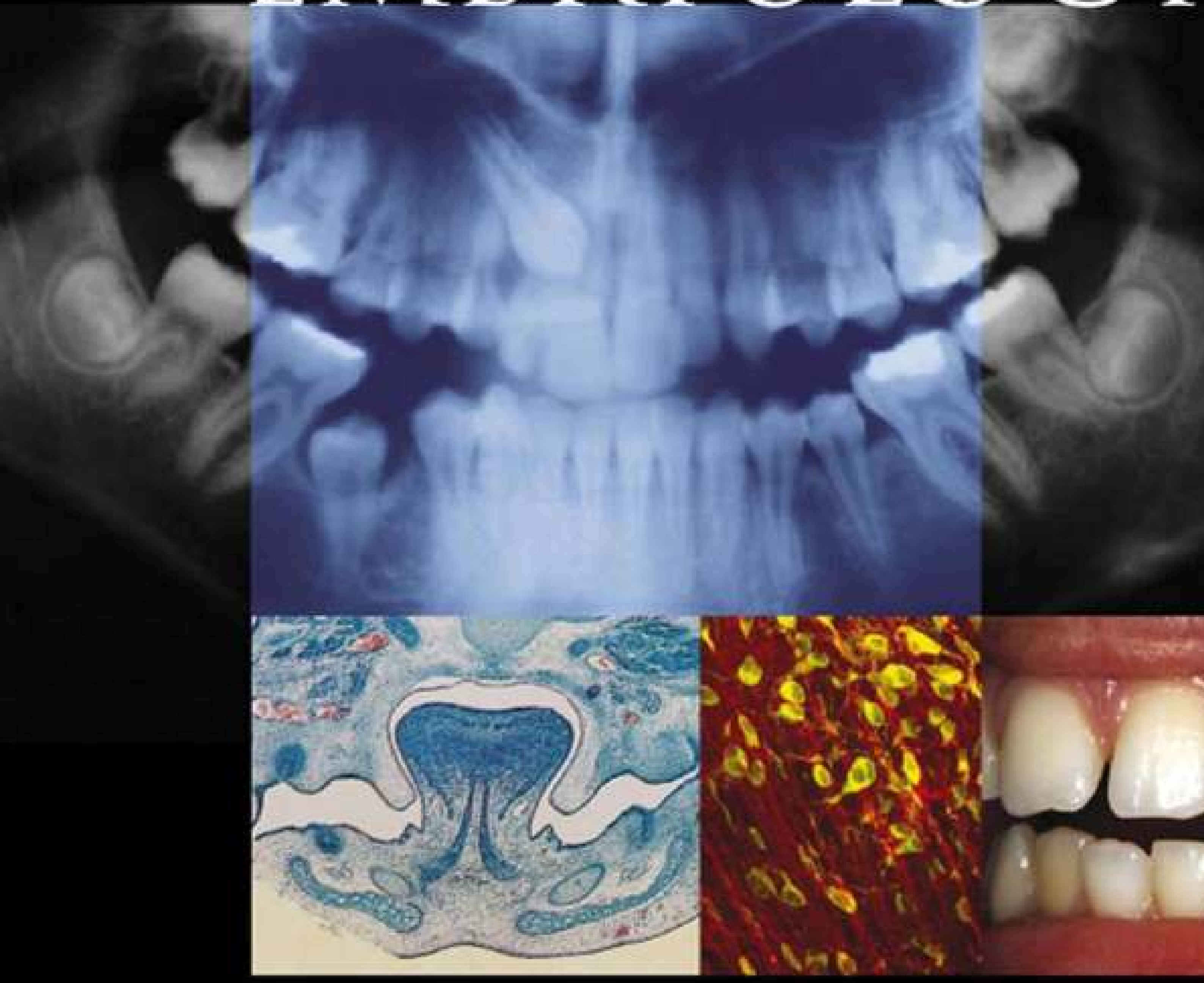
Fourth Edition

ORAL ANATOM
HISTOLOGY an
EMBRYOLOGY



B. K. B. Berkovitz • G. R. Holland • B. J. Mox

MOSBY
ELSEVIER

ORAL ANATO
HISTOLOGY
EMBRYOLOG

Commissioning Editor: Alison Taylor
Development Editor: Lulu Stader
Project Manager: Jane Dingwall
Designers: Sarah Russell/Kirsteen Wright
Illustrator: Marion Tasker (new figures)
Illustration Manager: Merlyn Harvey

Fourth Edition

ORAL ANATOMY, HISTOLOGY and EMBRYOLOGY

B. K. B. Berkovitz BDS, MSc, PhD, FDS (Eng)

Emeritus Reader, Anatomy and Human Sciences, Biomedical and Health Sciences, King's College, Lond

G. R. Holland BSc, BDS, PhD, CERT ENDO

Professor, Department of Cariology, Restorative Sciences and Endodontics, School of Dentistry and De Cell and Developmental Biology, University of Michigan, Ann Arbor, USA

B. J. Moxham BSc, BDS, PhD

Professor of Anatomy, Cardiff School of Biosciences, Cardiff University, Cardiff, UK

MOSBY

ELSEVIER

EDINBURGH LONDON NEW YORK OXFORD PHILADELPHIA ST LOUIS SYDNEY TORONTO 2009

Contents

This page intentionally left blank

Preface

This, the fourth edition of our book, follows the form and principles we established in the earlier third edition. Thus, although in that third edition we changed the format of the book from a textbook and atlas to a textbook, we retained the considerable number of illustrations, believing strongly that anatomical and histological textbooks must present information in a visual format. This fourth edition maintains this principle and we have expanded the book considerably to incorporate nearly 1100 illustrations (over twenty percent of the illustrations being new). This time, the expansion of the book has been accomplished without removing any of the topics covered in the previous edition. On the contrary, we have added a chapter on ageing of orodental tissues, because of the increased longevity of humans and the consequences of this to the types of patient seeking dental treatment. This chapter also includes some information concerning forensic dentistry and dental archaeological material. As for the earlier editions of our book, we have preferred, wherever possible, to use photographs and photomicrographs for our illustrations rather than diagrams or drawings, however expertly and artistically presented, as we wish to encourage students to look at 'real' material, warts and all!

As for the previous edition, we are adamant that dental students should not just learn basic ('core') material for oral anatomy, histology and embryology. These are important subjects that provide essential scientific material that should be appreciated by all dental surgeons who wish to consider themselves professionals (in all senses of the term). Indeed, it seems to us that a book such as this that attempts to be encyclopaedic in scope is increasingly necessary where there is a shortage of experienced teachers for the subjects covered! Furthermore, because of the increasing shortage of teachers with clinical backgrounds in dentistry, we have expanded the 'clinical considerations' section in most chapters of our book.

It is, unfortunately, increasingly difficult to obtain funding for basic dental research that involves significant amounts of morphological investigation. And yet, such research does continue and considerable advances in our knowledge of the microscopic anatomy and development of orodental tissues have occurred in recent times. All chapters have been reviewed. In some (e.g. enamel integuments), only minor changes were deemed necessary whereas in others (e.g. alveolar bone and the salivary glands) we have made significant additions. We have also taken the opportunity to improve some of the illustrations where no changes in the text were required. For example, all of the photographs relating to tooth morphology are new. Finally, we are, as ever, grateful to those readers who have provided comments and criticisms. We do not pretend to be infallible and would ask for indulgence if we have strayed from scientific rectitude!

2008
B. K. B. Berkovitz
G. R. Holland
B. J. Moxham

Acknowledgements

We are most grateful to the numerous colleagues who generously provided photographic material for our book and these have been acknowledged in the text. In addition, we owe a debt of thanks to the following researchers for their constructive criticisms of draft chapters: Dr T. Arnett, Dr A. E. Barrett, Dr J. H. Bennett, Dr S. R. Berkovitz, Dr R. Brooks, Dr M. Cobourne, Dr R. J. Cook, Professor M. C. Dean, Dr A. Grigoriadis, Dr J. D. Harrison, Dr M. Ide, Professor R. W. A. Linden, Dr H. Liversidge, Professor F. McDonald, Dr T. A. Mitsiadis, Professor P. R. Morgan, Dr I. Needleman, Professor R. G. Oliver, Dr C. Orr, Professor R. M. Palmer, Professor T. Pitt-Ford, Dr G. D. Procter, Professor P. T. Sharpe, Dr A. Thexton, Professor T. J. Watson.

We are grateful to Ms K. Kirwan for much photographic help and for producing a number of the new line diagrams. We also acknowledge photographic help from Mr G. Fox.

In vivo appearance of the oral cavity

Fig. 1.1 The oral cavity.

The oral cavity (Fig. 1.1) extends from the lips and cheeks externally to the pillars of the fauces internally, where it continues into the oropharynx. It is subdivided into the vestibule external to the teeth and the oral cavity proper internal to the teeth. The palate forms the roof of the mouth and separates the oral and nasal cavities. The floor of the oral cavity consists of mucous membrane covering the mylohyoid muscle and is occupied mainly by the tongue. The lateral walls of the oral cavity are defined by the cheeks and retromolar regions. The primary functions of the mouth are concerned with the ingestion (and selection) of food, and with mastication and swallowing. Secondary functions include speech and ventilation (breathing).

LIPS

The lips (Fig. 1.2) are composed of a muscular skeleton (the orbicularis oris muscle) and connective tissue, and are covered externally by skin and internally by mucous membrane. The red portion of the lip (the vermilion) is a feature characteristic of humans. The sharp junction of the vermilion and the skin is termed the vermilion border. In the upper lip the vermilion protrudes in the midline to form the tubercle. The lower lip shows a slight depression in the midline corresponding to the tubercle. From the midline to the corners of the mouth the lips widen and then narrow. Laterally, the upper lip is separated from the cheeks by nasolabial grooves. Similar grooves appear with age at the corners of the mouth to delineate the lower lip from the cheeks (the labiomarginal sulci). The labiomental groove separates the lower lip from the chin. In the midline of the upper lip runs the philtrum. The corners of the lips (the labial commissures) are usually located adjacent to the maxillary canine and mandibular first premolar teeth. The lips exhibit sexual dimorphism; as a general rule, the skin of the male is thicker, firmer, less mobile and hirsute. The lips illustrated are lightly closed at rest and are described as being ‘competent’.

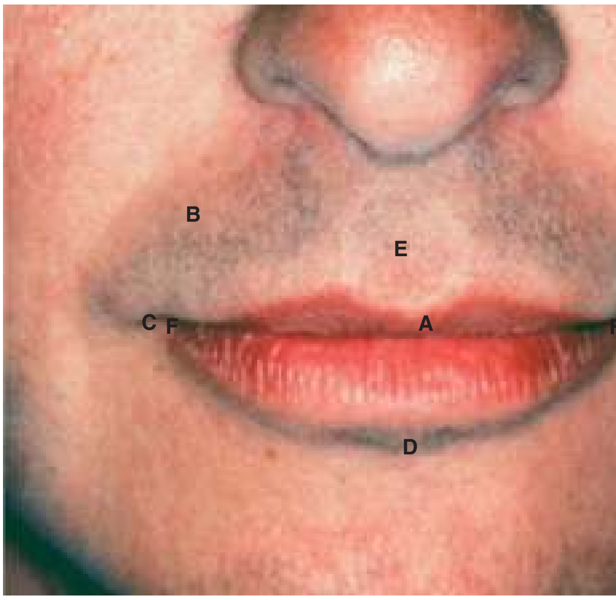


Fig. 1.2 The lips. A = tubercle; B = nasolabial groove; C = labioma
D = labiomental groove; E = philtrum; F = labial commissure.

Incompetent lips (Fig. 1.3) describe a situation where, a
the facial muscles relaxed, a lip seal is not produced. It is c
tance that this is distinguished from conditions where the
held apart habitually (as often occurs with ‘mouth breat
posture illustrated in Figure 1.3 can be described as bei
competent’, as the lips would be capable of producing a sea
were no interference caused by the protruding incisors. Wh
incompetent, the pattern of swallowing is often modified

Fig. 1.3 Incompetent lips.

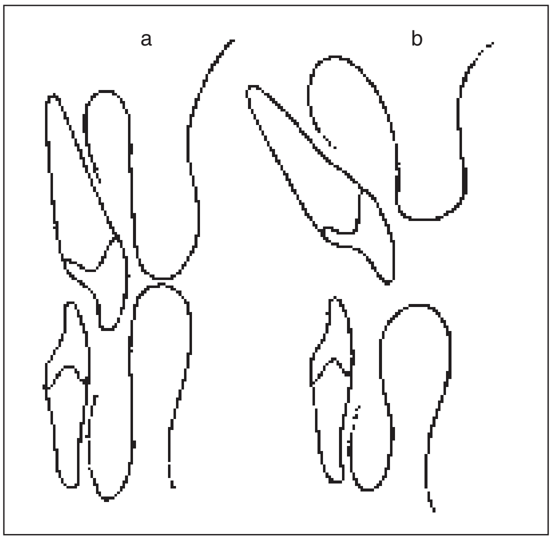


Fig. 1.4 (a) Competent lips maintaining normal inclination of the incisors. (b) Incompetent lips resulting in proclination of the upper incisors.

anterior oral seal. Accordingly, an oral seal may be formed by contact between the lower lip (or the tongue) and the palatal mucosa, and there may even be a forcible tongue thrust. It has been estimated that in the UK and the USA about 50% of children at the age of 11 years have some degree of lip incompetence.

The position and activity of the lips are important in controlling the degree of protrusion of the incisors. With competent lips (Fig. 1.4a) the tips of the maxillary incisors lie below the upper border of the lower lip, this arrangement helping to maintain the 'normal' inclination of the incisors. With incompetent lips (Fig. 1.4b) the maxillary incisors may not be so controlled and the lower lip may even lie behind them, thus producing an exaggerated proclination of these teeth. If there is tongue thrusting to provide an anterior oral seal, further forces that tend to protrude the incisors are generated. A tight, or overactive, lip musculature may be associated with retroclined incisors.

ORAL VESTIBULE

The oral vestibule (Fig. 1.5) is a slit-like space between the lips and cheeks, and the teeth and alveolus. At rest, or with the mouth open, the vestibule and oral cavity proper directly communicate between the

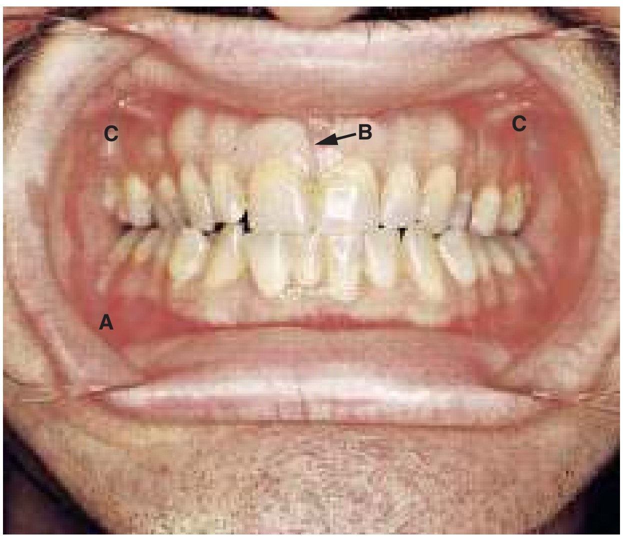


Fig. 1.5 The oral vestibule. A = vestibular fornix; B = upper labial frenum; C = frenum in the region of the upper premolar teeth.

Fig. 1.6 Midline diastema between upper central incisor teeth, produ enlarged labial frenum.

teeth. When the teeth occlude, the vestibule is a closed spa municates with the oral cavity proper only behind the last retromolar regions). This provides a pathway for the adm nutrients in a patient whose jaws have been wired together fracture.

The mucosa covering the alveolus is reflected on to the lips forming a trough or sulcus called the vestibular fornix. In sor the sulcus, the mucosa may show distinct sickle-shaped folds the cheeks and lips to the alveolus. The upper and lower la frenula are such folds in the midline. Other folds of variable may traverse the sulcus in the region of the canines or pre frena are said to be more pronounced in the lower sulcus. All loose connective tissue and are neither muscle attachments large blood vessels.

The upper labial frenum should be attached well below crest. A large frenum with an attachment near this crest may with a midline diastema between the maxillary first inciso Prominent frena may also influence the stability of dentures.

GINGIVA

The gums or gingivae, the oral mucosa covering the a (which supports the roots of the teeth) and the necks (cervic the teeth, are divided into two main components (Fig. 1.7). lining the lower part of the alveolus is loosely attached to th via a diffuse submucosa and is termed the alveolar mucosa. It from the gingiva (which covers the upper part of the alveo the necks of the teeth) by a well defined junction, the r junction. The alveolar mucosa appears red, the gingiva pale colour differences relate to differences in the type of kerat the proximity to the surface of underlying blood vessels. I blood vessels may readily be seen coursing beneath the alve (Fig. 1.7b). The gingiva may be further subdivided into gingiva and the free gingiva. The attached gingiva is firmly periosteum of the alveolus and to the teeth, and the free gin attached around the cervical region of the tooth. A groove (the groove) may be seen between the free and attached gingiva. corresponds roughly to the floor of the gingival sulcus that inner surface of the attached gingiva from the enamel its 14.36). The interdental papilla is that part of the gingiva that f between adjacent teeth. A feature of the attached gingiva i stippling. The degree of stippling varies from individual to in according to age, sex and the health of the gingiva. Unlike gingiva, the free gingiva is not stippled. On the lingual surface

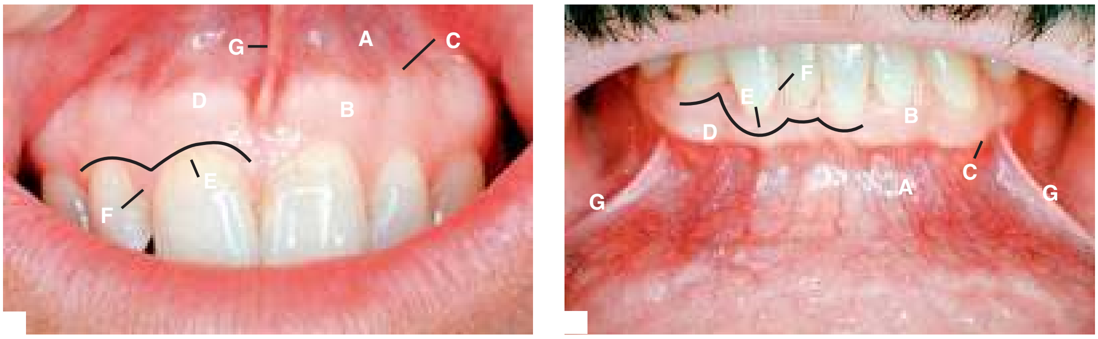


Fig. 1.7 Upper (a) and lower (b
A = alveolar mucosa; B = gingiv
gival junction, D = attached ging
gingiva; F = interdental papilla;
frenum.

jaw the attached gingiva is sharply differentiated from the alveolar mucosa towards the floor of the mouth by a mucogingival line. On the palate, however, there is no obvious division between the attached gingiva and the rest of the palatal mucosa as this whole surface is keratinized masticatory mucosa.

CHEEKS

The cheeks extend intra-orally from the labial commissures anteriorly to the ridge of mucosa overlying the ascending ramus of the mandible posteriorly. They are bounded superiorly and inferiorly by the upper and lower vestibular fornices (Fig. 1.5). The mucosa is non-keratinized and, being tightly adherent to the buccinator muscle, is stretched when the mouth is opened and wrinkled when closed. Ectopic sebaceous glands without any associated hair follicles may be evident in the mucosa and are called Fordyce spots (Fig. 1.8). They are seen as small, yellowish-white spots,

Fig. 1.8 Inner surface of the cheek, showing Fordyce spots as yellowish patches.

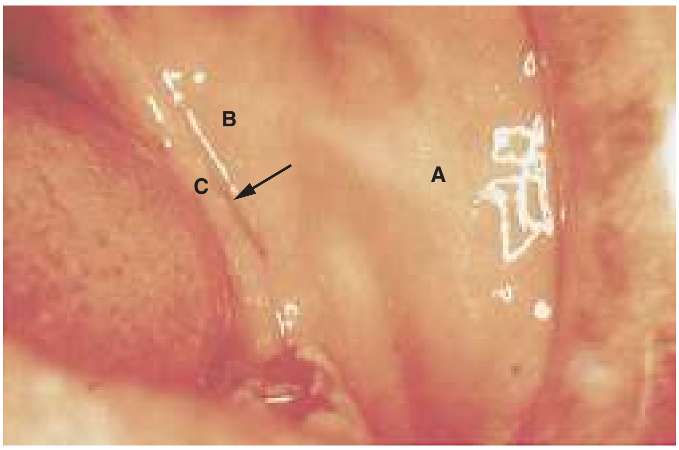


Fig. 1.9 Retromolar region. A = inner surface of cheek; B = ridge overlying ramus of mandible; C = ridge overlying the pterygomandibular raphe. The arrow indicates a landmark for the insertion of needle for local anaesthesia of the lingual and inferior alveolar nerves.

occurring singly or in clusters on the margin of the lips or
the cheeks (and other sites such as genital skin). They can
majority of patients and are said to increase with age.

Few structural landmarks are visible in the cheeks. Th
drains into the cheek opposite the maxillary second mola
opening may be covered by a small fold of mucosa term
papilla (see Fig. 1.25). In the retromolar region, in front o
the fauces, a fold of mucosa containing the pterygoma
extends from the upper to the lower alveolus (Fig. 1.9). Th
dibular space, in which the lingual and inferior alveolar n
lateral to this fold and medial to a ridge produced by the man
The groove lying between the ridges produced by the raphe
of the mandible is an important landmark for insertion of a
anaesthesia of the lingual and inferior alveolar nerves (see

PALATE

The palate forms the roof of the mouth and separates the
cavities. It is divided into the immovable hard palate ant
movable soft palate posteriorly. As their names imply, the
hard palate is bony while that of the soft palate is fibrous.

The hard palate is covered by a masticatory, keratinized
firmly bound down to underlying bone and also contains se
It shows a distinct prominence immediately behind the m
incisors, the incisive papilla (Fig. 1.10). This papilla overl
fossa through which the nasopalatine nerves enter on to the
ing posteriorly in the midline from the papilla runs a rid
palatine raphe. Here, the oral mucosa is attached directly t
the presence of a submucous layer of tissue. Palatine rug
ridges in the anterior part of the hard palate that radiate so
versely from the incisive papilla and the anterior part of the
Their pattern is unique to the individual and, like fingerprin
for forensic purposes to help identify individuals. At the

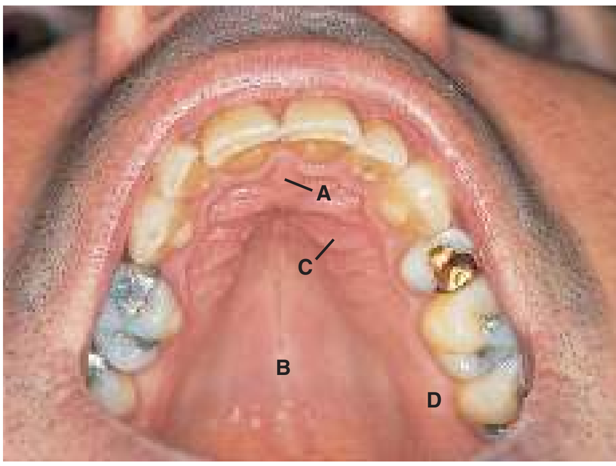


Fig. 1.10 The hard palate. A = incisive papilla; B = palatine raphe;
rugae; D = alveolus.

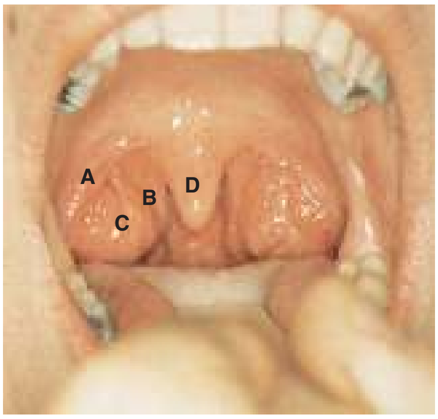


Fig. 1.11 The soft palate and oropharyngeal isthmus. A = palatoglossal fold; B = palatopharyngeal fold; C = palatine tonsil; D = uvula.

palate and the alveolus lies a mass of soft tissue (submucosa) in which run the greater palatine nerves and vessels. The shape and size of the dome of the palate varies considerably, being relatively shallow in some cases and having considerable depth in others.

The boundary between the soft palate and the hard palate is readily palpable and may be distinguished by a change in colour, the soft palate having a yellowish tint. Extending laterally from the free border of the soft palate on each side are the palatoglossal and palatopharyngeal folds (pillars of the fauces), the palatoglossal fold being more anterior (Fig. 1.11). These folds cover the palatoglossus and palatopharyngeus muscles and between them lies the tonsillar fossa that, in children, houses the palatine tonsil. The palatine tonsil is a collection of lymphoid material of variable size that is likely to atrophy in the adult. It exhibits several slit-like invaginations (the tonsillar crypts), one of which is particularly deep and named the intratonsillar cleft. The free edge of the soft palate in the midline is termed the palatal uvula. The oropharyngeal isthmus is where the oral cavity and the oropharynx meet. It is delineated by the palatoglossal folds.

Knowledge of the anatomy of the palate has clinical relevance when siting the posterior border (postdam) of an upper denture. The denture needs to bed into the tissues at the anterior border of the soft palate (at a location sometimes referred to as the 'vibrating line' because the soft palate can be seen to move here on asking a patient to say 'ah'). In most individuals two small pits, the fovea palatini, may be seen (Fig. 1.12) on either side of the midline; these represent the orifices of ducts from some of the minor mucous glands of the palate. The fovea palatini can also be seen on impressions of the palate and a postdam may usually be safely placed a couple of millimetres behind the pits.

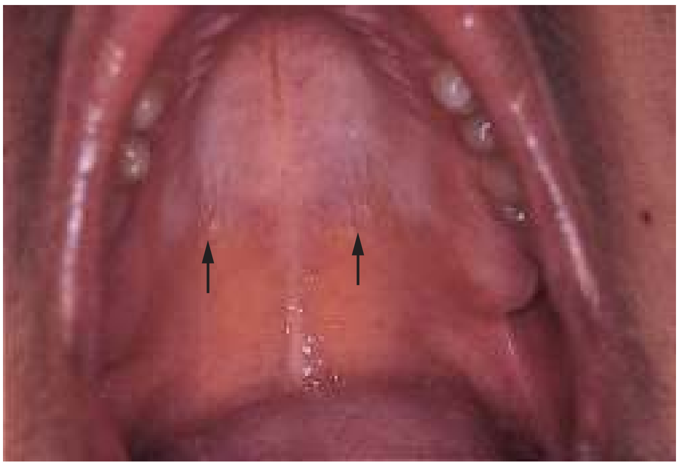


Fig. 1.12 Oral surface of the soft palate showing the fovea palatini (arrows).

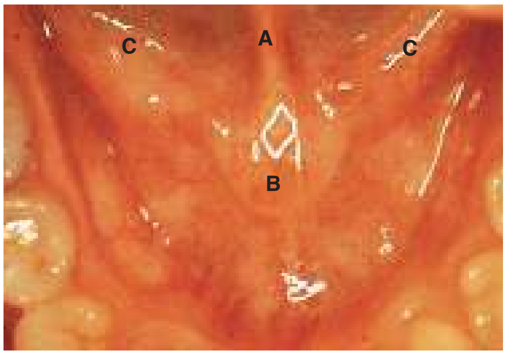


Fig. 1.13 Floor of the mouth. A = lingual frenum; B = sublingual pap
C = sublingual folds.

FLOOR OF THE MOUTH

The moveable floor of the mouth is a small, horseshoe-sh
above the mylohyoid muscle and beneath the movable part o
(Fig. 1.13). It is covered by a lining of non-keratinized mu
midline, near the base of the tongue, a fold of tissue calle
frenum extends on to the inferior surface of the tongue. Th
papilla, on to which the submandibular salivary ducts open in
is a large centrally positioned protuberance at the base of th
either side of this papilla are the sublingual folds, beneath w
submandibular ducts and sublingual salivary glands.

TONGUE

The tongue is a muscular organ with its base attached to th
mouth. It is attached to the inner surface of the mandible nea
and gains support below from the hyoid bone. It functions in
swallowing and speech and carries out important sensory fu
ticularly those of taste. The lymphoid material contained in
third has a protective role.

The inferior (ventral) surface of the tongue, related to the
mouth, is covered by a thin lining of non-keratinized mucosa
bound down to the underlying muscles. In the midline, ext
the floor of the mouth, lies the lingual frenum (Fig. 1.14).
extends across the floor of the mouth to be attached to the
alveolus. Such an overdeveloped lingual frenum (ankylog
restrict movements of the tongue. Lateral to the frenum
fringed folds: the fimbriated folds. Also visible through the m
deep lingual veins.

The upper (dorsal) surface of the tongue may be subdiv
anterior two-thirds (palatal part) and a posterior one-third
part). The junction of the palatal and pharyngeal parts is

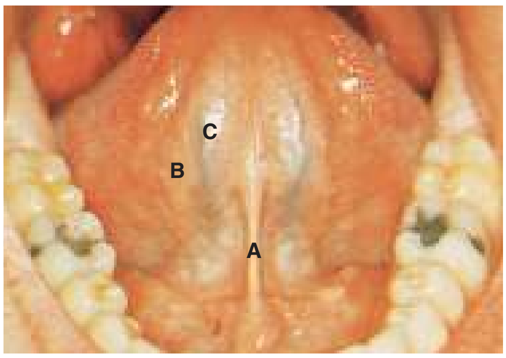


Fig. 1.14 Inferior surface of the tongue. A = lingual frenum; B = fim
C = deep lingual vein.

Fig. 1.15 Dorsu
tongue.
A = sulcus term
B = foramen ca
C = circumvalla
D = lingual folli
E = palatogloss
F = palatine ton

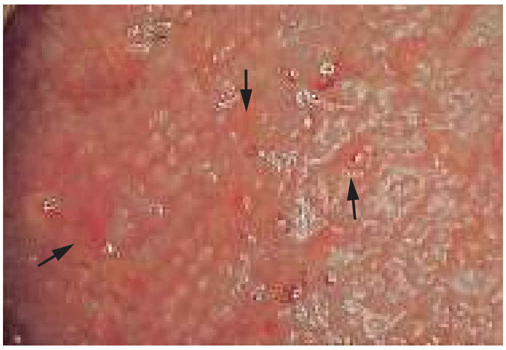


Fig. 1.16 Dorsum of the tongue, showing filiform and fungiform (arrows) papillae.

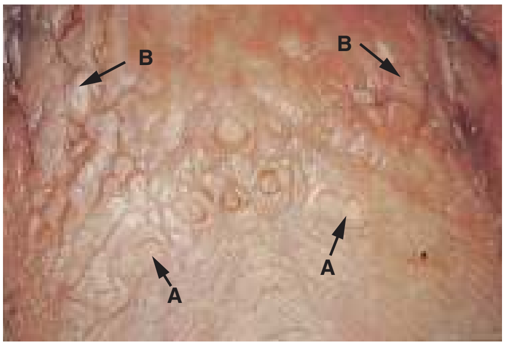


Fig. 1.17 Dorsum of the tongue, showing circumvallate papillae (A). B = lingual follicles.

Fig. 1.18 Side of the tongue, showin
appearance of foliate papillae.

shallow V-shaped groove, the sulcus terminalis (Fig. 1.15). The angle (or ‘V’) of the sulcus terminalis is directed posteriorly. In the midline, near the angle, may be seen a small pit called the foramen caecum. This is the primordial site of development of the thyroid gland.

The mucosa of the palatal part of the dorsum of the tongue is mainly keratinized and is characterized by an abundance of projections (papillae). The most numerous are the filiform papillae appearing as whitish, conical elevations (Fig. 1.16). Interspersed between the filiform papillae and readily seen at the tip of the tongue are isolated reddish prominences, the fungiform papillae. The largest papillae on the palatal surface of the tongue are the circumvallate papillae, which lie immediately in front of the sulcus terminalis. There are about 10–15 circumvallate papillae (Fig. 1.17). They do not project beyond the surface of the tongue and are surrounded by a circular ‘trench’. Foliate papillae (Fig. 1.18) appear as a series of parallel, slit-like folds of mucosa on each lateral border of the tongue, near the attachment of the palatoglossal fold. The foliate papillae are of variable length in humans and are the vestige of large papillae found in many other mammals. Apart from the filiform papillae, the papillae are the site of taste buds.

The pharyngeal surface of the dorsum of the tongue is non-keratinized and is covered with large rounded nodules termed the lingual follicles. These follicles are composed of lymphatic tissue, collectively forming the lingual tonsil. The posterior part of the tongue slopes towards the epiglottis, where three folds of mucous membrane are seen: the median and lateral glossoepiglottic folds. The anterior pillars of the fauces (the palatoglossal arches) extend from the soft palate to the sides of the t
circumvallate papillae.

CLINICAL CONSIDERATIONS

There are a number of conditions in the mouth that can l
the non-clinical environment. They provide examples of 1
tion, 2) common benign disorders and 3) disorders that
normal features, which may be otherwise inconspicuous.

As examples of normal variation, we can consider pigmen
spots and black hairy tongue. In dark-skinned patients, patc
pigment may be seen in the mouth, particularly in the ging
This pigmentation is due to the extra melanosome granules
the oral epithelium (see Fig. 14.22). Such pigmentation n
tinguished from other forms of mucosal pigmentation and
melanin pigmentation associated with a range of inflammat
such as lichen planus where melanin pigment is held withi
in the lamina propria (Figs 1.20, 1.21). Fordyce spots are
degrees as small, yellowish-white spots, occurring singly o
the margin of the lips (Fig. 1.22) or in the mucosa of the ch
(and other sites such as genital skin). They can be seen in
patients and are said to increase with age. They represen
sebaceous glands (Fig. 1.23) without any associated hai
range of variation in the filiform papillae on the dorsum o

Fig. 1.19 Patches of dark melanin pigment appearing in the region of the attached gingiva. Courtesy of Professor P.R. Morgan.

Fig. 1.20 Area of increased pigmentation (arrowed) associated with whitish patches due to lichen planus. Courtesy of Professor P.R. Morgan.

Fig. 1.21 Micrograph of biopsy taken fr mented area seen in Fig. 1.20, showing pigment within macrophages (arrows) ly lamina propria. The epithelium is parake giving the whitish patches (H & E; ×100 Professor P.R. Morgan.

Fig. 1.22 Fordyce spots appearing as yellow spots on the vermilion (red zone) of the lip. The black spots below represent hair follicles on the surface of the adjacent skin of the chin. Courtesy of Professor P.R. Morgan.

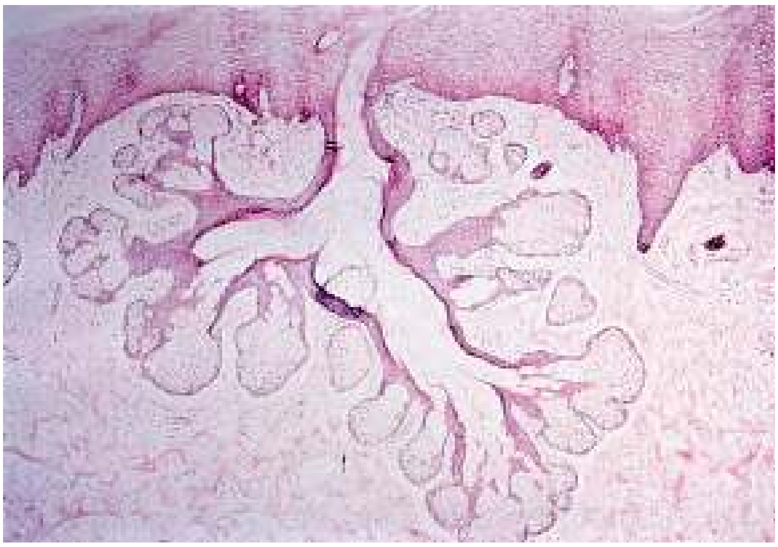


Fig. 1.23 Micrograph of a Fordyce spot, showing it to be a sebaceous gland (H & E;. ×50). Courtesy of Professor P.R. Morgan.

well illustrated by black hairy tongue (lingua villosa nigra), a benign condition in which there is hypertrophy of these papillae (Fig. 1.24). Instead of being about 1 mm in length, the filiform papillae may reach up to 15 mm, giving the dorsum an appearance of being covered in fine hairs. This provides a suitable environment for bacteria (and sometimes fungi)

Fig. 1.24 Black hairy tongue. Courtesy of Professor P.R. Morgan.

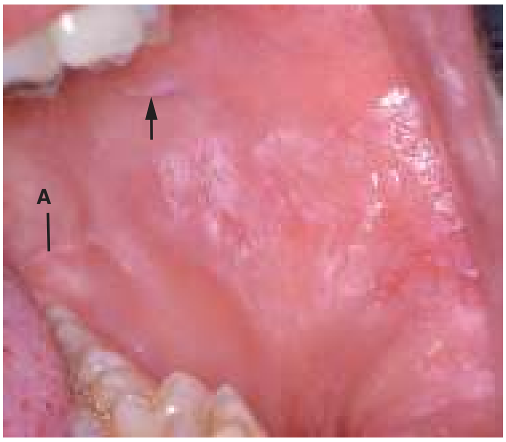


Fig. 1.25 View of buccal mucosa showing a linea alba adjacent to th (A) at the level of the occlusal plane. In front of this line, the white p cheek represent more diverse cheek chewing. Arrow shows the paro Courtesy of Professor P.R. Morgan.

to accumulate and, together with retained pigments of dietary origin, may colour the surface of the tongue black. The cond associated with the administration of antibiotics or mouthwas alter the normal bacterial population. It has a frequency of the population.

Examples of common benign disorders are linea alba and inside of the cheek and level with the occlusal plane, a li raised whitish ridge may be seen, the linea alba (Fig. 1.25). It the result of low-grade, intermittent trauma due to folds of c being trapped between the teeth. More active trauma associate chewing produces a much larger, irregular white patch (Fig

Fig. 1.26 Section of buccal mucosa showing the linea alba to be parakeratinized compared with the normal non-keratinized state of the buccal mucosa (H & E; ×50). Courtesy of Professor P.R. Morgan.

Fig. 1.27 Upper jaw showing a relatively small torus palatinus as an overgrowth of bone along the midline of the palate. Courtesy of Dr C. Dunlap.

Fig. 1.28 Upper jaw showing a large torus palatinus as an overgrowth of bone along the midline of the palate. Courtesy of Dr C. Dunlap.

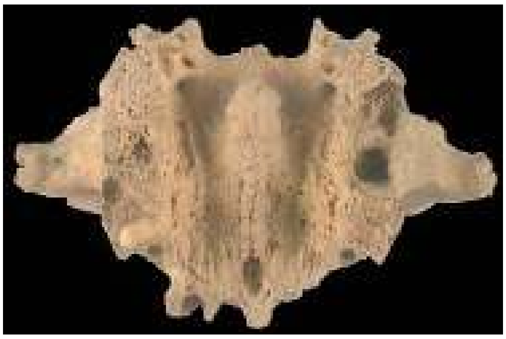


Fig. 1.29 Isolated palate showing torus palatinus as an overgrowth of bone along the midline. Courtesy of the Royal College of Surgeons of England.

Fig. 1.30 Unilateral torus mandibula lingual surface of the mandible. Cou P.R. Morgan.

Fig. 1.31 Bilateral torus mandibularis (arrows) on the lingual surface of the mandible. Courtesy of Dr C. Dunlap.

Fig. 1.32 Torus mandibularis on the buccal surface of the mandible. Courtesy of Dr C. Dunlap.

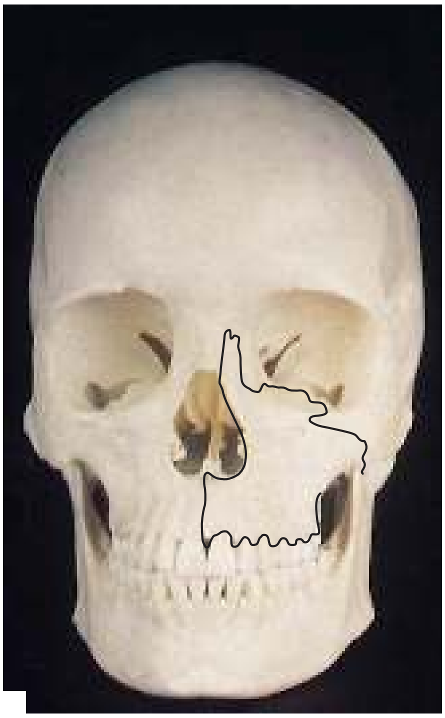
Fig. 1.33 The palate of a heavy smok with an overall whitish appearance to highlights the orifices of the mucous spots. Courtesy of Professor P.R. Morg

constant irritation converts the surface epithelium from its normal non-keratinized state into a parakeratinized layer (Fig. 1.26).

Individual variation in the shape of the jaws is recognized by anatomists and pathologists. Such variations blend with benign conditions. As an example, tori are benign localized overgrowths of bone found in both the upper (torus palatinus) and lower (torus mandibularis) jaws, resulting in an increased radiopacity in the region. In the upper jaw, the enlargement is typically seen in the midline (Figs 1.27–1.29), while in the lower jaw it is usually on the lingual aspect in the canine/premolar region and may be unilateral (Fig. 1.30) or bilateral (Fig. 1.31). However, a torus mandibularis may also affect the buccal surface of the mandible (Fig. 1.32). Torus palatinus is more common in females, while torus mandibularis is slightly more common in males. Tori vary in size from small to very large and there is a tendency for them to increase in size with age. Tori may be related to functional adaptatio some evidence that their incidence is decreased in associa teeth being present in the jaws. They require no treatm interfere with the construction of satisfactory removable incidence varies from about 0.5% to over 65%, being l Caucasians and more frequent in Eskimos, Mongoloids a groups.

As an example of a disorder that highlights normal fea be otherwise inconspicuous, one can inspect the palate o smokes heavily, revealing a whitish appearance that highl reddish spots (Fig. 1.33). The white appearance is the r nounced orthokeratinized layer being present due to chron this highlights the orifices of the ducts (as red spots) asso numerous mucous salivary glands present.

2 Dento-osseous structures



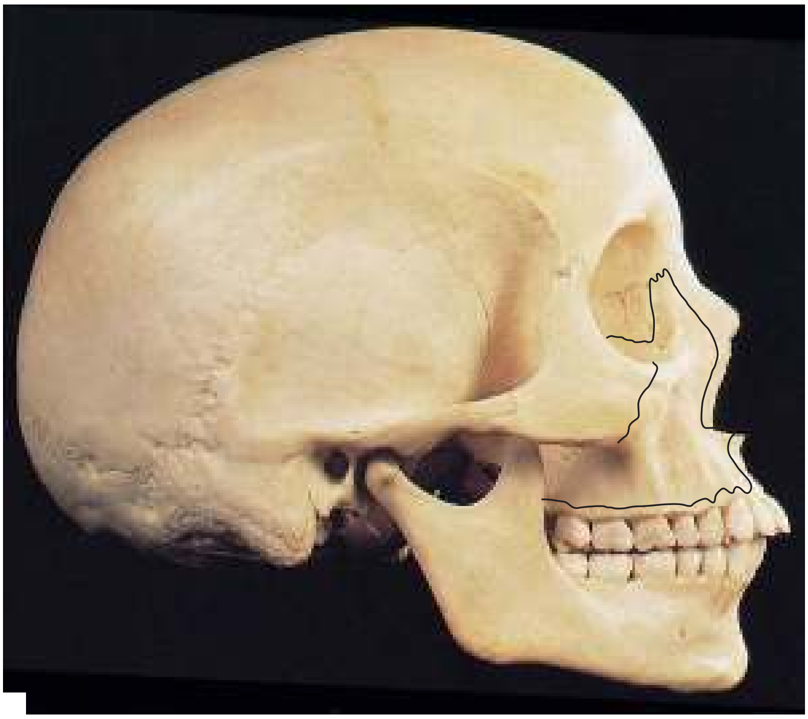


Fig. 2.1 Front (a) and side (b) views of the skull, showing the relationship between the jaws and the remainder of the skull. The black line describes the bou maxillary bone.

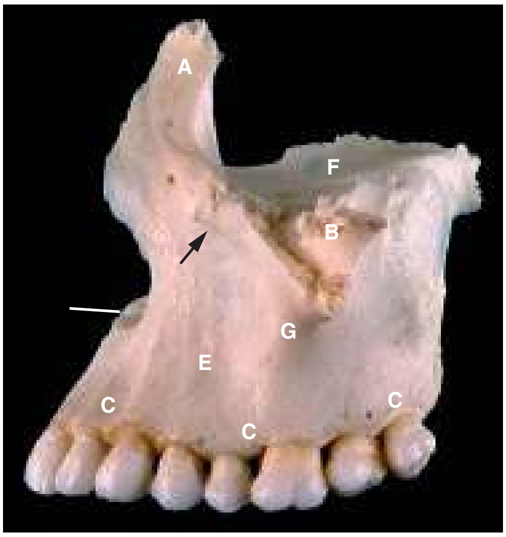


Fig. 2.2 Lateral aspect of the maxilla. A = frontal process; B = zygom C = alveolar process; D = site of anterior nasal spine; E = canine foss plate; G = jugal crest. The infra-orbital foramen is arrowed.

JAWS

The jaws are the tooth-bearing bones. They comprise three bones. The two maxillary bones form the upper jaw. The lower jaw is a single bone, the mandible (Fig. 2.1).

The skull is the most complex osseous structure in the body. It protects the brain, the organs of special sense and the cranial parts of the respiratory and digestive systems. The skull is divided into the neurocranium (which houses and protects the brain and the organs of special sense) and the viscerocranium (which surrounds the upper parts of the respiratory and digestive tracts). The jaws contribute the major part of the viscerocranium, comprising about 25% of the skull. The jaws have evolved from the gill arch elements of early agnathan vertebrates. It is probable that one or two anterior gill arches gradually disappeared with the expansion of the mouth cavity, so that the gill arch that developed phylogenetically into the jaws of ancestral gnathostomes was not the first of the series. Note that the upper jaw not only contains teeth but also contributes to the skeleton of the nose, orbit, cheek and palate.

MAXILLA

The maxilla consists of a body and four processes: the frontal, zygomatic, alveolar and palatine processes. Only the palatine process cannot be seen from the lateral aspect of the maxilla (Fig. 2.2). The anterolateral surface of the maxilla (the malar surface) forms the skeleton of the anterior part of the cheek. In the midline, the alveolar processes of the two maxillae meet at the intermaxillary suture whence they diverge laterall opening into the nasal fossae (the piriform aperture). At the of the piriform aperture, in the midline, lies the bony proje the anterior nasal spine. The malar surface of the body of t concave, forming the canine fossa. Superiorly, the malar su tinuous with the orbital plate of the maxilla and forms the floo

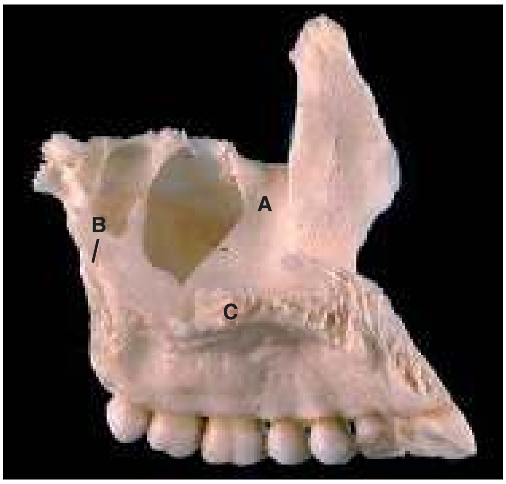


Fig. 2.3 Medial aspect of the maxilla. A = lacrimal groove; B = palatine groove; C = palatine process of maxilla. Note the large opening into the maxillary sinus.

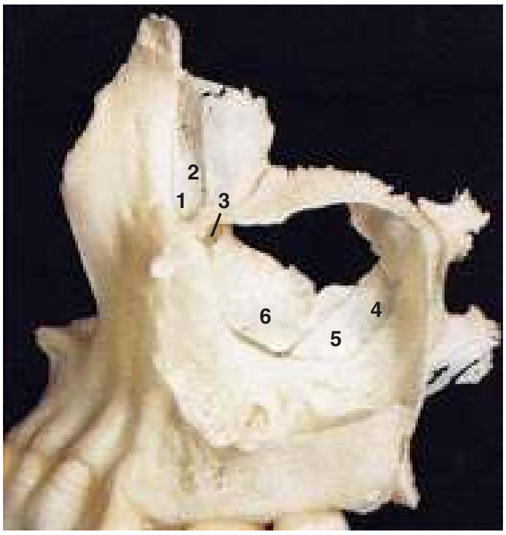


Fig. 2.4 Osteology of the maxillary air sinus showing adjacent bones reducing the size of the ostium. 1 = lacrimal groove of maxilla; 2 = lacrimal groove; 3 = lacrimal bone; 4 = ethmoid bone; 5 = palatine bone; 6 = inferior nasal concha. Courtesy of Professor R.M.H. McMinn.

Anterior to the orbital plate, the frontal process extends above the piriform aperture to meet the nasal and frontal bones. Below the infra-orbital rim lies the infra-orbital foramen through which the infra-orbital branch of the maxillary nerve and the infra-orbital artery from the maxillary artery emerge on to the face. The posterolateral surface of the maxilla (the infratemporal surface) forms the anterior wall of the infratemporal fossa. The malar and infratemporal surfaces meet at a bony ridge extending from the zygomatic process to the alveolus adjacent to the first molar tooth. This ridge is called the zygomatico-alveolar, or jugal, crest. The posterior convexity of the infratemporal surface is termed the maxillary tuberosity and presents several small foramina associated with the posterior superior alveolar nerves (which supply the posterior maxillary teeth). The zygomatic process extends from both the malar and the infratemporal surfaces of the maxilla. From the entire lower surface of the body arises the alveolar process, which supports the maxillary teeth.

The medial aspect of the maxilla is illustrated in Figure 2.3. This part of the maxilla forms the lateral wall of the nose. In the specimen illustrated, the central hollow of the body of the maxilla (the maxillary air sinus or antrum) is divided by a bony septum. In front of the antrum lies a deep

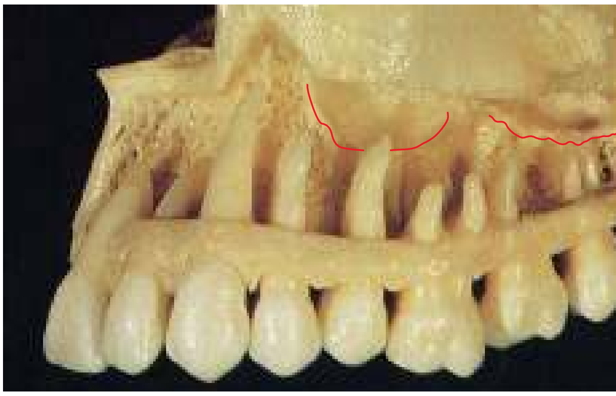


Fig. 2.5 Lateral view of the maxilla, showing close relationship of cheek teeth to the floor of the maxillary sinus (red outline).

vertical groove called the lacrimal groove. This groove n
edge of the lacrimal bone to form the nasolacrimal can
antrum lies the palatine groove, which is converted into a
the greater palatine nerve and artery by the perpendicul
palatine bone. The maxillary palatine process extends ho
the medial surface of the maxilla where the body mee
process.

The lateral wall of the nasal fossa consists mainly of the
of the maxilla. This surface of the isolated bone is occupied
large maxillary hiatus (Fig. 2.3). To reduce the size of this
the hiatus is overlapped by the lacrimal bone and the ethmo
the palatine bone behind and the inferior concha below (F

Maxillary sinus

The maxillary sinus (antrum) is the largest of the paranasa
situated in the body of the maxilla. It is pyramidal in sh
(medial wall) forms part of the lateral wall of the nose. Th
into the zygomatic process of the maxilla. The roof of the
the floor of the orbit and the floor of the sinus is formed
process and part of the palatine process of the maxilla. Th
of the sinus is the facial surface of the maxilla and the p
the infratemporal surface of the maxilla. Running in the ro
is the infra-orbital nerve and vessels. The anterior superior
and vessels run in the anterior wall of the sinus. The pos
alveolar nerve and vessels pass through canals in the poste
the sinus. The medial wall of the maxillary sinus contai
(ostium) of the sinus that leads into the middle meatus of th
opening lies well above the floor of the sinus, its position i
for drainage (see Fig. 5.4a). Infections of the maxillary sinu
require surgical intervention, creating a more favourable dr
closer to the floor of the sinus.

The roots of the cheek teeth are related to the floor o
sinus (Fig. 2.5). The most closely related are the roots of t
manent maxillary molar, especially the apex of its palatal
of the first and third molars and the second premolar ar
further away. Sometimes, only mucosa separates the roots
Care must be taken (particularly when extracting fracture
region) to avoid creating an oro-antral fistula, when an e
channel exists between the oral cavity and maxillary sinus

The maxillary air sinus is lined by respiratory epithel
columnar epithelium), with numerous goblet cells. The sinu
by the infra-orbital nerve and superior alveolar branches o
nerve.

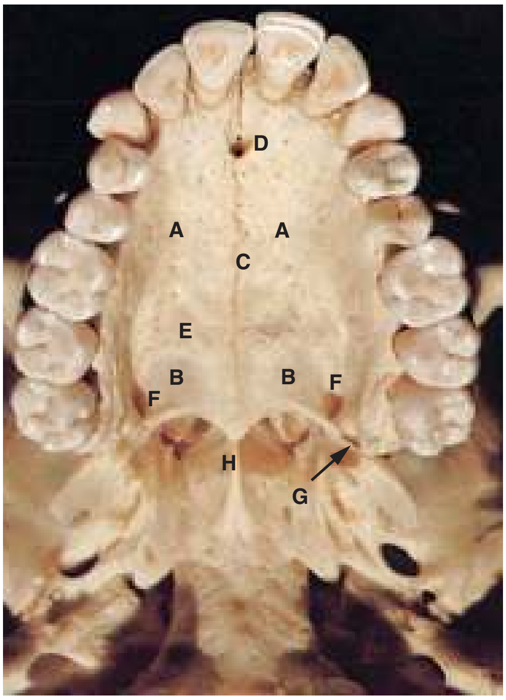


Fig. 2.6 Oral surface of the hard palate.
A = palatine processes of maxillae
B = horizontal plates of the palatine bones
C = median palatine suture
D = incisive fossa
E = transverse palatine suture
F = greater palatine foramina
G = lesser palatine foramen
H = posterior nasal spine.

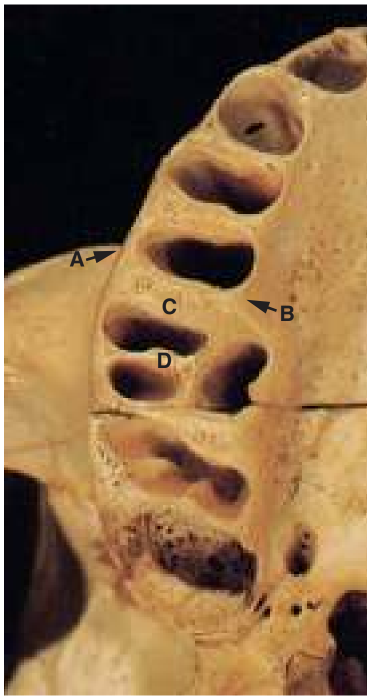


Fig. 2.7 View of the maxilla following removal of teeth to show the disposition of the roots in the alveolus.
A = buccal alveolar plate
B = palatal alveolar plate
C = interdental bony septa between the second premolar and first permanent molar
D = interradicular septum between the buccal roots of first permanent molar.

An inferior view of the maxillae shows their important contributions to the hard palate (Fig. 2.6). The four major bones contributing to the hard palate are the palatine processes of the maxillae and the horizontal plates of the palatine bones. The maxillary palatine processes arise as horizontal plates at the junction of the bodies and alveolar processes of the maxillae. The boundary between the palatine and alveolar processes is well defined in its posterior aspect only; anteriorly, the angle between the two is less well defined. The junction between the palatine processes in the midline is termed the median palatine suture. Anteriorly, behind the central incisors, this junction is incomplete, thus forming the incisive fossa, through which pass the nasopalatine nerves. Unlike the nasal surface, the oral surface of the palatine process is rough and irregular. The posterior edges of the palatine processes articulate with the horizontal plates of the two palatine bones to form the transverse palatine suture. Laterally, this junction is incomplete, forming the greater palatine foramina, through which pass the greater palatine nerves and vessels. Behind the greater palatine foramina lie the lesser palatine foramina, through which pass the lesser palatine nerves and vessels. The junction of the two palatine bones in the midline completes the median palatine suture. The posterior borders of the horizontal palatine plates are concave and, in the midline, form a sharp ridge of bone called the posterior nasal spine. To the posterior edge of the hard palate is attached the fibrous palatine aponeurosis of the soft palate, which is formed by the tendons of the tensor veli palatini muscles.

MAXILLARY ALVEOLUS

The maxillary alveolar processes extend inferiorly from the bodies of the maxillae and support the teeth within bony sockets (Fig. 2.7). Each maxilla can contain a full quadrant of eight permanent teeth or five deciduous teeth. The form of the alveolus is related to the functional demands put upon the teeth. When the teeth are lost the alveolus resorbs.

Essentially, the alveolar process consists of two parallel plates of cortical bone, the buccal and palatal alveolar plates, between which lie the sockets of individual teeth. Between each socket lie interalveolar or interdental septa. The floor of the socket has been termed the fundus, its rim the alveolar crest. The form and depth of each socket is defined by the form and length of the root it supports, and thus shows considerable variation. In multirooted teeth, the sockets are divided by interradicular septa.

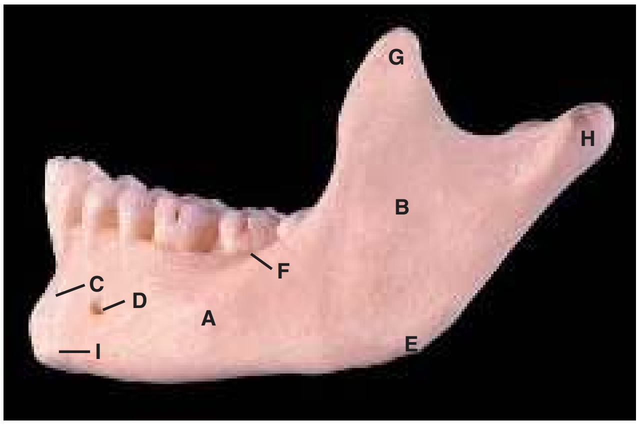


Fig. 2.8 Lateral aspect of the mandible. A = Body; B = ramus; C = in
D = mental foramen; E = angle; F = external oblique line; G = corono
H = condyle; I = mental protuberance.

The apical regions of the sockets of anterior teeth are close
the nasal fossae, while those of posterior teeth are closely r
maxillary air sinuses. The positions of the sockets in relation
and palatal alveolar plates are shown in Figure 2.12.

MANDIBLE

The mandible consists of a horizontal, horseshoe-shaped co
body of the mandible, and two vertical components, the ram
join the body posteriorly at obtuse angles. The body of the man
the mandibular teeth and their associated alveolar processes.
the body consists of two lateral halves that meet in the midl
physis. As viewed laterally (Fig. 2.8), on either side of the n
to the inferior margin of the body lies a distinct prominen
mental tubercle. These tubercles constitute the mental pro
chin. Above the mental protuberance lies a shallow depressio
incisive fossa. Behind this fossa, the canine eminence overlie
the mandibular canine. Midway in the height of the body of t
related to the premolar teeth, is the mental foramen. The men

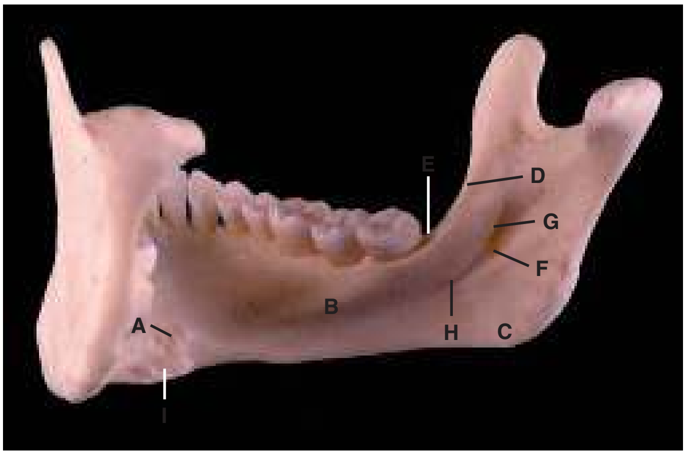


Fig. 2.9 Inner (medial) surface of the mandible. A = genial spines (tubercles); B = internal oblique ridge (mylohyoid ridge); C = attachment area for medial pterygoid muscle; D = temporal crest; E = retromolar triangle; F = mandibular foramen; G = lingula; H = mylohyoid groove; I = digastric fossa.

Fig. 2.10 Lateral view of the mandible, showing the roots of the t
relationship to the mandibular canal (A). B = mandibular foramen.

Fig. 2.11 The mandibular alveolus and the arrangement of the to
that the left second permanent mandibular molar has previously b
and the socket has healed.

of the inferior alveolar nerve and artery pass on to the face through this foramen. The most common position for the mental foramen is on a vertical line passing through the mandibular second premolar. During the first and second years of life, as the prominence of the chin develops, the direction of the opening of the mental foramen alters from facing forwards to facing upwards and backwards. Rarely, there may be multiple mental foramina. The inferior margin of the mandibular body meets the posterior margin of the ramus at the angle of the mandible. This area is irregular, being the site of insertion of the masseter muscle and stylomandibular ligament. The alveolus forms the superior margin of the mandibular body. The junction of the alveolus and ramus is demarcated by a ridge of bone, the external oblique line, which continues downwards and forwards across the body of the mandible to terminate below the mental foramen. As this line progresses upwards, it becomes the anterior margin of the ramus and ends as the tip of the coronoid process. The coronoid and condylar processes form the two processes of the superior border of the ramus. The coronoid process provides attachment for the temporalis muscle. The condylar process has a neck supporting an articular surface, which fits into the mandibular fossa of the temporal bone to form a moveable synovial joint (the temporomandibular joint). The concavity between the coronoid and condylar processes is called the mandibular notch.

Several important features are seen on the internal (medial) surface of the mandible (Fig. 2.9). Close to the midline, on the inferior surface of the mandibular body, lie two shallow depressions called the digastric fossae, into which are inserted the anterior bellies of the digastric muscles. Above the fossae, in the midline, are the genial spines or tubercles. There are generally two inferior and two superior spines, which serve as attachments for the geniohyoid muscles and the genioglossus muscles, respectively. Passing upwards and backwards across the medial surface of the body of the mandible is a prominent ridge. This is termed the mylohyoid or internal oblique ridge. From this ridge, the mylohyoid muscle takes origin. The mylohyoid ridge arises between the genial spines and digastric fossa and increases in prominence as it passes backwards to end on the anterior surface of the ramus. Because the mylohyoid muscle forms the floor of the mouth, the bone above the mylohyoid ridge forms the anterior wall of the oral cavity proper, while that below the ridge forms the lateral wall of the submandibular space (see page 78). The following features may be seen on the medial surface of the ramus. Around the angle of the mandible, the bone is roughened for the attachment of the medial pterygoid muscle. Commencing at the tip of the coronoid process, a ridge

of bone called the temporal crest runs down the anterior
ramus to end behind the mandibular molars at the retromo
the centre of the medial surface of the ramus lies the mand
through which the inferior alveolar nerve and artery pass
dibular canal. A bony process, the lingula, extends from the
surface of the foramen. The lingula is the site of atta
sphenomandibular ligament (see page 64). The mylohyoid
seen running down from the posteroinferior surface of the

The mandibular canal, that transmits the inferior alveol
and veins, begins at the mandibular foramen and extends t
the premolar teeth, where it bifurcates into the mental and
(Fig. 2.10). The course of the mandibular canal and its re
the teeth is variable; this variation is illustrated in conne
course of the inferior alveolar nerve (Fig. 4.6).

MANDIBULAR ALVEOLUS

As for the maxilla, the mandibular alveolus consists of buc
alveolar plates joined by interdental and interradicular se
In the region of the second and third molars, the external
superimposed upon the buccal alveolar plate. The form an
tooth sockets are related to the morphology of the roots of
teeth and the functional demands placed upon them.

Fig. 2.12 Buccolingual sections through the maxilla and mandible demonstrating the distribution of alveolar bone in relation to the roots of the teeth. (a) M region. (b) Maxillary canine region. (c) Maxillary premolar region. (d) Maxillary molar region. (e) Mandibular incisor region. (f) Mandibular canine region. (g) M premolar region. (h) Mandibular molar region. Note the relationship of the mandibular cheek teeth to the mandibular canal (A) and of the maxillary cheek te maxillary sinus (B). Courtesy of the Royal College of Surgeons of England.

Figure 2.12 illustrates buccolingual sections through the teeth and jaws, demonstrating the directional axes and bony relationships of the teeth and their alveoli and the relative thickness of the buccal and lingual alveolar plates. The relationships of the mandibular teeth to the mandibular canal, and the maxillary teeth to the maxillary sinus have clinical significance. Thus, the thickness of bone may determine the direction in which teeth are levered during extractions and explain why local infiltration techniques can be used for anaesthetizing anterior mandibular teeth but not mandibular molar teeth. Care must be taken when exploring for fractured roots in the maxillary region in order to avoid an oro-antral fistula, due to the presence of the maxillary sinus in close relationship to the maxillary molar teeth, while the presence of the inferior alveolar nerve and its branches requires care when placing dental implants in the mandibular region.

TOOTH MORPHOLOGY

Humans have two generations of teeth: the deciduous (or primary) dentition and the permanent (or secondary) dentition. No teeth are erupted into the mouth at birth but, by the age of 3 years, all the deciduous teeth have erupted. By 6 years, the first permanent teeth appear and thence the deciduous teeth are exfoliated one by one to be replaced by their permanent successors. A complete permanent dentition is present at or around the age of 18 years. Thus, given the average life of 75 years, the functional lifespan of the deciduous dentition is only 5% of this total while, with care and luck, that of the permanent dentition can be over 90%. In the complete deciduous dentition there are 20 teeth – 10 in each jaw; in the complete permanent dentition there are 32 teeth – 16 in each jaw.

In both dentitions, there are three basic tooth forms: incisiform, caniniform and molariform. Incisiform teeth (incisors) are cutting teeth, with thin, blade-like crowns. Caniniform teeth (canines) are piercing or tearing teeth, having a single, stout, pointed, cone-shaped crown. Molariform teeth (molars and premolars) are grinding teeth possessing a num on an otherwise flattened biting surface. Premolars are bicusp are peculiar to the permanent dentition and replace the decid Table 2.1 gives definitions of terms used for the descripti form.

DENTAL NOTATION

The types and numbers of teeth in any mammalian dent expressed using dental formulae. The type of tooth is repre initial letter – I for incisors, C for canines, P for prem molars. The deciduous dentition is indicated by the letter D. for the deciduous human dentition is DI$^2_2$ DC$^1_1$ DM$^2_2$ = 10, an manent dentition I$^2_2$ C$^1_1$ PM$^2_2$ M$^3_3$ = 16, where the numbers fo letter refer to the number of teeth of each type in the upper an on one side only. Identification of teeth is made not only acc dentition to which they belong and basic tooth form but al to their anatomical location within the jaws. The tooth-bear the jaws can be divided into four quadrants: the right and l and mandibular quadrants. A tooth may thus be identified the quadrant in which it is located – e.g. a right maxillary deci or a left mandibular permanent molar. In both the permanent a dentitions, the incisors may be distinguished according to thei to the midline. Thus, the incisor nearest the midline is the cer incisor and the more laterally positioned incisor the lateral incisor. The permanent premolars and the permanent and deci can also be distinguished according to their mesiodistal (see Fig. 2.13). The molar most mesially positioned is de first molar, the one behind it being the second molar. In th dentition, the tooth most distally positioned is the third mola premolar is the first premolar, the premolar behind it bein premolar.

Table 2.1 *Some terms used for the description of tooth form*

Crown	Clinical crown – that portion of a tooth visible in the oral cavity Anatomical crown – that portion of a tooth covered with enamel
Root	Clinical root – that portion of a tooth which lies within the alveolus Anatomical root – that portion of a tooth covered by cementum
Cervical margin	The junction of the anatomical crown and the anatomical root
Occlusal surface	The biting surface of a posterior tooth (molar or premolar)
Cusp	A pronounced elevation on the occlusal surface of a tooth
Incisal margin	The cutting edge of anterior teeth, analogous to the occlusal surface of the posterior teeth
Tubercle	A small elevation on the crown
Cingulum	A bulbous convexity near the cervical region of a tooth
Ridge	A linear elevation on the surface of a tooth
Marginal ridge	A ridge at the mesial or distal edge of the occlusal surface of posterior teeth. Some anterior teeth have equivalent ridges
Fissure	A long cleft between cusps or ridges
Fossa	A rounded depression in a surface of a tooth
Buccal	Towards, or adjacent to, the cheek. The term buccal surface is reserved for that surface of a premolar or molar which is positioned immediately adjacent to the cheek
Labial	Towards, or adjacent to, the lips. The term labial surface is reserved for that surface of an incisor or canine which is positioned immediately adjacent to the lips
Palatal	Towards, or adjacent to, the palate. The term palatal surface is reserved for that surface of a maxillary tooth which is positioned immediately adjacent to the palate
Lingual	Towards, or adjacent to, the tongue. The term lingual surface is reserved for that surface of a mandibular tooth which lies immediately adjacent to the tongue
Mesial	Towards the median. The mesial surface is that surface which faces towards the median line following the curve of the dental arch
Distal	Away from the median. The distal surface is that surface which faces away from the median line following the curve of the dental arch

A dental shorthand may be used in the clinic to simplify tooth identification. The permanent teeth in each quadrant are numbered 1–8 and the deciduous teeth in each quadrant are lettered A–E. The symbols for the quadrants are derived from an imaginary cross, with the horizontal bar placed between the upper and lower jaws and the vertical bar running between the upper and lower central incisors. Thus, the maxillary right first permanent molar is allocated the symbol $\underline{6|}$ and the mandibular left deciduous canine $\overline{|c}$. This system of dental shorthand is termed the Zsigmondy system. An alternative scheme has been devised by the Federation Dentaire Internationale, in which the quadrant is represented by a number:

1 = maxillary right quadrant 2 = maxillary left quadrant 3 = mandibular left quadrant 4 = mandibular right quadrant	Permanent
5 = maxillary right quadrant 6 = maxillary left quadrant 7 = mandibular left quadrant 8 = mandibular right quadrant	Deciduous

In this system, the quadrant number prefixes a tooth number. Thus, the maxillary right first permanent molar is symbolized as 1,6 and the mandibular left deciduous canine as 7,3.

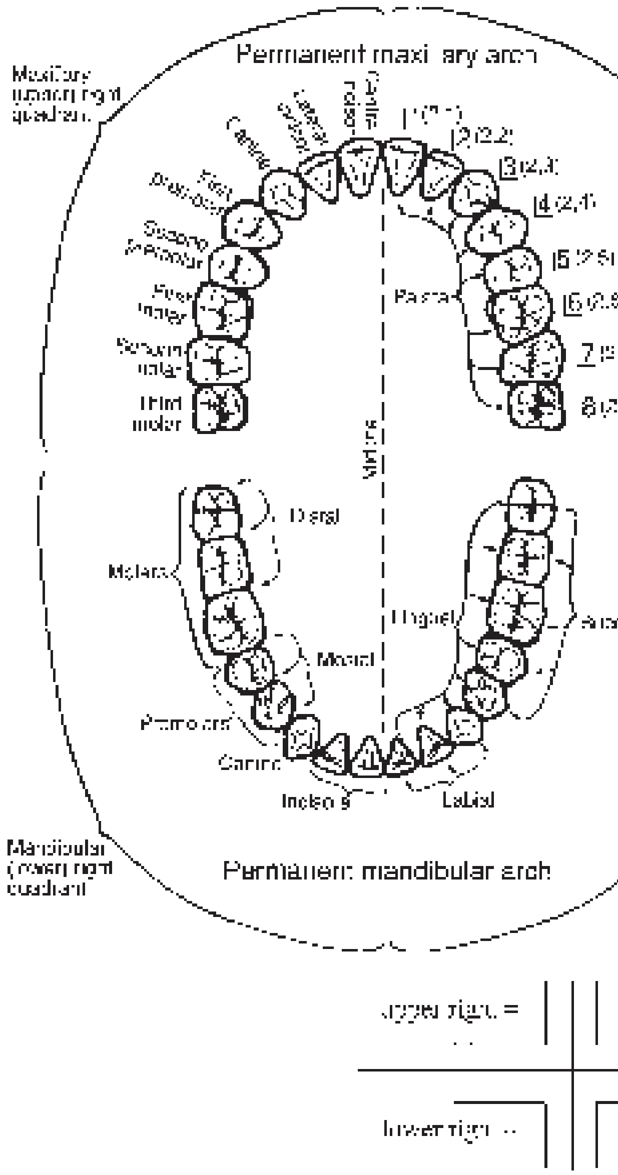


Fig. 2.13 Terminology employed for the identification of teeth acc location in the jaws.

Figure 2.13 summarizes some of the terminology em identification of teeth according to their location in the jav

DIFFERENCES BETWEEN TEETH OF THE DEC AND PERMANENT DENTITIONS

1. The dental formula for the deciduous dentition is:
   $DI\frac{2}{2}\ DC\frac{1}{1}\ DM\frac{2}{2} = 10$
   That of the permanent dentition is:
   $I\frac{2}{2}\ C\frac{1}{1}\ PM\frac{2}{2}\ M\frac{3}{3} = 16.$
2. The deciduous teeth are smaller than their correspondi successors although the mesiodistal dimensions of the premolars are generally less than those for the deciduo molars.
3. Deciduous teeth have a greater constancy of shape tha teeth.
4. The crowns of deciduous teeth appear bulbous, often h nounced labial or buccal cingula.
5. The cervical margins of deciduous teeth are more shar cated and pronounced than those of the permanent teet bulging at the cervical margins rather than gently taper

Fig. 2.14 Models of deciduous (a) and permanent (b) dental arches and some examples of deciduous and permanent teeth. (c) Deciduous canine. (d) Permanent canine. (e) Deciduous second molar. (f) Permanent first molar.

6. The cusps of newly erupted deciduous teeth are more pointed than those of the corresponding permanent teeth.
7. The crowns of deciduous teeth have a thinner covering of enamel (average width 0.5–1.0 mm) than the crowns of permanent teeth (average width 2.5 mm).
8. The enamel of deciduous teeth, being more opaque than that of permanent teeth, gives the crown a whiter appearance.
9. The enamel of deciduous teeth is softer than that of permanent teeth and is more easily worn.
10. Enamel of deciduous teeth is more permeable than that of permanent teeth.
11. The aprismatic layer of surface enamel (see pages 111–112) is wider in deciduous teeth.
12. The enamel and dentine of all deciduous teeth exhibit neonatal lines (see pages 115, 142).
13. The roots of deciduous teeth are shorter and less robust than those of permanent teeth.
14. The roots of deciduous incisors and canines are longer in proportion to the crown than those of their permanent counterparts.
15. The roots of deciduous molars are widely divergent, extending beyond the dimensions of the crown.
16. The pulp chambers of deciduous teeth are proportionally larger in relation to the crowns than those of the permanent teeth. The pulp horns in deciduous teeth are more prominent.
17. The root canals of deciduous teeth are extremely fine.
18. The dental arches for the deciduous dentition are smaller.

Some of these differences are illustrated in Figure 2.14.

The following descriptions of individual teeth will be considered according to tooth class (incisors, canines, premolars and molars) rather than by membership of the permanent or deciduous dentition. For each class, the permanent teeth will be described before the deciduous teeth. This arrangement allows emphasis of the basic features common to each class to be made.

To help visualize the tooth as a three-dimensional object, the illustrations of each tooth are arranged according to the 'third angle projection technique', which aligns each side of a tooth to its occlusal or incisal aspect. The morphology of the pulp is treated independently of the mor-

Table 2.2 *Average dimensions of the permanent teeth*

Tooth	Crown height (mm)	Length of root (mm)	Mediodistal crown diameter (mm)	L c d (
Maxillary				
1	10.5	13.0	8.5	
2	9.0	13.0	6.5	
3	10.0	17.0	7.5	
4	8.5	14.5	7.0	
5	8.5	14.0	7.0	
6	7.5	12.5	10.5	
7	7.0	11.5	9.5	
8	6.5	11.0	8.5	
Mandibular				
1	9.0	12.5	5.0	
2	9.5	14.0	5.5	
3	11.0	15.5	7.0	
4	8.5	14.0	7.0	
5	8.0	14.5	7.0	
6	7.5	14.0	11.0	
7	7.0	12.0	10.5	
8	7.0	11.0	10.0	

Table 2.3 *Average dimensions of the deciduous teeth*

Tooth	Crown height (mm)	Length of root (mm)	Mediodistal crown diameter (mm)	L c d (
Maxillary				
A	6.0	10.0	6.5	
B	5.6	10.2	5.2	
C	6.5	13.0	6.8	
D	5.1	10.0	7.1	
E	5.7	11.7	8.4	
Mandibular				
A	5.0	9.0	4.0	
B	5.2	9.8	4.5	
C	6.0	11.2	5.5	
D	6.0	9.8	7.7	
E	5.5	12.5	9.7	

phology of the external surfaces of the teeth on pages 28 chronology of the developing dentitions see page 365, for dimensions of the teeth see Tables 2.2 and 2.3, and for ethr in tooth morphology see pages 24–28.

INCISORS

Human incisors have thin, blade-like crowns that are ada cutting and shearing of food preparatory to grinding. Viewed distally, the crowns of the incisors are roughly triangular in the apex of the triangle at the incisal margin of the tooth (Fig shape is thought to facilitate the penetration and cutting of f buccally or lingually, the incisors are trapezoidal, the shortest sides being the base of the crown cervically.

sample content of Oral Anatomy, Histology and Embryology