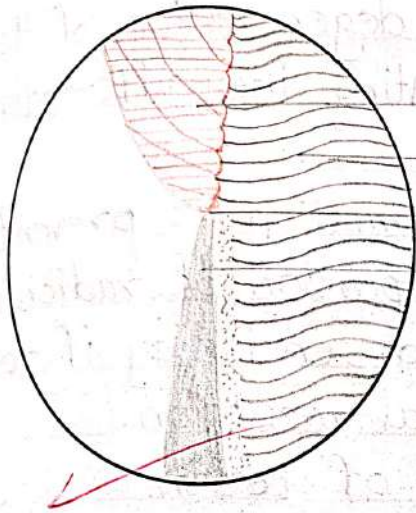
4) Cemento-enamel Junction - Sharp type

- The relation between cementum and enamel at cervical region of tooth is variable.
- In 30% of teeth cementum reaches to meet the cervical line of enamel relatively sharp line
- It is most commonest type of junction in deciduous teeth.



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Cemento-enamel junction - Sharp type



> Enamel

> Dentin

> Cemento-Enamel Junction: Sharpe Type

> Cementum



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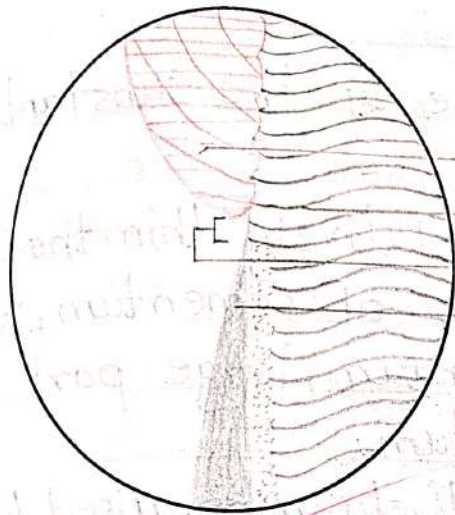
5) Cemento-enamel Junction - Gap Type

-
- In this type, there is no junction, instead a zone of root devoid of cementum is seen
- This occurs due to delayed degeneration of Hertwig's epithelial root sheath preventing the differentiation of cementoblasts.
- And therefore cementum formation is prevented
- In this type of junction a portion of radicular dentin is exposed causing a sensitivity if root is exposed due to gingival recession.
- This type is seen in 15% of teeth.



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Cemento-Enamel junction - Gap type



- > Enamel
- > Dentin
- > Cemento-enamel junction; Gap Type
- > Cementum



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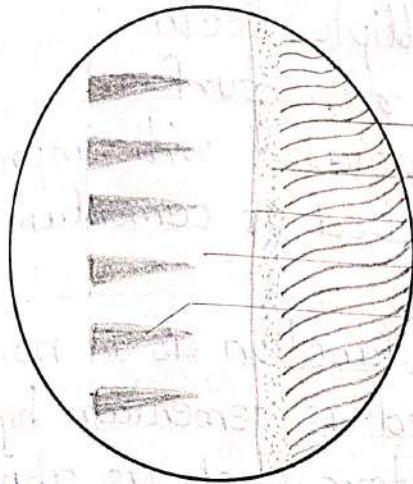
6) Sharpey's Fibers

- The principal fibers of periodontal ligament which are inserted into the cementum or bone are known as Sharpey's fibers.
- The Sharpey's fibers make up the substantial portion
- When cementum remains relatively thin the Sharpey's fibers cross entire thickness of cementum, with further deposition of cementum, large part of fibers incorporated cementum.
- Cementum surface with actively mineralised fronts have numerous small openings.
- The opening represents the mineralised area of fibers.



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Sharpey's Fibres



- Dentin
- Tomes Granules
- Hyaline layer of Hopewell & Smith
- Cementum
- Sharpey's Fibers



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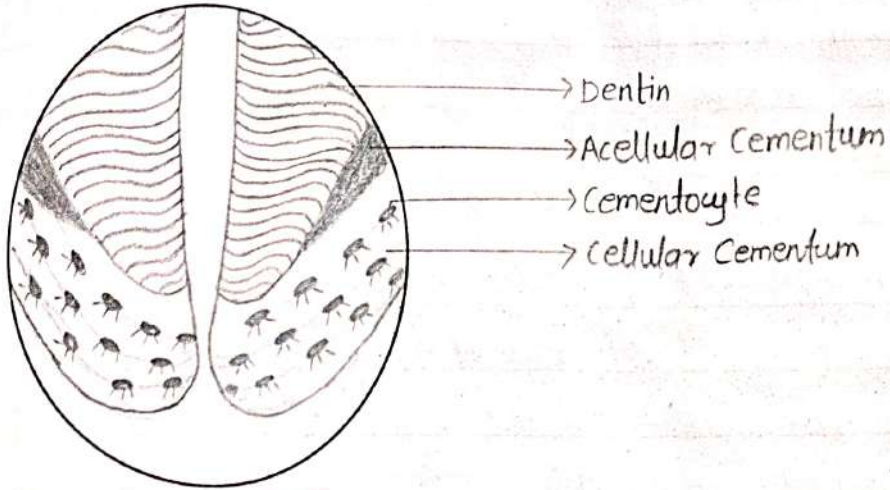
7) Hypercementosis

- Deposition of excessive amount of 2° cementum on root surface is called as hypercementosis.
- It may involve single/multiple teeth.
- It may be at apex or at root surface.
- If hypercementosis is associated with improved functional quality, it is called as cementum hypertrophy.
- If it is not related to function as in non-functional tooth, it is called as cementum hyperplasia.
- It occurs due to local factors such as abnormal occlusal trauma, chronic periapical inflammation and unopposed teeth.



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Hyper Cementosis



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Study of Periodontal Ligament



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1. Principal fibers of PDL

Principal fibers of PDL have been categorised into five groups-

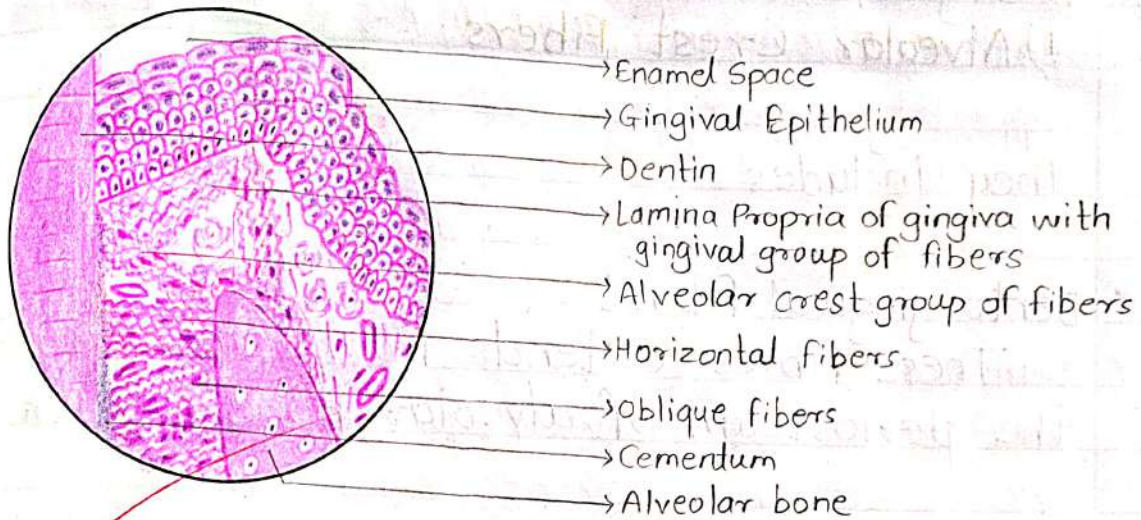
- 1) Alveolar crest fibres
- 2) Horizontal fibers
- 3) Oblique fibers
- 4) Apical fibers
- 5) Interradicular fibers

- Alveolar crest fibres extends from the crest of the alveolar bone obliquely, attaching to the cementum immediately below dentogingival junction.
- Horizontal fibres are located just below the alveolar crest fibres and extends horizontally.
- Oblique fibres extend in an oblique direction from above coronary and cementum apically.
- Apical fibres are arranged radially around the apical ends of roots.
- Interradicular fibres are seen only in multi-erupted teeth. They extends radially from crest of curvature alveolar bone between the roots of multirooted teeth.



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Principal fibers of PDL



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2. Gingival Group of fibres

- These group of fibres are accessory fibres to the periodontal ligament. They play an important role in maintaining integrity of supporting apparatus.

They includes

- Dento-gingival fibres-

These fibres extends from cementum to the periosteum of alveolar bone.

- Alveolo-gingival fibres

These fibres extends from crest of alveolar bone to the lamina propria of gingiva

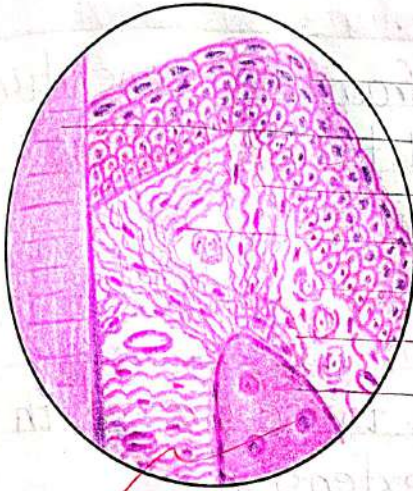
- Circular fibres

These fibres are arranged in gingival connective tissue, encircling the neck of tooth maintaining a tightly fitting gingival collar, also known as marginal ligament.



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Gingival Group of Fibres



→ Gingiva

→ Tooth

→ Alveologingival fibers

→ Dentogingival fibers

→ Circular fibers

→ Dentoperiosteal fibers

→ Alveolar bone



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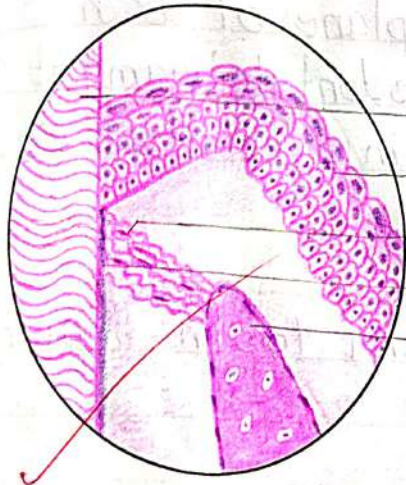
3. Alveolar Crest fibers

- Alveolar crest group of fibres extends obliquely from the cementum just beneath the junctional epithelium to alveolar crest.
 - The fibres are also seen from the cementum over the alveolar crest and to the fibrous layer of periosteum covering bone.
- Function
- Alveolar crest fibers help to secure tooth in the socket and prevents extension.



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Alveolar Crest fibers



→ Dentin

→ Gingival Epithelium

→ Alveolar Crest fibers

→ Cementum

→ Alveolar bone



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4. Horizontal Group of Fibers

- These fibers run at right angle to long axis tooth from cementum of alveolar bone and roughly parallel to occlusal plane of arch
- These bundles of the periodontal ligament space to become arrested in alveolar process.

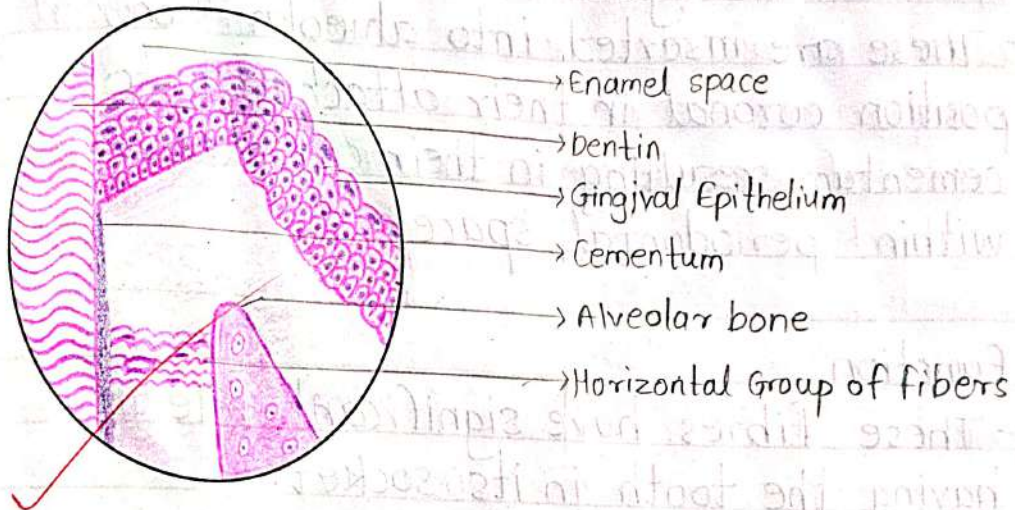
• Function

- These fibres help to resist tooth displacement against lateral pressure.



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Horizontal Group of Fibers



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5. Oblique Group of Fibers

- Oblique fibres are the most numerous nearly $\frac{2}{3}^{rd}$ of the ligament.
- These are inserted into alveolar bone at position coronal in their attachment to cementum resulting in their orientation within periodontal space.

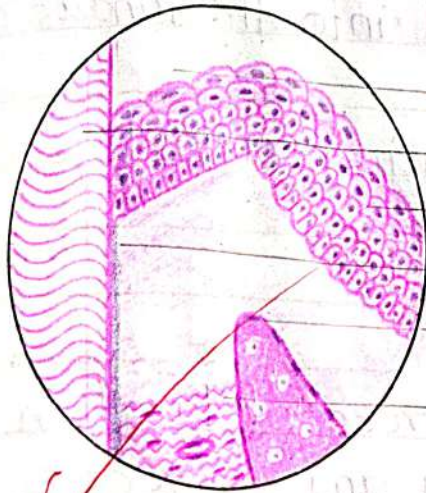
• Function

- These fibres have significant role in having the tooth in its socket.



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Oblique Group of fibers



→ Enamel Space

→ Dentin

→ Gingival Epithelium

→ Cementum

→ Alveolar bone

→ Oblique Group of Fibers



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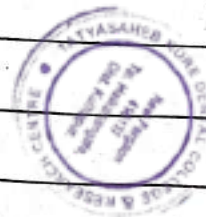
6. Apical Group of Fibers

- From the cementum at root tip fibres of the apical bundles radiates through the periodontal space to become anchored into the fundus of bony socket.

- These fibers are not seen in incompletely formed root.

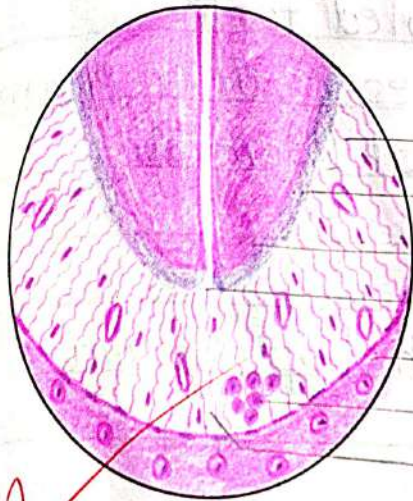
• Functions

Apical fibres resist the forces of laxation may prevent tooth tipping and protect delicate blood vessels and nerves and lymph vessels.



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Apical Group of Fibers



- Oblique group of fibers
- Cementum
- Root apex
- Apical foramen
- Alveolar socket
- Cell rests of Malassez
- Apical fibers of PDL



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7. Inter-radicular group of fibers

- These principal fibres of this group are inserted the cementum from crest of inter-radicular septum in multirrooted teeth.
- Total loss of these fibres occur in chronic inflammation in periodontal ligament.

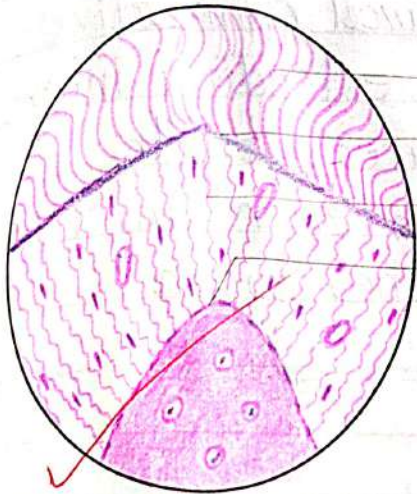
- Function

- These fibres resist tooth tipping and laxation.



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Inter-radicular group of fibers



→ Dentin

→ Cementum

→ Inter-radicular group of fibers

→ Alveolar bone



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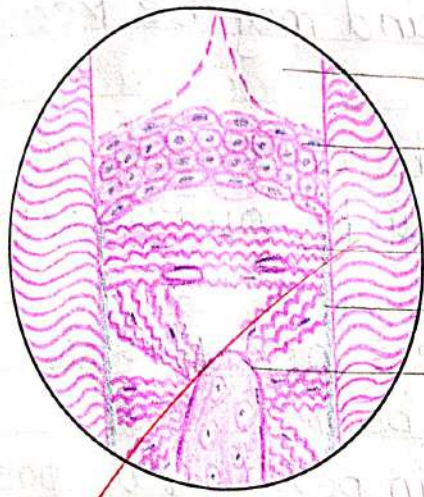
8. Trans-septal fibers

- Trans-septal fibres are also called as inter-dental ligament.
- They are formed in gingival connective tissue as accessory fibres extending interproximally between 2 adjacent teeth.
- These fibres extends from cementum of one tooth to cementum of other tooth.



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Trans-septal fibers



→ Enamel space

→ Interdental gingiva

→ Trans-septal fibers

→ Cementum

→ Alveolar bone



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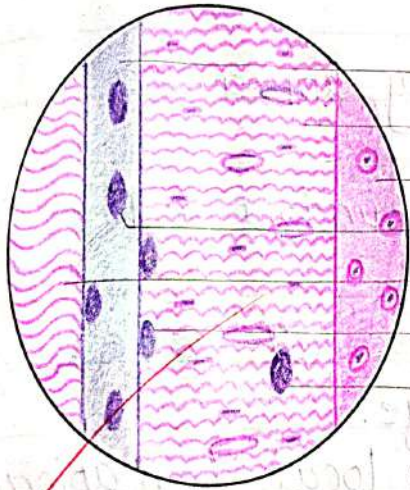
9. Cementicles

- Cementicles are calcified body sometimes found in periodontal space.
- These bodies are seen and may be free in connective tissue.
- They may fuse with each other to form huge masses or they may be joined with cementum.
- As the cementum thickness increases, it encircles these calcified bodies.
- They may be lying free in periodontal space or attached to connective or embedded in cementum.
- When the cementicles are firmly adherent to the cementum they form excrementosis.



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Cementicles



- Cementum
- Periodontal ligament
- Alveolar bone
- Embedded cementicle
- Dentin
- Attached cementicle
- Free cementicle



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10. Epithelial Cell rests of Malassez

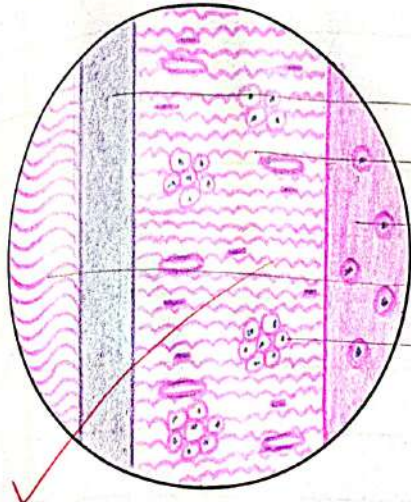
- The periodontal ligament contains the epithelial cells that are fixed close to cementum.
- The cross section, they appears as cluster like.
- These cells rests are abundant in furcation areas.
- The distribution of these cells varies according the site and age.
- At first they are mostly located in apical region later they are located cervically in gingiva above the cementum.

~~8/12/20~~



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Epithelial cell rests of Malassez

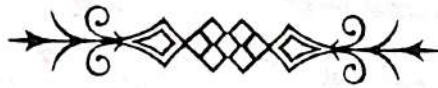


- Cementum
- Periodontal ligament
- Alveolar bone
- Dentin
- Cell rests of Malassez



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Study of Bone



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1. Transverse section of compact bone

- Mature or adult bone whether compact or cancellar are histologically identical within consist of microscopic layer of lamella.
- The 3 distinct layer are recognised

① Circumferential lamellae

- Enclose the entire adult bone and form outer and inner perimeter.

② Concentric lamellae

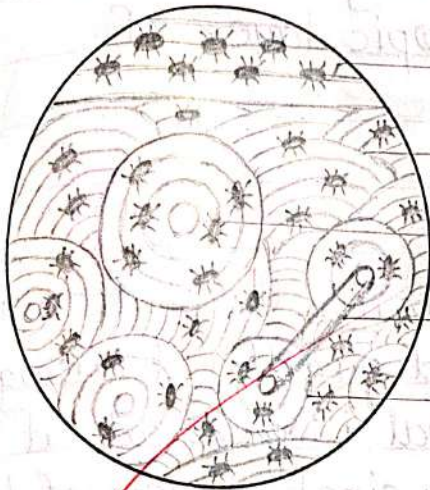
- Make up of compact bone and form basic metabolic unit of bone the osteon or haversial system.

③ Interstitial lamellae

- They are interspread between adjacent concentric lamellae and fill the space between them. They actually fragments of pre-existing concentric lamellae from osteon created during reassembling can take a multiple of shapes.



Transverse Section of compact bone



→ External circumferential Lamellae

→ Interstitial Lamellae

→ Osteon

→ Volkmann's Canal

→ Internal circumferential Lamellae



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2. Longitudinal section of compact bone

Mature or adult bone whether cancellous or compact bone are histologically identical in that they consist of microscopic layer of lamella.

① Circumferential lamella

Encloses the entire adult bone. The osteon is cylindrical generally oriented parallel to long axis of bone. Haversian canal is present at the centre where lined by single layer of bone cells that the surface such bone houses a capillary adjacent to the haversian system and interconnected by Volkmann's canal.

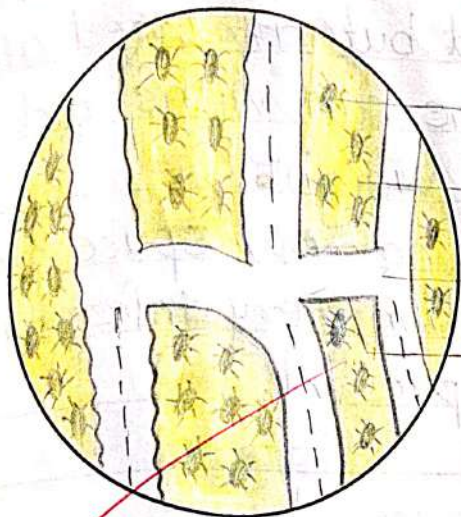
② Interstitial lamellae

These are interspread between adjacent concentric lamellae and fills the space between adjacent concentric lamellae. These are actually fragments of the pre-existing concentric lamella from often created during remodeling that can multiply of shapes.



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Longitudinal Section of compact bone



- lacunae
- lamellae
- Haversian canal
- Volkmann's canal

Osteoplast

There are the cells responsible for bone formation. They secrete collagen type I as well as collagenous matrix of bone. After losing this formation part of interstitial in lacunae of bone are called osteocytes.



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3. Trabecular Bone

Here, individual lamella appoid to each from trabeculae (50 μm thick). These trabecular are not randomly arranged but arranged along lines of stress than bone can withstand for a without increase in weight.

Trabeculae surrounds narrow space from which they recieve nutrition very infrequently Haversian canal may be present.

4. Osteoblast

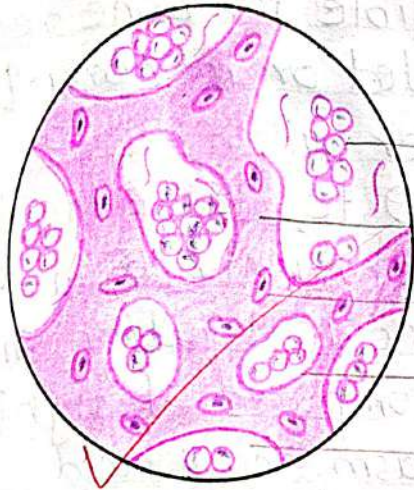
There are the cells responsible for bone formation. They secrete collagen Type-I fibres as well as collagenous matrix of bone.

After losing this formation they get interrupted in lacunae of bone and are called osteocyte.



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Trabecular Bone



→ Adipose cell

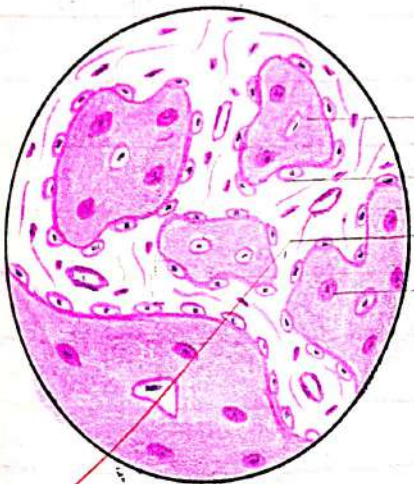
→ Lacunae

→ Lamellae

→ Bony Trabeculae

→ Marrow cavity

Osteoblast



→ Bony Trabeculae

→ Osteoblast

→ Bone marrow

→ Osteocyte



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5. Osteoclast

- There are cells responsible for bone resorption.
- They may be multinucleated or mononucleated.
- They are large in diameter with 15-20 clearly packed nucleus. Osteoclast line in resorption bone surface show striation or ruffled bone surface show striation with electron microscopically composed of tightly packed microvilli. Cytoplasm show acid phosphate contain vesicles and vacuoles which distinguish from another giant cell during bone resorption. First they will deprived and then degradation of osteoid matrix of proteolytic enzyme take place.



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osteoclast



→ osteoblast

→ osteoclast

→ osteocyte



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6. Periosteum

The outer aspect of compact bone is surrounded by condensed fibrous collagen layer. The periosteum has 2 layers - outer & inner. Outer layer is dense irregular connective tissue formed as fibrous layer. Inner near to the bone surface consisting of bone cells and their supply inner surface of compact bone and cancellous bone are covered by cellular layer called endosteum.

The periosteal and endosteal surface contact lamellae are arranged in parallel layer surrounding bony surface and are called circumferential lamellae.



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7. Resting and Reversal Line

A cement line of mineralised matrix. The haversian system lines contain little or no collagen is strongly basophilic because it contain highly glycoprotein and polyglycan.

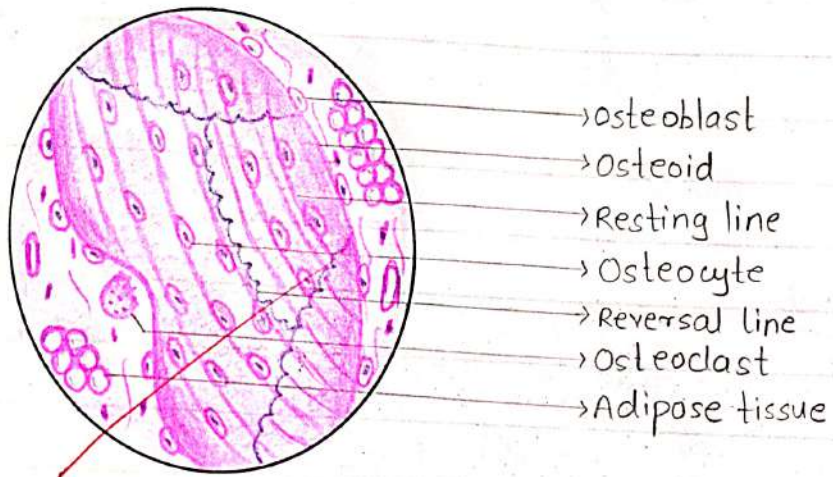
It makes limit or bone emulsion prior to the formation of osteon and hence known as reversal line. This line appears to be highly irregular formed by collapsed outline of the Howships lacunae. This line has to be distinguished from mere regular appearance of the resting line which denotes the period of rest during formation.

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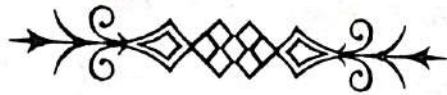
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Resting and Reversal line



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Study of Salivary Glands



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1. Serous Salivary Gland : Parotid Gland

- Serous salivary gland is composed of numerous serous secretory units called serous acini.
- Serous acinus is a collection of many serous cells.
- Serous cells are the secretory cells and are pyramidal in shape with a broad base resting on a basement membrane and a narrow apex facing towards the lumen.
- Nucleus is round and located at the basal one-third of the cell.
- Apical part of the cytoplasm is filled with zymogen granules and appears eosinophilic in a hematoxylin and eosin stained section.
- Serous cells are arranged to form an acinus.
- Serous acinus is round or circular in shape, has fewer cells and a small lumen.
- Salivary gland is divided into lobes by connective tissue septa that carry blood vessels.
- Intralobular and interlobular ducts are seen.



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Serous Salivary Gland : Parotid Gland



- Connective tissue septa dividing gland into lobes
- Intralobular ducts
- Interlobular ducts
- Serous acini



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2. Mucous Salivary Gland : Sublingual Gland

- Mucous salivary glands have numerous secretory units called mucous acini.
- These acini are collection of mucous cells.
- Mucous cells are columnar in shape with nucleus flattened and pressed against the basement membrane.
- Cytoplasm is restricted to basal region.
- Apical portion of the cell is filled with mucous secretory droplets and appear empty in H and E stained sections.
- Mucin can be stained positively using periodic acid-Schiff stain
- Mucous cells are arranged to form mucous acini that are ovoid or tubular with large lumen.
- In a histologic section along with acini intratubular ducts are also seen.
- Connective tissue ~~septa~~ is present between the acini that ~~shows~~ blood vessels and interlobular ~~ducts~~.

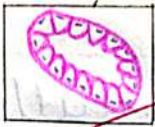


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Mucous Salivary Gland: Sublingual Gland



- Intralobular ducts
- Connective tissue septa dividing gland into lobes
- Interlobular duct
- Mucous acini

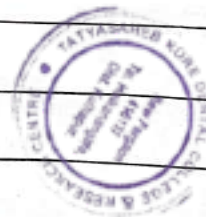


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3. Mixed Salivary Gland : Submandibular Gland

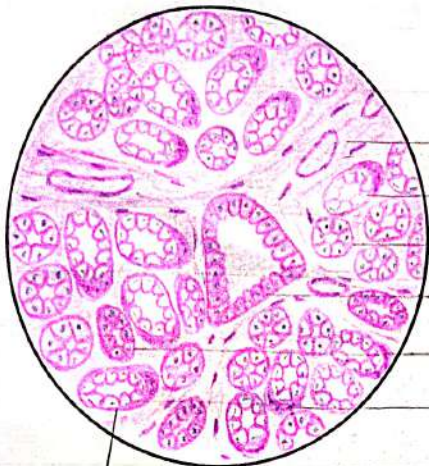
² In a mixed salivary gland both serous and mucous acini are seen.

- The number can vary depending on predominantly serous or mucous.
- Along with these acini, mixed acini are also seen having both serous and mucous cells.
- In a mixed acinus the basic secretory unit is a typical mucous acinus in a tubular shape.
- The blind end of this tubular structure is capped by a group of serous cells form a crescent-shaped structure.
- This crescent-shaped structure is called 'demilune of Gianuzzi'.
- Intralobular and interlobular ducts, connective tissue septa are also seen.

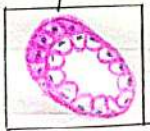


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Mixed Salivary Gland: Submandibular Gland

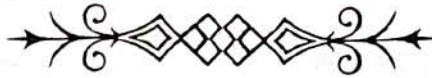


- Connective tissue septa dividing gland into lobes
- Mucous acini
- Serous acini
- Interlobular duct
- Intralobular duct
- Serous demilunes



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Study of Oral Mucous Membrane



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1. Gingiva :

- In histological section or portion,
- Gingiva has 2 portion : Epithelium & lamina propria
- Overlying epithelium is keratinised and stratified squamous with four distinct layer.
- First layer adjacent to basement membrane is stratum basale composed of single layer of cuboidal cells with nucleus arranged perpendicular to basement membrane.
- Stratum spinosum is composed of two layers of polyhedral cells.
- Next layer is stratum granulosum made up of few layers of flattened cells.
- Most superficial of many layers of flattened cells filled with ~~relation~~ Keratin called as stratum granulosum



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1. Gingiva



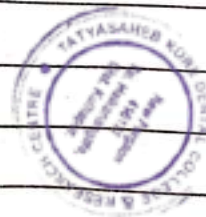
- Stratum corneum (Parakeratinised)
- Stratum Granulosum
- Stratum Spinosum
- Stratum Basale
- Long thin Rete ridges
- Lamina propria



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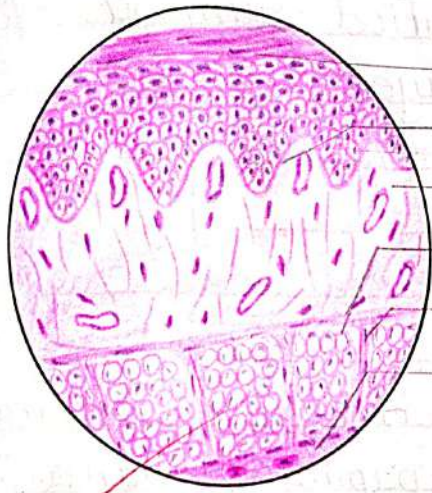
2. Anterolateral part of hard palate:

- Hard palate is lined by masticatory mucosa and therefore similar to gingiva
- It consists of keratinised stratified squamous epithelium with four distinct layers i.e. stratum basale, stratum spinosum, stratum granulosum, stratum corneum
- Epithelial ridges are long, regular, interdigitative with connective tissue.



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2. Anterolateral part of hard palate



- orthokeratinised stratified squamous epithelium
- Long regular rete ridges
- Lamina Propria
- Submucosa containing fat cells
- Vertical band of connective tissue
- Palatal bone with periosteum



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3. Posterolateral part of hard palate

- Glandular layer is similar to fatty zone with overlying keratinised stratified squamous epithelium having four distinct layers.

1) Stratum basale

2) Stratum spinosum

3) Stratum granulosum

4) Stratum corneum

- Rete ridges are long and irregular interdigitative with connective tissue papillae, lamina propria is dense and less thicker than anterior region than that region of palate.

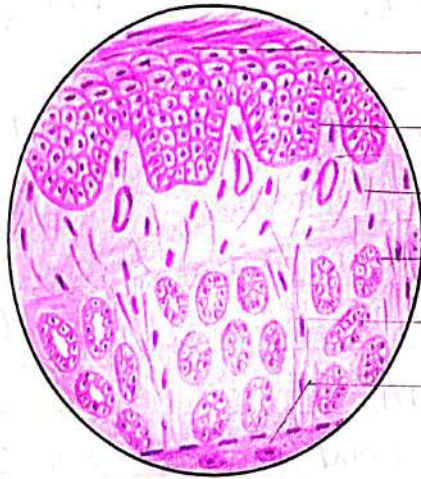
- Minor salivary glands are present.



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3. Posterolateral part of hard palate



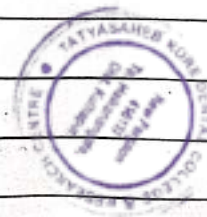
- orthokeratinized stratified squamous epithelium
- Long regular rete ridges
- Lamina Propria
- Submucosa containing minor salivary Gland.
- Vertical band of connective tissue.
- Palatal bone with periosteum



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4. Vermilion Zone

- This is transitional zone between skin lining outer surface of lip and labial mucosa lining inner aspect.
- The skin composed of keratinised stratified squamous epithelium with all appendages like hair follicle, sweat gland and serous glands.
- Labial mucosa is lined by non-keratinised stratified squamous epithelium.
- Connective tissue beneath show minor salivary glands.
- Central portion of lip is orbicularis oris muscle.
- Transitional zone has thin lining epithelium with the thin ~~non~~-keratinised surface.



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4. Vermilion Zone



- skin covering outer surface of lip
- Transitional zone covered by thin epithelium having long rete ridges
- Orbicularis oris muscle
- Minor salivary glands in submucosa of labial mucosa
- Labial mucosa covering inner aspect of lip.



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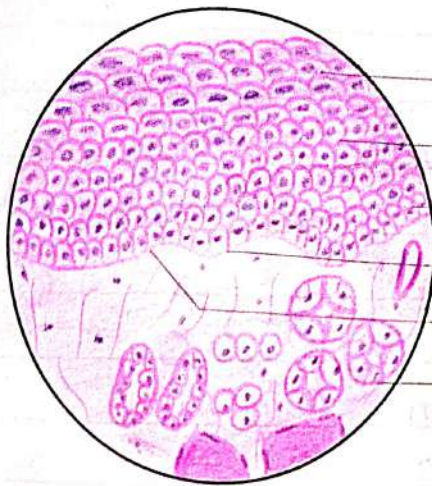
5. Labial Mucosa

- Epithelium of labial mucosa is stratified non-keratinised epithelium.
- Lamina propria consists of dense connective tissue and has short irregular papillae.
- Submucosa layer connects strands in dense ground collagen fibers.
- The dense connective tissue contain fat and small mixed salivory glands between the strands.



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5. Labial Mucosa



- Stratum superficiale
- Stratum intermedium
- Stratum basale
- Basement membrane
- Short irregular rete ridges
- Submucosa containing muscle, fat and salivary glands.



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6. Buccal Mucosa

It shows two parts

- 1) Overlying epithelium
- 2) Lamina propria

- Epithelium is thick and non-keratinised stratified squamous epithelium and has three layers:

- i) Stratum basale
- ii) Stratum intermedium
- iii) Stratum superficiate

- Stratum basale is composed of single layer of cuboidal cells arranged on basement membrane.

- Stratum superficiate is made up of flattened cells.

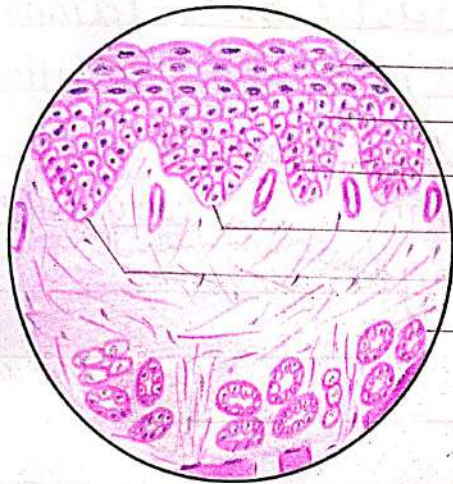
- Lamina propria is less and shows collagen cells.

- Fibroblast and blood vessels are seen.



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6. Buccal Mucosa



- stratum superficiale
- stratum intermedium
- stratum basale
- Basement membrane
- Short irregular rete ridges
- Submucosa containing muscle, fat cells and salivary gland



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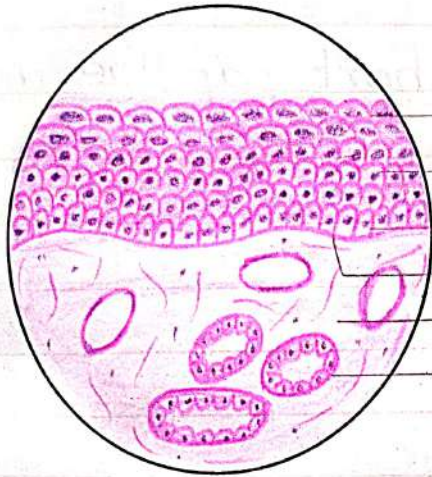
7. Soft Palate

- It is lined by thin non-keratinised squamous epithelium which may show taste buds, lamina propria is thick and shows numerous papillae, taste buds.
- Submucosa contains many minor salivary glands.
- Epithelium consist of 3 layers
 - 1) Stratum basale
 - 2) Stratum intermedium
 - 3) Stratum superficiale
- Stratum basale is composed of single layer of cuboidal cell arranged on basement membrane.
- Above thin basale layer of polyhedral cell is present.
- Stratum superficiale is made from flattened cell.
- Lamina propria is less dense shows collagen fibers, fibroblast and blood vessels.



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7. Soft palate



- Stratum superficiale
- Stratum intermedium
- Stratum basale
- Basement membrane
- Lamina Propria
- Minor Salivary Gland



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8. Floor of Mouth

- It is lined by very thin non-keratinised epithelium
- Lamina propria shows short papillae and it is rich in ~~non~~-vascular supply.
- Submucosa has loose fibrous tissue.



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8. Floor of Mouth

Salivary Glands



- Non-keratinized epithelium
- Glandular duct
- Fat cell
- Lamina Propria
- Minor Salivary Gland.



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9. Filiform papillae

- Filiform papillae are seen on lateral half side thread like projections on dorsal surface of tongue.
- This cone shaped structure lined by stratified squamous epithelium with thick keratin on the surface.
- These are not concerned with any taste as it does not contain any taste bud.



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9. Filiform Papillae



→ Filiform papillae lined by
Keratinized epithelium

→ Connective tissue core of papilla

→ Submucosa containing muscles



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10. Fungiform papillae



→ Taste bud

→ Fungiform papilla lined by non-keratinized epithelium

→ Filiform papilla

→ Connective tissue

→ Submucosa containing muscles



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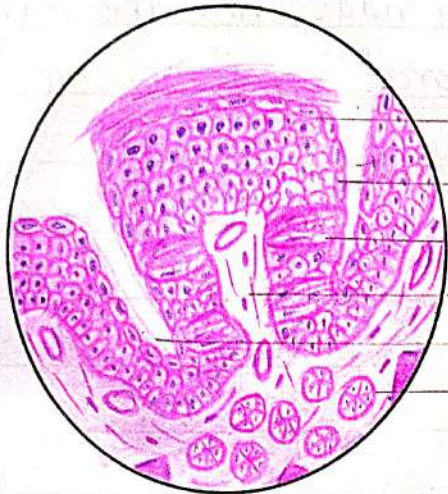
11. Circumvallate Papillae

- These are seen on anterior $2/3^{\text{rd}}$ of the tongue just anterior to sulcus terminalis.
- These are 10-12 in number.
- Superficial layer of these papillae is at the level of surface of tongue and V-shaped sulcus present all around the papillae.
- Lining the epithelium on superficial layer by ~~by~~ non-keratinized on lateral surface of papillae.
- Taste buds are seen on lateral surface.
- The characteristic feature of these papillae are presence of minor salivary gland in connective tissue which are named as von-Ebner salivary gland.
- Circumvallate papillae are concerned with bitter taste.



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11. Circumvallate papillae



- Keratinized stratified squamous epithelium
- Non-keratinized epithelium lining lateral wall
- Taste bud
- Connective tissue core
- V-shaped trough around the papillae
- Von Ebner's salivary gland



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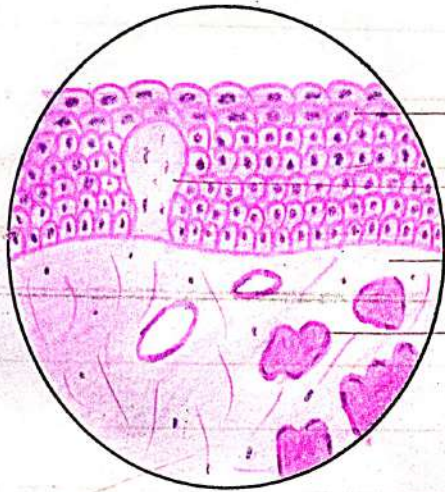
12. Foliate Papillae

- foliate papillae are 4-20 in number and are long consisting vertical groove & ridges near the margin.
- They are situated on lateral surface of tongue in front of sulcus terminalis.
- They are concerned with sour taste.



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12. Foliate Papillae



- Non-keratinized stratified squamous epithelium
- Taste bud
- Lamina Propria
- Muscle

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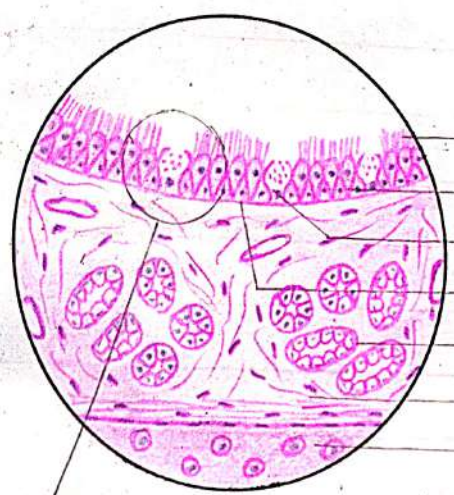
• Histology of maxillary sinus

- Maxillary sinus is lined by pseudostratified ciliated columnar epithelium.
- This epithelium layer is mainly composed of ciliated columnar cells. Along with these, there are non-ciliated columnar cells, basal cells and goblet cells.
- Goblet cells are unicellular secretory organ which are goblet-shaped with a basally placed nucleus and apical cytoplasm filled with secretory products.
- In H&E stained section, cytoplasm of goblet cells appears empty.
- Cilia of the lining epithelium help to move the secretions.
- This epithelium is separated from subepithelial connective tissue by a basal lamina.
- Subepithelial connective tissue layer has collagen fibers and fibroblasts and also minor salivary glands. which include both serous and mucous glands. This layer is attached to the periosteum of the bone of the maxilla.



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Histology of Maxillary Sinus



- Cilia
- Pseudostratified ciliated columnar epithelium
- Goblet cell
- Basal lamina
- Minor salivary gland
- Connective tissue
- Bone



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