Oral Biology
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Lecture - 04
Tooth and it's Supporting Structures - Part 2

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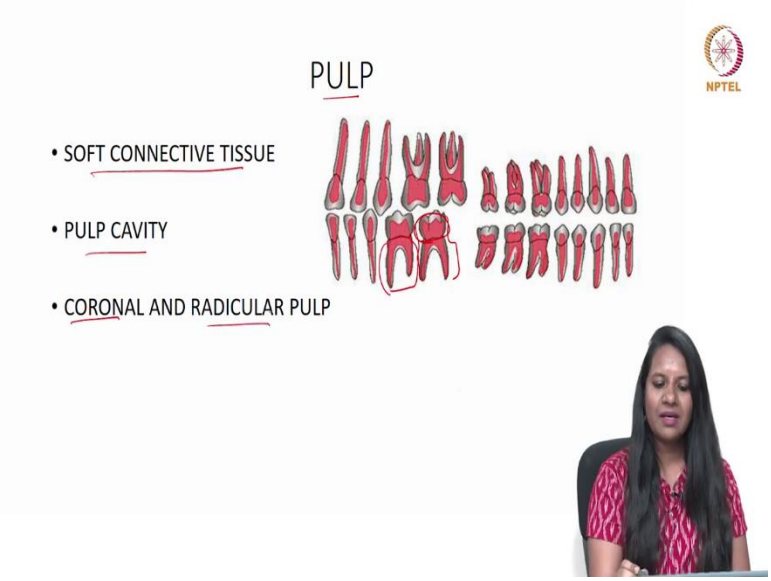

So, moving to the next structure of tooth that is pulp; pulp is a soft connective tissue and it is present within the pulp cavity & the rigid confinement of pulp within the hard structure makes the tissue very unique. And the one which is present in the crown area is known as coronal and the one which is present in the root is known as radicular pulp.

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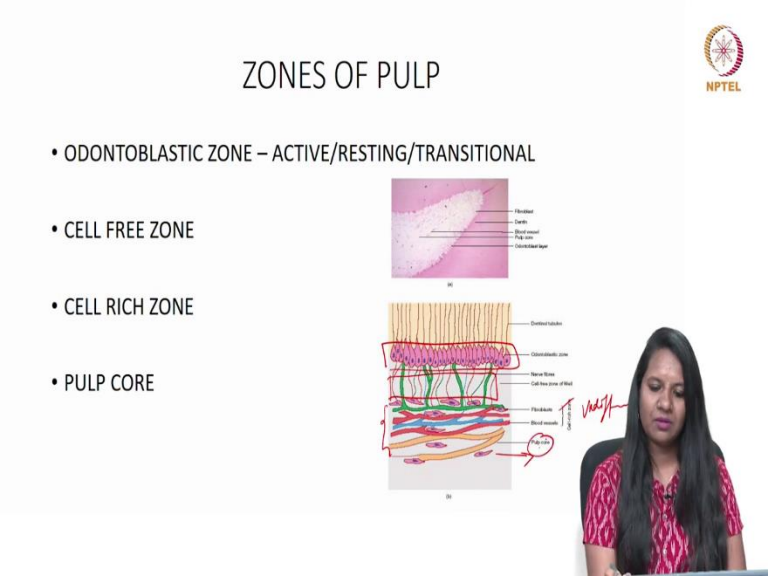

The zones of pulp involve odontoblastic zone which where the odontoblasts were arranged in a palisading fashion and there exist a cell free zone which is devoid of cell and cell rich zone which consist of fibroblast and undifferentiated mesenchymal cells then comes the pulp core.

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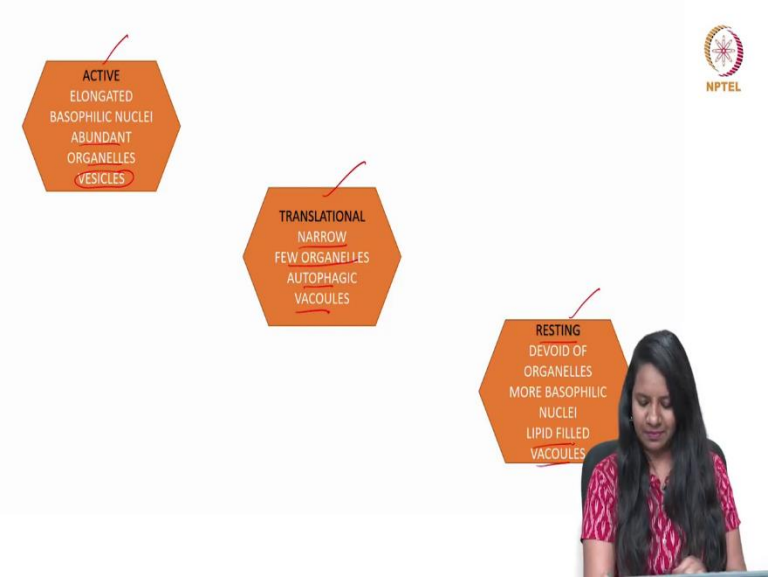

And the odontoblast will be in different phases throughout the odontoblastic zone of pulp either it could be active or transitional or resting. So, how do you differentiate all these three under microscope? In the active cell, it will be elongated with a basophilic nuclei and there will be abundant organelles and presence of vesicles whereas in translational it will be narrow with fewer organelles and autophagic vacuoles and in case of resting, it is devoid of organelles with more basophilic nuclei and lipid filled vacuoles.

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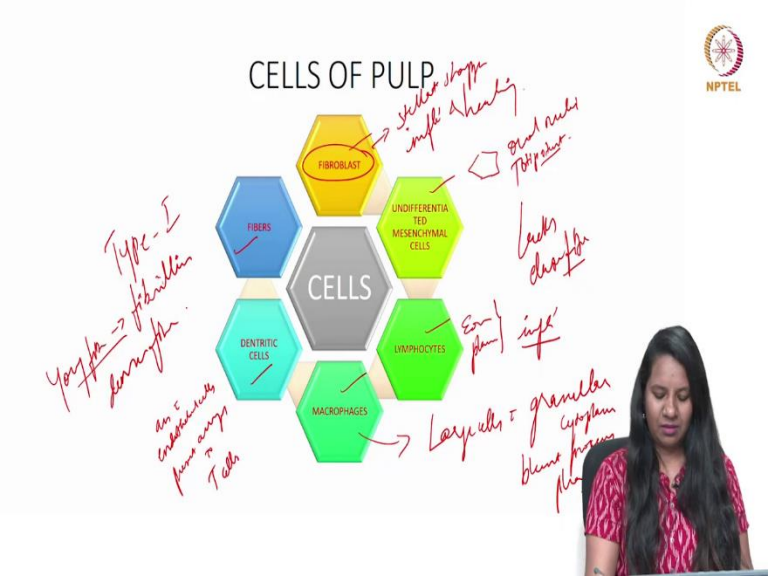

The cells of pulp include fibroblast undifferentiated mesenchymal cells, lymphocytes, macrophages dendritic cells and few fibers. Pulp is very unique because it lacks elastic fibers. So, fibroblast is the most common cell present in the pulp, it is stellate shaped and it helps in the inflammation and healing.

The undifferentiated cells were polyhedral in shape with an oval nucleus and they are said to be totipotent that is they can be differentiated into fibroblast, odontoblast and many other cells.

Then macrophages are large cells with granular cytoplasm and has a blunt process, they contain phagosomes that is, the debris after phagocytosis.

Dentritic cells were associated with endothelial cells and they present antigen to T cells. Lymphocytes, eosinophils and plasma cells were present during any inflammation. Then coming to fibers, pulp consist mainly of type I collagen fiber and young thin fibers were known as fibrillin which later upon age leading to formation of dense fibers.

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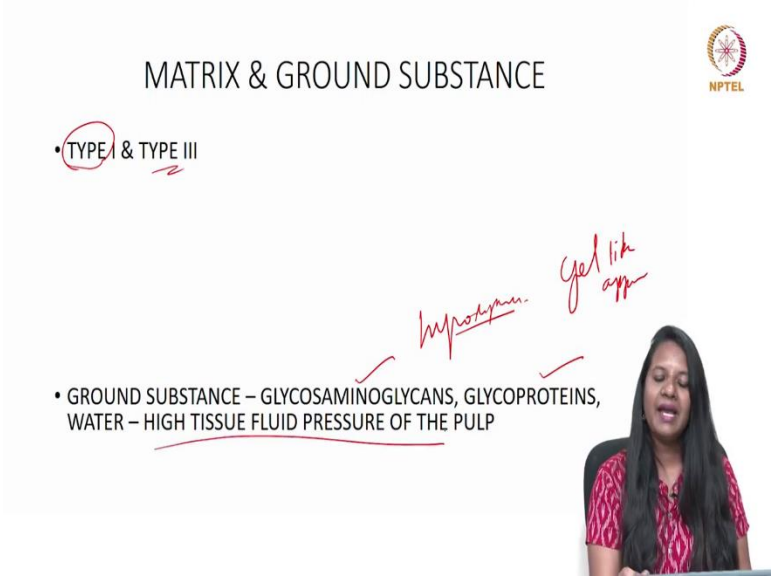

Moving to matrix and ground substance pulp consist of mainly of type I collagen and traces of type III. And the ground substance consists of glycosaminoglycan, glycoproteins. Since the glycosaminoglycans is hydrophilic, it will take up the water and gives a gel like appearance and it is responsible for the high tissue fluid pressure of the pulp.

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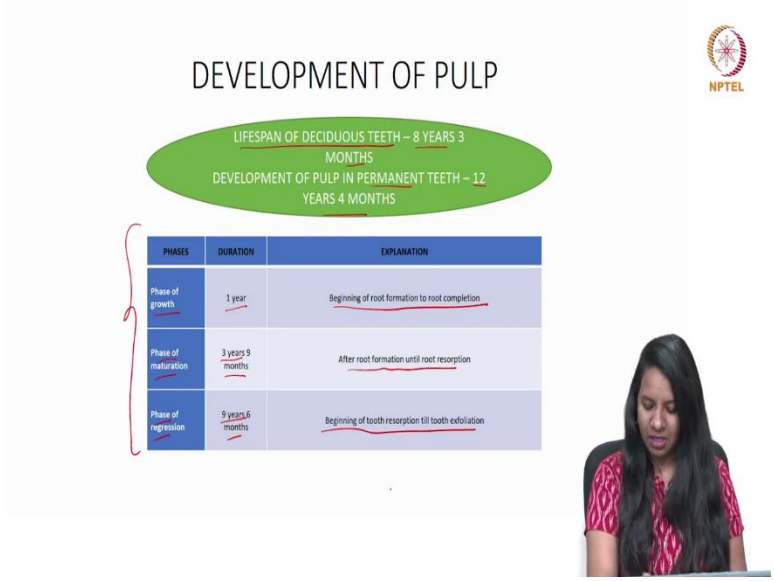

Lifespan of deciduous teeth takes up to 8 years and 3 months whereas, development of pulp in a permanent tooth takes 12 years and 4 months. So, these phases depict the development of pulp in a deciduous tooth. There are three phases - the first phase being phase of growth which occurs for 1 year and it starts from the beginning of root formation to root completion.

Then comes the phase of maturation which occurs for 3 years and 9 months and it is after root formation until root resorption. Then comes the phase of regression which occurs at 9 years and 6

months & it depicts the beginning of tooth resorption till tooth exfoliation whereas, the permanent teeth develop 12 years and 4 months.

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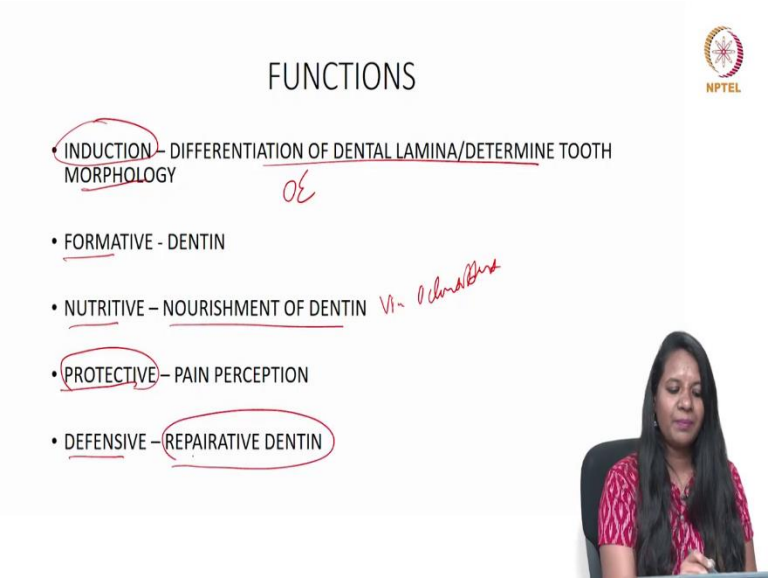

The first most important function is **induction**. This pulp anlage will help in the differentiation of dental lamina or it will determine the tooth morphology by interacting with the oral epithelium. **Protection** - It helps in the formation of dentin like either reactionary or reparative dentin after any stimuli.

Nutritive - The vascular supply of pulp gives nourishment to the dentin via odontoblast. And it is protective also because of the pain perception to all stimuli it is giving a protective nature to the tooth then comes the defensive as I already mentioned stimulus or any irritation there will be formation of reparative dentin.

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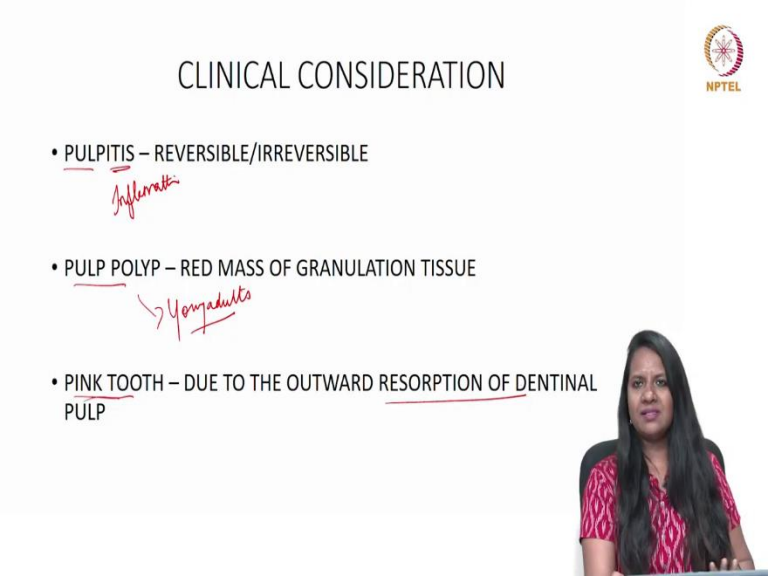

Moving to clinical consideration, pulpitis, "itis" means inflammation. So, it is nothing but inflammation of pulp. It could be either reversible or irreversible depending upon the range of stimulus. Then pulp polyp which usually occur in children and young adults when the pulpitis will be reflected as red mass of granulation tissue over the occlusal aspect.

Then pink tooth which is due to the form outward resorption of the dentinal pulp and dentinal walls and the pulp inside will be seen through the translucent enamel and that teeth is known as pink tooth that is nothing the internal resorption.

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Pulp stones are nothing but calcification which is present in the pulp chamber. It could be either true or false. It is called true when it mimics the dentin that is it should have dentinal tubules otherwise just concentric layers of calcification is called as false denticles.

And when it is free in the pulp chamber it is called free and when it is attached to the dentin it is known as attached denticles. When calcifications present diffusely throughout the pulp chamber, it is called Diffuse calcification.

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Age related changes in pulp is one of the most important clinical implications because as the age goes there will be reduction in the size of the pulp organ due to the deposition of secondary dentin. There will be more deposition of secondary dentin leading to the regression of the pulp in old age.

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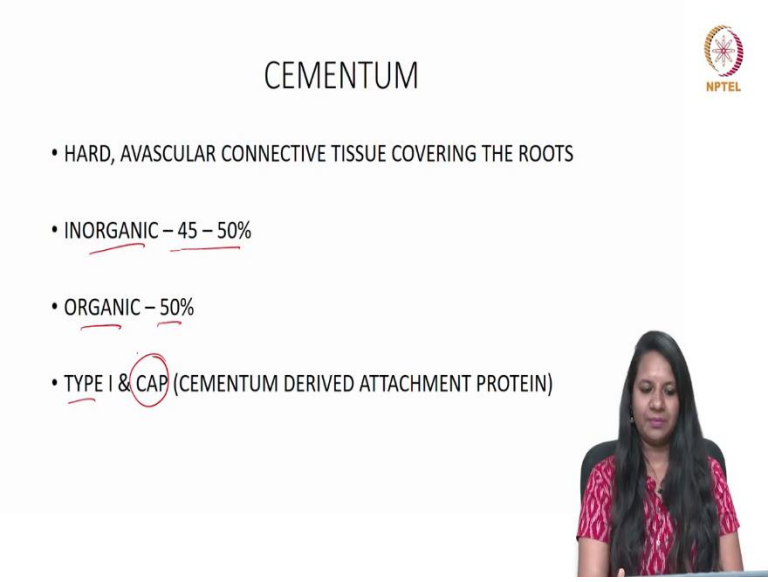

Cementum is another hard avascular connective tissue covering the roots. It consists of 45 to 50 percent of inorganic and 50 percent of organic material. Like pulp, it also contains mostly of type

I collagen and a specific unique protein that is cementum derived attachment protein which is helps in the attachment of the cementoblasts during formation.

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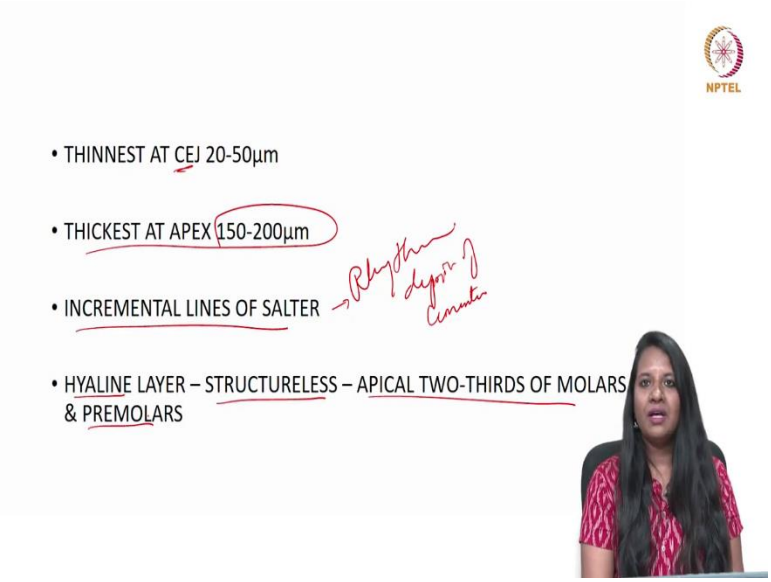

So, the thickness of the cementum varies. It is thinnest at the CEJ where it is 20 to 50 micrometer and it is very thickest at the root apex where it is 150 to 200 micrometers. The incremental lines were known as incremental lines of salter which depicts the rhythmic deposition of cementum.

A hyaline layer is a structureless layer which doesn't resemble neither dentin nor cementum. It will be seen in the apical two thirds of molars and premolars, but research studies have stated that it is of dentinal origin.

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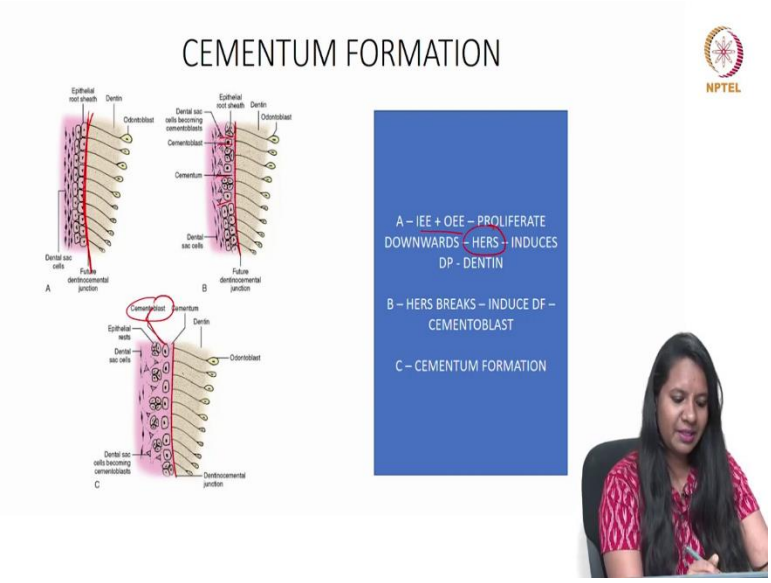

The inner enamel epithelium and outer enamel epithelium proliferate downwards leading to formation of hertwig's epithelial root sheath which induces dental papilla cells to form odontoblast on the forming root. This hertwig epithelial sheath cells break & induce dental follicle cells to differentiate into cementoblast. Then cementoblast will start forming cementum overlaying the radicular dentin.

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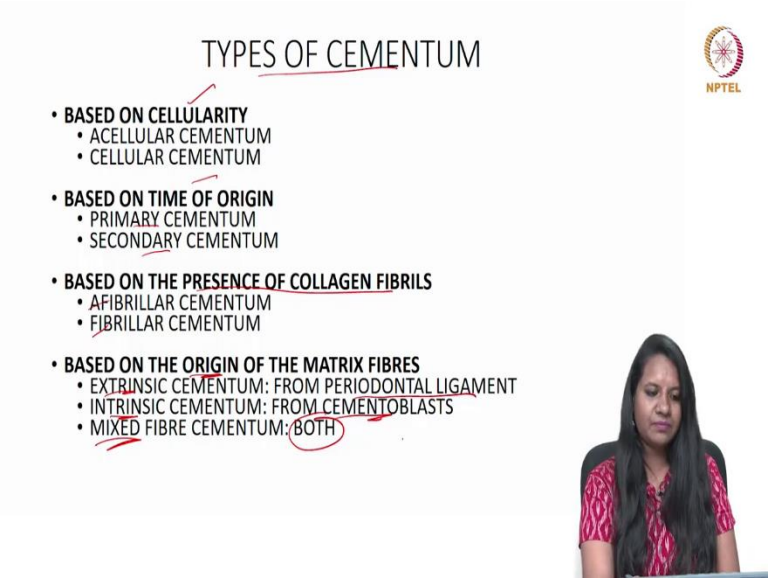

Types of cementum. Based on cellularity, it is acellular and cellular; acellular means absence of cementoblast and cellular means presence of cementoblast. Based on the time of origin it is either primary or secondary. Based on the presence of collagen fibrils it is either afibrillar or fibrillar afibrillar means absence of fibrils and fibrillar presence of fibrils.

Based on the origin of matrix fibers- Extrinsic & Intrinsic. If it is extrinsic, they were formed from the periodontal ligament and if it is intrinsic, it is formed from its own cementoblast and mixed fiber cementum which is formed by both periodontal ligament and cementoblast.

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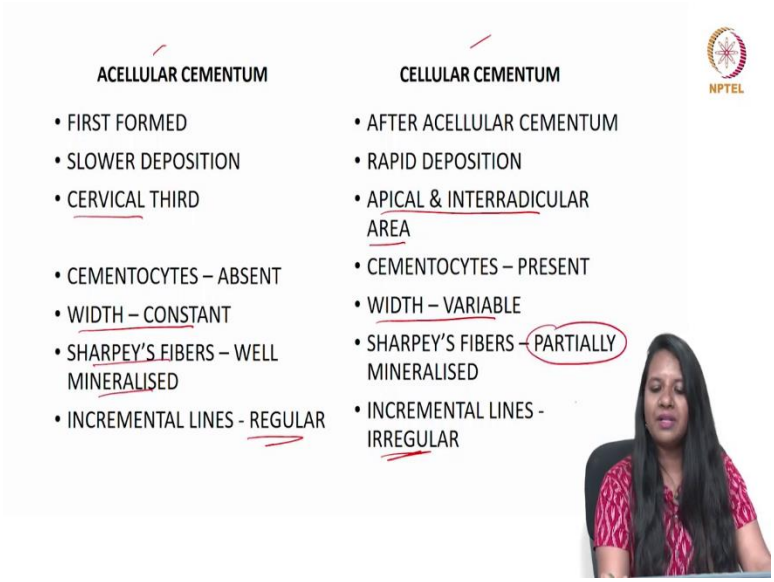

So, the differences between acellular and cellular cementum being; acellular cementum is first formed whereas, cellular cementum is formed after acellular cementum. So, deposition rate of acellular is very slower when compared to cellular cementum whereas, in cellular cementum the deposition rate is really high that is why the cementoblast getting interrupt within it and there will be more amount of cementocyte seen in the cellular cementum whether there is no cementocyte seen in the acellular cementum.

Since there will be a slower deposition, the incremental lines present in the acellular cementum is very regular whereas, in case of cellular cementum it is irregular. The width of acellular cementum is constant whereas in cellular cementum the width is variable. Acellular cementum is present in the cervical third whereas, cellular cementum is present in the apical and interradicular area. And sharpey's fibers were well mineralized in case of acellular cementum & it is partially mineralized in case of cellular cementum.

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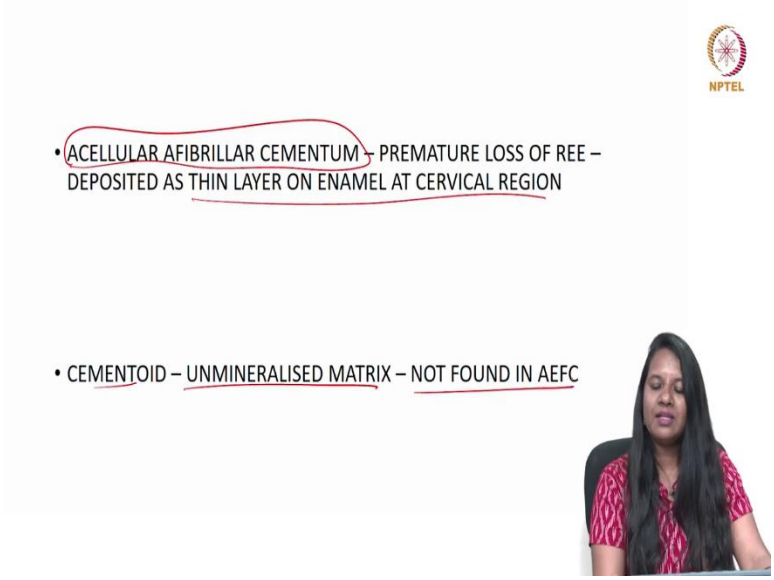

Acellular afibrillar cementum is devoid of cells, devoid of fibrils which is due to the premature loss of reduced enamel epithelium. Hence it is deposited as a thin layer on enamel at the cervical region and cementoid is unmineralized matrix which is not found in the acellular extrinsic fiber cementum.

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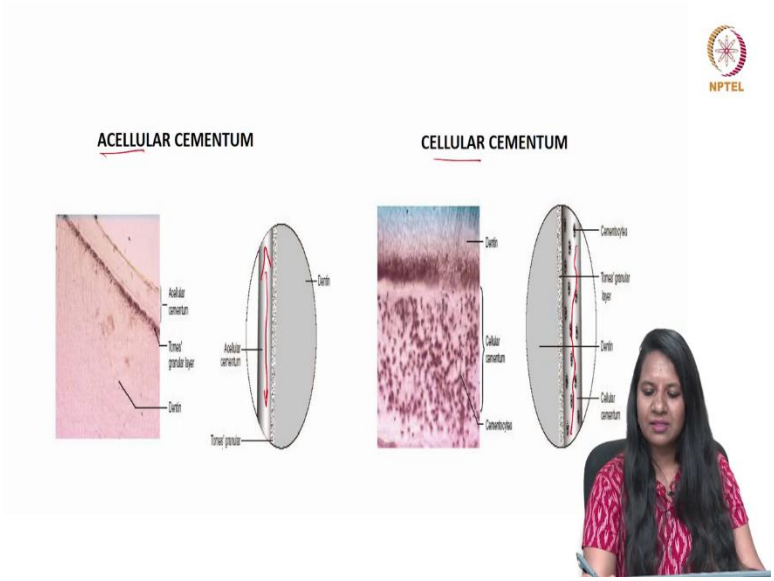

So, this is the picture showing acellular cementum and cellular cementum. In the acellular cementum there is no cells throughout the cementum; whereas cementocytes are seen in the cellular cementum.

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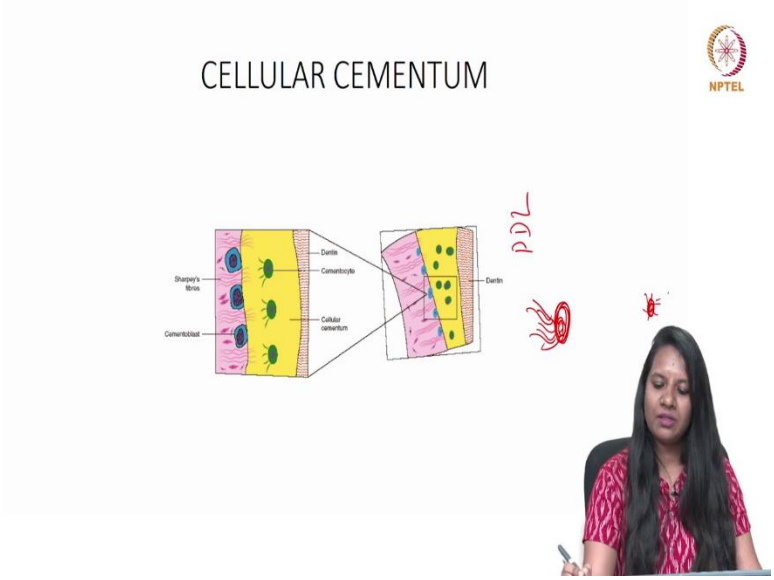

So, how do you differentiate between a cementocyte and an osteocyte? Cementocyte lie in a lacuna with a canaliculi radiating towards PDL whereas in osteocyte, it will be radiated throughout all the surface.

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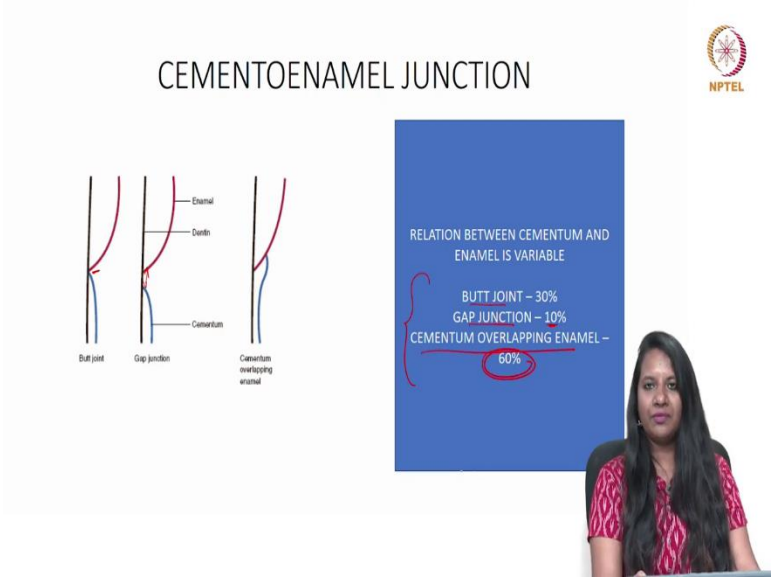

Moving to the cemento enamel junction, it is the junction between cementum and enamel. This is of three types - Butt joint which is 30 percent that is the cementum and enamel will meet in the same point. Gap junction which is only 10 percent that is there is no relation between the cementum and dentin and hence there is no cemento enamel junction in such cases. The most common is the cementum overlapping enamel which is seen in the 60 percent of population.

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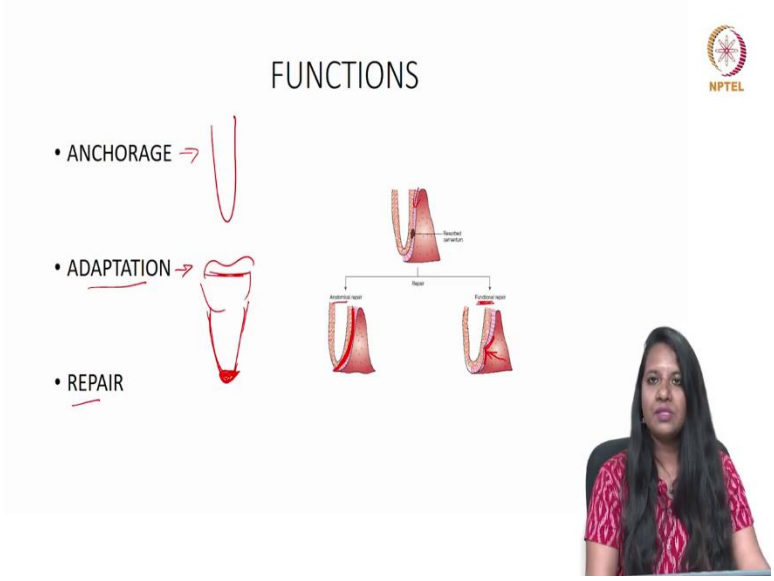

The functions of cementum involve anchorage - it will anchor the teeth to the PDL. Then comes the adaptation - if there is any occlusal loss, it can be compensated by the formation of cementum in the apical region. Repair - repair is of two types, one is anatomic repair & the another one is a functional repair.

When the cementoblast can form cementum which will maintains its previous length and width then it is known as anatomical repair and functional repair is when there is a bay like recess occur and the bony projection will be starting from the periodontal space to compensate that, then it is known as functional repair.

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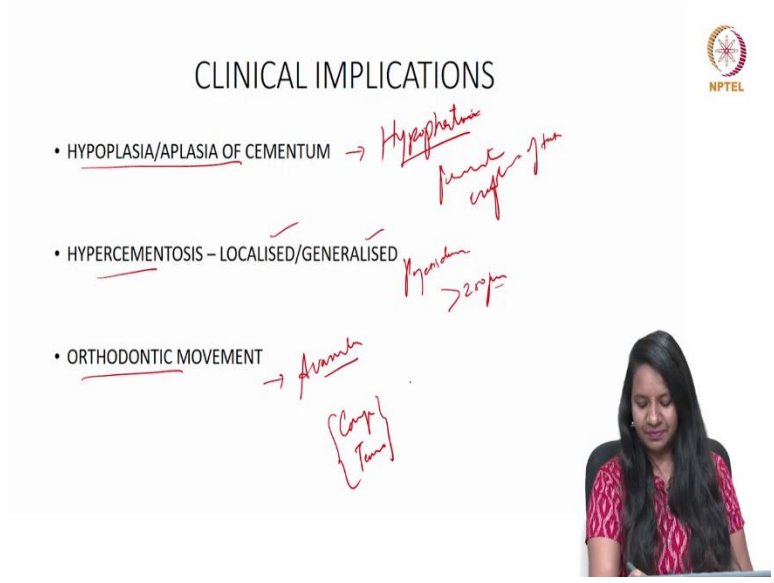

Clinical implications - Hypoplasia or aplasia of cementum is nothing but absence of cementum which is seen in condition called hypophosphatasia where there will be complaint of premature

exfoliation of teeth. And hypercementosis which is nothing but the increased cemental deposition it could be either localized or it could be either generalized as seen in paget's disease.

So, the width of the cementum will be more than 250 micrometer and since the cementum is avascular, the orthodontic tooth movement is possible that is the compression and tension which were given due to during the orthodontic treatment are taken up by the cementum because it is avascular.

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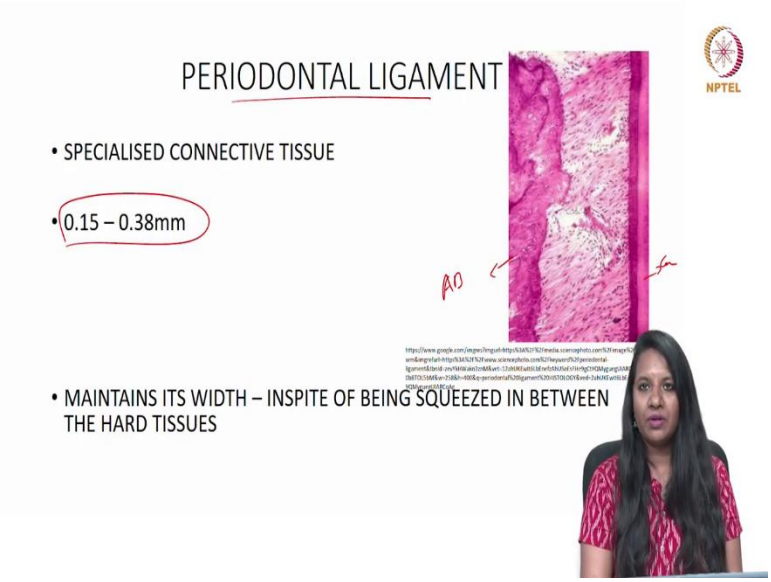

Moving to another peculiar soft tissue that is periodontal ligament. It is a specialised connective tissue and a width of the periodontal ligament is of 0.15 to 0.38 mm. It maintains its width instead of being squeezed between the two hard structures; one is cementum and the other one is the alveolar bone thus it is present in between these two hard structures. It still maintains its width and it still maintains the homeostasis and that is the specialty of the periodontal ligament.

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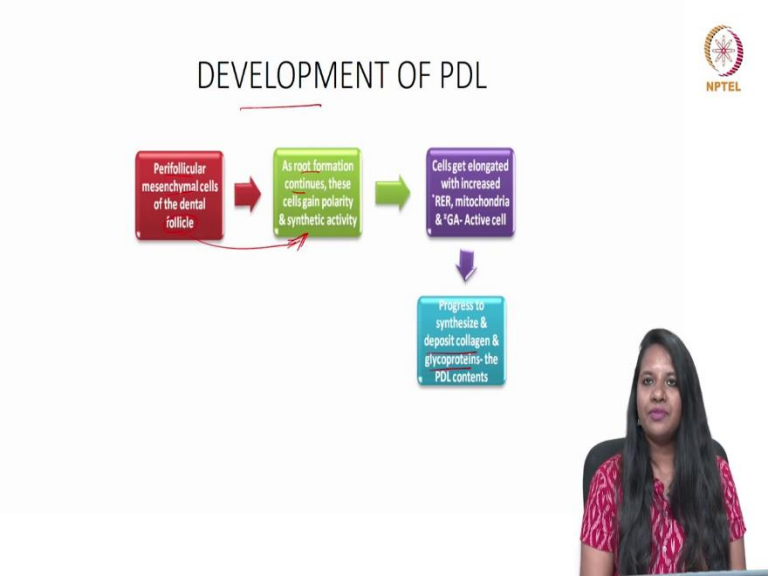

So, how do they develop? The perifollicular mesenchymal cells of the dental follicle will have the synthetic activity, they gain polarity and they will start synthesizing as the root formation continues and the cells gets elongated with a greater number of organelles and they will become an active cell from being a polarized cell. Then later leads to deposition of collagen and glycoproteins which were the contents of the periodontal ligament.

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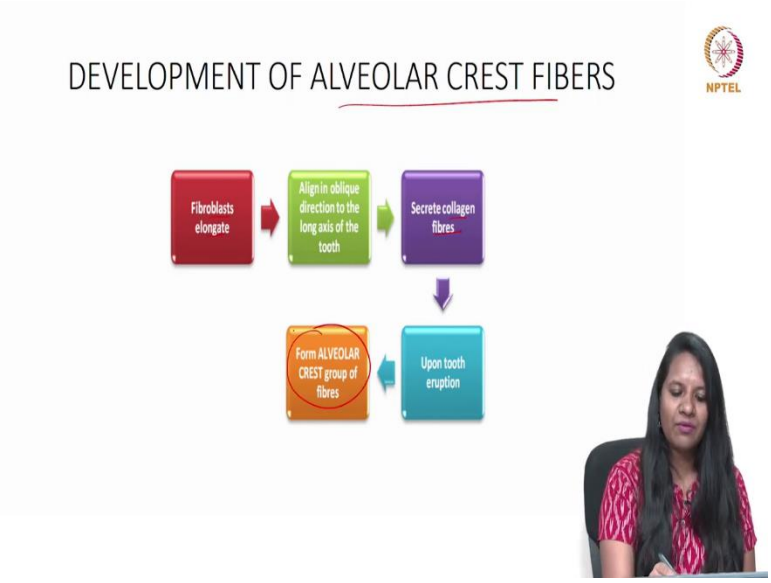

The first developed fiber is the alveolar crest fiber. So, these fibroblasts elongates and they align in an oblique direction to the long axis of the tooth and they secrete collagen fibers and once the tooth starts erupting, they will be formed as an alveolar crest group of fiber.

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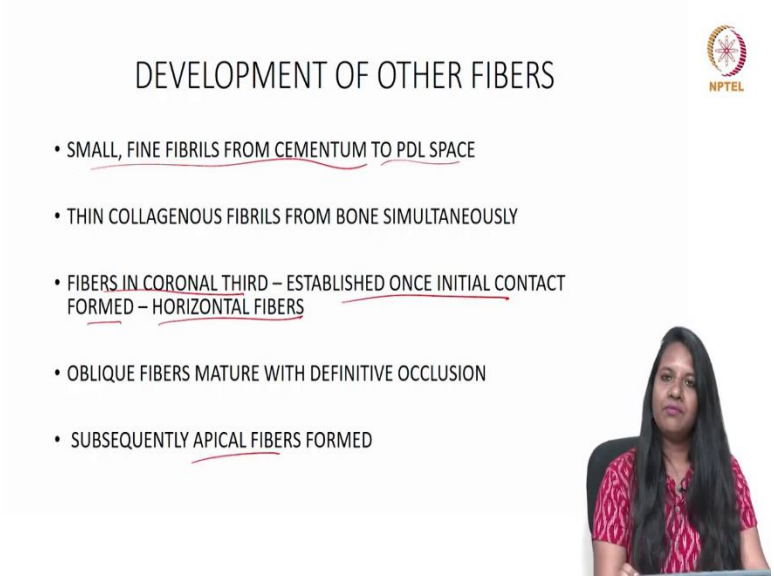

Then how do other fibers form? Small fine fibrils from the cementum enters the PDL space & thin collagen fibrils from bone enter simultaneously that is few fibers from the cemental side and few fibers from the bone. Then fibers in coronal third will established once initial contact is formed and that forms the horizontal fibers later oblique fibers mature with definitive occlusion. And subsequently the apical fibers were formed once the root formation completes.

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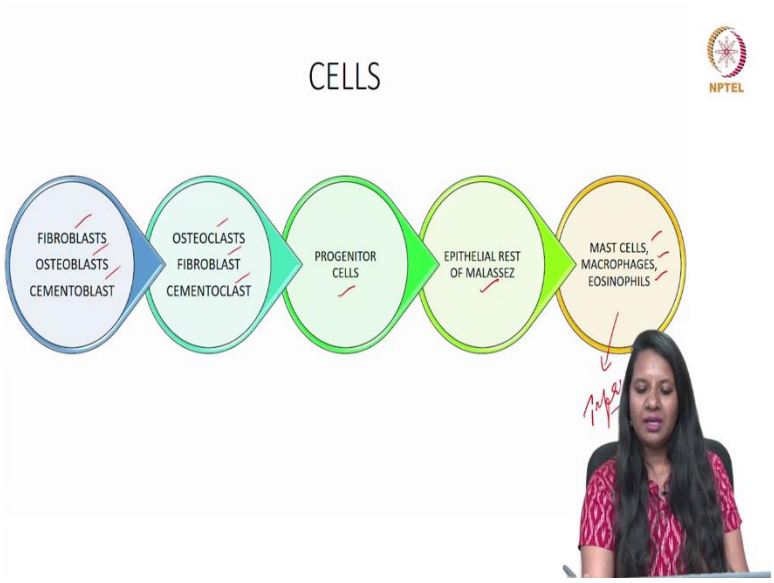

So, the cells of the fibroblast include synthetic cells; that is fibroblast, osteoblast and cementoblast then resorptive cells osteoclast, fibroblast and cementoclast. The others inculde progenitor cells, epithelial cell rest of malassez & inflammatory cells such as mast cells, macrophages and eosinophils.

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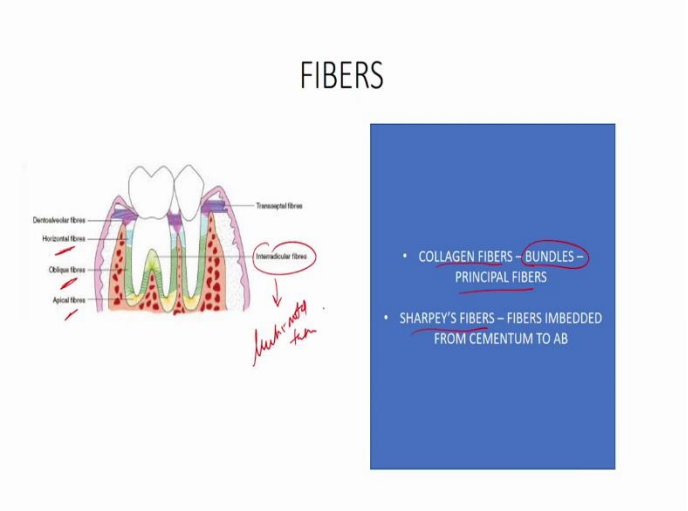

Moving to the fibers these collagen fibers will present as bundles and they are known as principal fibers. Sharpey's fibers were the one which run from cementum and embedded to the alveolar bone which is completely mineralized in case of acellular cementum and in cellular acementum area, it is partially mineralised.

So, this is the picture showing dentoalveolar that is the first formed fiber then horizontal, oblique, apical & interradicular fibers is present only when then there is an multi rooted teeth.

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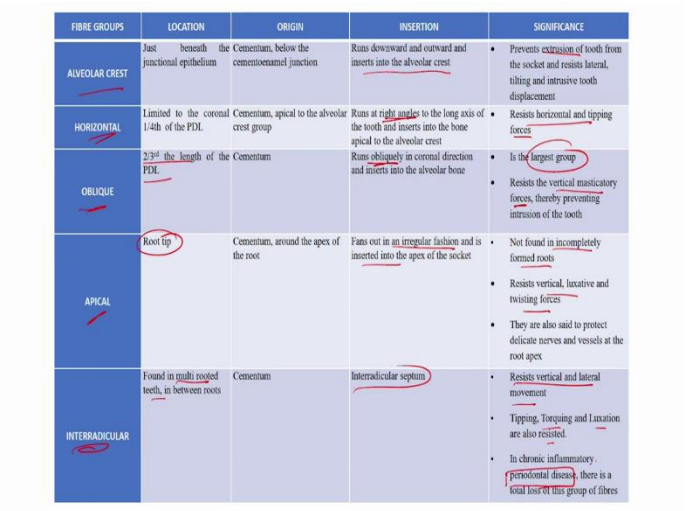

FIBRE GROUPS	LOCATION	ORIGIN	INSERTION	SIGNIFICANCE
ALVEOLAR CREST	Just beneath the junctional epithelium	Cementum, below the cementoenamel junction	Runs downward and outward and inserts into the alveolar crest	• Prevents extrusion of tooth from the socket and resists lateral, tilting and intrusive tooth displacement
HORIZONTAL	Limited to the coronal 1/4th of the PDL	Cementum, apical to the alveolar crest group	Runs at right angles to the long axis of the tooth and inserts into the bone apical to the alveolar crest	• Resists horizontal and tipping forces
OBLIQUE	2/3rd the length of the PDL	Cementum	Runs obliquely in coronal direction and inserts into the alveolar bone	• Is the largest group • Resists the vertical masticatory forces, thereby preventing intrusion of the tooth
APICAL	Root tip	Cementum, around the apex of the root	Fans out in an irregular fashion and is inserted into the apex of the socket	• Not found in incompletely formed roots • Resists vertical, luxative and twisting forces • They are also said to protect delicate nerves and vessels at the root apex
INTERRADICULAR	Found in multi rooted teeth, in between roots	Cementum	Interradicular septum	• Resists vertical and lateral movement • Tipping, Torquing and Luxation are also resisted. • In chronic inflammatory periodontal disease, there is a total loss of this group of fibres

So, each fiber has its own function. The alveolar crest fiber which runs downwards and outwards insert into the alveolar crest that is why it is termed as alveolar crest fiber and it prevents extrusion of tooth from the socket and it also resist lateral tilting and intrusive tooth displacement.

Then comes the horizontal; horizontal is limited to the coronal third and it runs at right angles it resists horizontal and tipping forces; oblique is the most numerous fiber that covers the two third of the length of the tooth and it runs in oblique direction. It resists the vertical masticatory forces and thereby preventing intrusion of the tooth.

The apical group is present in the root tip and it fans out in an irregular fashion and is inserted into the apex of the socket. It is not found in incompletely formed roots and it resist vertical and twisting forces.

The interradicular is present only in the multi rooted teeth and it is present in the interradicular septum and it resist vertical and lateral movement. Tipping, torquing and luxation is also resisted. These types of fibers will be lost in case of periodontal disease.

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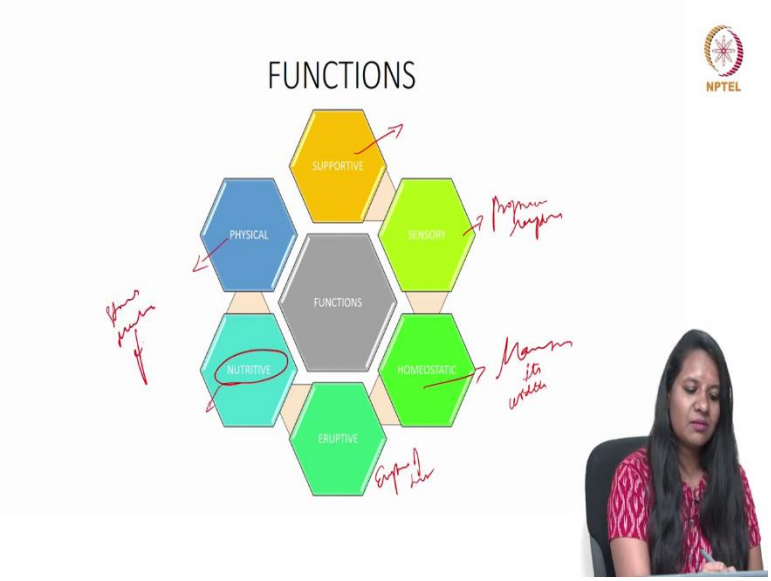

Function - It supports the entire tooth to present inside the alveolar bone socket and it has proprioceptive receptors. It maintains its width throughout and there is no formation of hard tissue though it is squeezed in between the two hard tissues and it helps in the eruption of tooth, it provides nutrition and it also stand withstands mechanical forces.

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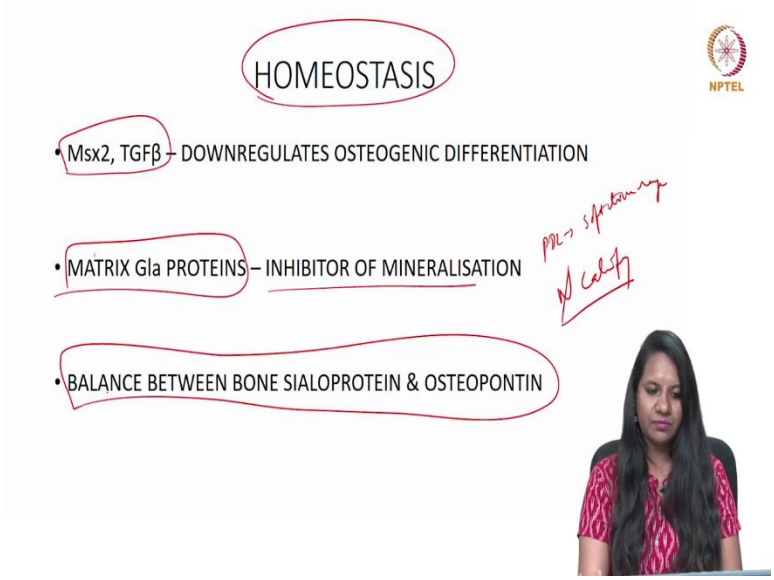

So, homeostasis which is a special feature of periodontal ligament occur because of the various factors. Msx 2 and TGF beta will down regulate osteogenic differentiation and matrix Gla proteins which are the main inhibitor of mineralisation will maintain the periodontal ligament in a soft tissue range, it will not allow them to calcify. There is no calcification because of these three products and the balance exist between bone sialoprotein and osteopontin to maintain its width and also to maintain homeostasis.

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Clinical implication: Any periapical pathology will destroy the apical fibers and leads to formation of periapical cyst or periapical granuloma. And guided tissue regeneration has been recently used to correct any PDL destruction. The orthodontic tooth movement depends on cementum, bone and also the PDL. PDL is the one which withstands compression and tension which were produced during orthodontic treatment.

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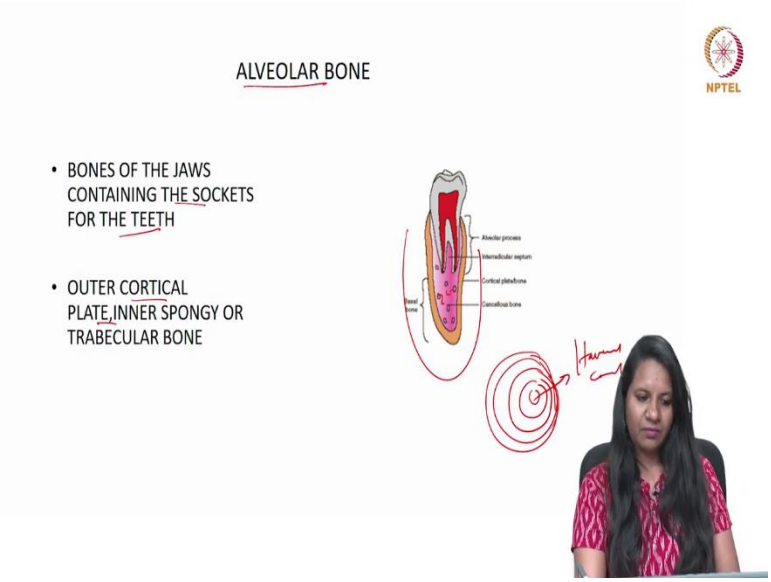

Moving to the alveolar bone; bones of the jaws containing sockets for the teeth outer cortical plate otherwise called as compact bone which consist of circumferential lamellae that are tightly packed around the haversian canal.

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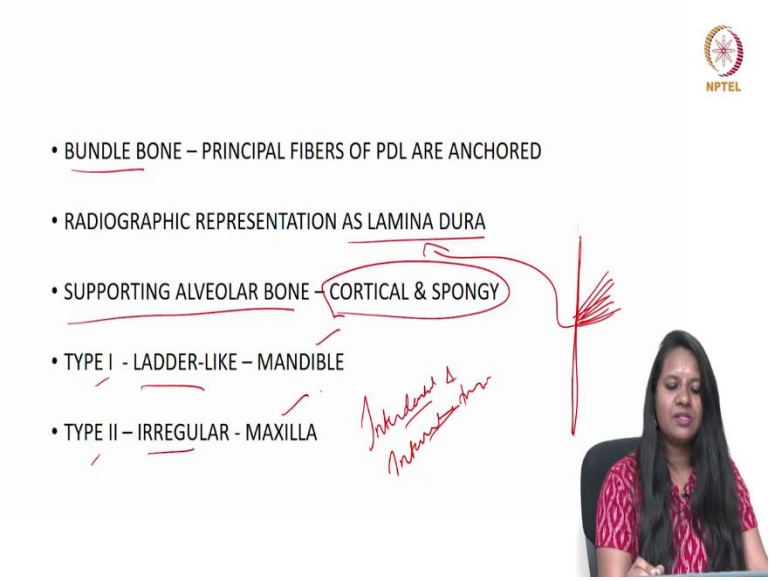

Bundle bone is nothing but the part of alveolar bone where the principal fibers of PDL were anchored. So, radiographically it will be depicted as lamina dura. The supporting alveolar bone consist of cortical and spongy bone. The interdental and interradicular trabeculae are arranged ladder like in case of mandible and it is irregular in case of maxilla.

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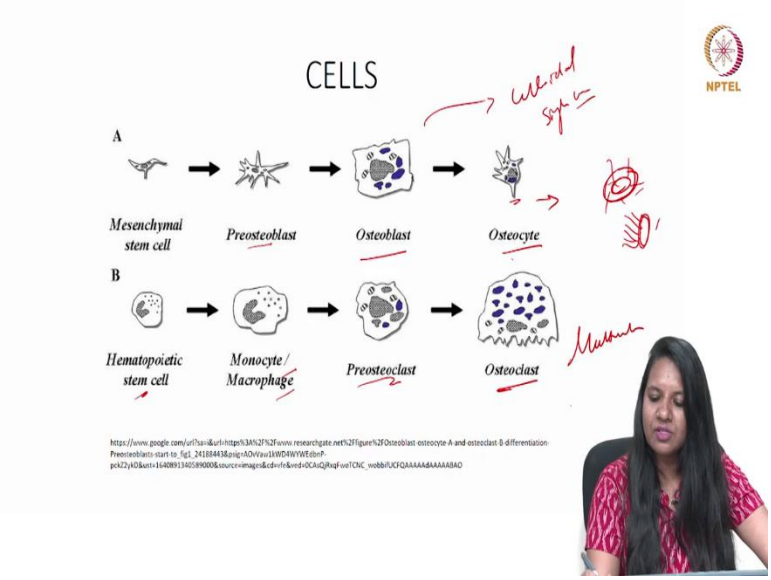

So, what are the cells of bone? It consists of osteoblast, osteocyte and osteoclast. Osteoblast develop from mesenchymal stem cells and they convert to preosteoblast and then osteoblast. Osteoblast is a cuboidal cell with a single nuclei and osteocyte lie in a lacuna with canaliculi projective from all over the surface whereas, in case of cementocyte it is projected only towards PDL. Osteoclast will arise from the hematopoietic stem cells which is converted to monocyte or macrophages and preosteoclast leading to the formation of a multi nucleated cell.

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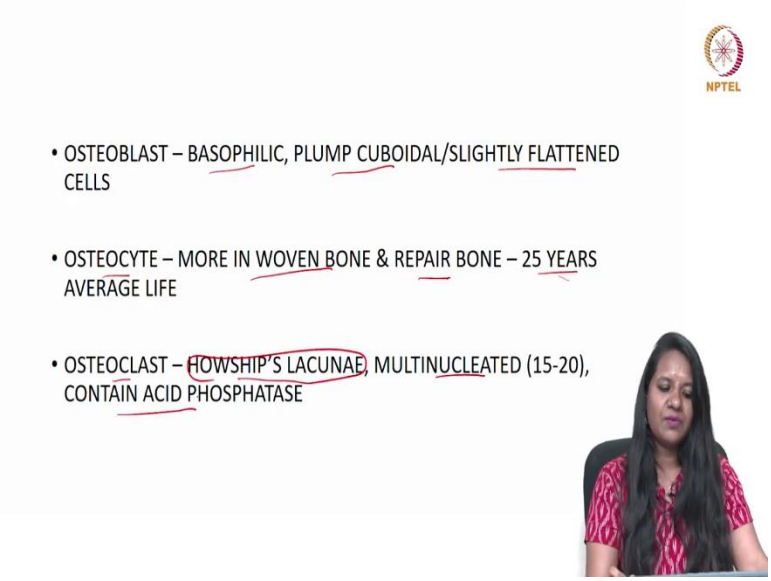

So, osteoblast is a basophilic plump cuboidal or slightly flattened cells. These osteocytes will be seen in more in woven bone and repair bone which have 25 years of average life and osteoclast will lie in a howship lacunae and it is multi nucleated and contains acid phosphatase.

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So, moving to the reversal and resting line. Resting line is nothing but the incremental line that is regular rhythmic deposition of bone, hence it is regular whereas, irregular is the reversal line which depicts the clear distinction between the formation and resorption and it is also basophilic. So, when we view it under the microscope, we can clearly find a difference between the reversal and the resting line.

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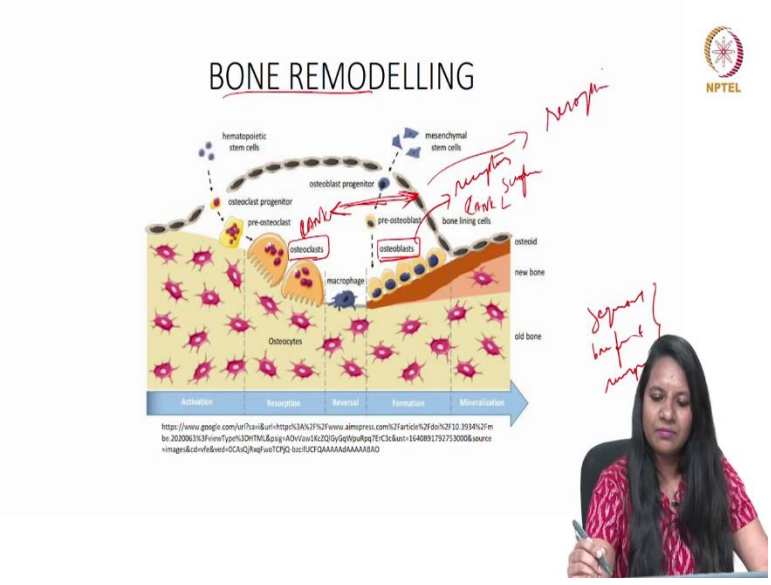

What is bone remodeling? That is sequential bone formation and resorption which is necessary for the bone growth is known as the bone remodelling which involves osteoblast & osteoclast. So, the bone either to form or to resorb is decided by the osteoblast depending upon the receptors what it is showing over the surface.

So, the osteoclast consists of RANK and osteoblast consist of RANKL. So, when there is an interaction between the RANK and RANKL, there will be formation of resorption.

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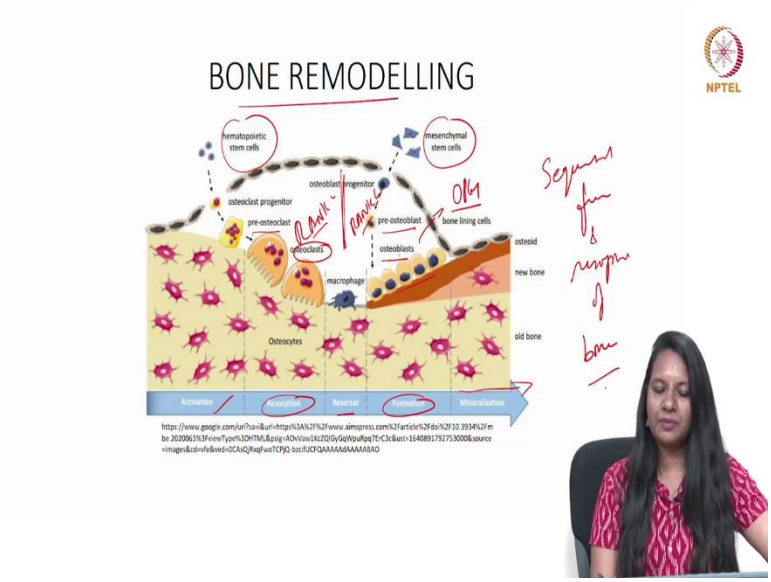

And resorption it is reversed and again formation is formed because of the presence of OPG that is osteoprotegerin on the osteoblast which will break the bond between this RANK and RANKL and hence leads to formation of bone by the osteoblast which leads to the extended mineralization; and thus bone remodelling is the sequential formation and resorption of bone.

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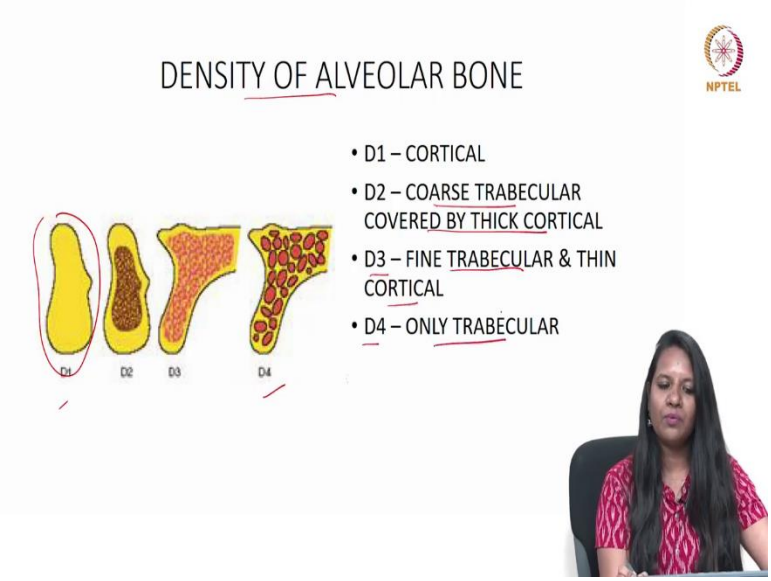

So, density of alveolar bone changes. It starts from D1 to D4 where D1 consist of fully cortical, D2 which will have coarse trabecular covered by thick cortical and D3 is fine trabecular and thin cortical and D4 consist of only trabecular bone.

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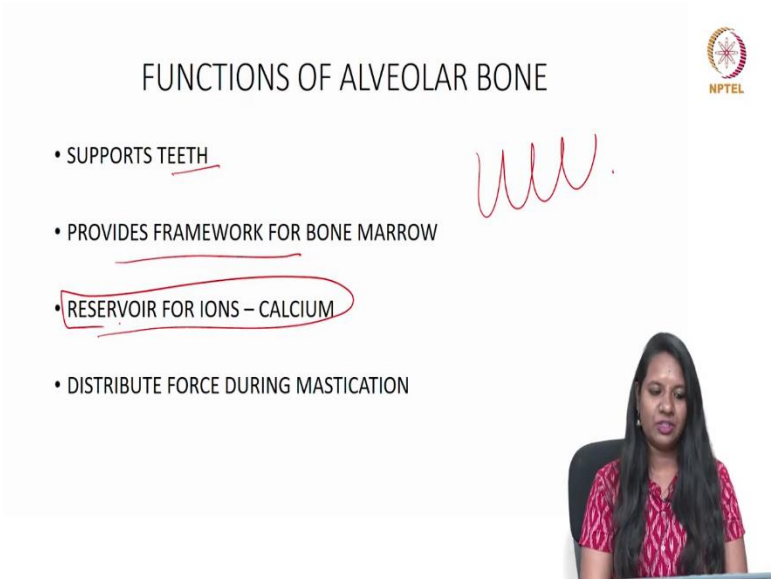

Now, moving to the functions of alveolar bone. It supports teeth and it provides the framework for the bone marrow especially it is the reservoir for calcium ions and it distributes the occlusal forces equally during mastication.

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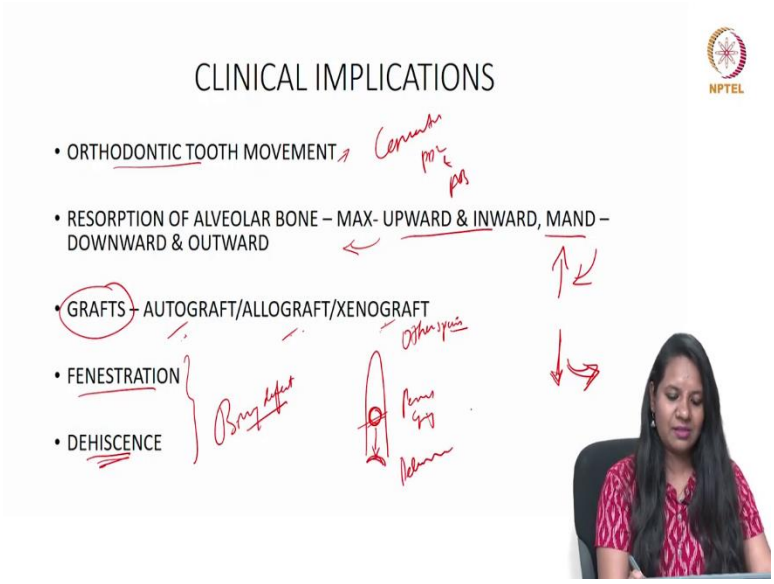

And clinical implications include orthodontic tooth movement which is due to cementum, PDL and the alveolar bone also play an important role in the orthodontic tooth movement. The

resorption of alveolar bone occurs upward and inward in case of maxilla and in case of mandible it is downward and outward.

Graft is of three types - autograft, allograft or xenograft. Autograft is taken from the same human and allograft is taken from the other human and xenograft is taken from the other species. Fenestration is when the bony coverage has a defect. So, it is covered only by periosteum and gingiva and the dehiscence is when the defect extends to the marginal bone.

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These are my references.

Thank you.

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