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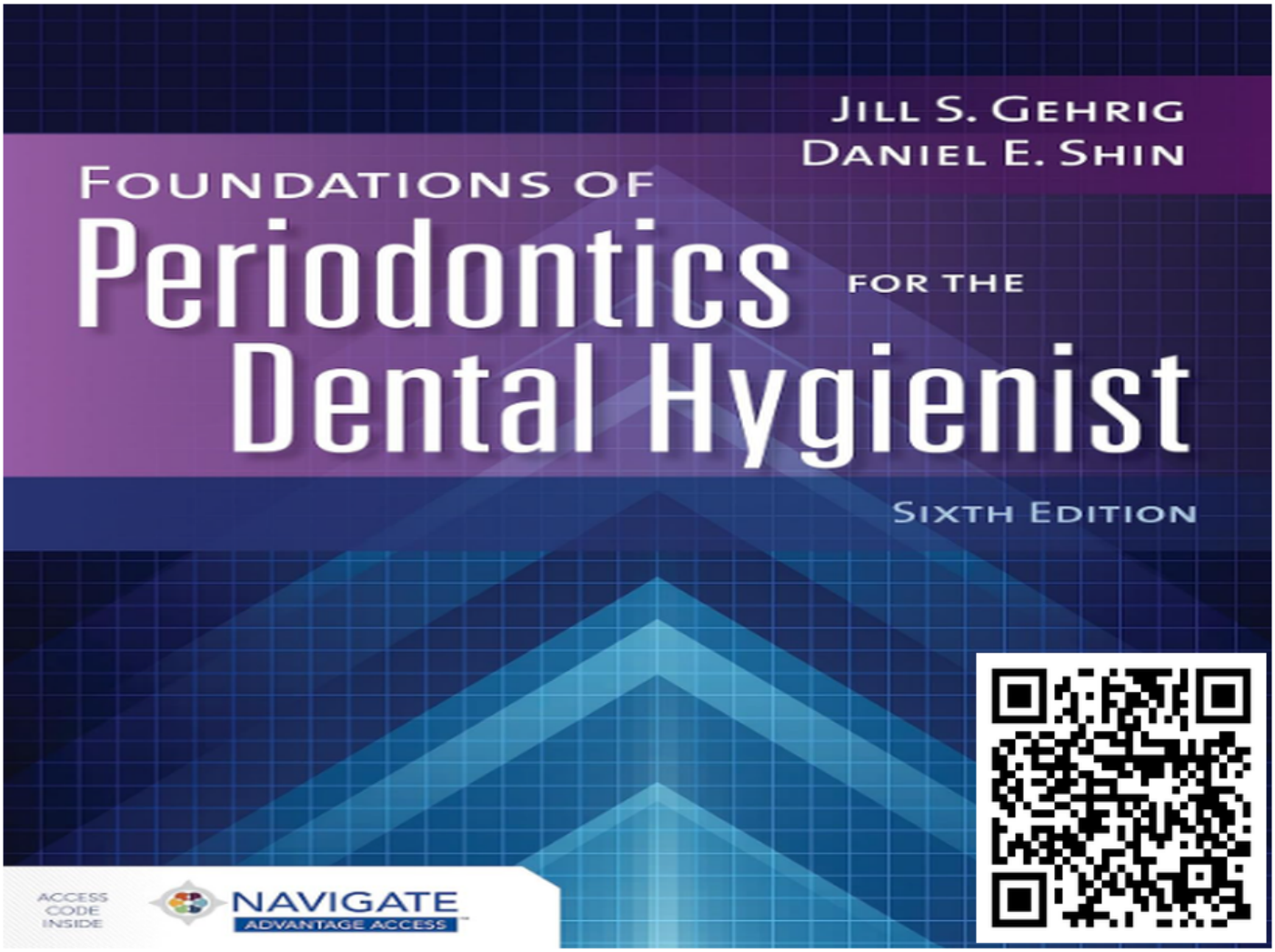

Jill S. Gehrig
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Foundations of Periodontics for the Dental Hygienist

Sixth Edition

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Sixth Edition

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Brief Contents

Contents

Preface

This textbook endeavors to present an evidence-based discussion of periodontology based on information from recent research. Periodontology, however, is a rapidly changing science. The authors, editors, and publisher have made every effort to confirm the accuracy of the information presented and to describe generally accepted practices at the time of publication. However, as new information becomes available, changes in treatment may become necessary. The reader is encouraged to keep up with dental and medical research through the many peer-reviewed journals available to verify information found here and to determine the best treatment for each individual patient. The authors, contributors, editors, and publisher are not responsible for errors or omissions or for any consequences from application of the information in this book and make no warranty, express or implied, with respect to the contents of this publication.

The ancient Greek philosopher Heraclitus famously stated: "*There is nothing permanent except change*." This quotation serves as the basis for the evolution of each successive edition of our textbook. And, while some may view any semblance of change with a sense of apprehension, the authors of the sixth edition of *Foundations of Periodontics for the Dental Hygienist* see this as an opportunity to grow upon previous editions so as to improve the preparation of students for productive functioning in the rapidly evolving and highly demanding environment of clinical periodontology.

The *Sixth Edition* is written with three primary goals in mind. First and foremost, this textbook focuses on the dental hygienist's role in periodontics. Our second goal is to develop a book with an instructional design that facilitates the teaching and learning of the complex subject of periodontics—as it relates to dental hygiene practice—without omitting salient concepts or "watering down" the material. Third, we hope to help guide you, the teacher, in transmitting your expertise and knowledge in periodontology to your students. To accomplish all our goals, many of the complex theoretical concepts that are covered in this textbook are reinforced with clinical photographs/radiographs, illustrations, flowcharts, and hypothetical case scenarios that, we hope, may provide your students with visualization aids that can assist in the learning process. Written primarily for dental hygiene students, *Foundations of Periodontics for the Dental Hygienist* also would be a valuable resource on current concepts in periodontics for the practicing dental hygienist or general dentist.

Content Sequencing

The textbook is divided into eight major content areas:

Part 1: The Periodontium in Health

Part 2: Diseases Affecting the Periodontium and Peri-Implant Tissues

Part 3: Etiologic Factors for Periodontal Diseases and Peri-Implant Diseases/Conditions

Part 4: Assessment and Planning for Patients with Periodontal Diseases and Peri-Implant Diseases/Conditions

Part 5: Implementation of Therapy for Patients with Periodontal Diseases and Peri-Implant Diseases/Conditions

Part 6: Other Aspects of the Management of Patients with Periodontal Diseases and Peri-Implant Diseases/Conditions

Part 7: Comprehensive Patient Cases

Part 8: Online Resources

New to This Edition

The sixth edition of *Foundation of Periodontics for the Dental Hygienist* has been extensively updated.

- The content section "Diseases of the Periodontium and Peri-Implant Tissues" aligns with the 2017 AAP/EFP Classifications of Periodontal and Peri-Implant Diseases and Conditions in Chapters 3–9.
- The content section "Etiologic Factors for Periodontal Diseases and Peri-Implant Diseases/Conditions" has been updated to include Chapters 10–18.
- **Chapter 1** contains expanded content on the position of the gingival margin in health as related to age and history of previous periodontitis, as well as new content on the vascular supply to the periodontium.
- **Chapter 3** contains additional content on transseptal fibers and pathologic tooth migration, as well as new content on the changes in alveolar bone height in disease, patterns of bone loss, and osseous defects.
- **Chapter 4** contains new content in the category of periodontal health, as well as new content on intact periodontium versus reduced periodontium.
- **Chapter 5** is a NEW! chapter on periodontal health and gingival diseases and addresses the new 2017 AAP/EFP Classification category of periodontal health and gingival diseases/conditions.
- **Chapter 6** contains new content to align with the 2017 AAP/EFP Classification of Periodontal and Peri-Implant Diseases and Conditions.
- **Chapter 7** is a NEW! chapter focusing on mucogingival deformities around the teeth and aligns with the 2017 AAP/EFP Classification of Periodontal and Peri-implant Diseases and Conditions.
- **Chapter 8** contains new content on titanium implants versus zirconia implants, hard and soft tissue deficiencies, biomechanical overload, and the range of probing depths compatible with peri-implant health.
- **Chapter 9** contains new content on the implications of an untreated periodontal abscess, the differentiation of periodontal versus pulpal abscesses, the signs and symptoms of the periocoronal abscess, recurrent abscesses, endodontic–periodontal lesions, necrotizing periodontal diseases, and typical treatment steps of necrotizing periodontal diseases.
- **Chapter 10** contains new content on the balance between periodontal health and disease.
- **Chapter 11** contains new content on the transmission of biofilm bacteria.
- **Chapter 12** contains new content on innate and adaptive immunity, components of the immune system, and the subsets of T-lymphocytes.
- **Chapter 13** contains new content on the role the host immunoinflammatory response plays in the pathogenesis of periodontal disease, as well as new content on the bone remodeling cycle.
- **Chapter 14** and **Chapter 15** are NEW! chapters designed to assist students in understanding the effect of systemic disorders/conditions on oral health versus the effect of oral diseases on systemic health.
- **Chapter 16** contains new content on the detrimental impact contributing factors can have in the development and progression of periodontal disease.
- **Chapter 17** contains new content on tobacco and nicotine delivery systems, the biochemical basis underlying nicotine dependence and addiction, the impacts of combustible smoking and noncombustible tobacco on the oral microbial biofilms and periodontitis, smoking and bone metabolism, oral jewelry, cannabis as a risk factor for periodontal disease, and the effects of smoking on periodontal therapy.
- **Chapter 18** contains updated content on nutrition and the periodontium.
- **Chapter 19** contains a comparison of the terms *clinical attachment level* and *clinical attachment loss*.
- **Chapter 20** contains new content on the radiographic appearance of cortical and cancellous bone, as well as new content on the importance of accurate three-dimensional images (CBCT) for treatment planning for surgical placement of dental implants.
- **Chapter 26** contains a new section on the types of manual and power toothbrushes.
- **Chapter 27** contains new content on power-driven air floss.
- **Chapter 28** contains new content on the use of antibiotics, locally delivered controlled-released chemotherapeutic agents, non-controlled-release chemotherapeutic agents, and educating patients on the use of complementary and alternative dental products/remedies.
- **Chapter 29** contains new content on anticytokine medications, statins, probiotics, and specialized proresolution mediators.

- **Chapter 30** contains new content on flap reflection to provide better access for periodontal instrumentation of root surfaces, as well as updated information on the concepts of relative and absolute contraindications for periodontal surgery.
- **Chapter 33** contains new content on ultrasonic periodontal probes.
- **Chapter 37** is a NEW! chapter on oral malodor and xerostomia/hyposalivation.

Textbook Features

The sixth edition of *Foundations of Periodontics for the Dental Hygienist* has many features designed to facilitate learning and teaching.

1. **Chapter Overview and Outline.** Each chapter begins with a concise overview of the chapter content. The chapter outline makes it easier to locate material within the chapter. The outline provides the reader with an organizational framework with which to approach new material.
2. **Learning Objectives and Key Terms.** Learning objectives assist students in recognizing and studying important concepts in each chapter. Key terms are listed at the beginning of each chapter. One of the most challenging tasks for any student is learning a whole new dental vocabulary and gaining the confidence to use new terms with accuracy and ease. The "Key Terms" list assists students in this task by identifying important terminology and facilitating the study and review of terminology in each chapter. Terms are highlighted in bold type and clearly defined within the chapter.
3. **Instructional Design**
   - Each chapter is subdivided into sections to help the reader recognize major content areas.
   - Chapters are written in an expanded outline format that makes it easy for students to identify, learn, and review key concepts.
   - Material is presented in a manner that recognizes that students have different learning styles. Hundreds of illustrations and clinical photographs visually reinforce chapter content.
   - Chapter content is supplemented in a visual format with boxes, tables, and flow charts.
4. **Focus on Patients.** *Focus on Patients* items allow the reader to apply chapter content in the context of clinical practice. The cases provide opportunities for students to integrate knowledge into their clinical work. Three types of scenarios help students apply content to the real-world setting:
   - Clinical Patient Care scenarios
   - Evidence in Action scenarios
   - Ethical Dilemma scenarios
5. **Patient Case Studies**
   - Chapter 34 presents five hypothetical patient scenarios. Patient assessment data pertinent to the periodontium challenges the student to interpret and use the information in periodontal care planning for the patient.
   - Chapter 38 (an online chapter) provides radiographs for six cases. These cases are intended to give students the opportunity to develop their critical-thinking skills in analyzing and interpreting radiographs as it pertains to the hard tissues of the periodontium in health and disease.
6. **Glossary.** The glossary provides quick access to common periodontal terminology.
7. **Online Chapters**
   - Chapter 35: Periodontal Disease in the Pediatric Population
   - Chapter 36: Iatrosedation: Easing and Managing Pediatric Patient Fears
   - Chapter 37: Oral Malodor, Xerostomia, and Hyposalivation
   - Chapter 38: Patient Cases Radiographic Analysis
8. **Online Instructor and Student Resources**
   - Instructor Resources
     - Slides in PowerPoint format for each chapter
     - Lesson plans
     - Test bank
     - Answers to Chapter Review Exercises

- Image bank
- Discussion topics and classroom activities

- Student Resources
  - Animation: Anatomy of Periodontium in Disease
  - Chapter Review Questions
  - Learning Objectives

Foundations of Periodontics for the Dental Hygienist, Sixth Edition strives to present the complex subject of periodontics in a reader-friendly manner. The authors greatly appreciate the comments and suggestions from educators and students about previous editions of this book. It is our sincere hope that this textbook will assist students and practitioners alike to acquire knowledge that will serve as a foundation for the prevention and management of periodontal diseases.

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PART 1

The Periodontium in Health

CHAPTER 1

Periodontium: The Tooth-Supporting Structures

- Section 1 Tissues of the Periodontium
  - The Gingiva
  - Periodontal Ligament
  - Root Cementum
  - Alveolar Bone
- Section 2 Nerve Supply, Blood Supply, and Lymphatic System
  - Nerve Supply to the Periodontium
  - Blood Supply to the Periodontium
  - Lymphatic System and the Periodontium
- Section 3 Focus on Patients
  - Clinical Patient Care

CLINICAL APPLICATION

Dental health care providers continuously interact with patients when making clinical decisions, performing clinical procedures, evaluating new techniques, and adapting to emerging treatment approaches. Nearly every action taken by a clinician requires a detailed knowledge of the anatomy of the tooth-supporting structures—the periodontium. Chapters 1 and 2 outline current knowledge about the anatomy of the periodontium. Chapter 1 deals with what is known about the fundamental structure of the complex system of tissues that support the teeth and can serve as a basis for organizing thoughts about additional anatomical information as it becomes available through additional research. Chapter 2 deals with the microscopic anatomy of these structures.

LEARNING OBJECTIVES

- Identify the tissues of the periodontium on an unlabeled diagram depicting the periodontium in cross section.
- Describe the function that each tissue serves in the periodontium, including the gingiva, periodontal ligament, cementum, and alveolar bone.
- In a clinical setting or on a color photograph, identify the following anatomical areas of the gingiva: free gingiva, gingival sulcus, interdental gingiva, and attached gingiva.
- In a clinical setting or on a color photograph, identify the following boundaries of the gingiva: gingival margin, free gingival groove, and mucogingival junction.
- In a clinical setting, identify the free gingiva on an anterior tooth by inserting a periodontal probe to the base of the sulcus.

- In a clinical setting, compare and contrast the coral pink tissue of the attached gingiva with the darker, shiny tissue of the alveolar mucosa.
- In the clinical setting, use compressed air to detect the presence or absence of stippling of the attached gingiva.
- Identify the alveolar process (alveolar bone) on a human skull.
- Describe the shape and contour of the alveolar crest of the bone in health.
- Describe the nerve and blood supply to the periodontium.
- Explain the role of the lymphatic system in the health of the periodontium.

KEY TERMS

Periodontium
Gingiva
Periodontal ligament (PDL)
Cementum
Alveolar bone (alveolar process)
Gingival margin
Alveolar mucosa
Free gingival groove
Mucogingival junction
Free gingiva
Attached gingiva
Stippling
Interdental col
Interdental gingiva
Papillae
Gingival sulcus
Gingival crevicular fluid
Sharpey's fibers
Alveolar bone proper
Cribriform plate
Alveolus
Cortical bone
Alveolar crest
Cancellous bone (spongy bone)
Periosteum
Innervation
Trigeminal nerve
Anastomose
Lymphatic system
Lymph nodes

Section 1
Tissues of the Periodontium

The **periodontium** (*peri* = around and *odontos* = tooth) is the functional system of tissues that surrounds the teeth and attaches them to the jawbone (**Figures 1-1** and **1-2**). The periodontium is also called **the supporting tissues of the teeth** and the attachment apparatus. The tissues of the periodontium include the following:

1. **Gingiva**—the tissue that covers the cervical portions of the teeth and the alveolar processes of the jaws.
2. **Periodontal ligament (PDL)**—the fibers that surround the root of the tooth. These fibers attach to the bone of the socket on one side and to the cementum of the root on the other side.
3. **Cementum**—the thin layer of mineralized tissue that covers the root of the tooth.
4. **Alveolar bone** (also known as **alveolar process**)—the bone that surrounds the roots of the teeth. It forms the bony sockets that support and protect the roots of the teeth.

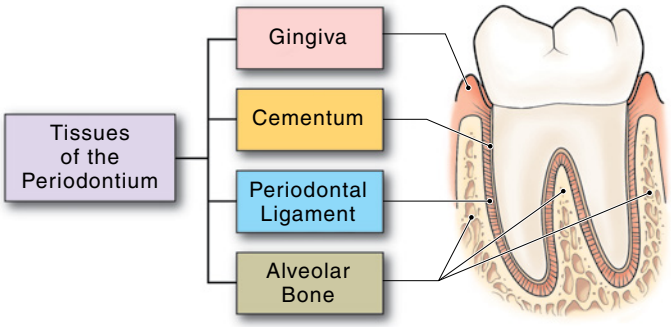


Figure 1-1 Tissues Comprising the Periodontium. A graphic representation of the periodontium in cross section.

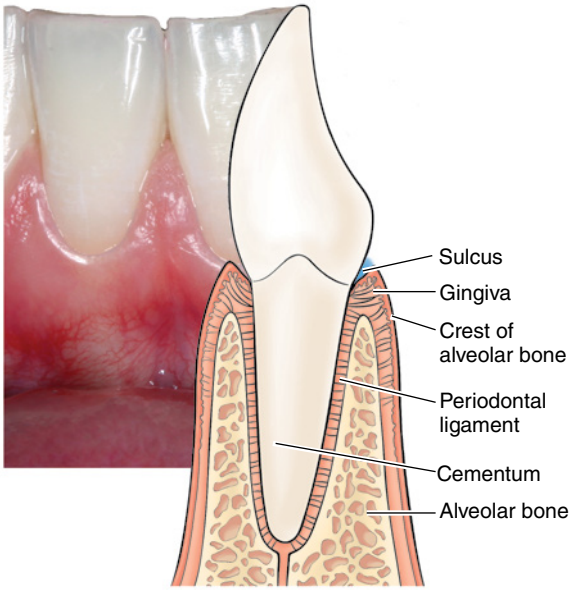


Figure 1-2 Healthy Periodontium. Clinical photograph and drawing depicting the structures of the periodontium.

Each of the tissues of the periodontium plays a vital role in maintaining the health and function of the periodontium (**Table 1-1**). Knowledge of the periodontal tissues in health is a necessary foundation for understanding the concepts of (1) normal function of the periodontium, (2) disease prevention, and (3) the periodontal disease process.

Table 1-1 The Periodontium

Structure	Brief Description of Its Function
Gingiva	■ Provides a tissue seal around the cervical portion (neck) of the tooth ■ Covers the alveolar processes of the jaws ■ Holds the tissue against the tooth during mastication
Periodontal ligament	■ Suspends and maintains the tooth in its socket
Cementum	■ Anchors the ends of the periodontal ligament fibers to the tooth so that the tooth stays in its socket ■ Protects the dentin of the root
Alveolar bone	■ Surrounds and supports the roots of the tooth

Dental hygiene students usually are introduced to the tissues of the periodontium during the first semester or quarter of the dental hygiene curriculum. In the preclinical stages of the curriculum, mastering dental terminology and anatomy can sometimes be overwhelming and confusing. This chapter provides an opportunity to review this complex system of tissues known as the periodontium.

The Gingiva

1. **Overview of the Gingiva**
   a. **Description.** The gingiva is the part of the mucosa that surrounds the cervical portions of the teeth and covers the alveolar processes of the jaws (**Figure 1-3**).

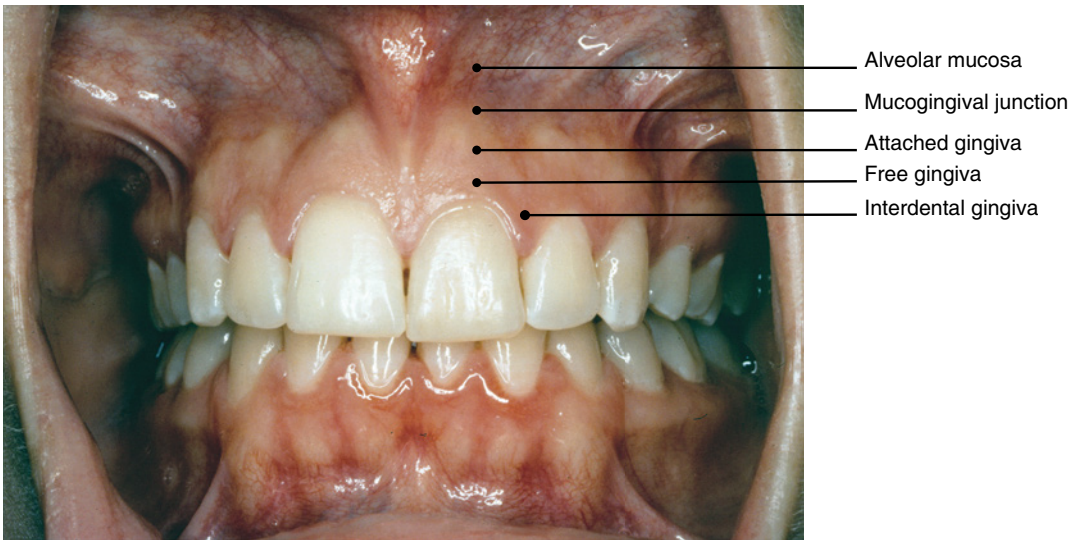


Figure 1-3 The Gingival Tissues. Photograph of healthy gingival tissues showing the free, attached, and interdental gingiva.

1. In health, the contour and shape of the gingival margin approximates the scalloped curvature of the cementoenamel junction (CEJ).
2. The position of the gingival margin in health may be age dependent. In a periodontally healthy young individual, the position of the gingival margin may be located at or slightly coronal to the CEJ of each tooth. In contrast, in a periodontally healthy older individual, the gingival margin may be positioned apical to the CEJ. Reasons for this may be attributed to a previous history of periodontitis (resulting in recession of the gingival margin) or due to non-periodontitis reasons (e.g., history of mechanical abrasion).
3. The gingiva attaches to the tooth by means of a specialized epithelial tissue (junctional epithelium).
4. The gingiva is composed of a thin outer layer of epithelium and an underlying layer of connective tissue.
5. The gingiva is divided into four anatomical areas:
   a. Free gingiva
   b. Gingival sulcus
   c. Interdental gingiva
   d. Attached gingiva

b. **Function.** The gingiva protects the underlying tooth-supporting structures of the periodontium from the oral environment. The oral environment is exposed to a wide range of temperatures in food and drink, mechanical forces, and many oral bacteria. To accomplish these functions, the gingiva has several defense mechanisms, including saliva and the immune system.

c. **Boundaries of the Gingiva**

1. The coronal boundary, or upper edge, of the gingiva is the **gingival margin** (Figure 1-4).

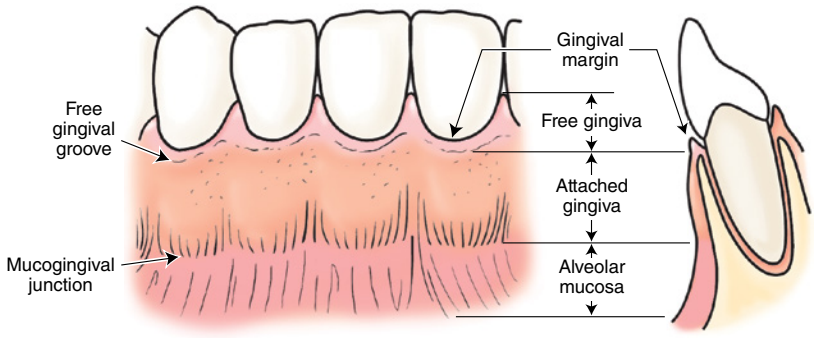


Figure 1-4 Boundaries of the Gingiva. Illustration showing the boundaries and anatomical areas of the gingiva.

2. The apical boundary, or lower edge, of the gingiva is the alveolar mucosa. The **alveolar mucosa** can be distinguished easily from the gingiva by its dark red color and smooth, shiny surface.

d. **Demarcations of the Gingiva**

1. The **free gingival groove** is a shallow linear depression that separates the free and attached gingiva (this line is rarely visible to the naked eye).
2. The **mucogingival junction** is the clinically visible boundary where the pink attached gingiva meets the red, shiny alveolar mucosa. (*Clinically visible* means that this landmark is readily seen by the naked eye.)

2. **Free Gingiva.** The **free gingiva** is the unattached portion of the gingiva that surrounds the tooth in the region of the CEJ. The free gingiva is also known as the *unattached gingiva* or the *marginal gingiva*.

a. **Location of the Free Gingiva**

1. The free gingiva is the most coronal boundary of the gingiva.
2. It surrounds the tooth in a turtleneck or cuff-like manner.
3. The free gingiva attaches to the tooth by means of a specialized epithelium, known as the junctional epithelium.

b. **Characteristics of the Free Gingiva**

1. The tissue of the free gingiva fits closely around the tooth, but is not directly attached to it.
2. Because it is unattached, a periodontal probe can be used to slightly retract the free gingiva away from the tooth.
3. The free gingiva also forms the soft tissue lateral wall of the gingival sulcus.

c. **Contour of the Free Gingival Margin**

1. The tissue of the free gingiva meets the tooth in a thin rounded edge called the gingival margin.
2. In health, the gingival margin follows the scalloped, curved contours of the underlying CEJ.

3. **Attached Gingiva.** The **attached gingiva** is continuous with the free gingiva and is the part of the gingiva that is tightly bound to the underlying cementum on the cervical-third of the root and to the periosteum (connective tissue cover) of the alveolar bone.

a. **Location of the Attached Gingiva.** The attached gingiva lies between the free gingiva and the alveolar mucosa (**Figure 1-5**).

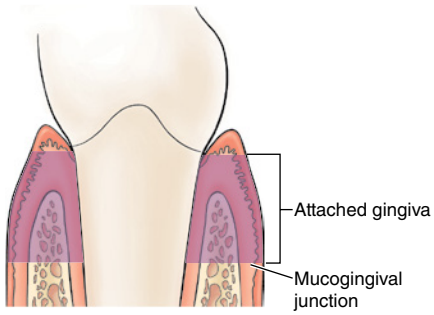


Figure 1-5 Location of the Attached Gingiva. The attached gingiva extends from the free gingival groove to the mucogingival junction.

b. **Width of the Attached Gingiva**

1. The attached gingiva is widest in the incisor and molar regions, ranging from 3.3 to 3.9 mm on the mandible and 3.5 to 4.5 mm on the maxilla (**Figure 1-6**).

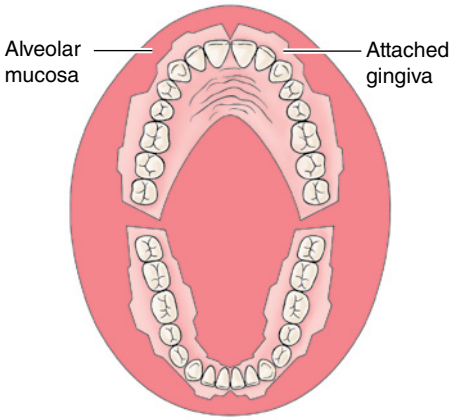


Figure 1-6 Mean Width of the Attached Gingiva. The attached gingiva is widest in the incisor and molar regions and narrowest in premolar regions.

2. The attached gingiva is narrowest in premolar regions (1.8 mm on mandible and 1.9 mm on maxilla).
3. The width of the attached gingiva is not measured on the palate because clinically it is not possible to determine where the attached gingiva ends and the palatal mucosa begins (**Figure 1-7**).

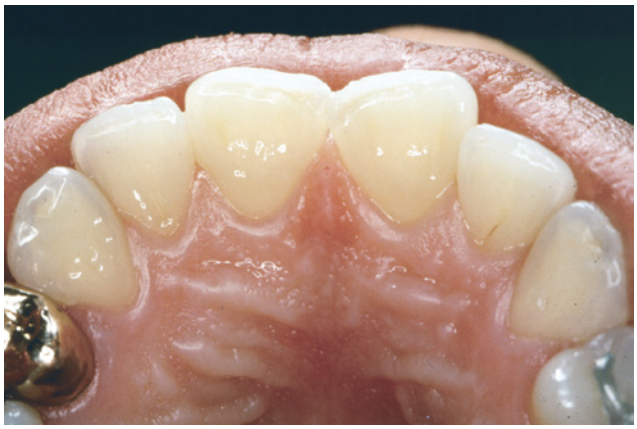
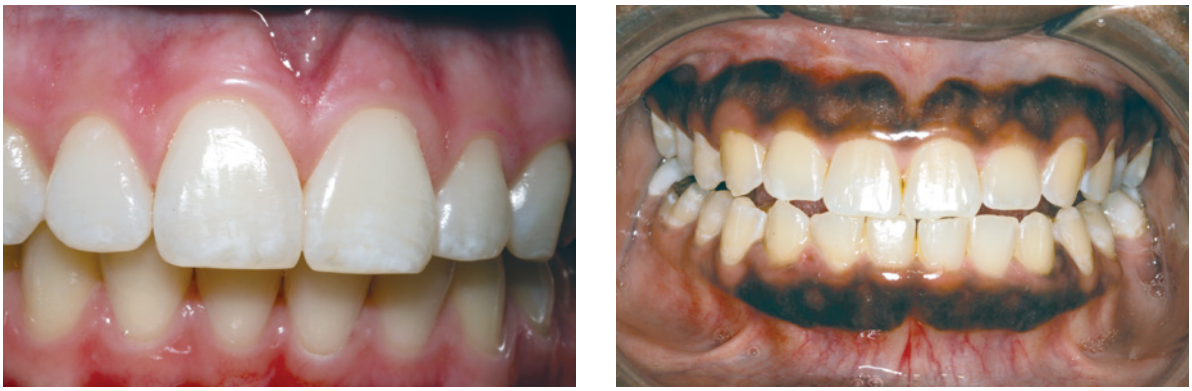


Figure 1-7 Gingival Tissue of the Palate. On the palate, the palatal gingiva is directly continuous with the keratinized masticatory mucosa.

4. It was once believed that a minimum 2-mm width of keratinized gingiva (free gingiva plus attached gingiva) was necessary to maintain the health of the periodontium.[1] Currently, this concept is being revisited because the amount of keratinized tissue that is "necessary" has never been established.

c. **Color of the Attached Gingiva**

1. In health, the attached gingiva is pale or light coral pink.
2. The attached gingiva may be pigmented (**Figure 1-8**). This pigmented tissue is known as physiologic pigmentation.



A **B**

Figure 1-8 Color Variations of Normal Gingiva. The color of the normal gingiva varies among different individuals. **A.** The color is a lighter, coral pink in individuals with fair complexions. **B.** In individuals with dark skin and hair, the gingiva may be pigmented.

A and **B:** Courtesy of Elizabeth Carr, University of Mississippi Medical Center, Jackson, MS.

a. Pigmentation occurs more frequently in dark-skinned individuals.[2]
b. The pigmented areas of the attached gingiva may range from light brown to black.
c. Pigmentation is due to an increased production of melanin (pigment) from melanocytes (melanin-producing cells found in the epidermal layer).

d. **Texture of the Attached Gingiva.** In health, the surface of the attached gingiva may have a dimpled appearance similar to the skin of an orange peel. This dimpled appearance is known as **stippling** (**Figure 1-9**). Stippling acts to provide mechanical reinforcement to the gingiva. Stippling is seen only on the attached and interdental gingiva, not the free gingiva. Healthy tissue, however, does not always exhibit a stippled appearance, and the presence of stippling varies greatly from individual to individual. In fact, stippling is only present in 40% of periodontally healthy adults. As such, stippling is absent in the majority of periodontally healthy individuals.

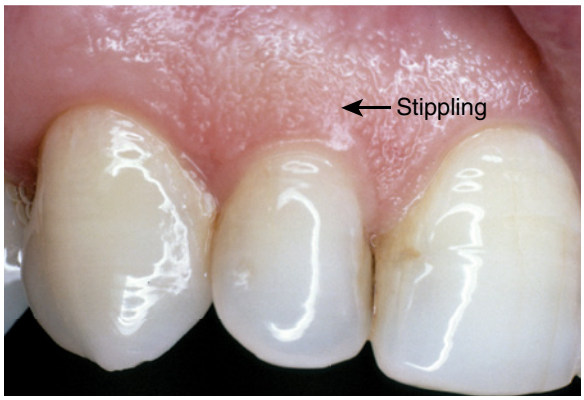


Figure 1-9 Gingival Stippling. In health, the surface of the attached gingiva and interdental gingiva may have a dimpled appearance known as gingival stippling.

e. **Function of the Attached Gingiva**
1. The attached gingiva allows the gingival tissue to withstand the mechanical forces created during activities such as mastication, speaking, and toothbrushing.
2. The attached gingiva prevents the free gingiva from being pulled away (apically) from the tooth when tension is applied to the alveolar mucosa.

4. **Interdental Gingiva.** The **interdental gingiva** is the portion of the gingiva that fills the interdental embrasure between two adjacent teeth apical to the contact area (**Figure 1-10**).

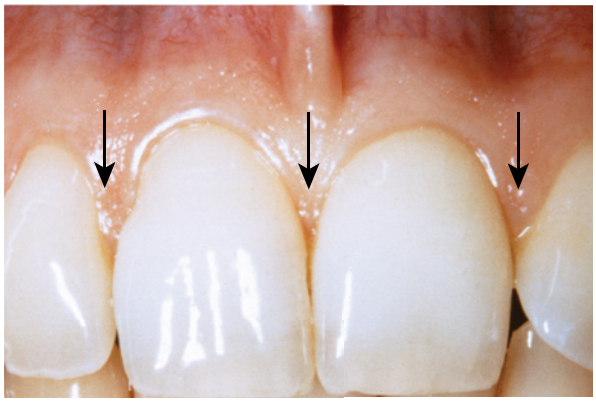


Figure 1-10 The Interdental Gingiva. The interdental tissue fills the area between two adjacent teeth.

   a. **Parts of Interdental Gingiva**
      1. The interdental gingiva consists of two interdental **papillae**—one facial papilla and one lingual papilla (*papilla* = singular noun; *papillae* = plural noun).
         a. The lateral borders and tip of an interdental papilla are formed by the free gingiva from the adjacent teeth.
         b. The center portion of the interdental papilla is formed by the gingival col.
      2. The **interdental col** is a valley-like depression in the portion of the interdental gingiva[2] that lies directly apical to the contact area of two adjacent (touching) teeth and connects the facial and lingual papillae (**Figure 1-11**). ***The col is absent if the adjacent teeth are not in contact*** (i.e., there is a space between two adjacent teeth), there is no adjacent tooth (i.e., the lingual surface of the posterior-most tooth in the arch), or if the interdental gingiva has receded.

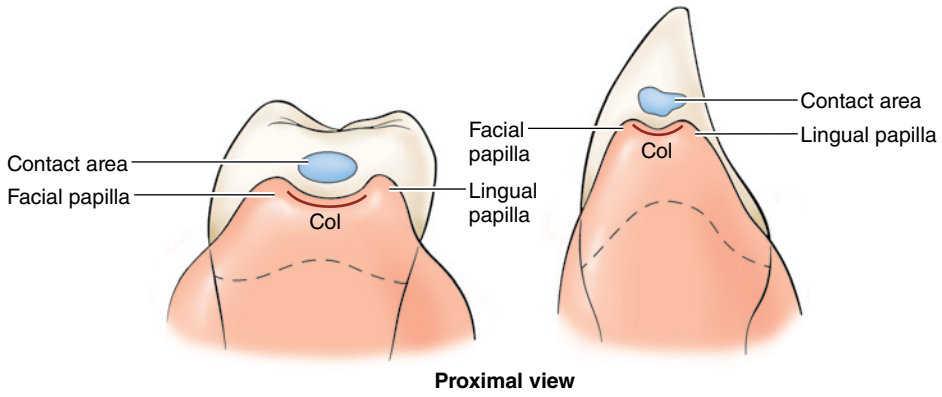


Figure 1-11 Interdental Col. Apical to the contact area between two teeth, the interdental gingiva has a concave (depressed) form. The concavity, the "col," is located between the facial and lingual papillae and passes beneath the contact area of two adjacent teeth.

   b. **Function of Interdental Gingiva.** The interdental gingiva prevents food from becoming packed between the teeth during mastication.

5. **Gingival Sulcus.** The **gingival sulcus** is the *space* between the free gingiva and the tooth surface (**Figure 1-12**).

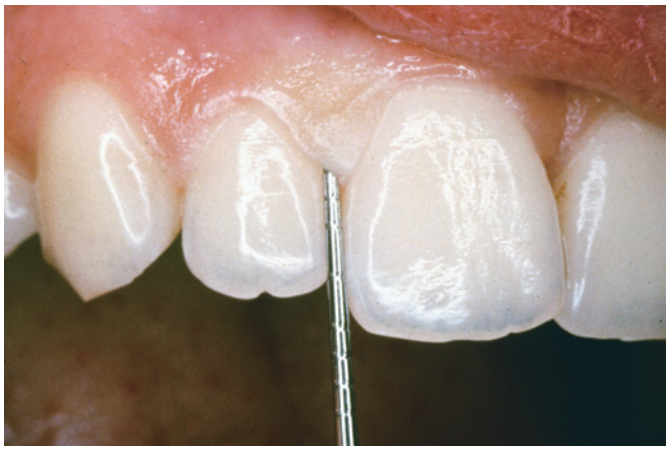


Figure 1-12 Gingival Sulcus. This photograph shows a periodontal probe inserted into the gingival sulcus, the space between the free gingiva and the tooth.

a. **Description.** The sulcus is a V-shaped, shallow crevice space encircling the neck of a tooth.[3]
   1. The depth of a clinically healthy gingival sulcus is from 1 to 3 mm, as measured using a periodontal probe.
   2. Base of Sulcus. The base of the sulcus interfaces with the most coronal portion of the junctional epithelium (a specialized type of epithelium that attaches to the tooth surface).

b. **Gingival Crevicular Fluid.** The **gingival crevicular fluid**, also called the gingival sulcular fluid, is a fluid that seeps from the underlying connective tissue into the sulcular space.[4]
   1. Little or no fluid is found in the healthy gingival sulcus, but the fluid flow increases in the presence of dental plaque biofilm and the resulting gingival inflammation.[5]
   2. Fluid flow increases in response to toothbrushing, mastication, or other stimulation of the gingiva. The flow is greatly increased when the gingiva is inflamed.
   3. If a filter strip is inserted into the sulcus, it absorbs the fluid in the sulcus. Using the filter strip, the amount of gingival crevicular fluid can be measured and used as an index of gingival inflammation.

Periodontal Ligament

1. **Description**
   a. The periodontal ligament (PDL) is a network of soft connective tissue fibers that attach the root of the tooth to the bony walls of the tooth socket (**Figure 1-13**).

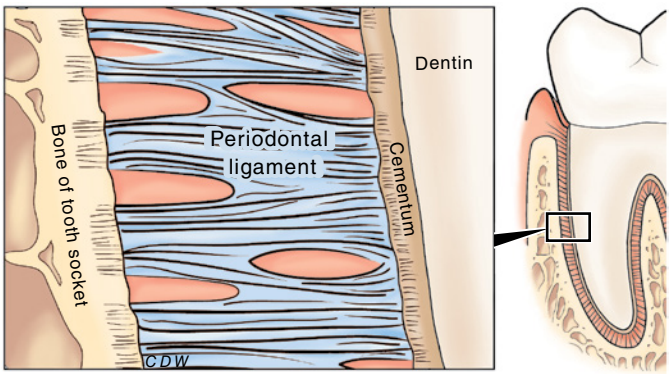


Figure 1-13 Periodontal Ligament.

- On the tooth side, the ends of the PDL fibers are anchored to the cementum of the root.
- On the bone side, the ends of the PDL fibers are anchored to the alveolar bone of the tooth socket.

1. The PDL is composed mainly of dense fibrous connective tissue.[3]
2. The fibers of the PDL attach on one side to the root cementum and on the other side to the alveolar bone of the tooth socket.[6]

b. The PDL not only connects the tooth to the alveolar process, but also supports the tooth in the socket and absorbs mechanical loads placed on the tooth, thus protecting the tooth in its socket.[7]

2. **Functions.** The PDL has five functions in the periodontium:
   a. Supportive function—the ligament fibers suspend and maintain the tooth in its socket.
   b. Sensory function—specialized nerve endings course through the PDL space to relay sensory information (such as pain and pressure sensations) from the tooth and surrounding attachment apparatus to the central nervous system.
   c. Nutritive function—blood vessels course through the PDL space are critical to providing oxygen and vital nutrients to the tissues of the periodontium
   d. Formative function— the tissues of the PDL contain many specialized formative cells such as fibroblasts, cementoblasts, and osteoblasts which build and maintain the attachment apparatus all throughout the lifetime of the tooth. Moreover, dormant epithelial cells (remnants of Hertwig's epithelial root sheath) and undifferentiated periodontal ligament cells populate the periodontal ligament space and may play a critical role in periodontal regeneration. Hence, ongoing periodontal research is focused on finding ways to tap into the regenerative potential of these promising cells.
   e. Remodeling function—can remodel the alveolar bone in response to pressure, such as that applied during orthodontic treatment (braces).

Cementum

1. **Description.** Cementum is a thin layer of hard, mineralized connective tissue that covers the surface of the tooth root (**Figure 1-14**).

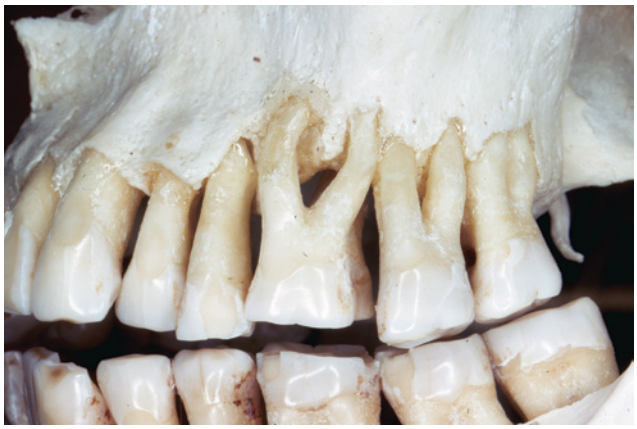


Figure 1-14 Cementum. Cementum is mineralized connective tissue that covers the root of the tooth; it is light yellow in color.

2. **Characteristics of Cementum**
   a. Cementum overlies the dentin of the root. It is light yellow in color and softer than dentin or enamel. In terms of weight, it is composed of 50% to 55% organic substance—primarily, Type I collagen and noncollagenous matrix proteins—and 45% inorganic content (calcium and phosphate forms of hydroxyapatite and trace elements).
   b. Cementum is a bone-like tissue that is more resistant to resorption than bone.[8]
      1. Resistance to resorption (loss of substance) is an important characteristic of cementum that makes it possible for the teeth to be moved during orthodontic treatment.[9]

2. The high resistance of cementum to resorption allows the pressure applied during orthodontics to cause resorption of the alveolar bone, for tooth movement, without resulting in root resorption.

c. Like bone remodeling, cementum undergoes a continuous and slow physiologic process of resorption and repair throughout the lifetime of a tooth. This process allows for repair of existing cementum and deposition of new cementum. Thus, as an individual ages, the average thickness of cementum increases.

d. There are two main types of cementum: cellular and acellular (**Table 1-2**).

Table 1-2 Characteristics of Cementum

	Acellular Cementum	Cellular Cementum
Time of development	Forms before teeth are in occlusion	Forms after teeth have reached occlusion
Histologic features	Devoid of cells	Composed of cementocytes
Location on root	Covers cervical two-thirds of root	Covers apical one-third of root
Function	Plays important role in tooth support	Compensates for active eruption and normal tooth wear by continuous deposition of cementum

e. Cementum does not have its own blood or nutrient supply; it receives its nutrients from the PDL.

f. Cementum is relatively permeable to extrinsic dyes, organic substances, inorganic ions, and bacteria. In periodontal disease, bacteria have been shown to invade the cementum.

3. **Functions of Cementum in the Periodontium.** Cementum performs several important roles in the periodontium; therefore, conservation of healthy cementum should be a goal of periodontal instrumentation.

a. The primary function of cementum is to give attachment to the collagen fibers of the PDL. Cementum anchors the ends of the PDL fibers (via terminal endings known as **Sharpey's fibers**) to the tooth. Without cementum, the tooth would fall out of its socket.

b. The outer layer of cementum protects the underlying dentin and seals the ends of the open dentinal tubules.

c. Cementum formation compensates for tooth wear at the occlusal or incisal surface due to attrition.

1. Cementum is formed at the apical area of the root to compensate for occlusal attrition. This allows for the tooth to maintain its length. Consequently, the apical third of the root tends to be thicker (150 to 250 μm) than the coronal half of the root (16 to 60 μm).

2. However, excessive deposition of cementum in the apical third of the root may result in an abnormality known as hypercementosis, which can potentially obstruct the apical foramen. Radiographically, the characteristic hallmark of hypercementosis is a radiopaque thickening of the cementum that is enveloped by the radiolucent shadow of the PDL space and an intact lamina dura. In the absence of any pathology, hypercementosis does not pose a problem and does not require treatment.

Alveolar Bone

1. **Description**

a. The alveolar process, or alveolar bone, is the bone of the upper or lower jaw that surrounds and supports the roots of the teeth (**Figure 1-15**).

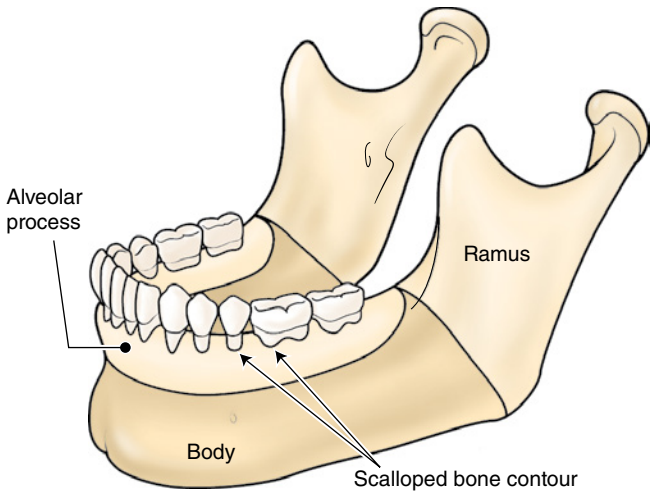


Figure 1-15 Alveolar Process. The alveolar process is the bone that surrounds and supports the roots of the teeth.

b. Bone is mineralized connective tissue and consists by weight of about 60% inorganic material, 25% organic material, and 15% water.
c. The existence of the alveolar bone is dependent on the presence of teeth; when teeth are extracted, in time, the alveolar bone resorbs. If teeth do not erupt, the alveolar bone does not develop.

2. **Function of the Alveolar Bone in the Periodontium.** The alveolar bone forms the bony sockets that provide support and protection for the roots of the teeth.
3. **Layers That Compose the Alveolar Process.** When viewed in cross section, the alveolar process is composed of three layers of hard tissue and covered by a thin layer of connective tissue (**Figures 1-16** and **1-17**).

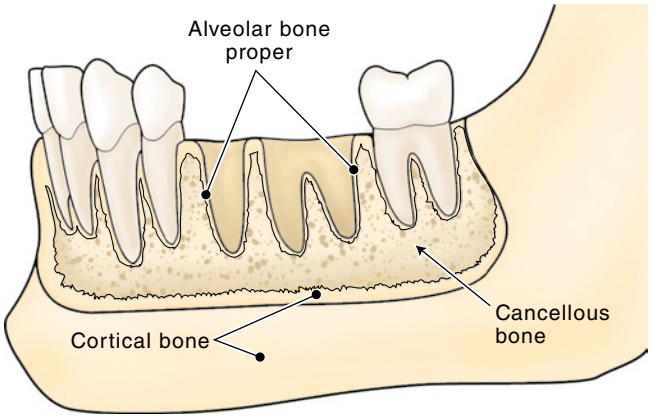


Figure 1-16 Layers of the Alveolar Process. A lateral section of the mandible reveals three bony layers: the alveolar bone proper, cancellous bone, and cortical bone.

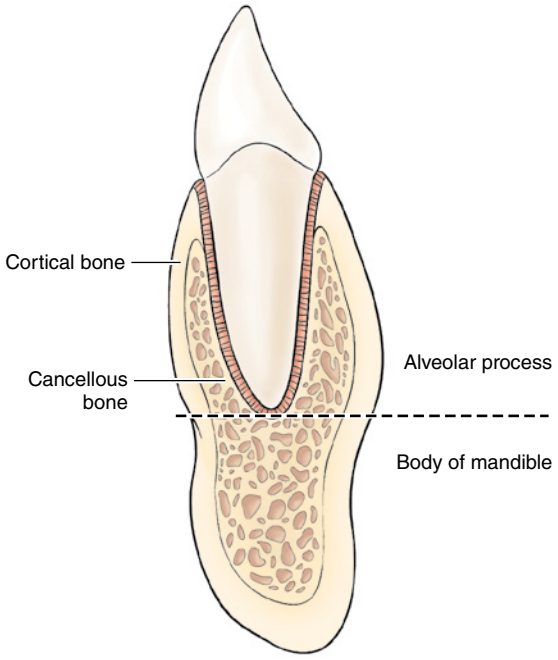


Figure 1-17 Cross Section of the Mandible. The dotted line indicates the boundary of the alveolar process with the body of the mandible.

a. The **alveolar bone proper** (or **cribriform plate**) is the thin layer of bone that lines the socket that surrounds the root of the tooth.
   1. The **alveolus** is the bony socket, a cavity in the alveolar bone that houses the root of a tooth (*alveolus* = singular; *alveoli* = plural) (**Figure 1-18**).

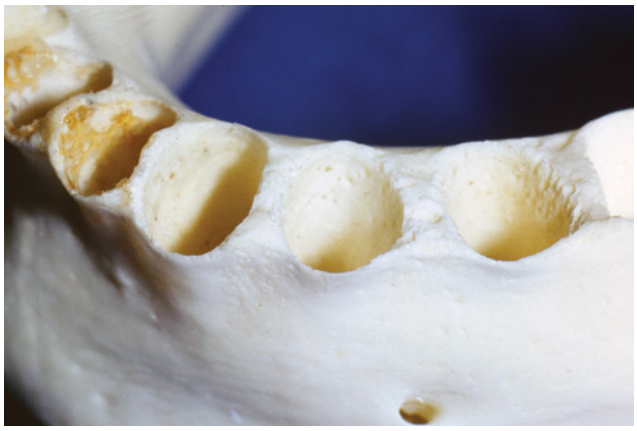


Figure 1-18 Alveoli of the Mandible. The alveoli are the sockets in the alveolar bone that house the roots of the teeth.

Courtesy of Dr. Don Rolfs, Periodontal Foundations, Wenatchee, WA.

   2. The alveolar bone proper has numerous holes (foramina) that allow blood vessels from the cancellous bone to connect with the vessels of the PDL space.
   3. The ends of the PDL fibers (Sharpey's fibers) are embedded in the alveolar bone proper.

b. The **cortical bone** (or cortical plate) is a layer of compact bone that forms the hard, outer wall of the mandible and maxilla on the facial and lingual aspects. This cortical bone surrounds the alveolar bone proper and gives support to the socket.
   1. The buccal cortical bone is thinner in the incisor, canine, and premolar regions; while thicker in molar regions.
   2. Because the cortical plate is only on the facial and lingual sides of the jaw, it will not appear on a radiograph; only the cancellous bone and the alveolar bone proper can be seen on a radiograph.
   3. The **alveolar crest** is the coronal-most portion of the alveolar process.
      a. In health, the alveolar crest is located 1 to 2 mm apical to (below) the CEJs of the teeth (**Figure 1-19**).

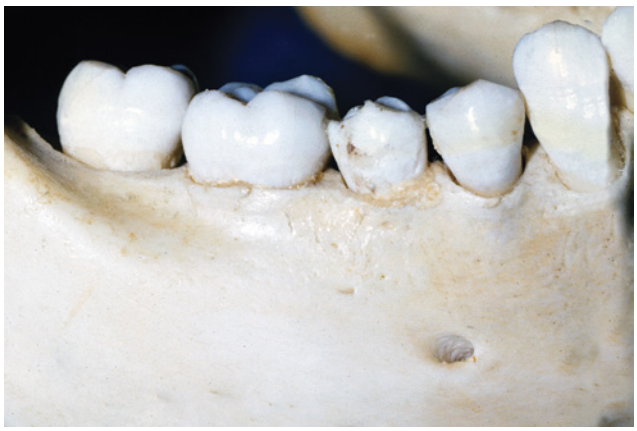


Figure 1-19 Bony Contours. The alveolar crest conforms to a scalloped (curved) line that follows the contours of the cementoenamel junctions.

Courtesy of Dr. Don Rolfs, Periodontal Foundations, Wenatchee, WA.

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