The Histology of Dentin

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Objectives:
To recognize and apply the following:

- Physical Properties of Dentin
- Dentinal Tubules
  - Dentinal Tubules
  - Peritubular Dentin
  - Intertubular Dentinal
- Types of Dentin
  - Peritubular
  - Intertubular
  - Primary Dentin
  - Secondary Dentin
  - Tertiary Dentin
  - Dead Tracks
  - Sclerotic Dentin
  - Globular Dentin
  - Interglobular Dentin
- Markings on Dental Tubules
  - Dailey Imbrication Lines of Von Ebner
  - Contour Lines of Owen
  - Neonatal Line
- Dentin Innervation
  - Granular Layer of Tomes
  - Hyline Layer of Hopewell-Smith
- Root Dentin (Homework- locate the following theories and prepare to report at the beginning of one of your next lectures)
  - Nerve Fiber Theory
  - Odontoblastic Process Theory
  - Hydrodynamic Theory
Physical Properties of Dentin

- **Dentin**, located in both the crown and root. Second hardest surface of the body. It is harder than cementum and bone; and softer than enamel.
- It is composed of 65-70% mineralized substances and 20-25% organic material and 10% bound water.
  - The mineralized substance is *calcium hydroxyapatite*.
  - The organic material is *collagen and ground substance*.
- The color of dentin is yellow.
- Dentin is highly elastic. It is the support substance for Enamel which is extremely brittle. Dentin is living tissue. The odontoblasts reside in the pulp and continue to be active throughout the life of the tooth.
Dentinal Tubules

- Dentinal tubules are enclosed spaces, surrounded by **peritubular dentin**, which connect the pulp to the DCJ and DEJ.

A scanning electron microscope specimen of dentinal tubules. Reproduced with permission from Mathias Nordve, IOB, UiO, University of Oslo. Web Histo.com
Dentinal Tubules

- **Primary Curvature is**: S-shaped
- **Secondary Curvature**: jagged or wrinkled texture
- Curvatures result from movement of odontoblasts during development

*Black lines to reveal shapes only. It is not an additional layer of Dentin*
• In the coronal portion of the tooth, dentin has a “S” shaped curvature.

Vs.

• In the root portion of the tooth, dentin has a more straight path.
Dentinal Tubules

- Note the “S” shape primary curvatures of Dentinal Tubules in the illustration of a ground section of coronal dentin on the right.
- Illustration below, shows the second degree curves in dentin
Dentinal Tubules, Peritubular dentin and Intertubular dentin

- Dentinal tubules contain fluid = extracellular fluid (ECF)
  - Comes from pulp and provides nutrients
  - Extends from the pulp to the DCJ or DEJ
  - Important for pain sensation
Dentinal Tubules, Peritubular dentin and Intertubular dentin

Types of Dentin

- **Primary Dentin:** all dentin formed prior to root formation or completion.

- **Secondary Dentin:** all dentin produced after root formation or completion. (NOT due to trauma)

- **Tertiary Dentin:** all reparative dentin (all regular and irregular)*
Identification of Histology Sites

The image above can be found on the Leeds University WebSite: The Virtual Histology Lab (Ver. 2.1)
http://www.leeds.ac.uk/dental/Oroface/virtlab/histolab/histintr.html#
**Types of Dentin: Primary Dentin**

- **Two Types:** All collagen in Dentin is produced by Odontoblasts.
  - Mantle Dentin is the area of initial dentin matrix formation and is the first formed dentin. It is located in the crown and underlying the DEJ.
    - It is \( \sim \)20 micrometers thick.
    - The fibers are perpendicular to the DEJ.
    - Contains von Korff’s fibers
      - Large coarse bundles of type I collagen.
  - Circumpulpal dentin forms the remaining and the bulk of primary dentin.
    - The collagen fibers are much narrower (\( \sim \)0.05 micrometers thick) than mantle dentin.
    - It is more mineralized than mantle dentin.
    - It is more compactly arranged collagen fibers than mantle dentin.

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Types of Dentin: Secondary Dentin

- Secondary Dentin is a narrow band of dentin around the pulp chamber and is formed subsequent to root completion.
- It is **not** formed as a response to trauma.
- It is formed at a slower rate than primary dentin.
- It contains fewer tubules than primary dentin.
- It is formed in an unequal fashion and more secondary dentin produced on the roof and floor of the pulp than on the walls.
- There is usually a bend in the direction of of the tubules where primary and secondary meet.

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Types of Dentin: Dead Tracks

If the carious demineralization of enamel reaches dentin, the carious lesion allows bacteria to enter the dentinal tubules

- Odontoblasts can then be either damaged or killed, as well as their processes.
  - If killed, then there will be areas of dentin w/ no odontoblasts:
  - Called **Dead Tracts** (empty dentinal tubules that lead directly to pulp)
Types of Dentin: Reparative Dentin

- Reparative Dentin: Once a carious lesion or fracture reaches dentin, the pulp will try to protect itself by making new dentin (Reparative dentin) to seal off the open tubules on the pulp side.
  - 2 kinds:
    - If lesion is due to chronic trauma (slow process), dentin is **regular**
    - If lesion is due to acute trauma (fast process), dentin is **irregular**
      - Chronic reparations made by odontoblasts (more recovery)
      - Acute reparations made by fibroblasts (because the cell died)

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http://www.leeds.ac.uk/dental/Oroface/virtlab/histolab/histintrad.html#
Types of Dentin: Sclerotic

- **Sclerosis** of dentin is the naturally occurring deposition of minerals within tubules that results in a thicker layer of peritubular dentin.
- It is highly mineralized.
- Deposited inside the periphery of the tubules.
- The tubules become smaller in diameter and less permeable and so transmit stimuli to a lesser degree.

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Types of Dentin: Globular vs. Interglobular Dentin

- Arrows indicate regions of hypocalcified dentin called interglobular dentin.
- Interspersed among regions of normally calcified dentin which is occasionally called Globular dentin.

Dentinal tubules, cross section
This section is not decalcified. It is colored by toluidine blue. The interglobular dentin can be seen. Stain: toluidine blue
Reproduced with permission from Mathias Nordve, IOB, UiO, University of Oslo. Web Histo.com
Markings on Dentin Tubules:

- **Length of the Dentin tubule**
  - Has striations called **Daily Imbrication Lines of Von Ebner**
  - In between the lines is the amount of dentin that you make in 1 day (4-8μm)
  - Segments of dentin are called **Contour Lines of Owen**
    - Result from metabolic disturbances during development
    - Indicative of health of person during dentin formation
    - **Neonatal Line** is an exaggerated Line of Owen
      - Just like in enamel, a **Neonatal line in dentin**: Demarcates trauma experienced during birth
Dentin: Granular layer of Tomes/ Hyaline layer of Hopewell-Smith

- Granular layer of Tomes: A granular appearing layer of dentin underlying the cementum that covers the root. Viewed under transmitted light in ground sections.
  - Located in the peripheral most layer of radicular dentin.
  - Increases slightly in width, proceeding from the CEJ to the root apex.
  - Possibly a coalescing and looping of the terminal portions of the dentinal tubules. Seen only because of light refraction in thick ground sections.
  - Also, suggested to be a special arrangement of collagen and noncollagenous matrix proteins at the interface between dentin and cementum.

- The clear layer between the granular layer of Tomes and cementum is known as the Hyaline layer of Hopewell-Smith. Facilitates the adherence of cementum and dentin.

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The image above is a cross section of a decalcified root. Note the position of Odontoblasts, predentin and dentin as you move out from the pulp.
Clinical Significance: Natural Desensitization

- Sclerosis of dentin deposition of secondary, and repairative dentin. Several naturally occurring processes that can improve hypersensitivity over time.
Clinical Significance:
Tetracycline staining and Bleaching

During the 1950’s Tetracycline was the drug of choice for pneumonia. If a young child receives this antibiotic during tooth development, it can be incorporated into tooth structure and be seen histologically. Depending on the stage and level within the tooth when the tetracycline was incorporated, clinical bleaching of the stained teeth can be compromised. Generally, tetracycline stained teeth have a decreased prognosis for success and in many cases the preferred treatment are veneers.
THE END