Enamel

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This material was taken from:

- WebHisto.com
- Leeds University Web Site:
  - The Virtual Histology Lab (Ver. 2,1)
    - http://www.leeds.ac.uk/dental/Oroface/virtlab/histolab/histintr.html
Objectives: To recognize and apply the following concepts:

- Physical Properties of Enamel
- Enamel Rods
  - Rod Arrangement
  - Rod Morphology
  - Arrangement of Enamel Crystals
- Histology of Enamel
- Dentinoenamel Junction (DEJ)
  - Enamel Spindles
  - Enamel Tufts
  - Enamel Lamellae
- Gnarled Enamel
- Hunter-Schreger Bands
- Clinical Significance of Histology
Physical Properties of Enamel

- **Enamel**, located only in the crown, is the hardest tissue in the body.
- It is composed of 96% mineralized substances and 4% organic material and bound water.
  - The mineralized substance is *calcium hydroxyapatite*.
  - The organic material is mostly *enamelin*.
- The color of enamel ranges from yellow to white depending upon its transparency. At the incisal edge in a newly erupted tooth, it is pale blue.
- The enamel of a young individual is more permeable to water, ions, and low molecular weight substances than that of an older person.
Enamel Rods

- Enamel is manufactured by *ameloblasts* in increments called rod segments that are placed on top of each other to form an *enamel rod* (enamel prism).
- These tightly packed rods are parallel to each other.
- Each rod follows a tortuous course from the *dentinoenamel junction (DEJ)* to the tooth surface.
- Each rod is perpendicular to a tangent at its origin at the DEJ as well as to its termination at the surface of the tooth.

Histological slide prepared and provided by the Department of Biomedical Sciences, University of Maryland, Dental School.
Rod Arrangement

- Enamel rods are arranged in such a fashion that they radiate from the DEJ similar to the spokes of a wheel; however, each spoke has curves superimposed upon it in three dimensions.

- Visualizing rods as they are arranged throughout the length of enamel, it becomes evident that enamel rods are parallel to each other within any one plane.

- Comparing the paths of enamel rods in parallel planes, it may be noted that the paths of the rods diverge by 2 degrees from each other, to a maximum of +/- 10 degrees.

- It is this arrangement of the rods that reduces the formation of cleavage planes in enamel.
Rod Morphology

- Enamel rods are keyhole shaped.
- Each rod possesses a wide head and narrow tail.
- This shape permits a tight packing of the rods so that they appear to fit together as pieces of a puzzle.
- During amelogenesis, each head is formed by a single ameloblast and three other ameloblasts participate in the formation of the tail.
- The head is believed to be the actual enamel rod, whereas the tail is considered to be interrod enamel.

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Arrangement of Enamel Crystals

- The ability to differentiate between individual rods and between head and tail within individual rods is dependent upon the orientation of crystals within the rod.
- Crystals located within the center of the rod are arranged parallel to the longitudinal axis of the rod, whereas crystals at the periphery of the rod are arranged at an oblique angle to the longitudinal axis of the rod.
- Crystals located within the center of the tail of the enamel rod are arranged perpendicular to the longitudinal axis of the rod.
Arrangement of Enamel Crystals

- This arrangement of the crystals permits a differential refraction of the electron beam and thus delineates the limit of each enamel rod as well as the ability to differentiate between the rod and the tail.
- Each crystal is as much as 800-900 nm in length and approximately 25 nm in breadth.
- Each crystal is covered by a thin layer of enamelin; thus, the organic component of enamel is equally distributed throughout the substance of enamel.
Histology of Enamel

- Viewed with the light microscope, enamel displays the diurnal rhythm of amelogenesis by the presence of **daily imbrication lines**, transverse lines across the enamel rods.
  - The enamel located between two adjacent daily imbrication lines was formed in a single day and is the rod segment of tooth development.
  - Depending on the health of the mother and/or baby, the enamel formed may be hypocalcified or calcified normally.
  - **Striae of Retzius** are resultant developmental disturbances recorded in enamel. They are composed of sequential groups of hypocalcified or normally calcified enamel rods.

![Diagram of daily deposition of enamel matrix, Striae of Retzius, Rod, Rod sheath (a, b)]
A special form of daily imbrication lines, known as neonatal lines, are present in those teeth whose crowns were being formed at the time of birth.

At the tooth surface, Striae of Retzius overlap each other, forming parallel shallow grooves known as **perikymata**, and parallel elevations known as **imbrication lines of Pickerill**.

- Both perikymata and imbrication lines of Pickerill disappear as the enamel is abraded with function and age.
Histology of Enamel

**A Striae of Retzius is located between the two arrows.

Histological slide prepared and provided by the Department of Biomedical Sciences, University of Maryland, Dental School.
Dentinoenamel Junction (DEJ)

- The **DEJ** is scalloped so that the convexity of the enamel fits into the concavity of dentin.
- Several structures are evident at the DEJ: enamel spindles, enamel tufts, and enamel lamellae.

Histological slide prepared and provided by the Department of Biomedical Sciences, University of Maryland, Dental School.
Tufts and Enamel Lamella

- **Enamel spindles** are short spindle-like structures that are the ends of dentinal tubules that are trapped in enamel.
- **Enamel tufts** are hypocalcified enamel rods that resemble tufts of grass.
- **Enamel lamellae**, hypocalcified enamel rods, are of two types, false and true.
  - *False enamel lamellae* are cracks in enamel and frequently extend into the dentin.
  - *True enamel lamellae* are hypocalcified enamel rods that are poorly calcified or uncalcified due to developmental disturbances affecting the ameloblasts.
Tufts and Enamel Lamella

The image above can be found on the Leeds University Web Site: The Virtual Histology Lab (Ver. 2,1)
http://www.leeds.ac.uk/dental/Oroface/virtlab/histolab/histinintr.html#
Enamel Lamellae

**Histological slides prepared and provided by the Department of Biomedical Sciences, University of Maryland, Dental School.**
**Gnarled Enamel and Hunter-Schreger Bands**

- **Gnarled enamel** is located deep to the cusps and is a region where the enamel rods intertwine as they pass from the DEJ to the tooth surface.
  - This changing orientation protects the enamel from the formation of cleavage planes.

- When viewed with reflected light instead of transmitted light, the curvature of enamel rods illustrate a phenomenon as Hunter-Schreger bands. The dark bands are diazones, whereas the light bands are known as parazones. See image #1. below:

Illustration #2 above is of the changing orientation of rods in the region of Hunter-Schreger Bands view under transmitted light.

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#](http://www.leeds.ac.uk/dental/Oroface/virtlab/histolab/histintr.html#)
Clinical Significance of Fluoride: Benefit vs. Risk

- When the fluoride ion is incorporated into the hydroxyapatite crystals during mineralization the resulting enamel is more resistant to acid. This is one aspect of the role of Fluoride in caries prevention.

- However, ameloblasts are very sensitive to Fluoride ions and high (above 5 parts/ million=Fluorosis) levels of fluoride can disturb or kill ameloblasts causing malformed enamel or “mottled” enamel.

Images complements of Dr. Glen Minah
Fluorosis

Excess F affects mineralization of developing teeth.

Up to age 6 is the critical age for fluorosis. After age 8, risk is past.

Images complements of Dr. Glen Minah
Clinical Significance: Trauma and High Fever During Enamel Formation

- Trauma to primary teeth can cause damage to the developing permanent tooth and result in an enamel defect.
- Childhood diseases causing high temperatures can disturb amelogenesis for the period of illness and cause a band of poorly formed enamel known as chronologic enamel hypoplasia.

**Note line of hypoplasia across anterior teeth, esp. noticeable on maxillary lateral incisors and mandibular canines.**
THE END