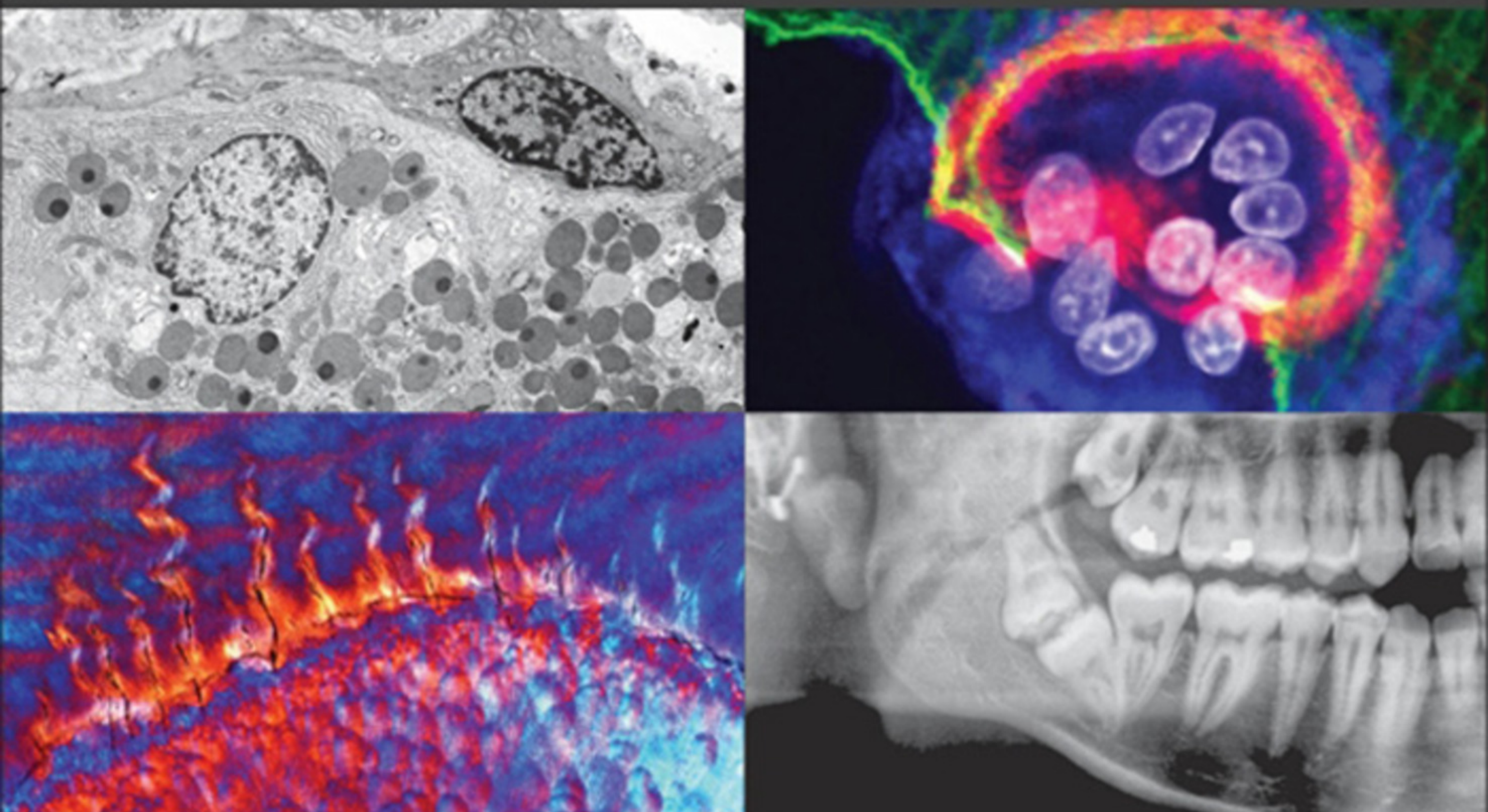
FIFTH EDITION

ORAL ANATOMY HISTOLOGY & EMBRYOLOGY

B. K. B. BERKOVITZ • G. R. HOLLAND • B. J. MOXHAM



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Oral Anatomy, Histology and Embryology

Fifth Edition

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Preface

The fifth edition of our book, although following the form and principles established in our earlier editions, has involved us making substantial changes to the text and to the imagery. In particular, we have made major revisions to the chapters concerned with functional anatomy, enamel, alveolar bone, temporomandibular joint, salivary glands, amelogenesis, dentinogenesis and anthropological applications of tooth structure. However, all chapters have undergone revisions, whether to change and update the text or to improve, or add to, the images. For example, for the chapter describing the general appearance of the oral cavity we have incorporated many new images and, within the chapter for dento-osseous structures, all the images for tooth morphology have been increased in size by 50% in order to make clearer the features we describe in the text. Line diagrams for each chapter have all been redrawn for consistency of style across the book and there is a brief overview at the beginning and a set of learning objectives at the end of each chapter. Many new references have been added at the end of each chapter so that students can, where interest takes them, follow up and expand upon our descriptions and comments.

As for the previous editions, we have retained the considerable number of illustrations so that much of the information we present is in visual form. Indeed, we remain adamant that a single image is 'worth a thousand words', particularly where photographs and photomicrographs are employed rather than diagrams. In this respect, we still wish students to look at 'real' material, warts and all!

There is much talk in the world of healthcare education about the need to teach 'core' material and to provide students with clear sets of objectives for their learning. Putting aside the issue of whether we wish students to become deep learners rather than superficial or strategic learners for examinations (the authors would prefer deep learning for a learned profession), it would indeed be most useful if internationally there were accepted standards that incorporated 'core' knowledge and agreed objectives. Such parameters presently do not exist! We accordingly anguished somewhat on the construction of the 'learning objectives' within our book. They remain very generalised at this stage but it is our intention to look very closely at these over the coming years to try to tease out what really is required of today's dental students for their education in the dental sciences. We would be most grateful for comments from academics and students on these issues so that we can better command what should be taught and learned for oral anatomy, histology and embryology. That said, we are totally wedded to the belief that this book should remain 'encyclopaedic' in scope, especially when it seems that there increasingly is a shortage of teachers in the discipline. Furthermore, dentally-qualified teachers in the dental sciences are getting as rare as 'hens' teeth' and hence we have expanded the sections in our book dealing with clinical considerations. Given that many students like to test themselves as they study, we have provided opportunities for self-assessment at the book's website.

Finally, as we have said in the prefaces for previous editions of this book, we are extremely grateful to our colleagues who have commented and criticised our efforts and we welcome further comments and suggestions. Indeed, we still 'do not pretend to be infallible and would ask for indulgence if we have strayed from scientific rectitude'.

Acknowledgements

We are most grateful to the numerous colleagues who generously provided photographic material for our book and these have been acknowledged in the legends. We acknowledge photographic assistance from Mr M Simons. In addition, we owe a debt of thanks to the following researchers for their help and constructive criticisms of the text: Prof. T R Arnett, Dr R J Cook, Prof. M C Dean, Dr L Feinberg, Dr A Grigoriadis, Dr J D Harrison, Prof. F Hughes, Prof. E Kidd, Prof. J Kirkham, Prof. A Linde, Prof. R W A Linden, Dr A Loughlin, Dr H M Liversidge, Prof. P R Morgan, Prof. P G Proctor, Prof. A J Sloan, Prof. T F Watson.

The appearance of the oral cavity

1

Overview

The mouth (oral cavity) is primarily concerned with the ingestion of food. It extends from the lips and cheeks externally to the pillars of the fauces internally. The palate forms the roof of the mouth and consists of hard (immobile) and soft (mobile) components. The tongue occupies the floor of the mouth. Beneath the tongue, in the floor of the mouth, are the openings of the sublingual and submandibular salivary glands. The lateral walls of the oral cavity are defined by the cheeks and retromolar regions. Here, the parotid duct opens into the oral cavity at the level of the maxillary second permanent molar. Further back at the junction between the mouth and pharynx, the lateral wall presents the anterior and posterior pillars of the fauces (between which the palatine tonsil is situated).

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 a 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).

Fig. 1.1 The oral cavity.

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 a 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, hirsute and less mobile. The lips illustrated are lightly closed at rest and are described as being ‘competent’. The lips provide an important aesthetic feature of the face and psychologically the importance of the smile cannot be underestimated.

Lip posture varies from person to person and is dependent upon the soft tissues and musculature within the lips. At rest, the lips are separated normally by no more than 3–4 mm. Above this figure, the lips are said to be ‘incompetent’. Thus, incompetent lips (Fig. 1.3) describe a situation where, at rest and with the facial muscles relaxed, a lip seal is not produced. It is of some importance that this is distinguished from conditions where the lips are merely held apart habitually (as often occurs with ‘mouth breathers’). The lip posture illustrated in Fig. 1.3 can be described as being ‘potentially competent’, as the lips would be capable of producing a seal at rest if there were no interference caused by the protruding incisors. True lip incompetence is frequently seen alongside straining of the mentalis muscles in the lower lip and with lack of tonic activity (flaccidity) in other parts of the lip musculature. Another sign is eversion of the lower lip so that the vermilion is rolled forward.

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

Fig. 1.3 Incompetent lips.

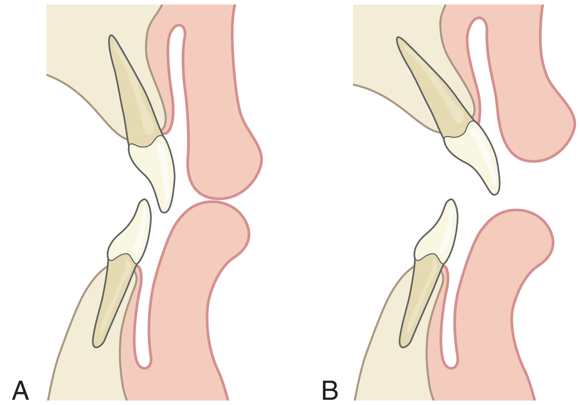

Fig. 1.4 (A) Competent lips maintaining normal inclination of the incisors. (B) Incompetent lips resulting in proclination of the upper incisors.

Where the lips are incompetent, the pattern of swallowing sometimes needs to be modified to produce an 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. Furthermore, lip incompetence may be associated with problems of the alignment of the teeth (see below) and with speech defects.

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 because the lips are not fully developed until late adolescence. Studies suggest therefore that lip incompetence is often diminished by the age of 13 years. In addition, lip incompetence is commonly seen where persons suffer from air obstructions (e.g., from allergic rhinitis). An unfortunate effect occurs where, despite an ability to maintain an anterior oral seal, a person retains an habitual lip incompetence. Anecdotally, it is said that incompetent lips might be aesthetically pleasing, although this may relate to the gender of the individual.

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 (the upper incisors are 'normally' overlapped by the lower lip by 2–3 mm). 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.

Since in everyday English the term 'incompetent' often denotes inferiority or ineptitude, the terms 'competent' and 'incompetent' are perhaps inappropriate and could be replaced by 'complete' or 'incomplete' lip seal. However, these terms are not yet accepted in the dental clinic. Lip incompetence can be modified by orthodontic treatment and/or by exercising the lip musculature. It is of some importance that lip incompetence is distinguished from conditions where the lips are merely held apart habitually (as often occurs with 'mouth breathers'). Mouth breathing often involves increased opening of the mandible at rest and this, with time, may lead to changes in dental alignment or even growth of the face.

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 teeth. When the teeth occlude, the vestibule is a closed space that communicates with the oral cavity proper only behind the last molars (the retromolar regions).

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

Fig. 1.6 Midline diastema between upper central incisor teeth, produced by an enlarged labial frenum.

The mucosa covering the alveolus is reflected on to the lips and cheeks, forming a trough or sulcus called the vestibular fornix. In some regions of the sulcus, the mucosa may show distinct sickle-shaped folds running from the cheeks and lips to the alveolus. The upper and lower labial frena or frenula are such folds in the midline. Other folds of variable dimensions may traverse the sulcus in the region of the canines or premolars. Such frena are said to be more pronounced in the lower sulcus. All folds contain loose connective tissue and are neither muscle attachments nor sites of large blood vessels.

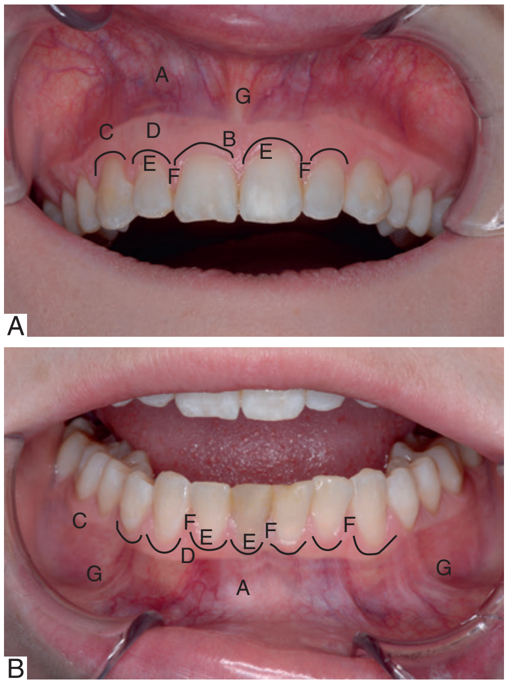

Fig. 1.7 Upper (A) and lower (B) gingival. A = alveolar mucosa; B = free gingival groove indicated by curved black line; C = mucogingival junction; D = attached gingiva: E = free gingiva; F = interdental papilla; G = labial frenum. Courtesy Prof. P R Morgan.

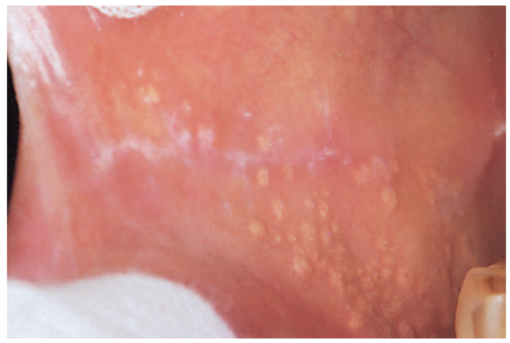

Fig. 1.8 Inner surface of the cheek, showing Fordyce spots as yellowish patches. (From Cawson RA, Odell EW (eds) 2008 Cawson's essentials of oral pathology and oral medicine, 8th edn. Churchill Livingstone, Edinburgh, with permission.)

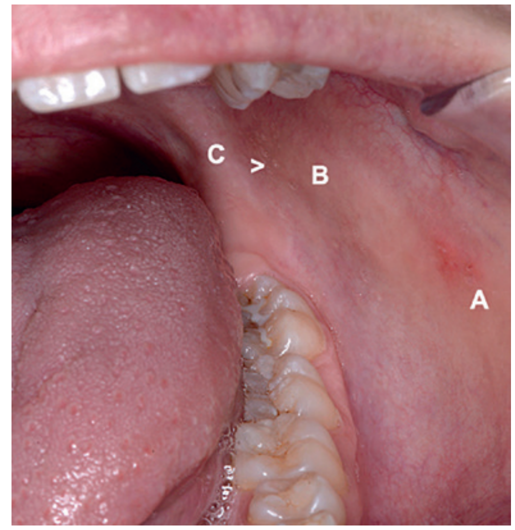

Fig. 1.9 Retromolar region. A = inner surface of cheek; B = ridge overlying ramus of mandible; C = ridge overlying the pterygomandibular raphe. The arrowhead indicates a landmark for the insertion of needle for local anaesthesia of the lingual and inferior alveolar nerves. Courtesy Prof. P R Morgan.

The upper labial frenum should be attached well below the alveolar crest. A large frenum with an attachment near this crest may be associated with a midline diastema between the maxillary central incisors (Fig. 1.6). Prominent frena may also influence the stability of dentures.

Gingiva

The gums or gingivae, the oral mucosa covering the alveolar bone (which supports the roots of the teeth) and the necks (cervical regions) of the teeth, are divided into two main components (Fig. 1.7). The portion lining the lower part of the alveolus is loosely attached to the periosteum via a diffuse submucosa and is termed the alveolar mucosa. It is delineated from the gingiva (which covers the upper part of the alveolar bone and the necks of the teeth) by a well-defined junction, the mucogingival junction. The alveolar mucosa appears red and the gingiva appears pale pink. These colour differences relate to differences in the type of keratinisation and the proximity to the surface of underlying blood vessels. Indeed, small blood vessels may readily be seen coursing beneath the alveolar mucosa (Fig. 1.7B). The gingiva may be further subdivided into the attached gingiva and the free gingiva. The attached gingiva is firmly bound to the periosteum of the alveolus and to the teeth, and the free gingiva lies unattached around the cervical region of the tooth. A groove (the free gingival groove) may be seen between the free and attached gingivae. This groove corresponds approximately to the floor of the gingival sulcus that separates the inner surface of the attached gingiva from the enamel itself (Fig. 14.36). The interdental papilla is that part of the gingiva that fills the space between adjacent teeth. A feature of the attached gingiva is its surface stippling. The degree of stippling varies from individual to individual and according to age, sex and the health of the gingiva. Unlike the attached gingiva, the free gingiva is not stippled (see Fig. 1.18). On the lingual surface of the lower 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 keratinised masticatory mucosa.

Cheeks

The cheeks extend intraorally 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 nonkeratinised and, being tightly adherent to the buccinator muscle, is stretched when the mouth is open 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, occurring singly or in clusters, and may also be seen on the margin of the lips (see Fig. 1.21). They can be seen in most patients and are said to increase with age.

Few structural landmarks are visible in the cheeks. The parotid duct drains into the cheek opposite the maxillary second molar tooth and its opening may be covered by a small fold of mucosa termed the parotid papilla (Fig. 1.24). In the retromolar region, in front of the pillars of the fauces, a fold of mucosa containing the pterygomandibular raphe extends from the upper to the lower alveolus (Fig. 1.9). The pterygomandibular space, in which the lingual and inferior alveolar nerves run, lies lateral to this fold and medial to a ridge produced by the mandibular ramus. The groove lying between the ridges produced by the raphe and the ramus of the mandible is an important landmark for insertion of a needle for local anaesthesia of the lingual and inferior alveolar nerves (see pages 99–100).

Palate

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

The hard palate is covered by a masticatory, keratinised mucosa that is firmly bound down to underlying bone and also contains some taste buds. It shows a distinct prominence immediately behind the maxillary central incisors, the incisive papilla (Fig. 1.10). This papilla overlies

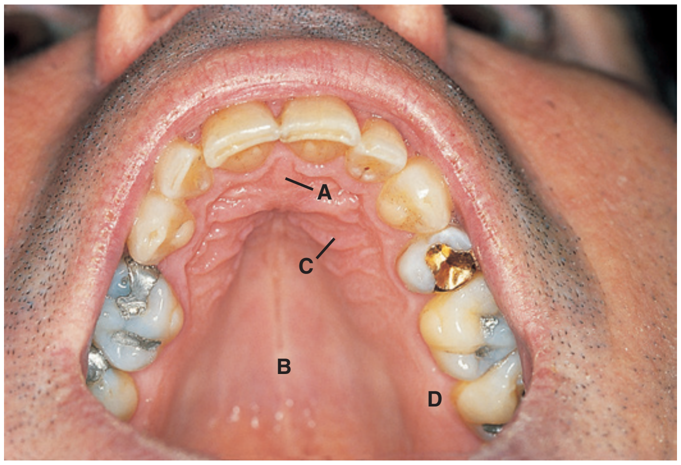

Fig. 1.10 The hard palate. A = incisive papilla; B = palatine raphe; C = palatine rugae; D = alveolus.

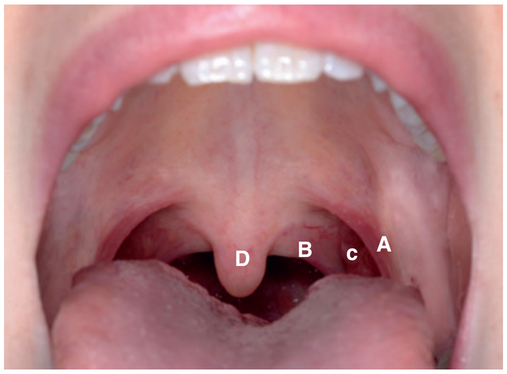

Fig. 1.11 The soft palate and oropharyngeal isthmus. A = palatoglossal fold; B = palatopharyngeal fold; C = palatine tonsil; D = uvula. Courtesy Prof. P R Morgan.

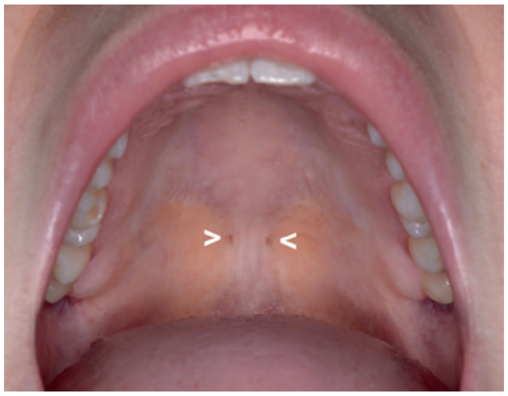

Fig. 1.12 Oral surface of the soft palate showing the fovea palatini (arrows). Courtesy Prof. P R Morgan.

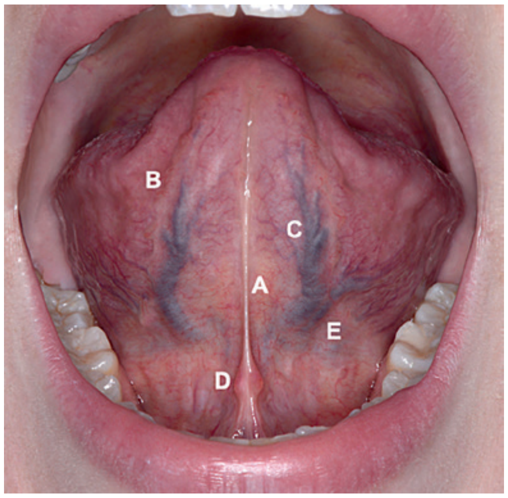

Fig. 1.13 Inferior surface of the tongue. A = lingual frenum; B = fimbriated fold; C = deep lingual vein; D = sublingual papilla; E = sublingual fold. Courtesy Prof. P R Morgan.

the incisive fossa through which the nasopalatine nerves enter on to the palate. Extending posteriorly in the midline from the papilla runs a ridge termed the palatine raphe. Here, the oral mucosa is attached directly to bone without the presence of a submucosal layer of tissue. Palatine rugae are elevated ridges in the anterior part of the hard palate that radiate transversely from the incisive papilla and the anterior part of the palatine raphe. Their pattern is unique to the individual and, like fingerprints, can be used for forensic purposes to help identify individuals. At the junction of the palate and the alveolus lies a mass of soft tissue (submucosa) in which the greater palatine nerves and vessels run. 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 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.

Floor of the mouth

The moveable floor of the mouth is a small, horseshoe-shaped region above the mylohyoid muscle and beneath the movable part of the tongue (Fig. 1.13). It is covered by a lining of nonkeratinised mucosa. In the midline, near the base of the tongue, a fold of tissue called the lingual frenum extends onto the inferior surface of the tongue. The sublingual papilla, on to which the submandibular salivary ducts open into the mouth, is a large centrally positioned protuberance at the base of the tongue. On either side of this papilla are the sublingual folds, beneath which lie the submandibular ducts and sublingual salivary glands.

Tongue

The tongue is a muscular organ with its base attached to the floor of the mouth. It is attached to the inner surface of the mandible near the midline and gains support below from the hyoid bone. It functions in mastication, swallowing and speech and carries out important sensory functions, particularly those of taste. The lymphoid material contained in its posterior third has a protective role.

The inferior (ventral) surface of the tongue, related to the floor of the mouth, is covered by a thin lining of nonkeratinised mucosa that is tightly bound down to the underlying muscles. In the midline, extending on to the floor of the mouth, lies the lingual frenum (Fig. 1.13). Occasionally, this extends across the floor of the mouth to be attached to the mandibular alveolus. Such an overdeveloped lingual frenum (ankyloglossia) may restrict movements of the tongue. Lateral to the frenum lie irregular, fringed folds: the fimbriated folds. The deep lingual veins are also visible through the mucosa.

The upper (dorsal) surface of the tongue may be subdivided into an anterior two-thirds (palatal part) and a posterior one-third (pharyngeal part). The junction of the palatal and pharyngeal parts is marked by a shallow V-shaped groove, the sulcus terminalis (Fig. 1.14A). 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 keratinised and is characterised by an abundance of projections (papillae) (Fig. 1.14B). The most numerous are the papillae appearing as whitish, conical elevations (Fig. 1.15). 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. 1.16). They do not project beyond the surface of the tongue and

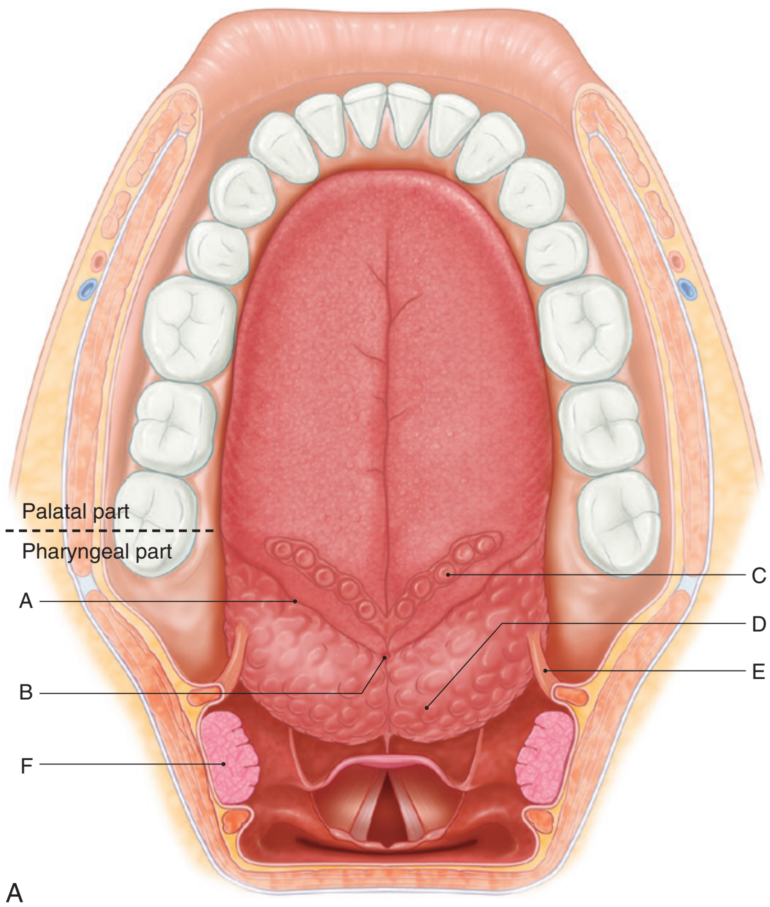

Fig. 1.14 (A) Dorsum of the tongue. A = sulcus terminalis; B = foramen caecum; C = circumvallate papillae; D = lingual follicles; E = palatoglossal arches; F = palatine tonsil. (B) Note the raised circumvallate papillae at the back of the tongue. (B) Courtesy Prof. P R Morgan.

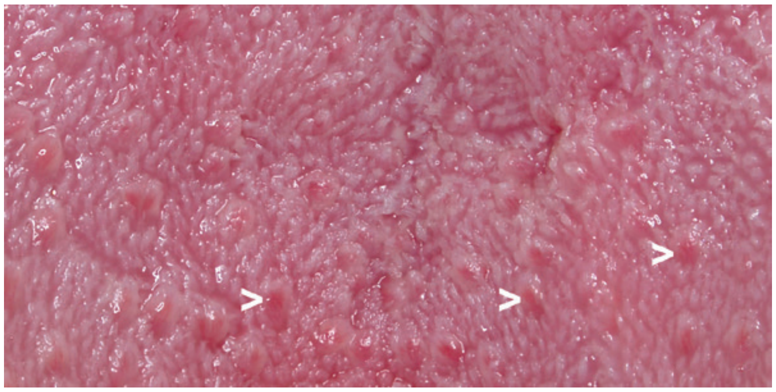

Fig. 1.15 Dorsum of the tongue, showing numerous, keratinised, whitish filiform with fewer, interspersed, reddish, nonkeratinised, fungiform papillae (arrowheads). Courtesy Prof. P R Morgan.

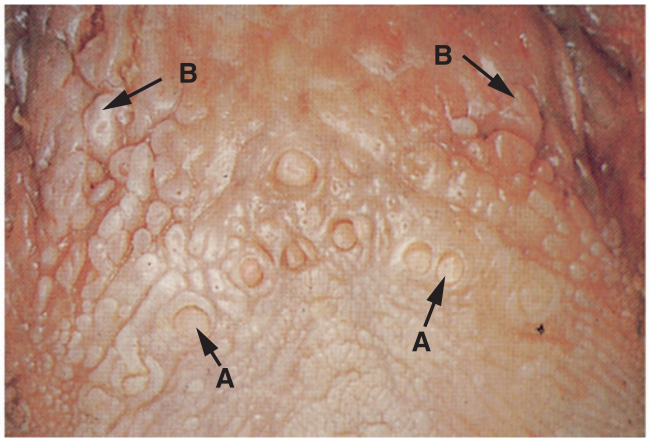

Fig. 1.16 Dorsum of the tongue, showing circumvallate papillae (A). B = lingual follicles.

Fig. 1.17 Side of the tongue, showing slit-like appearance of foliate papillae.

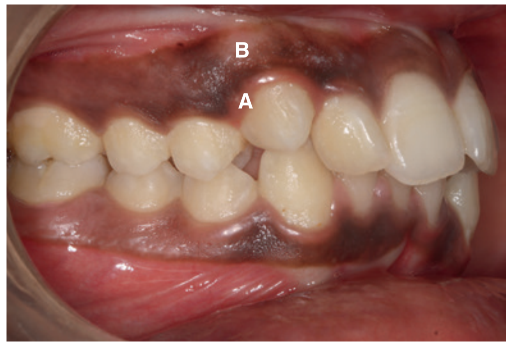

Fig. 1.18 Patches of dark melanin pigment appearing in the region of the attached gingiva. Note the free gingiva is not stippled (A), unlike the attached gingiva (B). Courtesy Drs P S Viswapurna and R Madan.

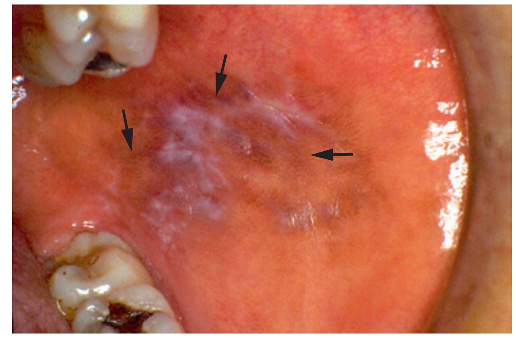

Fig. 1.19 Area of increased pigmentation (arrowed) associated with whitish patches due to lichen planus. Courtesy Prof. P R Morgan.

are surrounded by a circular ‘trench’. Foliate papillae (Fig. 1.17) 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 vestiges 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 nonkeratinised and is covered with large rounded nodules termed the lingual follicles. These follicles are composed of lymphoid 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 glossoepiglottic fold and two lateral glossoepiglottic folds. The anterior pillars of the fauces (the palatoglossal arches) extend from the soft palate to the sides of the tongue near the circumvallate papillae.

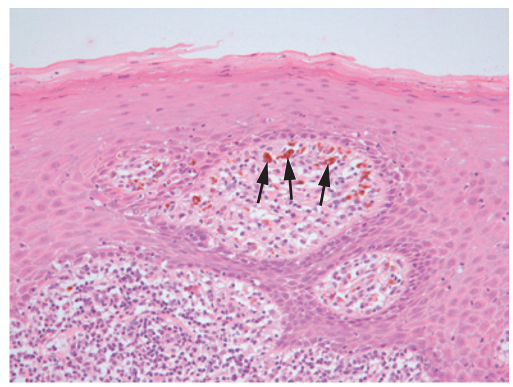

Fig. 1.20 Micrograph of biopsy taken from pigmented area seen in Fig. 1.19, showing melanin pigment within macrophages (arrows) lying within the lamina propria. The epithelium is parakeratinised, giving the whitish patches (H & E; ×80). Courtesy Prof. P R Morgan.

Fig. 1.21 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 Prof. P R Morgan.

Clinical considerations

There are several conditions in the mouth that can be inspected in the nonclinical environment. They provide examples of: 1) normal variation, 2) common benign disorders and 3) disorders that may highlight normal features, which may be otherwise inconspicuous.

Variation in pigmentation

As examples of normal variation, we can consider pigmentation, Fordyce spots and black hairy tongue. In dark-skinned patients, patches of melanin pigment may be seen in the mouth, particularly in the gingiva (Fig. 1.18). This pigmentation is due to the extra melanosome granules present within the oral epithelium (Fig. 14.22). Such pigmentation needs to be distinguished from other forms of mucosal pigmentation and from increased melanin pigmentation associated with a range of inflammatory conditions, such as lichen planus where melanin pigment is held within macrophages in the lamina propria (Figs 1.19, 1.20). Fordyce spots are seen in varying degrees as small, yellowish-white spots, occurring singly or in clusters on the margin of the lips (Fig. 1.21) or in the mucosa of the cheeks (see Fig. 1.8) (and other sites such as genital skin). They can be seen in most patients and are said to increase with age. They represent collections of sebaceous glands (Fig. 1.22) without any associated hair follicles. The range of variation in the filiform papillae on the dorsum of the tongue is well illustrated by black hairy tongue (lingua villosa nigra), a benign condition in which there is hypertrophy of these papillae (Fig. 1.23). 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) to accumulate and, together with retained pigments of dietary or microbial origin, potentially colour the surface of the tongue black. The condition may also be with the administration of antibiotics or mouthwashes that may alter the normal bacterial population. It has a frequency of about 5% of the population.

Fig. 1.22 Micrograph of a Fordyce spot, showing it to be a sebaceous gland (H & E; × 75). (From Cawson RA, Odell EW (eds) 2008 Cawson's essentials of oral pathology and oral medicine, 8th edn. Churchill Livingstone, Edinburgh, with permission.)

Fig. 1.23 Black hairy tongue. Courtesy Prof. P R Morgan.

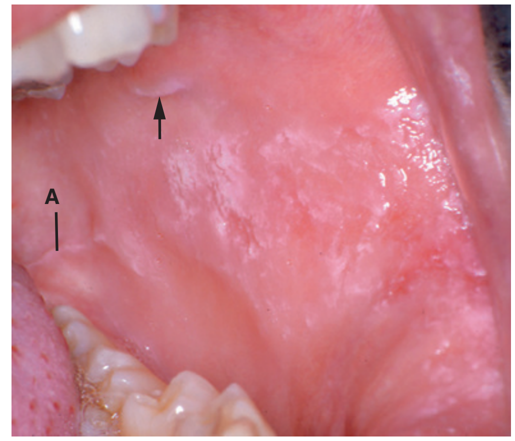

Fig. 1.24 View of buccal mucosa showing a linea alba adjacent to the molar teeth (A) at the level of the occlusal plane. In front of this line, the white patches on the cheek represent more diverse cheek chewing. Arrow shows the parotid papilla. Courtesy Prof. P R Morgan.

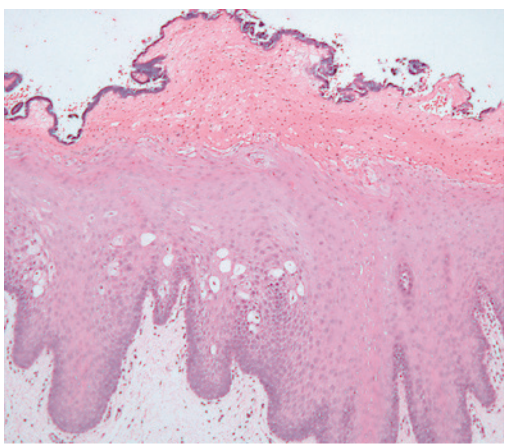

Fig. 1.25 Section of buccal mucosa showing the linea alba to be parakeratinised compared with the normal nonkeratinised state of the buccal mucosa (H & E; ×50). Courtesy Prof. P R Morgan.

Fig. 1.26 Upper jaw showing a relatively small torus palatinus as an overgrowth of bone along the midline of the palate. Courtesy Dr C Dunlap.

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

Benign disorders (linea alba, tori and smoker's keratosis)

Examples of common benign disorders are linea alba and tori. On the inside of the cheek and level with the occlusal plane, a linear, slightly raised whitish ridge may be seen, the linea alba (Fig. 1.24). It is commonly the result of low-grade, intermittent trauma due to folds of cheek mucosa being trapped between the teeth. More active trauma associated with cheek chewing produces a much larger, irregular white patch (Fig. 1.24). The constant irritation converts the surface epithelium from its normal nonkeratinised state into a parakeratinised layer (Fig. 1.25).

Individual variation in the shape of the jaws is recognised by anatomists and pathologists. Such variations blend with benign conditions. As an example, tori are benign localised 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 1.26–1.28), while in the lower jaw it is usually on the lingual aspect in the canine/premolar region and may be unilateral (Fig. 1.29) or bilateral (Fig. 1.30). However, a torus

Fig. 1.28 Isolated palate showing torus palatinus as an overgrowth of bone along the midline. Courtesy the Royal College of Surgeons of England.

Fig. 1.29 Unilateral torus mandibularis (arrow) on the lingual surface of the mandible. Courtesy Prof. P R Morgan.

Fig. 1.30 Bilateral torus mandibularis on the lingual surface of the mandible. Courtesy Prof. P R Morgan.

Fig. 1.31 Torus mandibularis on the buccal surface of the mandible. Courtesy Dr C Dunlap.

Fig. 1.32 The palate of a heavy smoker presenting with an overall whitish appearance to the mucosa that highlights the inflamed orifices of the mucous glands as red spots. (From Cawson RA, Odell EW (eds) 2008 Cawson's essentials of oral pathology and oral medicine, 8th edn. Churchill Livingstone, Edinburgh, with permission.)

mandibularis may also affect the buccal surface of the mandible (Fig. 1.31). 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 adaptations, as there is some evidence that their incidence is decreased in association with fewer teeth being present in the jaws. They require no treatment unless they interfere with the construction of satisfactory removable dentures. Their incidence varies from about 0.5% to over 65%, being less frequent in Caucasians and more frequent in Eskimos, Mongoloids and other Asian groups. Torus palatinus has an hereditary basis to its aetiology (autosomal dominant).

As an example of a disorder that highlights normal features that may be otherwise inconspicuous, one can inspect the palate of a patient who smokes heavily, revealing a whitish appearance that highlights numerous reddish spots (Fig. 1.32). The white appearance is the result of a pronounced orthokeratinised layer being present due to chronic irritation and this highlights the orifices of the ducts (as red spots) associated with the numerous mucous salivary glands present.

Learning outcomes

Concerning the appearance of the oral cavity, the student should be able to:

1) use correct and appropriate anatomical and dental terminologies to describe, accurately and in detail, all the visible features present in the mouth
2) know the functional significance of lip posture and of producing an anterior oral seal and appreciate the clinical significance of normal and abnormal lip postures
3) understand that clinical situations in the mouth may be related to normal variation, or disorders that highlight normal features that may otherwise be inconspicuous, or be common benign disorders or less common severe (possibly life-threatening) disorders.

Dento-osseous structures

2

Overview

The jaws bear the teeth and comprise two maxillary bones and the mandible. Structurally and functionally the human dentition is characteristic of an omnivorous mammal. Indeed, the heterodonty features all basic tooth forms in the dentition (i.e., incisors, canines and molars). It is diphyodontic (having two generations or series of teeth – there being a primary or deciduous dentition that is succeeded by a secondary or permanent dentition). Internally, each tooth has a pulp chamber containing a highly vascular and well-innervated, nonmineralised connective tissue. The morphology of the pulp chamber is crucial for understanding endodontic treatments. Occlusion of the dentition refers to the way that the teeth bite together. Its main feature relates to the fact that, in normal (or anatomical) centric occlusion, a maxillary (upper) tooth occludes with its opposite tooth in the mandible plus the tooth located distally. Thus, the maxillary first (central) incisor occludes with the mandibular first (central) and the second (lateral) incisors. Radiographically, the hard tissues of the jaws and the teeth are radio-opaque. Traditionally, radiographic images (using X-rays) of the jaws and teeth involve either an extraoral or an intraoral approach. More recently, special imaging techniques such as MRI and CT scans are increasingly used in the clinic. Using standardised procedures and a cephalostat (head-holder), it is possible to measure planes and angles that provide information useful for oral surgery and orthodontics that relates to jaw growth, facial form and jaw relationships.

Jaws

The jaws are the tooth-bearing bones, and comprise three bones. The two maxillary bones form the upper jaw, while the lower jaw is a single bone termed 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 (houses and protects the brain and the organs of special sense) and the viscerocranium (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

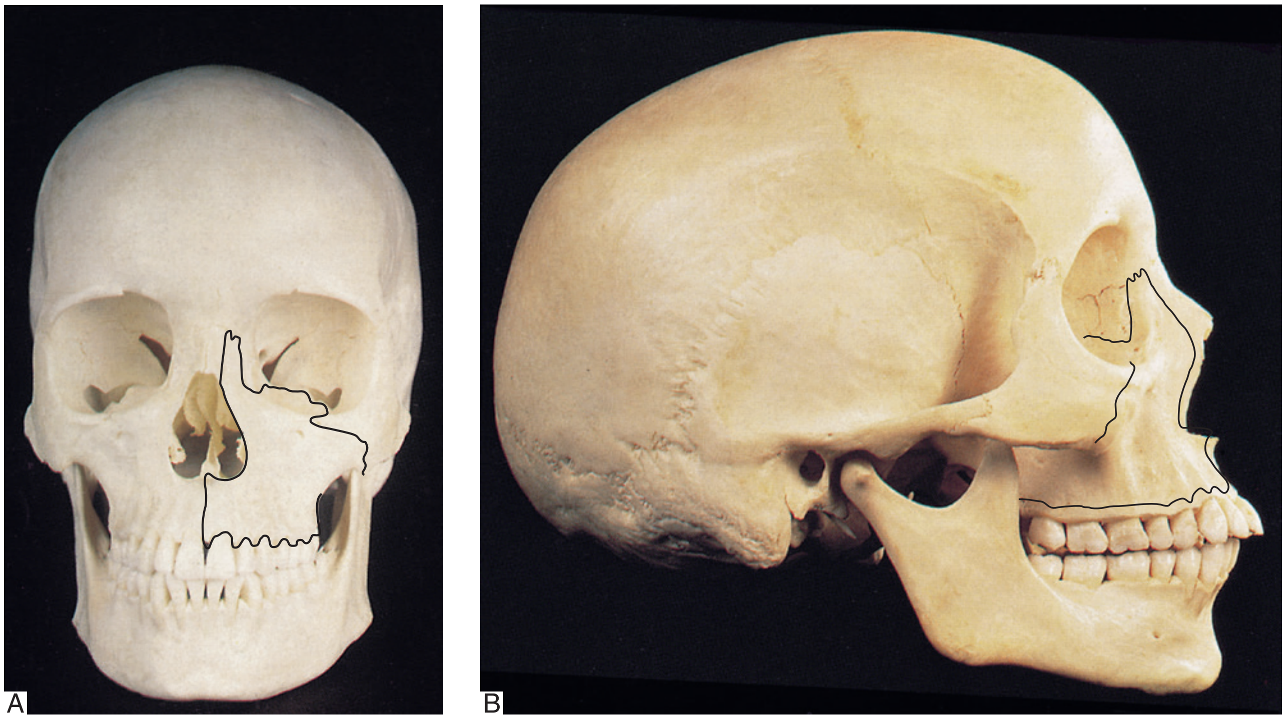

Fig. 2.1 Front (A) and side (B) views of the skull, showing the relationship between the jaws and the remainder of the skull. The black line describes the boundaries of a maxillary bone.

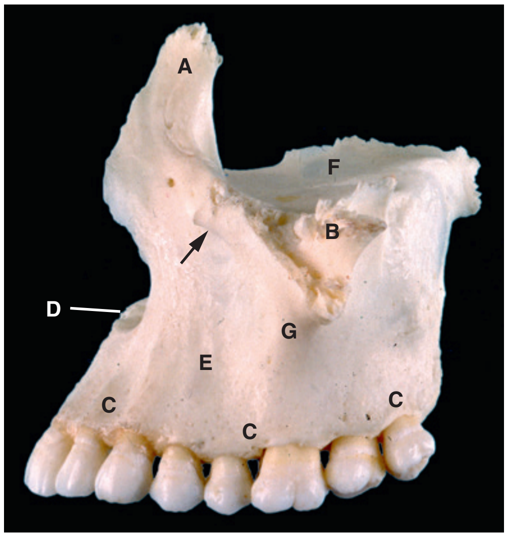

Fig. 2.2 Lateral aspect of the maxilla. A = frontal process; B = zygomatic process; C = alveolar process; D = site of anterior nasal spine; E = canine fossa; F = orbital plate; G = jugal crest. The infraorbital foramen is arrowed.

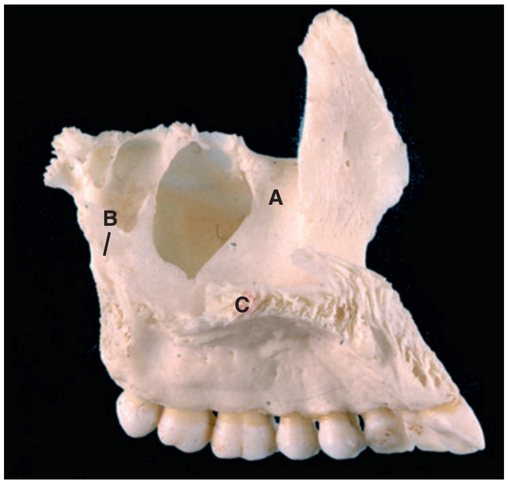

Fig. 2.3 Medial aspect of the maxilla. A = lacrimal groove; B = palatine groove; C = palatine process of maxilla. Note the large opening into the maxillary sinus.

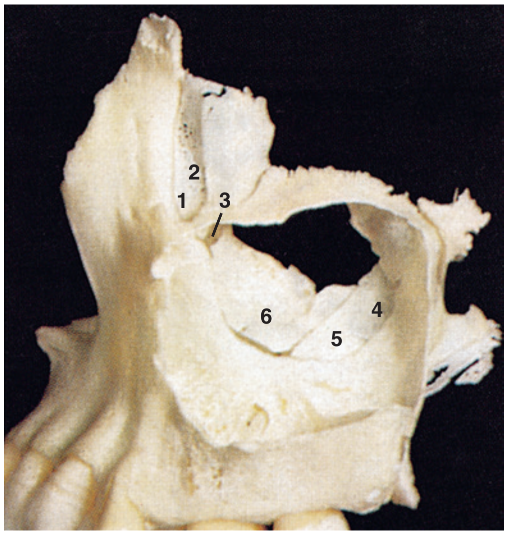

Fig. 2.4 Osteology of the maxillary air sinus showing adjacent bones reducing the size of the ostium. 1 = lacrimal groove of maxilla; 2 = lacrimal groove; 3 = lacrimal bone; 4 = ethmoid bone; 5 = palatine bone; 6 = inferior nasal concha. Courtesy Prof. R M H McMinn.

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 laterally to form the opening into the nasal fossae (the piriform aperture). At the lower border of the piriform aperture, in the midline, lies the bony projection termed the anterior nasal spine. The malar surface of the body of the maxilla is concave, forming the canine fossa. Superiorly, the malar surface is continuous with the orbital plate of the maxilla and forms the floor of the orbit. Anterior to the orbital plate, the frontal process extends above the piriform aperture to meet the nasal and frontal bones. Below the infraorbital rim lies the infraorbital foramen through which the infraorbital branch of the maxillary nerve and the infraorbital artery from the maxillary artery emerge onto 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 forms the lateral wall of the nose (Fig. 2.3). 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 vertical groove called the lacrimal groove. This groove meets the lower edge of the lacrimal bone to form the nasolacrimal canal. Behind the antrum lies the palatine groove which is converted into a canal carrying the greater palatine nerve and artery by the perpendicular plate of the palatine bone. The maxillary palatine process extends horizontally from the medial surface of the maxilla where the body meets the alveolar process.

The lateral wall of the nasal fossa consists mainly of the medial surface of the maxilla and is occupied mainly by the large maxillary hiatus (Fig. 2.3). To reduce the size of this space in vivo, the hiatus is overlapped by the lacrimal bone and the ethmoid bone above, the palatine bone behind and the inferior concha below (Fig. 2.4).

Maxillary sinus

The maxillary sinus (antrum) is the largest of the paranasal sinuses and is situated in the body of the maxilla. It is pyramidal in shape. The base (medial wall) forms part of the lateral wall of the nose. The apex extends into the zygomatic process of the maxilla. The roof of the sinus is part of the floor of the orbit and the floor of the sinus is formed by the alveolar process and part of the palatine process of the maxilla. The anterior wall of the sinus is the facial surface of the maxilla and the posterior wall is the infratemporal surface of the maxilla. Running in the roof of the sinus are the infraorbital nerve and vessels. The anterior superior alveolar nerve and vessels run in the anterior wall of the sinus. The posterior superior alveolar nerve and vessels pass through canals in the posterior surface of the sinus. The medial wall of the maxillary sinus contains the opening (ostium) of the sinus that leads into the middle meatus of the nose. As this opening lies well above the floor of the sinus, its position is unfavourable for drainage (see Fig. 5.4A). Infections of the maxillary sinus may therefore require surgical intervention, creating a more favourable drainage channel closer to the floor of the sinus.

The roots of the cheek teeth are related to the floor of the maxillary sinus (Fig. 2.5). The most closely related are the roots of the second permanent maxillary molar, especially the apex of its palatal root; the roots of the first and third molars and the second premolar are only slightly further away. Sometimes, only mucosa separates the roots from the sinus. Care must be taken (particularly when extracting fractured roots in this region) to avoid creating an oroantral fistula, when an epithelial-lined channel exists between the oral cavity and maxillary sinus.

The maxillary air sinus is lined by respiratory epithelium (a ciliated columnar epithelium), with numerous goblet cells. The sinus is innervated by the infraorbital nerve and superior alveolar branches of the maxillary nerve.

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

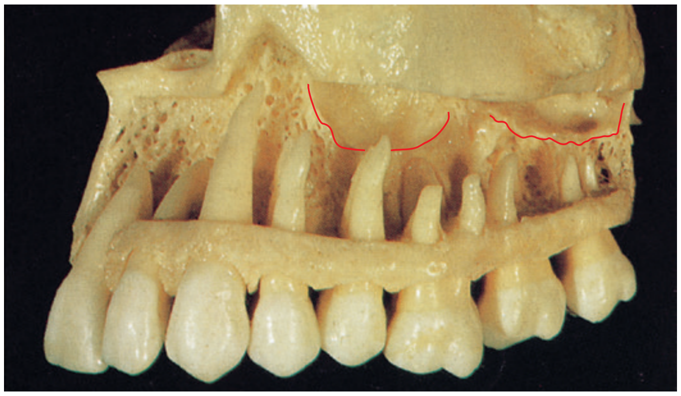

Fig. 2.5 Lateral view of the maxilla, showing close relationship of roots of the cheek teeth to the floor of the maxillary sinus (red outline).

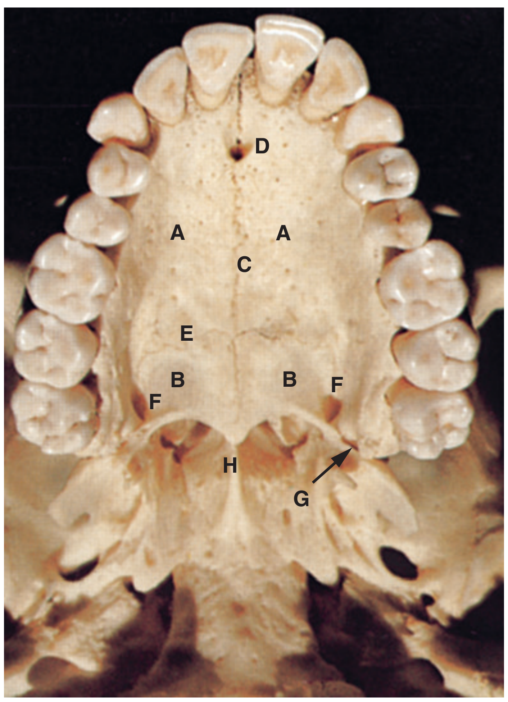

Fig. 2.6 Oral surface of the hard palate. A = palatine processes of maxillae; B = horizontal plates of the palatine bones; C = median palatine suture; D = incisive fossa; E = transverse palatine suture; F = greater palatine foramina; G = lesser palatine foramen; H = posterior nasal spine.

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.

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.

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 on the teeth. When the teeth are lost the alveolus resorbs.

The alveolar process consists of two parallel plates of cortical bone, the buccal and palatal alveolar plates, between which lay 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. The apical regions of the sockets of anterior teeth are closely related to the nasal fossae, while those of posterior teeth are closely related to the maxillary air sinuses. The positions of the sockets in relation to the buccal and palatal alveolar plates are shown in Fig. 2.12, page 13.

Mandible

The mandible consists of a horizontal, horseshoe-shaped component, the body of the mandible, and two vertical components, called the rami. The rami join the body posteriorly at obtuse angles. The body of the mandible carries the mandibular teeth and their associated alveolar processes. Before birth, the body consists of two lateral halves that meet in the midline at a symphysis. As viewed laterally (Fig. 2.8), on either side of the midline, close to the inferior margin of the body lies a distinct prominence called the *mental tubercle*. These tubercles constitute the mental protuberance or chin. Above the mental protuberance lies a shallow depression termed the incisive fossa. Behind this fossa, the canine eminence overlies the root of the mandibular canine. Midway in the height of the body of the mandible, related to the premolar teeth, is the mental foramen. The mental branches of the inferior alveolar nerve and artery pass to the face through

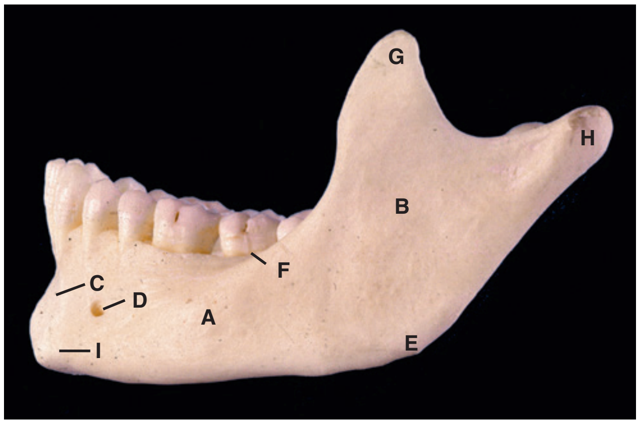

Fig. 2.8 Lateral aspect of the mandible. A = body; B = ramus; C = incisive fossa; D = mental foramen; E = angle; F = external oblique line; G = coronoid process; H = condyle; I = mental protuberance.

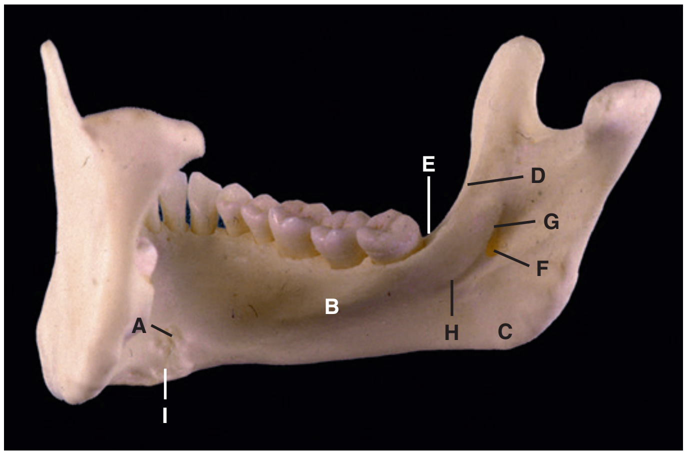

Fig. 2.9 Inner (medial) surface of the mandible. A = genial spines (tubercles); B = internal oblique ridge (mylohyoid ridge); C = attachment area for medial pterygoid muscle; D = temporal crest; E = retromolar triangle; F = mandibular foramen; G = lingula; H = mylohyoid groove; I = digastric fossa.

this foramen. The most common position for the mental foramen is 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. Accessory mental foramina are found in approximately 14% of cases, although bilateral accessory foramina are only found in about 0.5% of mandibles. Unilateral foramina occur singly, or in double or triple forms. They are located usually at the same level or in a higher position as the mental foramen. However, large accessory foramina tend to be found close, or anterosuperiorly, to the mental foramen. In addition to nerves, arteries pass through the accessory mental foramina. Accessory mental foramina are clinically important in relation to periodontal, endodontic and implant surgery.

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 [TMJ]). 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

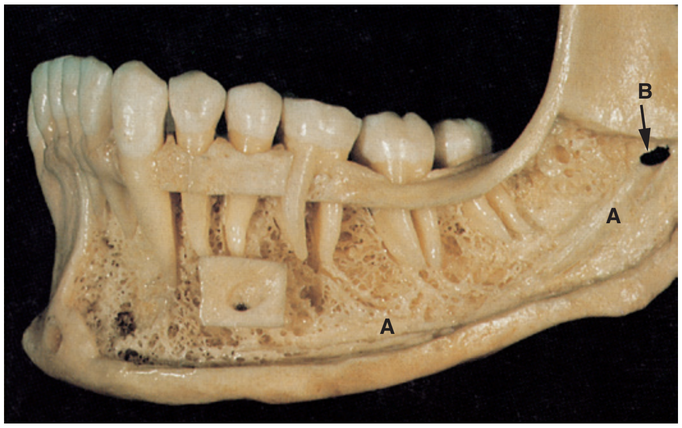

Fig. 2.10 Lateral view of the mandible, showing the roots of the teeth and the relationship to the mandibular canal (A). B = mandibular foramen.

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 13). 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 surface of the ramus to end behind the mandibular molars at the retromolar triangle. In the centre of the medial surface of the ramus lies the mandibular foramen, through which the inferior alveolar nerve and artery pass into the mandibular canal. A bony process, the lingula, extends from the anterosuperior surface of the foramen. The lingula is the site of attachment of the sphenomandibular ligament (see page 72). The mylohyoid groove may be seen running down from the posteroinferior surface of the foramen.

The mandibular canal, that transmits the inferior alveolar nerve, artery and veins, begins at the mandibular foramen and extends to the region of the premolar teeth where it bifurcates into the mental and incisive canals (Fig. 2.10). The course of the mandibular canal and its relationship with the teeth is variable; this variation is illustrated in connection with the course of the inferior alveolar nerve (see Fig. 4.6).

Mandibular alveolus

As for the maxilla, the mandibular alveolus consists of buccal and lingual alveolar plates joined by interdental and interradicular septa (Fig. 2.11). In the region of the second and third molars, the external oblique line is superimposed upon the buccal alveolar plate. The form and depth of the tooth sockets are related to the morphology of the roots of the mandibular teeth and the functional demands placed upon them.

Fig. 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 anaesthetising 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 oroantral fistula, due to the presence of the maxillary sinus in close relation 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.

Fig. 2.11 The mandibular alveolus and the arrangement of the tooth sockets. Note that the left second permanent mandibular molar has previously been extracted and the socket has healed.

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. However, 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 and replaced by their permanent successors. A complete permanent dentition is present at or around the age of 18 years. 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, bladelike 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 number of cusps on an otherwise flattened biting surface. Premolars are bicuspid teeth;

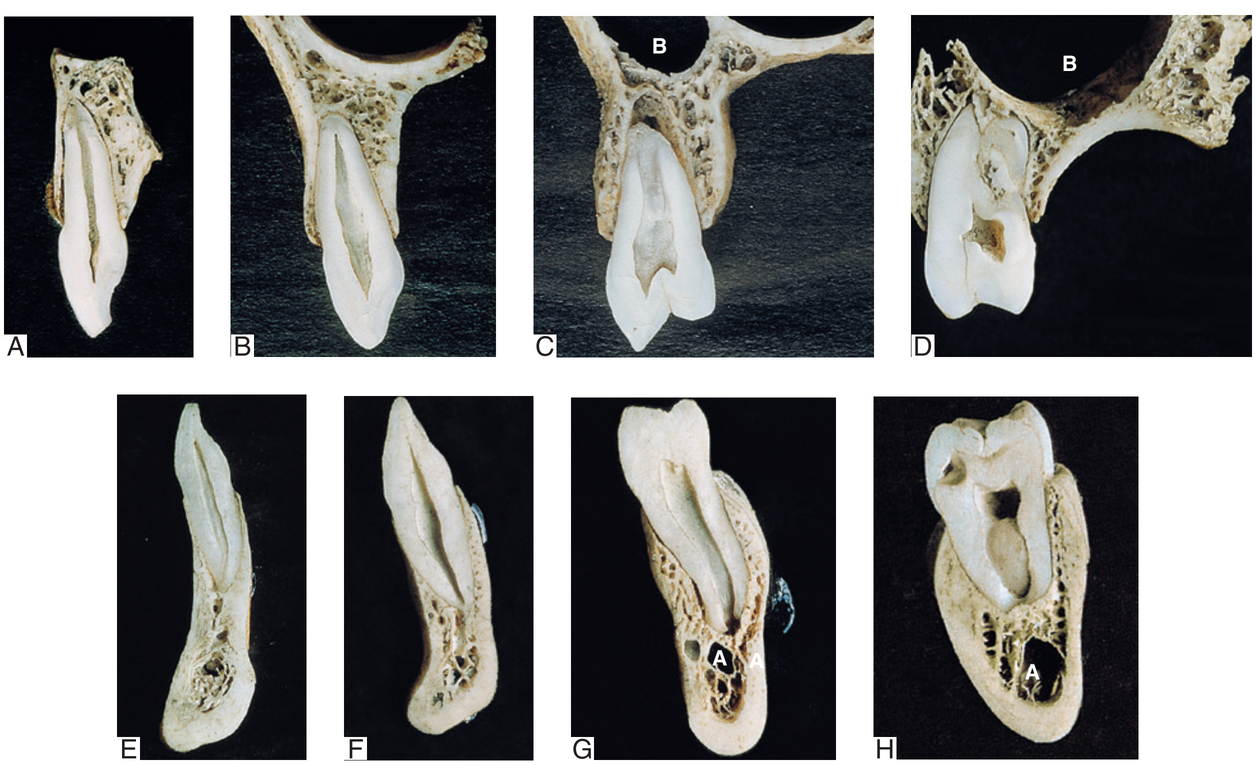

Fig. 2.12 Buccolingual sections through the maxilla and mandible demonstrating the distribution of alveolar bone in relation to the roots of the teeth. A = maxillary incisor region; B = maxillary canine region; C = maxillary premolar region; D = maxillary molar region; E = mandibular incisor region; F = mandibular canine region; G = mandibular premolar region; H = mandibular molar region. Note the relationship of the mandibular cheek teeth to the mandibular canal (A) and of the maxillary cheek teeth to the maxillary sinus (B). Courtesy the Royal College of Surgeons of England.

Table 2.1 Terms for the description of tooth form	
Crown	Clinical crown – portion of a tooth visible in the oral cavity
	Anatomical crown – portion of a tooth covered with enamel
Root	Clinical root – portion of a tooth which lies within the alveolus
	Anatomical root – 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

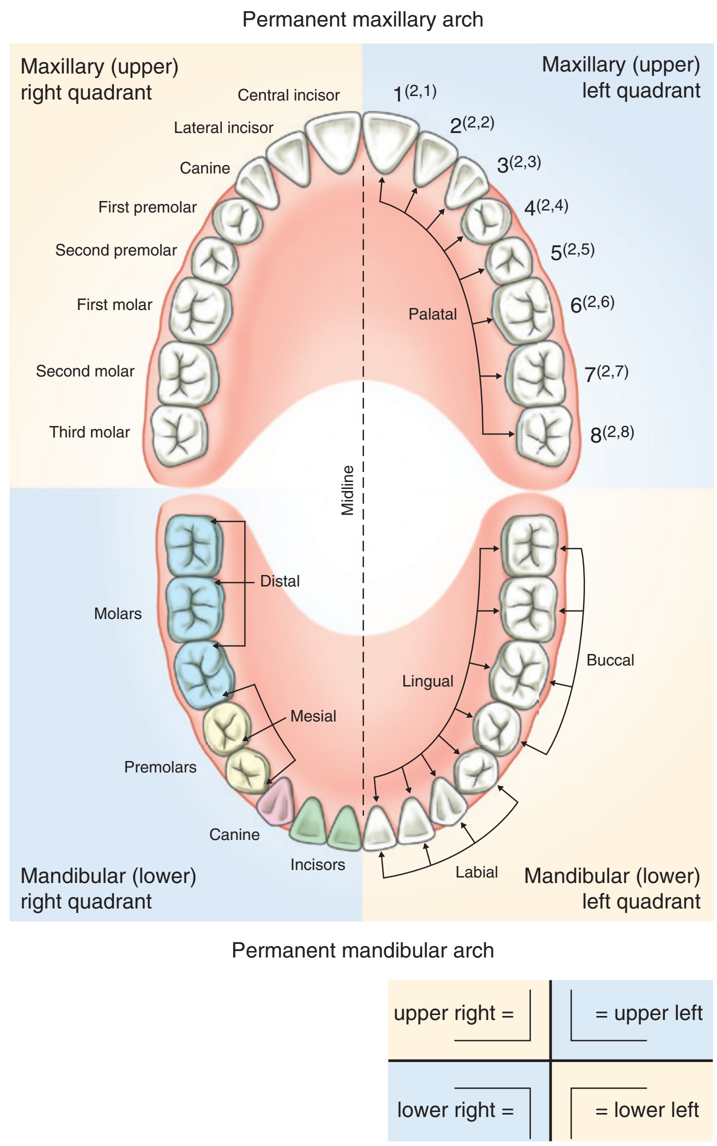

Fig. 2.13 Terminology employed for the identification of teeth according to their location in the jaws.

they are peculiar to the permanent dentition and replace the deciduous molars. Table 2.1 gives definitions of terms used for the descriptions of tooth form.

Dental notation

The types and numbers of teeth in any mammalian dentition can be expressed using dental formulae. The type of tooth is represented by its initial letter – I for incisors, C for canines, P for premolars, M for molars. The deciduous dentition is indicated by the letter D. The formula for the deciduous human dentition is $DI\frac{2}{2}\ DC\frac{1}{1}\ DM\frac{2}{2} = 10$, and for the permanent dentition $I\frac{2}{2}\ C\frac{1}{1}\ PM\frac{2}{2}\ M\frac{3}{3} = 16$, where the numbers following each letter refer to the number of teeth of each type in the upper and lower jaws on one side only. Identification of teeth is made not only according to the dentition to which they belong and basic tooth form but also according to their anatomical location within the jaws. The tooth-bearing region of the jaws can be divided into four quadrants: the right and left maxillary and mandibular quadrants. A tooth may thus be identified according to the quadrant in which it is located – e.g., a right maxillary deciduous incisor or a left mandibular permanent molar. In both the permanent and deciduous dentitions, the incisors may be distinguished according to their relationship to the midline. Thus, the incisor nearest the midline is the central (or first) incisor and the more laterally positioned incisor the lateral (or second) incisor. The permanent premolars and the permanent and deciduous molars can also be distinguished according to their mesiodistal relationships (Fig. 2.13). The molar most mesially positioned is designated the first molar, the one behind it being the second molar. In the permanent dentition, the tooth most distally positioned is the third molar. The mesial premolar is the first premolar, and the premolar behind it being the second premolar.

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 6⌋ and the mandibular left deciduous canine ⌈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 symbolised as 1,6 and the mandibular left deciduous canine as 7,3.

Fig. 2.13 summarises some of the terminology employed for the identification of teeth according to their location in the jaws.

Differences between teeth of the deciduous 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 corresponding permanent successors although the mesiodistal dimensions of the permanent premolars are generally less than those for the deciduous molars.
3) Deciduous teeth have a greater constancy of shape than permanent teeth.
4) The crowns of deciduous teeth appear bulbous, often having pronounced labial or buccal cingula.
5) The cervical margins of deciduous teeth are more sharply demarcated and pronounced than those of the permanent teeth, the enamel bulging at the cervical margins rather than gently tapering.
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.

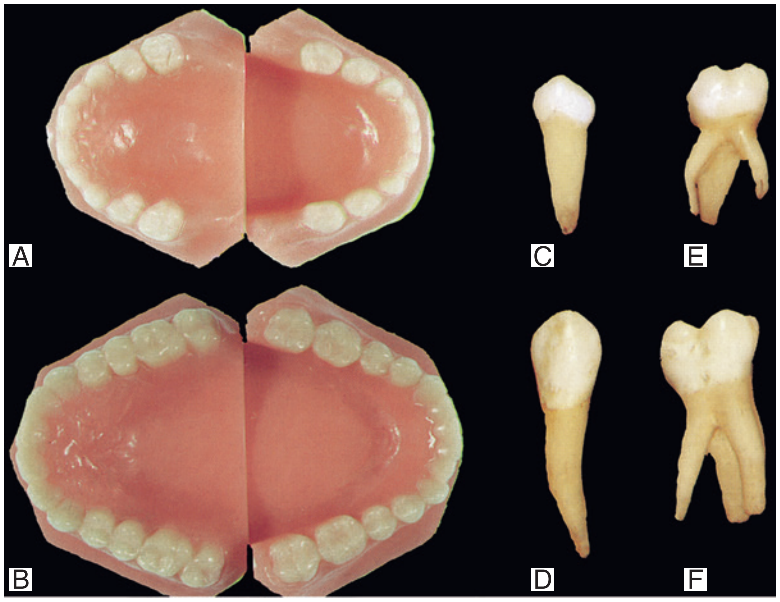

Fig. 2.14 Models of deciduous (A) and permanent (B) dental arches and some examples of deciduous and permanent teeth. C = deciduous canine; D = permanent canine; E = deciduous second molar; F = permanent first molar.

11) The aprismatic layer of surface enamel (see pages 129–131) is wider in deciduous teeth.
12) The enamel and dentine of all deciduous teeth exhibit neonatal lines (see pages 134, 165).
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 Fig. 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 help visualise 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 morphology of the external surfaces of the teeth on pages 33–39. For the chronology of the developing dentitions see page 428, for the average dimensions of the teeth see Tables 2.2 and 2.3, and for ethnic variations in tooth morphology see page 33.

Incisors

Human incisors have thin, bladelike crowns that are adapted for the cutting and shearing of food preparatory to grinding. Viewed mesially or