Lec. 4 **Restorative dentistry**

Biologic Considerations of Dentin and its Clinical Significance in Restorative dentistry

Dentin forms the largest portion of the tooth; the coronal dentin (in crown) provides both color & elastic foundation for enamel, together with radicular dentin (in root) provides the wall and protection for the pulp.

Dentin formation (*dentinogenesis*) is accomplished by cells called *odontoblasts*. Odontoblasts are considered part of pulp and dentin tissues; because their cell bodies are in the pulp cavity, but their long, slender cytoplasmic cell processes into the tubules in dentin. Because of these odontoblastic cell processes, dentin is considered a living tissue, with the capability of reacting to physiologic and pathologic stimuli. In contrast to enamel, dentin formation continues after tooth eruption and throughout the life of the pulp.

Dentin contains 70 percent inorganic (hydroxyapatite crystals) and the rest is organic substance and water making it more resilient than enamel. Dentin is less mineralized than enamel but it more than cementum and bone. Therefore, by X-ray it appears more radiolucent than enamel and more radio-opaque than cementum and bone.

Dentin is light yellowish in color in young individuals while it becomes darker with age. On constant exposure to oral fluids and other irritants, the color becomes light brown or black.

Thickness:

Dentin thickness is usually more on the cuspal heights and incisal edges and less in the cervical areas of tooth. It is around 3 to 3.5 mm on the coronal surface. With advancing age and various irritants, the thickness of secondary and tertiary dentin increases.

Hardness

Hardness of dentin is one-fifth of that of enamel. Hardness of dentin also increases with advancing age. Low modulus of elasticity of dentin makes it flexible in nature. This flexibility provides support or cushion to the brittle enamel.

During tooth preparation, dentin can be distinguished from enamel by:

	Enamel	Dentin
Color	Whitish blue or white gray	Yellowish white or slightly darker than enamel
Sound	Sharp, high-pitched sound on moving fine explorer tip	Dull or low-pitched sound on moving fine explorer tip
Hardness	Hardest structure of the tooth	Softer than enamel. Sharp explorer tends to catch and hold in dentin.
Reflectance	More shiny surface and reflective to light than dentin	Dull and reflects less light than enamel

Table (1) Difference between enamel and dentin

Structure:

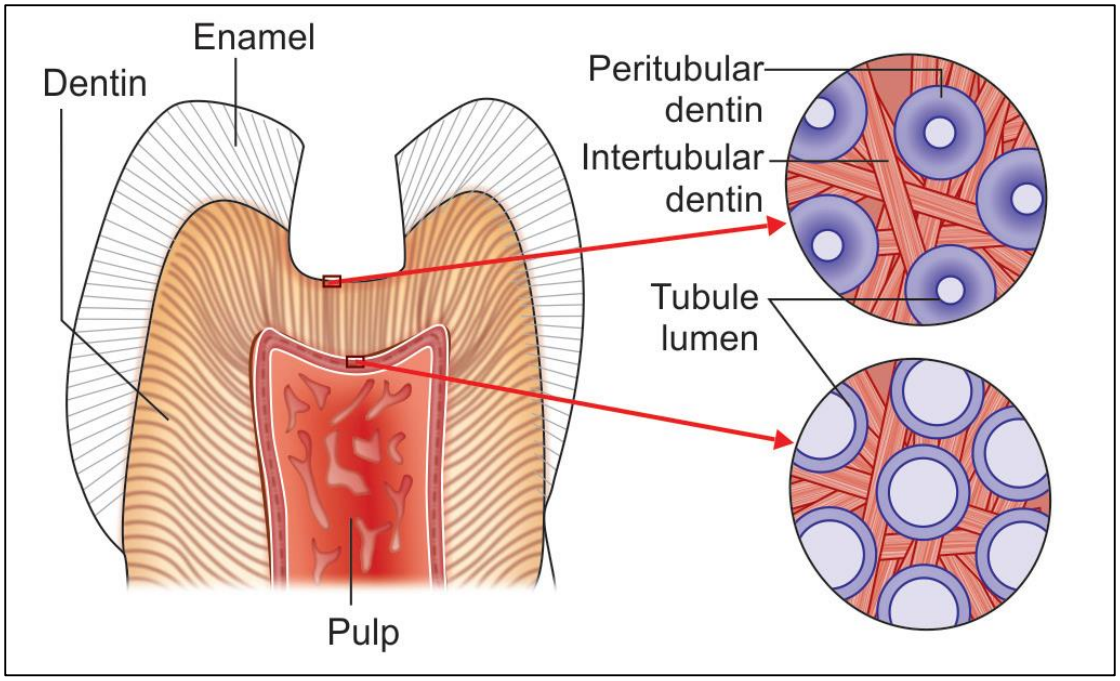
Predentin: It is 10 to 30 μ m unmineralized zone between the mineralized dentin and odontoblasts. It lies very close to the pulp tissue which is just next to cell bodies of odontoblasts.

Peritubular Dentin: It lines the dentinal tubules and is more mineralized than intertubular dentin and predentin.

Intertubular Dentin: located between dentinal tubules and formed the most of the body of dentin, it is less mineralized than the peritubular dentin and consist of collagen matrix with the hydroxyapatite crystals embedded on it.

The peritubular/ intertubular ratio vary according to depth of dentin, age & traumatic history of the tooth.

Dentin permeability is not uniform throughout the tooth. Coronal dentin is much more permeable than root dentin. There also are differences within coronal dentin the D. near the DEJ, Outer dentin, the tubules are few and relatively far apart & the Intertubular D. makes up 96% of the surface area. While In the inner D. (the D. near the pulp) the tubules more and diameters are larger & the distance between tubule centers is half that of tubules at DEJ. The Intertubular matrix area is only 12% of the surface area; the permeability of inner dentin is about eight times more permeable than the D. near DEJ.



Clinical significance:

The permeability of dentin is directly related to its protective function. When the external cap of enamel & cementum is lost from the periphery of the dentinal tubules due to caries, preparation with burs or abrasion & erosion, the exposed tubules become conduits between the pulp & the external oral environment.

Restored teeth are also at risk of toxic seepage due to the phenomenon of microleakage between the restorative material & the cavity wall, so fluids containing various acidic & bacterial products can penetrate the gap between the tooth & restoration & initiate secondary caries. Bacterial substances can continue diffusion through permeable dentinal tubules to reach the pulp... putting the tooth at risk for pulpal inflammation & sensitivity. So restorative techniques with varnishes, liners or dentin bonding resin adhesives are effective to provide reliably sealed margins & sealed dentinal surface. The remaining dentin thickness is the key determinant of the diffusion of gradient.

Sensitivity of Dentin

Dentin is neither vascularized nor innervated; but dentin is sensitive to thermal, tactile and osmotic stimuli across its (3-3.5 mm) thickness, Therefore odontoblast & its process is the possible stimulus receptor.

The most accepted theory of pain transmission is the **hydrodynamic theory**, which accounts for pain transmission through rapid movements of fluid within the dentinal tubules causing displacement of odontoblast bodies & the nerve endings deformation in the pulp.

NOTE: As dentin near the pulp, has numerous tubules, that larger in diameter, thus increasing both the volume & flow of fluid. This explains why deeper restorations are associated with more problems of sensitivity.

Carious Dentin

Caries advances more rapidly in dentin than in enamel. Dentin contains much less mineral and possesses microscopic tubules that provide a pathway for the ingress of bacteria and egress of minerals. Dentinal caries is V-shaped in cross-section with a wide base at the DEJ and the apex directed pulpally. In operative procedures, it is important to distinguish between the ***infected*** dentin, which requires removal, and ***affected,*** which does not require removal. ***Affected dentin*** is inner demineralized dentin that is not yet invaded by bacteria, while infected dentin is outer softened and contaminated with bacteria, it includes superficial, granular necrotic tissue and dry, leathery dentin. The degree of dentin hardness, as determined by tactile feedback from excavating burs and hand instruments, is the most reliable guide to differentiate between them.

Types of dentin

Primary Dentin:

This type of dentin is formed before root completion, and gives the initial shape of the tooth.

Secondary Dentin:

Secondary dentin is formed after completion of root formation, normally after the tooth is erupted and functional. In this type of dentin, the tubules is fewer and there direction is more asymmetrical and complicated as compared to primary dentin. Secondary dentin forms at a slower rate than primary dentin. The continued deposition of this type of dentin gradually decreases the size of pulp cavity. Thus making the liability of pulp exposure during cavity preparation much less likely to happen.

***Reparative Dentin/Tertiary Dentin*:**

Tertiary dentin is frequently formed in response to external stimuli. When moderate to severe stimuli are applied to dentin, such as caries,

attrition, trauma and some operative procedures, the affected odontoblasts may die, odontoblast like cells (secondary odontoblasts are developed from undifferentiating mesenchymal cells of pulp) synthesize specific reparative dentin just beneath the site of injury to protect pulp tissue. The tubular pattern of the reparative dentin ranges from an irregular to an atubular in nature.

Reparative dentin is less permeable than primary dentin; this prevents the diffusion of noxious agents from the dentinal tubules. Unless the lesion is either arrested or removed & a restoration placed, the diffusion of bacterial toxins reaching the pulp & initiate strong inflammatory response & result in pulpal necrosis.

Sclerotic Dentin:

It occurs due to aging or chronic and mild irritation (such as slowly advancing caries) which causes a change in the composition of the primary dentin. In sclerotic dentin, peritubular dentin becomes wider due to deposition of calcified materials. This area becomes harder, denser, less sensitive and more protective of pulp against irritations. Sclerosis resulting from aging is called ***physiologic dentin sclerosis***; sclerosis resulting from a mild irritation is called ***reactive dentin sclerosis***.

	Primary	*Secondary*	*Tertiary*
Definition	Dentin formed before root completion	Formed after root completion	Formed as a response to any external stimuli such as dental caries, attrition and trauma
Type of cells	Usually formed by primary odontoblasts	Formed by primary odontoblasts	Secondary odontoblasts or undifferentiated mesenchymal cells of pulps
Location	Found in all areas of dentin	It is not uniform, mainly present over roof and floor of pulp chamber	Localized to only area of external stimulus
Orientation of tubules	Regular	Irregular	Atubular
Rate of formation	Rapid	Slow	Rapid between 1.5 and 3.5 µm/day depending on the stimuli
Permeability	More	Less	Least

Table (2) Difference between primary, secondary and tertiary dentin.