

WOELFEL'S
**DENTAL
ANATOMY**
Its Relevance to Dentistry

SEVENTH EDITION



Rickne C. Scheid

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Its Relevance to Dentistry
SEVENTH EDITION

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Julian B. Woelfel, D.D.S.

Professor Emeritus Woelfel, known primarily for his expertise on complete dentures, research, and occlusion, taught clinical dentistry for 40 years in the College of Dentistry, The Ohio State University, Columbus, Ohio. He served as an Army prosthodontist for 2 years, conducted clinical research for the American Dental Association at the National Bureau of Standards in Washington, D.C. for 2 years, and was a visiting professor in Japan, Taiwan, England, and Brazil. Dr. Woelfel has lectured in 18 foreign countries. He has published 75 scientific articles, four editions of *Dental Anatomy*, and chapters in five books. He holds patents on two inventions that are used in Europe and the United States for accurately recording jaw relations. In addition to his love for students and teaching, he conducted a part-time private practice limited to partial and complete dentures for 33 years. One of his proudest accomplishments is this textbook. In 1967, he was the first recipient of the International Association of Dental Research Award for Research in Prosthodontics, and became a Life Member of the Nihon University Dental Alumni Association. In 1972, the New York Prosthodontic Society selected him for the Jerome and Dorothy Schweitzer Award for Outstanding and Continuing Research in Prosthodontics. In 1992, the Ohio Dental Association chose Dr. Woelfel for the prestigious Callahan Award, and in 2004, he was the recipient of the Distinguished Alumni Award of the College of Dentistry at The Ohio State University. He is a Life Member of several professional societies including Sigma Xi, the International Association for Dental Research, the American Prosthodontic Society, and the ADA, FDI, FICD, and FACD.

Rickne C. Scheid, D.D.S., M.Ed.

Dr. Rickne Scheid received his D.D.S. in 1972 at The Ohio State University and was inducted into the dental honorary fraternity, Omicron Kappa Upsilon. After serving in the U.S. Navy Dental Corps, he went into part-time practice and has taught at his alma mater since 1974. His appointments at the College of Dentistry have been in the Department of Operative Dentistry, the Division of Dental Hygiene, and currently, he holds a dual appointment in the Section of Restorative and Prosthetic Dentistry and the Section of Primary Care in Dental Hygiene. While teaching, he received his Masters in Education with honors in 1980. He has authored or coauthored nearly 50 scientific papers and abstracts. Throughout his teaching career, he has developed and directed 12 different courses, including directing the dental anatomy course, which is presented each year to 130 dental and dental hygiene students. Further, he helped develop and annually codirects over 184 hours of continuing education, including a review course for dental hygienists returning to practice, a dental anatomy review course for dentists and dental auxiliaries, and an expanded functions course for dental auxiliaries. He was inducted into the dental hygiene honorary, Sigma Phi Alpha, in 1989, and has received numerous dental and dental hygiene student teaching awards as well as the peer-evaluated Postle Teaching Award in 1996.

Preface to the Seventh Edition

Woelfel's Dental Anatomy: Its Relevance to Dentistry is primarily intended as a study guide for dental students, dental hygiene students, dental assistants, and dental laboratory technicians in the study of tooth morphology and related structures. The text is designed to help the reader appreciate the relationship of teeth to one another and to the bones, muscles, nerves, and vessels closely associated with the teeth and face. This text also includes considerable emphasis on the application of dental morphology to the practice of dentistry. The book is organized to be used by instructors of dental anatomy courses as a teaching manual during lectures, discussion periods, and laboratory sessions, and in early clinical experiences. It is also useful as a reference in a dental office.

HOW THE BOOK IS ORGANIZED:

Chapter 1 begins with a very brief overview of the teeth: just enough to help the reader appreciate the relationship of the teeth to the head and neck anatomy presented in the remaining sections of this chapter. Topics include the bones of the skull and associated bony landmarks, the temporomandibular joints, the chewing muscles, and the nerves, blood supply, and lymph drainage associated with the oral cavity. **Chapter 2** includes the location and description of *normal* oral structures observed during a head and neck cancer screening examination in the dental office, followed in **Chapter 3** by a more detailed description of general terminology of normal tooth morphology and ideal tooth and occlusal relationships. **Chapters 4 through 7** include detailed descriptions of each type of adult tooth, with drawings, photographs, and charts designed to illustrate the normal characteristics of each tooth type. These chapters also help the reader appreciate the variation that can occur between the same type of teeth in different mouths. The roots of the adult teeth are discussed in more detail in **Chapter 8** (relative to periodontics) and **Chapter 9** (relative to endodontics). **Chapter 10** includes the discussion of deciduous or primary teeth, along with eruption patterns occurring throughout the time when mixed dentition is present. **Chapter 11** provides a contemporary overview of occlusion. Here, the authors describe the relationship of the jaws and teeth during various normal and abnormal relationships, including a discussion of treatment modalities used to correct malocclusion or temporomandibular joint dysfunction. Next, in **Chapter 12**, there is an extensive discussion of many commonly encountered dental anomalies. The importance of dental anatomy and terminology related to operative and restorative dentistry is presented in **Chapter 13**. **Chapter 14** includes helpful techniques for learners to draw, sketch, and carve teeth, and **Chapter 15** includes the importance of tooth morphology within the field of forensic dentistry.

Each chapter includes methods designed to help you, the reader, master the content and put it to practice immediately.

- **Topic list:** Each *chapter* begins with a list of topics that are presented within that chapter. The topics are presented in the same order as the section outline headings within that chapter.
- **Learning objectives:** In each section, important learning objectives are presented to help you appreciate what you can expect to learn as you read. You can refer to the objectives to ensure that you are mastering the appropriate knowledge and skills.
- **New terms:** As each new term is encountered for the first time, it is highlighted in **bold print** and is defined within the text at that time, often with references to figures or diagrams to improve understanding. The bold print is helpful when using the text as a reference for understanding terms that can be found within the text's index.
- **Index (instead of a glossary):** The extensive index has been used instead of a glossary since many terms in dentistry are best appreciated by referring to illustrations or photographs for a complete understanding. In most cases, the first page where a term is referenced in the index is the page where you can find the term (in bold) and can refer to the suggested illustrations for the best learning.
- **Pronunciations:** New terms that may be difficult to pronounce have phonetic suggestions placed within brackets [like this] immediately after the word is first encountered.

- **Learning questions with answers:** Many chapters or sections end with a series of learning questions to test the learner's mastery of the objectives. These questions, in many cases, cover topics similar to those included on past dental and dental hygiene national examinations. For the convenience of quick and convenient feedback, the answers are presented immediately following the questions (but upside down). Available for instructors who use this edition is a CD that includes a bank of additional test items.
- **Learning exercises:** Practically every chapter provides the reader with a series of learning exercises. These exercises are presented within the body of each chapter at intervals where the authors feel an active learning experience would be helpful for you to understand and/or apply the topic. These exercises may suggest that you examine extracted teeth or tooth models, or skulls (or skull models), or perform specific self- or partner examinations. More advanced exercises (as in Chapter 14) provide methods for drawing, sketching, and carving teeth from wax, helping you to become intimately familiar with tooth shape and terminology.
- **Tables:** Throughout the text, the authors have placed numerous tables to help summarize the many facts presented within the text. These tables are helpful when reviewing the highlights of content found within each section.
- **Illustrations and drawings:** For complete understanding and clinical application of each topic, the authors have included a variety of photographs, illustrations, and original drawings selected and designed to illustrate key points and improve learning. A number of new illustrations and summary charts have been added to this edition, and many of the new illustrations are in color. Since a picture is worth a thousand words, it is critical that you refer to figures whenever they are referenced within the text in order to maximize your learning. Many figures are designed, so you can cover up the names of structures and test yourself. In some instances, important additional information is presented or clarified in the illustration legends. New in this edition is a CD for instructors containing all of the illustrations and drawings in the text that can be used when lecturing.
- **Appendix of comparative dental anatomy:** The text's unique appendix is designed to help the learner visualize the many tooth similarities and differences that are often difficult to understand with words alone. Each **adult tooth** class is referenced on two appendix pages. The first page includes characteristics (each labeled with a different letter) that are *common* to all teeth within that class. The second page is devoted to the *differences* (each identified with a letter) between the types of teeth within each class, and differences between teeth in each arch. Two additional appendix pages are included that illustrate the unique characteristics of anterior and posterior **primary teeth**. The layout on these pages makes it easy to compare the differences between teeth because various views of each tooth type are lined up on the same page next to other teeth in that class. As each tooth characteristic is described within the chapters on tooth morphology (Chapters 4–7 and 10), reference is frequently made to the illustrated representation of that characteristic on an appendix page as follows: the word "Appendix" is followed by the page number and letter denoting items being discussed (for example, "**Appendix 1a**" refers you to the Appendix, page 1, item "a"). Appendix pages are printed on heavier, perforated paper to permit removal and placement in a separate loose-leaf notebook. When used in this fashion, these pages provide you with increased *convenience* (since fewer page turns are required when referencing tooth characteristics within each chapter), *easier learning* (since the complex terminology used to describe each characteristic is best learned by visualizing that characteristic and comparing it to other similar teeth), and a separate *study guide* (since all labeled characteristics for each type of tooth are described on the back of each appendix page).
- For learning the morphology of individual teeth, the best learning resource is a collection of as many intact **extracted teeth** as you are able to acquire. A dentist, if presented with a quart jar of bleach, will remember his or her own student days and will probably be glad to put extracted teeth in the jar. Do not expect these teeth to be clean or sorted out; sorting is your job. While handling these teeth, it is **critical that the guidelines for infection control be followed:**

GUIDELINES FOR STERILIZING EXTRACTED TEETH: Using protective gloves and a mask, tooth specimens should be scraped clean with a knife. Soaking for several hours in hydrogen peroxide before scraping is helpful. After scraping to remove hard deposits and soft tissue, tooth specimens should be further cleansed by soaking for 20 minutes in 4 ounces of household bleach containing 2 tablespoons of Calgon (a water softener). Teeth can then be placed in water (in a beaker covered with tin foil) to be autoclaved for 40 minutes at 121°C and 15 psi (Pantera E, Schuster G. *J Dent Ed* 1990;54[5]:284). Once

prepared, teeth should be kept moist, either by soaking in water or, as suggested by Dr. Kim Loos, D.D.S., soaked in 25% glycerin and 75% water (parentsplace.com, Feb. 28, 2001).

As you begin learning the characteristics that differentiate each type of tooth as described in Chapters 4 through 7, you need to be aware of the considerable variation in tooth morphology that can occur from one patient to the next. You must keep in mind that relative tooth sizes and characteristics cited within the text do *not* apply to *all* patients' teeth, but are based on average sizes or particular morphology occurring with the greatest frequency. This text is unique in providing you with both **original and reviewed research** findings based on the study of thousands of teeth, casts, and mouths. The data from these studies are presented throughout the text in *brackets* [like this] and provide a scientific basis for understanding the frequency and extent to which differences from the norm occur. For example, the text states that “a mesial marginal groove is a distinguishing characteristic of the maxillary first premolar [but this occurred in only 97% of the 600 premolars checked, which means that, on the average, 3% may not have this groove], whereas the maxillary second premolar is not nearly as likely to have this groove [but 37% do have it].”

As you read the description of tooth morphology, not only identify each structure visually, but also use a dental explorer on an actual tooth or model to “feel” the contours being described since you will eventually be required to evaluate, reproduce, and/or clean the surfaces of these tooth contours with specific dental instruments. As you become familiar with the many similarities and differences of tooth morphology, you can later apply this information during patient treatment, evaluation, and education.

Hopefully, you will spend some time thinking about and comprehending the concepts as you read. After all, you are learning the “foreign” language of dental anatomy that you will be using for the rest of your professional lives. Have fun looking at teeth as though you were a tooth detective. Take notes, sketch different views of each tooth, and take advantage of all learning exercises, references to figures, and the appendix. Ask questions until your curiosity is satisfied. Most importantly, the authors hope this book will stimulate your interest and involvement in the wonderful and fascinating field of dentistry and that you will consider it to be a worthwhile addition to your library even after your formal education is complete.

Rickne C. Scheid

Comments or suggestions may be submitted to Dr. Scheid on e-mail (scheid.2@osu.edu).

Introduction to the Seventh Edition and Acknowledgments

During my first year teaching at The Ohio State University College of Dentistry in 1974, I was fortunate to be assigned to teach in a laboratory for dental anatomy where I worked with and was mentored by, Dr. Julian Woelfel. He asked me to contribute the chapter on Operative Dentistry in the third edition in 1984. Little did I realize that in 1994, I would be selected by him to coauthor the fifth edition of a text on the very topic I began teaching in 1974: dental anatomy. During the preparation for the fifth and sixth editions, Julian permitted me great latitude in reorganizing the text to reflect my teaching style since I use this text as I teach over 135 dental and dental hygiene students each year. During this major reorganization, I was careful to maintain the unique aspects that he had incorporated into previous editions. This includes the results of his personal, science-based research, which formed the basis for many of the conclusions presented within this text: on everything from the average mandibular hinge opening to the frequency of Carabelli cusp formation and the comparative sizes of deciduous and permanent (or secondary) teeth. Now, in the seventh edition, Dr. Woelfel entrusted me to take over the text. In this edition, I was able to fine-tune the text to make it even more learner-friendly, adding more summary charts and more illustrations, including many color photographs and a CD for instructors.

I would like to express my appreciation to all of the contributors to this and previous editions of this book. Obviously, my thanks goes to Dr. Woelfel for selecting me to take over the new edition and teaching me to be meticulous, and for his many contributions to previous editions; to his wife, Marcile, who has helped tremendously in typing and editing previous editions; and to Dr. Gabriela Weiss (who proofed many pages and provided many test items for the CD), Dr. Lewis Claman (who organized and updated Chapter 8), Dr. John Nusstein (who organized and updated Chapter 9), Dr. Robert Rashid (who organized and updated Chapter 13), and Dr. Daniel Jolly (who completely rewrote Chapter 15). I would also like to recognize Ms. Dorothy Permar, who conceived and wrote the first edition in 1974, and Dr. Theodore Berg, Jr., Dr. Al Reader, and Ms. Connie Sylvester, who contributed to previous editions.

Rickne C. Scheid, D.D.S. M.Ed.

Contents

	Preface to the Seventh Edition .....	.vi
	Introduction to the Seventh Edition .....	.x
1	Structures That Form the Foundation for Tooth Function .....	.1
2	Oral Examination: Normal Anatomy of the Oral Cavity .....	.76
3	Basic Terminology for Understanding Tooth Morphology .....	.110
4	Morphology of the Permanent Incisors .....	.144
5	Morphology of the Permanent Canines .....	.172
6	Morphology of Premolars .....	.191
7	Morphology of Permanent Molars .....	.229
8	Periodontal Considerations Related to External Morphology and Surrounding Structures (contributed by Dr. Lewis Claman) .....	.278
9	Application of Root and Pulp Morphology Related to Endodontic Therapy (contributed by Dr. John Nusstein) .....	.303
10	Primary (and Mixed) Dentition .....	.324
11	Functional Occlusion and Malocclusion .....	.359
12	Dental Anomalies .....	.403
13	Operative Dentistry .....	.432
	(contributed by Dr. Robert G. Rashid)	
14	Guidelines for Drawing, Sketching, and Carving Teeth .....	.466
15	Forensic Dentistry .....	.481
	(contributed by Dr. Daniel E. Jolly)	
	Appendix .....	.499
	Index .....	.521

Color plates follow page 256.

Structures That Form the Foundation for Tooth Function

1

Topics covered within the seven sections of this chapter include the following:

- I. Naming teeth based on location within the normal, complete human dentition
 - A. Complete primary dentition
 - B. Complete permanent dentition
- II. Bones of the human skull (with emphasis on the sphenoid, temporal, maxillae, and mandible bones)
 - A. Bones of the neurocranium
 - B. Bones of the face (visceral apparatus)
- III. The temporomandibular joint
 - A. Anatomy of the temporomandibular joint
 - B. Ligaments that support the joint and limit joint movement
 - C. Development of the temporomandibular joint
- IV. Muscles of chewing (mastication)
 - A. Muscles involved in mastication (chewing)
 - B. Other muscles affecting mandibular movement
 - C. Other factors affecting tooth position or movement
- D. Summary of muscles that move and control the mandible
- V. Nerves of the oral cavity (with emphasis on cranial nerves V, VII, IX, and XII)
 - A. Trigeminal nerve (fifth cranial nerve)
 - B. Facial nerve (seventh cranial nerve)
 - C. Glossopharyngeal nerve (ninth cranial nerve)
 - D. Hypoglossal nerve (12th cranial nerve)
 - E. Summary of nerve supply to the tongue, salivary glands, facial skin, and facial muscles
- VI. Vessels associated with the oral cavity (arteries, veins, and lymphatic system)
 - A. Arteries
 - B. Veins
 - C. Lymph
- VII. Structures visible on a panoramic radiograph

This chapter introduces the reader to the structures that form the foundation for tooth function: gross anatomy of the bones, muscles, nerves, blood supply, and lymph drainage of the head and neck. Emphasis is placed on the importance of these structures as they relate to the functioning of the jaws and teeth. Initially, however, the reader must master a few basic terms related to teeth.

SECTION I. NAMING TEETH BASED ON LOCATION WITHIN THE NORMAL, COMPLETE HUMAN DENTITION

OBJECTIVES

This section is designed to prepare the learner to perform the following:

- Based on location in the normal, complete primary dentition, name all 20 teeth by dentition, arch, quadrant, class, and type.
- Based on location in the normal, complete permanent dentition, name all 32 teeth by dentition, arch, quadrant, class, and type.

Prior to a discussion of the structures that support the teeth, it is necessary to familiarize yourself with a brief description of the names of teeth based on their location in the human skull and mouth. This overview is necessary to appreciate and understand the full description of the bones, nerves, and blood vessels presented in this chapter, as well as the description of oral landmarks described in Chapter 2. A more in-depth description of all teeth begins in Chapter 3.

In general, each human tooth has a clinical **crow**n, the portion of the tooth projecting beyond the gum line, and a clinical **root**, the portion hidden below the gum line. All of the teeth in the mouth together are referred to as the **dentition** [den TISH un]. Humans have two dentitions throughout life: one during childhood, called the **primary dentition**, and one that will hopefully last throughout adulthood, called the **secondary** (also known as **permanent**) **dentition**. The teeth in the upper jawbones (called the maxillae [mak SIL ee]) collectively form an arch shape known as the **maxillary** [MAK sei lair ee] **arch**, and those teeth in the lower jawbone (called the mandible) collectively form the **mandibular** [man DIB yoo ler] **arch**. Each arch can further be divided into the left and right halves (also known as left and right **quadrants** since each quadrant contains one-fourth of all teeth in that dentition).

A. COMPLETE PRIMARY DENTITION

The *complete* primary dentition is normally present in a child from the ages of about 2 to 6 years. There are 20 teeth in the entire primary dentition (shown in Fig. 1-1): 10 in the maxillary arch and 10 in the mandibular arch. This dentition is also called the **deciduous** [de SID] oo us] **dentition**, referring to the fact that all of these teeth are eventually shed by age 12 or 13, being replaced sequentially by teeth of the permanent dentition. The complete primary dentition has five teeth in each quadrant. The primary teeth in each quadrant are further divided into three **classes**: incisors [in SI zertz], canines, and molars. Based on location, starting on either side of the midline between the right and left quadrants, the two front teeth in each quadrant of the primary dentition are **incisors** (I), followed by one **canine** (C), then two **molars** (M). Using these abbreviations for the classes of teeth, followed by a ratio composed of a top number representing the number of teeth in each upper quadrant and the bottom number representing the number of teeth in each lower quadrant, a formula can be used to represent the teeth in the human primary dentition as follows:

$$I \frac{2}{2} C \frac{1}{1} M \frac{2}{2} = 5 \text{ upper and } 5 \text{ lower teeth on either side; } 20 \text{ teeth in all}$$

The classes of primary teeth containing more than one tooth per quadrant (incisors and molars) are subdivided into **types** within each class. Each type can also be identified by its location within the complete quadrant. The primary incisor closest to the midline separating the right and left quadrants is called a **central incisor**; the incisor next to or lateral to the central incisor is called a **lateral incisor**. Next in each quadrant is a canine, followed by two molars: a **first molar** behind the canine and then a **second molar**.

LEARNING EXERCISE

Using either models of the complete primary dentition or Figure 1-1 while covering up the labels, identify each primary tooth based on its location in the arch. To identify each tooth accurately, include the dentition (primary); arch (maxillary or mandibular); quadrant (right or left); class (incisor, canine, or molar); type of incisor (central or lateral); and type of molar (first or second).

B. COMPLETE PERMANENT DENTITION

The complete permanent (or secondary) dentition is present in the adult. It is composed of 32 teeth: 16 in the maxillary arch and 16 in the mandibular arch (shown in Fig. 1-2). The permanent dentition has eight teeth in each quadrant, which are divided into four **classes**: incisors, canines, **premolars** (PM; a new class for permanent teeth), and molars. Based on location, the two permanent front teeth in each quadrant are

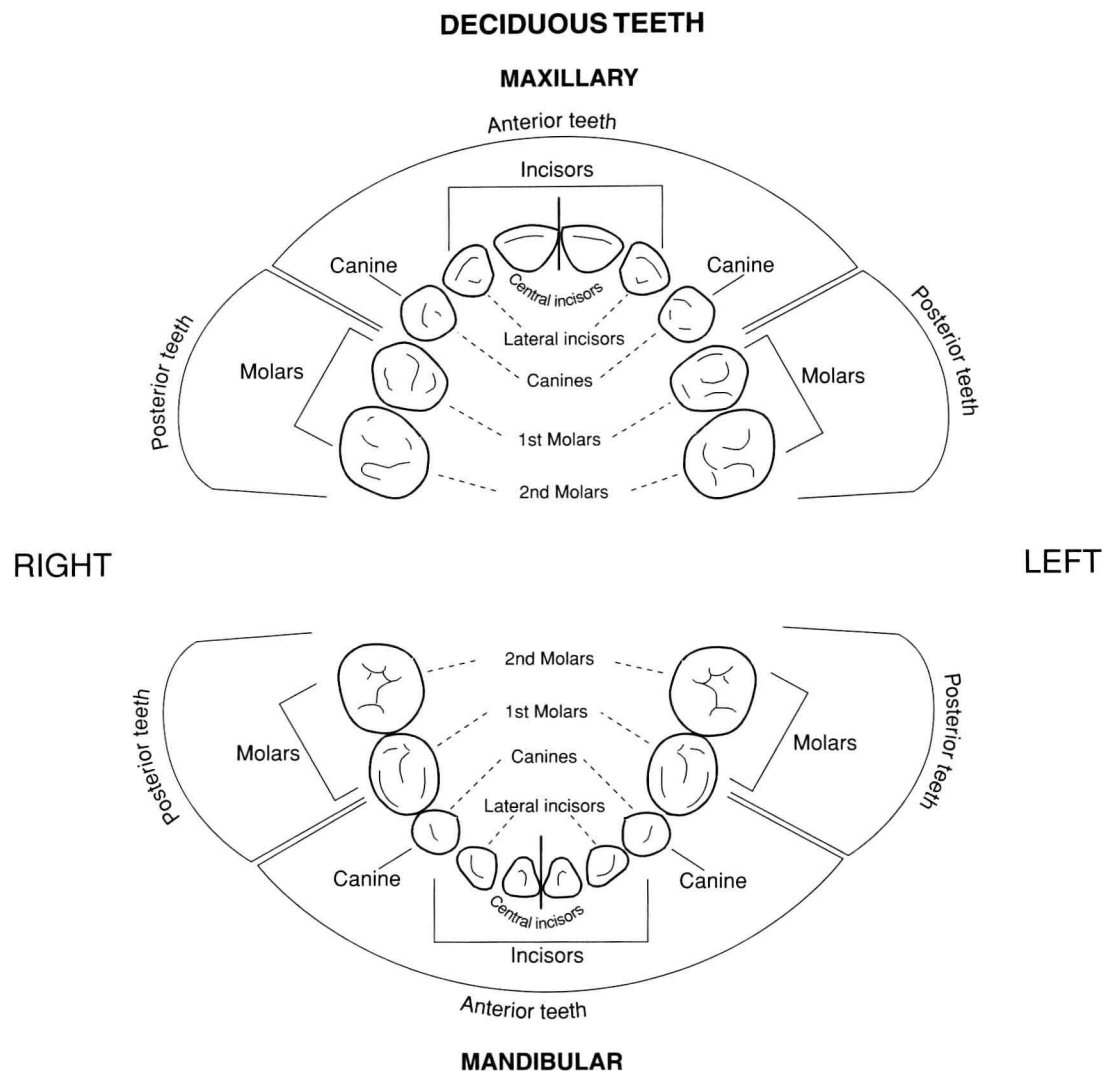


FIGURE 1-1. Maxillary and mandibular primary dentition (chewing surfaces).

incisors (I), followed by one *canine* (C), then two *premolars* (PM), and finally three *molars* (M). The dental formula for the human permanent dentition is:

$$I \frac{2}{2} C \frac{1}{1} PM \frac{2}{2} M \frac{3}{3} = 8 \text{ upper and } 8 \text{ lower teeth on either side, } 32 \text{ teeth in all}$$

The classes of permanent teeth containing more than one tooth per quadrant (namely, incisors, premolars, and molars) are subdivided into **types** within each class. Each type can also be identified by location within the quadrant. As in the primary dentition, the permanent incisor closest to the midline between the right and left quadrants is called a **central incisor**; the incisor next to or lateral to the central incisor is called a **lateral incisor**. Next in the arch is a **canine**, followed by a **first premolar**, then a **second premolar**. Continuing around toward the back in each quadrant are three molars: a **first molar**, a **second molar**, and finally a **third molar** (sometimes referred to as a wisdom tooth).

As noted by comparing the formulas for deciduous and permanent teeth, differences exist. Although central and lateral incisors and canines are similarly positioned in both dentitions, permanent dentitions have a new category of teeth called premolars, which are located between canines and molars. Premolars are positioned in the spaces left where the primary molars were located earlier in life. Behind the premolars, there are three instead of two molars.

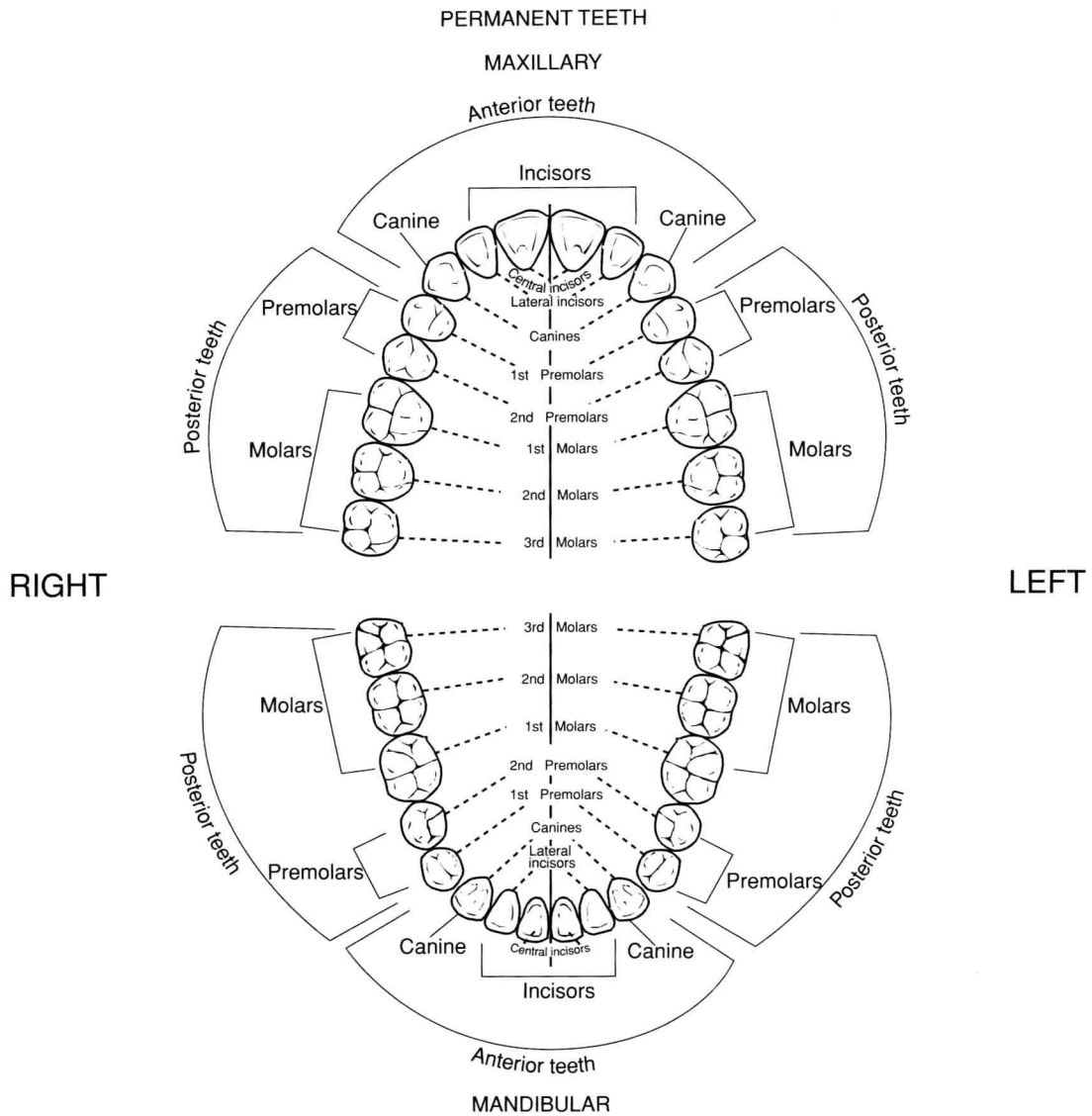


FIGURE 1-2. Maxillary and mandibular permanent dentition (chewing surfaces).

Two other terms are used to categorize or distinguish groups of teeth by their location: anterior and posterior teeth. **Anterior teeth** are those teeth in the front of the mouth, specifically, the incisors and the canines. **Posterior teeth** are those in the back of the mouth, specifically, the premolars and the molars.

It is interesting to note that animal dentition can be represented by the same type of formula as described above. Look at the formulas for animals in *Table 1-1* and note that cows have no upper incisors or upper canines. They have three upper and three lower premolars on each side. Did you know that dogs have twice as many premolars as humans if you include uppers and lowers, as well as the right and left sides?

LEARNING EXERCISE

Using either models of the complete permanent dentition or Figure 1-2 while covering up the labels, identify each permanent tooth based on its location in the arch. To identify each tooth accurately, include the dentition

Table 1-1

SOME DENTAL FORMULAE (ORDER OF TEETH PER QUADRANT) AND INTERESTING FACTS ABOUT TEETH IN ANIMALS³³⁻³⁵

Humans, Old World monkeys, and apes	$1\frac{2}{2} c \frac{1}{1} P \frac{2}{2}$	$M \frac{3}{3}$	Porcupines and beavers	$1\frac{1}{1} c \frac{0}{0} P \frac{1}{1}$	$M \frac{3}{3}$
New World monkeys	$1\frac{2}{2} c \frac{1}{1} P \frac{3}{3}$	$M \frac{3}{3}$	Bears and pandas	$1\frac{3}{3} c \frac{1}{1} P \frac{4}{4}$	$M \frac{2}{3}$
Dogs, wolves, and foxes	$1\frac{3}{3} c \frac{1}{1} P \frac{4}{4}$	$M \frac{2}{3}$	Squirrels	$1\frac{1}{1} c \frac{0}{0} P \frac{2}{1}$	$M \frac{3}{3}$
Cats	$1\frac{3}{3} c \frac{1}{1} P \frac{3}{2}$	$M \frac{1}{1}$	Rabbit [‡]	$1\frac{2}{1} c \frac{0}{0} P \frac{3}{2}$	$M \frac{3}{3}$
Cows	$1\frac{0}{3} c \frac{0}{1} P \frac{3}{3}$	$M \frac{3}{3}$	Mice and rats	$1\frac{1}{1} c \frac{0}{0} P \frac{0}{0}$	$M \frac{3}{3}$
Horses and zebra*	$1\frac{3}{3} c \frac{1}{1} P \frac{4}{4}$	$M \frac{3}{3}$	Moles	$1\frac{3}{3} c \frac{1}{1} P \frac{4}{4}$	$M \frac{3}{3}$
Walrus	$1\frac{1}{0} c \frac{1}{1} P \frac{3}{3}$	$M \frac{0}{0}$	Vampire bats	$1\frac{1}{2} c \frac{1}{1} P \frac{2}{3}$	$M \frac{0}{0}$
Elephants	$1\frac{1}{0} c \frac{0}{0} Dm^{\dagger} \frac{3}{3}$	$M \frac{3}{3}$	Shrews	$1\frac{3}{1} c \frac{1}{1} P \frac{3}{1}$	$M \frac{3}{3}$

* Pigs and hippopotami have the same formula, except that they have two or three upper and two or three lower incisors.

† Elephants have deciduous molars but no premolars. An elephant's skull is larger than necessary to house its brain. The size is needed to provide mechanical support for the tusks (one-third of their length is embedded in the skull) and the enormous molars. Each molar weighs about 9 pounds and is nearly a foot long mesiodistally on the occlusal surface. Tusks (the central incisors) can be as long as 11½ feet and weigh 440 pounds.⁴²

‡ Guinea pigs have the same formula, except that they have only one maxillary incisor.

The beaver has four strong curved incisors. They have very hard, bright orange enamel on the labial surface and much softer exposed dentin on the lingual surface. As the dentin wears off, this leaves very sharp cutting edges of enamel. The incisors continue to grow throughout life. The posterior teeth have flat, rough edges on the occlusal surface, and they stop growing at 2 years of age. There is a large diastema immediately posterior to the incisors, and flaps of skin fold inward and meet behind the incisors to seal off the back part of the mouth during gnawing. Therefore, splinters are kept out. The flaps of skin relax for eating and drinking.

The shrew has two hooked cusps on the upper first incisor. Its deciduous dentition is shed in utero. The shrew's 1- to 1½-year life span is limited by the wear on their molars. Death occurs by starvation once the molars wear out. Also, their small body can store only enough food for 1-2 hours, so they must feed almost continually. Their diet consists of small invertebrates, woodlice, and fruit.

The vampire bat has large canines, but its highly specialized upper incisors, which are V-shaped and razor-edged, are what remove a piece of the victim's skin. The bat's saliva contains an anticoagulant, and its tongue rolls up in a tube to suck or lap the exuding blood.

Some vertebrates do not have any teeth (complete anodontia) but have descended from ancestors that possessed teeth. Birds have beaks but depend on a gizzard to do the grinding that molars would usually perform. Turtles have heavy jaw coverings, which are thin edged in the incisor region and wide posteriorly for crushing. The duck-billed platypus has its early-life teeth replaced by keratinous plates, which it uses to crush aquatic insects, crustaceans, and molluscs. The whalebone whale and anteaters also have no teeth, but their diets do not require mastication.

(permanent); arch (maxillary or mandibular); quadrant (right or left); class (incisor, canine, premolar, or molar); type of incisor (central or lateral); type of premolar (first or second); and type of molar (first, second, or third).

LEARNING QUESTIONS

Select the one best answer.

- How many teeth are present in one quadrant of a complete adult (permanent) dentition?
 - 5
 - 8
 - 10
 - 20
 - 32

2. What class of teeth is present in the permanent dentition that is NOT present in the primary dentition?
 - a. incisors
 - b. canines
 - c. premolars
 - d. molars
3. In a permanent dentition, the fifth tooth from the midline is a:
 - a. canine
 - b. premolar
 - c. molar
 - d. incisor
4. Posterior teeth in the permanent dentition include which of the following?
 - a. premolars only
 - b. molars only
 - c. premolars and molars only
 - d. canines, premolars, and molars
5. What permanent tooth erupts into the space previously held by the primary second molar?
 - a. first molar
 - b. second molar
 - c. first premolar
 - d. second premolar

ANSWERS: 1-b, 2-c, 3-b, 4-c, 5-d

SECTION II. BONES OF THE HUMAN SKULL

OBJECTIVES

This section is designed to prepare the learner to perform the following:

- Describe and identify each bone seen on an intact human skull.
- Describe and identify each bony structure highlighted in bold in this chapter. Emphasis is placed on structures of the mandible, maxillae, temporal, and sphenoid bones.
- Describe and identify the location of the attachment of chewing muscles and ligaments attached to the mandible.
- Describe and identify the foramen of the nerves and arteries that supply the teeth and oral cavity.

LEARNING EXERCISE

To obtain a clear understanding of the bones of the skull and their relationship to one another and to the teeth, it is best to have a skull at hand to examine while reading this chapter. If you touch and trace each bone with your fingers as you read, you are not apt to forget its characteristics.

There are 206 distinct bones in our skeleton, 28 of which are in the skull if we count the malleus, stapes, and incus bones of each ear. The skull bones can be divided into two parts: the **neurocranium** [NOOR o CRAY ne um] surrounding the brain and the **facial** (or visceral) **apparatus** (making up the face).

When studying bones (and teeth), there are many descriptive terms that must be learned. Terms with similar definitions are grouped here to facilitate learning. Since anatomy terms are often similar to common familiar words, the new terms are compared to familiar words whenever possible.

BUMPS—(CONVEXITIES) ON BONES AND/OR TEETH

- crest:** a projecting ridge along a bone
- eminence:** a prominence or elevation of bone
- process:** a projection or outgrowth from a larger bone structure
- protuberance** [pro TU ber ahns]: a prominence or swelling (of bone)
- ridge:** linear, narrow, elevated portion of bone or tooth
- tubercle** [TOO ber k'l]: a small rounded projection on a bone or tooth

DEPRESSIONS—(CONCAVITIES) IN BONES AND/OR TEETH

- alveolus** [al VEE o lus] (plural: **alveoli** [al VEE o lie]): small hollow space or socket where the tooth root fits within the jaw bones
- cavity:** a hollow place within the body of bone (or within a tooth)
- fissure** [FISH er]: a cleft or groove (crack) between parts
- fossa** [FOS ah] (plural: **fossae** [FOS ee]): a small hollow or depressed area
- fovea** [FO ve ah]: small pit or depression
- groove:** linear depression or furrow
- sinus:** hollow, air-filled cavity or space within skull bones, or a channel for venous blood

OPENINGS—(HOLES) IN BONES AND/OR TEETH

- aperture:** an opening; compare a camera lens aperture
- foramen** [fo RA men] (plural: **foramina** [fo RAM i nah]): a small hole through bone or tooth for passage of nerves and vessels
- foramen ovale** [o VAL ee]: an oval or egg-shaped foramen (which is bigger than the round [rotundum] foramen)
- foramen rotundum:** a round foramen; recall the Capitol's rotundum or dome is round when viewed from above
- meatus** [me A tus]: a natural passage or opening in the body

RELATIVE LOCATION—FIGURE 1-3 WILL BE HELPFUL IN UNDERSTANDING TERMS WITH AN ASTERISK (*).

- ***anterior:** toward the front of the body
- buccal** [BUCK al]: related to or near the cheek; the buccal nerve innervates the cheek; the buccinator muscle is within the cheek; the buccal surface of a tooth is the side toward the cheek (also called *facial* side because it is toward the face that we see)
- cervix:** of the neck or neck-like; compare a *cervical* vertebrae in the neck
- external:** toward the outside of the body; seen from the outside
- ***facial:** toward the face; seen when viewing the face side
- ***inferior** or the prefix **infra:** located below or beneath; lower than
- ***medial:** the surface toward, or closest to, the midline (medial) plane of the body; do not confuse medial with mesial, which will be described later
- ***median plane:** a longitudinal plane that divides the body into relatively equal right and left halves
- ***midsagittal plane** [SAJ i t'l]: same as median plane
- ***posterior:** toward the rear of the mouth or body
- retro** (prefix): back or behind
- sub** (prefix): under or beneath; compare to *infra*
- superficial:** closer to the surface
- ***superior** or the prefix **supra:** located above or over; higher or upper

GENERAL TERMS RELATED TO BONES

- acoustic** [ah KOOS tik]: referring to sounds or hearing; near the ear
- cervical** [SER vi kal]: related to the neck; like *cervical* vertebrae
- condyle** [KON dile]: an articular prominence of a bone resembling a knuckle

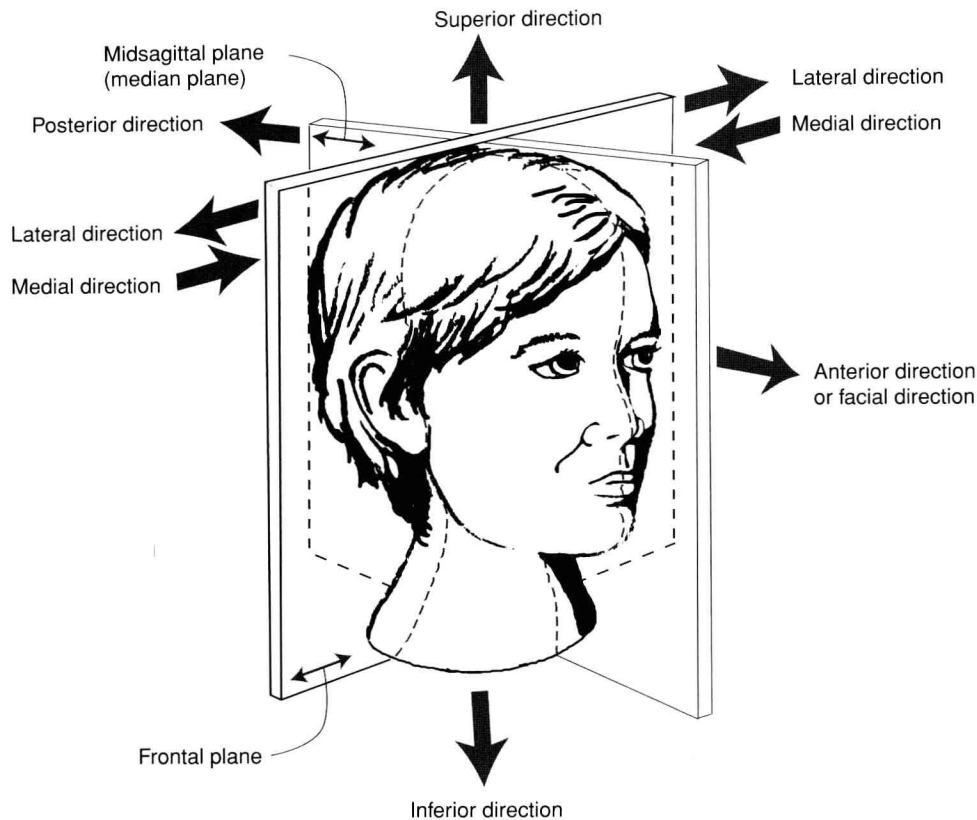


FIGURE 1-3. Planes of the head and directions used to identify relative location of structures or surfaces of the head.

coronoid: where the crown fits or the shape of a crown (compare coronation); for example, the coronoid process of the mandible is shaped like the point of a coronation crown; or a coronoid suture is where the crown fits

dura: hard, not soft (compare durable)

glenoid [GLE noyd]: socket-like

labial [LAY bee al]: related to the lips; toward the lips

lacrimal [LAK ri mal] (also spelled lachrymal): referring to the tears (compare lacrimosa)

lamina: a thin layer (compare laminated wood)

lingula [LING gyoo la]: tongue-shaped structure (compare lingual)

malar [MAY lar]: referring to the cheek or cheek bone (not to be confused with molar)

meatus [mee A tus]: a pathway or opening

palpebral [PAL pe bral]: referring to the eyelid

piriform [PEER i form]: pear shaped

septum: a partition (compare separate)

suture [SOO chur] **line:** the line of union of adjoining bones of the skull

symphysis [SIM fi sis]: fibrocartilaginous joint where opposed bony surfaces are joined (a suture line may not be evident)

trochlea [TROK lee ah]: pulley shaped

A. BONES OF THE NEUROCRANIUM

The **neurocranium** is the portion of the skull that supports, encloses, and protects the brain. It is made up of replacement bone (that is, there is a cartilaginous precursor or model for these bones). Other names for this type of bone are cartilage bone and endochondral bone. The eight bones of the neurocranium are