Dentin

   a. Assigned Reading:
      i. Chapter 3.

B. Objectives: To recognize and apply the following concepts to clinical dentistry.
   1. Physical Properties of Dentin
   2. Dentinal Tubules
   3. Dentinal Tubules
      a. Peritubular Dentin
      b. Intertubular Dentinal
   4. Types of Dentin
      a. Peritubular
      b. Intertubular
      c. Primary Dentin
      d. Secondary Dentin
      e. Tertiary Dentin
      f. Dead Tracks
      g. Sclerotic Dentin
      h. Globular Dentin
      i. Interglobular Dentin
   5. Markings on Dental Tubules
      a. Daily imbrication lines of von Ebner
      b. Contour Lines of Owen
      c. Neonatal line
   6. Dentin Intervention
      a. Granular layer of Tomes
      b. Hyline layer of Hopewell-Smith
   7. Root Dentin
      a. Nerve Fiber Theory
      b. Odontoblastic process Theory
      c. Hydrodynamic Theory

C. Physical Properties of Dentin
   a. 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.
   b. It is composed of 65-70% mineralized substances and 20-25% organic material and 10% bound water.
c. The mineralized substance is calcium hydroxyapatite in the form of small plates.
d. The organic material is about 30% (mainly type I) collagen and ground substance.
e. The color of dentin is yellow.
f. 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.

D. Dentinal Tubules

a. Dentinal tubules are enclosed spaces, surrounded by peritubular dentin, which connects the pulp to the DCJ and DEJ.
b. Primary Curvature is S-shaped (note the lazy “s” of the primary curvature)

c. Secondary Curvature: jagged or wrinkled texture
d. Curvatures result from movement of odontoblasts during development

e. In the coronal portion of the tooth, dentin has a “S” shaped curvature.

   Vs.

f. In the root portion of the tooth, dentin has a more straight path.
g. Dentinal tubules contain fluid = extracellular fluid (ECF)
i. Comes from pulp and provides nutrients
ii. Extends from the pulp to the DCJ or DEJ
iii. Important for pain sensation

h. Peritubular dentin and Intertubular dentin
   i. Peritubular Dentin- A more highly calcified “collar” of dentin which surrounds the dentinal tubules.
   ii. Intertubular dentin- dentin located between the dentinal tubules
       1. Type I collagen: arranged randomly and roughly approximately right angles to dental tubules.

Cross section of Dentin

E. Types of Dentin
   a. Primary Dentin: all dentin formed prior to root formation or completion.
   i. Two Types: All collagen in Dentin is produced by Odontoblasts.
      a. Mantle Dentin (M) is the area of initial dentin matrix formation and is the first formed dentin. Some
         Investigators disagree on the location of mantle dentin and believe it is only located in the crown of the tooth. Ten
         Cate and Gartner locate it in both the crown just below the DEJ and the root of the tooth.
         b. Mantle Dentin is ~20 micrometers thick and slightly less mineralized than circumpulpal dentin.
      c. The fibers are perpendicular to the DEJ in the crown.
i. Made principally of Large coarse bundles of type I collagen.
   1. However the first sign of dentin formation contains von Korff's fibers, which are large-diameter Type I collagen fibrils.

2. Circumpulpal dentin forms the remaining and the bulk of primary dentin.
   a. The collagen fibers are much narrower (~0.05 micrometers thick) than mantle dentin.
   b. It is more mineralized than mantle dentin.
   c. It is more compactly arranged collagen fibers than mantle dentin.

**Mantle dentin drawn in

b. Secondary Dentin: all dentin produced after root formation or completion. (NOT due to trauma)
   i. Secondary Dentin is a narrow band of dentin around the pulp chamber and is formed subsequent to root completion.
   ii. It is not formed as a response to trauma.
   iii. It is formed at a slower rate than primary dentin.
   iv. It contains fewer tubules than primary dentin.
   v. It is formed in an unequal fashion and more secondary dentin produced on the roof and floor of the pulp than on the walls.
vi. There is usually a bend in the direction of the tubules where primary and secondary meet.

c. Tertiary Dentin: all reparative dentin (all regular and irregular)*
   i. 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
      1. 2 kinds:
         a. If lesion is due to chronic trauma (slow process), dentin is regular
            i. Chronic reparations made by odontoblasts (more recovery)
         b. If lesion is due to acute trauma (fast process), dentin is irregular
            i. Acute reparations made by fibroblasts (because the cell died)

d. Dead Tracts (empty dentinal tubules that lead directly to pulp)
   i. If the carious demineralization of enamel reaches dentin, the carious lesion allows bacteria to enter the dentinal tubules
   ii. Odontoblasts can then be either damaged or killed, as well as their processes.
      1. If killed, then there will be areas of dentin w/ no odontoblasts:

Note the dead tracks (D) as a result of bacteria entering into the dentinal tubules.
e. Sclorotic Dentin
   i. Sclerosis of dentin is the naturally occurring deposition of minerals within
tubules that results in the occlusion of the dentinal tubules and a thicker
layer of peritubular dentin.
   1. It is highly mineralized
   2. Deposited inside the periphery of the tubules.
   3. The tubules become smaller in diameter and less permeable and
so transmit stimuli to a lesser degree.
f. Process of Dentin Calcification: Dentin is formed throughout the life of the tooth.
i. It begins at the onset of tooth eruption.
ii. The rate of deposition of radicular dentin is slower than coronal dentin.
iii. It is completed after the completion of eruption.
   1. Deciduous teeth: dentin formation complete ~18 months post
eruption.
   2. Permanent teeth: dentin formation complete ~2-3 years post
eruption.
iv. Two patterns of dentin mineralization
   1. Dependant on the rate of dentin formation.
a. Globular Mode of Calcification: Dentin deposition is the
fastest. Dentin is NOT uniformly calcified.
   i. Located in the Crown of the tooth: Coronal Dentin
begins at the early bell stage of tooth development
in the apex of the crown.
   ii. Formed from the deposition of crystals in various
discrete areas.
      1. Globular masses are formed by continued
crystal growth until they fuse and form a
single calcified structure.
      2. Best seen in the calcification of mantle
dentin.
      3. Globular Dentin: 65% calcified
4. Interglobular Dentin: not as calcified
   a. May be the result of a vitamin D
deficiency and/or high Floride
   concentration during
dentinogenesis
b. **Linear Mode of Calcification:** Slowly deposited dentin.
   i. In Circumpulpal dentin there is both the globular and the linear mode of mineralization.

c. **Root:** *Radicular Dentin* forms at a slightly later stage than coronal dentin and is uniformly calcified in the root.
   1. Different in Structure and composition from coronal dentin.
      a. Less phosphoryn and degree of mineralization is slightly less than coronal dentin.
      b. The first collagen fibers of the dentin matrix are aligned parallel to the dental lamina.

F. **Markings on Dentinal Tubules**
   a. Length of the Dentin tubule
      i. Has striations called **Daily Imbrication Lines of Von Ebner**
         a. In between the lines is the amount of dentin that you make in 1 day (4-8µm)
      ii. Wide arcs of rings in dentin are called **Contour Lines of Owen**
         a. Result from metabolic disturbances during development.
         b. Indicative of health of person during dentin formation.
         c. Hypocalcified dentin.

a. Just like in enamel, a **Neonatal line in dentin:**
   b. Demarcates trauma experienced during birth

G. **Dentin Intervention**
   a. Granular layer of Tomes: A granular appearing layer of dentin underlying the cementum that covers the root. Viewed under transmitted light in ground sections.
      i. Located in the peripheral most layer of radicular dentin.
ii. Increases slightly in width, proceeding from the CEJ to the root apex.

iii. Possibly a coalescing and looping of the terminal portions of the dentinal tubules. Seen only because of light refraction in thick ground sections.

iv. Also, suggested to be a special arrangement of collagen and noncollagenous matrix proteins at the interface between dentin and cementum.

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

c. Facilitates the adherence of cementum and dentin.

H. Natural Desensitization

a. Sclerosis of dentin and deposition of secondary, and tertiary dentin. are several naturally occurring processes that can improve hypersensitivity over time.

I. Tetracycline Staining and Veneers

a. Generally, tetracycline stained teeth have a decreased prognosis for successful bleaching and in many cases the preferred treatment are veneers.