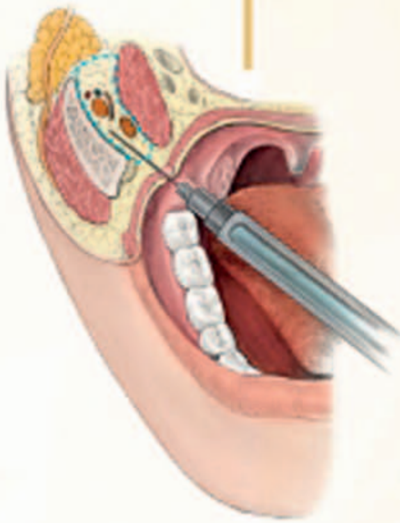
25th Anniversary Edition

6th EDITION

# ILLUSTRATED ANATOMY of the HEAD and NECK



Margaret J. Fehrenbach
Susan W. Herring

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6TH EDITION

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# PREFACE

## OVERVIEW OF NEW EDITION

To meet the needs of today's dental professional, the sixth edition of *Illustrated Anatomy of the Head and Neck*, published on the twenty-fifth anniversary of the first edition, offers more than basic information on head and neck anatomy. To facilitate the learning process, chapters are divided into the various anatomic systems, followed by the considerations for the anatomic basis for local anesthesia and the regional study of fasciae and spaces as well as the spread of infection. Clinical considerations are noted throughout the textbook and have been greatly expanded to include newer techniques and pathologic considerations.

## FEATURES IN THIS EDITION

Each chapter begins with learning objectives. Each chapter also features both **key terms** and **anatomic terms** that appear in bold with an updated pronunciation guide when the term is first presented.

All chapter topics discussed in depth have been chosen for their relevance to the needs of the dental professional and to build on former topics. Within each chapter are cross-references to other figures or chapters so the reader can review or investigate interrelated subjects. The content of this edition incorporates additional input from students and educators as well as the latest information from scientific studies and experts.

High-quality color original illustrations and photographs are included throughout the text to reinforce a three-dimensional understanding of anatomy. We are excited to have additional osteology figures provided by Neil S. Norton, PhD, Professor of Oral Biology, School of Dentistry, Creighton University, Omaha. He is the editor of the outstanding atlas, ***Netter's Dental Anatomy***. Other in-depth figures have also been added or expanded in this new edition to improve overall anatomic understanding; many exhibit the latest in imaging techniques.

Tables and boxes summarizing important information appear throughout the text. Flow charts have been included to help understand the relationships among anatomic structures.

At the end of the book are three appendices. **Appendix A** is an updated bibliography that references published works relevant to head and neck anatomy as well as the associated embryology, histology, and pathology. **Appendix B** provides a review of extraoral and intraoral clinical examination skills, especially in the area of palpation. **Appendix C** provides a review of the procedural steps for performing extraoral and intraoral patient examinations. Following Appendix C is the **Glossary,** which contains both key terms and anatomic terms and uses short, easy-to-remember definitions along with the updated pronunciation guide. A detailed **Index** can be used to quickly look up topics for review.

The new companion ***Workbook for Illustrated Head and Neck Anatomy,*** edited by Margaret J. Fehrenbach, is also now available for student use. The workbook features activities such as structure identification exercises, patient extraoral and intraoral examination procedures, glossary exercises, and review questions for each chapter. Summary case studies are also presented as well as removable flashcards using the original illustrations from the textbook. The creation of this additional resource allows more real-time laboratory and clinical integration of the materials presented in the textbook. It has also freed the textbook to allow more discussion of clinical ramifications for fuller integration of material into daily dental practice.

This textbook is coordinated with ***Illustrated Dental Embryology, Histology, and Anatomy*** by Margaret J. Fehrenbach and Tracy Popowics and can be considered a companion textbook to complete the curriculum in oral biology. Many of the figures in this text also appear in the ***Dental Anatomy Coloring Book***, edited by Margaret J. Fehrenbach.

## NOTABLE IN THIS EDITION

The important clinically related key chapters on the temporomandibular joint, local anesthesia anatomy, and spread of infection have been significantly revised to allow for the latest updated evidence-based information.

The **Evolve website** continues to be an important component, as it was in the previous edition, and has been further expanded. This site provides a variety of resources for both instructors and students. Included for instructors by Margaret are an image collection, answer keys, supplemental considerations, and a test bank. Included for students by Margaret are chapter review and assessment questions and practice quizzes as well as Elsevier's Body Spectrum Electronic Anatomy Coloring Book and an interactive game.

In addition, the resource of **TEACH** online has been continued, an exciting coordinated effort for instructors, which includes **Lesson Plans** for all topics covered in the textbook. It features updated online **PowerPoint Lectures** courtesy of Margaret with notes that can be individualized for custom presentations. There are also other related materials for both students and instructors. Elsevier sales representatives will be able to help demonstrate the latest in this exciting digital format; student dental professionals can check with their instructors.

As authors, we have tried to make the text easy to follow and interesting as well as worthwhile to read and the figures easy to understand. We hope that it still challenges the reader to incorporate the information presented into clinical situations after these past 25 years.

Margaret J. Fehrenbach, RDH, MS, primary author
Susan W. Herring, PhD, secondary author

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# ACKNOWLEDGEMENTS

We thank Private Sector Education Content Director Kristin Wilhelm, Education Content Strategists Joslyn Dumas and Kelly Skelton, Content Development Specialist Brooke Kannady, and Senior Project Manager/Specialist Carrie Stetz as well as the rest of the staff at Elsevier for making this textbook possible.

Finally, we would like to thank our dear families as well as our colleagues and students who have chosen this textbook over the past 25 years.

Margaret J. Fehrenbach, RDH, MS, Primary Author
Susan W. Herring, PhD, Secondary Author

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# CONTENTS

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1

# Introduction to Head and Neck Anatomy

## LEARNING OBJECTIVES

1. Define and pronounce both the key and anatomic terms in this chapter.
2. Discuss the clinical applications of head and neck anatomy by dental professionals.
3. Discuss anatomic variation and how it applies to head and neck structures.
4. Apply the correct anatomic nomenclature during dental clinical procedures.

*Additional resources and practice exercises are provided on the companion Evolve website for this book: http://evolve.elsevier.com/Fehrenbach/headneck/.*

## CLINICAL APPLICATIONS

The dental professional must have a thorough understanding of head and neck anatomy when performing patient examination procedures, both extraoral and intraoral procedures (Fig. 1.1). This will help determine whether any abnormalities or pathologic lesions exist and possibly indicate their cause and degree of involvement. This will also provide a basis for the description of the lesion and its location for record-keeping purposes. See **Appendix B** for the skills needed to complete a patient examination as well as **Appendix C** for the procedural steps. See related textbooks in oral pathology for further discussion as listed in the bibliography within **Appendix A**.

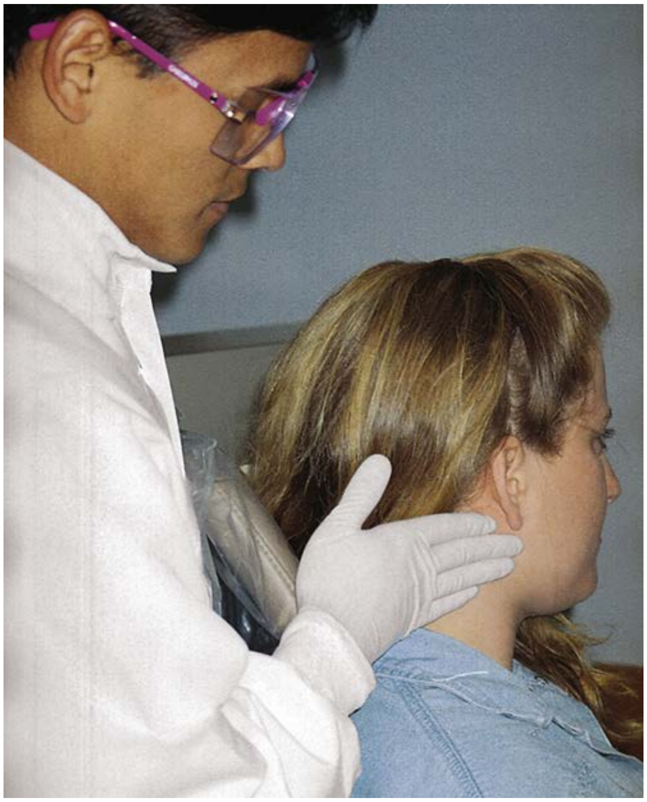


**Fig. 1.1** Examination of the patient is based on an understanding of head and neck anatomy. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

During examination of the patient, the dental professional may specifically note the presence of dental (or odontogenic) infection. It is important to know the source of the infection as well as the areas to which it could spread by way of certain anatomic features of the head and neck. This background in anatomy will help the dental professional understand the spread of dental infection to reduce its risk.

A patient may also present with features of a temporomandibular joint disorder. A dental professional must understand the anatomy of the joint to understand the various disorders associated with it.

When taking radiographs, the dental professional uses surface landmarks for film placement and consistency. In addition to these landmarks, an understanding of anatomy is important in the analysis of the films.

The administration of local anesthesia is also based on landmarks of the head and neck. Knowledge of anatomy helps the dental professional plan for use of a local anesthetic to reduce pain levels during various dental procedures. This knowledge also allows for correct placement of the syringe and its anesthetic agent, potentially avoiding complications but ensuring clinical efficacy.

To initially consider patient care through anatomic study, this text takes mainly a systemic approach to the study of head and neck anatomy after two initial background chapters, **Chapters 1 and 2.** Through most of the chapters, **Chapters 3 to 10,** this approach takes a look at each system separately (e.g., skeletal, muscular). Another way to study anatomy for patient care integration is the regional approach, which is taken up later within **Chapter 11,** since it focuses on the fasciae and fascial spaces of the head and neck. Both approaches, when used in the order presented in this text, are complementary and effective ways to study head and neck anatomy and prepare for patient care considerations.

To reinforce the material already presented and make it readily useful for clinicians, **Chapter 9** also has an expanded clinical emphasis covering the anatomy of local anesthesia. The final chapter, **Chapter 12,** also emphasizes this important clinical approach to head and neck anatomy during the consideration of the spread of infection. In addition, all the other chapters include important clinical considerations when appropriate, such as related pathology.

## ANATOMIC NOMENCLATURE

Before beginning the study of head and neck anatomy, the dental professional may need to review **anatomic nomenclature** (an-uh-**tom**-ik **noh**-muhn-kley-cher), which is the system of names for anatomic structures. This review will allow for easy application of these terms to the head and neck area when examining a patient, for use in the patient's record, or during related clinical procedures.

While visiting a new city or country, people often bring along a map or use smartphone apps. Anatomists also use a type of mapping to identify exactly what part of the body is being examined. Just like standard maps, there are ways to describe direction and then the areas to visit. However, instead of "north," "south," "east," and "west" or "uptown" and "downtown" there are certain terms that are used to describe direction of the parts in relationship to the whole body as well as the regions of the body.

The nomenclature of anatomy is based on the body being in **anatomic position** (Fig. 1.2). In anatomic position, the body can be standing erect. The arms are at the sides with the palms and toes directed forward and the eyes looking forward. This position is assumed even when the body may be supine (on the back) or prone (on the front) or even with respect to the position of the patient's head and neck when sitting upright in a dental chair.

When studying the body in anatomic position, certain terms are used to refer to areas in relationship to other areas (Fig. 1.3). The front of an area in relationship to the entire body is its **anterior** part. The back of an area is its **posterior** part. The **ventral** (**ven**-truhl) part is directed toward the anterior and is the opposite of the **dorsal** (**dawr**-suhl) part that is directed toward the back when considering the entire body.

Other terms can be used to refer to areas in relationship to other areas of the body. An area that faces toward the head and away from the feet is its **superior** part. An area that faces away from the head and toward the feet is its **inferior** part. As an example, the face is on the anterior side of the head, and the hair is superior and posterior to

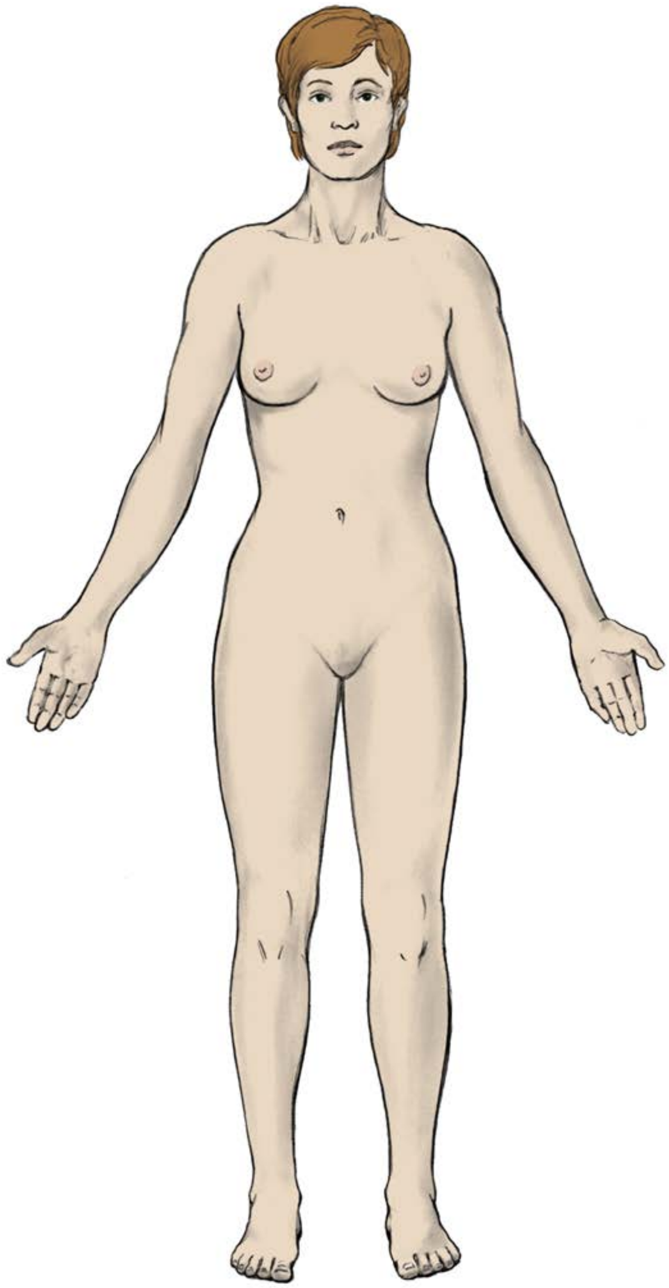


**Fig. 1.2** Body in anatomic position.

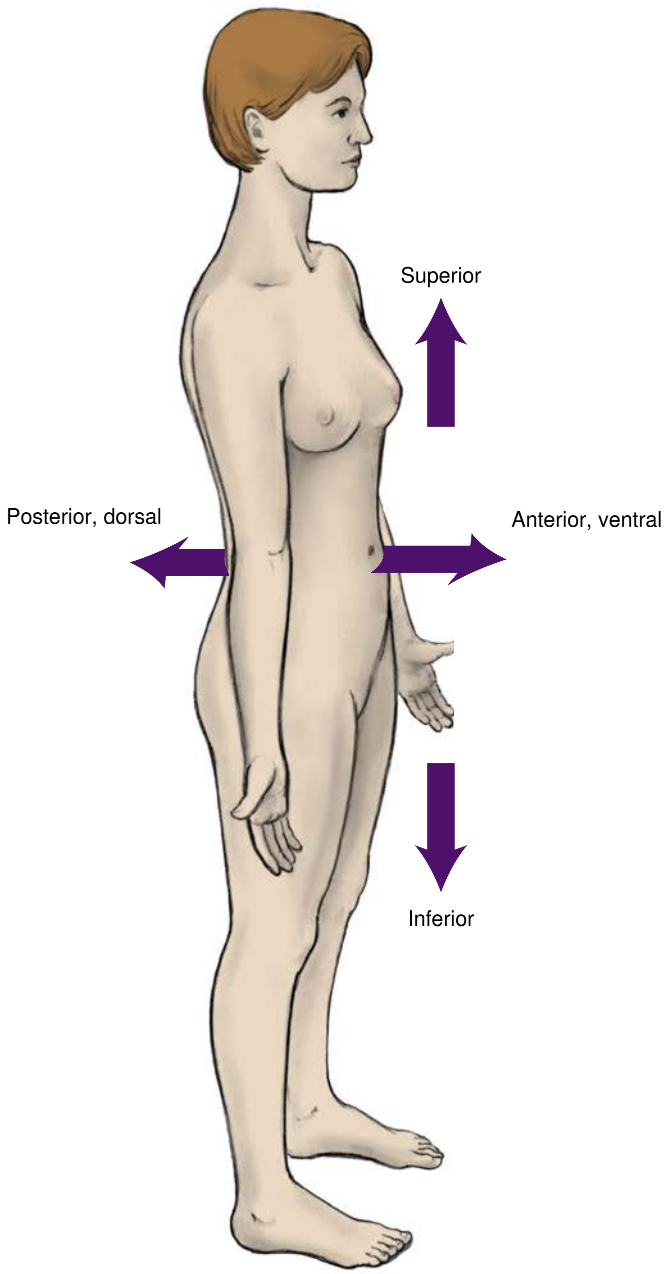



**Fig. 1.3** Body in anatomic position with the anterior (or ventral), posterior (or dorsal), superior, and inferior areas noted.

the face. The **apex** (plural, **apices**) (**ey**-peks, **ey**-puh-seez) or tip is the pointed end of a conical structure such as the apex or tip of the tongue.

The body in anatomic position can be divided into areas by flat surface planes (Fig. 1.4). The **midsagittal plane** (mid-**saj**-i-tl) or **median plane** (**mee**-dee-uhn) divides the body into equal right and left halves. On the surface of the body, these halves are generally symmetric, yet the same symmetry does not apply to all internal structures. In the same lengthwise manner, a **sagittal plane** (**saj**-i-tl) divides the body parallel to the midsagittal plane just discussed.

Differing planes can divide the body in differing ways. A **coronal plane** (**kor**-o-nuhl) or **frontal plane** (**fruhn**-tl) divides the body at any level into anterior and posterior parts. A **transverse plane** (tranz-**vurs**) or **axial plane** (**ak**-see-uhl) divides the body at any level horizontally into superior and inferior parts and is always perpendicular to the midsagittal plane.

Parts of the body in anatomic position can also be described in relationship to these planes (Fig. 1.5). A structure located at the midsagittal plane or median plane (e.g., the nose) is considered **median**. An area closer to the midsagittal plane or median plane of the body or structure is considered **medial** (**mee**-dee-uhl) within the body or structure as a whole or **mesial** (**mee**-zee-uhl) within the dentition. An area farther from the midsagittal plane or median

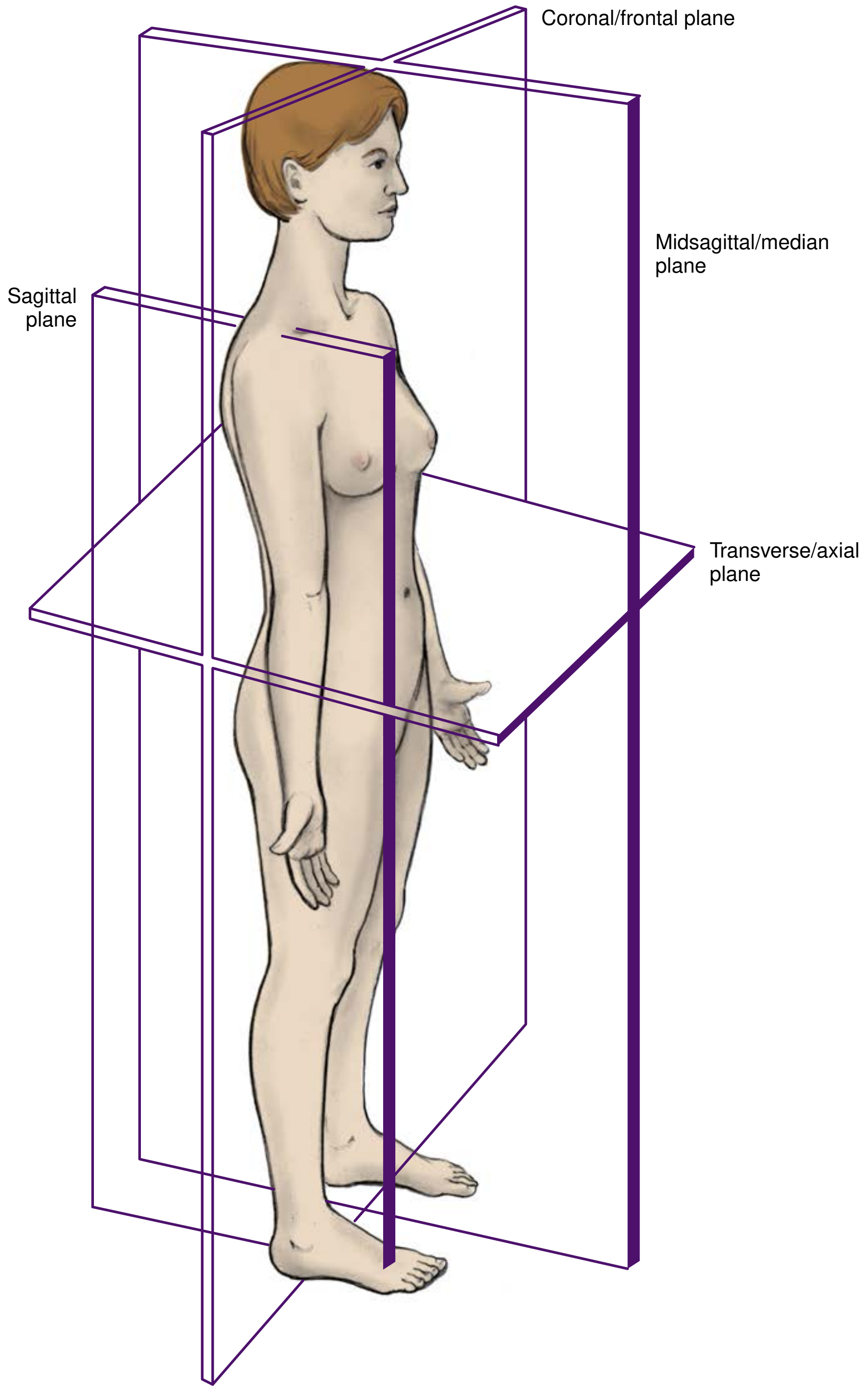



**Fig. 1.4** Body in anatomic position with the midsagittal (or median), sagittal, coronal (or frontal), and transverse (or axial) planes noted.

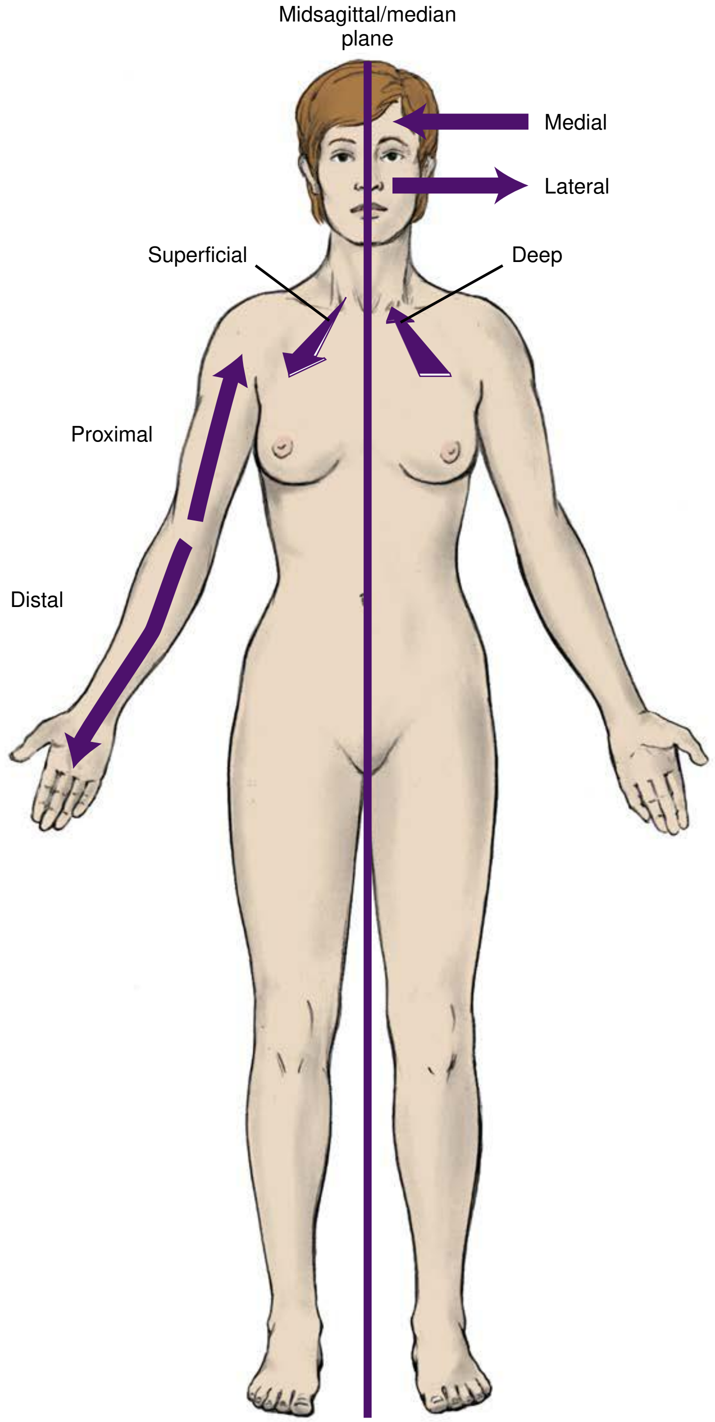



**Fig. 1.5** Body in anatomic position with the medial (or proximal), lateral (or distal), and superficial (or deep) areas noted.

plane of the body or structure is considered **lateral**. For example, the eyes are medial to the ears and the ears are lateral to the eyes.

In addition, an area closer to the midsagittal plane or median plane is considered to be **proximal** (**prok**-suh-muhl), and an area farther from the midsagittal plane or median plane is **distal** (**dis**-tl) even within the dentition. For example, with the upper arm, the shoulder is proximal and the same side fingers are distal.

The body or parts of it in anatomic position can also be divided by various planes into sections in order to study the specific anatomy of a region (Fig. 1.6). The **midsagittal section** or **median section** is a division by the midsagittal (or median) plane. A **sagittal section** is a division by any sagittal plane. In addition, the **coronal section** or **frontal section** is a division by any coronal (or frontal) plane. The **transverse section** or **axial section** is a division by any transverse (or axial) plane.

A midsagittal section formed by the midsagittal plane is similar to cutting down the middle of a baked potato before adding the toppings. Many sagittal sections formed by many sagittal planes are similar to cutting a roasted turkey breast into slices. Many coronal sections formed by many coronal planes are similar to the slices from

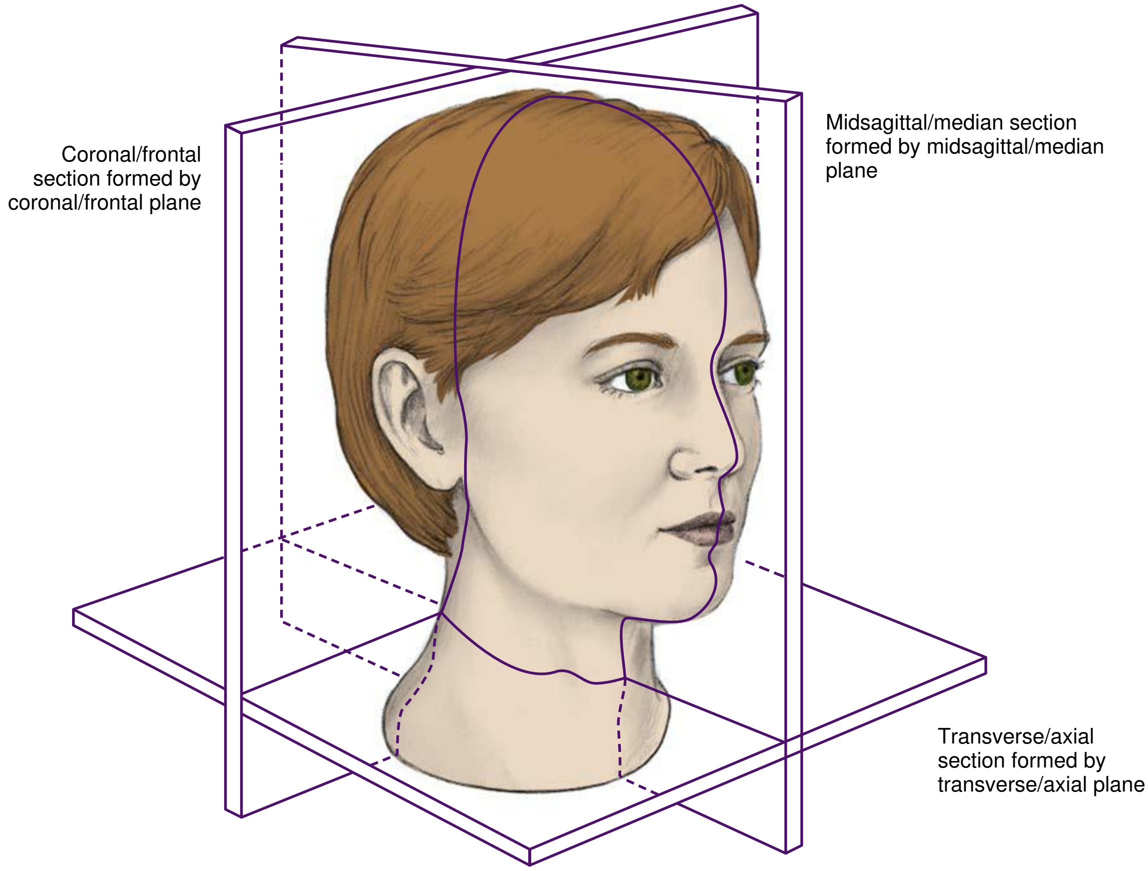



**Fig. 1.6** Head and neck in anatomic position with the midsagittal (or median), coronal (or frontal) and transverse (or axial) sections as well as related planes noted.

a loaf of bread. A transverse section formed by a transverse plane is similar to slicing a hamburger bun or bagel. Many transverse sections form a series of slices, rather like stacking a group of pancakes atop one another.

Additional terms can be used to describe relationships between structures. A structure on the same side of the body as another structure is considered **ipsilateral** (ip-suh-**lat**-er-uhl). A structure on the opposite side of the body from another structure is considered **contralateral** (kon-truh-**lat**-er-uhl). For example, the right leg is ipsilateral to the right arm but contralateral to the left arm.

Certain terms can be used to give information about the depth of a structure in relationship to the surface of the body (see Fig. 1.5). A structure located toward the surface of the body is **superficial**. A structure located inward away from the body surface is **deep**. For example, the skin is superficial to the bones and the bones are deep to the skin.

Terms also can be used to give information about the relative location in hollow structures such as the braincase of the skull. The inner side of the wall of a hollow structure is referred to as **internal**. The outer side of the wall of a hollow structure is **external**.

It is important to keep in mind initially when studying diagrams or associated photographs, especially those of dissections, to note any overall associated descriptions (e.g., view, section) as well as any nearby directional pointers (e.g., medial or lateral). Secondly, note any familiar structures (e.g., apex of tongue or nose, maxillae, or mandible) to allow for basic orientation. Finally, look to the areas highlighted, if noted, and of course those structures that are labeled. This process will help overall in the study of the head and neck.

## ANATOMIC VARIATION

When studying anatomy, the dental professional must understand that there can be anatomic variations of head and neck structures. The number of bones and muscles in the head and neck is usually constant, but specific details of these structures can vary from patient to patient. Bones may have different sizes of processes. Muscles may differ in size and details of their attachments. Joints, vessels, nerves, glands, lymph nodes, fasciae, and spaces of an individual can vary in size, location, and even presence. The most common variations of the head and neck that impact dental treatment are discussed in this text.

# 2

# Surface Anatomy

## LEARNING OBJECTIVES

1. Define and pronounce both the key and anatomic terms in this chapter.
2. Discuss how the surface anatomy of the face and neck may impact dental clinical procedures.
3. Locate and identify the regions and associated surface landmarks of the head and neck on a diagram and a patient.
4. Integrate an understanding of surface anatomy into the clinical practice of dental procedures.

*Additional resources and practice exercises are provided on the companion Evolve website for this book: http://evolve.elsevier.com/Fehrenbach/headneck/.*

## SURFACE ANATOMY OVERVIEW

The dental professional must be comfortably familiar with the surface anatomy of the head and neck in order to examine patients. **Surface anatomy** is the study of the structural relationships of the external features of the body to the internal organs and parts. The features of the surface anatomy provide essential landmarks for the deeper anatomic structures that will be examined and discussed in subsequent chapters. Thus the examination of these accessible surface features by visualization and palpation can give vital information about the health of deeper tissue. See **Appendix B** for information on examination skills and **Appendix C** for procedural steps. In addition, procedures in dental practice are related to the anatomic features of the head and neck (see **Chapter 1**).

Some degree of variation in surface features can be possible as was discussed in the last chapter. However, a change in surface features in a given person may signal a condition of clinical significance and must be noted in the patient record, as well as thoroughly followed up by the examining dental professional. Thus it is not variations among individuals but changes in a particular individual that should be noted. In addition, the underlying histologic and embryologic concerns may also help when examining a patient's head and neck; therefore, related reference materials may need to be reviewed. See related textbooks for further discussion as listed in the bibliography within **Appendix A**.

The study of anatomy of the head and neck begins with the division of the surface into regions. Within each region are certain surface landmarks. To improve the skills of examination, practice finding these surface landmarks in each region of the face and neck using a mirror. Later, locating them on peers and then on patients in a clinical setting adds a real-world level of competence.

In this text, the illustrations of the head and neck, as well as any structures associated with them, are oriented to show the patient's head and neck in anatomic position unless otherwise noted (see **Chapter 1**). This is the same as if the patient is viewed straight on while sitting upright in the dental chair.

Within each of these various regions are certain significant underlying structures for the dental professional. The underlying bony structure of the head and neck is covered in **Chapter 3**. The underlying muscles of the head and neck are covered in **Chapter 4**. In addition, **Chapter 5** discusses the temporomandibular joint. The underlying glandular tissue, such as the lacrimal, salivary, thyroid, and thymus glands, is covered in **Chapter 7**. Lymph nodes that are within the tissue of the head and neck are covered in **Chapter 10**, with the related vascular and nervous systems covered in **Chapters 6 and 8**, respectively.

## REGIONS OF HEAD

The **regions of the head** include the frontal, parietal, occipital, temporal, auricular, orbital, nasal, infraorbital, zygomatic, buccal, oral, and mental regions (Fig. 2.1). These regions are used as a basis for the process of an overall evaluation of the head as discussed in **Appendix C**. During an extraoral examination, seat the patient upright and in a relaxed manner, while noting the symmetry and coloration of the surface regions. It is important to note that the superficial to deep relationships of the head are relatively simple over most of its posterior and superior surfaces but are more difficult in the region of the face.

### Frontal Region

The **frontal region** of the head includes the forehead and the area superior to the eyes and is defined by the deeper skull bone (Fig. 2.2). Directly inferior to each eyebrow is the **supraorbital ridge** (soo-pruh-**awr**-bi-tl). The smooth elevated area between the eyebrows is the **glabella** (gluh-**bel**-uh). The prominence of the forehead, the **frontal eminence** (**em**-uh-nuhns), is also evident. During an extraoral examination, visually inspect the forehead and bilaterally palpate it (Fig. 2.2, *B*).

### Parietal and Occipital Regions

The **parietal region** (puh-**rahy**-i-tl) and the **occipital region** (ok-**sip**-ih-tl) of the head are both covered by the **scalp** and defined by the related deeper skull bones. The scalp consists of layers of soft tissue overlying the bones of the braincase. Large areas of the scalp may be additionally covered by hair. Trying to fully survey these areas during an extraoral examination is important because any lesions present may be hidden visually from the clinician as well as the patient. During an extraoral examination, visually inspect the scalp by moving the hair, especially around the hairline, starting from around one ear and proceeding to the other ear (Fig. 2.3).

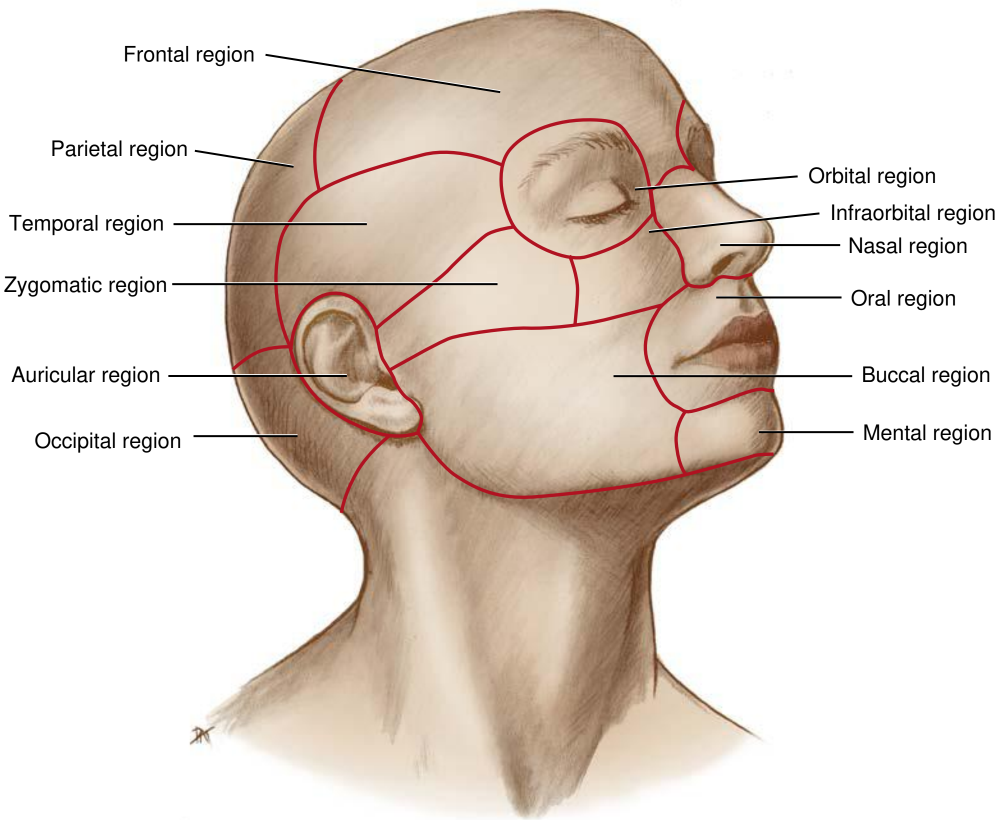



**Fig. 2.1** Oblique lateral view of the regions of the head noted that include the frontal, parietal, occipital, temporal, auricular, orbital, nasal, infraorbital, zygomatic, buccal, oral, and mental regions.

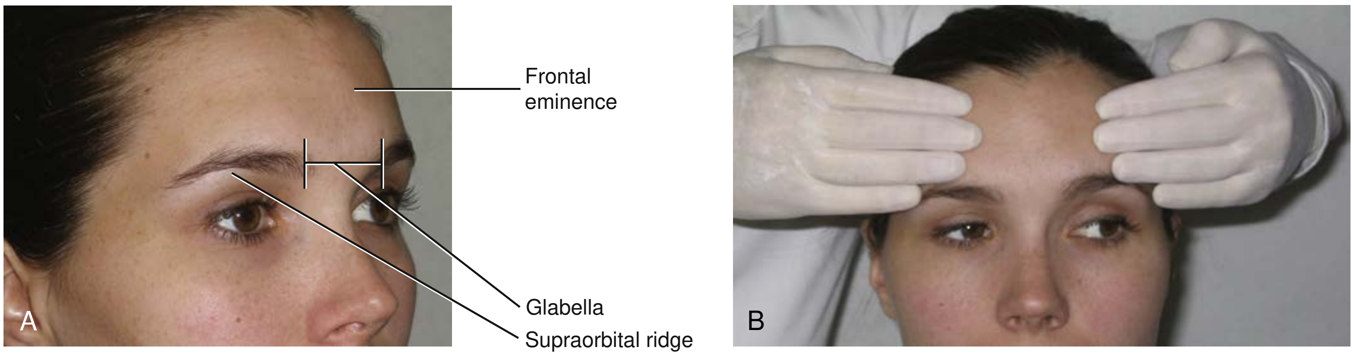



**Fig. 2.2** Frontal view of the head with the associated landmarks of the frontal region noted (**A**), and the demonstration of bilateral palpation of the forehead during an extraoral examination (**B**). (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Temporal and Auricular Regions

Within the **temporal region** (**tem**-pruhl) is the **temple**, the superficial side of the head posterior to each eye, which is defined by the deeper skull bone.

The **auricular region** (aw-**rik**-yuh-ler) of each side of the head has the **external ear** as a prominent feature (Fig. 2.4). The external ear is composed of an **auricle** (**awr**-ih-kuhl) or oval flap of the ear and the centrally located **external acoustic meatus** (**EAM**) (uh-**koos**-tik mee-**ey**-tuhs). The auricle collects sound waves. The external acoustic meatus is a tube through which sound waves are transmitted to the middle ear within the skull.

The superior and posterior free margin of the auricle is the **helix** (**hee**-liks), which ends inferiorly at the **lobule** (**lob**-yool), the fleshy protuberance of the earlobe. The upper apex of the helix is usually level with the eyebrows and the glabella, and the lobule is approximately at the level of the apex of the nose.

The **tragus** (**tray**-guhs) is the smaller flap of tissue of the auricle anterior to the external acoustic meatus. The tragus, as well as the rest of the auricle, is flexible when palpated due to its underlying cartilage. The other flap of tissue opposite the tragus is the **antitragus** (an-ti-**tray**-guhs). Between the tragus and antitragus is a small groove, the **intertragic notch** (in-ter-**tray**-jik). The external acoustic meatus and tragus are important landmarks when taking certain radiographs and administering certain local anesthesia blocks. During an extraoral examination, visually inspect and manually palpate the external ear, as well as the scalp and face around each ear (Fig. 2.5).

**Fig. 2.3** Demonstration of the visual inspection of the scalp during an extraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

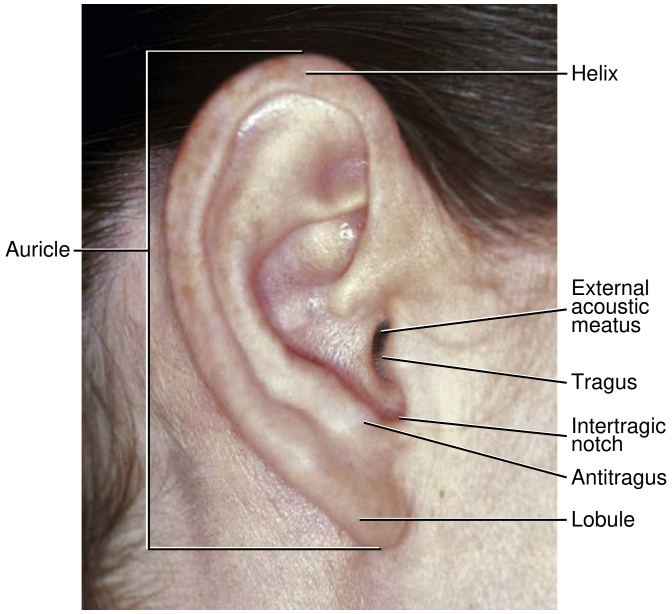



**Fig. 2.4** Lateral view of the right external ear with its associated landmarks within the auricular region noted during an extraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Orbital Region

In the **orbital region** (**awr**-bi-tl) of each side of the head, the eyeball and all its supporting structures are contained within the bony socket or **orbit** (**awr**-bit), which is formed by various skull bones (Fig. 2.6). The eyes are usually near the midpoint of the vertical height of the head. The width of each eye is usually the same as the distance between the eyes. On the eyeball is the white area or **sclera** (**skleer**-uh) with its iris (**ahr**-ris). The opening in the center of the iris is the **pupil** (**pyoo**-puhl), which appears black and changes size as the iris responds to changing light conditions.

Two movable eyelids, upper and lower, cover and protect each eyeball. Behind each upper eyelid and deep within the orbit are the lacrimal glands that produce **lacrimal fluid** (**lak**-ruh-muhl) or *tears* from the gland's ducts.

The **conjunctiva** (kon-**juhngk**-tahy-vuh) is the delicate and thin membrane lining the inside of the eyelids and the front of the eyeball.

**Fig. 2.5** Demonstration of palpation of the external ear during an extraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

The outer corner(s) where the upper and lower eyelids meet is the **lateral canthus** (plural, **canthi**) (**kan**-thus, **kan**-thy) or *outer canthus*. The inner angle(s) of the eye is the **medial canthus** or *inner canthus*. These canthi are important landmarks when taking certain extraoral radiographs. During an extraoral examination, visually inspect the eyes with their movements and responses to light and action (see Fig. 2.6).

## Nasal Region

The main feature of the **nasal region** (**ney**-zuhl) of the head is the **external nose** (Fig. 2.7). The **root of the nose** is located between the eyes. Inferior to the glabella is a midpoint cephalometric landmark of the nasal region that corresponds with the junction between the underlying bones, the **nasion** (**ney**-zee-on). Inferior to the nasion is the bony structure of the skull that forms the **bridge of the nose**. The tip or **apex of the nose** is flexible when palpated because it is formed from cartilage.

Inferior to the apex on each side of the nose is a nostril(s) or **naris** (plural, **nares**) (**nair**-is, **nair**-eez). The nares are separated by the midline **nasal septum** (**sep**-tuhm), which is formed by various skull bones and the adjoining **nasal septal cartilage** (**sep**-tl **kahr**-ti-lij). The nares are bordered laterally on each side by a winglike cartilaginous structure(s), the **ala** (plural, **alae**) (**ey**-luh, **ey**-lee) of the nose. The width between the alae should be approximately the same width as one eye or the space between the eyes. Both the nasion and the alae of the nose are landmarks when taking certain extraoral radiographs. During an extraoral examination, visually inspect the external nose and palpate it by starting at the root of the nose and proceeding to its apex (Fig. 2.8).

## Infraorbital, Zygomatic, and Buccal Regions

The infraorbital, zygomatic, and buccal regions of each side of the head are all located on the facial aspect (Fig. 2.9). The **infraorbital region** (in-fruh-**awr**-bi-tl) of the head is located inferior to the orbital region and lateral to the nasal region. Farther laterally is the **zygomatic region** (zahy-guh-**mat**-ik), which overlies the cheekbone, the **zygomatic arch**. The zygomatic arch is formed from various skull bones and extends from just inferior to the lateral margin of the eye toward the middle part of the ear.

Inferior to the zygomatic arch and just anterior to the external ear is the **temporomandibular joint (TMJ)** (tem-poh-roh-man-**dib**-yuh-ler). This is the location where the upper skull forms a joint with the lower jaw. The movements of the joint can be felt when opening and closing the mouth or when moving the lower jaw to the right or left. After palpating the joint during various movements, feel the lower jaw moving at the temporomandibular joint on a patient by gently placing a finger into the outer part of the external acoustic meatus.

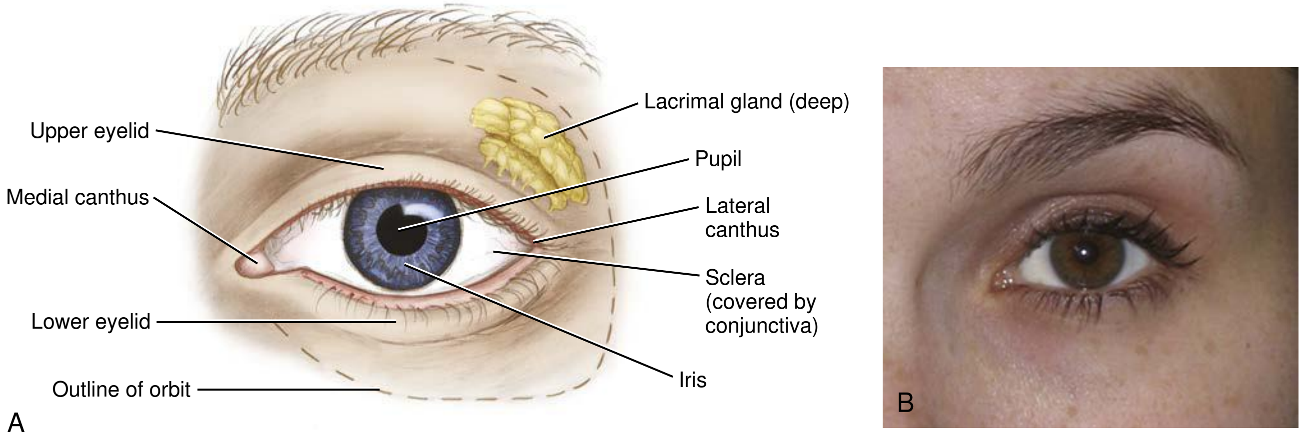



**Fig. 2.6** Frontal view of the left eye with the associated landmarks of the orbital region noted (**A**), and visualization of the eye during an extraoral examination (**B**). (**B,** Courtesy of Margaret J. Fehrenbach, RDH, MS.)

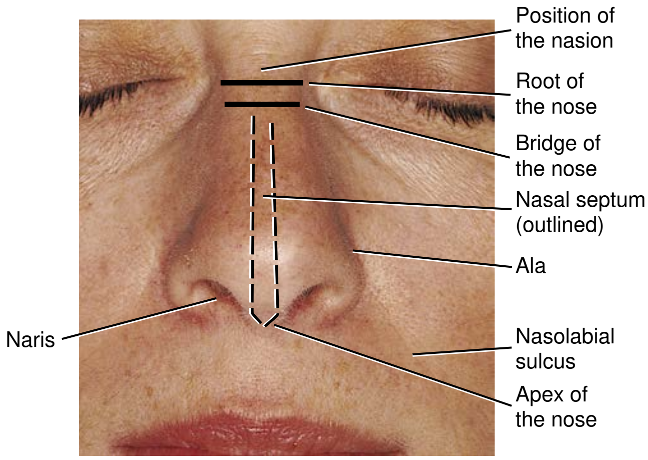



**Fig. 2.7** Frontal view of the face with the landmarks of the nasal region noted during an extraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

**Fig. 2.8** Demonstration of palpation of the external nose during an extraoral examination starting at the root and proceeding to its apex. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

The **buccal region** (**buhk**-uhl) of the head is composed of the soft tissue of the cheek. The cheek forms the side of the face and is the broad area between the nose, mouth, and ear. Most of the upper cheek is fleshy and is mainly formed by a mass of fat and muscles. One of these is the strong **masseter muscle** (mas-**seh**-ter/mas-**see**-ter), which is felt when a patient clenches the teeth. Also during an extraoral examination, visually inspect and palpate bilaterally the infraorbital, zygomatic, and buccal regions, as well as specifically the temporomandibular joint.

The face can be divided into thirds, and this perspective is the **vertical dimension of the face**. A discussion of vertical dimension allows a comparison of the three parts of the face for functional and esthetic purposes using the **Golden Proportions**, which is a set of guidelines. Loss of height in the lower third of the face, which contains the teeth and jaws, can occur in certain circumstances such as with the loss of bony jaw support from increased aging and severe chronic periodontal disease. These negative clinical ramifications cause pronounced changes in the functions as well as esthetics of the orofacial structures.

## Oral Region

The **oral region** of the head contains significant structures to the dental professional within it such as the lips, oral cavity, palate, tongue, floor of the mouth, and parts of the throat (or pharynx). The lips are the gateway of the oral region, and each lip's **vermilion zone** (ver-**mil**-yuhn) has a darker reddish appearance than the surrounding skin (Fig. 2.10). The lips are outlined from the surrounding skin by the transition of the **mucocutaneous junction** (**myoo**-koh-kyoo-tey-nee-uhs) at the **vermilion border**. Both lips are covered externally by skin and internally by the same mucous membranes that line the oral cavity (see discussion next).

Beneath the lip skin is a layer of subcutaneous tissue with many muscles (such as the orbicularis oris), nerves, and blood vessels. Blood supply to the lip is from the superior and inferior labial arteries that branch from the facial arteries, which run along the margin of mucocutaneous junction deep to the vermilion of the lip.

Sensory supply to the lip is covered by branches of the fifth cranial or trigeminal nerve. The infraorbital nerves extend to the upper lip, and the mental nerve provides sensation to the lower lip. Lymphatic drainage is to both the submental and submandibular lymph nodes and can often be bilateral. Also present are numerous labial minor salivary glands, each with a small duct penetrating the mucosal membrane. Between the vermilion zone and the inner oral cavity is the *intermediate zone*. The width of the lips at rest should be approximately the same distance as that between the irises of the eyes.

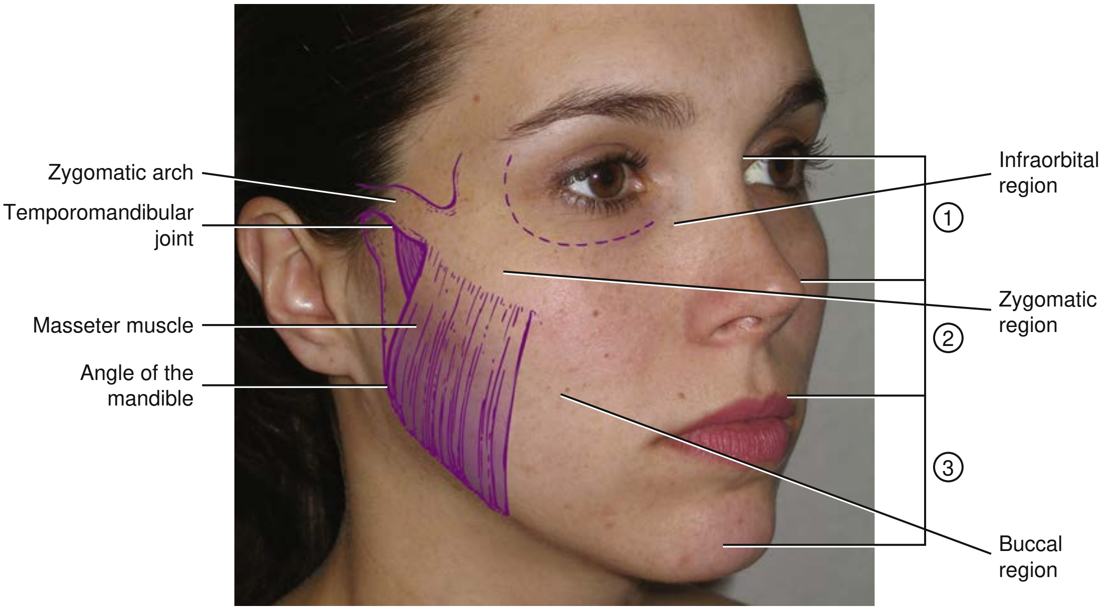



**Fig. 2.9** Oblique lateral view of the face with landmarks of the zygomatic and buccal regions noted as well as the vertical dimension of the face, with the face divided into thirds. This division allows a comparison of the three parts of the face for functional and esthetic purposes using the guidelines of the Golden Proportions. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

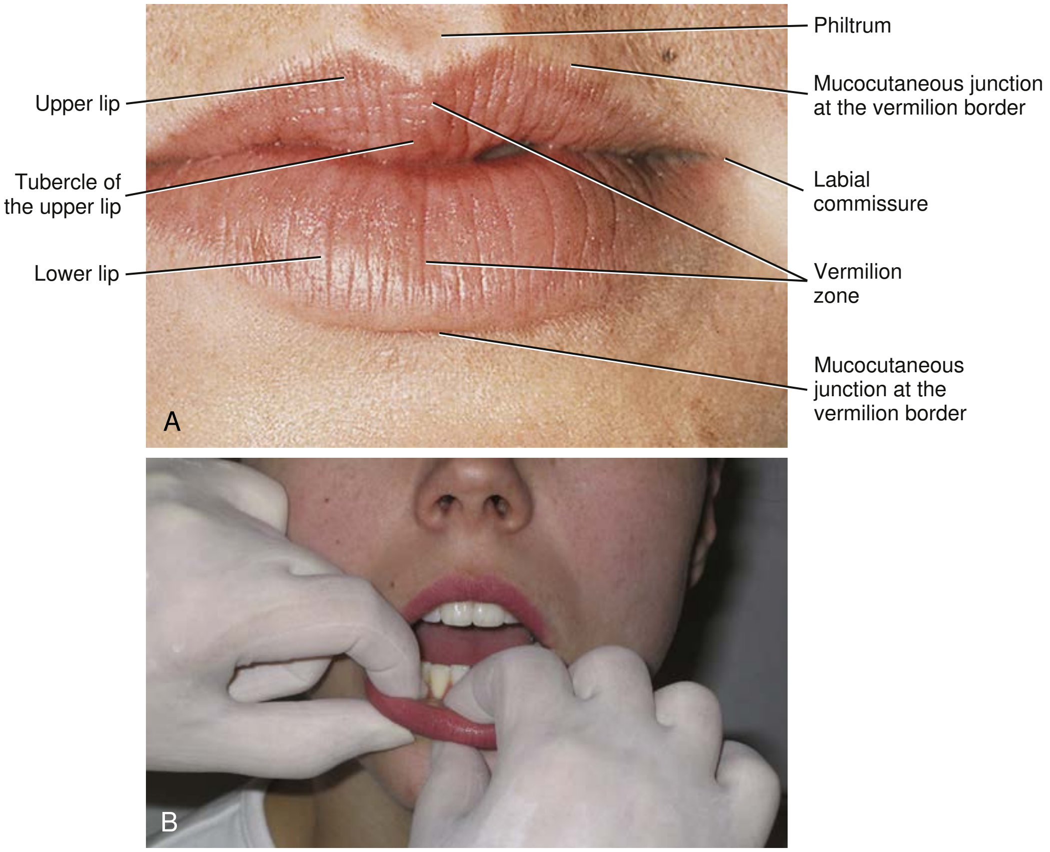



**Fig. 2.10** Frontal view of the lips within the oral region (**A**) and demonstration of bidigital palpation of the lips during an intraoral examination (**B**). (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

Superior to the midline of the upper lip, extending inferiorly from the nasal septum, is a vertical groove on the skin, the **philtrum** (**fil**-truhm). Inferior to the philtrum, the midline of the upper lip terminates in a thicker area or **tubercle of the upper lip** (**too**-ber-kuhl). The upper and lower lips meet at each corner of the mouth or **labial commissure** (**kom**-uh-shoor). Displacement or effacement (as thinning) of the philtrum is quickly noticed; thus this area represents an important region during lip reconstruction. The health of the labial commissure tissue is an important consideration for overall patient health.

The groove running upward between each labial commissure and each ala of the nose is the **nasolabial sulcus** (ney-zoh-**ley**-bee-uhl **suhl**-kuhs) (see Fig. 2.7). They are more commonly called "smile lines" or "laugh lines." The lower lip extends to the horizontally located **labiomental groove** (ley-bee-oh-**men**-tl), which separates the lower lip from the chin in the mental region (see Fig. 2.22). This groove should be approximately midway between the apex of the note and chin as well as level with the angle of the mandible; it can become deepened with age. During intraoral examination, bidigitally palpate the lips and visually inspect them in a systematic manner starting on the upper lip from one labial commissure to the one on the other side and then completing the lower lip in the same manner (see Fig. 2.10, *B*).

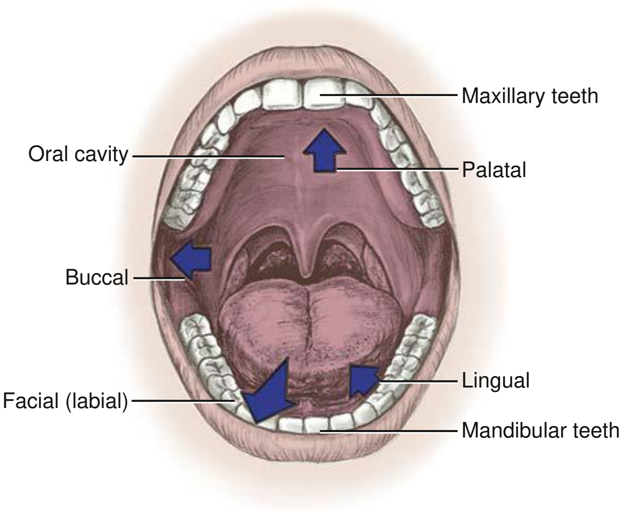



**Fig. 2.11** Oral cavity and jaws with the designation of the terms lingual, palatal, buccal, facial, and labial within the oral cavity. (From Fehrenbach MJ, Popowics T. *Illustrated Dental Embryology, Histology, and Anatomy*, 5th ed. St. Louis: Elsevier; 2020.)

## Oral Cavity

The inside of the mouth is considered the **oral cavity**. The jaws are within the oral cavity and deep to the lips (Fig. 2.11). Underlying the upper lip is the bony upper jaw or **maxilla(e)** (mak-**sil**-uh, mak-**sil**-lee); the bone underlying the lower lip is the bony lower jaw or **mandible** (**man**-duh-buhl) (see Fig. 3.4). The sharp bent of the lower jaw inferior to the ear's lobule is the **angle of the mandible**.

An understanding of the divisions of the oral cavity is aided by knowing its borders; certain structures of the face and oral cavity mark the borders of the oral cavity (see Fig. 2.1). The lips of the face mark the anterior border of the oral cavity, and the throat or pharynx is the posterior border. The cheeks of the face mark the lateral borders, and the roof of the mouth or palate marks the superior border. The floor of the mouth is the inferior border of the oral cavity.

Specific areas within the oral cavity are identified with orientational terms based on their relationship to other orofacial structures such as the facial surface, lips, cheeks, palate, and tongue. Structures closest to the facial surface are termed **facial**. Those facial structures that are also closer to the lips are termed **labial** (**ley**-bee-uhl). Facial structures closest to the inner cheek are termed **buccal**. Structures closest to the tongue are termed **lingual** (**ling**-gwuhl). Those lingual structures that are also closest to the palate are termed **palatal** (**pal**-uh-tl).

The oral cavity is lined by a mucous membrane or **oral mucosa** (myoo-**koh**-suh) (Fig. 2.12). The inner parts of the lips are lined by a pink and thick **labial mucosa**. The labial mucosa is continuous with the equally pink and thick **buccal mucosa** that lines the inner cheek. However, both the labial and buccal mucosa may vary in coloration, as do other regions of healthy oral mucosa, in individuals with pigmented skin. The buccal mucosa covers a dense pad of inner tissue, the **buccal fat pad**.

Further landmarks can be noted in the oral cavity. On the inner part of the buccal mucosa, just opposite the maxillary second molar, the **parotid papilla** (puh-**rot**-id puh-**pil**-uh) is a small elevation of tissue that protects the ductal opening of the parotid salivary gland. During an intraoral examination, observe the salivary flow from each duct near the parotid papillae after drying it with gauze. A tissue-covered elevation on the maxilla just posterior to the most distal maxillary molar is the **maxillary tuberosity** (**mak**-suh-ler-ee too-buh-**ros**-i-tee). A similar feature on the mandible just posterior to the most distal mandibular molar is a dense pad of tissue, the **retromolar pad** (ret-roh-**moh**-ler).

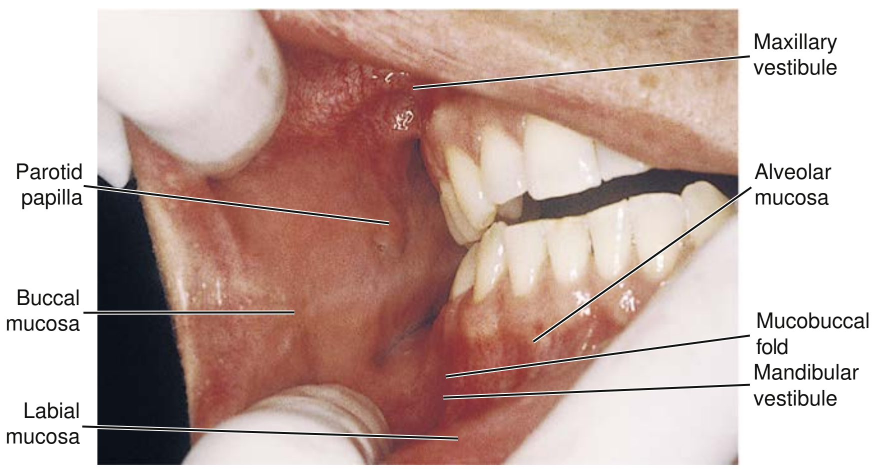



**Fig. 2.12** Oral view of the buccal mucosa and labial mucosa of the oral cavity with associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

In order to examine the labial mucosa during an intraoral examination, ask the patient to open the mouth slightly and gently pull the lips away from the teeth so as to be able to visually inspect and then bidigitally palpate the inner lips. Then gently pull the buccal mucosa slightly away from the teeth so as to be able to visually inspect and then bidigitally palpate the inner cheek on each side using circular compression.

The upper and lower horseshoe-shaped spaces in the open area of the oral cavity between the lips and cheeks anteriorly and laterally and the teeth and their soft tissue medially and posteriorly are considered the maxillary and mandibular **vestibules** (**ves**-tuh-byoolz). Deep within each vestibule is the **vestibular fornix** (veh-**stib**-yuh-ler **fawr**-niks), where the pink and thick labial or buccal mucosa meets the redder and thinner **alveolar mucosa** (al-**vee**-uh-ler) at the **mucobuccal fold** (myoo-**koh**-buhk-uhl). The **labial frenum** (plural, **frena**) (**free**-nuhm, **free**-nuh) is a fold(s) of tissue located at the midline between the labial mucosa and the alveolar mucosa on both the maxilla and mandible (Fig. 2.13).

The **alveolar process** or alveolar bone is the bony extension for both the maxilla and mandible that contains each tooth socket or **alveolus** (plural, **alveoli**) (al-**vee**-uh-luhs, al-**vee**-uh-lahy). The teeth of the maxilla are the **maxillary teeth**, and the teeth of the mandible are the **mandibular teeth** (man-**dib**-yuh-ler). The maxillary anterior teeth overlap the mandibular anterior teeth, and posteriorly, the maxillary buccal cusps overlap the mandibular buccal cusps. Both dental arches in the adult have permanent teeth that include the **incisors** (in-**sahy**-zuhrz), **canines** (**kahy**-ninez), **premolars** (pre-**moh**-lerz), and **molars** (**moh**-lerz).

Surrounding both the maxillary and mandibular teeth are the gums or **gingiva** (jin-**juh**-vuh) or more accurately referred to, but not commonly by the dental community, by its plural form, *gingivae* (jin-**juh**-vee). The gingiva is composed of a firm pink oral mucosa (Fig. 2.14 and see Fig. 2.13). The gingiva that tightly adheres to the bone around the roots of the teeth is the **attached gingiva**. The attached gingiva may also have localized areas of pigmentation. The line of demarcation between the firmer and pinker attached gingiva and the movable and redder alveolar mucosa is the scallop-shaped **mucogingival junction** (mu-koh-**jin**-ji-vuhl).

At the gingival margin of each tooth is the nonattached or **marginal gingiva** (**mahr**-juh-nuhl) or *free gingiva*. The inner surface of the marginal gingiva faces a space(s) or **gingival sulcus**. The **interdental gingiva** (in-ter-**den**-tl) is the gingival tissue between adjacent teeth adjoining attached gingiva, with each individual extension being an **interdental papilla**. During an intraoral examination, retract both the buccal mucosa and labial mucosa in order to visually inspect and digitally palpate the vestibular area and the gingival tissue using circular compression, including the maxillary tuberosity and retromolar pad on each side.

## Palate

The **palate** (**pal**-it) or roof of the mouth has two parts: the hard palate and the soft palate (Fig. 2.15). The bony whiter anterior arched part is the **hard palate.** A small bulge of tissue at the most anterior part of the hard palate, lingual to the anterior teeth, is the **incisive papilla** (in-**sahy**-siv). Directly posterior to this papilla are the **palatine rugae** (**pal**-uh-tahyn **roo**-gee/jee), which are firm irregular ridges of tissue.

The yellower, looser and softer posterior part of the palate is the **soft palate**; it is the smaller part of the palate since it only comprises approximately 15% of the total palatal surface (see Figs. 2.15 and 2.21). The soft palate is directly connected to the hard palate, but it can be separately elevated and depressed by muscles (see **Chapter 4**).

A midline muscular structure, the **uvula of the palate** (**yoo**-vyuh-luh), hangs as an extension from the posterior margin of the soft palate. The midline ridge of tissue on the palate is the **median palatine raphe** (**rey**-fee), which runs from the incisive papilla to the uvula (see Fig. 2.21).

The **pterygomandibular fold** (**ter**-i-goh-man-**dib**-yuh-ler) is a vertical fold of tissue that extends from the junction of the hard and soft palates to the medial side of the mandibular ramus, just posterior to the most distal mandibular molar and the nearby retromolar pad. The pterygomandibular fold stretches when the patient opens the mouth wider. This fold covers a deeper tendinous band that separates the cheek from the throat (or pharynx).

During an intraoral examination, have the patient tilt the head back slightly and extend the tongue to visually inspect the soft palate and throat (or pharynx). Use the mouth mirror to intensify the light source. Then gently place the mouth mirror with the mirror side down on the middle of the top surface of the tongue and ask the patient to say "*ah*" (see Fig. 4.31). As this is done, visually observe the soft palate with uvula and any visible parts of the throat (or pharynx). Then, compress the hard palate with the first or second finger of one hand, avoiding circular compression. It is also recommended not to palpate the nearby soft palate so as to prevent initiating the gag reflex.

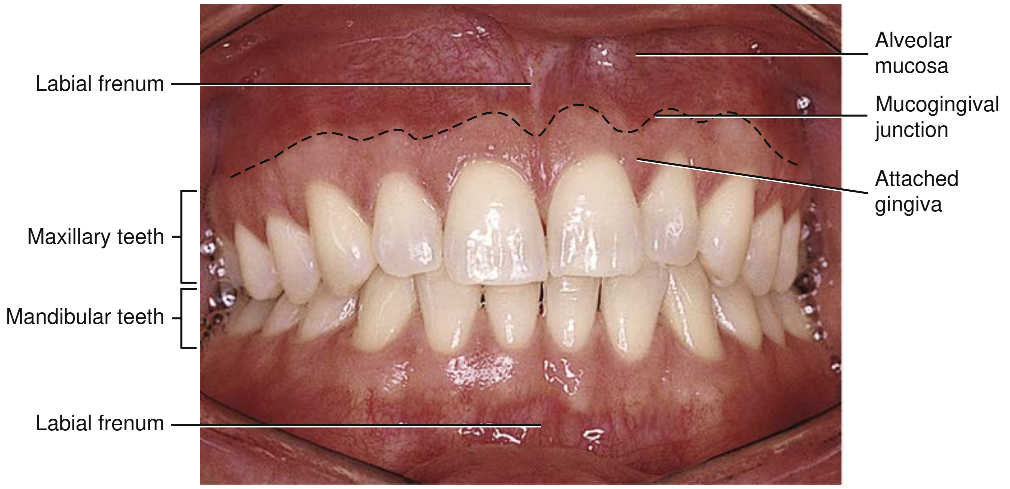



**Fig. 2.13** Frontal view of the oral cavity with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

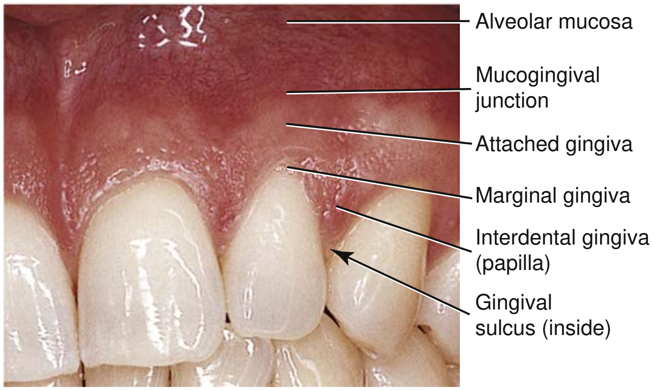



**Fig. 2.14** Close-up of the gingiva with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

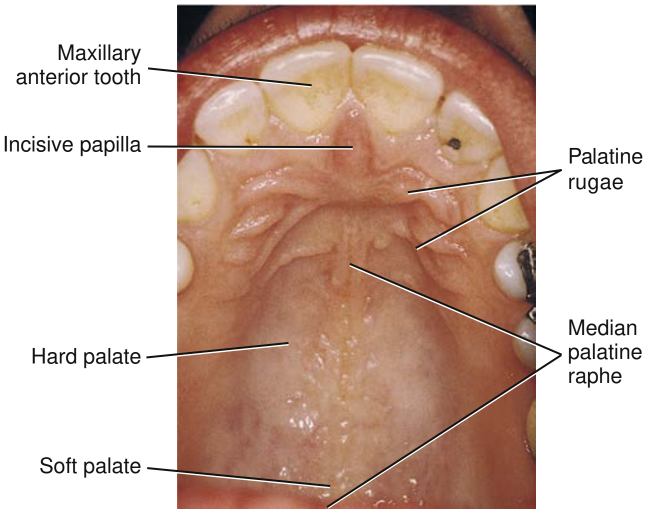



**Fig. 2.15** Inferior view of the palate with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Tongue

The **tongue** is a prominent feature of the oral region (Fig. 2.16). The posterior one-third of the tongue is the *pharyngeal part* or **base of the tongue**. The base of the tongue attaches to the floor of the mouth. The base of the tongue does not lie within the oral cavity but within the oral part of the throat or pharynx. The anterior two-thirds of the tongue is the *oral part* or **body of the tongue** since it lies within the oral cavity. Separating the tongue into a posterior one-third and an anterior two-thirds is important as the two areas have different innervation, structure, and embryonic development.

The top surface or **dorsal surface of the tongue** (**dawr**-suhl) has a midline depression, the **median lingual sulcus**, corresponding with the position of a midline tendinous band deep within the tongue (Fig. 2.17). This dividing septum makes a relatively surgically bloodless plane of dissection. The tip of the tongue is the **apex of the tongue**.

Farther posteriorly on the dorsal surface of the tongue and more difficult to see clinically is a V-shaped groove, the **sulcus terminalis** (tur-**muh**-nl-is). The sulcus terminalis is the division that separates the base from the body of the tongue. Where the sulcus terminalis points backward toward the throat or pharynx is a small pitlike depression, the **foramen cecum** (fuh-**rey**-muhn **see**-kuhm). Even farther posteriorly on the dorsal surface of the tongue base on each side is an irregular mass of lymphoid tissue, the **lingual tonsil** (**ton**-suhl).

The underside or **ventral surface of the tongue** is noted for its visibly large blue blood vessel branches of the deep lingual veins that are close to the surface on each side (Fig. 2.18). Lateral to the deep lingual veins on each side is the **plica fimbriata** (plural, **plicae fimbriatae**) (**plahy**-kuh fim-bree-**ahy**-tuh, **plahy**-kee fim-bree-**ahy**-tee), a fold(s) with fringelike projections.

Again, the term used for the underside of the tongue, *ventral*, referred originally to four-footed animals in anatomic position and now is used for that surface for our upright position on our two feet. In relationship to the tongue, *dorsal* and *posterior* do not mean the same, nor are *ventral* and *anterior* the same either as discussed later. Instead, they are four different locations. This is because the human tongue still has the same orientation as the tongue of four-footed animals, in which anterior and posterior originally meant toward the nose and tail, respectively, and *dorsal* and *ventral* refer to the back and belly, respectively (see **Chapter 1**). Our upright posture on our two feet is the reason that *dorsal* and *posterior* have come to mean the same in the rest of

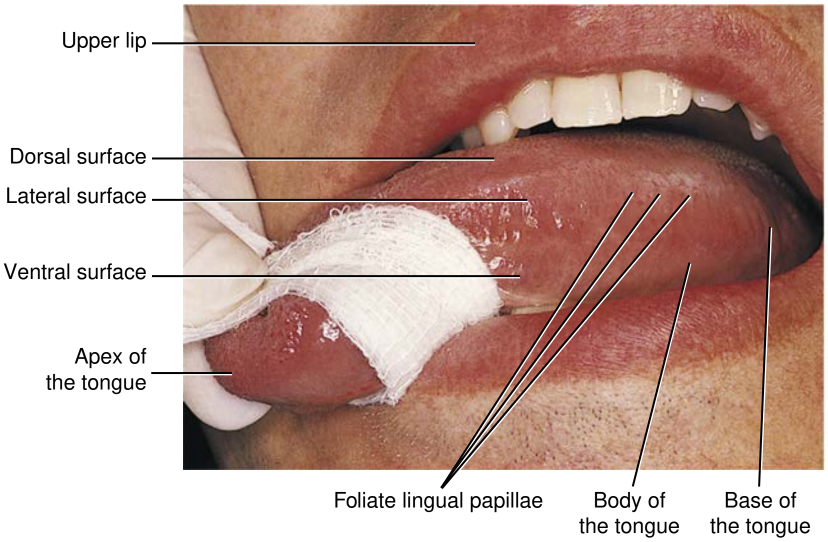



**Fig. 2.16** Lateral view of the tongue with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

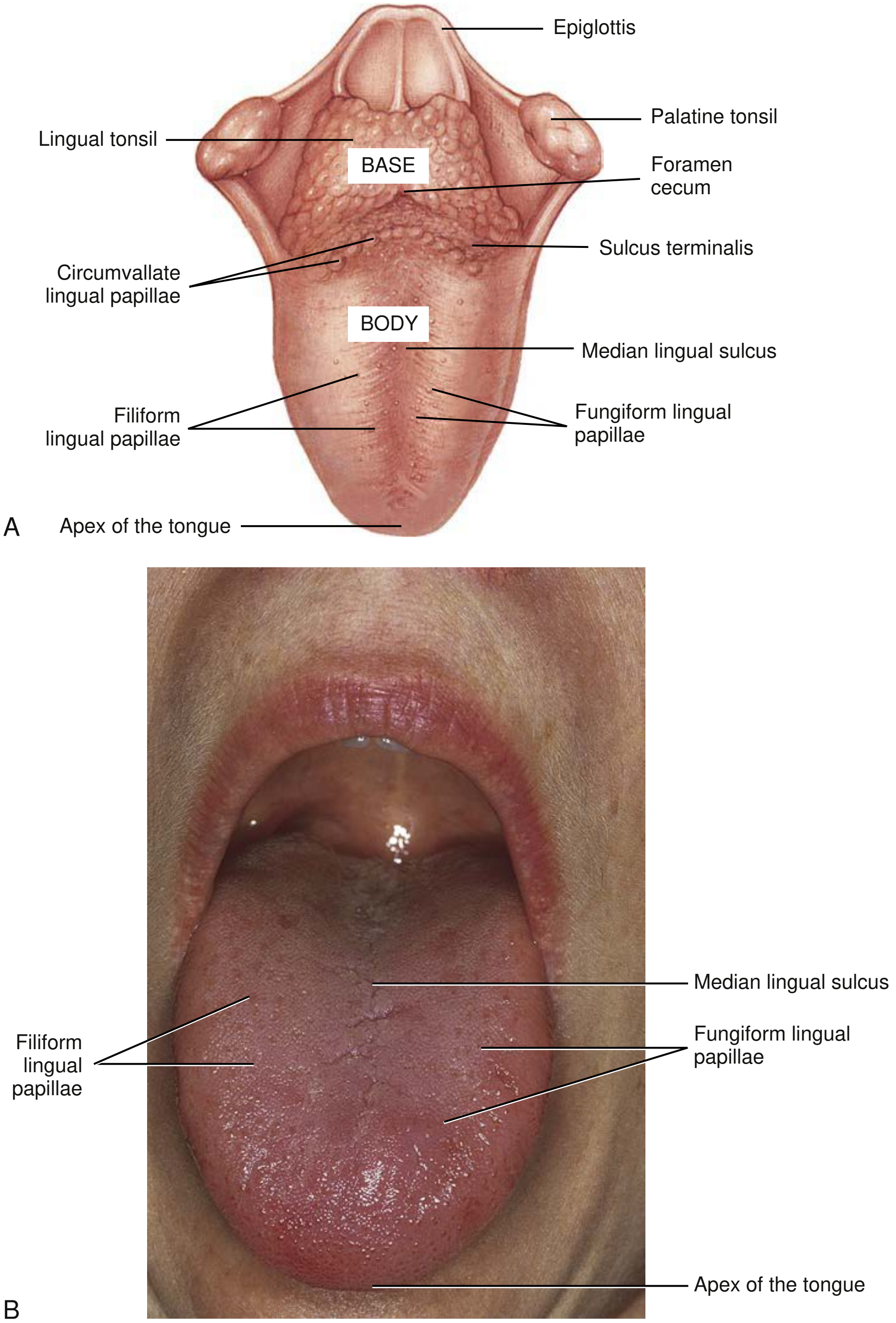



**Fig. 2.17** Dorsal view of the tongue with its associated landmarks noted **(A)** and during an intraoral examination **(B)**. (From Fehrenbach MJ, Popowics T. *Illustrated Dental Embryology, Histology, and Anatomy,* 5th ed. St. Louis: Elsevier; 2020.)

the body and now are used in that manner when referring anatomically to these surfaces.

Certain surfaces of the tongue have elevated small structures of specialized mucosa, the **lingual papillae**, some of which are associated with taste buds. The side or **lateral surface of the tongue** is noted for its vertical ridges, the **foliate lingual papillae** (**foh**-lee-eyt), which contain taste buds. These lingual papillae are more prominent in children.

The dorsal surface of the tongue also has varying forms of lingual papillae. The slender threadlike lingual papillae are the **filiform lingual papillae** (**fil**-u-fawrm), which give the dorsal surface its velvety texture. The red mushroom-shaped dots are the **fungiform lingual papillae** (**fuhn**-juh-fawrm/**fuhng**-guh-fawrm). The fungiform are found in lesser numbers than are the filiform on the body of the dorsal surface of the tongue and contain taste buds. The **circumvallate lingual papillae** (sur-kuhm-**val**-eyt), which are approximately 10 to 14 in number, line up along the anterior side of the sulcus terminalis on the body. These large mushroom-shaped lingual papillae have taste buds at their bases.

To examine the dorsal and lateral surfaces of the tongue, have the patient slightly extend the tongue and wrap gauze around its body or anterior two-thirds of the tongue in order to obtain a firm grasp (see Fig. 2.16). First, visually inspect and then digitally palpate the dorsal surface of the body of the tongue. Then, turn the tongue slightly on its side to visually inspect its base or posterior one-third and bidigitally palpate its lateral borders. To examine the ventral surface, have the patient slightly lift the tongue to the palate so as to visually inspect and digitally palpate its surface.

## Floor of the Mouth

The **floor of the mouth** is a mucosal covered space that extends from the lingual surface of the mandibular alveolar process inferiorly to the ventral surface of the tongue (Fig. 2.19). Posteriorly, it extends to the beginning of the throat (at the anterior tonsillar pillar). The left and right sides meet at the lingual frenum along the anterior midline. The **lingual frenum** is an anterior midline fold of tissue between the ventral surface of the tongue and the floor of the mouth. The underlying muscles provide support for the floor of the mouth.

A ridge of tissue also exists on each side of the floor of the mouth, the **sublingual fold** (sub-**ling**-gwuhl). Together these folds are arranged in a V-shaped configuration from the lingual frenum to the base of the tongue. The sublingual folds are associated with the underlying sublingual salivary gland and contain openings of the sublingual duct. The small papilla or **sublingual caruncle** (**kar**-uhng-uhl) at the anterior end of each sublingual fold and also the base of the lingual frenum contains the duct openings from both the submandibular and sublingual salivary glands.

While the patient lifts the tongue to the palate during an extraoral examination, visually inspect the mucosa of the floor of the mouth using the mouth mirror to intensify the light source and check the lingual frenum at the midline as well. Dry each sublingual caruncle with gauze to observe salivary flow from the ducts. Bimanually palpate the sublingual area by placing an index finger intraorally and the fingertips of the opposite hand extraorally under the chin, compressing the tissue between the fingers (see Fig. 7.10).

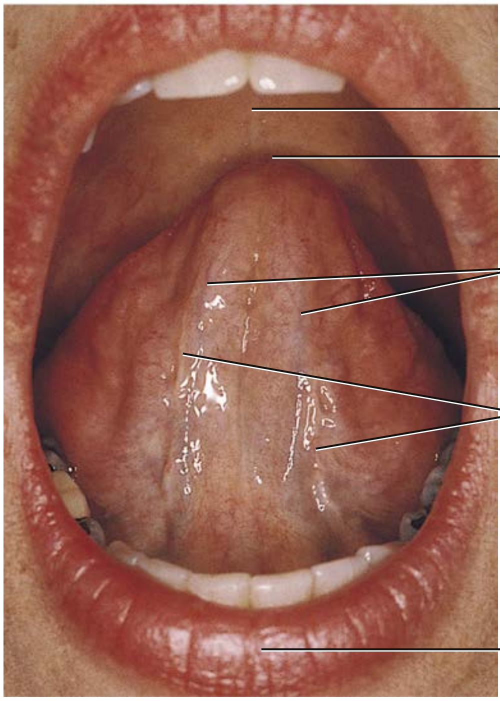



**Fig. 2.18** Ventral surface of the tongue with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Pharynx

The oral cavity also provides the entrance into the throat or **pharynx** (**fare**-ingks). The pharynx is a muscular tube that serves both the respiratory and digestive systems. The pharynx consists of three parts: the nasopharynx, oropharynx, and laryngopharynx (Fig. 2.20). The **laryngopharynx** (luh-ring-goh-**far**-ingks) is located more inferior, close to the laryngeal opening, and thus is not visible during an intraoral examination.

The part of the pharynx that is superior to the level of the soft palate is the **nasopharynx** (ney-zoh-**far**-ingks). The nasopharynx is continuous with the nasal cavity. The part of the pharynx that is between the soft palate and the opening of the larynx is the **oropharynx** (ohr-oh-**far**-ingks) (Fig. 2.21). Parts of the nasopharynx and oropharynx are visible during an intraoral examination when examining the palate as discussed earlier. To examine the more extensive parts of the nasopharynx, as well as the laryngopharynx or even the oropharynx in some patients, special diagnostic tools are needed.

Behind the base of the tongue and in front of the oropharynx is the **epiglottis** (ep-i-**glot**-tis), a flap of cartilage (see Figs. 2.17, 2.20, and 4.30). At rest, the epiglottis is upright and allows air to pass through the larynx and into the rest of the respiratory system. During swallowing, it folds back to cover the entrance to the larynx, preventing food and liquid from entering the deeper still trachea and then entering the lungs.

The opening from the oral region into the oropharynx is the **fauces** (**faw**-seez) or *faucial isthmus*. The fauces are formed laterally on each side by folds of tissue created by the underlying muscles, the **anterior faucial pillar** (**faw**-shuhl) and the **posterior faucial pillar**. Tonsillar tissue, the **palatine tonsils**, is located between each of these pillars (Fig. 2.21 and see Fig. 4.31). The palatine tonsils are the tonsillar tissue that patients call their "tonsils."

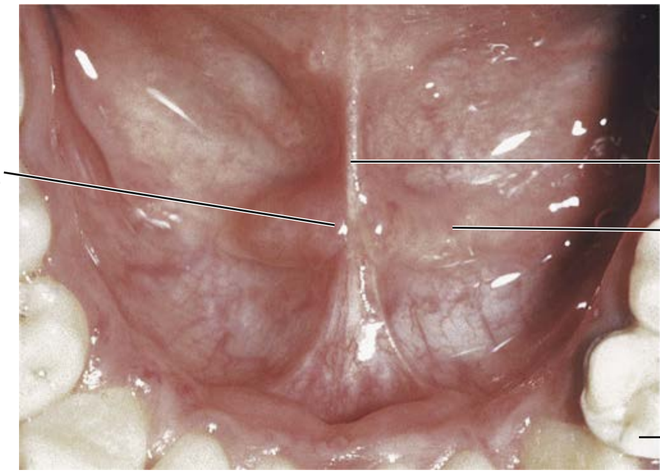



**Fig. 2.19** View of the floor of the mouth with its associated landmarks noted during an intraoral examination. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Mental Region

The chin is the major feature of the **mental region** (**men**-tl) of the head (Fig. 2.22). The **mental protuberance** (pro-**too**-ber-uhns) is the prominence of the chin. The labiomental groove, a horizontal groove between the lower lip and the chin mentioned in the description of the oral region, should be approximately midway between the apex of the nose and the chin and level with the angle of the mandible.

Also present in some individuals on the surface of the chin is a midline depression or dimple that marks the underlying bony fusion of the lower jaw. Visually inspect and bilaterally palpate the chin during an extraoral examination (see Fig. 2.22).

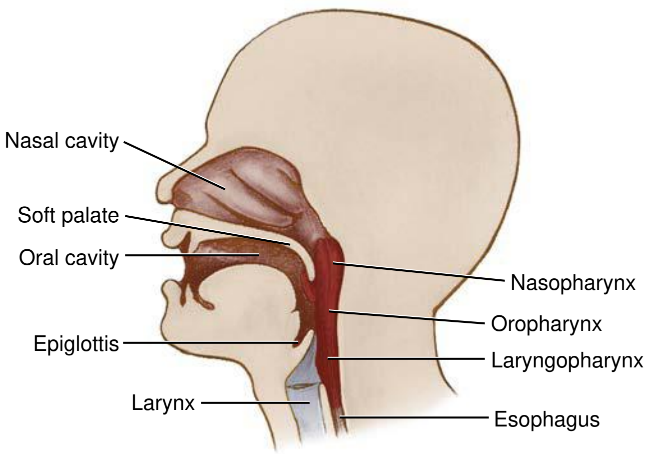



**Fig. 2.20** Midsagittal section of the head and neck with the divisions of the pharynx noted.

## REGIONS OF NECK

The neck extends from the skull and mandible inferiorly to the clavicles and sternum. However, the posterior neck is at a higher level than the anterior neck so as to connect the cervical internal organs with the posterior openings of the nasal and oral cavities. The **regions of the neck** can be divided into different cervical triangles on the basis of the large bones and muscles in the area, with each triangle containing structures that are palpated during an extraoral examination (Fig. 2.23). An overview of the borders as well as the contents of each triangle will be noted here for a regional approach but then later discussed in the appropriate systems' chapter (Table 2.1).

The large strap muscle, the **sternocleidomastoid (SCM) muscle** (stur-noh-klahy-duh-**mas**-toid), divides each side of the neck diagonally into a larger **anterior cervical triangle** (**ser**-vih-kal) and a smaller **posterior cervical triangle**. The SCM muscle is also palpated during an extraoral examination, as are the regions anterior and posterior to it (see Fig. 4.2 and discussed in detail in **Chapter 4**).

The anterior region of the neck corresponds with the two anterior cervical triangles, which are separated by a midline. Investing fascia covers the roof of the anterior cervical triangle and the visceral fascia covers the floor.

The lateral region of the neck that is posterior to the SCM muscle is considered the posterior cervical triangle on each side. The roof of the posterior cervical triangle is covered by the investing layer of fascia and the floor is covered by the vertebral fascia.

At the anterior midline, the largest of the larynx's cartilages, the **thyroid cartilage** (**thahy**-roid), is visible as the laryngeal prominence or what patients call their "Adam's apple," especially in adult men. This cartilage is superior to the thyroid gland, which is also palpated during an extraoral examination (Fig. 2.24 and see Fig. 7.10; discussed in detail in **Chapter 7**). The **superior thyroid notch** of the thyroid cartilage is just superior to the laryngeal prominence and is also a palpable landmark of

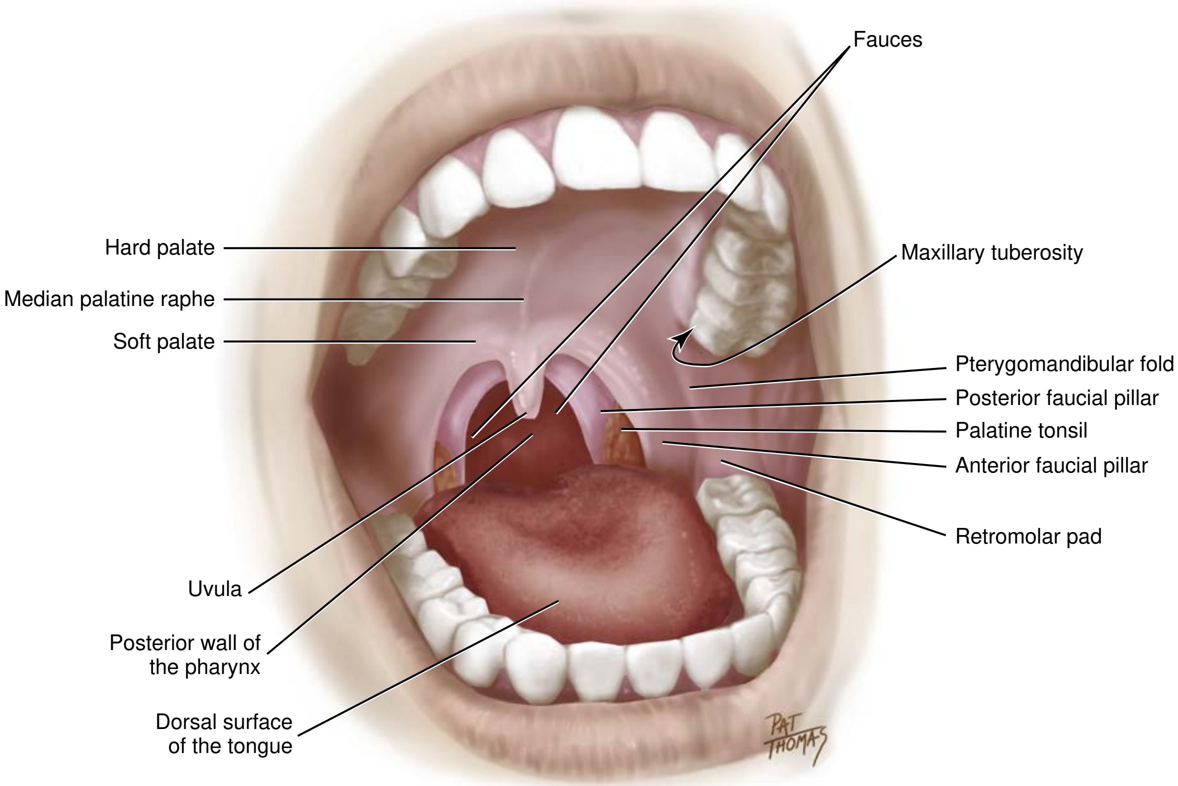



**Fig. 2.21** Oral view of the oral cavity and oropharynx with associated landmarks noted.


**Fig. 2.22** Oblique lateral view of the mental region with its landmarks noted **(A),** and demonstration of bilateral palpation of the mental region during an intraoral examination **(B)**. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

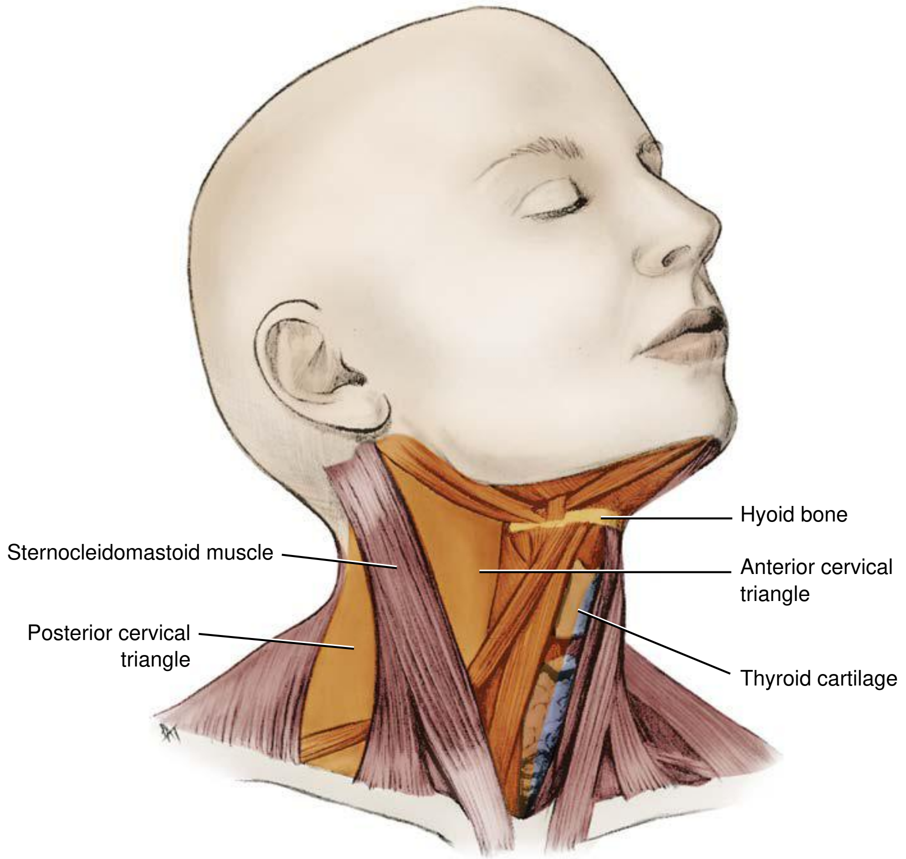



**Fig. 2.23** Division of neck region by the sternocleidomastoid muscle into the anterior cervical and posterior cervical triangles.

**TABLE 2.1 Cervical Triangle Borders**

| Triangles | Borders | Contents |
|---|---|---|
| **Anterior cervical triangles:** Submental, carotid, muscular, submandibular triangles | **Superiorly:** Inferior border of mandible<br>**Laterally:** Anterior border of sternocleidomastoid muscle<br>**Medially:** Midline of neck | See specifics below |
| **Submental triangle** | **Inferiorly:** Body of hyoid bone<br>**Medially:** Mandibular symphysis<br>**Laterally:** Anterior belly of digastric muscle | Submental lymph nodes; tributaries forming anterior jugular vein |
| **Carotid triangles** | **Superiorly:** Posterior belly of digastric muscle<br>**Laterally:** Anterior border of sternocleidomastoid muscle<br>**Inferiorly:** Superior belly of omohyoid muscle | Common carotid artery; external and internal carotid arteries; superior thyroid; ascending pharyngeal; lingual, facial, occipital arteries; tributaries to common facial vein; internal jugular vein; vagus (X), accessory (XI), and hypoglossal (XII), cervical branch of facial (VII) nerves |
| **Muscular triangles** | **Superiorly:** Hyoid bone<br>**Medially:** Midline of neck<br>**Superolaterally:** Superior belly of omohyoid muscle<br>**Inferolaterally:** Anterior border of sternocleidomastoid muscle | Sternohyoid, omohyoid, sternohyoid, thyrohyoid muscles; thyroid and parathyroid glands; pharynx |
| **Submandibular triangles** | **Superiorly:** Body of mandible<br>**Anteriorly:** Anterior belly of digastric muscle<br>**Posteriorly:** Posterior belly of digastric muscle | Submandibular salivary gland; submandibular lymph nodes; mylohyoid and hypoglossal [XII] nerves; facial artery and vein |
| **Posterior cervical triangles:** Occipital triangles and subclavian triangles | **Superiorly:** Occipital bone just posterior to mastoid process at junction of trapezius and sternocleidomastoid muscle attachments<br>**Anteriorly:** Posterior border of sternocleidomastoid muscle<br>**Posteriorly:** Anterior border of trapezius muscle<br>**Inferiorly:** Middle one-third of clavicle | Sternocleidomastoid, trapezius, omohyoid, vertebral muscles; external jugular, subclavian veins accompanied by respective arteries; accessory nerve (XI) |

the neck. The vocal cords or ligaments of the **larynx** (**lar**-ingks) or *voice box* are attached to the posterior surface of the thyroid cartilage.

The **hyoid bone** (**hahy**-oid) is also located in the anterior midline superior to the thyroid cartilage. The bone is suspended in the neck without any bony articulations (see Fig. 2.24 and Fig. 4.24). Instead, muscles are attached to the hyoid bone that control the tongue and pharynx so as to assist the muscles of mastication as well as those muscles involved in swallowing. This bone is also palpated along with the larynx during an extraoral examination.

The anterior cervical triangle on each side can be further subdivided into four smaller triangular regions by area muscles that are not as prominent as those of the SCM muscle (Fig. 2.25 and see Figs. 4.25 and 4.27). Thus the superior part of each anterior cervical triangle is demarcated by two parts of the digastric muscle (both anterior and posterior bellies), with the superior mandible forming a **submandibular triangle** (sub-man-**dib**-yuh-ler) on each side.

The inferior part of each anterior cervical triangle is further subdivided by the omohyoid muscle (superior belly) into a **carotid triangle** (kuh-**rot**-id) superior to it and a **muscular triangle** inferior to it. The muscular triangle is situated more inferiorly than the other subdivisions. It is a slightly off-kilter triangle, in reality having four boundaries.

A single midline **submental triangle** (sub-**men**-tl) is also formed by the two parts of both digastric muscles (both right and left anterior bellies) as well as the hyoid bone.

Each posterior cervical triangle can also be further subdivided into smaller triangular regions on each side by area muscles (Fig. 2.26). The omohyoid muscle (inferior belly) divides the posterior cervical triangle into the larger **occipital triangle** (ok-**sip**-ih-tl) superior to it and the smaller **subclavian triangle** (sub-**klay**-vee-uhn) inferior to it on each side.

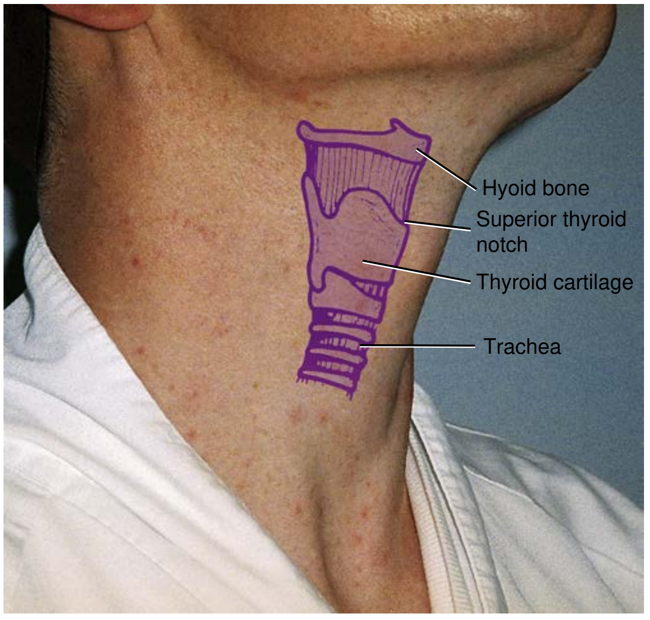



**Fig. 2.24** Oblique lateral view of the neck with the skeletal landmarks of the anterior cervical triangle superimposed. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

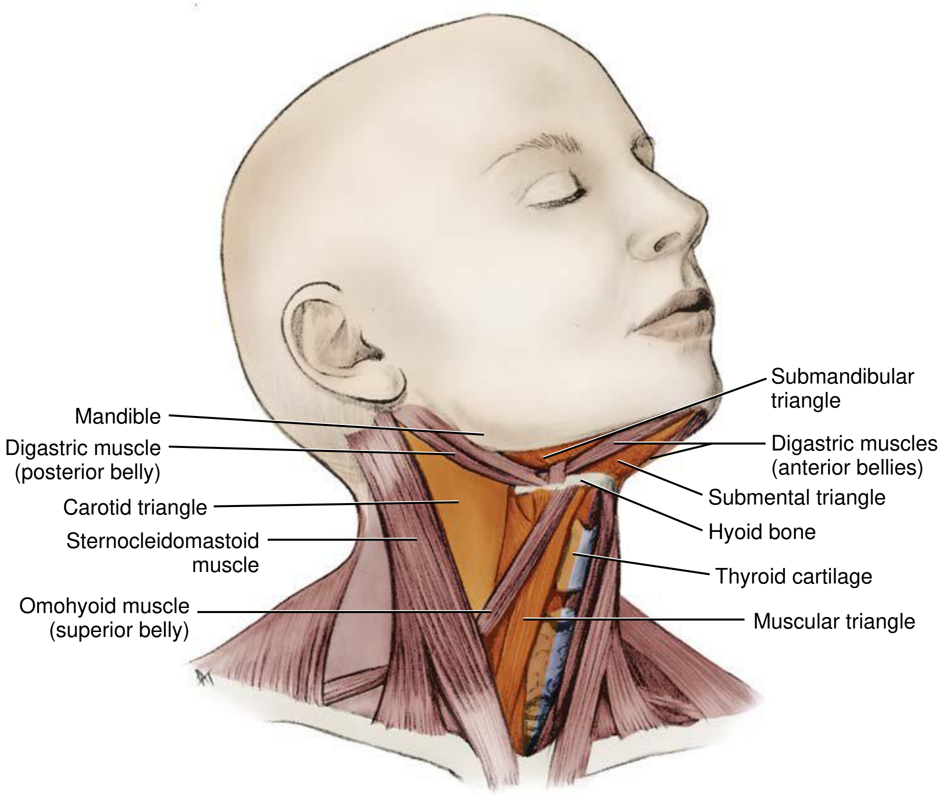



**Fig. 2.25** Division of the anterior cervical triangle by area muscles into the submandibular, submental, carotid, and muscular triangles.

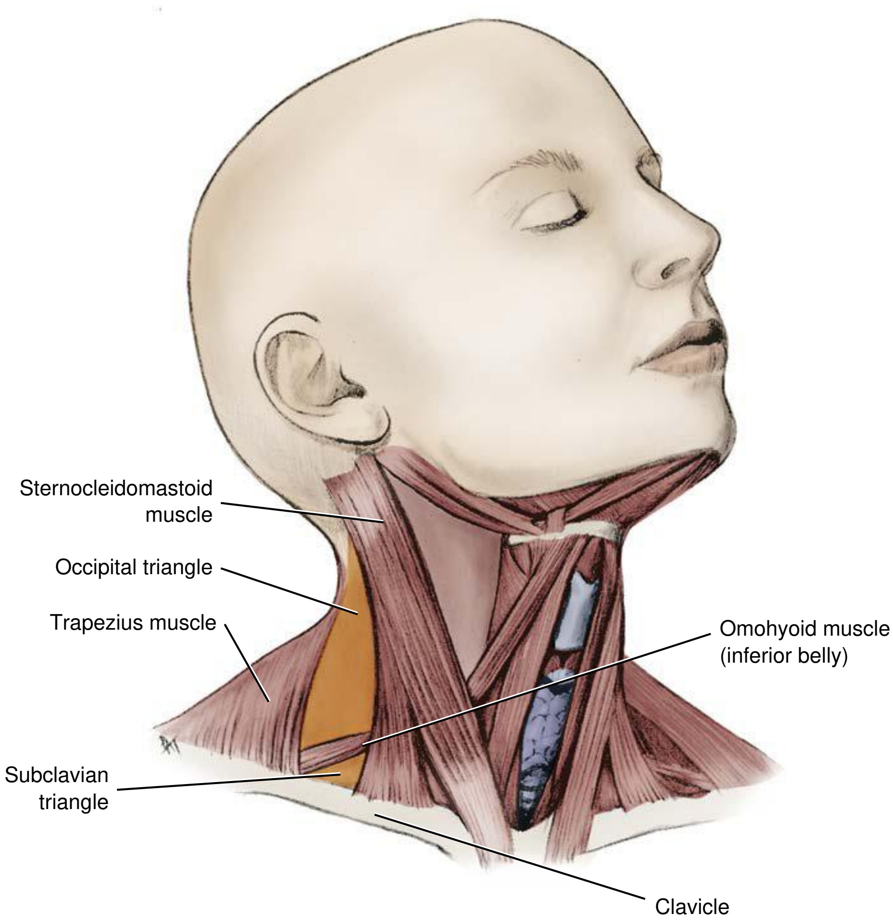



**Fig. 2.26** Division of the posterior cervical triangle by area muscles into the occipital and subclavian triangles.

# 3

# Skeletal System

## LEARNING OBJECTIVES

1. Define and pronounce both the key and anatomic terms in this chapter.
2. Locate and identify the bones of the head and neck and their landmarks on a diagram, skull, and patient.
3. Describe in detail the landmarks of the maxilla and mandible.
4. Discuss the skeletal system pathology associated with the head and neck.
5. Integrate an understanding of the skeletal system into the overall study of the head and neck anatomy and clinical dental practice.

*Additional resources and practice exercises are provided on the companion Evolve website for this book: http://evolve.elsevier.com/Fehrenbach/headneck/.*

## SKELETAL SYSTEM OVERVIEW

The **skeletal system** consists of the bones and their associated cartilage and joints. The **bones** of the skeletal system are mineralized structures protecting the internal soft tissue. Bones also serve as the biomechanic basis for movement along with muscles, tendons, and ligaments.

The bony prominences and depressions on a bony surface serve as muscle attachments (see **Chapter 4**). Another feature of a bone are the openings where various nerves and blood vessels travel through (see **Chapters 6 and 8**). Bones of the skeleton also join together at articulations.

### Bony Prominences

A general term for any prominence on a bony surface is a **process**. One specific type of prominence located on a bony surface is a **condyle** (**kon**-dahyl), an oval prominence usually involved in joints. A rounded structure projecting from a bony surface by a neck is a **head**. Another large, often rough prominence on a bony surface is a **tuberosity** (too-buh-**ros**-i-tee). Tuberosities are usually attachment sites for muscles or tendons. An **arch** is a prominence shaped like a bridge with a bowlike outline. A **cornu** (**kawr**-noo) is a small hornlike prominence on a bony surface.

Other prominences of bone include tubercles, crests, lines, and spines. These primarily serve as muscle and ligament attachments. A **tubercle** (**too**-ber-kuhl) or **eminence** is a small rounded elevation on a bony surface. A **crest** is a prominent, often roughened border or ridge on a bony surface. A **line** is a small straight ridge. An abrupt small prominence of a bone that may be a blunt or sharply pointed projection is a **spine**.

### Bony Depressions

One type of depression on a bony surface is a **notch**, which is an indentation at the edge of a bone. Another depression(s) on a bony surface is a **sulcus** (plural, **sulci**) (**suhl**-kuhs, **suhl**-sahy), which is a shallow depression or groove that usually marks the course of blood vessels or nerves.

A generally deeper depression(s) or concavity on a bony surface is a **fossa** (plural, **fossae**) (**fos**-uh, **fos**-ee). Fossae can be parts of joints or attachment sites for muscles, or they can have other functions. A small pit or depression in a bone or other structure is a **fovea** (**foh**-vee-uh).

However, an area on a bony surface that is neither a prominence nor depression is a **plate**, which is a flat structure of a bone.

### Bony Openings

Bones can have openings within them such as a foramen or canal. A **foramen** (plural, **foramina**) (fuh-**rey**-muhn, fuh-**ram**-uh-nuh) is a short windowlike opening(s) in a bone. Another opening in a bone is a **fissure** (**fish**-er), which is narrow and cleftlike. A smaller opening(s), especially as an entrance into a hollow organ or canal, is an **ostium** (plural, **ostia**) (**os**-tee-uhm, **os**-tee-uh). A narrow opening is an **aperture** (**ap**-er-cher). A **canal** is a longer narrow tubelike opening in a bone. A **meatus** is a type of canal.

### Skeletal Articulations

An **articulation** (ahr-tik-yuh-**lay**-shuhn) is an area of the skeleton where the bones are joined to each other. An articulation can be associated with either a movable or immovable joint. A **joint** is a site of a junction or union between two or more bones.

A **suture** (**soo**-chuhr) is the union of bones joined by fibrous tissue that appears on the dry skull as a jagged line. Sutures are considered to be generally immovable but may provide biomechanic protection from the force of a blow by moving slightly to absorb the force. They are most flexible in infants, with much of the early growth of the skull occurring at the sutural edges of the cranial bones.

## HEAD AND NECK BONES

The bones of the head and neck serve as a base for palpation of the soft tissue during both an intraoral and extraoral examination of a patient (see **Appendix B**). A dental professional must not only locate each of the head and neck bones but also recognize any abnormalities in the bony surface structure (discussed later).

In order to recognize any bony abnormalities, the dental professional must understand the anatomy of the bones of the head and neck. This includes locating the surface bony prominences, depressions, and articulations as well as the openings in these bones deep to the skin and the nerves and blood vessels that travel through those openings.

The bones of the head and neck are the most complicated bony structures of the body. For effective study of the bones of the head and neck, it is helpful to use both photographs and diagrams of these bones as well as the skull itself. Unless noted, the skull in these figures is in anatomic position, so that the inferior margins of the orbits and the superior margins of the external acoustic meatuses are within parallel transverse planes (see Chapter 1). This is similar in respect to the position of the patient's head and neck when sitting upright in a dental chair. Thus the palpation of the skull of peers, and then later of patients, during both extraoral and intraoral examination adds to the overall study of the skeletal system.

Bones and their associated surface tissue also serve as landmarks when describing the location of a pathologic lesion, taking dental radiographs (see Chapter 2), and administering a local anesthetic injection (see Chapter 9), as well as understanding the spread of dental (or odontogenic) infections (see Chapter 12).

## CLINICAL CONSIDERATIONS WITH SKELETAL SYSTEM PATHOLOGY

A **bone fracture** or *broken bone* is common; the average person has two during a lifetime. They occur when the physical force exerted on the bone is stronger than the bone itself. The risk of fracture depends, in part, on one's age. Broken bones are very common in childhood, although children's fractures are generally less complicated than fractures in adults. With age, the bones become more brittle and are more likely to suffer fractures from falls that would not occur at a younger age.

There are many types of fractures, but the main categories are displaced, nondisplaced, open, and closed. Displaced and nondisplaced fractures refer to the alignment of the fractured bone. In a *displaced fracture*, the bone snaps into two or more parts and moves so that the two ends are not lined up straight. If the bone is in many pieces, it is then considered a *comminuted fracture*. In a *nondisplaced fracture*, the bone cracks either partially or as a whole but does move and maintains its proper alignment.

A *closed fracture* is when the bone breaks but there is no puncture or open wound in the skin. An *open fracture* is one in which the bone breaks through the skin; however, it may then recede back into the wound and not be visible through the skin. This is an important difference from a closed fracture because with an open fracture there is a risk of a deep bone infection (or osteomyelitis) (see **Chapter 12**).

Bone fracture of the skull can occur with severe blows to the face. Fractures of the facial skeleton tend to occur at its points of buttress with the cranium. These buttress points include the medial aspect of the orbit, the articulation of the zygomatic bone with both the frontal bone and temporal bones, the articulation of the pterygoid plates of the sphenoid bone, the palatine bones, and each maxilla. When the skull is fractured, reconstructive surgeons also rely upon these buttresses as anchor points for plates, screws, and other devices.

The fracture of a bone may be detected by gentle palpation of the patient during an extraoral examination after radiographic analysis. If the fracture is bilateral, the entire facial skeleton can be pushed posteriorly, resulting in upper respiratory tract obstruction. These fractures may also heal poorly, resulting in abnormal bony contours.

It is important to note that the alveolar process undergoes intended bony fracture to allow for extraction of the mandibular third molar in more complex cases (see later discussion in this chapter).

## Skull Bones

The bones of the **skull** or braincase can be divided into the **cranium** (**krey**-nee-uhm), which contains the brain with its outer shell of the **cranial bones** (**krey**-nee-uhl), and into the face with its inner support by the **facial bones**. The bones of the skull, whether cranial or facial, protect the brain, form the facial features, participate in the temporomandibular joint, and serve as a base for the dentition. The bones of the skull can be single or paired.

Anatomists may also use the term *neurocranium* for the cranial bones because they enclose the brain, and the term *viscerocranium* for the facial bones. The skull has 22 bones, not including the six auditory ossicles of the middle ear (Table 3.1). Each middle ear contains one *malleus*, *incus*, and *stapes* (in order from outer to inner). Their function is to transmit and amplify vibrations to the inner ear by way of the tympanic membrane or *eardrum*.

Growth continues to take place in all bones of the skull (except the middle ear bones) during early childhood. Growth of the upper face also occurs at the sutures between the maxillae and other bones, as well as at bony surfaces. Growth in the lower face takes place at the bony surfaces of the mandible and at the head of its condyle. Inadequate or disproportionate bone growth of the upper face or mandible may leave inadequate room for the developing dentition and cause occlusal complications. These difficulties with growth involving the dentition can be addressed by orthodontic therapy and osseous surgery, if needed, after ruling out any underlying endocrine disorder.

All skull bones are immovable, except the mandible at its temporomandibular joint. Instead, the articulation between certain skull bones is by sutures (Table 3.2). In addition, the skull also has a movable articulation with the bony vertebral column in the cervical region.

**TABLE 3.1 Cranial Bones and Facial Bones**

| Cranial Bones | Number | Facial Bones* | Number |
|---|---|---|---|
| Ethmoid bone | Single | Inferior nasal conchae | Paired |
| Frontal bone | Single | Lacrimal bones | Paired |
| Occipital bone | Single | Mandible | Single |
| Parietal bones | Paired | Maxillae | Paired |
| Sphenoid bone | Single | Vomer | Single |
| Temporal bones | Paired | Zygomatic bones | Paired |

*Note that palatine bones are paired bones of the skull that are not included since they are not strictly considered facial bones.

**TABLE 3.2 Skull Sutures and Articulations**

| Suture(s) | Number | Bony Articulations |
|---|---|---|
| Coronal sutures | Paired | Frontal bone and parietal bones |
| Frontonasal suture | Single | Frontal bone and nasal bones |
| Intermaxillary suture | Single | Maxillae |
| Lambdoidal suture | Single | Occipital bone and parietal bones |
| Median palatine suture | Single | Anterior part: Maxillae<br>Posterior part: Palatine bones |
| Sagittal suture | Single | Parietal bones |
| Squamosal sutures | Paired | Temporal bones and parietal bones |
| Temporozygomatic sutures | Paired | Temporal bones and zygomatic bones |
| Transverse palatine suture | Single | Maxillae and palatine bones |
| Zygomaticomaxillary sutures | Paired | Zygomatic bones and maxillae |

**TABLE 3.3 Skull Bony Openings and Contents***

| Bony Opening(s) | Location | Contents for Openings |
|---|---|---|
| Carotid canals | Temporal bones | Internal carotid arteries and plexuses of nerves |
| Cribriform plate with foramina | Ethmoid bone | First cranial nerves |
| External acoustic meatuses | Temporal bones | Canals with tympanic membranes that when intact block entry to tympanic cavities |
| Foramina lacera | Between sphenoid bone, occipital bone, and temporal bones | Cartilage when intact |
| Foramen magnum | Occipital bone | Spinal cord, vertebral arteries, and eleventh cranial nerves |
| Foramina ovales | Sphenoid bone | Mandibular nerves (or third division) of fifth cranial or trigeminal nerve and lesser petrosal nerves and blood vessels |
| Foramina rotunda | Sphenoid bone | Maxillary nerves (or second division) of fifth cranial or trigeminal nerve and blood vessels |
| Foramina spinosa | Sphenoid bone | Middle meningeal arteries |
| Greater palatine foramina | Palatine bones | Greater palatine nerves and blood vessels |
| Hypoglossal canals | Occipital bone | Twelfth cranial nerves and blood vessels |
| Incisive foramen | Maxillae | Right and left nasopalatine nerves and branches of the sphenopalatine arteries |
| Inferior orbital fissures | Between sphenoid bone and maxillae | Infraorbital and zygomatic nerves, infraorbital arteries, and inferior ophthalmic veins |
| Infraorbital foramina and canals | Maxillae | Infraorbital nerves and blood vessels |
| Internal acoustic meatuses | Temporal bones | Seventh and eighth cranial nerves |
| Jugular foramina | Between occipital bone and temporal bones | Internal jugular veins and ninth, tenth, and eleventh cranial nerves |
| Lesser palatine foramina | Palatine bones | Lesser palatine nerves and blood vessels |
| Mandibular foramina | Mandible | Inferior alveolar nerves and blood vessels |
| Mental foramina | Mandible | Mental nerves and blood vessels |
| Optic canals and foramina | Sphenoid bone | Optic nerves and ophthalmic arteries |
| Petrotympanic fissures | Temporal bones | Chorda tympani nerves |
| Posterior superior alveolar foramina | Maxillae | Posterior superior alveolar nerves and blood vessels |
| Pterygoid canals | Sphenoid bone | Nerve of pterygoid canal and blood vessels |
| Sphenopalatine foramina | Between palatine bones and sphenoid bone | Sphenopalatine arteries, nasopalatine nerves, and posterior superior nasal nerves |
| Stylomastoid foramina | Temporal bones | Seventh cranial nerves |
| Superior orbital fissures | Sphenoid bone | Third, fourth, and sixth cranial nerves and ophthalmic nerves (or first division) of fifth cranial or trigeminal nerve and superior and inferior divisions of ophthalmic veins |
| Supraorbital notches (foramina) | Frontal bone | Supraorbital nerves and arteries |
| Zygomaticofacial foramina | Zygomatic bones | Zygomaticofacial nerves and blood vessels |
| Zygomaticotemporal foramina | Zygomatic bones | Zygomaticotemporal nerves and blood vessels |

*Openings of the nasal cavity are not included.

The skull bones have openings for the main nerves and blood vessels of the head and neck (Table 3.3). Skull bones also have associated processes that are involved in prominent structures of the face and head (Table 3.4). For more effective study, this chapter can also be later reviewed after reading the chapters on the vascular and nervous systems (see **Chapters 6 and 8**), the muscles of the head and neck (see **Chapter 4**), and the temporomandibular joint (see **Chapter 5**).

This chapter studies the skull by first looking at it externally from different viewpoints: superior, anterior, lateral, and inferior views, and then by examining its internal surface from both superior and inferior viewpoints. This format of first visualizing the entire skull helps to obtain more general information about structures formed by several skull bones. Next, the skull is studied by looking at its individual bones and their various features, using the major categories of the cranial bones, facial bones, and cervical bones. Finally, the more general features of the skull are again studied including the skull fossae and paranasal sinuses.

## Superior View of External Skull

To view the external skull, the cap can be removed from the skull and studied. The cranial bones and associated sutures are easily noted from this view.

***Cranial Bones from Superior View.*** When the external skull is viewed from the superior aspect, four cranial bones are noted (Fig. 3.1). At the anterior part of the skull is the single **frontal bone**. At each lateral part of the skull is the paired **parietal bone**. At the posterior part of the skull is the single **occipital bone**. This main division of the cranial bones of the skull is discussed in detail later.

**TABLE 3.4 Skull Processes**

| Process(es) of Skull | Skull Bone | Associated Structures |
|---|---|---|
| Alveolar process | Mandible | Contains roots of mandibular teeth within alveoli |
| Alveolar process | Maxillae | Contains roots of maxillary teeth within alveoli |
| Condyloid processes | Mandible | Consist of mandibular condyles and necks |
| Coronoid processes | Mandible | Parts of mandibular rami |
| Frontal processes | Maxillae | Articulate with frontal bone |
| Frontal processes | Zygomatic bones | Form anterior lateral orbital walls |
| Lesser wings | Sphenoid bone | Anterolateral processes to body of sphenoid bone and form bases of orbital apices |
| Greater wings | Sphenoid bone | Posterolateral processes to body of sphenoid bone |
| Hamuli | Sphenoid bone | Inferior terminations of medial pterygoid plates |
| Mastoid processes | Temporal bones | Composed of mastoid air cells |
| Maxillary processes | Zygomatic bones | Form lateral part of infraorbital rims and parts of anterior lateral orbital walls |
| Orbital processes | Palatine bone | Small inferior parts of orbital apices |
| Palatine processes | Maxillae | Form anterior hard palate |
| Postglenoid processes | Temporal bones | Posterior structures to temporomandibular joints |
| Pterygoid processes | Sphenoid bone | Consists of medial and lateral pterygoid plates |
| Pyramidal processes | Palatine bones | Project posteriorly and lateralward from junction of vertical and horizontal plates |
| Styloid processes | Temporal bone | Serve as attachments for muscles and ligaments |
| Temporal processes | Zygomatic bones | Form parts of zygomatic arches |
| Zygomatic processes | Frontal bone | Lateral to orbits |
| Zygomatic processes | Maxillae | Form medial parts of infraorbital rims |
| Zygomatic processes | Temporal bones | Form parts of zygomatic arches |

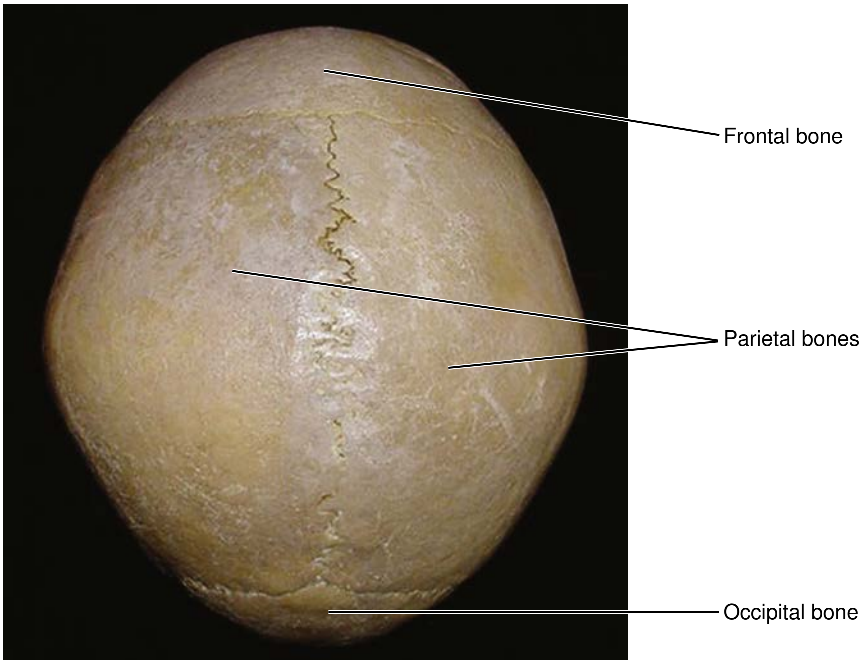



**Fig. 3.1** Superior view of the external skull with its cranial bones noted from this view. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

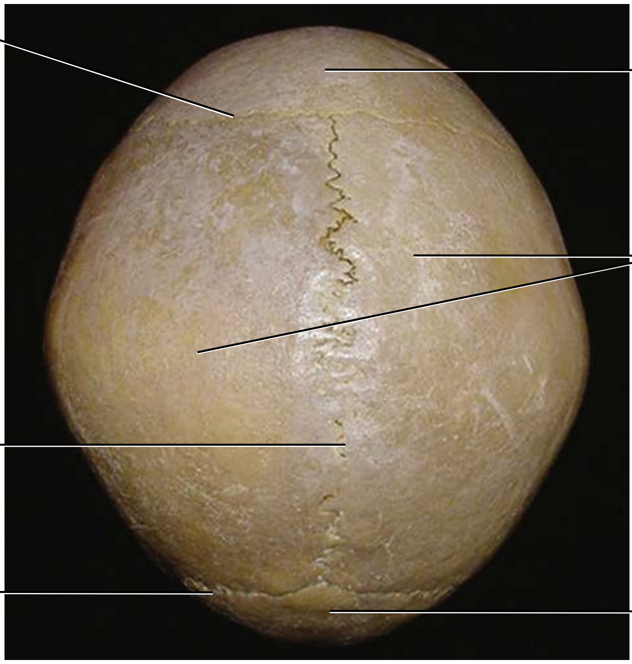



**Fig. 3.2** Superior view of the external skull with its cranial bones and associated sutures noted from this view.

***Skull Sutures from Superior View.*** Sutures among these four cranial bones as noted from the superior aspect include the coronal, sagittal, and lambdoidal sutures (Fig. 3.2 and see Table 3.2). The suture extending across the skull, between the frontal bone and each parietal bone, is the paired **coronal suture**. This is also the location of the diamond-shaped **anterior fontanelle** (fon-tn-**el**) or what is referred to as a "soft spot" in a newborn where the frontal bone and both parietal bones join. This site generally remains open until closure at about 2 years of age.

A single suture, the **sagittal suture,** extends from the anterior to the posterior of the skull at the midline between the parietal bones; the sagittal suture is in line with the sagittal plane of the skull. The coronal sutures and sagittal suture are generally perpendicular with each other. Another single suture located between the occipital bone and each parietal bone is the **lambdoidal suture** (lam-**doid**-l), which is typically more serrated looking than the others and resembles an upside side down V-shape in anatomic position.

## Anterior View of External Skull

When the external skull is viewed from the anterior aspect, certain bones of the skull (or parts of these bones) are noted (Fig. 3.3). These bones include the single frontal bone, ethmoid bone, vomer, sphenoid bone, mandible, and also the paired lacrimal bones, nasal bones, inferior nasal conchae, and zygomatic bones as well as the maxillae. The facial bones as a group that form the facial features, the orbit, and the nasal cavity are also noted from this view.

***Facial Bones from Anterior View.*** The facial bones noted on the anterior aspect of the skull include the **lacrimal bone**, **nasal bone, vomer** (**voh**-muhr), **inferior nasal concha, zygomatic bone**, maxilla, and mandible (Fig. 3.4). However, the paired **palatine bone** is not noted from this view. In fact, the palatine bone is not considered to be a facial bone by anatomists, but for ease of learning it is included under the general heading of facial bones. This main division of the facial bones of the skull is discussed in detail later.

***Orbit and Associated Structures from Anterior View.*** The orbit, which contains and protects the eyeball, is a prominent feature of the anterior part of the skull (Fig. 3.5 and see Fig. 2.6). Certain skull bones form the four walls and apex of each of the orbits (Table 3.5). The larger **orbital walls** are composed of the orbital surfaces of the frontal bone (the roof or superior wall), the ethmoid bone (the greatest part of the medial wall), the lacrimal bone (at the anterior medial corner of the orbit), the maxilla (the floor or inferior wall), and the zygomatic bone (the anterior part of the lateral wall), and the greater wing of the sphenoid bone is also included (the posterior part of the lateral wall).

The **orbital apex** (plural, **apices**) is the deepest part of the orbit and is composed of both the lesser wing of the sphenoid bone (the base) and the palatine bone (a small inferior part) (Fig. 3.6 and see Table 3.5). The round opening in the orbital apex is the **optic canal** (**op**-tik), which lies between the two roots of the lesser wing of the sphenoid bone (see Table 3.3). The second cranial or optic nerve passes through the optic canal to reach the eyeball. The ophthalmic artery also extends through the optic canal to reach the eye.

Two orbital fissures are noted on the anterior aspect, the superior and inferior orbital fissures (Fig. 3.7 and see Table 3.3). Lateral to the optic canal is the curved and slitlike **superior orbital fissure**, located between the greater wing and lesser wing of the sphenoid bone. Similar to the optic canal, the superior orbital fissure connects the orbit with the cranial cavity. The third cranial or oculomotor nerve, the fourth cranial or trochlear nerve, the sixth cranial or abducens nerve, and the ophthalmic nerve (or first division from the fifth cranial or trigeminal nerve) and vein (both superior and inferior divisions) travel through this fissure (see Figs. 8.8 and 8.9).

The **inferior orbital fissure** can also be noted between the greater wing of the sphenoid bone and the maxilla. The inferior orbital fissure connects the orbit with both the infratemporal fossa and pterygopalatine fossa (discussed later). Both the infraorbital and zygomatic nerves, which are branches of the maxillary nerve, and the infraorbital artery

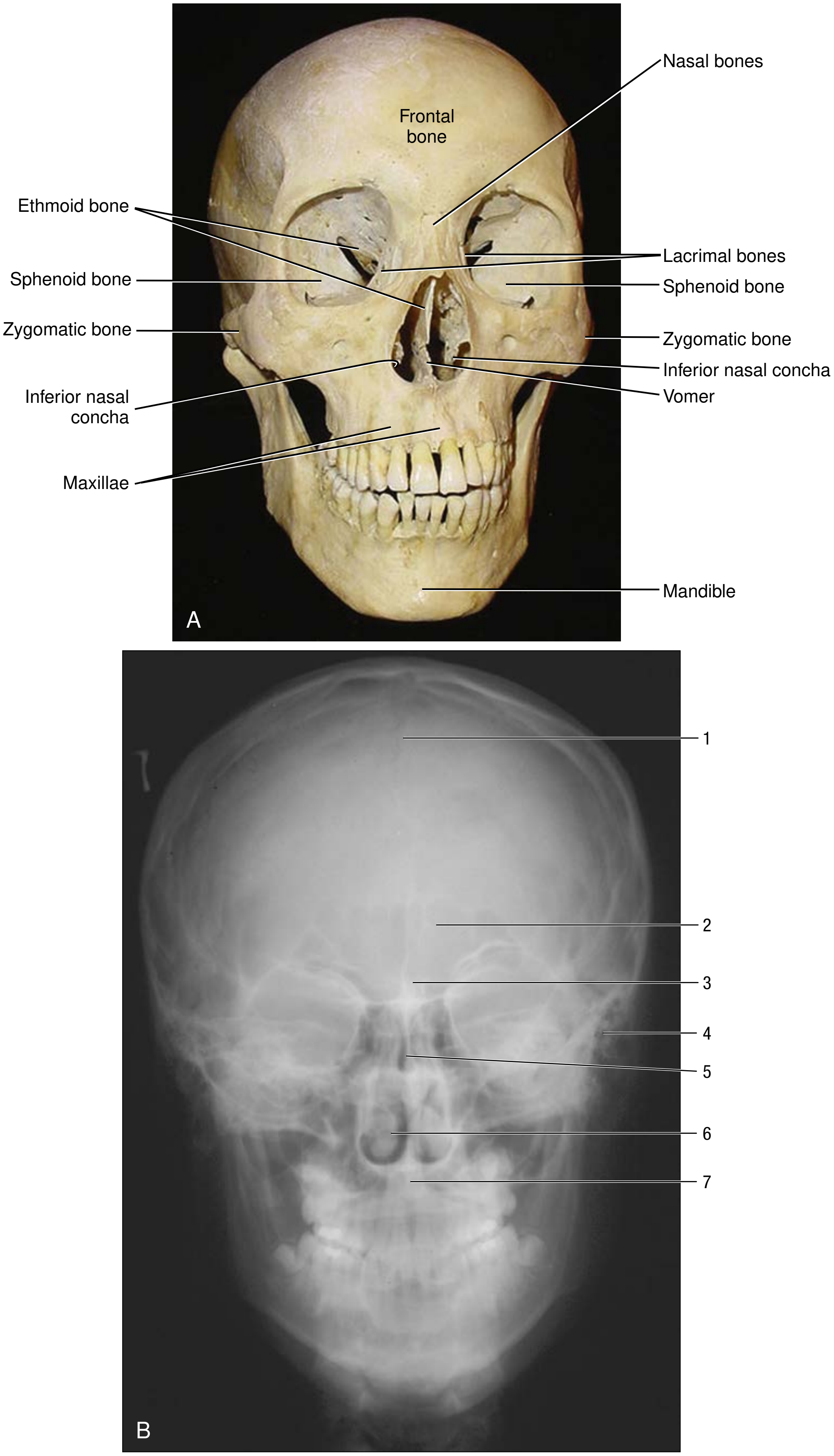



**Fig. 3.3** Anterior view of the external skull with its bones noted from this view (**A**). Anteroposterior radiograph of the skull and upper cervical spine of a young adult. *1,* Sagittal suture. *2,* Frontal sinus. *3,* Crista galli. *4,* Mastoid air cells. *5,* Nasal septum. *6,* Inferior concha. *7,* Dens of axis (**B**). (**A**, Courtesy of Margaret J. Fehrenbach, RDH, MS. **B,** From Standring S. *Gray's Anatomy: The Anatomical Basis of Clinical Practice*, 40th ed. London: Churchill Livingstone; 2008.)

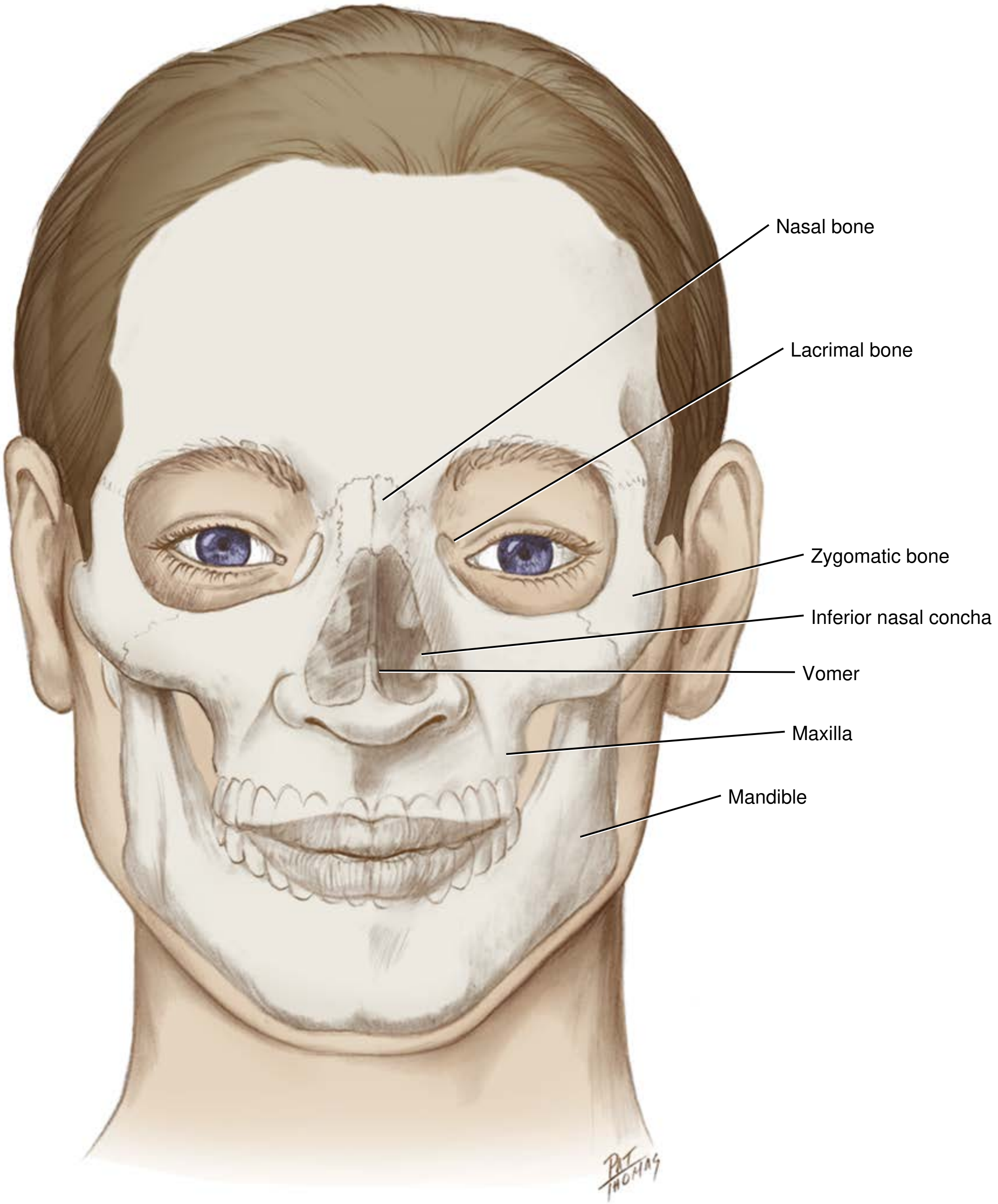



**Fig. 3.4** Anterior view of the facial bones superimposed over the corresponding facial features formed from them.

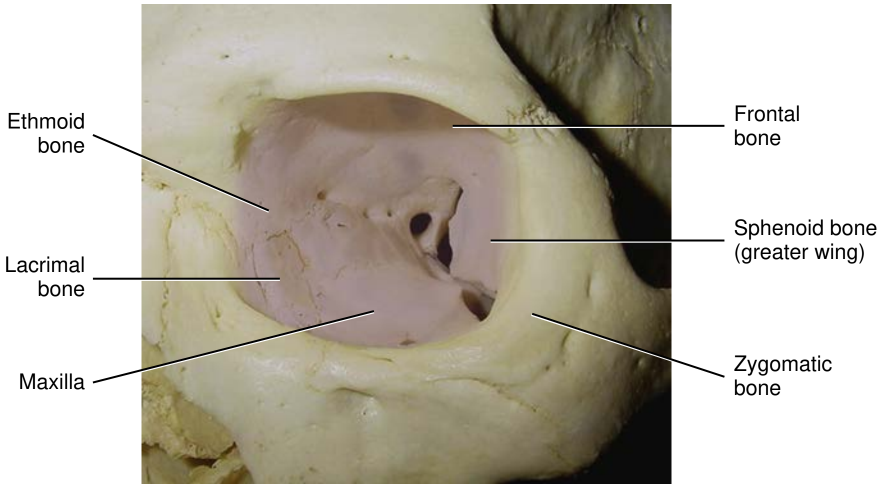



**Fig. 3.5** Anterior view of the left orbit of the skull with the orbital walls highlighted and the bones that form them noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

enter the orbit through this fissure. The inferior ophthalmic vein also travels through this fissure to join the pterygoid plexus of veins (see Fig. 6.12).

The mostly sharp edge of the orbital opening or orbital rim (or margin) is the peripheral border of the base of the pyramid-shaped orbit. The orbital rim is rectangular-shaped with rounded corners; its margin is discontinuous at the lacrimal fossa. The superior half of the orbital rim is the **supraorbital rim** (or margin), and the inferior half is the **infraorbital rim** (or margin) (see Fig. 3.7). The frontal bone and zygomatic bone as well as the maxilla contribute to the orbital rim, which is generally strong to protect the orbital contents (also discussed later in the chapter with each of the bones).

A "notch," or more correctly described as a depression, in the midpoint of the infraorbital rim (or margin) can usually be palpated on a patient and is formed by the paired vertical **zygomaticomaxillary suture** (zahy-guh-**mat**-i-ko-**mak**-suh-ler-ee). This suture is located between the two bones that form the infraorbital rim (or margin): the zygomatic bone with its maxillary process (lateral part) and the maxilla with its zygomatic process (medial part).

***Nasal Cavity and Associated Structures from Anterior View.*** The **nasal cavity** or *nasal fossa* can also be viewed on the skull from the anterior (Fig. 3.8 and see Figs. 2.7, 3.39, and 3.56). The nasal cavity is the superior part of the respiratory tract and is located between the orbits. It has lateral walls and a floor with anterior and posterior openings, and it is mainly composed of bone and cartilage.

The bridge of the nose is formed from the paired nasal bones (see Figs. 2.7 and 3.40). The nasion, a midpoint cephalometric landmark, is located at the junction of the frontal bone and nasal bones. The prominent anterior opening of the nasal cavity on the skull, the **piriform aperture** (**pir**-i-fohrm), is large and almost pear-shaped. The large deeper posterior openings are the posterior nasal apertures or **choanae** (koh-**uh**-nee) (discussed later). The piriform aperture anchors the cartilaginous midline part of the nose, the nasal septal cartilage, in an intact state. Also when intact, the anterior openings to the nasal cavities are the nares, bordered laterally by the cartilaginous alae.

The floor of the nasal cavity is formed from the two separate bones of the hard palate: the palatine processes of the maxillae anteriorly and the horizontal plates of the palatine bones posteriorly (see Fig. 3.16). The lateral walls of the nasal cavity are mainly formed by the maxillae. In addition, each lateral wall of the nasal cavity has three projecting structures that extend inward, which are the three nasal conchae or **turbinates** (**tur**-buh-neyts).

These paired nasal conchae are designated as the superior, middle, and inferior nasal conchae and each will be discussed further in this chapter. Each nasal concha projects into the nasal cavity. By projecting into the nasal cavity on each side, the medial surface of these bony structures assists in increasing the surface area of the cavity by directing and deflecting airflow of inspired air. Protected by each nasal concha is an air channel, the **nasal meatus** (see Fig. 3.38). Each nasal meatus has openings through which the paranasal

**TABLE 3.5 Orbital Bones**

| Part of Each Orbit | Skull Bones |
|---|---|
| Roof or superior wall | Frontal bone |
| Medial wall | Ethmoid bone and lacrimal bone |
| Lateral wall | Zygomatic bone and sphenoid bone |
| Floor | Maxilla |
| Apex or base | Sphenoid bone and palatine bone |

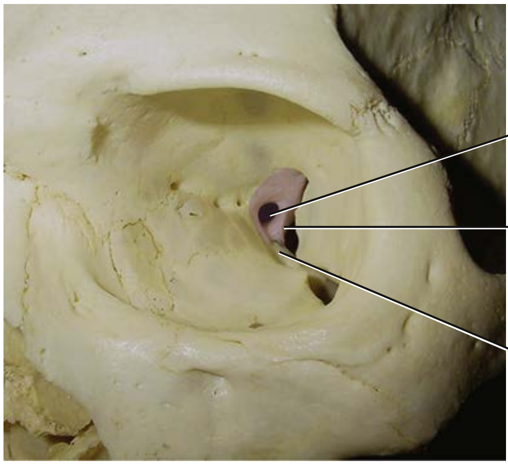



**Fig. 3.6** Anterior view of the left orbit with the orbital apex highlighted and the bones that form it noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

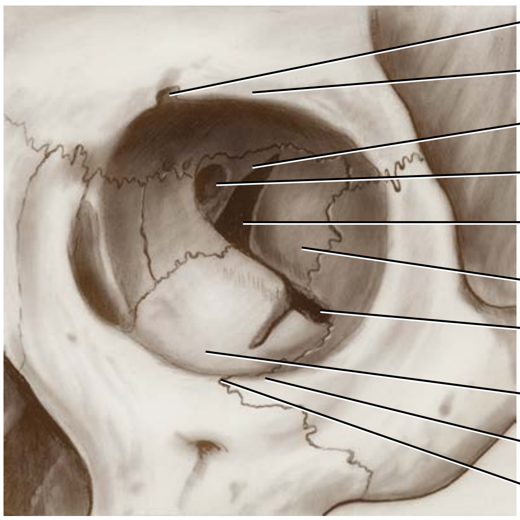



**Fig. 3.7** Anterior view of the left orbit with the orbital fissures and the bones associated with them noted along with parts of the orbital rim.

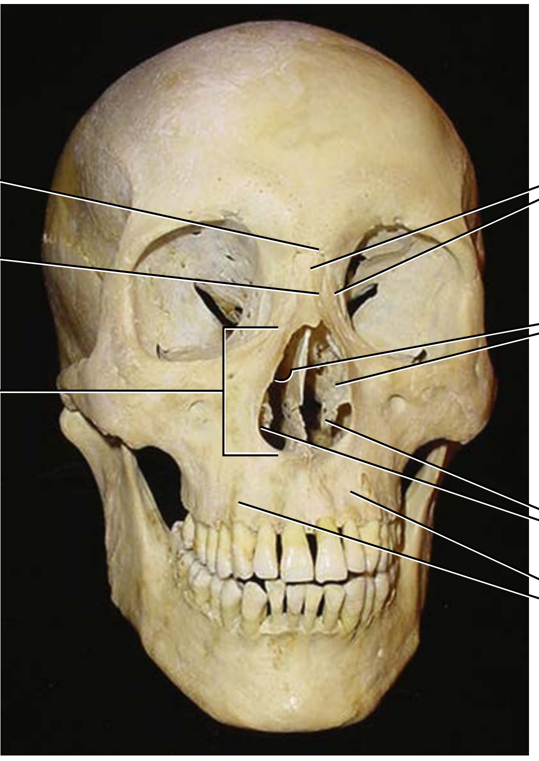



**Fig. 3.8** Anterior view of the external skull and nasal cavity with its features and associated bones noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

sinuses or nasolacrimal duct communicate with the nasal cavity. The superior nasal concha and middle nasal concha are bony projections from the ethmoid bone; the inferior nasal concha is a separate facial bone.

The nasal septum is a vertical partition that divides the nasal cavity into two parts (Fig. 3.9 and see Figs. 2.7 and 3.39). Although it is frequently deviated slightly to the left or right, in general the septum is aligned perpendicularly. Anteriorly, the nasal septum is formed by both the perpendicular plate of the ethmoid bone superiorly and the nasal septal cartilage inferiorly; the posterior part of the nasal septum is formed by the vomer.

## CLINICAL CONSIDERATIONS FOR NASAL SEPTUM

A **deviated nasal septum** occurs when the thin wall that forms the nasal septum inside the nose is deflected more than slightly to one side. Since the nasal septum separates the right and left nasal cavities, the ideal situation is situated in the middle of the nose, equally separating the two sides. In about 80% of people, however, the nasal septum is noticeably displaced, making one nasal passage smaller.

When a deviated nasal septum is more severe, it can block one side of the nose and reduce airflow. Resulting signs and symptoms can include difficulty breathing, nasal congestion, nosebleeds, and frequent sinus infections. A deviated nasal septum may be present at birth or, more commonly, may be the result of an injury such as a blow to the nose or disproportionate growth. Treatment of nasal obstruction may include medications to manage symptoms. To completely correct a deviated nasal septum, surgery is necessary.

## Lateral View of External Skull

When the external skull is viewed from the lateral aspect, the division between the cranial bones and facial bones can be noted. This division between the bones of the skull can be reinforced by making an imaginary diagonal line that passes inferior and posterior from the supraorbital ridge of the frontal bone to the tip of the mastoid process of the temporal bone (Fig. 3.10). These two main divisions of the bones of the skull are discussed in more detail later.

***Cranial Bones from Lateral View.*** Parts of the cranium are noted on the lateral aspect and include the following cranial bones: the occipital, frontal, parietal, and temporal bones, as well as the **sphenoid bone** (**sfee**-noid) and **ethmoid bone** (**eth**-moid) (Fig. 3.11). This main division of the bones of the skull is discussed in detail later.

***Skull Sutures from Lateral View.*** Also noted on the lateral surface of the skull are the associated sutures of the cranial bones (see Fig. 3.11 and Table 3.2). These sutures include the coronal suture, an articulation between the frontal bone and each parietal bone, and the lambdoidal suture, an articulation between the occipital bone and each parietal bone. Also present is the arched paired **squamosal suture** (**skwuh**-moh-suhl), which is located between the temporal bone and parietal bone on each side.

***Skull Lines from Lateral View.*** On the lateral surface of the skull are two separate parallel ridges, the temporal lines, crossing both the frontal bone and each parietal bone (Fig. 3.12). The superior ridge is the **superior temporal line**. The inferior ridge is the **inferior temporal line**, which is the superior border of the temporal fossa where the fan-shaped temporalis muscle originates (see Fig. 4.22).

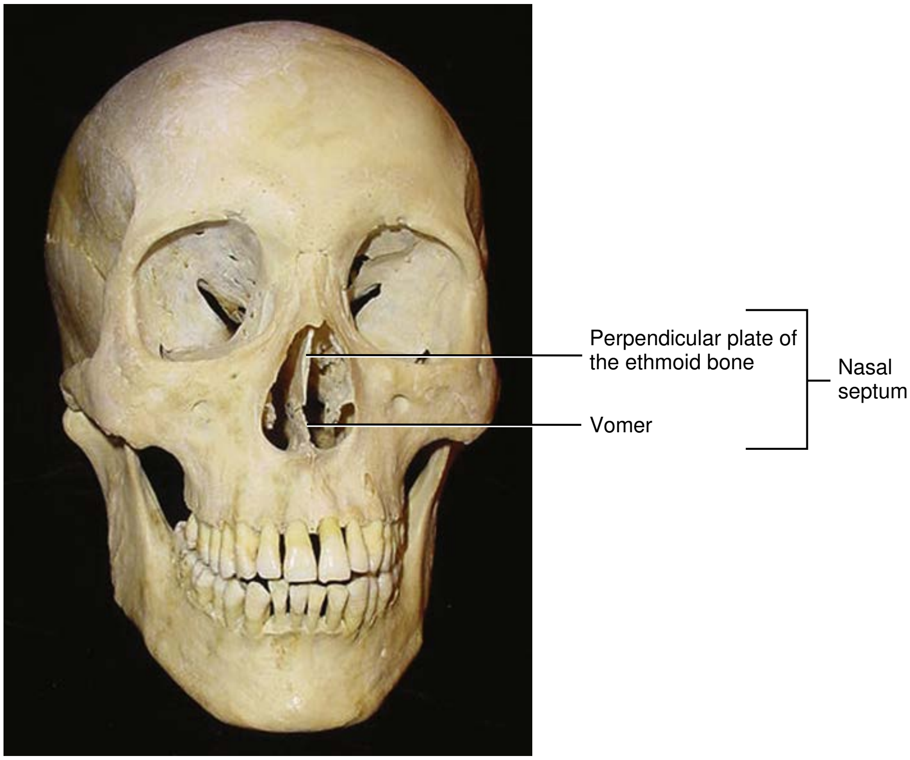



**Fig. 3.9** Anterior view of the external skull with the nasal septum and the bones that form it noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

***Skull Fossae from Lateral View.*** The **temporal fossa** is noted on the lateral surface of the skull (Fig. 3.13). The temporal fossa is formed by parts of several bones of the skull and contains the body of the temporalis muscle. Inferior to the temporal fossa is the **infratemporal fossa** (in-fruh-**tem**-pruhl). Deep to the infratemporal fossa and more difficult to see is the **pterygopalatine fossa** (**ter**-i-goh-**pal**-uh-tahyn). The temporal, infratemporal, and pterygopalatine fossae are discussed in detail later, including the head and neck structures that travel through them.

***Zygomatic Arch and Temporomandibular Joint from Lateral View.*** Farther inferior on the lateral aspect of the skull are prominent landmarks (Fig. 3.14). The zygomatic arch or cheekbone is noted, which is formed by the union of the slender zygomatic process of the temporal bone and the broad temporal process of the zygomatic bone (see Table 3.4 and Fig. 2.9). The suture between these two bones is the paired **temporozygomatic suture** (**tem**-puh-roh-zahy-guh-**mat**-ik) (see Table 3.2). The zygomatic arch serves as the origin for the prominent masseter muscle (see Fig. 4.21).

Also noted is the nearby temporomandibular joint (TMJ), a movable articulation between the temporal bone and the mandible (see **Chapter 5**). More specific landmarks of each of these bones are discussed later.

## CLINICAL CONSIDERATIONS WITH SKULL IMAGING

A lateral cephalometric radiograph (LCR) also known as a *ceph* is a radiograph used primarily in dentistry for orthodontic diagnosis and treatment planning (see Fig. 3.11, *B*). The cephalostat machine incorporates two posts that are placed in the external acoustic meatus; the patient's sagittal plane should be parallel to the x-ray film, the teeth positioned in centric occlusion, and the **Frankfort plane (frangk**-fert) aligned horizontally. This plane in craniometry uses the superior margin of the opening of each external acoustic meatus and then the inferior margin of the orbit to orient a skull or head so that the plane is usually horizontal.

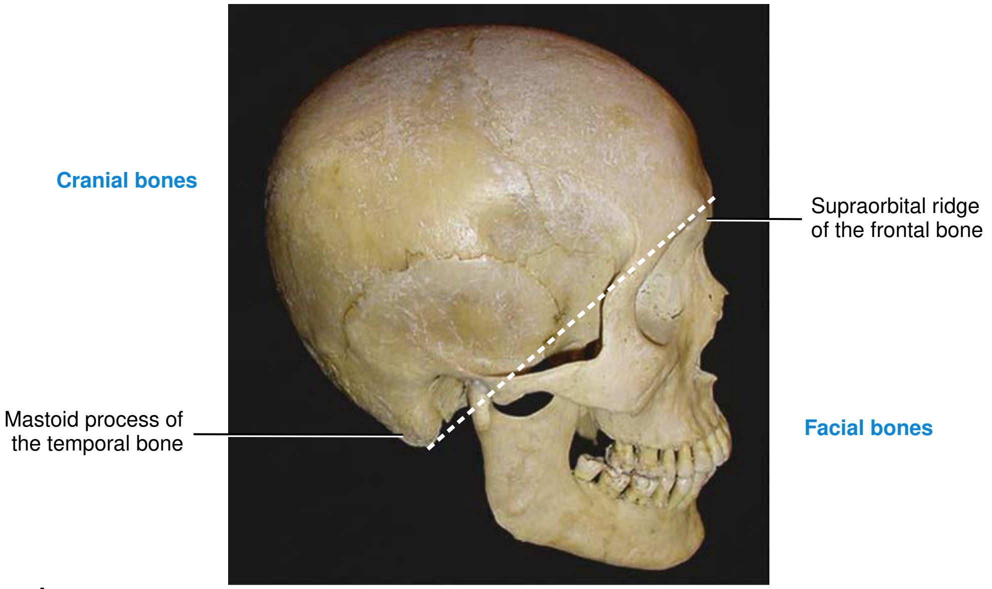
The LCR is used to assess the etiology of malocclusion, to determine whether the malocclusion is due to skeletal relationship, dental relationship, or both prior to treatment and can also be used during treatment to assess progress. Once taken, the LCR is traced upon its surface to determine the cephalometric points for the individual, either by hand or digitally and analyzed to help with diagnosis and treatment planning for orthodontic therapy.

In orthodontic assessments, there are three planes that are usually assessed: anteroposterior, vertical, and transverse relationships. Using the LCR, the anteroposterior (directed toward both front and back) and vertical relationships can be assessed. The transverse relationship can be assessed by posteroanterior views of the skull, although this is rarely done in practice.

With newer technology, the cone-beam computed tomography (CBCT) is gaining use in dentistry since it is an advancement in computed tomography (CT) with its three-dimensional (3D) view (see Fig. 3.50, *C,* as well as Figs. 5.1, *B* and *C,* 5.9, *B,* and 9.42, *B* and *C*). With this device, the x-rays are divergent, forming a cone. Thus CBCT has become increasingly important in diagnosis and treatment planning in dental traumatic cases, orthodontic therapy, implant dentistry, oral and maxillofacial surgery, and endodontics.

During dental imaging, the CBCT scanner rotates around the head, obtaining up to nearly 600 distinct images. The scanning software collects the data and reconstructs it, producing what is termed a *digital volume* composed of 3D voxels of anatomic data that can then be manipulated and visualized with specialized software.

An important disadvantage with CBCT is the increased radiation exposure compared to conventional radiographs. There needs to be a balance of the risk against the benefits so that CBCT is indicated when it is the only way to get the necessary information for appropriate treatment. A patient who receives a CBCT does not also need a 2D panoramic radiograph (see later discussion in this chapter) since all information that can be gained from a 2D image can also be seen in the CBCT, which helps to limit the need for additional radiation exposure. Along with CBCT, 3D printing is poised to take a more diagnostic role in dentistry since it is now capable of rendering a wide range of oral appliances, models, and more.

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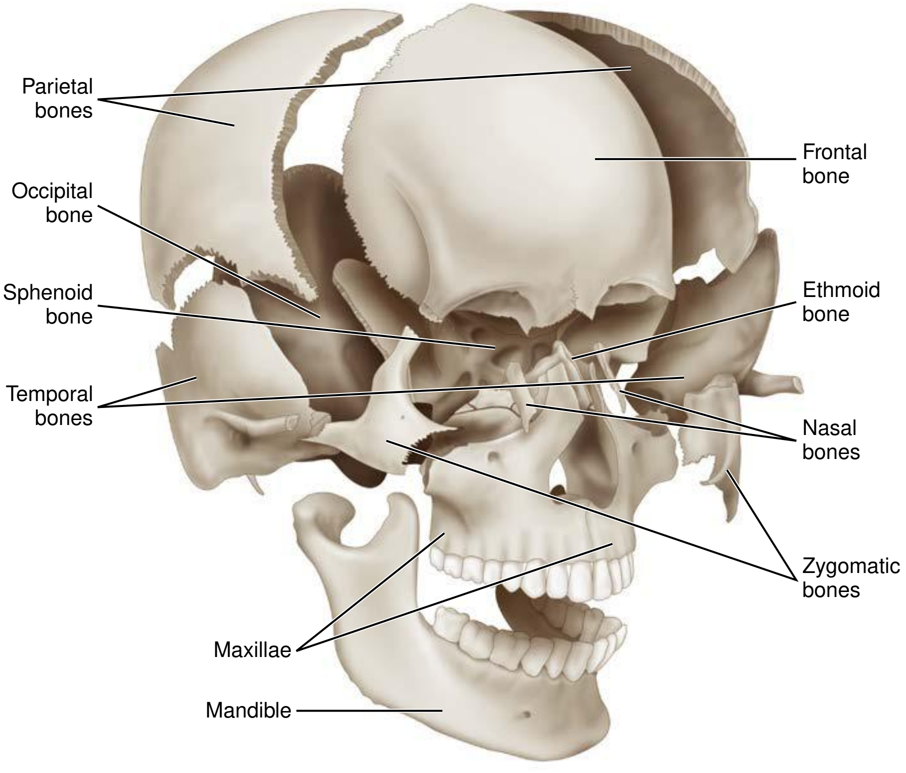


B

**Fig. 3.10** Lateral view of the external skull with an imaginary diagonal line *(dashed)* that divides the cranial bones and facial bones (**A**). The line passes inferior and posterior from the supraorbital ridge of the frontal bone to the tip of the mastoid process of the temporal bone. The cranium is formed from the cranial bones, with the facial features formed from the facial bones. An anterolateral view of a diagram of a disarticulated skull showing both cranial and facial bones (**B**). Note the palatine bones are not shown and the lacrimal bones are not indicated. (**A**, Courtesy of Margaret J. Fehrenbach, RDH, MS.)

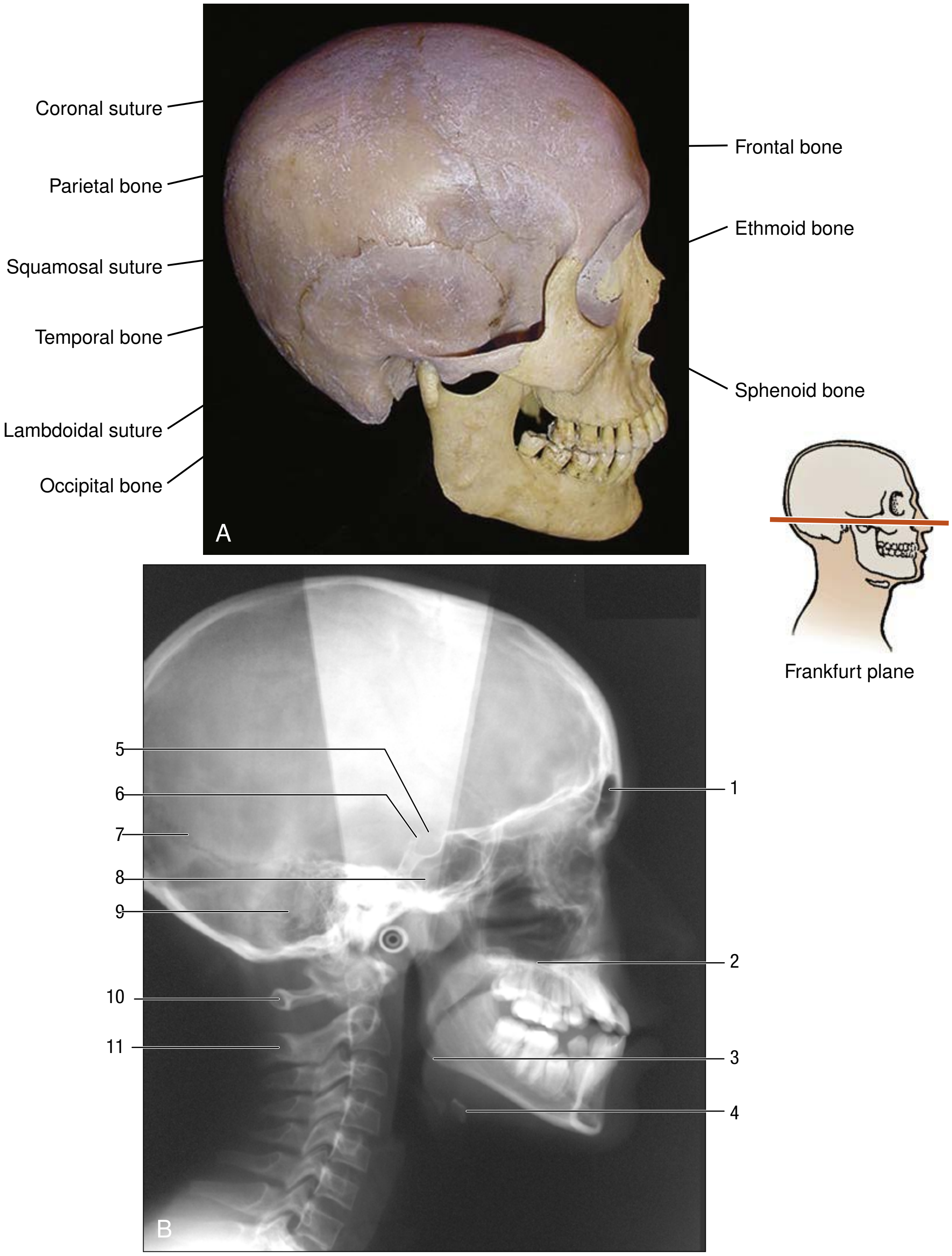


**Fig. 3.11** Lateral view of the external skull with the cranial bones highlighted and noted along with the associated suture lines (**A**). A lateral cephalometric radiograph (LCR) or *ceph* of a young adult with the head held in a cephalostat using the Frankfurt plane to obtain a true lateral view. The concentric circle is the ear rod placed in the external acoustic meatus bilaterally, and the brighter area over the middle third of the skull is the head band device. *1,* Frontal sinus. *2,* Hard palate. *3,* Angle of mandible. *4,* Hyoid bone. *5,* Sella turcica. *6,* Posterior clinoid process. *7,* Lambdoidal suture. *8,* Sphenoidal sinus. *9,* Mastoid air cells. *10,* Posterior tubercle of atlas. *11,* Spinous process of axis (**B**). (**A**, Courtesy of Margaret J. Fehrenbach, RDH, MS. **B,** From Standring S. *Gray's Anatomy: The Anatomical Basis of Clinical Practice*, 40th ed. Churchill London: Livingstone; 2008.)

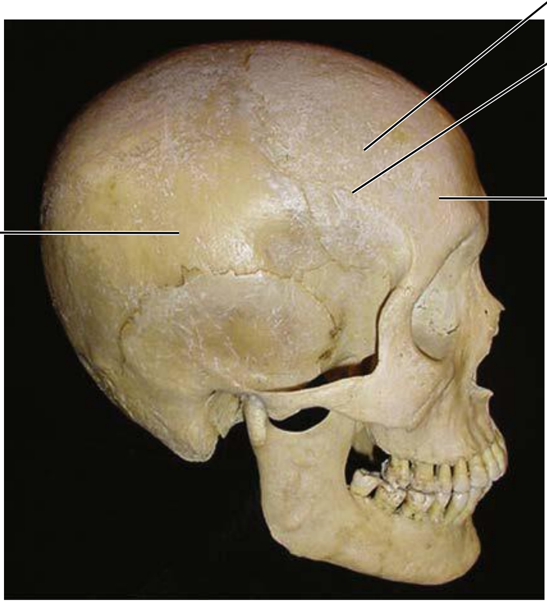


**Fig. 3.12** Lateral view of the external skull with the superior and inferior temporal lines and associated bones noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

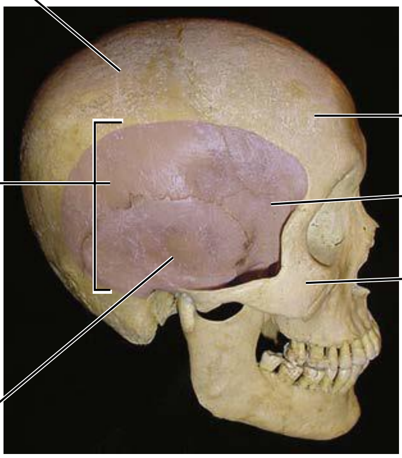


**Fig. 3.13** Lateral view of the external skull with the temporal fossa highlighted and the bones that form it noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

## Inferior View of External Skull

Most of the structures of the inferior view of the external skull are noted on the skull when the mandible is removed. The zygomatic bones, vomer, temporal bones, sphenoid bone, occipital bones, and palatine bones, as well as the maxillae are noted on the inferior view of the skull's external surface (Fig. 3.15).

***Hard Palate from Inferior View.*** At the anterior part of the skull's inferior surface is the hard palate, which is bordered by the **alveolar process of the maxilla** that usually contains the roots of the maxillary teeth within the alveoli (Fig. 3.16 and see Fig. 2.15 and Table 3.4). The hard palate is formed from two separate bones: the two palatine processes of the maxillae anteriorly and the two horizontal plates of the palatine bones posteriorly, with an articulation at the prominent median palatine suture that underlies the median palatine raphe (see Fig. 2.15 and Table 3.2). The other nearby suture is the **transverse palatine suture**, an articulation located between the two palatine

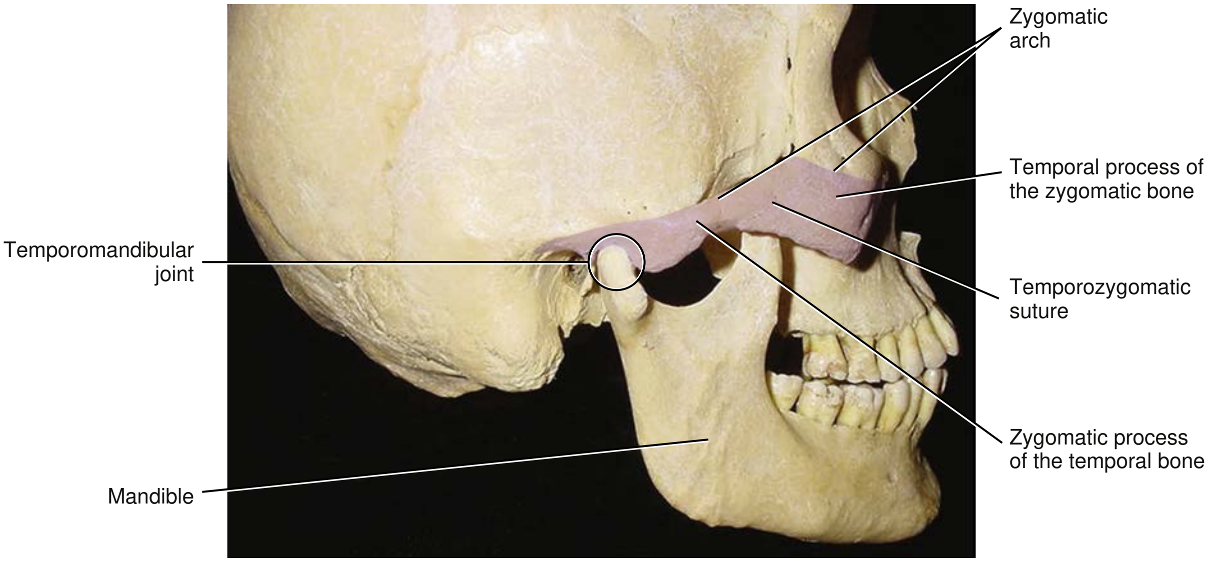


**Fig. 3.14** Lateral view of the external skull with the zygomatic arch highlighted and the bones that form it noted along with the nearby temporomandibular joint (*circle*). (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

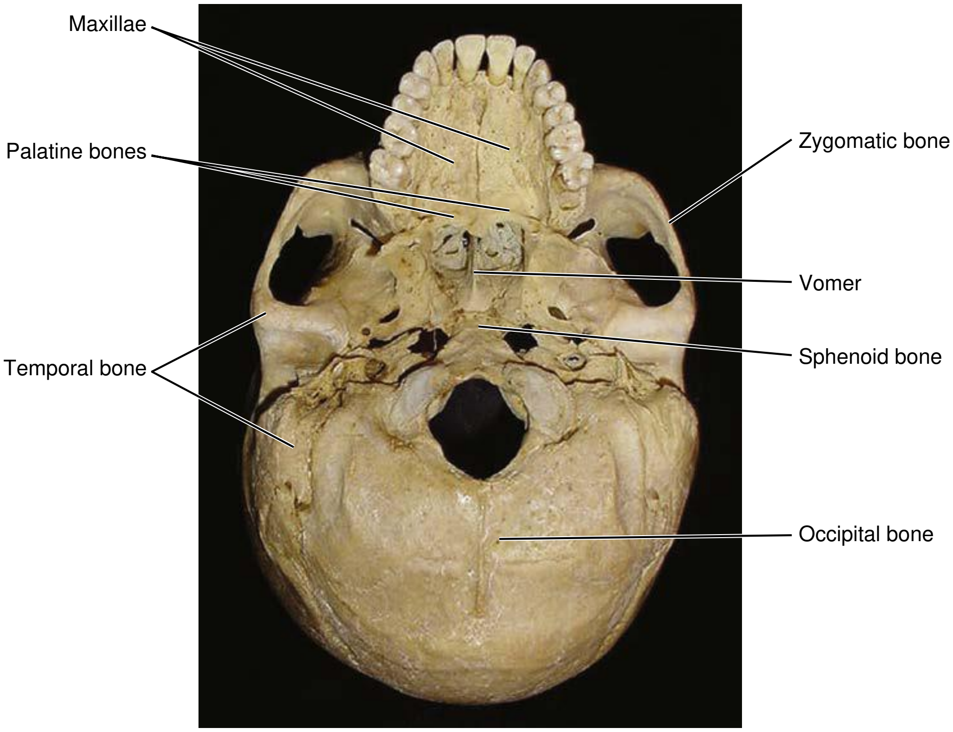


**Fig. 3.15** Inferior view of the external surface of the skull with its bones noted from this view. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

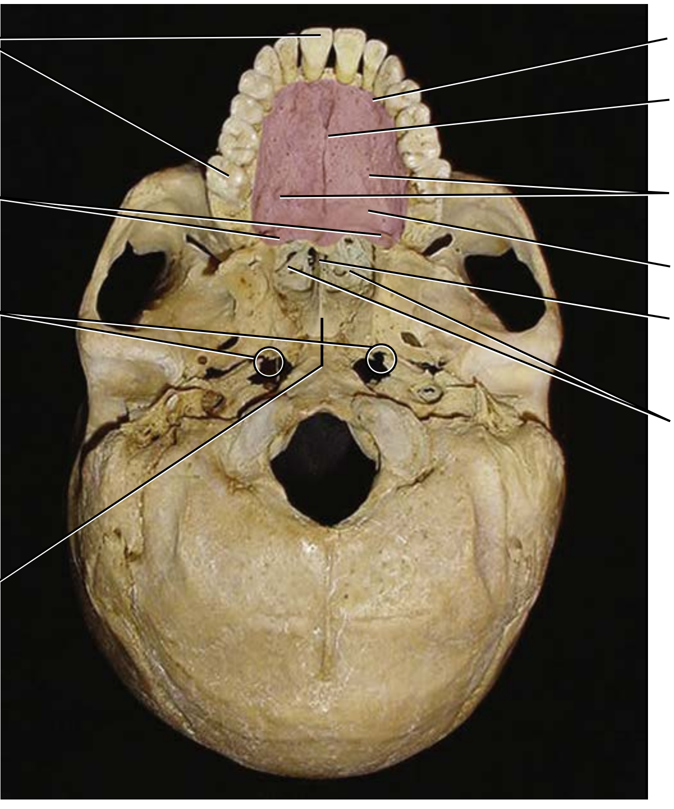


**Fig. 3.16** Inferior view of the external skull with the hard palate highlighted and the bones that form it noted along with other features noted. Note the pterygoid canals (*circles*). (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

processes of the maxillae and the two horizontal plates of the palatine bones. These paired midline bones completely separate the oral cavity from the nasal cavity superiorly.

Also present on the posterior part of the hard palate are the **fovea palatinae** (pal-**ah**-tin-ee), which are two small depressions, one on each side of the midline, that are located anterior to the junction of the soft and hard palate. They have no particular anatomic function, but they are noted when working with a complete maxillary denture case as a reliable anatomic set point since they are generally around 2 mm anterior to the soft palate and its "vibrating line." The (anterior) vibrating line is an imaginary line located at the junction of the attached tissue overlying the hard palate and the movable tissue of the immediately adjacent soft palate.

The hard palate forms the floor of the nasal cavity as well as the roof of the mouth. The posterior edge of the hard palate forms the inferior border of two funnel-shaped cavities, the **posterior nasal apertures** or *choanae* as discussed earlier with the nasal cavity (see Fig. 3.16). These apertures serve as the posterior openings of the nasal cavity. Each posterior nasal aperture is bordered medially by the vomer, inferiorly by the horizontal plate of the palatine bone, laterally by the medial pterygoid plate of the sphenoid bone, and superiorly by the body of the sphenoid bone. Thus the posterior nasal apertures are located between the nasal cavity and the nasopharynx, allowing for communication between the two spaces.

Near the superior border of each posterior nasal aperture is a small canal, the **pterygoid canal** (**ter**-i-goid) (see Fig. 3.16 and Table 3.3). The pterygoid canal runs anteriorly through the root of the pterygoid process of the sphenoid bone (discussed next) to open into the pterygopalatine fossa. The pterygoid canal carries the nerve of the pterygoid canal and associated blood vessels (discussed later) to the pterygopalatine fossa.

***Middle Part of Skull from Inferior View.*** The middle part of the skull from the inferior view also has prominent landmarks (Fig. 3.17). The lateral borders of the posterior nasal apertures are formed on each side by the **pterygoid process** of the sphenoid bone (see Table 3.4).

Each pterygoid process consists of a thin **medial pterygoid plate** and a flattened **lateral pterygoid plate**. The depression located between the medial plate and lateral plate is the **pterygoid fossa**. At the inferior part of the medial plate of the pterygoid process is a thin curved process, the **hamulus** (plural, **hamuli**) (**ham**-yuh-luhs, **ham**-yuh-lahy). The sphenoid bone and its structure are discussed in detail later.

***External Skull Foramina from Inferior View.*** The inferior surface of the external skull has a large number of foramina (Fig. 3.18 and see Table 3.3). These openings provide entrances and exits for the arteries and veins that supply the brain and facial tissue (see **Chapter 6**). They also allow the cranial nerves to pass to and from the brain (see Fig. 8.5).

The larger anterior oval opening on the sphenoid bone, the **foramen ovale** (oh-**vah**-lee), is for the mandibular nerve (or third division) of the fifth cranial or trigeminal nerve (see Fig. 8.7). The adjacent smaller and more posterior opening is the **foramen spinosum** (**spahyn**-oh-sum), which carries the middle meningeal artery into the cranial cavity. The foramen spinosum receives its name from the nearby (angular) **spine of the sphenoid bone**, which is at the posterior extremity of the sphenoid bone.

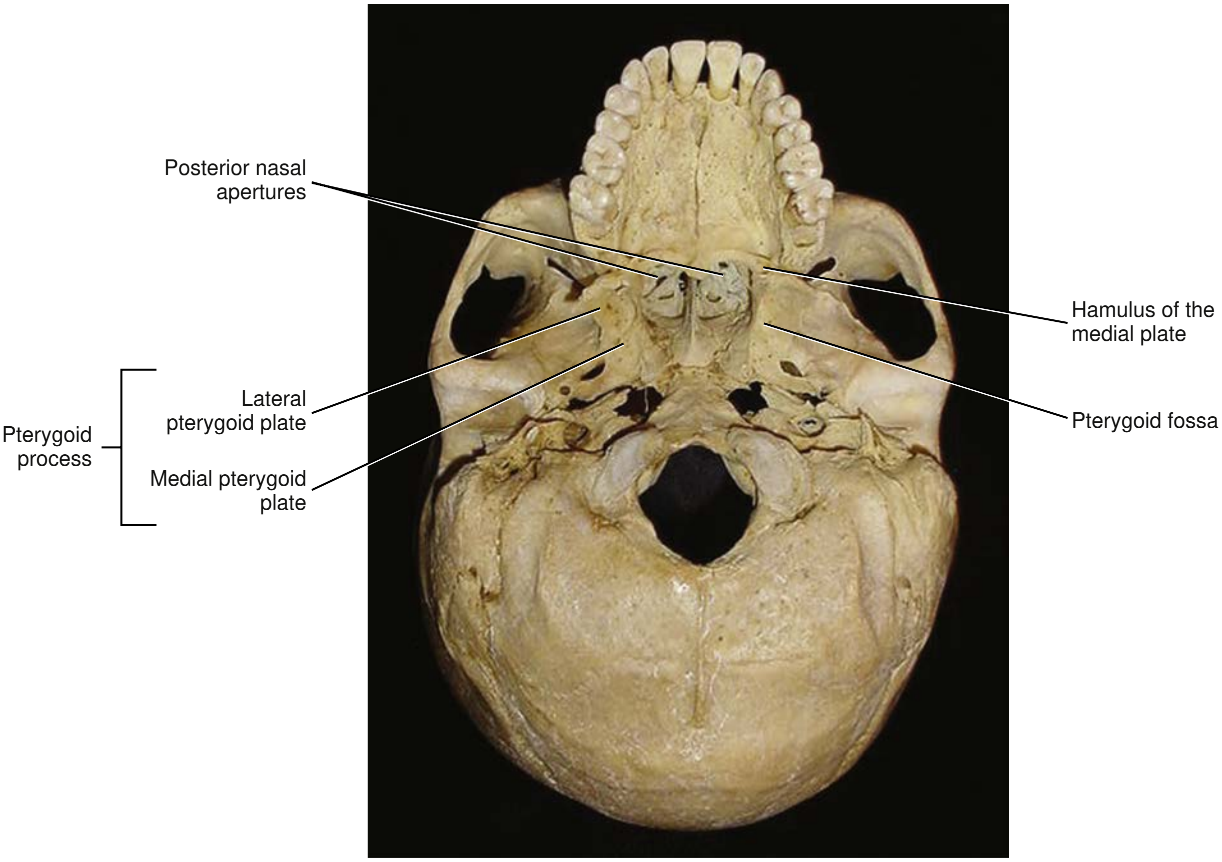


**Fig. 3.17** Inferior view of the external skull with its features of the middle section noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

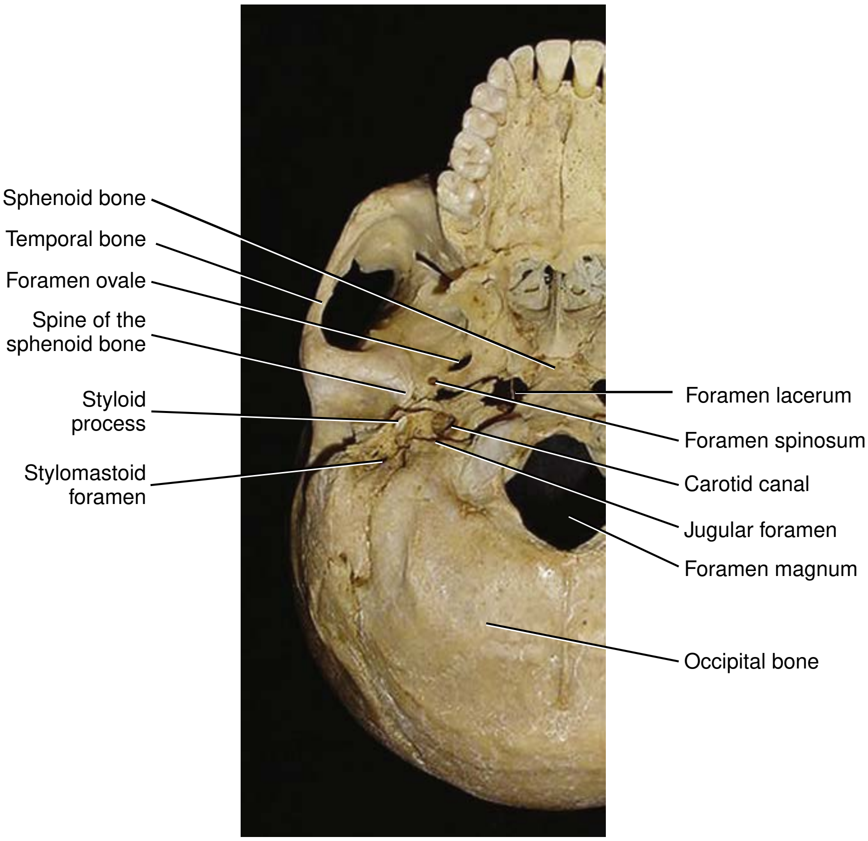


**Fig. 3.18** Inferior view of the external skull with its foramina and associated structures noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

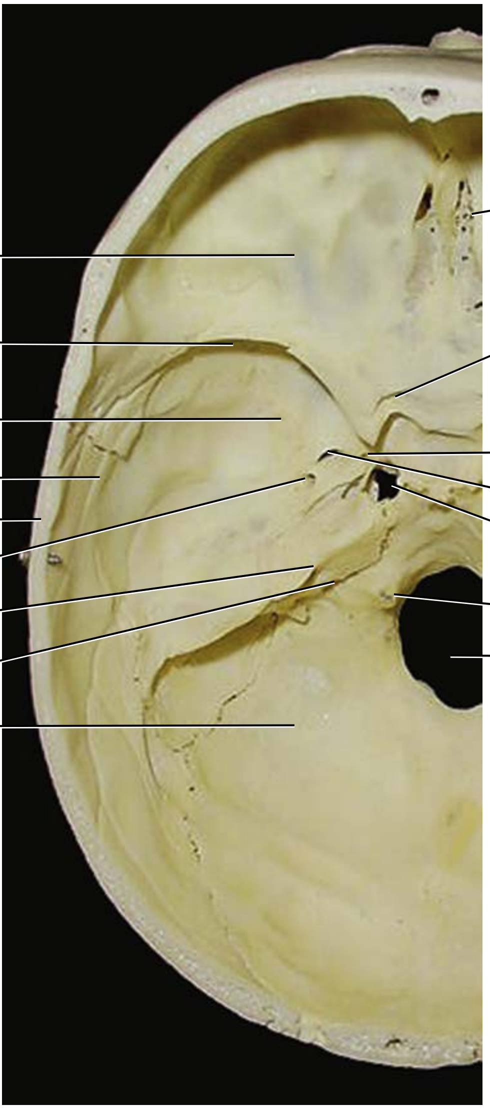


**Fig. 3.19** Superior view of the internal surface of the skull with its foramina and associated structures noted. (Courtesy of Margaret J. Fehrenbach, RDH, MS.)

Also on the external surface of the skull is the large, irregularly shaped **foramen lacerum** (**las**-er-uhm), which when intact is filled with cartilage. This foramen is located between the sphenoid bone, apex of petrous part of the temporal bone, and basilar part of the occipital bone (discussed later). Posterolateral to the foramen lacerum is a round opening in the petrous part of the temporal bone, the **carotid canal**. The carotid canal carries the internal carotid artery and carotid plexus of nerves. The carotid plexus of nerves is a network of intersecting sympathetic nerves that run parallel to the carotid artery into the head. A pointed bony projection, the **styloid process** (**stahy**-loid) of the temporal bone, is noted lateral and posterior to the carotid canal (see Table 3.4). Immediately posterior to the styloid process is the **stylomastoid foramen** (stahy-loh-**mas**-toid), an opening through which the seventh cranial or facial nerve exits from the skull to the face.

The **jugular foramen** (**juhg**-yuh-ler), just medial to the styloid process, is visible if the skull is tilted to one side (see also Fig. 3.22). The jugular foramen is the opening through which pass the internal jugular vein and three cranial nerves: the ninth cranial or glossopharyngeal nerve, the tenth cranial or vagus nerve, and the eleventh cranial or accessory nerve.

The largest opening on the inferior view is the **foramen magnum** (**mag**-nuhm) of the occipital bone, through which the spinal cord, vertebral arteries, and the cervical part of the eleventh cranial or accessory nerve pass.

## Superior View of Internal Skull

For a superior view of the internal skull, again remove the cap of the skull. The frontal bone, ethmoid bone, sphenoid bone, temporal bones, occipital bone, and parietal bones are noted from this view of the internal surface of the skull (Fig. 3.19).

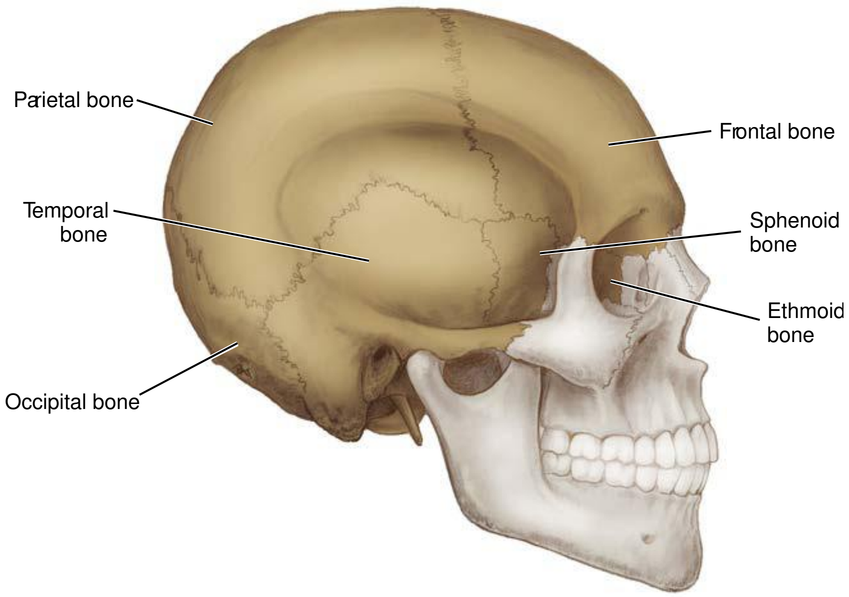


**Fig. 3.20** Lateral view of the external skull with the cranial bones highlighted.

***Internal Skull Foramina from Superior View.*** Also present on the superior surface of the internal skull are the inner openings of the optic canal, superior orbital fissure, foramen ovale, foramen spinosum, foramen lacerum, jugular foramen, and foramen magnum, as discussed before when viewing the external skull surface (see Fig. 3.19 and Table 3.3). Additionally, other foramina are present on the internal surface of the skull. The perforated **cribriform plate** (**krib**-ruh-fawrm), with numerous foramina for the first cranial or olfactory nerve, and the **foramen rotundum** (roh-**tun**-dum) for the maxillary nerve (or second division) of the fifth cranial or trigeminal nerve are also noted from this view (see Fig. 8.7).

Finally, also present are the **hypoglossal canal** (hahy-puh-**glahs**-suhl) for the twelfth cranial or hypoglossal nerve and the **internal acoustic meatus** (**IAM**) for the seventh cranial or facial nerve and the eighth cranial or vestibulocochlear nerve.

## Cranial Bones

The cranium is formed from the eight cranial bones. The cranial bones include the single occipital bone, frontal bone, sphenoid bone, and ethmoid bone as well as the paired parietal bones and temporal bones (Fig. 3.20).

### Occipital Bone

The occipital bone is a single cranial bone that forms the posterior part of the skull and the base of the cranium (Fig. 3.21). It is an irregular four-sided bone that is somewhat curved. It can be divided into four parts: the single squamous part, the single basilar part, and the paired lateral parts. The occipital bone articulates with the parietal bones, temporal bones, and sphenoid bone of the skull. The occipital bone also articulates with the first cervical vertebra or atlas (see Fig. 3.62). The occipital bone can be additionally studied from an inferior view as well as a posterior view of its external surface.

***Occipital Bone from Inferior View.*** On the external surface of the occipital bone from an inferior view, it can be noted that the foramen magnum is completely formed by the occipital bone (Fig. 3.22 and see Table 3.3).

On the lateral part of the occipital bone and anterior to the foramen magnum are the paired **occipital condyles**, which are curved and smooth projections. The occipital condyles have a movable articulation with the atlas, the first cervical vertebra of the vertebral column (discussed later). On the stout **basilar part of the occipital bone** (**bas**-uh-ler), which is a four-sided plate anterior to the foramen magnum, there is a midline projection, the **pharyngeal tubercle** (fuh-**rin**-jee-uhl). A cephalometric landmark on the midpoint of the anterior border of foramen magnum is the **basion** (**bey**-see-on), which is also called *point Ba*.

When tilting the skull, prominent openings anterior and lateral to the foramen magnum are noted on the inferior view of the occipital bone (see Table 3.3). These openings are the paired hypoglossal canals (see Fig. 3.22, *A*). The twelfth cranial or hypoglossal nerve is transmitted through the hypoglossal canal. Also present is the **jugular notch of the occipital bone**, which forms the medial part of the jugular foramen (the lateral part is from the temporal bone).

***Occipital Bone from Posterior View.*** On the external surface of the occipital bone from a posterior view, the horizontally located nuchal lines can be noted that mark the superior limit of the neck. The most raised of the nuchal lines include the **superior nuchal line** (**noo**-kuhl) and the **inferior nuchal line** (see Fig. 3.22, *B*). These curved ridges on the external surface of the occipital bone serve as sites for muscle attachments; the originations of the sternocleidomastoid, trapezius, and occipitalis muscles are from the superior nuchal line (see Figs. 4.1 and 4.3). A dramatic feature of the superior nuchal line is a midline projection of the bone's posterior surface, the **external occipital protuberance,** which is also a cephalometric landmark called the **inion (in**-ee-uhn).

### Frontal Bone

The frontal bone is a single cranial bone that forms the anterior part of the skull superior to the eyes in the frontal region. It includes the majority of the forehead as well as the roof of each orbit (Fig. 3.23 and see Figs. 2.2 and 2.6). It develops as two bones, which are usually fused together by 5 or 6 years of age.

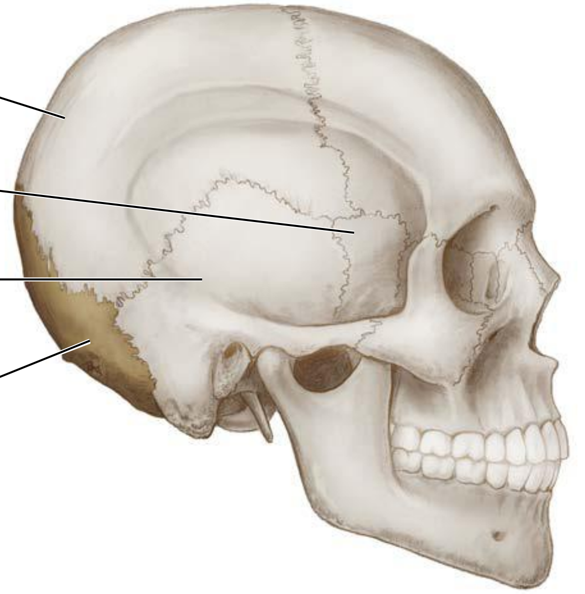


**Fig. 3.21** Lateral view of the external skull with the occipital bone highlighted and its bony articulations noted.

The frontal bone's part of the superior temporal line and inferior temporal line is noted when the bone is viewed from the lateral aspect as discussed earlier. The frontal bone articulates with the parietal bones, sphenoid bone, lacrimal bones, nasal bones, ethmoid bone, and zygomatic bones, as well as the maxillae. Internally, the frontal bone contains the paired paranasal sinuses, the frontal sinuses (discussed later). The frontal bone can also be studied from both anterior and inferior viewpoints.

***Frontal Bone from Anterior View.*** On the anterior aspect, landmarks are noted on the frontal bone (Fig. 3.24 and see Figs. 2.2 and 2.6). The orbital plate of the frontal bone forms the superior wall or orbital roof. The curved elevations over the superior part of the orbit are the supraorbital ridges, subjacent to the eyebrows, with these ridges more prominent in adult men.

Located between the supraorbital ridges is the glabella, the smooth elevated area also between the eyebrows, which tends to be flat in children and adult women but forms a rounded prominence in adult men. The prominence of the forehead, the frontal eminence, is also evident. In contrast, the frontal eminence is usually more pronounced in children and adult women. Lateral to the orbit is a projection, the orbital surface of the **zygomatic process of the frontal bone** (see Table 3.4).

The **supraorbital notch** (or supraorbital foramen) is located on the medial part of the more inferiorly located supraorbital rim, where the supraorbital nerve and artery travel from the orbit to the frontal region. Due to the presence of the nerve, palpation of this indentation in the supraorbital rim in a patient can produce transient soreness during an extraoral examination.

The frontal bone articulates with the nasal bones and the frontal processes of the maxillae to form the root of the nose (see Fig. 2.7).

***Frontal Bone from Inferior View.*** From the inferior view of the frontal bone, each **lacrimal fossa** is noted (Fig. 3.25 and see Fig. 2.6). The lacrimal fossa is located just internal to the lateral part of the supraorbital rim. This fossa contains the lacrimal gland, which produces lacrimal fluid or *tears* (see **Chapter 7**). After lubricating the eye, the lacrimal fluid empties into the nasal cavity through the nasolacrimal duct.

## Parietal Bones

The parietal bones are paired cranial bones that articulate with each other at the sagittal suture (Fig. 3.26 and see Table 3.2). Each bone is relatively square, like a curved plate, and has four borders. These bones are located posterior to the frontal bone, forming the greater part of the right and left lateral walls and the roof of the skull. The parietal bones also articulate with each other at the sagittal suture, with the occipital bone at the lambdoidal suture, with the frontal bone at the coronal suture, with the temporal bones at the squamosal sutures, and with the sphenoid bone.

## Temporal Bones

The **temporal bones** are paired cranial bones that form the lateral walls of the skull in the temporal region and part of the base of the skull in the auricular region. Each bone is deep to the temple, the superficial side of the head posterior to each eye (Fig. 3.27). Each temporal bone articulates with the zygomatic bone and parietal bone as well as the occipital bone, sphenoid bone, and the mandible. Each temporal bone is composed of three parts: the squamous, tympanic, and petrous parts.

These three parts of the temporal bone can be best viewed all at one time from the lateral aspect of the skull (Fig. 3.28). The large fan-shaped flat part on each of the temporal bones is the **squamous part of the temporal bone** (**skwey**-muhs). The second part is the small, irregularly shaped **tympanic part of the temporal bone** (tim-**pan**-ik), which is associated with the ear canal. The third part is the **petrous part of the temporal bone** (**peh**-truhs), which is inferiorly located and helps form the cranial floor.

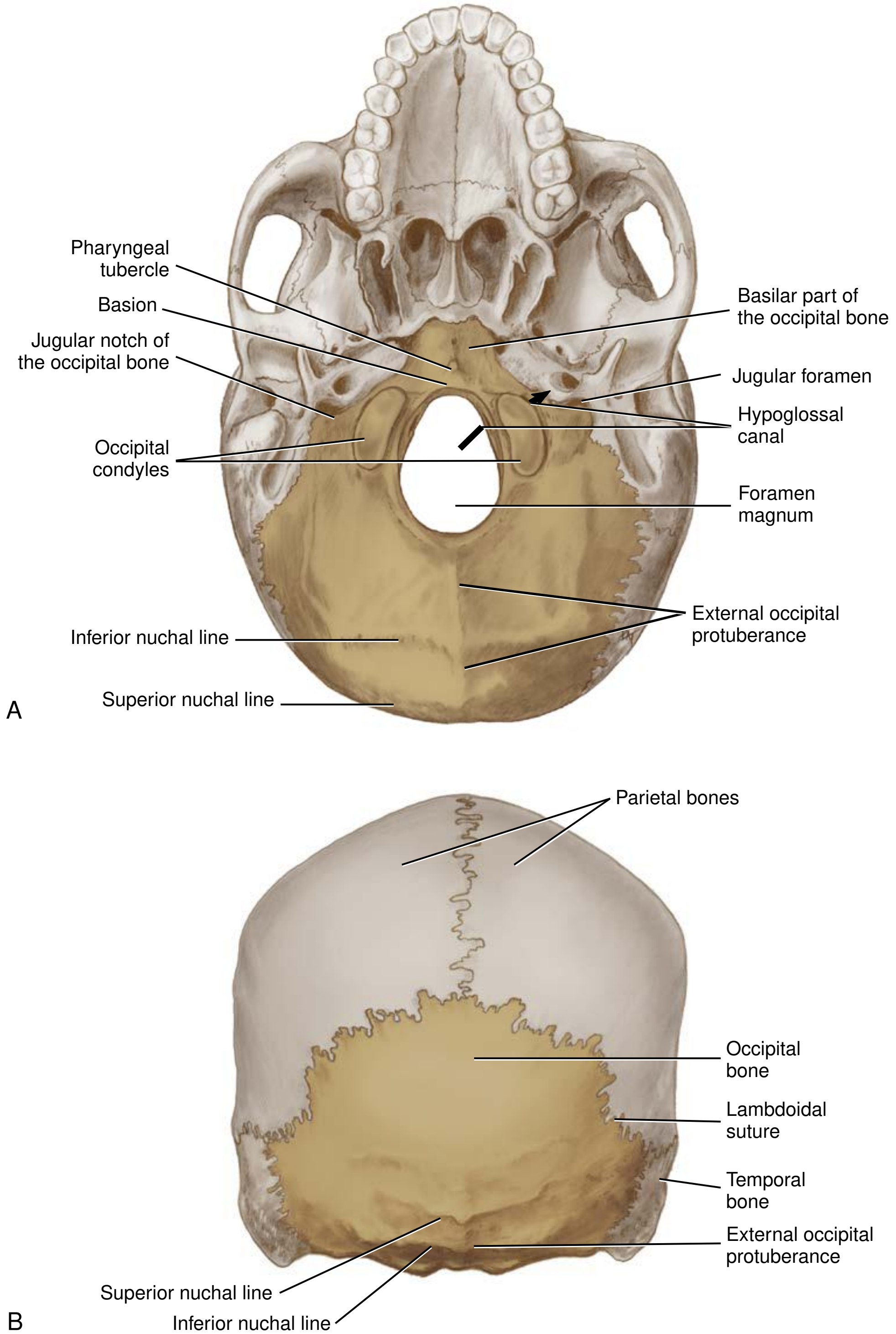


**Fig. 3.22** External surface of the skull with the occipital bone highlighted. From an inferior view, its features are noted including the passageway of the hypoglossal canal *(arrow)* (**A**), and also from a posterior view (**B**).

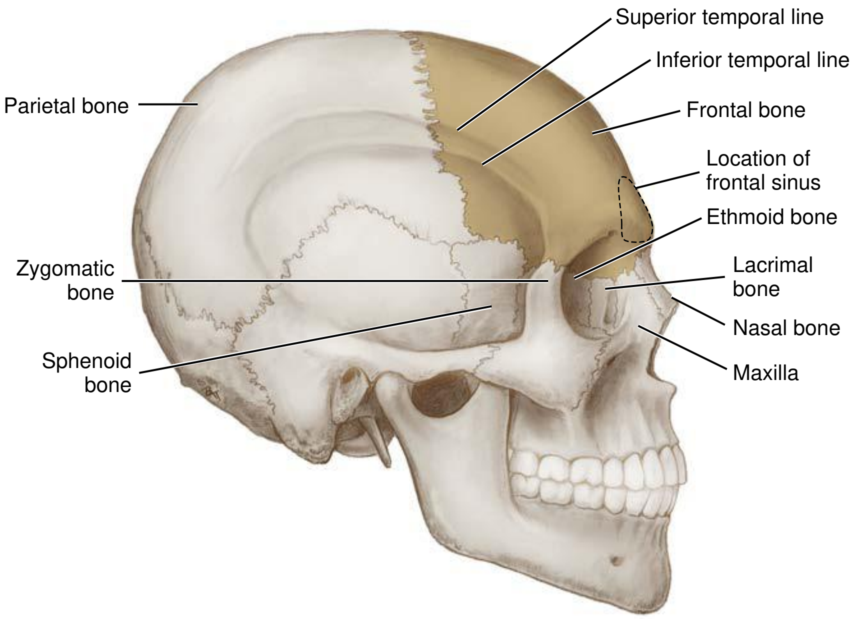


**Fig. 3.23** Lateral view of the skull with the frontal bone highlighted and its bony articulations and features noted including the location of the frontal sinuses *(dashed lines)*.

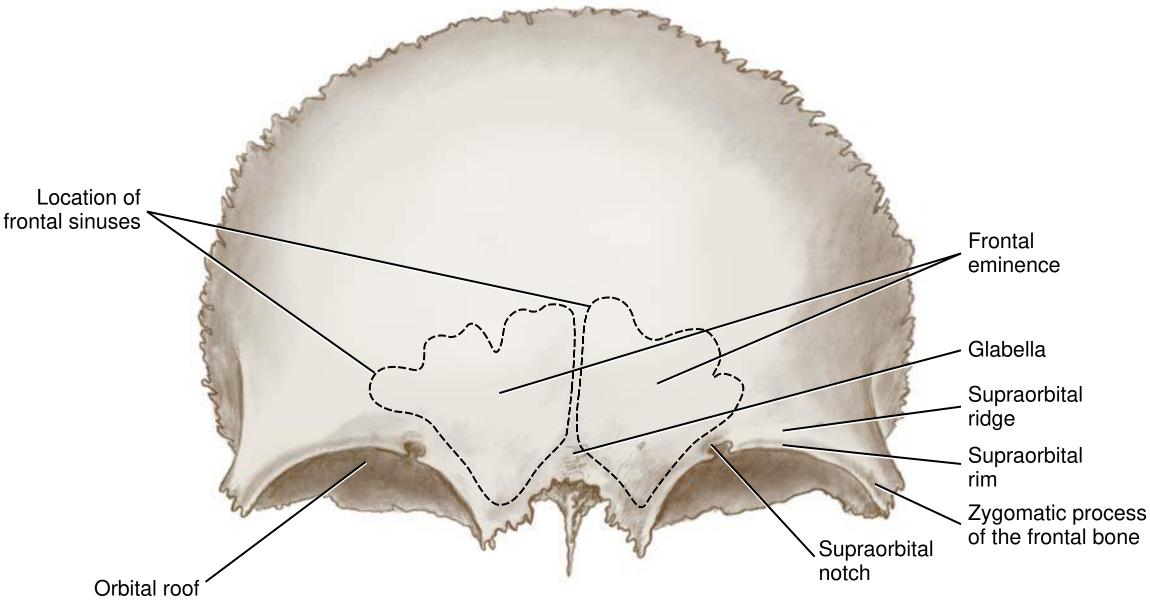


**Fig. 3.24** Anterior view of the disarticulated frontal bone with its features noted including the location of the frontal sinuses *(dashed lines)*.

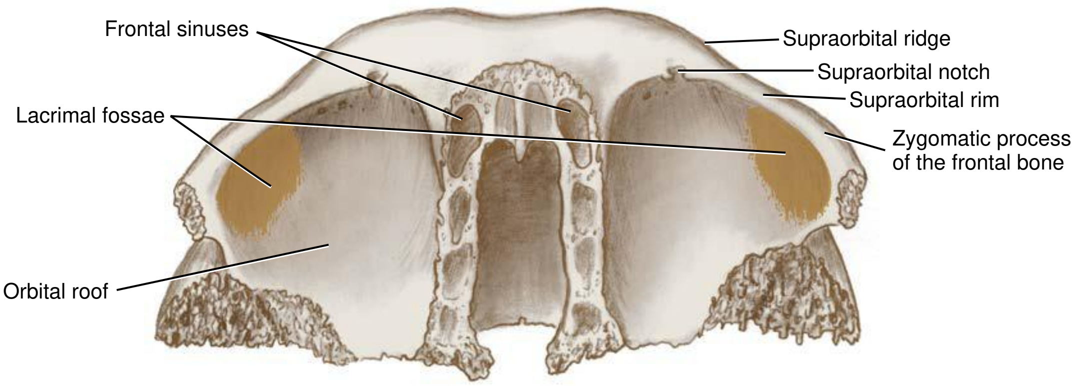


**Fig. 3.25** Inferior view of the disarticulated frontal bone with the lacrimal fossae highlighted and other features noted.

***Squamous Part of Temporal Bone.*** In addition to helping form the braincase, the squamous part of the temporal bone forms the **zygomatic process of the temporal bone**, which consequentially goes on to be a part of the zygomatic arch (Fig. 3.29 and see Table 3.4). This part of the temporal bone also forms the cranial part of the temporomandibular joint with its own complex structures (see **Chapter 5**). On the inferior surface of the zygomatic process of the temporal bone is the **articular fossa** (ahr-**tik**-yuh-ler) (see Figs. 5.2 and 5.4). Anterior to the articular fossa is the **articular eminence** and posterior to it is the **postglenoid process** (post-**glee**-noid) (see Table 3.4).

***Tympanic Part of Temporal Bone.*** The tympanic part of the temporal bone forms most of the **external acoustic meatus (EAM)**, a short canal leading to the tympanic membrane when intact, located posterior to the articular fossa (Fig. 3.30 and see Fig. 2.4 and Table 3.3). Also posterior to the articular fossa, the tympanic part is separated from the petrous part by the **petrotympanic fissure** (peh-troh-tim-**pan**-ik), through which the chorda tympani nerve emerges.

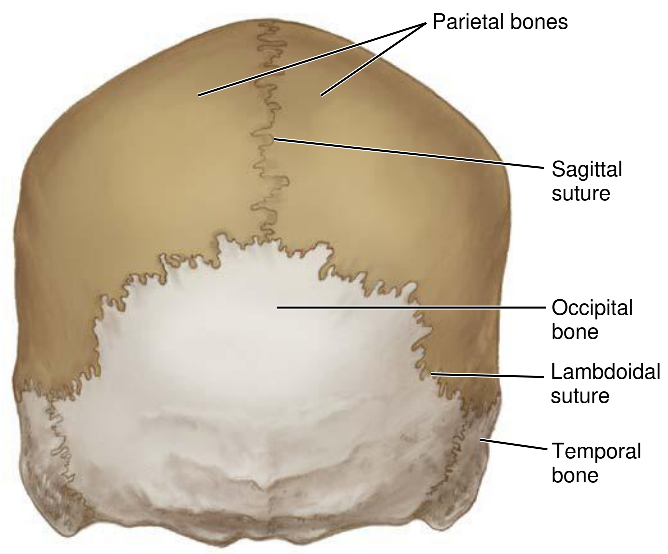


**Fig. 3.26** The skull with the parietal bones highlighted and some of its bony articulations noted from a posterior view.

***Petrous Part of Temporal Bone.*** On the inferior aspect of the petrous part of the temporal bone and posterior to the external acoustic meatus is a large roughened projection, the **mastoid process** (**mas**-toid) (Fig. 3.31 and see Table 3.4). The mastoid process is composed of *air spaces* or **mastoid air cells** that communicate with the middle ear and also serves as the site for attachment of the large cervical muscles including the sternocleidomastoid muscle (see Fig. 4.1). Medial to the mastoid process is the deep groove of the **mastoid notch** (see Fig. 3.31).

Inferior and medial to the external acoustic meatus is a long pointed bony projection, the styloid process, which is a structure that serves as a site for muscle attachments of the tongue as well as the pharynx (see Table 3.4). The nearby stylomastoid foramen carries the seventh cranial or facial nerve and is named for its location between the styloid process and mastoid process (see Table 3.3).

The stylomastoid foramen lies about 2 cm deep to the center of the anterior border of the mastoid process. However, in the newborn, the stylomastoid foramen lies at the surface of the mastoid bone since the mastoid process has not yet formed but instead grows to its full extent around the second year after birth.

Also noted is the large circular aperture of the carotid canal, which first ascends vertically, and then making a bend, runs horizontally and anteriorly medialward. The carotid canal transmits the internal carotid artery and the carotid plexus of nerves into the cranium. When the skull is tilted, the **jugular notch of the temporal bone** is visible (see Table 3.3), which forms the lateral part of the jugular foramen (the medial part is from the occipital bone).

On the intracranial surface of the petrous part of the temporal bone is the internal acoustic meatus (IAM), which carries the eighth cranial or vestibulocochlear nerve and the seventh cranial or facial nerve (see Fig. 3.19 and Table 3.3). The size of the internal acoustic meatus varies considerably; its margins are smooth and rounded. The internal acoustic meatus leads into a canal approximately 1 cm in length, which then runs lateralward. Both of these cranial nerves enter the skull at the internal acoustic meatus from the brain. The

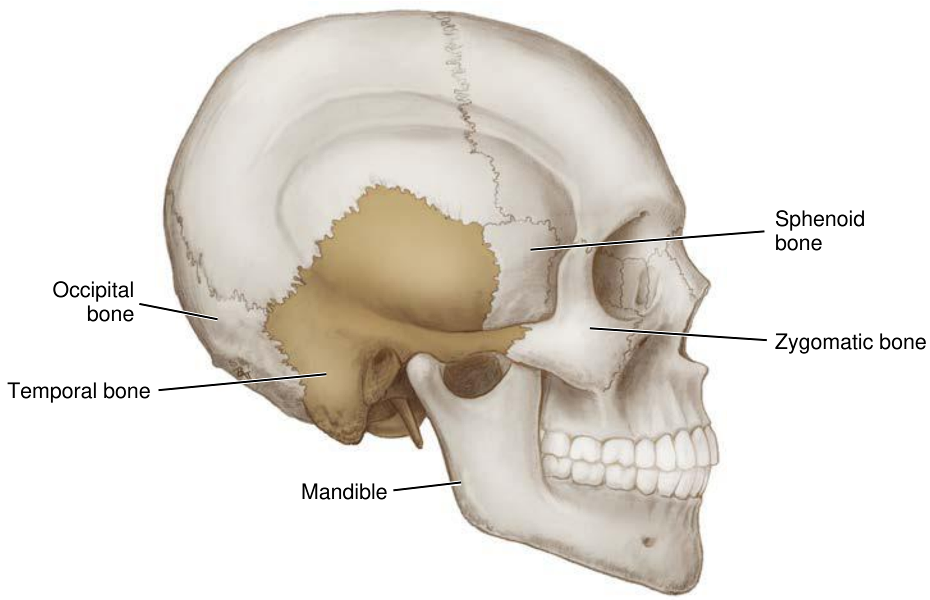


**Fig. 3.27** Lateral view of the skull with the temporal bone highlighted and its bony articulations noted.

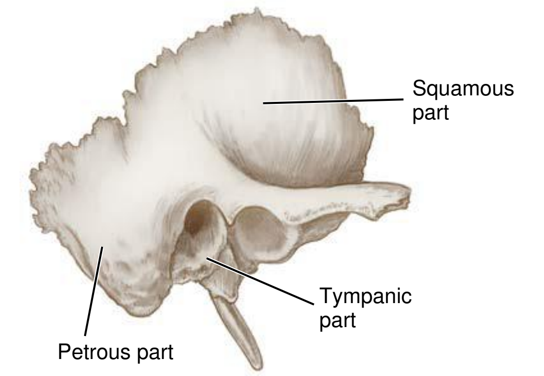


**Fig. 3.28** Lateral view of disarticulated temporal bone and its three parts noted, the squamous, tympanic, and petrous parts.

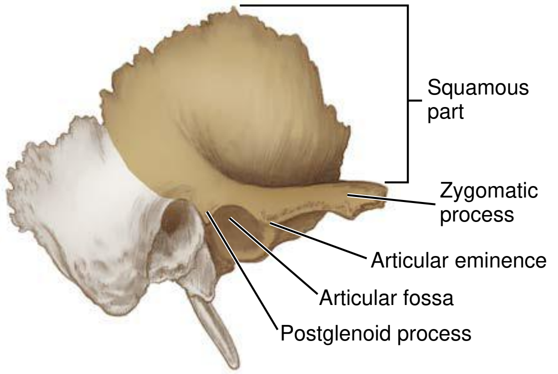


**Fig. 3.29** Lateral view of the disarticulated temporal bone with its squamous part highlighted.

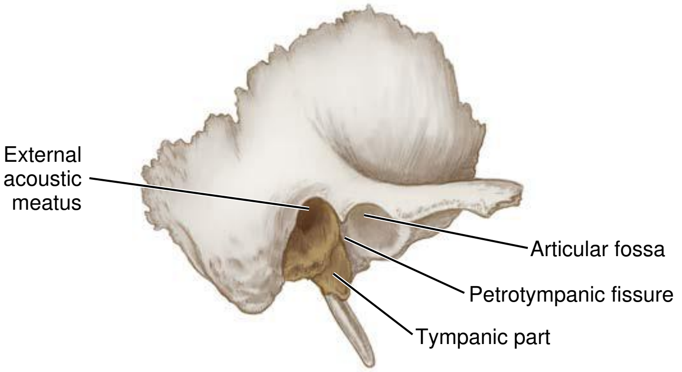


**Fig. 3.30** Lateral view of the temporal bone with its tympanic part highlighted.

vestibulocochlear nerve remains within the petrous part of the temporal bone, which contains the inner ear. In contrast, the facial nerve takes a convoluted path through the bone, eventually emerging at the stylomastoid foramen.

## Sphenoid Bone

The sphenoid bone is a single midline cranial bone that runs through the midsagittal plane and thus is internally wedged between several other bones in the anterior part of the cranium (Figs. 3.32 to 3.34). It

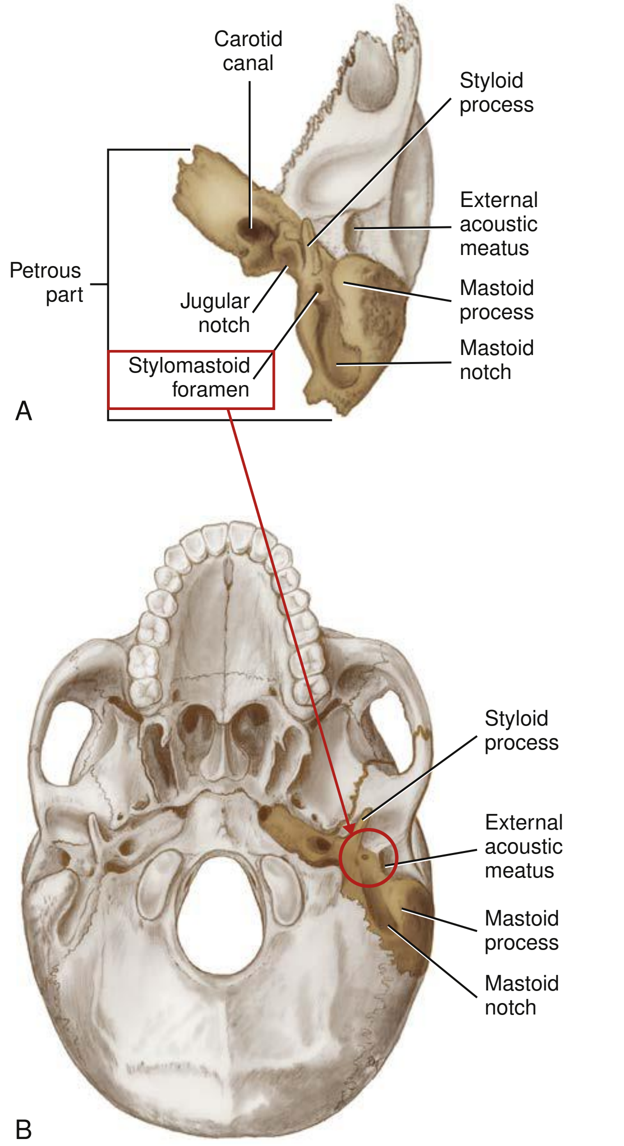


**Fig. 3.31** Inferior view of the disarticulated temporal bone with its petrous part highlighted and its features noted (**A**), and also an inferior view of the external skull surface with the petrous part of the temporal bone highlighted (**B**).

## CLINICAL CONSIDERATIONS FOR MASTOID PROCESS

**Mastoiditis** (mas-toi-**dahy**-tis) is an infection within the mastoid antrum and mastoid cells of the mastoid process. It is usually secondary to infection in the middle ear (otitis media). The mastoid cells provide an excellent culture medium for infection. Infection of the bone (osteomyelitis) may also develop, spreading into the middle cranial fossa.

Drainage of the suppuration (pus) within the mastoid air cells is necessary and there are numerous surgical approaches. When undertaking this type of surgery, it is extremely important that care is taken not to damage the mastoid wall of the middle ear to prevent injury to the facial nerve (or cranial nerve VII). Any breach of the inner table of the cranial vault may allow bacteria to enter the cranial cavity and meningitis will ensue (see Chapter 12).

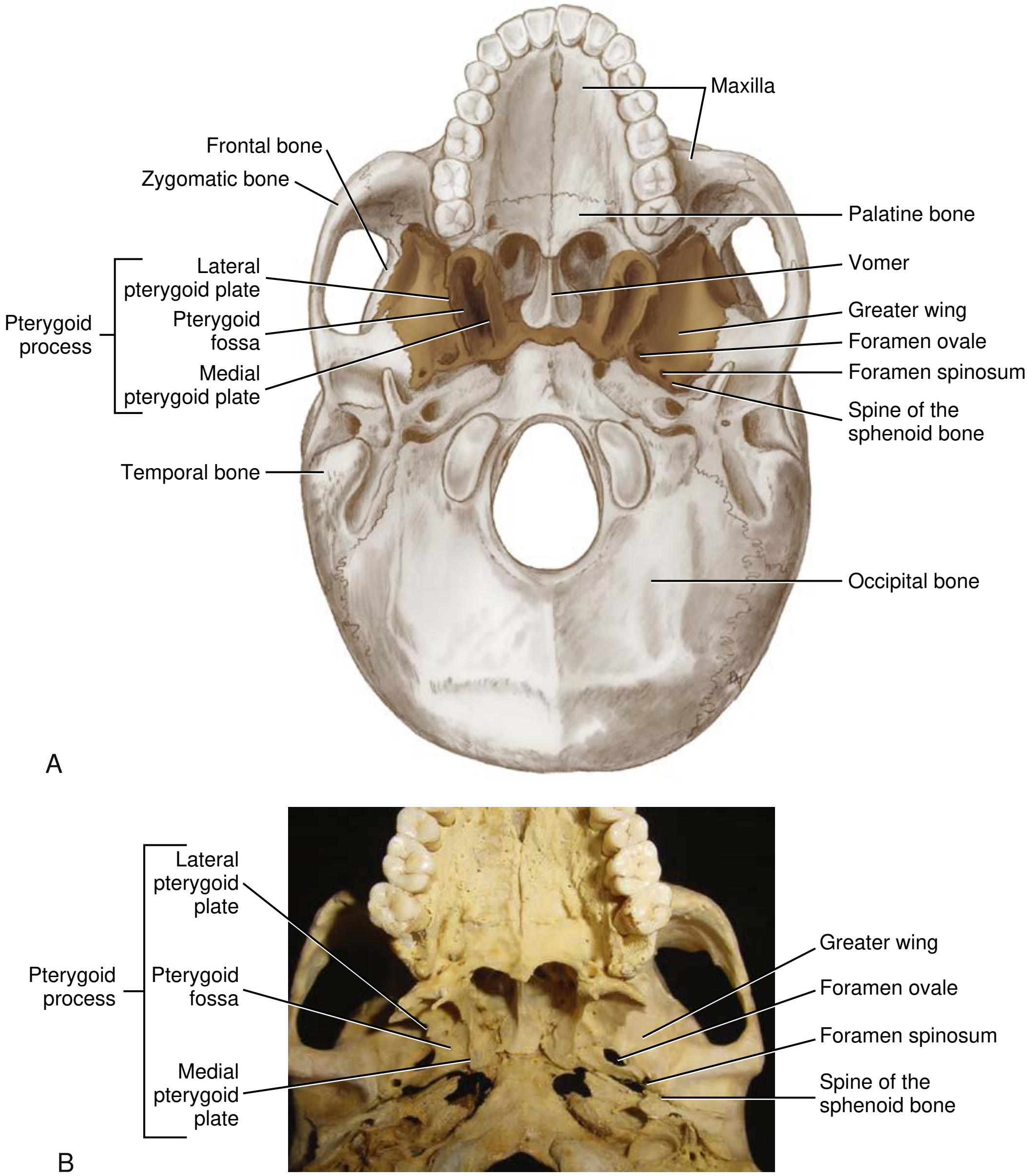


**Fig. 3.32** Inferior view of the external surface of the skull with the sphenoid bone highlighted with its bony articulations and features noted (**A**), and also a close-up of the sphenoid bone (**B**). (**B**, Courtesy of Margaret J. Fehrenbach, RDH, MS.)

somewhat resembles a bat with its wings extended; others see a butterfly taking wing. The bone itself consists of a body and its processes along with other features and openings.

The sphenoid bone has also been called the "keystone" of the cranial floor because it is in contact with most of the other cranial bones. The sphenoid bone articulates with the frontal bone, parietal bones, ethmoid bone, temporal bones, zygomatic bones, palatine bones, vomer, and occipital bones as well as the maxillae. Thus the sphenoid helps to connect the cranial skeleton to the facial skeleton.

Since this bone is complex and centrally located, parts of the sphenoid are encountered in almost every significant juncture of the skull. This bone also assists with the formation of the base of the cranium and the lateral borders of the skull, as well as the floors and walls of each of the orbits. Both of these factors allow the sphenoid bone to be noted from various viewpoints of the skull. Even upon viewing it so readily, it still is one of the more difficult bones of the intact skull to describe and visualize separately.

The sphenoid bone is also important to dental professionals because it is the attachment site for certain muscles of mastication and also provides passage by way of its foramina for the branches of the fifth cranial or trigeminal nerve that serves the oral cavity.

Although it lies centrally, a sphenoidal fracture can occur (see the earlier discussion on bone fractures in this chapter). However, since its location is somewhat hidden within the rest of the skull, injuries to it are not as common as those exposed at the anterior of the skull. With severe impacts such as whiplash with vehicle accidents, the sphenoid bone can fracture affecting vision or causing nerve damage since the many neurovascular structures that traverse it are also vulnerable to