PERIODONTIUM

Cementum

PDL

Alveolar bone

Sharpey's fibers

Attachment organ

Pulp cavity
Enamel
Dentin
Gingiva

Cementum

Periodontal ligament

Root canal

Alveolar bone

Apical foramen

Alveolar vessels & nerves
TEETH IN-SITU
Periodontium (forms a specialized fibrous joint called Gomphosis)

• Cementum
• Periodontal Ligament
• Alveolar bone
• Gingiva facing the tooth
Cementum

The other bone (not so simple)
It is a hard avascular connective tissue that covers the roots of teeth
Role of Cementum

1) It covers and protects the root dentin (covers the opening of dentinal tubules)

2) It provides attachment to the periodontal fibers

3) It compensates for tooth resorption
Varies in thickness: thickest in the apex and in the inter-radicular areas of multirooted teeth, and thinnest in the cervical area

10 to 15 µm in the cervical areas to 50 to 200 µm (can exceed > 600 µm) apically
Cementum simulates bone

- Organic fibrous framework, ground substance, crystal type, development
- Lacunae
- Canaliculi
- Cellular component
  - Osteoblast-specific membrane protein Bril
- Incremental lines (also known as “resting” lines; they are produced by continuous but phasic, deposition of cementum)
Differences between cementum and bone

- Not vascularized – a reason for it being resistant to resorption
- Minor ability to remodel
- More resistant to resorption compared to bone
- Lacks neural component – so no pain
- 70% of bone is made by inorganic salts (cementum only 45-50%)
- 2 unique cementum molecules: Cementum attachment protein (CAP) and Insulin-like Growth Factor
Clinical Correlation

Cementum is more resistant to resorption: Important in permitting orthodontic tooth movement
Development of Cementum

Cementum formation occurs along the entire tooth.

Hertwig’s epithelial root sheath (HERS) – Extension of the inner and outer dental epithelium

HERS sends inductive signal to ectomesenchymal pulp cells to secrete predentin by differentiating into odontoblasts.

HERS becomes interrupted.

Ectomesenchymal cells from the inner portion of the dental follicle come in contact with predentin by differentiating into cementoblasts.

Cementoblasts lay down cementum.
How cementoblasts get activated to lay down cementum is not known

3 theories:

1. Infiltrating dental follicle cells receive reciprocal signal from the dentin or the surrounding HERS cells and differentiate into cementoblasts

2. HERS cells directly differentiate into cementoblasts

3. What are the function of epithelial cell rests of Malassez?
Cementoblasts

• Derive from dental follicle
• Transformation of epithelial cells
  – Epithelial-mesenchymal transition
Proteins associated with Cementogenesis

• Growth factors
  – T(transforming)GF: cementoblast differentiation and cementogenesis
  – PDGF: cementum formation
  – FGF: PDL formation

• Adhesion molecules
  – Osteopontin: mineralization
  – Epithelial/enamel proteins
  – Collagens
    • I, III, XII (maintenance of PDL vs. continuous formation of cementum
Proteins associated with Cementogenesis

• **Gla proteins, i.e. osteocalcin**
  – Cell maturation-regulation of mineralization
  – Matrix Gla → inhibition of mineralization (PDL maintenance)

• **Transcription factors**
  – Cbfa 1 (Runx2) and osterix

• **Signaling molecules**
  – Osteoprotegerin: PDL maintenance
  – Sclerostin: promotion of cementum formation
  – Wnt: differentiation of cementoblasts

• **Other**
  – Alkaline phosphatase
    • hypophosphatatasia
First layer of cementum is actually formed by the inner cells of the HERS and is deposited on the root’s surface is called intermediate cementum or Hyaline layer of Hopewell-Smith

Deposition occurs before the HERS disintegrates. Seals of the dentinal tubules

Intermediate cementum is situated between the granular dentin layer of Tomes and the acellular cementum; Approximately 10 μm thick and mineralizes greater than the adjacent dentin or the secondary cementum

Fig. 11.7 The appearance of acellular cementum (A). B = Hyaline layer (of Hopewell-Smith); C = granular layer (of Tomes); D = root dentine. Note that the dark layer arrowed between the hyaline layer and the acellular cementum may be related to the afibrillar cementum patchily present at this position (Ground section; × 200).
Properties of Cementum

**Physical**

Cementum is pale yellow with a dull surface

Cementum is more permeable than other dental tissues

Relative softness and the thinness at the cervical portion means that cementum is readily removed by the abrasion when gingival recession exposes the root surface to the oral environment
Chemical Composition of Cementum

Similar to bone

45% to 50% hydroxyapatite (inorganic)

50% to 55% collagenous and noncollagenous matrix proteins (organic)
Classification of Cementum

- Presence or absence of cells
- Origin of collagenous fibers of the matrix
- Prefunctional and functional
Cellular and Acellular Cementum

Acellular cementum: covers the root adjacent to dentin

Cellular: apical area and overlying acellular cementum. Also common in Inter-radicular areas

Cementum is more cellular as the thickness increases in order to maintain viability

The thin cervical layer requires no cells to maintain viability as the fluids bathe its surface

A: Acellular cementum (primary cementum)
B: Cellular Cementum (secondary cementum)
Cellular: Has cells
Acellular: No cells and has no structure

Cellular cementum usually overlies acellular cementum
Variations also noted where acellular and cellular reverse in position and also alternate.
CEMENTUM

- Canaliculus
- Lacuna of cementocyte
- Acellular cementum
- Cellular cementum
- Hyaline layer (of Hopewell Smith)
- Granular layer of Tomes
- Dentin with tubules

Dentin

GT
Cementoblast and cementocyte

Cementocytes in lacunae and the channels that their processes extend are called the canaliculi.

Cementoid: Young matrix that becomes secondarily mineralized.

Cementum is deposited in increments similar to bone and dentin.
Are acellular and cellular cementum formed from two different sources?

One theory is that the structural differences between acellular and cellular cementum is related to the faster rate of matrix formation for cellular cementum. Cementoblasts gets incorporated and embedded in the tissue as cementocytes.

Different rates of cementum formation also reflected in more widely spaced incremental lines in cellular cementum.

<table>
<thead>
<tr>
<th>Table 11.1</th>
<th>Summary of differences between acellular and cellular cementum</th>
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</thead>
<tbody>
<tr>
<td><strong>Acellular cementum</strong></td>
<td><strong>Cellular cementum</strong></td>
</tr>
<tr>
<td>No cells</td>
<td>Lacunae and canaliculi containing cementocytes and their processes</td>
</tr>
<tr>
<td>Border with dentine not clearly demarcated</td>
<td>Border with dentine clearly demarcated</td>
</tr>
<tr>
<td>Rate of development relatively slow</td>
<td>Rate of development relatively fast</td>
</tr>
<tr>
<td>Incremental lines relatively close together</td>
<td>Incremental lines relatively wide apart</td>
</tr>
<tr>
<td>Precementum layer virtually absent</td>
<td>Precementum layer present</td>
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</tbody>
</table>
Classification Based on the Nature and Origin of Collagen Fibers

Organic matrix derived from 2 sources:
1. Periodontal ligament (Sharpey’s fibers)
2. Cementoblasts

Extrinsic fibers derived from PDL. These are in the same direction of the PDL principal fibers i.e. perpendicular or oblique to the root surface

Intrinsic fibers derived from cementoblasts. Run parallel to the root surface and at right angles to the extrinsic fibers

The area where both extrinsic and intrinsic fibers is called mixed fiber cementum
Combined classification

Acellular Extrinsic Fiber Cementum (AEFC-Primary Cementum)
• Located in cervical half of the root and constitutes the bulk of cementum

• The collagen fibers derived from Sharpey’s fibers and ground substance from cementoblasts

• Covers 2/3rds of root corresponding with the distribution of primary acellular cementum

• Principal tissue of attachment

• Function in anchoring of tooth

• Fibers are well mineralized
Cellular intrinsic fiber cementum (CIFC-Secondary Cementum)

- Starts forming after the tooth is in occlusion
- Incorporated cells with majority of fibers organized parallel to the root surface
- Cells have phenotype of bone forming cells
- Very minor role in attachment (virtually absent in incisors and canine teeth)
- Corresponds to cellular cementum and is seen in middle to apical third and inter-radicular
- Adaptation
- Repair
Granular layer of Tome's

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Secondary cellular mixed fiber cementum

- Both intrinsic and extrinsic fibers
  [Extrinsic (5 – 7 μm) and Intrinsic (1 – 2 μm)]
- Bulk of secondary cementum
- Cementocytes
- Laminated structure
- Cementoid on the surface
- Apical portion and intrerradicular
- Adaptation

Intrinsic fibers are uniformly mineralized but the extrinsic fibers are variably mineralized with some central unmineralized cores
Zone of Transition
Acellular afibrillar cementum

- Limited to enamel surface
- Close to the CE junction
- Lacks collagen so plays no role in attachment
- Developmental anomaly vs. true product of epithelial cells
Distribution of Cementum on the Root

- Acellular afibrillar: cervical enamel
- Acellular extrinsic: Cervix to practically the whole root (incisors, canines) increasing in thickness towards the apical portion 50→200µm
- Cellular: Apical third, furcations
CE junction
The “OMG” rule

Cementum overlaps enamel 60%
Cementum just meets enamel 30%
Small gap between cementum and enamel 10%
Cementum overlaps enamel

(Not to scale)

(From Avery JK. Oral development and histology, ed 3, Stuttgart, 2002, Thieme Medical.)
Aging of Cementum

1. Smooth surface becomes irregular due to calcification of ligament fiber bundles where they are attached to cementum
2. Continues deposition of cementum occurs with age in the apical area. [Good: maintains tooth length; bad: obstructs the foramen]
3. Cementum resorption. Active for a period of time and then stops for cementum deposition creating reversal lines
4. Resorption of root dentin occurs with aging which is covered by cemental repair
Cementicles

- Calcified ovoid or round nodule found in the PDL
- Single or multiple near the cemental surface
- Free in ligament; attached or embedded in cementum
- Aging and at sites of trauma

**Origin:** Nidus of epithelial cell that are composed of calcium phosphate and collagen to the same amount as cementum (45% to 50% inorganic and 50% to 55% organic)
Cemental Repair

Protective function of cementoblasts after resorption of root dentin or cementum

Resorption of dentin and cementum due to trauma (traumatic occlusion, tooth movement, hypereruption)

Loss of cementum accompanied by loss of attachment

Following reparative cementum deposition attachment is restored
Clinical Correlation

Cellular cementum is similar to bone but has no nerves. Therefore it is non-sensitive to pain. Scaling produces no pain, but if cementum is removed, dentin is exposed causing sensitivity.

Cementum is resistant to resorption especially in younger patients. Thus, orthodontic tooth movement causes alveolar bone resorption and not tooth root loss.