中山醫學大學牙醫學系

口腔胚胎與組織學實驗講義

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Topic	Oral Histology and Embryology Lab
Owner	

中山醫學大學牙醫學系 105 級

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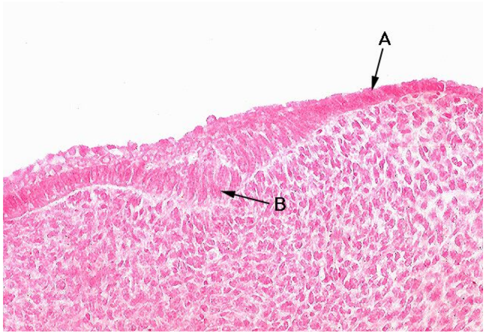
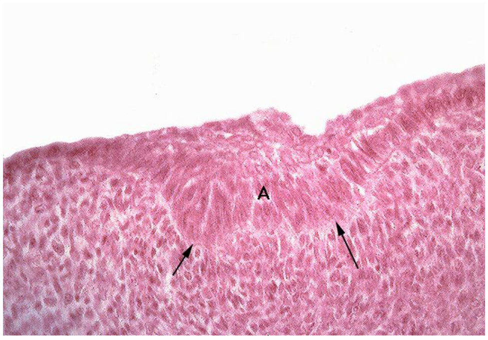
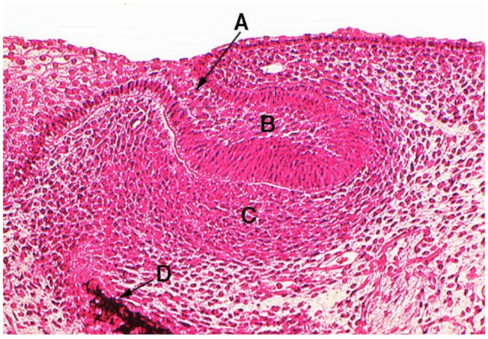
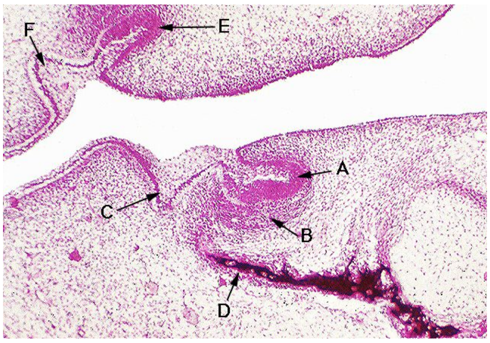
Oral Histology and Embryology Lab – Tooth development
(http://www.uky.edu/~brmacp/oralhist/module3/lab/oh3main.htm)

3. Primary epithelial band  A - oral epithelium B - primary epithelial band	The earliest event in the origin of each dental organ from the oral epithelium (A), is a thickening of the epithelium as is seen in this image. This proliferation of oral epithelium forms the primary epithelial band (B). This band arises in the lateral region of both maxillary and mandibular processes at about six weeks in utero. The band soon becomes continuous across the middle line of the developing arches and progresses posteriorly to form a horseshoe-shaped thickening in each process.
4. Invagination of primary epithelial band  A - primary epithelial band arrow - bifurcation of primary epithelial band	The primary epithelial band (A) thickens and begins to bifurcate into two bud-like processes (arrows).
5. Dental and vestibular laminae  A - primary epithelial band B - dental lamina C - vestibular lamina	The two processes that arise from the single primary epithelial band (A) continue to proliferate into the underlying tissue. One of these processes becomes the dental lamina (B), and the other becomes the vestibular lamina (C). These two laminae make their appearance during the 7th week in utero. The vestibular lamina will eventually form the oral vestibule - the space between your lip and gingiva.

7. Development of the dental organ  A - dental lamina B - dental organ C - mesenchymal cells D - alveolar bone socket	At the site of each future tooth, the epithelial cells of the dental lamina (A) proliferate to produce swellings. These swellings along the shelf-like dental lamina are referred to as primary dental (enamel) organs or tooth buds (B). This is referred to as the bud stage of morphogenesis. Note the condensation of underlying mesenchymal cells (C) in the region under the central aspect of the bud. This region of the tooth bud will continue to invaginate giving the tooth germ a cap-like morphology. Also note the beginning of the formation of the alveolar bone socket (D).
8. Mandibular tooth development  A - mandibular dental organ B - mesenchymal cells C - mandibular vestibular lamina D - alveolar process E - maxillary dental organ F - maxillary vestibular lamina	At low magnification, the relationship of a developing dental organ (A) in the lower (mandib-ular) arch with a corresponding one in the upper or maxillary arch (E) can be observed. Usually events in the mandibular arch occur slightly in advance of those in the maxillary arch. Note the condensation of mesenchymal cells (B) around the cap stage of the dental organ. These cells are derived from ectomesenchyme which is of neural crest origin. Also note the locations of the vestibular laminae (C and F), and the bone of the alveolar process (D). Ossification of the mandible begins in the 7th week in utero, at the same time that the dental lamina appears.

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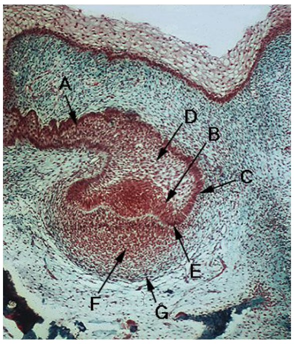
9. Cap stage of morphodifferentiation



A - dental lamina
B - inner dental epithelium
C - outer dental epithelium
D - stellate reticulum
E - cervical loop
F - mesenchymal cells
G - dental follicle/sac
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The cap shape of the dental organ is more distinct in this image. The vestibular lamina lies just outside the field to the left. The dental lamina (A) appears as a strand of epithelial tissue that connects the dental organ to the upper wall of the developing vestibular lamina. The dental organ (B through D), in the cap stage, consists of inner dental epithelium, IDE, (B) which forms the inner lining of the cap, outer dental epithelium, ODE, (C) which forms the outer lining of the cap, and the stellate reticulum (D) occupying the area between the two epithelial layers. The ODE and IDE are continuous at the cervical loop (E) - the rim of the cap. The condensed mesen-chymal cells (F) capped by the dental organ will form the dental papilla. Another condensation of mesenchyme that surrounds the dental organ and merges with the dental papilla is the dental follicle or sac (G). The dental organ and the dental papilla and follicle together are called the tooth germ. since at this stage, all of the formative tissues are present which will give rise to a complete tooth.
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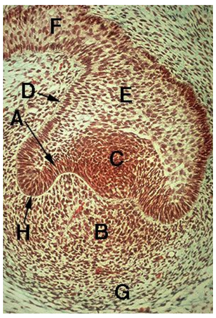
10. High power of cap stage



A - inner dental epithelium
B - dental papilla
C - enamel knot
D - outer dental epithelium
E - stellate reticulum
F - dental lamina
G - dental sac/follicle
H - cervical loop
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This is a higher magnification of the cap stage tooth bud seen in the preceding image (# 9). The knot of cells in the center of the field is composed of IDE cells (A) that bulge downward into the top of the dental papilla (B). This mass is referred to as the enamel knot (C). This is a transient structure that appears and disappears during the cap stage. There is no known functional significance attached to it. Also identify the ODE (D), stellate reticulum (E), dental lamina (F), dental sac/follicle (G), and cervical loop (H).
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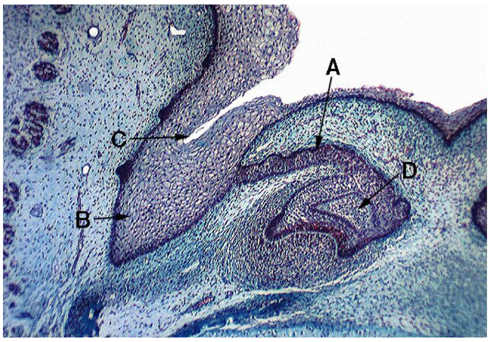
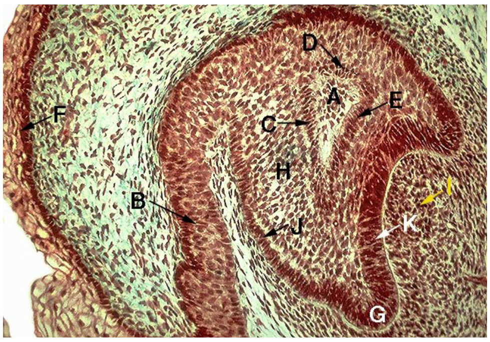
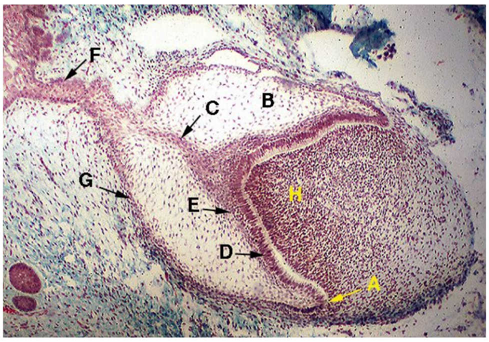
11. Development of enamel niche  A - dental lamina B - vestibular lamina C - lip furrow D - enamel niche	At this magnification, the relation-ship of the dental lamina (A) to the vestibular lamina (B) can be seen. During the cap stage, a cleft-like space develops in the vestibular lamina forming the lip furrow (C). Note the island of connective tissue that appears within the dental organ (D). This lateral invagination of connective tissue creates the enamel niche.
13. High power of enamel niche  A - enamel niche B - dental lamina C - lingual wall of niche D - buccal wall of niche E - floor of the niche F - oral epithelium G - cervical loop H - stellate reticulum I - dental papilla J - outer dental epithelium K - inner dental epithelium	This section shows an enamel niche (A). Connective tissue surrounding the dental organ fills the niche, giving the impression of an island of connective tissue within the dental organ. The dental lamina (B) forms the lingual wall of the niche (C), the thickened portion of the buccal lamina forms the buccal wall of the niche (D), and the dental organ forms the floor of the niche (E).

14. Bell stage of morphogenesis

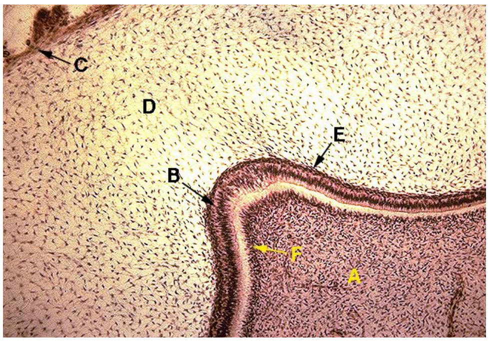


A - cervical loop
B - stellate reticulum
C - enamel septum
D - inner dental epithelium
E - stratum intermedium
F - dental lamina
G - outer dental epithelium
H - dental papilla

This tooth germ is further developed than those seen in the preceding images. The cells in the cervical loop area (A) proliferate causing the rim of the cap to grow deeper into the connective tissue. This transforms the shape of the dental organ from a cap to a bell. The tooth germ in this section is considered to be in the early bell stage. Note the increase in intercellular material in the stellate reticulum (B) and the elongation of the IDE (D) cells into columnar cells.

A dense strand of cells (C) crosses the stellate reticulum from the dental lamina to the central region of the inner dental epithelium - the enamel septum. The enamel septum is another transitory structure with no known significance. In the dental organ, a condensation of epithelial cells covers the inner surface of the columnar, IDE cells. The layer is called the stratum intermedium (E) - intermediate in position between the stellate reticulum and the IDE cells.

15. Bell Stage of IDE at Cusp of Tooth



A - dental papilla
B - inner dental epithelial cells
C - outer dental epithelium
D - stellate reticulum
E - stratum intermedium
F - odontoblasts

Up to mid bell stage, phenomenon within the dental organ have been concerned only with altering the shape or morphology of the developing tooth. The columnar cells of the IDE (B) will now induce the differentiation of columnar-shaped odontoblasts (F) from the dental papilla (A). This process begins at the tip (cusp) of the cap stage tooth germ where the oldest IDE cells are found. The youngest IDE cells lie in the periphery (not seen in this image) where they are arising from the proliferating epithelial at the cervical loop.

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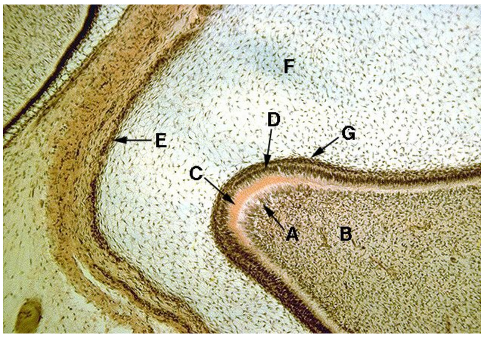
16. Secretion of predentin



A - odontoblasts
B - dental papillae
C - predentin
D - inner dental epithelium
E - outer dental epithelium
F - stellate reticulum
G - stratum intermedium

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As the odontoblasts (A) continue to differentiate on the periphery of the dental papilla (B), they begin to secrete a product between themselves and overlying cells of the IDE. This product is predentin (C). Predentin is converted to dentin by mineralization. The central region of a bell stage tooth germ is in the center of the field. You should be able to identify: IDE (D), ODE (E), stellate reticulum (F), and stratum intermedium (G).

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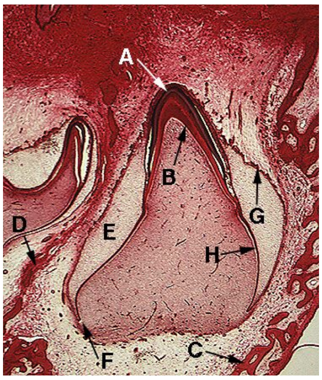
18. Enamel formation continues



A - enamel
B - dentin
C - alveolar bone socket
D - dental septum
E - stellate reticulum
F - cervical loop
G - outer dental epithelium
H - inner dental epithelium

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This tooth is further advanced in its development. The columnar IDE cells producing enamel called ameloblasts. The enamel (A) is the deep purple straining layer forming a "cap" over the reddish dentin layer (B). Enamel is deposited between the ameloblasts and the dentin. Enamel formation does not take place until some dentin has been formed. Note that an ODE (G), stellate reticulum (E) and stratum intermedium can no longer be distinguished in the region over the ameloblasts (at the tip of the developing cusp). The condensation of these layers bring capillary beds close to the ameloblasts which no longer can count on receiving nutrition from the capillaries in the dental papilla because of the intervening layers of dentin and enamel. Identify the structures indicated by the remaining letters.

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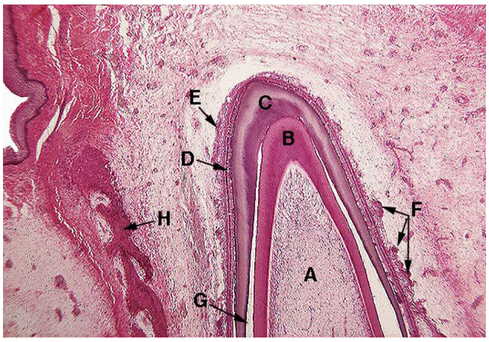
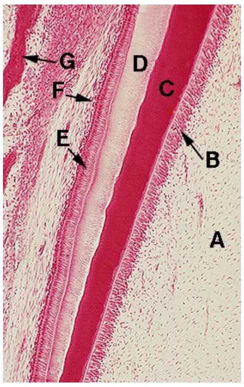
21. Developing cusp of a tooth



A - dental pulp
B - dentin
C - enamel
D - ameloblasts
E - stratum intermedium/ODE
F - capillaries
G - artifactual space
H - alveolar bone socket

This is a section of the developing cusp of a tooth. The term dental papilla is generally replaced by the term dental pulp (A) when hard tissues, dentin (B) and enamel (C) begin to be deposited. Also identify the layer of ameloblasts (D) on the leading edge of the enamel layer and the collapsed stratum intermedium and ODE (E) that lie immediately adjacent to them. Note the large number of capillaries (F) that lie immediately outside this cellular periphery of the cusp. The clear region, indicated by G, is an artifactual separation of enamel and dentin that occurred during processing. The alveolar bone socket (H) can be seen on the left.

22. Developing cusp of an incisor



A - pulp
B - odontoblasts
C - dentin
D - enamel
E - ameloblasts
F - condensed ODE and stratum intermedium
G - alveolar bone

This is part of a section through a developing incisor. Starting with the pulp (A) on the lower right portion of the field, and progress-ing upward to the connective tissue on the left, identify: odontoblasts (B), dentin (C), enamel (D), ameloblasts (E), and the condensed layer of the remaining cells of the dental organ (ODE and stratum intermedium - F). What is G?

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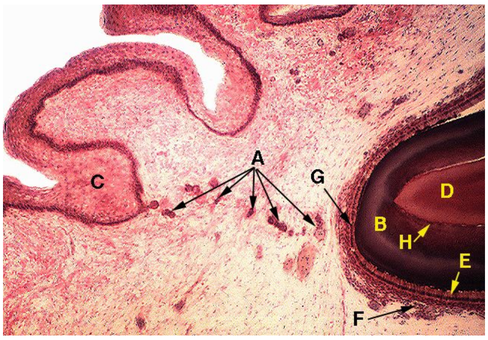
23. Disintegrating dental lamina



A - disintegrating dental lamina
B - enamel
C - oral epithelium
D - dentin
E - ameloblasts
F - condensed ODE and stratum intermedium
G - early reduced enamel epithelium
H - dentinoenamel junction

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Note the broken line of dark material (A) that extends from the tip of the developing cusp (G) to the epithelial surface (C). These are islands of epithelial cells that represent the remains of the disintegrating dental lamina. Identify all the structures labelled.

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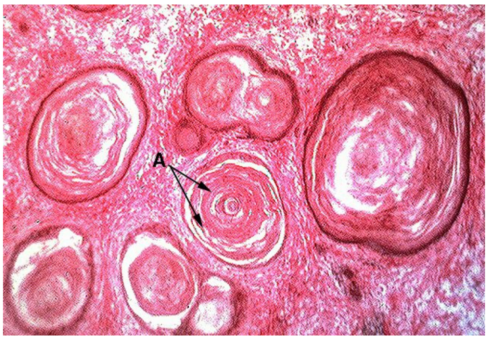
24. Epithelial pearls



A - epithelial (Serre's) pearl

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A disintegrating dental lamina is viewed at a much higher power. Frequently, these islands of epithelial cells form small cyst-like structures filled with a keratin-like material arranged in concentric lamella (A). These structures are referred to as epithelial (Serre's) pearls.

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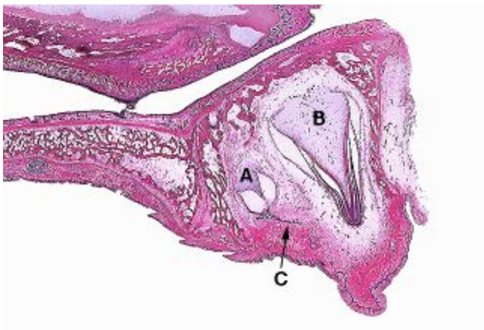
25. Primordia of Successional Teeth



A - primordium of successional tooth
B - bell stage development of deciduous tooth
C - dental lamina of successional tooth

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The primordia of the successional teeth arise from an offshoot of the dental lamina during the bell stage development of the deciduous teeth. In this image, the primor-dium of a permanent incisor (A) is arising lingual to the deciduous incisor (B). The dental lamina for the successional dental organ is still visible as a thin line (C).

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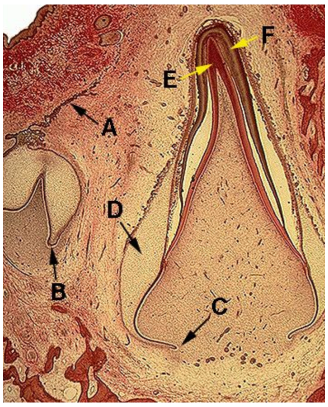
26. Dental Lamina of Successional Teeth



A - dental lamina of permanent tooth
B - cervical loop
C - epithelial diaphragm
D - stellate reticulum
E - dentin
F - enamel

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This is a higher magnification of the developing teeth seen in the preceding image (# 25). The attachment of the dental lamina (A) of the permanent tooth to adjacent epithelium is incomplete. The dental lamina for the successional tooth originates from the dental organ of the deciduous tooth near its dental lamina. Note the difference in morphology between the cervical loop region (B) in the deciduous tooth. The cervical loop turns inward once crown formation is complete and becomes the epithelial diaphragm (C). This will migrate downward to next form the root of the tooth. Identify the remaining structures indicated alphabetically.

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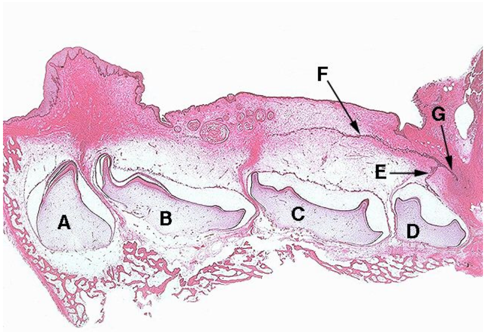
28. Section Through the Maxillary Process



A - canine tooth
B - first molar
C - second molar
D - first permanent molar
E - dental lamina of 1st permanent molar
F - shelf-like dental lamina
G - extension of dental lamina

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This section passes through the deciduous canine (A), first (B) and second (C) molars, and the first permanent molar (D). Note the strand of dental lamina attached to the dental organ of the first permanent molar (E). The dental lamina can be seen as a section through it's plate-like nature (F) and its posterior projection from which the second and third permanent molars will arise after birth (F) is evident. The dental lamina which first appears during the 7th week in utero remains active for five or six years.

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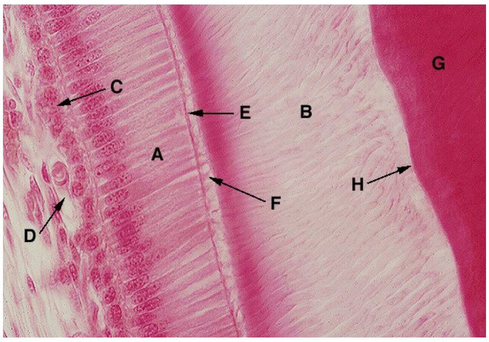
Oral Histology and Embryology Lab – Enamel
(http://www.uky.edu/~brmacp/oralhist/module6/lab/oh6main.htm)

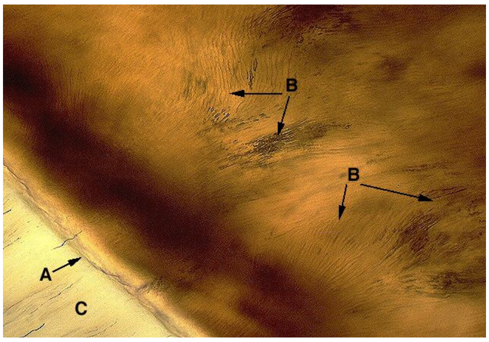
1. Enamel secretion



A - ameloblasts
B - enamel
C - condensed epithelial layer
D - capillaries
E - terminal bars
F - Tomes' processes
G - dentin
H - D-E junction

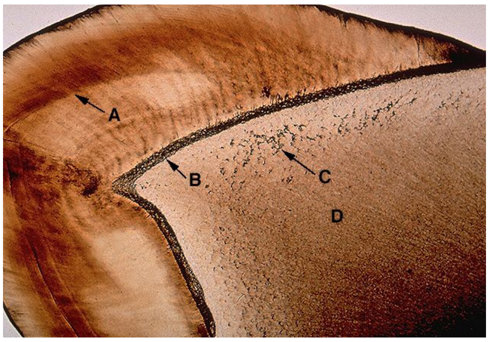
In this image ameloblasts (A) have differentiated from the cells of the IDE and are secreting enamel (B). They appear as a simple layer of tall columnar epithelial cells. Outside the ameloblasts is an epithelial layer (C) that at one time was 3 separate layers: the stratum intermedium, stellate reticulum and ODE. Capillaries (D) are always separated from the ameloblasts by this condensed epithelial layer that functions to monitor the flow of food and waste to and from the ameloblasts. Look carefully at the junction of the ameloblasts with the enamel. A densely stained line (E) appears to join the secretory ends of the ameloblasts together. This line is composed of the terminal bars. The very end of each ameloblast projects beyond the level of the terminal bars and is embedded in the immature enamel. These ends of the ameloblasts are called Tomes' processes (F). Dentin (G) lies in the upper right corner of the field.

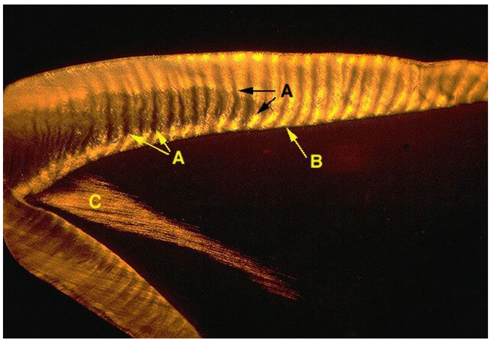
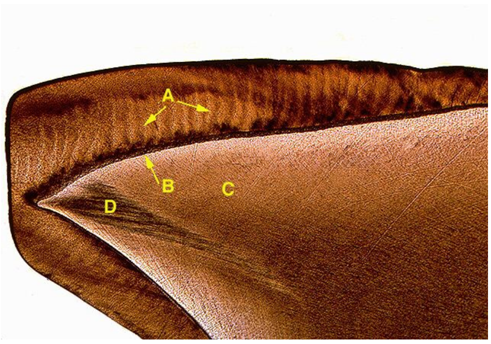
7. Gnarled enamel

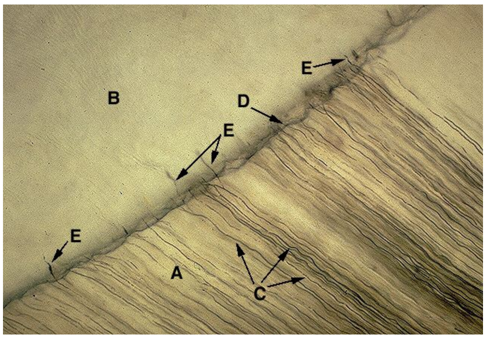
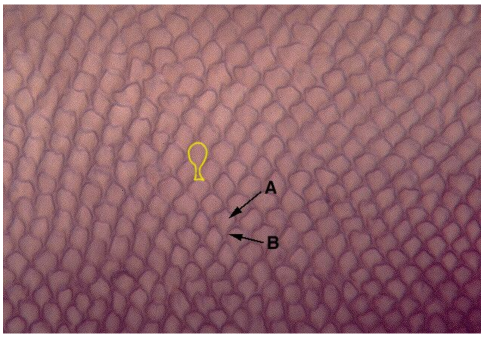
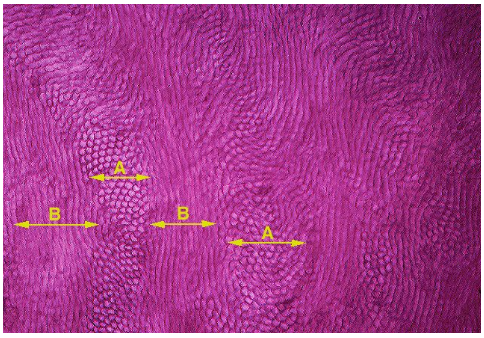


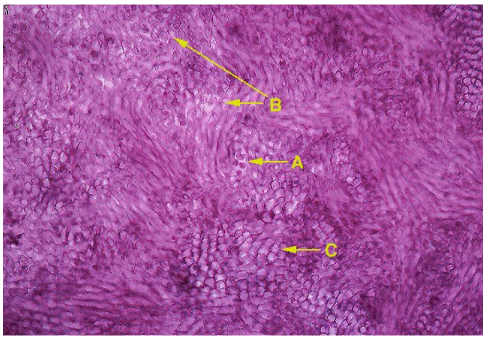
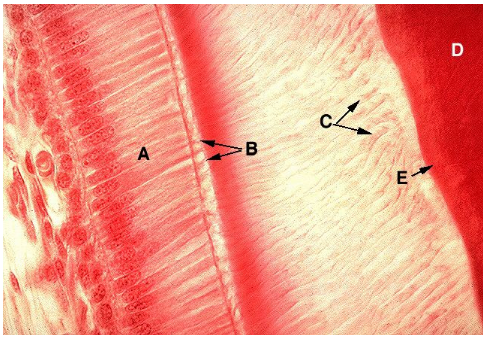
A - D-E junction
B - gnarled enamel
C - dentin

Near the D-E junction (A), espec-ially in the cuspal regions, the enamel rods form intertwining bundles (B). This arrangement of enamel rods, close to their origin at the D-E junction, is referred to as gnarled enamel.

10. Incremental lines in enamel  A - line of Retzius B - D-E junction C - interglobular dentin D - dentin	Note the lines of Retzius (A) that form an uninterrupted layer over the cusp - no part of it reaching the surface of the enamel. Lines of Retzius will not reach the surface until the thickness of the enamel in the cusp region is completed. The first line of Retzius occurs at birth and it is given a special name, the neonatal line. It reflects the dis-turbed functioning of the amelo-blasts that results from the change from intrauterine to extrauterine environments. Prenatal enamel (enamel deposited before birth) is devoid of lines of Retzius. Only deciduous teeth and 1st permanent molars possess prenatal enamel and will have a neonatal line.
14. Cross-Section Through Crown of Tooth  A - lines of Retzius	This is a cross-section through the crown of a tooth. Lines of Retzius (A) appear like growth rings in a tree stump. Enamel is harder toward the free surface than toward the D-E junction. Enamel hardness depends on: the degree of mineral-ization, the orientation of the enamel rods, the orientation of the crystallites within the rods, and the distribution of metallic ions which occur in trace amounts. Hardness at the enamel surface may be in-creased by the presence of fluoride ions.

15. Hunter-Schreger Bands  A - branching of odontoblast processes B - mantle dentin C - enamel D - lateral extensions of dentinal tubules	Examining a ground longitudinal section of the tooth with reflected rather than transmitted light, alternating light and dark bands appear in the enamel. This pattern is called Hunter-Schreger bands (A). They extend from the D-E junction (B) through about 2/3's of the enamel thickness and disappear in the outer 1/3. The bands are not commonly observed in the incisal or occlusal regions of enamel. Hunter-Schreger bands reflect the alternating direction taken by groups of enamel rods as they moved away from D-E junction during formation. What is C in this image? (look at C to check your answer).
16. Hunter-Schreger Bands in Transmitted Light  A - Hunter-Schreger bands B - D-E junction C - dentin	Using properly adjusted trans-mitted light, Hunter-Schreger bands (A) may also be identified. This is the same section examined by reflected light in the preceding image (#15). Identify B and C.

18. Enamel Spindles at the DEJ  A - dentin B - enamel C - odontoblast processes D - D-E junction E - enamel spindles	In this ground section, dentin (A) lies to the lower right, enamel (B) to the upper left. The black lines seen in the dentin represent odontoblast processes (C). Note that a few of these processes project across the D-E junction (D) into the enamel. These finger-like projections of odontoblast processes, not withdrawn during cytogenesis at the DEJ, are referred to as enamel spindles (E). Being extensions of the odontoblast process, they do not conform with the direction of enamel rods.
25. Human enamel rods  A - head of enamel rod B - tail of enamel rod	This is an image of human enamel. The configuration of the enamel rods is best seen in the lower half of the image. The yellow outlined rod indicates their configuration to be roughly key-hole or fish-shaped. Identify the two parts of each enamel rod indicated by by A and B.
28. Coronal Section Through Enamel  A - enamel rods in cross-section B - enamel rods cut longitudinally	This is a section through enamel near the D-E junction. Note how groups of enamel rods (A and B) alternate in direction. It is this arrangement of groups of enamel rods that is reflected in the Hunter-Schreger bands. Group A is oriented so that you can roughly determine the key-hole configur-ation (rods cut in cross-section). Group B on the other hand, has the enamel rods cut oblique to long-itudinally.

29. Enamel etching  A - etched enamel rods B - etched enamel rods C - non-etched enamel rods	Examine the rods near the center of the field (A). Note that they appear to be round in cross-section. Acid-etching of surface enamel is commonly done by dentists to condition enamel for better bonding with fissure sealants, restorative materials and orthodontic brackets. Acid-etching causes a dissolution of hydroxyapatite crystals to a depth of about 10 μm providing space for mechanical interlocking. Note that other areas have etched as well (B) but that some have resisted (C).
30. Enamel rod formation  A - ameloblasts B - Tomes' process C - enamel rod D - dentin E - mantle dentin	This image shows ameloblasts (A) depositing enamel. Each enamel rod is formed by the secretory products from four adjacent ameloblasts. Conversely, the secretory products from each ameloblast contributes to the formation of four rods. Each Tomes' process (B) is surrounded by the ends of four developing rods. Note the curved nature of the initial parts of each enamel rod (C). Identify D and E.

Oral Histology and Embryology Lab – Dentin
(http://www.uky.edu/~brmacp/oralhist/module5/lab/oh5main.htm)

<table>
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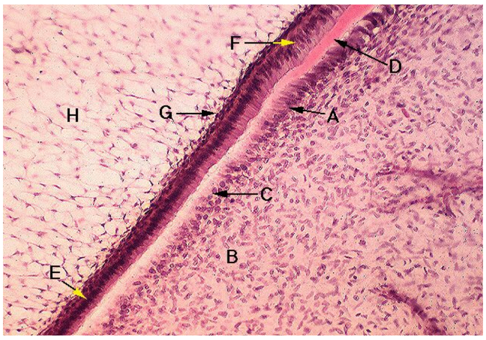
1. Developing odontoblast



A - odontoblasts
B - mesenchymal cells of pulp
C - preodontoblasts
D - predentin
E - inner dental epithelium
F - preameloblasts
G - stratum intermedium
H - stellate reticulum

</td>
<td>This image is from the region of a developing tooth where odontoblasts (A) are differentiating from the mesenchymal cells (B) of the pulp. Identify the following in this image: predentin (D), IDE (E), stratum intermedium (G) and stellate reticulum (H). The differentiation of odontoblasts is considered to result from the influence of the adjacent IDE cells. The odontoblasts on the lower half (C) are younger than those towards the top (A) and have not as yet secreted predentin (D). The cells of the IDE across from the active odontoblasts have transformed into preameloblasts (F).</td>
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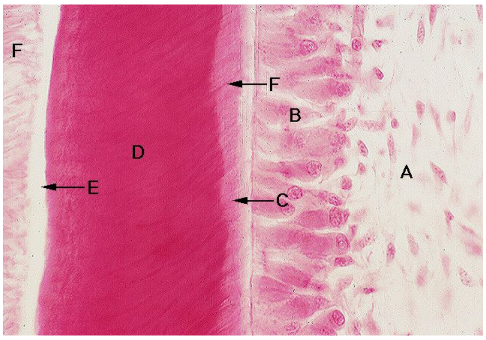
3. Dentin secretion



A - pulp
B - odontoblasts
C - predentin
D - dentin
E - enamel
F - dentinal tubule

</td>
<td>Identify the following structures in this high power image of the peripheral region of the pulp: pulp (A), odontoblasts (B), the light pink predentin (C), the darker pink dentin (D), and enamel (E). Note that the odontoblasts (B) vary in height and appear to be pseudo-stratified. Columnar-shaped odontoblasts are actively secreting predentin (C), an organic matrix. The deposition of minerals in this organic matrix converts predentin to dentin. The odontoblasts move away from the enamel as the predentin is deposited but they leave a cytoplasmic (odontoblastic) process within a tunnel of mineralizing dentin - the dentinal tubule (F).</td>
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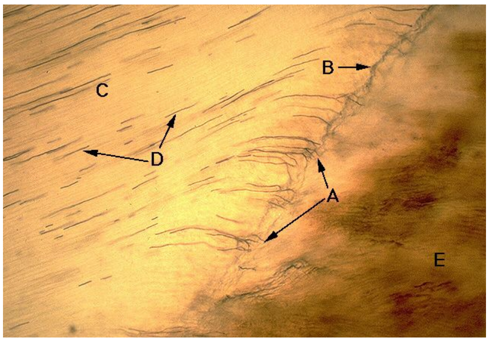
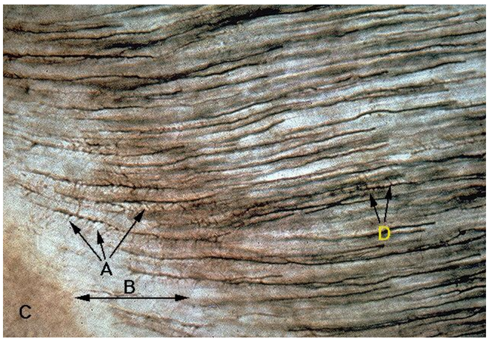
5. Odontoblast process branching  A - branching of odontoblastic processes B - D-E junction C - dentin D - odontoblast processes E - enamel	This is a ground section. Rather than processing the tissue through fluids to section it with a micro-tome knife, the tooth is simply dried and ground to a very thin disc through which light is passed. Ground sections do not demon-strate well-preserved cellular detail but do have an important role in demonstrating empty spaces in the tissue. In this ground section note the branching ends (A) of the odontoblastic processes (D) seen here in the mantle dentin just under the dentinoenamel junction (B). Terminal branching of odontoblast processes is especially profuse in root dentin.
6. Branching of odontoblast processes  A - branching of odontoblast processes B - mantle dentin C - enamel D - lateral extensions of dentinal tubules	Many fine branches of the odontoblast processes (A) can be observed in this preparation, especially in the mantle dentin (B) just under the enamel (C) at the DEJ. Lateral extensions of dentinal tubules (D), with or without a branch of the odontoblast process within them, occur at intervals of 1 to 2 µm along their length.

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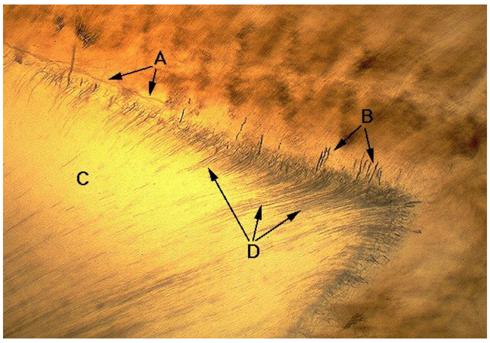
7. Enamel spindles



A - D-E junction
B - enamel spindles
C - dentin
D - dentinal tubules

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Occassionally odontoblast processes may not withdraw quickly enough back across the dentinoenamel junction (A) after touching the preameloblasts, and remain stuck in the enamel. These projections are referred to as enamel spindles (B). What are C and D?

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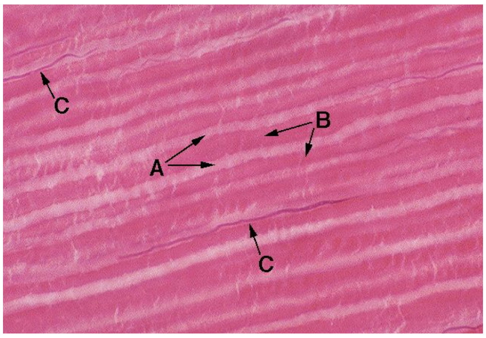
8. Dentinal tubules



A - dentinal tubules
B - intertubular dentin
C - odontoblast processes

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The concentration of dentinal tubules (A) in the mid region of the dentin layer is illustrated in this demineralized section. The tubules appear as clear (non-staining) areas, the odontoblast processes missing from most. Intertubular dentin (B) fills the space between tubules. When present, the processes appear as irregular dark purple staining lines (C). Compare the tubule density of dentin at this level with that in the next image - closer to the pulp-dentin interface.

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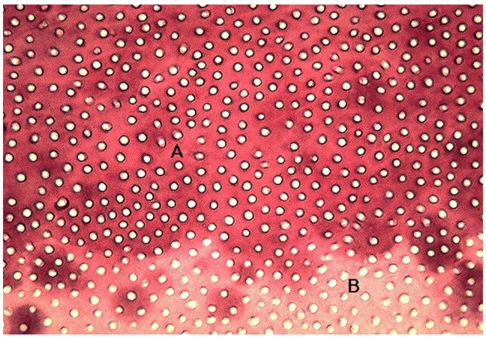
13. Demineralized cross section of dentinal tubules



A - intertubular dentin
B - predentin

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Dentin in this image has been demineralized prior to sectioning. Intertubular dentin (A) is the dark red staining material seen between tubules in this image. The pre-dentin (B) is light pink in this image. Note that intertubular dentin may also be circumpulpal or mantle dentin depending on its distance from the DEJ. Peritubular dentin is lost during demineral-ization because of its high mineral and very low collagen content. Consequently in demineralized sections, all of the dentinal tubules are approximately the same diameter. Contrast this with the last image which was a ground section where tubule size varied greatly as a result of the deposition of peritubular dentin around each odontoblast process.

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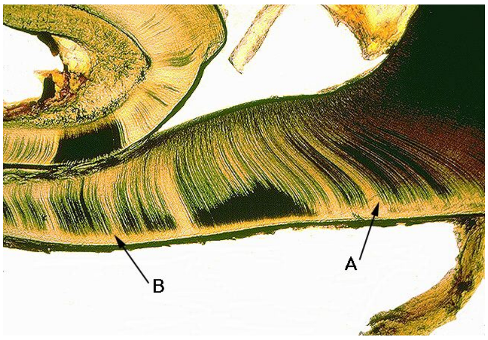
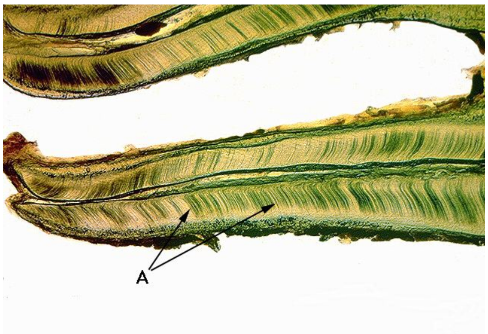
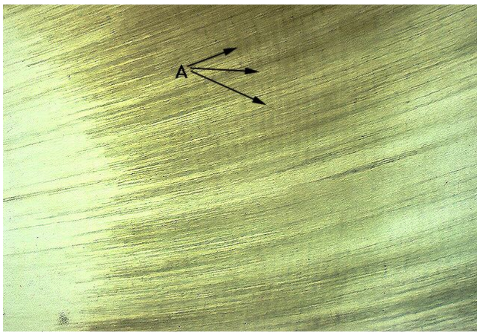
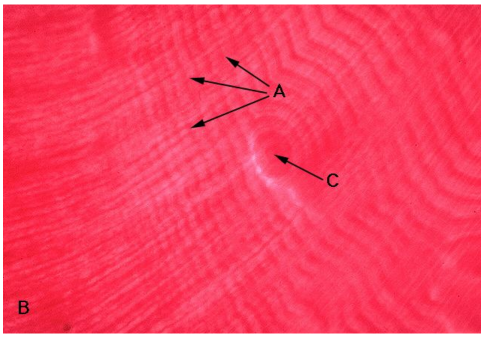
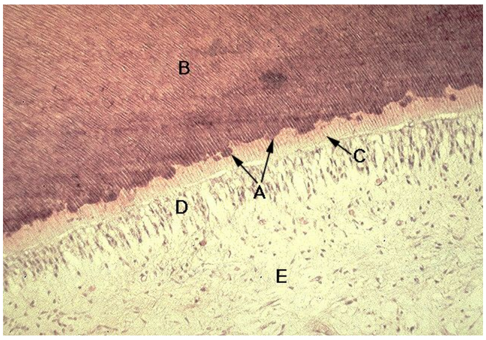
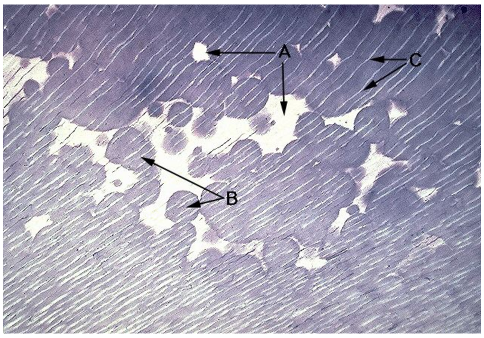
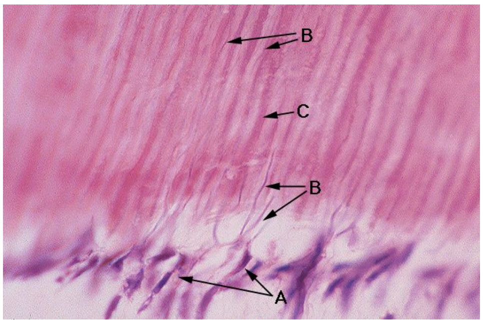
16. Changes in the primary curvature  A - dentinal tubules in the crown B - dentinal tubules in the root	Note the difference in the shape of the primary curvature of dentinal tubules in the crown (A) compared to those in the root (B). As you pass down into the root, the S-shape of the dentinal tubules flattens out to a more linear shape.
17. Dentinal tubules in the root  A - dentinal tubules in root dentin	These are the roots of the molar seen in the preceeding image. Note that the primary curvature is much less pronounced (less S-shaped) in root dentin - approaching linear (A).
20. Incremental lines in dentin  A - incremental lines of von Ebner	Dentinal tubules cross the field from left to right. Fine lines (A) run almost perpendicular to the dentinal tubules from top to bottom on the screen. Note that these lines occur at regular increments. These are the incremental lines of von Ebner. This is a ground section, but these lines can also be seen in demineralized sections. The lines of von Ebner represent cyclic activity of the odontoblasts during dentin formation. These incremental lines illustrate the daily pattern of dentin deposition that progresses at about 6 µm per day in the crown and about 3.5 µm per day in the root.

21. Demineralized incremental lines  A - incremental lines of von Ebner B - mantle dentin C - spherule-like pattern of dentin mineralization	Incremental lines of von Ebner (A) that reflect rhythmic dentin deposition are more distinctly visualized in this demineralized section. Dentinal tubules sweep across the field from lower left to upper right. The dentin in the lower left margin of the field (B) is devoid of such lines. This is a characteristic of mantle dentin. In the center of the field is a spherical configuration (C) that reflects the spherule-like mineralization pattern of dentin.
22. Dentin mineralization  A - dentin mineralization front B - dentin C - predentin D - odontoblasts E - pulp	The spherical manner of dentin mineralization is illustrated in the irregular border (A) between dentin (B) and predentin (C) in this image. Identify D and E.
24. Mineralization of dentin  A - interglobular dentin B - globular dentin C - dentinal tubules	Peritubular dentin is not deposited in interglobular dentin (A) or predentin. These two forms of dentin are similar in that they are hypomineralized. The deposition of peritubular dentin cannot be visualized in this image of globular (B) and interglobular dentin because the section has been demineralized. It does however reflect the manner in which fusion of globules of mineralized dentin eventually form a homogeneous mass.

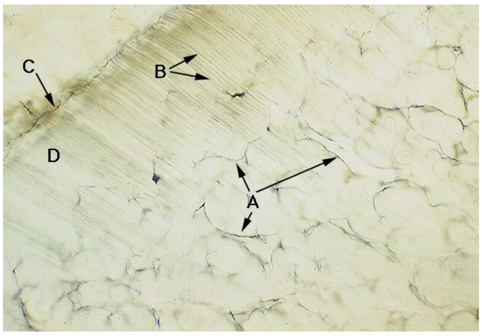
26. Pulp-dentin interface



A - odontoblasts
B - odontoblast processes
C - predentin

In this oil-imersion micrograph of the pulp-dentin interface, odontoblasts (A) and their elongated processes (B) can be visulaized. The processes extend up into the overlying layer of newly secreted predentin (C).

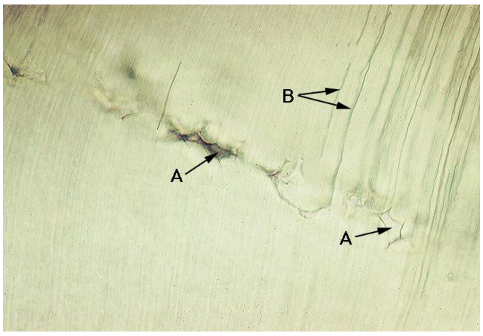
27. Interglobular dentin



A - interglobular dentin
B - dentinal tubules
C - D-E junction
D - mantle dentin

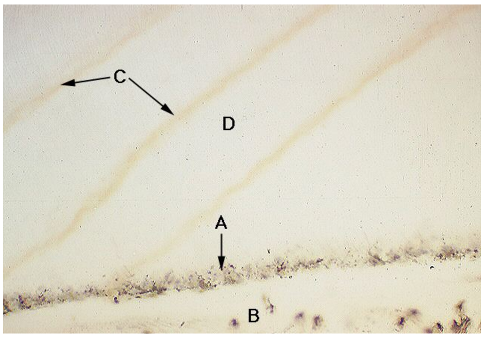
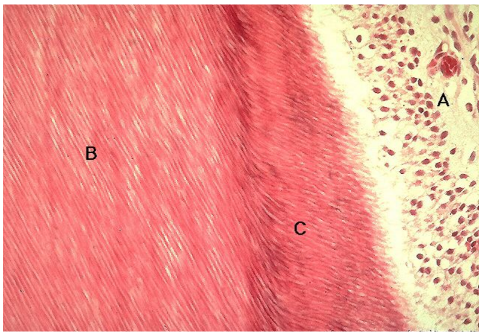
This slide illustrates the appearance of interglobular dentin in a ground section. The irregular outlines of interglobular dentin, identified by the dark semi-circular lines (A), reflect the spherical growth of the dentin globules. What are the striations indicated by B? What are the regions indicated by C and D?

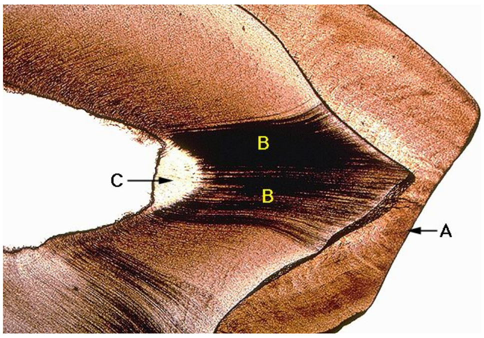
28. High power of interglobular dentin

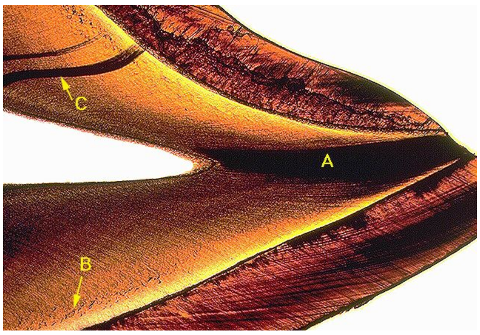


A - interglobular dentin
B - dentinal tubule

This is a higher magnification of the interglobular dentin (A) seen in the preceeding image (#27). Globular and interglobular dentin is also intertubular dentin and occurs in circumpulpal (but not mantle) dentin. What is B?

29. Tome's Granular Layer of Dentin  A - Tomes' granular layer B - cementum C - contour lines of Owen D - dentin	In the root, a layer of dark granules lie parallel to the outer surface of the dentin. This is called Tomes' granular layer (A). Cementum (B) lies along the lower margin of the field. Tomes' granular layer lies immediately adjacent to the cementum of the root in the region of the mantle dentin. Note the distinctly different colored lines (C) that traverse the dentin (D). These lines are not incremental lines of von Ebner, but rather contour lines of Owen. They reflect a major interruption in the deposition of dentin due to a metabolic distruption during odontogenesis.
32. Secondary dentin  A - pulp B - primary dentin C - secondary dentin	Note that the dentin in the left half of the field has a different pattern from that facing the pulp (A). One reason for the contrast in appear-ance is that there has been a fairly abrupt change in direction of the dentinal tubules. The dentin to the left is called primary dentin (B). That facing the pulp is secondary, or reactive, dentin (C). The dentinal tubules in the secondary dentin are regularly disposed in this particular instance. It is referred to as regular secondary dentin, its formation stimulated by acute or chronic trauma. It is best observed in permanent molars and premolars, not forming at an even rate on all surfaces.

<table>
<tr><td>35. Dead tracts


A - enamel
B - dead tracts of dentin
C - secondary dentin</td><td>Note the enamel layer (A) on the tip of the cusp has been worn down close to the dentin. The dentinal tubules under this region of trauma appear black . Trauma will cause the odontoblastic processes within the dentinal tubules to "die back" toward the cell body. In severe cases the cells themselves may die. Such regions of dentin (with empty dentinal tubules) are called dead tracts (B) and appear dark in ground sections. They are difficult to detect in demineralized sections. The odontoblasts whose processes had occupied the dentinal tubules have responded by forming a protective layer of secondary (or reactive) dentin (C).</td></tr>
<tr><td>36. Dead tracts of dentin


A - dead tracts
B - interlobular dentin
C - primary curvatures</td><td>Note the dead tracts (A) in this ground section. The enamel layer on the cusp has been completely eroded away down to the dentin (that must smart!). Also identify interglobular dentin (B). What is being indicated by the area labelled C?</td></tr>
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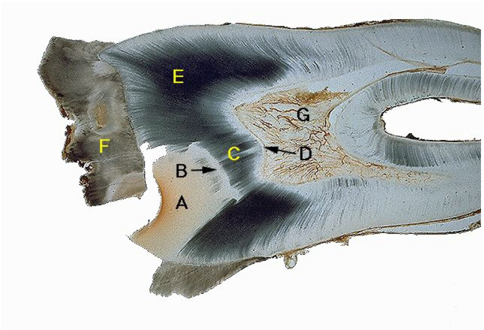
37. Sclerotic dentin



A - carious dentin
B - sclerotic dentin
C - dead tracts
D - secondary dentin
E - dentin
F - enamel
G - pulp
</td>
<td>This is a ground section through a tooth with a carious lesion. The carious dentin lies near the center of the field (A) with its free surface exposed. Close to the this dentin, between it and the pulp, is a homogeneous appearing "white" zone called sclerotic or trans- parent dentin (B). Sclerotic dentin contains dentinal tubules that have become completely obliterated by the deposition of peritubular dentin. This reaction by irritated odontoblasts forms a protective wall between themselves and noxious stimuli. Identify the remaining structures indicated on the image.</td>
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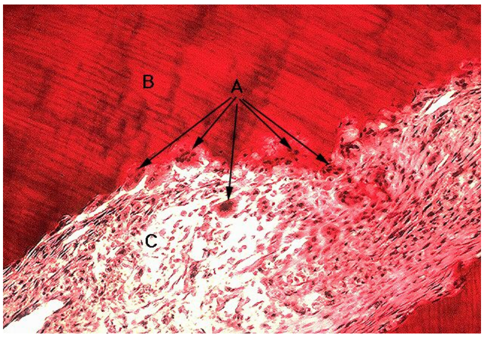
40. Dentin resorption



A - dentinoclasts
B - dentin
C - pulp
</td>
<td>Dentin is being destroyed in this image. Note the multinucleated, osteoclast-like cells (A) along the border of the dentin. These cells are referred to as dentinoclasts. Identify B and C.</td>
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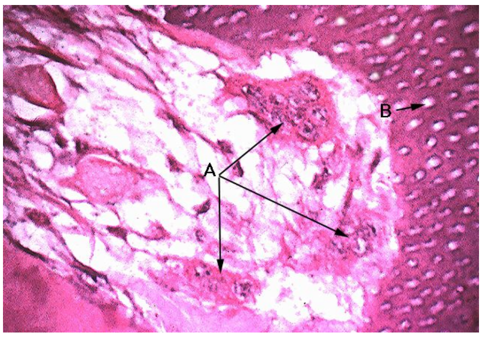
41. Dentinoclasts



A - dentinoclasts
B - dentinal tubule
</td>
<td>Dentinoclasts (A) are seen at a higher magnification than in the preceding image (#40). Dentin is normally destroyed when the roots of the deciduous teeth are being resorbed prior to their replacement by successional teeth. Dentin, also may be destroyed under pathologic circumstances. Identify B.</td>
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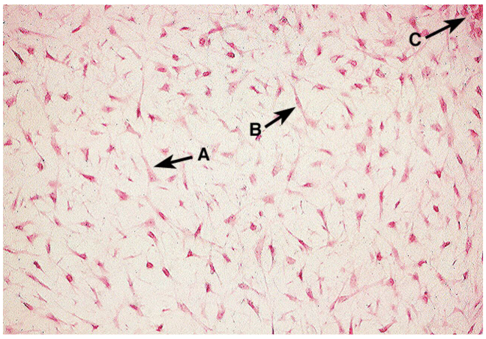
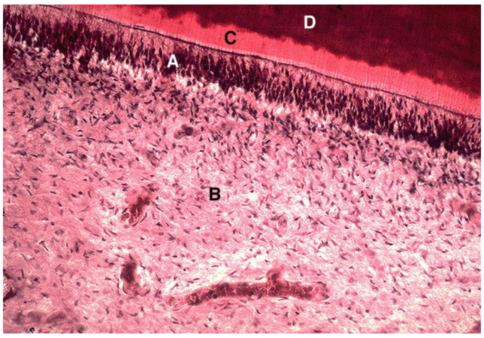
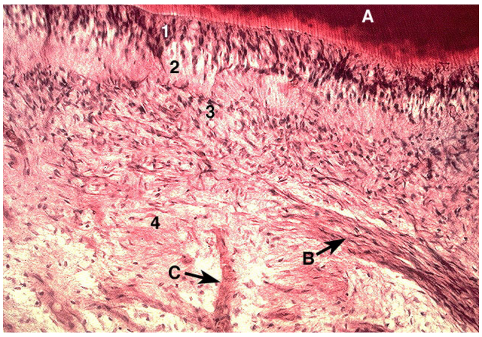
Oral Histology and Embryology Lab – Pulp
(http://www.uky.edu/~brmacp/oralhist/module4/lab/oh4main.htm)

1. The dental papilla  A - mesenchymal cell B - fibroblast C - capillary	The dental papilla of a developing tooth is composed primarily of mesenchymal cells (A), some fibroblasts (B) and macrophages. The first two cell types exhibit a stellate morphology and become reduced in number as the dental papilla transforms into pulp. Capillaries and nerves have invaded the dental papilla at this point of development. Nerves are not evident but a capillary (C) lies in the far right of the field. Only collagen and reticular fibers are present in the pulp.
3. Coronal pulp  A - odontoblasts B - pulp (coronal) C - predentin D - dentin	The odontoblasts (A) of coronal pulp (B) appear to be pseudo-stratified columnar in nature whereas those of the radicular pulp are simple columnar. In the roots of fully developed teeth, the odontoblasts may become simple cuboidal or even squamous in shape. The height of the cell bodies of the odontoblasts can be directly correlated with their metabolic activity. The pseudostratified appearance develops as a result of odontoblast crowding as they move inward towards the pulp in the coronal aspect of the pulp cavity. As the odontoblasts reduce the size of the pulp cavity by the deposition of dentin (D), there is a reduction in surface area on the predentin (C) for occupation by an essentially undiminished number of odontoblast cell bodies. The result is crowding and a compensatory pseudostratification.

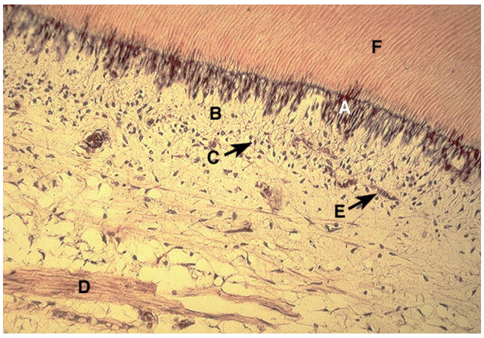
4. Zones of the pulp



1 - odontoblast zone
2 - cell-free zone
3 - cell-rich zone
4 - pulp core
A - Dentin
B - nerve
C - blood vessel

The pulp cavity exhibits four zones as you progress from the dentin-pulp junction toward the center of the pulp cavity: 1) the odontoblast zone, 2) cell-free zone (basal layer of Weil), 3) cell-rich zone, and 4) the pulp core. A cell-free zone is not present in developing teeth but becomes prominent in the coronal pulp after development. The cell-rich zone lies immediately under the cell-free zone and contains numerous fibroblasts, macro-phages and capillaries. The capillaries arise from arterioles (C) deeper in the pulp but are commonly found adjacent to, or even within, the odontoblast layer. A large nerve bundle (B) is evident in this image forming part of the subondontoblastic plexus (of Raschkow). Nerve fibers pass from the plexus out toward the dentin. Occasionally a nerve fiber extends a short distance into the dentinal tubule with the odontoblast process. Pain is the only sensation carried from the pulp to the conscious level.

5. Peripheral pulp region



A - odontoblast layer
B - cell-free zone
C - cell-rich zone
D - nerve pleus
E - capillary
F - dentin

From which region of the pulp would you predict this image was taken, coronal or radicular? Do the odontoblasts appear pseudo-stratified (coronal region) or simple columnar or shorter (radicular region)? Identify the cell-free and cell-rich zones, the nerve plexus and capillaries. The ground substance of the pulp contains a rich mixture of mucopolysacchar-ides, composed principally of hyaluronic acid and chondroitin sulfate. Tissue fluid of the pulp is continuous with that in the dentin where it lies between the odonto-blastic processes and the walls of the dentinal tubules.

Oral Histology and Embryology Lab – Cementum

(http://www.uky.edu/~brmacp/oralhist/module7/lab/oh7main.htm)

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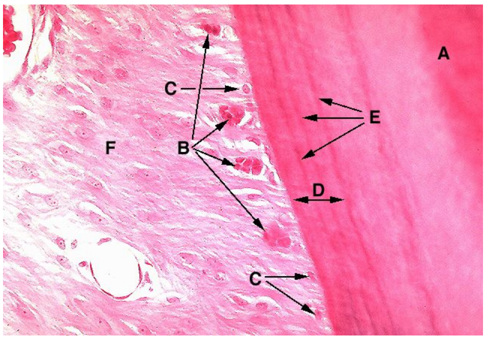
1. Formation of cementum



A - dentin
B - epithelial rests
C - cementoblasts
D - cementum
E - resting lines
F - periodontal region

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Dentin (A) lies along the right margin of the field, the periodontal region occupies the left side. Note the islands of epithelial cells (B) near the center of the field. These islands are called epithelial rests (of Malassez) and are remnants of the disintegrating epithelial root sheath (of Hertwig). As the epithelial root sheath breaks up, connective tissue of the dental follicle (sac) comes into contact with the dentin. In these regions multipotential cells of the dental follicle differentiate into cementoblasts (C) adjacent to the dentin. They deposit a ground substance around collagen fibers of fibroblast origin. The osteoid-like mixture of ground substance with collagen fibers is called cementoid. Mineralization converts cementoid to cementum.

Cementum (D) in this image contains several basophilic "resting" lines (E) that reflect periods when formation slows down or stops and then starts again. Resting lines are incremental lines formed by fiber-free ground substance. No cells are trapped in this cementum so it is classified as acellular cementum - the first type to be formed. It is also referred to as primary cementum.

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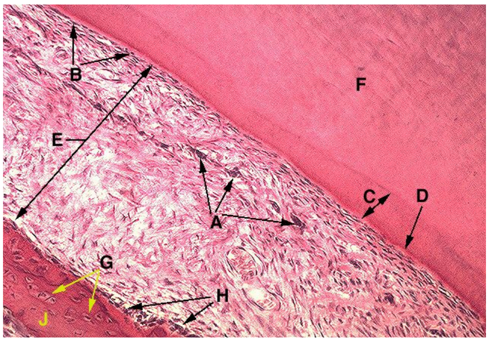
2. Epithelial rests



A - epithelial rests
B - cementoblasts
C - cementum
D - cementoid
E - periodontal region
F - dentin
G - osteocytes
H - osteoblasts
J - alveolar bone
K - primary cementum
L - it is acellular

</td>
<td>

Epithelial rests (A) appear as a broken string of small dense basophilic structures. Identify cementoblasts (B) whose dark nuclei stand out along the thin line of light pink staining material between the cementum (C) and the cementoblasts. This lighter layer is cementoid (D) indicating active formation of cementum. How would you classify this cementum? (look at K to check your answer) Why? (look at L). The perio-dontal region (E) lies between the tooth and the alveolar bone.

</td>
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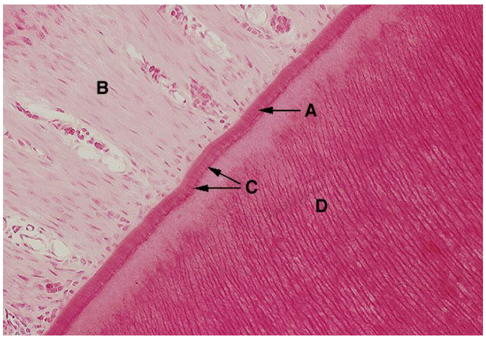
<td>

5. Principal fibers of the PDL



A - cementum
B - principal fibers of PDL
C - Sharpey's fibers
D - dentin

</td>
<td>

This is a cross-section through the crown of a tooth. Lines of Retzius (A) appear like growth rings in a tree stump. Enamel is harder toward the free surface than toward the D-E junction. Enamel hardness depends on: the degree of mineral-ization, the orientation of the enamel rods, the orientation of the crystallites within the rods, and the distribution of metallic ions which occur in trace amounts. Hardness at the enamel surface may be in-creased by the presence of fluoride ions.

</td>
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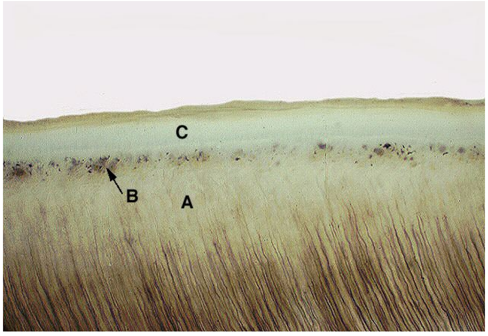
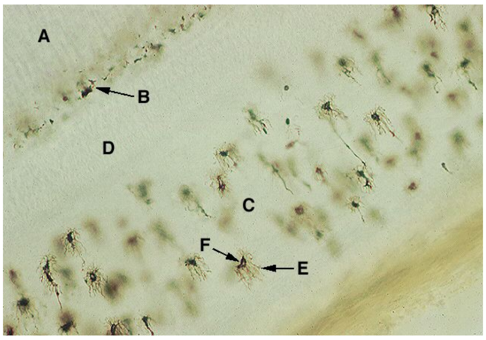
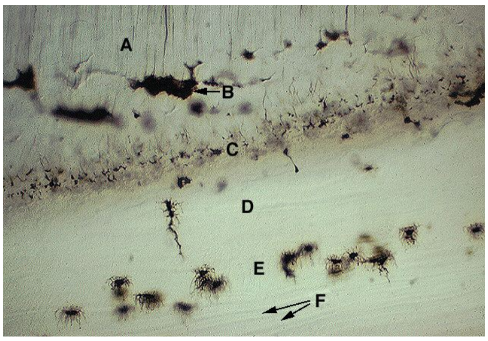
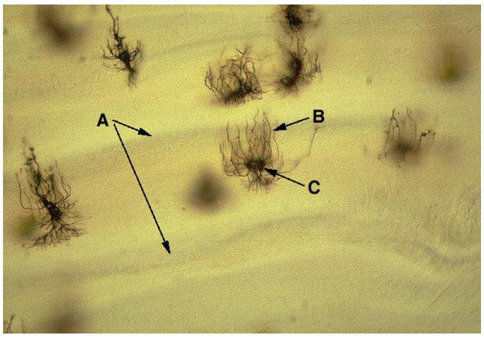
</table>

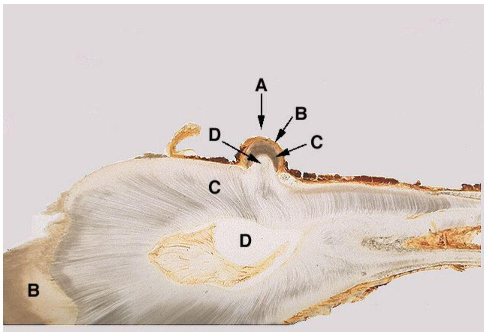
<table>
<tr>
<td>6. Primary cementum


A - dentin
B - Tomes' granular layer
C - primary cementum</td>
<td>This is a ground section of a tooth. From the bottom of the field up identify the following layers: dentin with dentinal tubules (A), Tomes' granular layer (B), primary (acellular) cementum (C). Note that primary cementum is a relatively clear layer, containing no cells (cementocytes).</td>
</tr>
<tr>
<td>9. High power of cementum


A - dentin
B - Tomes' granular layer
C - secondary cementum
D - primary cementum
E - canaliculi
F - cementocyte lacuna</td>
<td>In this ground section dentin (A) lies in the upper left corner of the field. Tomes' granular layer (B) lies just outside this. What type of cementum (D) lies next to the dentin? (look at D to check your answer). Secondary (cellular) cementum (C) overlies the primary cementum layer. Note the tiny fibrous channels, or canaliculi (E), that radiate from each lacuna (F). Cementocytes live in the lacunae of cementum, the canaliculi occupied by their cytoplasmic processes that radiate in the direction of the blood supply. Cementocytes are nourished by diffusion.</td>
</tr>
<tr>
<td>10. Ground section of cementum


A - dentin
B - interglobular dentin
C - Tomes' granular layer
D - primary cementum
E - secondary cementum
F - resting lines</td>
<td>In this ground section identify the following: dentin (A), interglob-ular dentin (B), Tomes' granular layer (C), primary cementum (D), secondary cementum (E), and resting lines (F). Is this section from an anterior or posterior tooth? (look at G to check your answer). How can you tell? (look at H). From which region of the tooth, cervical or apical? (look at I). How can you tell this? (look at J).</td>
</tr>
</table>

<table>
<tr>
<td>12. Cementocytes in cementum


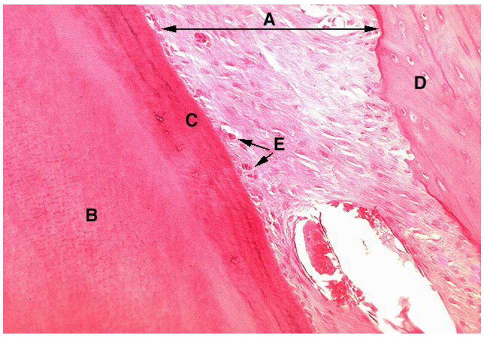
A - resting lines
B - cementocyte lacuna
C - canaliculi
D - toward top of image</td>
<td>Identify the resting lines (A) in this section. The cementocyte cell body inhabits the lacunae (B) while their cytoplasmic processes radiate outward in canaliculi (C). In which direction would you find the periodontal ligament? (look at D to check your answer). Beside the difference in the arrangement of the canaliculi, cementum differs from bone in its capacity to be resorbed and remodeled. Bone resorbs more readily than cementum. The practice of orthodontics is based upon this fact.</td>
</tr>
<tr>
<td>19. Enamel pearl in section


A - enamel pearl
B - enamel
C - dentin
D - pulp</td>
<td>Occasionally a small enamel protrusion (A) is deposited on the root of a tooth - an enamel pearl. These protrusions develop when a patch of the epithelial root sheath fails to break free from the dentinal surface to form an epithelial rest. The inner dental epithelial cells differentiate into ameloblasts which proceed to deposit enamel. Enamel pearls vary from 0.3 to 2.0 mm in diameter and may be composed of enamel (B) only, enamel and dentin (C), or enamel, dentin and pulp (D). This example contains all 3 tissues.</td>
</tr>
</table>

Oral Histology and Embryology Lab – PDL
(http://www.uky.edu/~brmacp/oralhist/module8/lab/oh8main.htm)

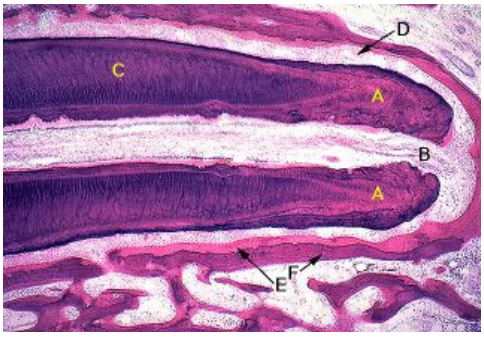
<table>
<tr><td>

2. Periodontal ligament

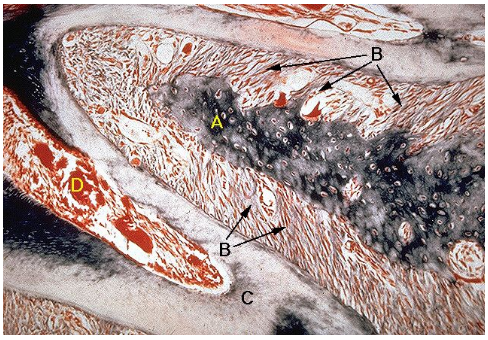
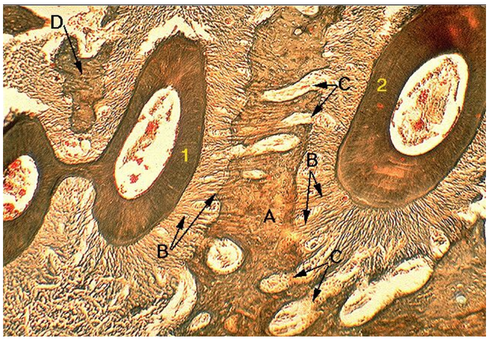


A - periodontal ligament
B - dentin
C - cementum
D - alveolar bone
E - epithelial rests
</td><td>A number of cell types are found within the PDL (A), the most predominant being fibroblasts and macrophages. The principal cell type is the fibroblast and the principal intercellular substance is collagen. Ground substance is composed of glycosaminoglycans, glycoproteins, and glycolipids. Identify the other labels on the image.</td></tr>
<tr><td>

10. Apical foramen

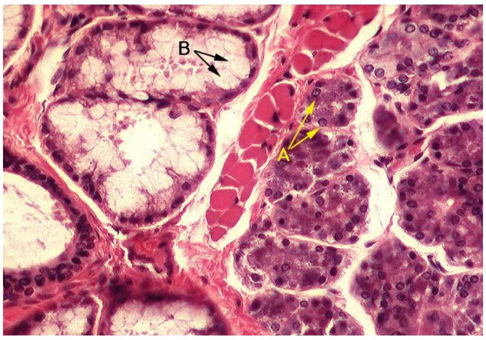
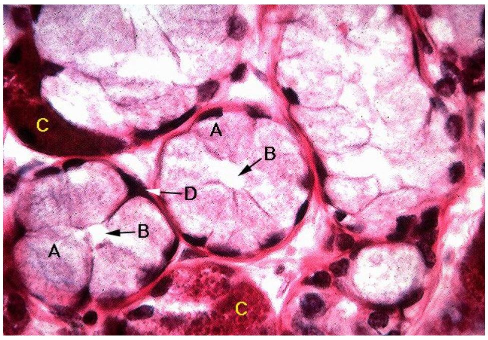


A - cementum
B - apical foramen
C - dentin
D - periodontal ligament
E - osteoid
F - alveolar bone
</td><td>As a tooth erupts further into the oral cavity cementum (A) is added to the end of the root to compensate for the eruptive movement. The opening of the pulp chamber at the apical end of the root is referred to as the apical foramen (B). This opening was initially formed by dentin (C) but is eventually redefined by cementum. The fibers of the periodontal ligament (D) also must gradually realign themselves. Note the layer of osteoid (E) that lines the alveolar bone. This is indicative of new bone deposition over existing alveolar bone (F).</td></tr>
</table>

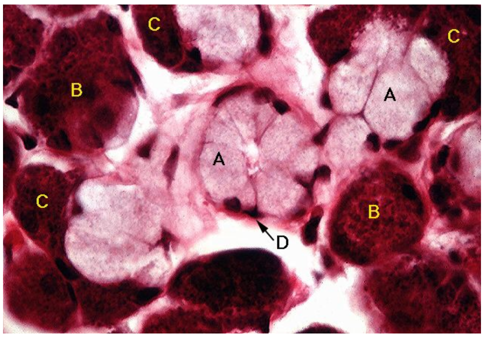
12. The interradicular septum  A - interradicular septum B - interradicular fibers C - dentin D - pulp	This is a multirooted tooth. The bony septum lying between the roots is called interradicular septum (A). Principal fibers that anchor the tooth to the interradicular septum are called interradicular fibers (B). Identify C and D.
13. The interdental septum  A - interdental septum B - alveolar bone C - alveolar vessels D - interradicular septum	This is a cross section through the roots of two adjacent teeth, labelled 1 and 2. The alveolar bone between tooth sockets is referred to as the interdental septum (A). Note the radial arrangement of the principal fibers extending between the tooth socket and the root (B). The PDL is supplied with blood and sensory innervation by branches of vessels and nerves from various locations: those that supply pulp (branching off prior to entering the apical foramen); those that supply the surrounding alveolar bone (C), and those that supply the gingiva. What is D?

Oral Histology and Embryology Lab – Glands of the oral cavity

(http://www.uky.edu/~brmacp/oralhist/module2/lab/oh2main.htm)

1. Secretory acini  A - serous secretory cells B - mucous secretory cells	All salivary glands have ducts and therefore exocrine in nature. They can be further classified on the basis of the shape of their secretory units; into tubular or alveolar (acinar); and by the complexity of their ducts into simple or compound. While the minor salivary glands are classified as being either simple or compound tubuloalveolar glands, most agree that all three major salivary glands are compound tubuloalveolar. This image illustrates the difference between serous and mucous secretory acini. Serous secretory (A) cells form the acini to the right in this field. Mucous secretory cells (B) compose the acini on the left. Serous acini generally stain darker than their mucous counterparts and exhibit spherical nuclei rather than flattened, basally located ones.
2. Serous demilunes  A - mucous secretory cell B - lumen of the acinus C - serous demilune D - myoepithelial cell	The secretory unit in the center of the field is composed totally of mucous-secreting cells (A) forming a mucous acinus. Note the position of the nuclei in the cells (basal) as well as their shape (flattened). The apical border of each cell opens into the lumen of the acinus (B). The mucous acinus on the upper left has a large serous demilune (C) covering its lower left outer boundary. Demilunes are always composed of serous cells. In the mucous secretory unit just to the lower left of center, note a triangular shaped nucleus lying between the base of the junction of two mucous cells and the basement membrane. This nucleus belongs to a myoepithelial cell (D).

3. Secretion through a "mixed" salivary gland



A - Mucous secretory acinus
B - serous secretory acinus
C - serous demilune
D - myoepithelial cell

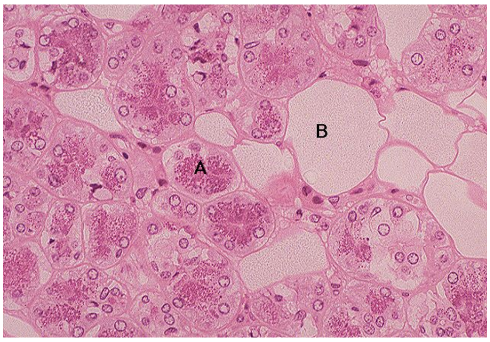
Can you identify mucous and serous secretory units? Do you see any demilunes? Do you see the nucleus of a myoepithelial cell? Note the granular appearance of the cytoplasm of the serous cells. This reflects the granular nature of the serous secretions. Identify the various structures labelled.

4. Myoepithelial cells

A - myoepithelial cell

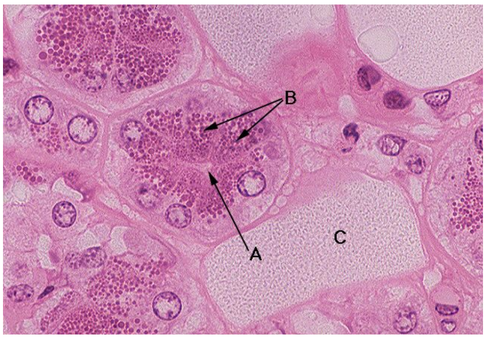
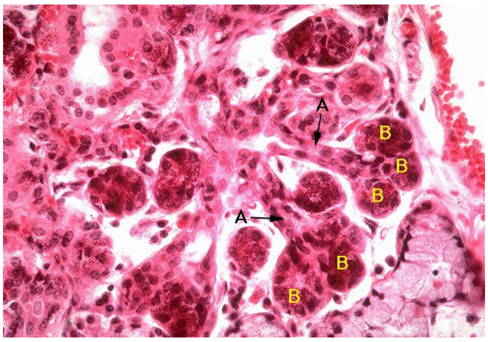
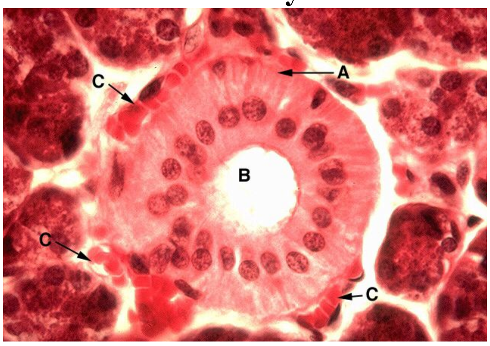
Look for the triangular-shaped nucleus of a myoepithelial cell (A) in the serous unit in the center of the field. Myoepithelial cells are thought to have contractile properties. They exhibit an octopus-like morphology, Their processes encompassing the acinus. It has been theorized that they gently "squeeze" the cells of the acinus to aid in the secretory process.

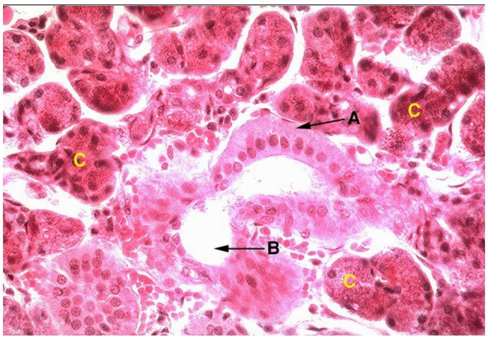
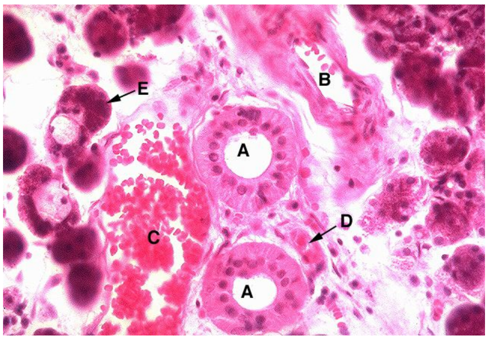
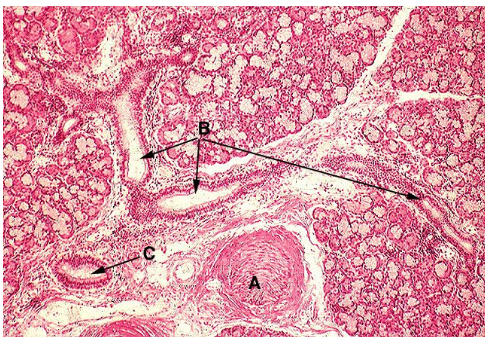
5. Serous secretory acini

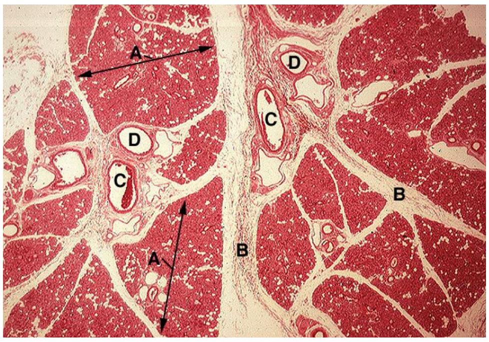
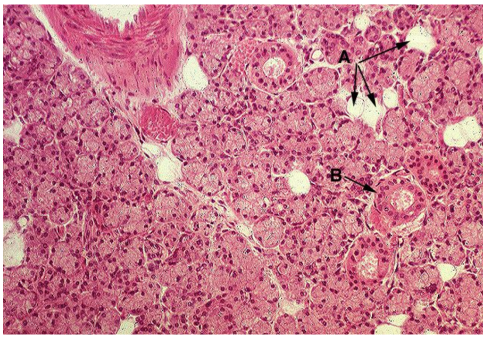
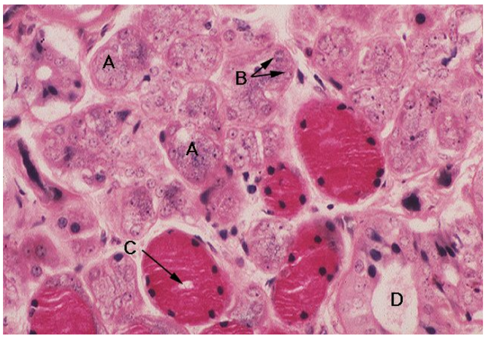


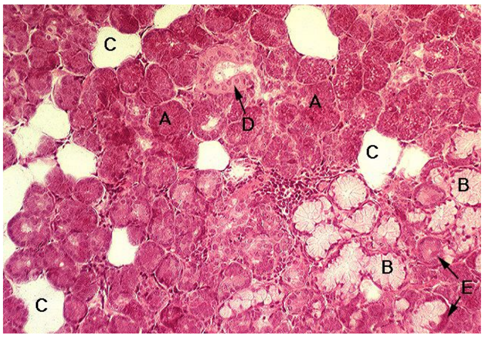
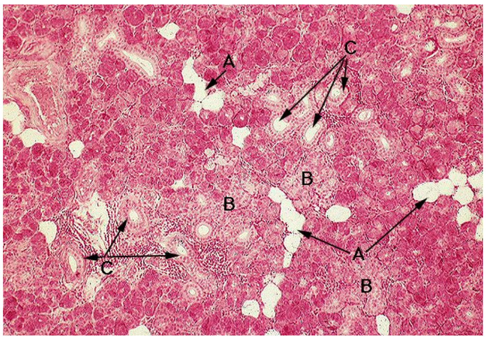
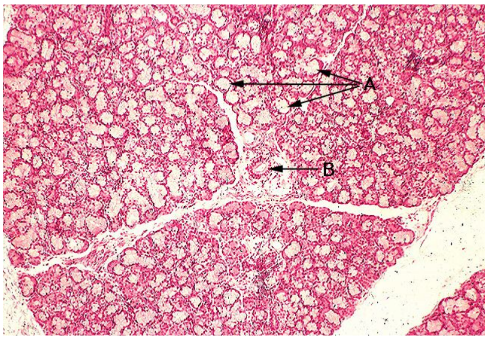
A - serous secretory acinus
B - fat cell

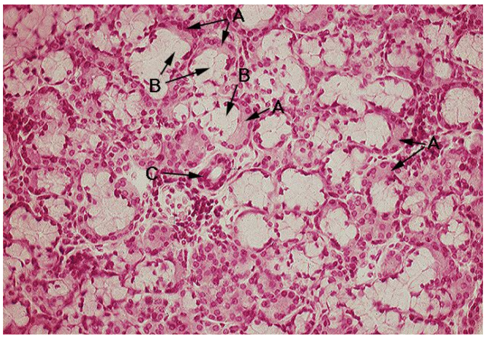
This image is a high power photomicrograph taken of a plastic-embedded piece of the parotid gland. The field is filled with serous secretory acini (A) and fat cells (B). Plastic embedding facilitates resolution of cellular detail. It is evident that the apical region of each serous acinar cell is filled with acidophilic secretory granules of varying size. Note the shape and size of the nucleus in each cell.

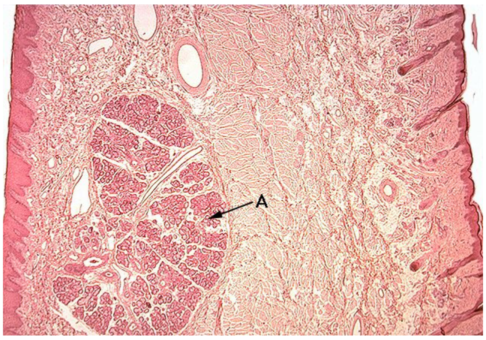
6. Serous secretory cells  A - lumen of serous acinus B - serous secretory granules C - fat cell	This is a higher resolution (oil immersion) micrograph of the cells seen in the preceding image (# 5). The lumen (A) of the serous acinus is evident and is completely bounded by the apical portions of serous secretory cells. Each cell has a large portion of its cytoplasm filled with acidophilic serous secretory granules (B). The granules are released in a merocrine fashion into the lumen upon vasomotor stimulation by the parasympathetic division of the autonomic nervous system.
8. Intercalated duct  A - intercalated ducts B - serous secretory acini	The secretory acini in the salivary glands secrete into intercalated ducts (A). These ducts link the acinar lumen with the larger components of the duct system within the salivary gland. Several intercalated ducts are seen converging toward the center of the field. Clusters of serous secretory acini (B) can be seen at the ends of two of the intercalated ducts.
11. Striated secretory duct  A - striations in the base of secretory duct cells B - lumen of secretory duct C - capillaries	Note the striated appearance of the basal aspect of the cells composing this duct (A). Because of this appearance they were initially referred to as "striated" ducts. The cells of striated ducts secrete into the lumen (B), adding to the mucous and/or serous secretions passed along the duct. For this reason, these ducts are now more commonly referred to as "secretory ducts". Note the capillaries (C) lying adjacent to the bases of the secretory duct cells. The secretory cells transport water and electrolytes from the capillaries to the duct lumen.

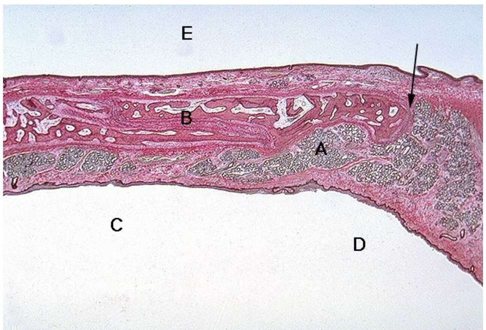
<table>
<tr>
<td>13. Intralobular duct

A - intralobular secretory duct
B - intercalated duct
C - serous secretory acini</td>
<td>How would you classify the ducts in the center of the field? Which one is secretory? intercalated? (Check your answers by clicking on the buttons). All intercalated ducts are found within the lobules of a gland and therefore are referred to as intralobular ducts.</td>
</tr>
<tr>
<td>14. Interlobular ducts

A - interlobular secretory duct
B - artery
C - vein
D - capillary
E - serous secretory acini</td>
<td>Lobules (compact aggregates of secretory units) are separated by connective tissue septa. The secretory products of each lobule must eventually be conveyed by ducts out of the lobules. The ducts pass from the lobules into the connective tissue septa where they join one to another. In this image are several secretory ducts (A) together with an artery (B) and vein (C) in a connective tissue septum located between two lobules. These particular secretory ducts are referred to as interlobular ducts. Secretory ducts are classified by their relationship to the lobules. Note the capillaries (D) closely related to the base of these secretory ducts.</td>
</tr>
<tr>
<td>15. Excretory ducts

A - nerve
B - interlobular secretory ducts
C - interlobular excretory duct</td>
<td>Extending across the central part of the image is a wide septum of connective tissue containing a nerve (A) and several secretory ducts (B). Secretory ducts empty into excretory ducts (C). Histo-logically, excretory ducts vary in appearance from simple columnar to pseudostratified columnar to stratified squamous. The cells lining the excretory duct in the center of the field appear to be pseudostratified columnar. Most excretory ducts are interlobular in position.</td>
</tr>
</table>

16. Low power of parotid gland  A - lobules B - connective tissue septae C - vessels D - ducts	This is a section through a parotid gland. Note the lobules (A), connective tissue septae (B), vessels (C) and ducts (D). The glandular tissue appears rather homogeneous except for light spots scattered here and there. The parotid gland secretions in "resting" conditions account for only about 25% of the saliva produced. During maximum stimulation (eating steak), the parotid glands secrete about twice the amount secreted by the submandibular glands. At rest the parotid secretes about 1/3rd the amount of the submandibular gland.
18. Serous acini of the parotid  A - fat cells B - intralobular secretory duct	At a still higher magnification of the parotid, the serous acini are easily distinguished. The light spots, seen in the preceding two images, can now be identified as fat cells (A). The adult human parotid gland is considered to be purely serous. Classify B.
20. High power of submandibular gland  A - serous secretory cells B - nuclei of serous acinar cells C - lumen of mucous acinus D - intralobular/secretory duct	This is a higher power micrograph of the mucous acini seen in the preceding image (# 19). Aside from the special mucicarmine staining technique demonstrating mucous acinar cells as fuschia colored, note that they also exhibit the typical basally located flattened nuclei. Compare them to the nuclei of the serous acinar cells (B). Identify the remaining labelled structures.

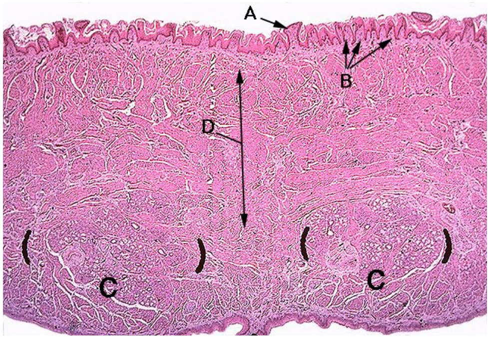
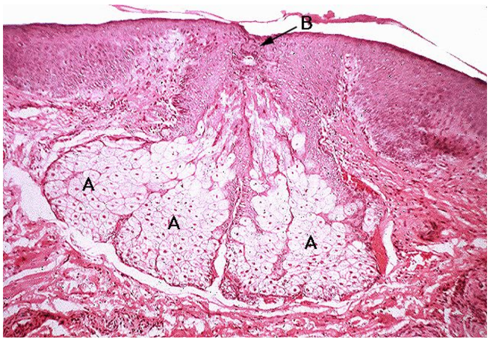
21. Section of a submandibular gland  A - serous acini B - mucous acini C - fat cell D - intralobular duct E - serous demilune	Do the secretory acini of the submandibular gland appear to be serous, mucous or seromucous (mucous acini with serous demilunes)? Actually, all three of these types are present: serous acini (A), mucous acini (B) fat cells (C), intralobular duct (D) and a serous demilune (E). During "resting" conditions, the submandibular gland secretes about 69% of the saliva produced.
22. Low power section through the submandibular gland  A - fat cells B - mucous acini C - intralobular/secretory ducts	At a lower magnification than that of the preceding image, it is easy to overlook mucous acini in the submandibular gland. The fat cells (A) help camouflage the mucous-secreting acini. The paler area in the center (B) of the field is several clusters of mucous acini. The cytoplasm of these cells stains faintly, whereas no staining is evident in the vacuolated fat cells.The majority of the cells stain darker pink and are forming serous acini. Note the numerous intralobular secretory ducts (C).
26. Low power of sublingual gland  A - mucous acini B - intralobular secretory duct	In this section through a sublingual gland, note the numerous mucous acini (A). Near the center of the field is a secretory duct (B). Secretory and intercalated ducts are very short in the sublingual gland. Therefore, fewer ducts are seen in sections of this salivary gland than compared with either the submandibular or parotid glands.

<table>
<tr><td>27. High power of sublingual gland


A - serous demilune
B - mucous acini
C - intralobular secretory duct</td><td>At this magnification numerous serous demilunes (A) can be identified surrounding the mucous cells (B) of the secretory acini within the sublingual gland. An intralobular duct is indicated by "C".</td></tr>
<tr><td>32. Labial gland


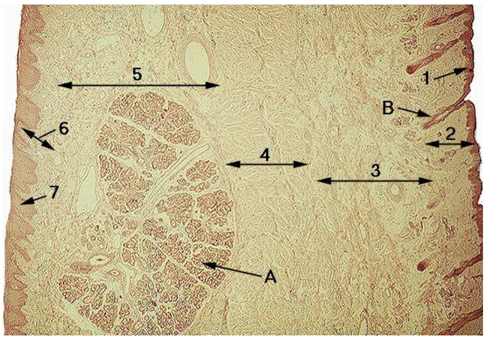
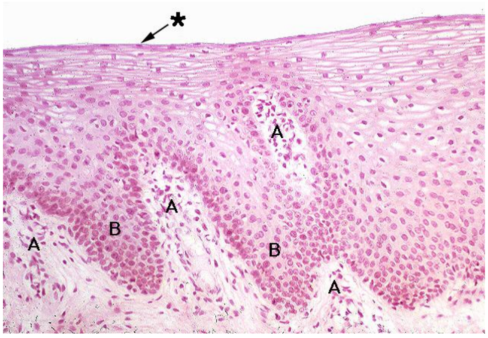
A - labial gland</td><td>A labial gland (A) is seen in this section of the lower lip. Run your tongue against the labial mucosa (inside aspect) of your lower lip. The series of little bumps you feel indicate the location of labial glands.
Labial glands are seromucous minor salivary glands. One of the functional differences between major and minor salivary glands is that minor salivary glands secrete continuously whereas major salivary glands secrete mainly during mastication of food.</td></tr>
<tr><td>33. Palatine glands


A - palatine glands
B - bone of hard palate
C - oral cavity
D - oropharyngeal cavity</td><td>Palatine glands (A) are embedded in the lining of the hard and soft palate. They fade out about 2/3s of the way forward from the junction of the hard and soft palate (arrow). This section is cut longitudinally through the hard (left) and soft (right) palates. Note the bone (B) of the hard palate. Palatine glands are seen in both regions. The oral cavity (C) and oropharynx (D) lie below the palate. What cavity would be represented by E?</td></tr>
</table>

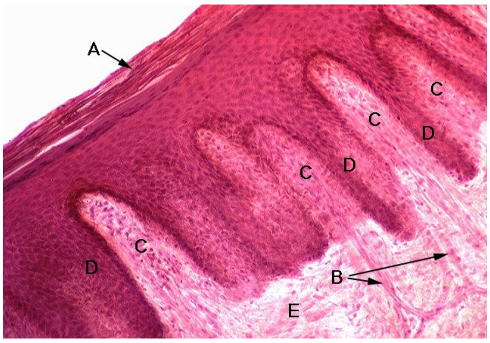
35. Lingual salivary glands  A - fungiform papilla B - filiform papillae C - anterior lingual glands D - intrinsic musculature of the tongue	In this cross-section through the tongue of a newborn infant, can you identify fungiform (A) and filiform (B) papillae of its dorsal surface? On either side of the midline in the lower half of the tongue are two masses of bracketed glandular tissue. These are the anterior lingual glands (C). They secrete onto the ventral surface of the tongue. Look carefully at the intrinsic musculature of the tongue. Can you identify bundles of skeletal muscle fibers (D) extending at right angles to one another?
38. Section through an oral sebaceous gland  A - oral sebaceous (Fordyce) gland B - duct of oral sebaceous gland	This is a section through a Fordyce spot (A). These glands are simple alveolar and have a holocrine mode of secretion. Note their similarity to the sebaceous glands associated with hair follicles. The cells arise in the base of the gland and begin to produce an oily product - sebum. The accumulation of sebum eventually kills the cell and it is secreted as a sac of oil through the duct (B).

Oral Histology and Embryology Lab – Oral mucosae

(http://www.uky.edu/~brmacp/oralhist/module1/lab/oh1main.htm)

1. Low power sagittal section of the lip  A - labial gland B - hair follicle 1 - stratified squamous keratinized epithelium 2 - dermis 3 - hypodermis 4 - skeletal muscle 5 - submucosa 6 - lamina propria 7 - non-keratinized stratified squamous epithelium	This is a sagittal section through the lip. To the right is skin with hair follicles (B) evident; to the left is mucous membrane with a large labial gland (A) lying just under this layer. Starting on the right identify the following layers: 1) stratified squamous keratinized epithelium, 2) dermis (relatively dense connective tissue), 3) hypodermis, also called superficial fascia (relatively loose connective tissue), 4) skeletal muscle (orbicularis oris muscle, forms the central layer of the lip), 5) submucosa (relatively loose connective tissue; in this slide, a labial gland is seen in the submucosa), 6) lamina propria (relatively dense connective tissue), and 7) stratified squamous epithelium (not keratinized).
5. High power of the labial mucosa  A - connective tissue papillae B - non-keratinized stratified squamous epithelium	This is a section of labial mucosa. The epithelium (B) is non-keratinized stratified squamous. Examine the uppermost layer (*) carefully and note that these cells still exhibit nuclei. The loose connective tissue of the lamina propria that underlies the epithelium inserts up into ithis overlying layer t in finger-like projections or papillae (A).

6. Mucosa of the hard palate

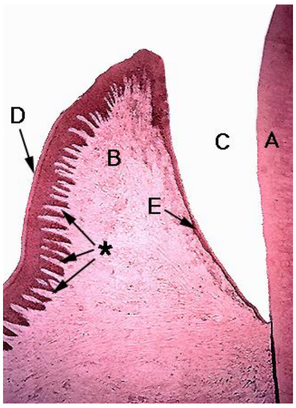


A - stratum corneum
B - capillary
C - connective tissue papilla
D - rete peg
E - lamina propria

The mucosa covering the hard palate exhibits a distinct keratinized layer - the stratum corneum (A). In addition, capillaries (B) loop up into the connective tissue papillae (C).

A characteristic feature of keratinized regions in the oral cavity is the presence of relatively high connective tissue papillae projecting into the overlying epithelium. High connective tissue papillae are associated with keratinized epithelium. This form of keratinization in the oral cavity is referred to as orthokeratinized stratified squamous epithelium.

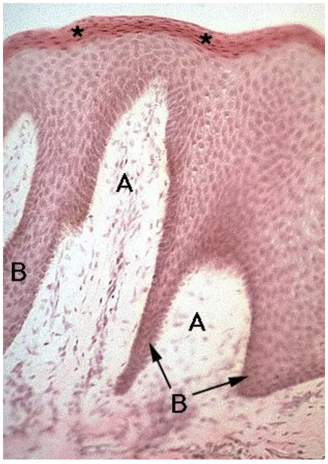
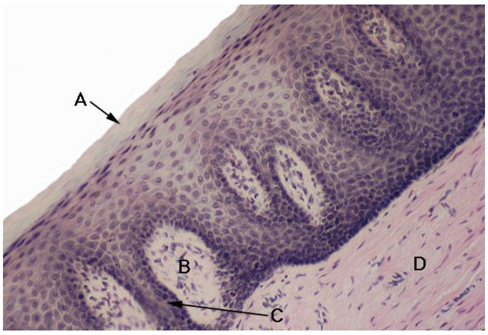
7. Section through the gingiva



* - connective tissue papillae
A - dentin
B - gingiva
C - enamel space
D - keratinized stratified squamous epithelium
E - sulcular epithelium

In this section through the gingiva, the space (C) between the dentin of the tooth (A) on the right and the gingiva (B) on the left is normally occupied by enamel which has been lost during tissue processing. Note the high connective tissue papillae (*) that insert into the keratinized epithelium (D) that faces the oral cavity.

The mucosa facing the enamel space lacks connective tissue papillae and a keratinized layer. It is called sulcular or crevicular epithelium (E) because it forms the gingival wall of the sulcus. The sulcus is the shallow groove between the gingiva and tooth. If the sulcus deepens, it is referred to as a periodontal pocket.

8. Parakeratinized epithelium  * - nuclei of outer epithelial layer A - connective tissue papillae B - rete pegs of epithelium	This is another section through gingiva. Note the connective tissue papillae (A). The overlying epithelium is keratinized, but it differs in appearance from the non-keratinized stratified squamous epithelium seen elsewhere in the oral cavity. This difference is due to the basophilia present in the cells of the outermost layers, the absence of a distinctive stratum granulosum and the presence of nuclei (*) in the outermost layers (absent in a stratum corneum). The term parakeratinization is used to describe the appearance of the epithelium in this section. Gingival tissue commonly has varying amounts of parakeratinized and non-keratinized stratified squamous epithelium.
9. Keratinized oral mucosa  A - stratum corneum B - connective tissue papilla C - epithelial rete peg D - lamina propria	Keratinization of stratified squamous epithelium may occur at sites in the oral cavity where the mucosa is subjected to habitual mechanical stress - such as continuous trauma from chewing. This response is similar to the formation of a callus on the hands of a manual laborer. Note the typical appearance of the stratum corneum (A). No nuclei are visible in contrast with the parakeratinized variety. Re-identify the other structures labelled.

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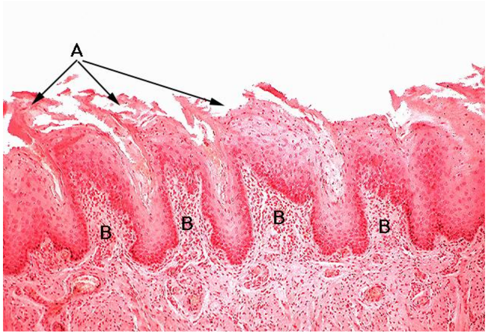
19. Section of filiform papillae



A - keratinized layer
B - connective tissue core
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This is the histological appearance of filiform papillae. Keratinization (A) occurs on the tips of these papillae. Each papilla has a core of connective tissue (B).
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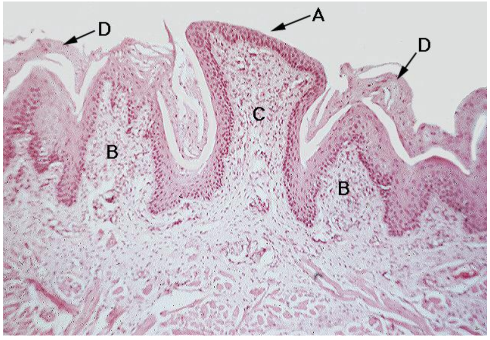
20. Section of a fungiform papilla



A - fungiform papilla
B - filiform papillae
C- connective tissue core
D - keratinized layer on filiform tip
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In the center of the field is a fungiform papilla (A). To either side are filiform papillae (B). Fungiform papillae are roughly mushroom-shaped. Their apical surface is not initially keratinized. The capillaries in the connective tissue core (C) show through the more translucent surface. This gives them their reddish appearance when identified on the tongue of younger individuals.
The surrounding filiform papillae exhibit heavy keratinization (D) of their tips. This layer prevents underlying vasculature in their core from showing through, giving them a more opaque (whitish) appearance on the dorsum of the tongue.
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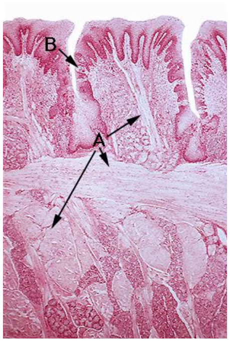
22. Section of foliate papillae



A - skeletal muscle fibers
B - taste buds
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This is a section through three foliate papillae on the tongue of a rabbit. Skeletal muscle fibers (A) extend from the muscular layer below, up into the center of each papilla, where it inserts into the lamina propria of their connective tissue core. Taste buds (B) are also present in the mucosa of their lateral aspects.
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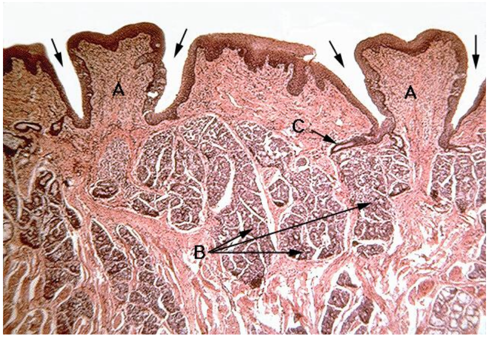
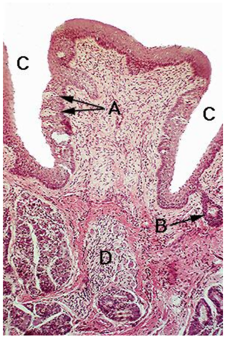
24. Section of circumvallate papillae  A - circumvallate papilla B - glands of von Ebner C - duct of glands of von Ebner	This is a section through two circumvallate papillae (A). At first glance they resemble fungiform papillae. However, unlike fungiform papillae they appear to be "countersunk" - sunken into the mucosa of the tongue - and surrounded by a moat-like space (arrows). Below the papillae are glands of Von Ebner (B) whose secretory products are conveyed by ducts (C) to the bottom of the moat-like recess surrounding each papilla.
25. Section through circumvallate papillae  A - taste buds B - duct of gland of von Ebner C - moat around circumvallate papilla D - nerve	This is a higher magnification of a circumvallate papilla than seen in the preceding image. The light spherical areas in the epithelium of the walls of the papilla (A) are taste buds. A duct (B) from the underlying glands of von Ebner can be seen opening into the moat-like space (C) around the papilla. Directly below the base of this papilla is a collection of nerve tissue (D).

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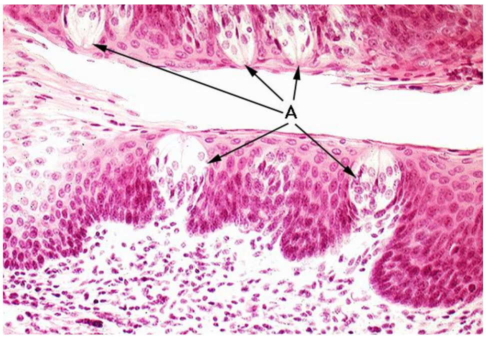
<td>26. Taste buds in sagittal section


A - taste buds</td>
<td>These barrel-shaped light areas (A) are taste buds embedded in the epithelial wall of a circumvallate papilla. Taste buds are also occasionally found on fungiform and foliate papillae as well as scattered throughout the mucosa of the soft palate, pharynx and epiglottis.</td>
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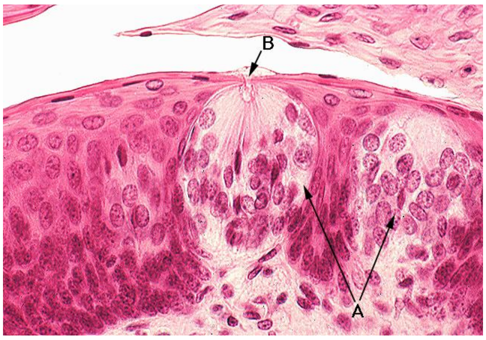
<td>27. High power of taste bud


A - taste buds
B - taste canal</td>
<td>In the center of the field is a taste bud (A). It is composed of two types of cells, neuroepithelial and supporting (sustentacular) cells. The neuroepithelial cells communicate with the free surface of the mucosa by the taste canal (B). The inner and outer openings of the canal are called the inner and outer taste pores. Microvilli ("taste hairs") project from the ends of the neuroepithelial cells into the taste canal. There are from 4 to 20 neuroepithelial cells in each taste bud. These cells are usually located centrally in the structure, surrounded by their supporting or sustentacular cells.</td>
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