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1 Introduction to Dental Anatomy

LEARNING OBJECTIVES

1. Correctly define and pronounce the nomenclature (terms) as emphasized in the bold type in this and each following chapter.
2. Be able to identify each tooth of the primary and permanent dentitions using the Universal, Palmer, and Fédération Dentaire Internationale (FDI) systems.
3. Correctly name and identify the surfaces, ridges, and anatomic landmarks of each tooth.
4. Understand and describe the methods used to measure anterior and posterior teeth.
5. Learn the tables of measurements and be able to discuss size comparisons between the teeth from any viewing angle. A useful skill at this point is to start illustrating the individual teeth with line drawings.

Pretest Questions

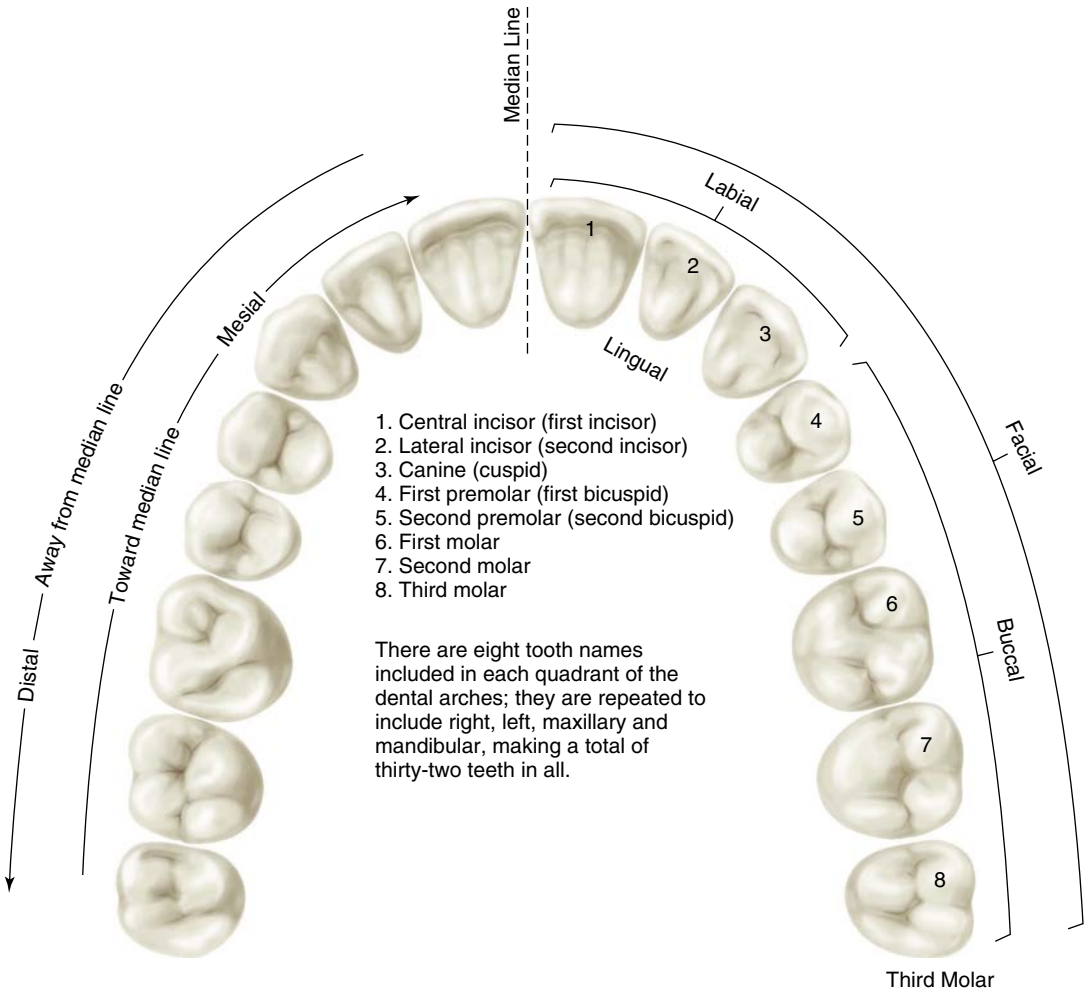
1. The dental formula for the permanent human dentition is which of the following?
   A. I 2/2 C 1/1 M 2/2 = 10
   B. I 2/2 C 1/1 P 1/1 M 2/2 = 12
   C. I 2/2 C 1/1 P 2/2 M 2/2 = 14
   D. I 2/2 C 1/1 P 2/2 M 3/3 = 16
2. The notation for the primary mandibular left canine is which of the following according to the FDI system?
   A. 53
   B. 63
   C. 73
   D. 83
3. The notation for the primary maxillary left lateral incisor is which of the following according to the Universal system?
   A. D
   B. G
   C. E
   D. F
4. Which of the following represents the name of the bone of the tooth socket that firmly fixes each tooth root?
   A. Alveolar process
   B. Alveolus
   C. Cementoenamel junction
   D. Dentinoenamel junction
5. Which of the following terms represents the surface of a tooth that is facing toward an adjoining tooth in the same dental arch?
   A. Occlusal
   B. Incisal
   C. Facial
   D. Proximal

For additional study resources, please visit Expert Consult.

Dental anatomy is defined here as, but is not limited to, the study of the development, morphology, function, and identity of each of the teeth in the human dentitions, as well as the way in which the teeth relate in shape, form, structure, color, and function to the other teeth in the same dental arch and to the teeth in the opposing arch. Thus the study of dental anatomy, physiology, and occlusion provides one of the basic components of the skills needed to practice all phases of dentistry.

The application of dental anatomy to clinical practice can be envisioned in Fig. 1.1A, where a faulty crown form has resulted in esthetic and periodontal problems that may be corrected by an appropriate restorative dental treatment, such as that illustrated in Fig. 1.1B. The practitioner must have knowledge of the morphology, occlusion, esthetics, phonetics, and functions of these teeth to undertake such treatment.

• **Fig. 1.1** Restoration of maxillary central incisors with porcelain veneers taking into account esthetics, occlusion, and periodontal health. (Case and photographs courtesy of Michael P. Webberson, DDS, Las Vegas, NV.)



• **Fig. 1.8** Application of nomenclature. Tooth numbers 1 to 8 indicating left maxillary teeth. Tooth surfaces related to the tongue *(lingual)*, cheek *(buccal)*, lips *(labial)*, and face *(facial)*, apply to four quadrants and the upper left quadrant. The teeth or their parts or surfaces may be described as being away from the midline *(distal)* or toward the midline *(mesial)*.

A **cusp** is an elevation or mound on the crown portion of a tooth making up a divisional part of the occlusal surface (Fig. 1.9; see also Fig. 1.4).

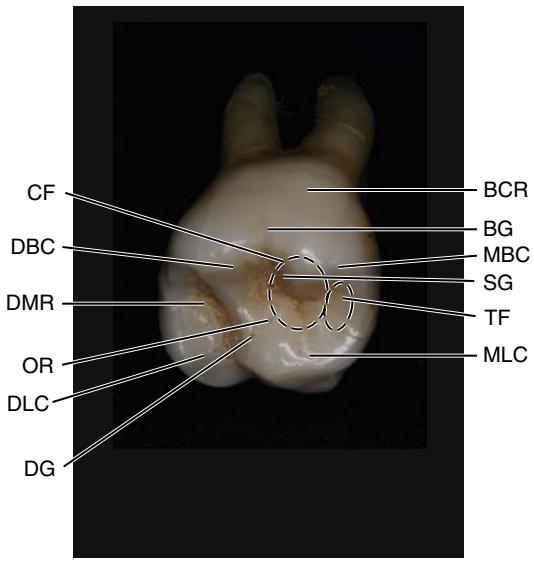
A **tubercle** is a smaller elevation on some portion of the crown produced by an extra formation of enamel (see Fig. 4.14A). These are deviations from the typical form.

A **cingulum** (Latin word for "girdle") is the lingual lobe of an anterior tooth. It makes up the bulk of the cervical third of the lingual surface. Its convexity mesiodistally resembles a girdle encircling the lingual surface at the cervical third (Figs. 1.10; see also Fig. 4.13A).

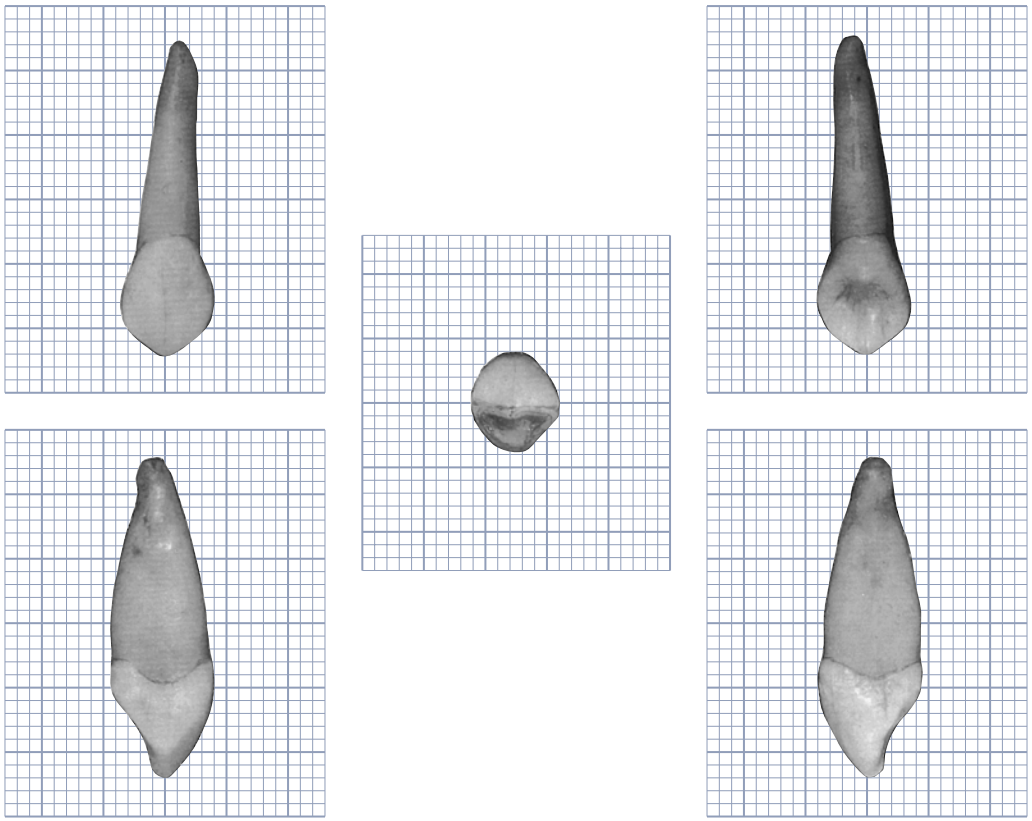
A **ridge** is any linear elevation on the surface of a tooth and is named according to its location (e.g., buccal ridge, incisal ridge, marginal ridge).

Marginal ridges are the rounded borders of the enamel that form the mesial and distal margins of the occlusal surfaces of premolars and molars, as well as the mesial and distal margins of the lingual surfaces of the incisors and canines (Fig. 1.11A; see also Figs 1.10A).

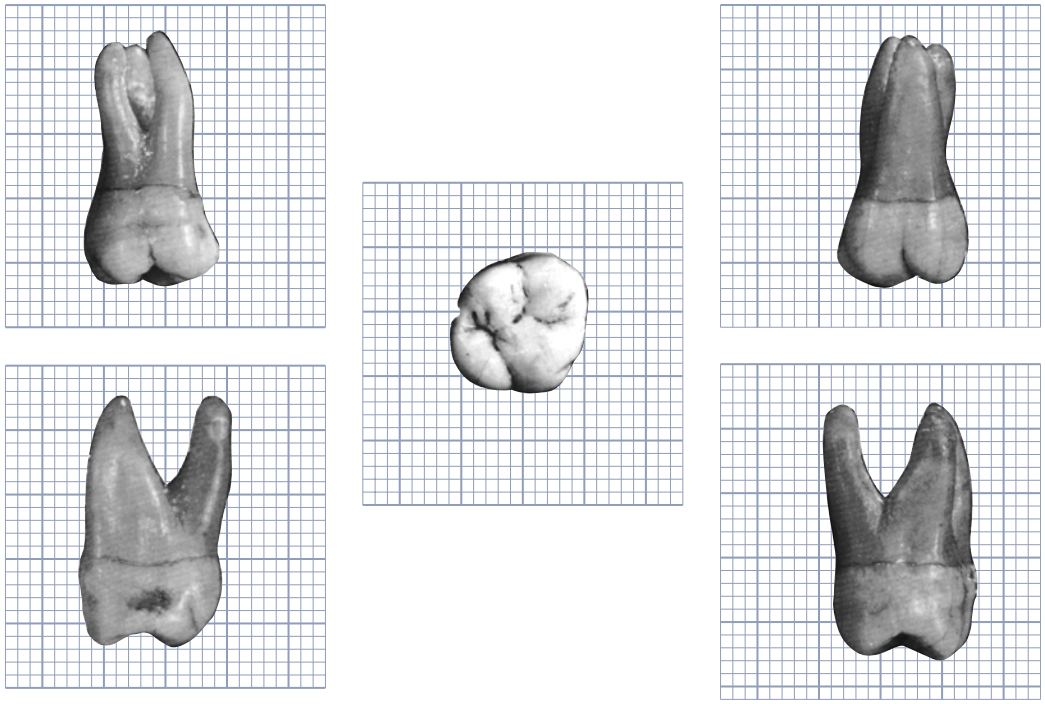
Triangular ridges descend from the tips of the cusps of molars and premolars toward the central part of the occlusal surfaces. They are so named because the slopes of each side of the ridge are inclined to resemble two sides of a triangle (Fig. 1.12; see also Figs. 1.11B and C). They are named after the cusps to which they



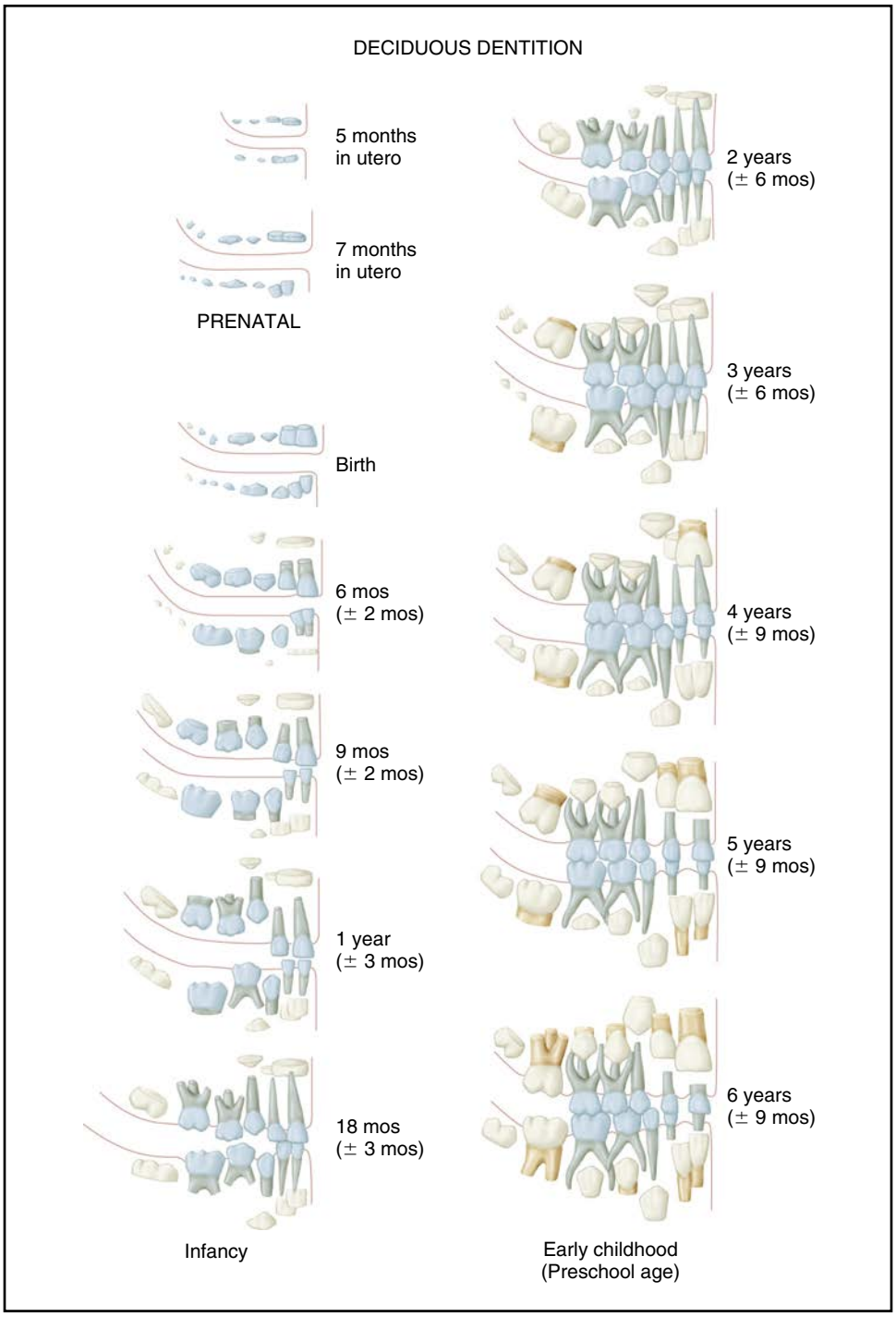
• **Fig. 1.9** Some landmarks on the maxillary first molar. *BCR,* Buccocervical ridge; *BG,* buccal groove; *CF,* central fossa; *DBC,* distobuccal cusp; *DG,* developmental groove; *DLC,* distolingual cusp; *DMR,* distal marginal ridge; *MBC,* mesiobuccal cusp; *MLC,* mesiolingual cusp; *OR,* oblique ridge; *SG,* supplemental groove; *TF,* triangular fossa. (To view Animations 3 and 4 for tooth #3, please go to Expert Consult.)



• **Fig. 1.19** Maxillary left canine. When viewing the mesial and distal aspects, note the curvature or bulge on the crown at the cervical third below the cementoenamel junction. This is called the *cervical ridge,* or the *cervicoenamel ridge.*



• **Fig. 1.20** Maxillary right first molar. When viewing the mesial and distal aspects, note the curvature or bulge on the crown at the cervical third below the cementoenamel junction. (To view Animations 3 and 4 for tooth #3, please go to Expert Consult.)



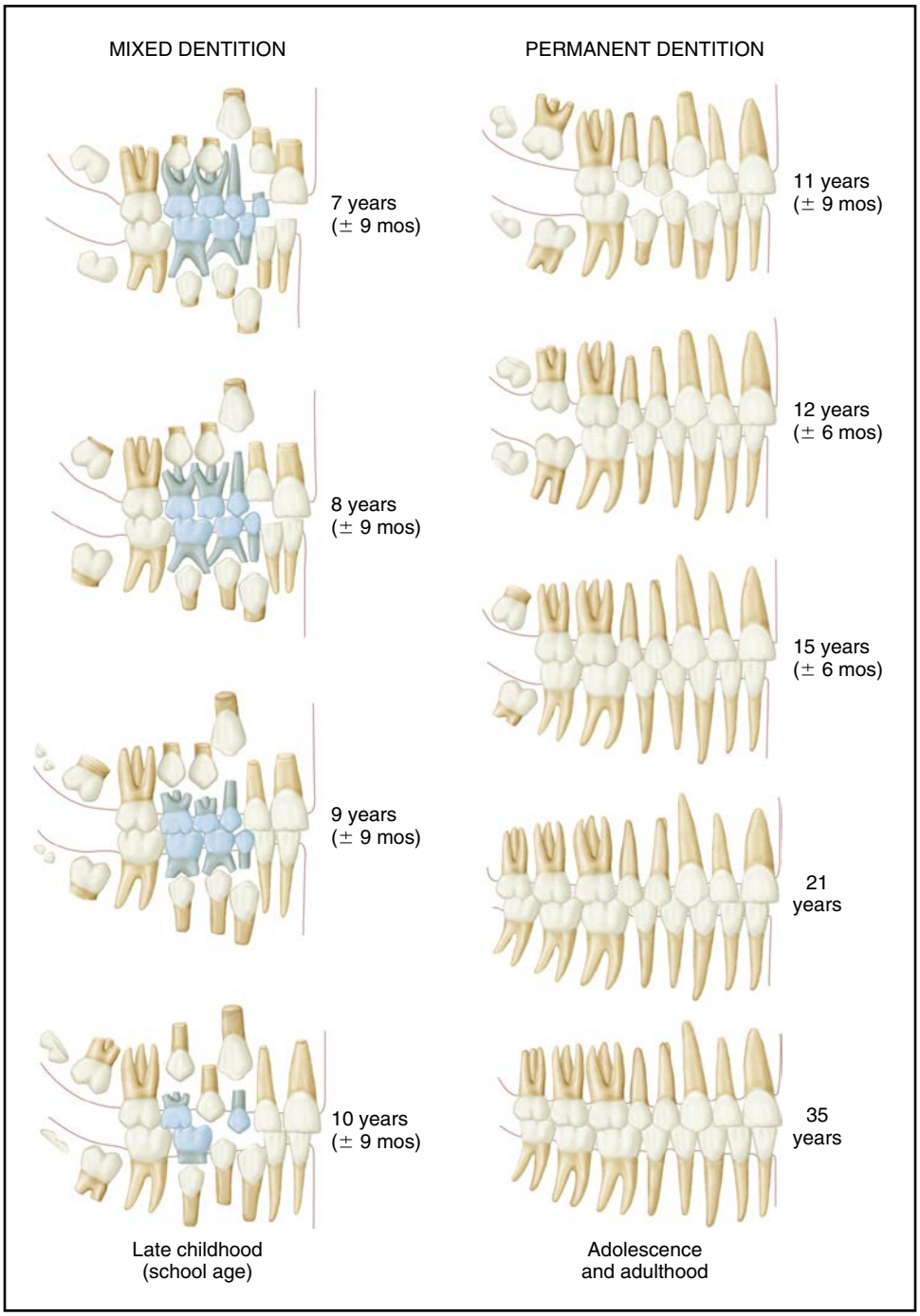
• **Fig. 2.3** Development of the human dentition to the sixth year. The primary teeth are the darker ones in the illustration. (From Schour L, Massler M: The development of the human dentition, *J Am Dent Assoc* 28:1153, 1941.)

Development of the Primary Dentition

Considerable growth follows birth in the neurocranium and splanchnocranium. Usually at birth, no teeth are visible in the mouth; occasionally, however, infants are born with erupted mandibular incisors. Development of both primary and permanent teeth continues in this period, and jaw growth follows the need for additional space posteriorly for additional teeth. In addition, the alveolar bone height increases to accommodate the increasing length of the teeth. However, growth of the anterior parts of the jaws is limited after about the first year of postnatal life.

Sequence of Emergence of Primary Teeth

The predominant sequence of eruption of the primary teeth in the individual jaw is central incisor (A), lateral incisor (B), first molar (D), canine (C), and second molar (E), as seen in Table 2.1. Variations in that order may be the result of reversals of central and



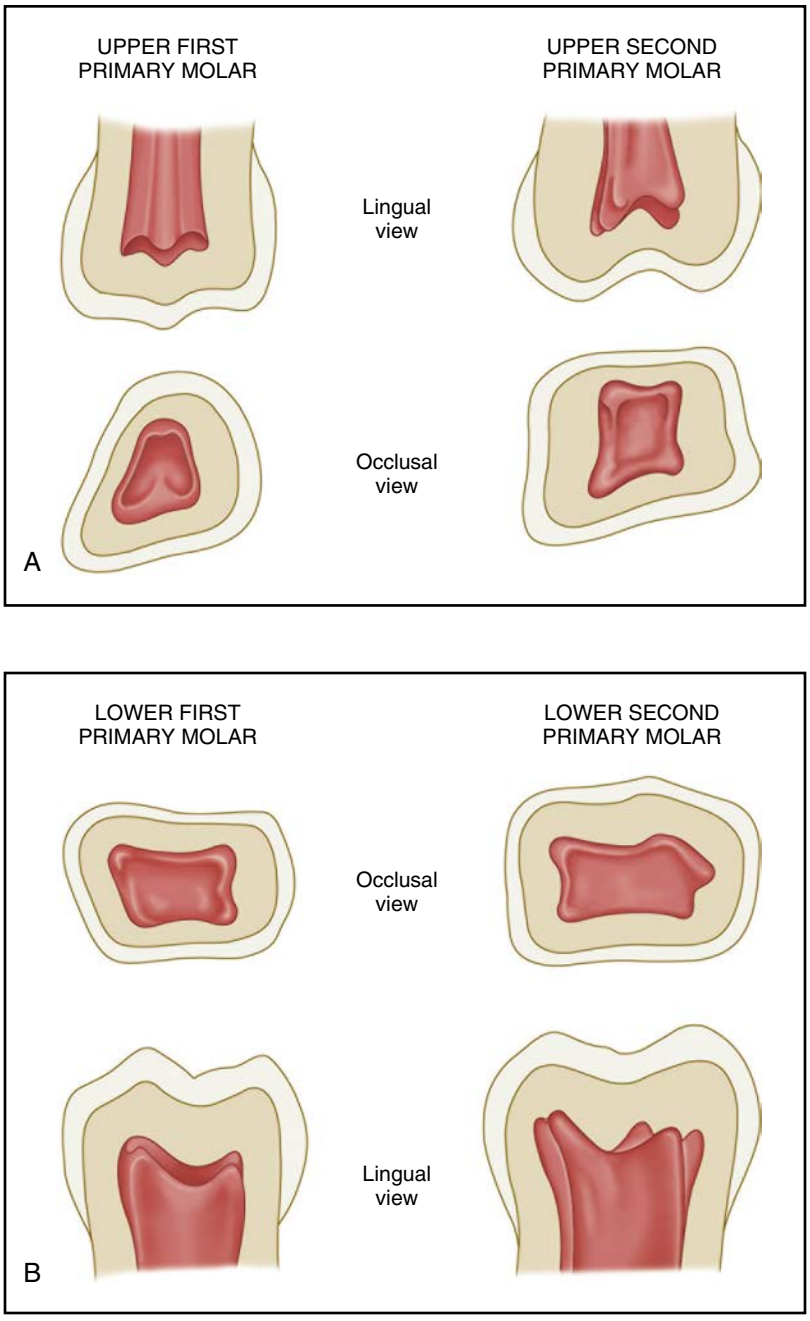
• **Fig. 2.4** Development of the human dentition from the seventh year to maturity. Note the displacement of the primary teeth. (From Schour L, Massler M: The development of the human dentition, *J Am Dent Assoc* 28:1153, 1941.)

lateral incisors or first molar and lateral incisor, or eruption of two teeth at the same time.[13] This subject is considered in more detail in the section on Tooth Formation Standards and in Chapter 16, which addresses development of the primary occlusion.

Investigations of the chronology of the emergence of primary teeth in different racial and ethnic groups show considerable variation,[7] and little information is available on tooth formation in populations of nonwhite/non-European ancestry.[14] World population differences in tooth standards suggest that patterned differences may exist that, in fact, are not large.[14] Tooth size, morphology, and formation are highly inheritable characteristics.[15] Few definitive correlations exist between primary tooth emergence and other physiologic parameters such as skeletal maturation, size, and gender.[16]

Emergence of the Primary Teeth

At approximately 8 (6 to 10) months of age, the mandibular central incisors emerge through the alveolar gingiva, followed by the other anterior teeth, so that by approximately 13 to 16 months, all eight primary incisors have erupted (see Table 2.1). Then the



• **Fig. 3.7** (A and B) Pulp chambers in the primary molars. Note the contours of the pulp horns within them. (Modified from Finn SB: *Clinical pedodontics,* ed 2, Philadelphia, 1957, Saunders.)

2. The enamel is relatively thin and has a consistent depth.
3. The dentin thickness between the pulp chambers and the enamel is limited, particularly in some areas (lower second primary molar).
4. The pulp horns are high, and the pulp chambers are large (Fig. 3.7A and B).
5. Primary roots are narrow and long compared with crown width and length.
6. Molar roots of primary teeth flare markedly and thin out rapidly as the apices are approached.

Studying the comparisons between the deciduous and the permanent dentitions (Figs. 3.8 and 3.9) is of utmost importance. Discussion of further variations between the macroscopic form of the deciduous and the permanent teeth follows, with a detailed description of each deciduous tooth.

Detailed Description of Each Primary Tooth

Maxillary Central Incisor

Labial Aspect

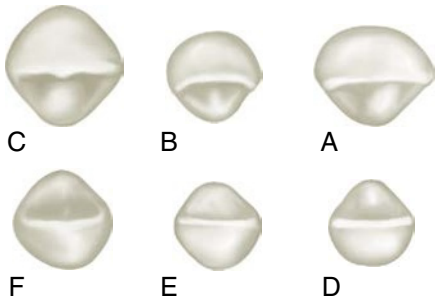
In the crown of the primary central incisor, the mesiodistal diameter is greater than the cervicoincisal length (Figs. 3.10 and 3.11A). (The opposite is true of permanent central incisors.) The labial surface is very smooth, and the incisal edge is nearly straight. Developmental lines are usually not seen. The root is cone-shaped

proportion to its length compared with that of its permanent successor. The heavy look at the root trunk makes this small tooth resemble the permanent maxillary lateral incisor.

The root of the primary central incisor is long and evenly tapered down to the apex, which is pointed. The root is almost twice the length of the crown (see Fig. 3.11D).

Lingual Aspect

On the lingual surface of the crown, the marginal ridges and the cingulum may be located easily (see Fig. 3.12D). The lingual surface of the crown at the middle third and the incisal third may have a flattened surface level with the marginal ridges, or it may present a slight concavity, called the **lingual fossa**. The lingual portion of the crown and root converges so that it is narrower toward the lingual and not the labial surface.



• **Fig. 3.14** Primary right anterior teeth, incisal aspect. (A) Maxillary central incisor. (B) Maxillary lateral incisor. (C) Maxillary canine. (D) Mandibular central incisor. (E) Mandibular lateral incisor. (F) Mandibular canine.

Mesial Aspect

The mesial aspect shows the typical outline of an incisor tooth, even though the measurements are small (see Figs. 3.13D and 3.17, *2*). The incisal ridge is centered over the center of the root and between the crest of curvature of the crown, labially, and lingually. The convexity of the cervical contours labially and lingually at the cervical third is just as pronounced as in any of the other primary incisors and more pronounced by far than the prominences found at the same locations on a permanent mandibular central incisor. As previously mentioned, these cervical bulges are important.

Although this tooth is small, its labiolingual measurement is only about a millimeter less than that of the primary maxillary central incisor. The primary incisors seem to be built for strenuous service.

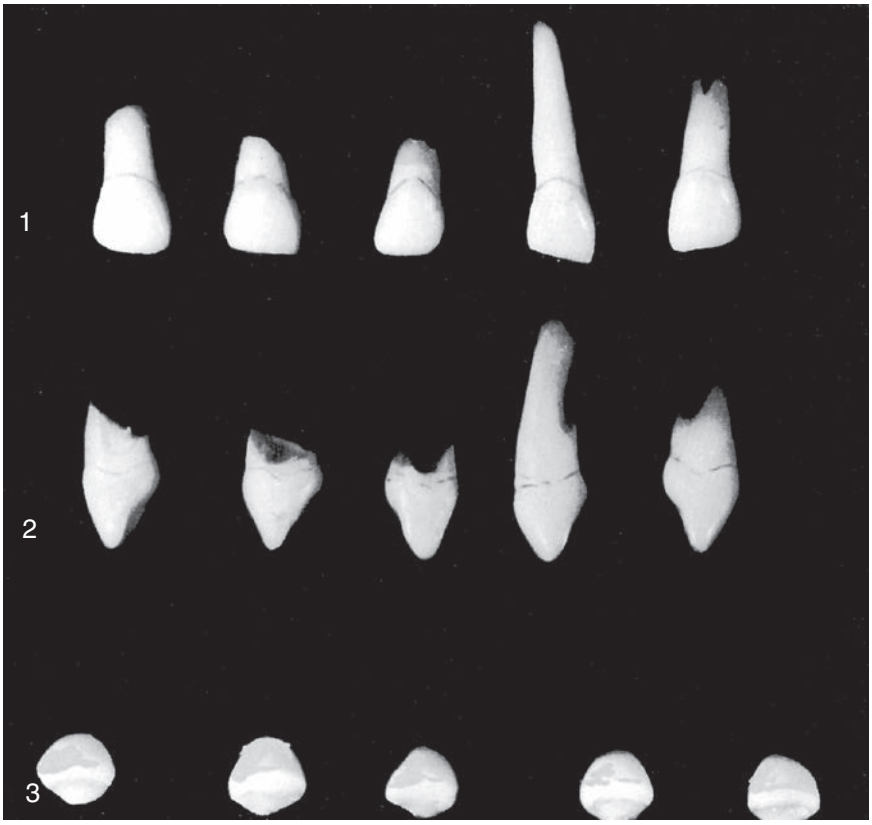
The mesial surface of the root is almost flat and evenly tapered; the apex presents a more blunt appearance than found with the lingual or labial aspects.

Distal Aspect

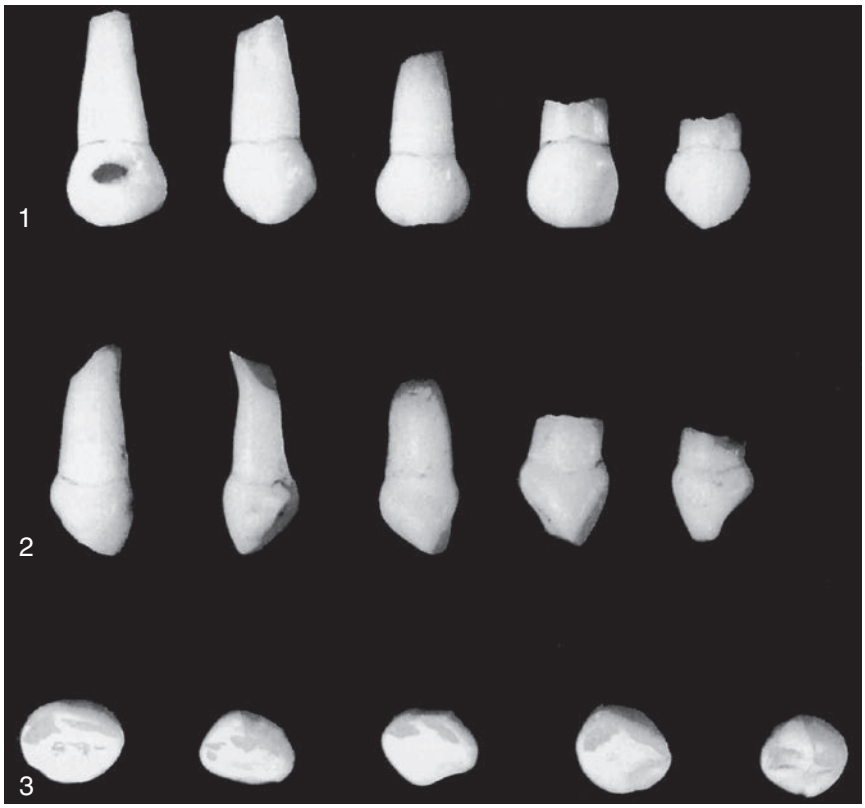
The outline of this tooth from the distal aspect is the reverse of that found from the mesial aspect. Little difference can be noted between these aspects, except that the cervical line of the crown is less curved toward the incisal ridge than on the mesial surface. Often, a developmental depression is evident on the distal side of the root.

Incisal Aspect

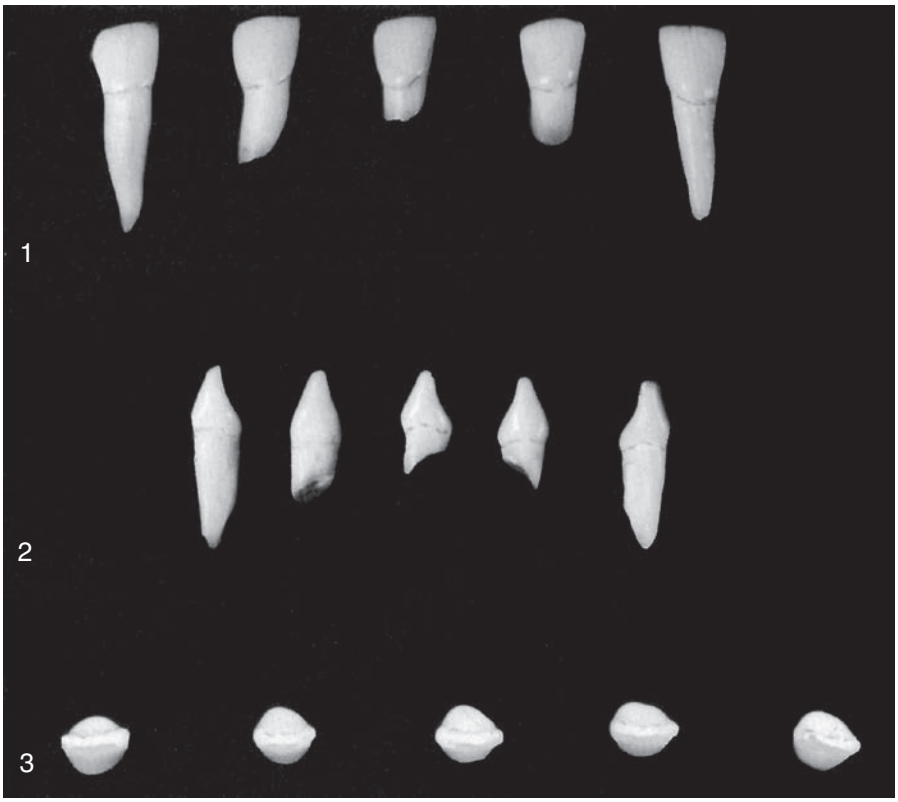
The incisal ridge is straight and bisects the crown labiolingually. The outline of the crown from the incisal aspect emphasizes the



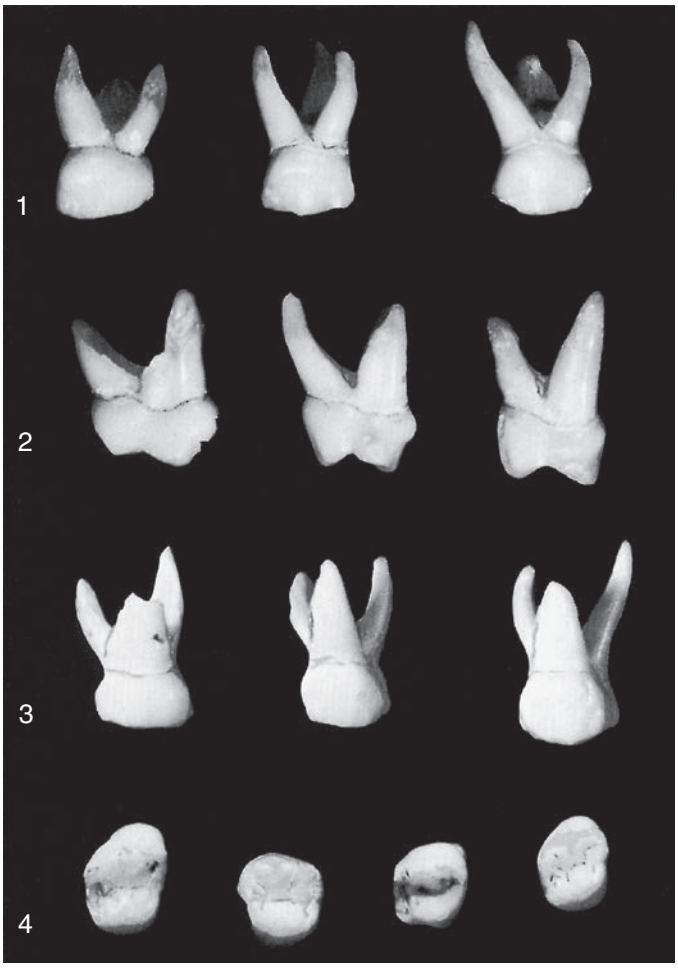
• **Fig. 3.15** Primary maxillary lateral incisors (second incisors). (1) Labial aspect. (2) Mesial aspect. (3) Incisal aspect.



• **Fig. 3.16** Primary maxillary canines. (1) Labial aspect. (2) Mesial aspect. (3) Incisal aspect.



• **Fig. 3.17** Primary mandibular central incisors. (1) Labial aspect. (2) Mesial aspect. (3) Incisal aspect.

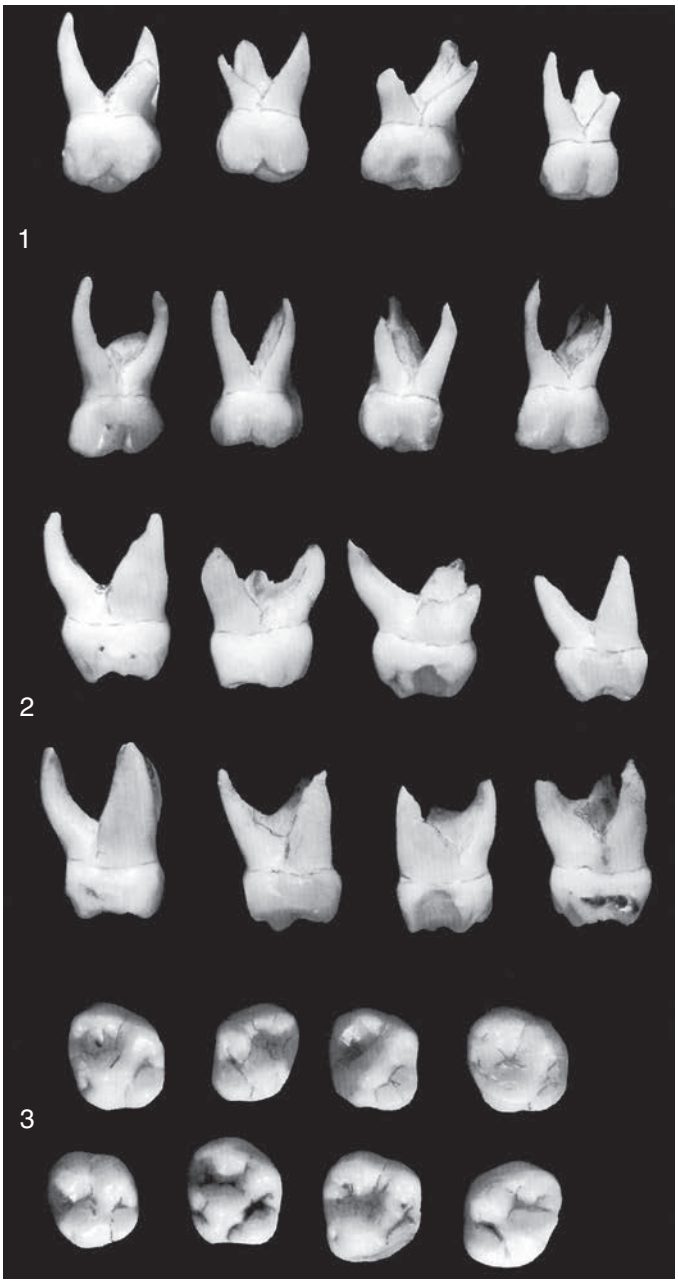


• **Fig. 3.25** Primary maxillary first molars. (1) Buccal aspect. Note the flare of roots. (2) Mesial aspect. The cervical ridge on the buccal surface is curved to the extreme. Also note the flat or concave buccal surface above this bulge as it approaches the occlusal surface. (3) Lingual aspect. (4) Occlusal aspect. This aspect emphasizes the extensive width of the mesial portion of primary first molars. The four specimens show size differentials even in deciduous teeth (see Fig. 3.24).

the roots appear slender, they are much longer and heavier than those that are a part of the maxillary first molar. The point of bifurcation between the buccal roots is close to the cervical line of the crown. The two buccal cusps are more nearly equal in size and development than those of the primary maxillary first molar.

Lingual Aspect

Lingually, the crown shows the following three cusps: (1) the mesiolingual cusp, which is large and well developed; (2) the distolingual cusp, which is well developed (more so than that of the primary first molar); and (3) a third supplemental cusp, which is apical to the mesiolingual cusp and sometimes called the **tubercle of Carabelli**, or the fifth cusp (see Fig. 3.22B). This cusp is poorly developed and merely acts as a buttress or supplement to the bulk of the mesiolingual cusp. If the tubercle of Carabelli seems to be missing, some traces of developmental lines or "dimples" remain (see Fig. 3.26, *3*). A well-defined developmental groove separates the mesiolingual cusp from the distolingual cusp and connects with the developmental groove, which outlines the fifth cusp.

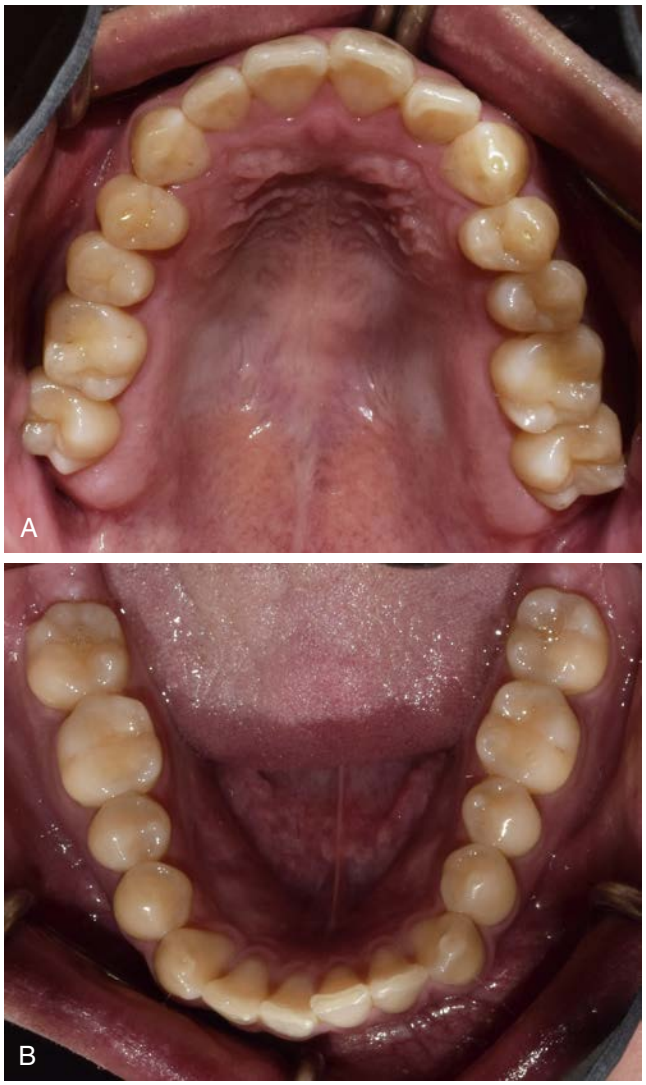


• **Fig. 3.26** Primary maxillary second molars. (1) Buccal aspect. (2) Mesial aspect. (3) Occlusal aspect.

All three roots are visible from this aspect; the lingual root is large and thick compared with the other two roots. It is approximately the same length as the mesiobuccal root. If it should differ, it will be on the short side.

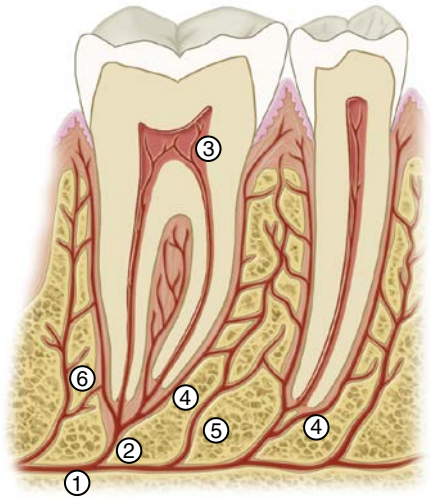
Mesial Aspect

From the mesial aspect, the crown has a typical molar outline that greatly resembles that of the permanent molars (see Figs. 3.23B and 3.26, *2*). The crown appears short because of its width buccolingually in comparison with its length. The crown of this tooth is usually only about 0.5 mm longer than the crown of the first deciduous molar, but the buccolingual measurement is 1.5 to 2 mm greater. In addition, the roots are 1.5 to 2 mm longer. The mesiolingual cusp of the crown with its supplementary fifth cusp appears large in comparison with the mesiobuccal cusp. The



• **Fig. 5.10** Contact relations in a patient with "normal" occlusion. (A) Maxillary arch. (B) Mandibular arch.

• **Fig. 5.11** Broad contact areas of the mandibular first and second molars in a young adult, 21 years old.



• **Fig. 5.12** Schematic drawing of distribution of the periodontal blood vessels and interdental papillae. *1,* Inferior alveolar artery; *2,* dental arteriole; *3,* pulpal branches; *4,* periodontal ligament arteriole; *5* and *6,* interalveolar arterioles. (From Ramfjord SR, Ash MM: *Periodontology and periodontics,* Philadelphia, 1979, Saunders.)

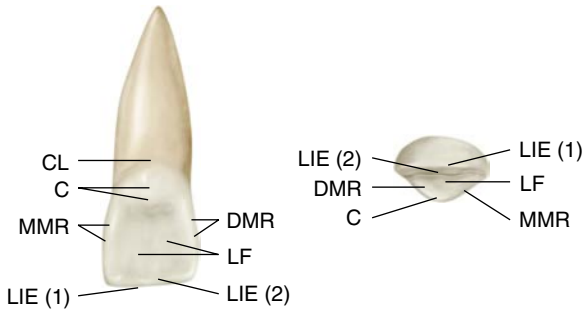
sufficient bone tissue between one tooth and another, which anchors the teeth securely in the jaws. It also simplifies the problem of space for the blood and nerve supply to the surrounding alveolar process and other investing tissues of the teeth (see Fig. 5.12).

The **type of tooth** also has a bearing on the interproximal space. Some individuals have teeth that are wide at the cervices, constricting the space at the base. Others have teeth that are more slender at the cervices than usual; this type of tooth widens the space. Teeth that are oversize or unusually small will likewise affect the interproximal spacing. Nevertheless, this spacing conforms to a plan that is fairly uniform, provided that the anatomic form is normal and the teeth are in good alignment.

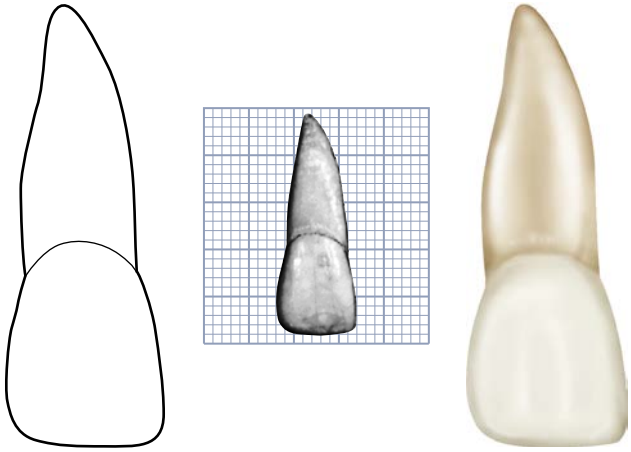
Embrasures (Spillways)

When two teeth in the same arch are in contact, their curvatures adjacent to the contact areas form spillway spaces called **embrasures**. The spaces that widen out from the area of contact labially or buccally and lingually are called *labial* or *buccal* and **lingual interproximal** embrasures. These embrasures are continuous with the interproximal spaces between the teeth (see Fig. 5.10). Above the contact areas incisally and occlusally, the spaces, which are bounded by the marginal ridges as they join the cusps and incisal ridges, are called the **incisal** or **occlusal embrasures**. These embrasures, and the labial or buccal and lingual embrasures, are continuous (Fig. 5.15; see also Fig. 5.8). The curved proximal surfaces of the contacting teeth roll away from the contact area at all points, occlusally, labially or buccally, and lingually and cervically, and the embrasures and interproximal spaces are continuous, as they surround the areas of contact.

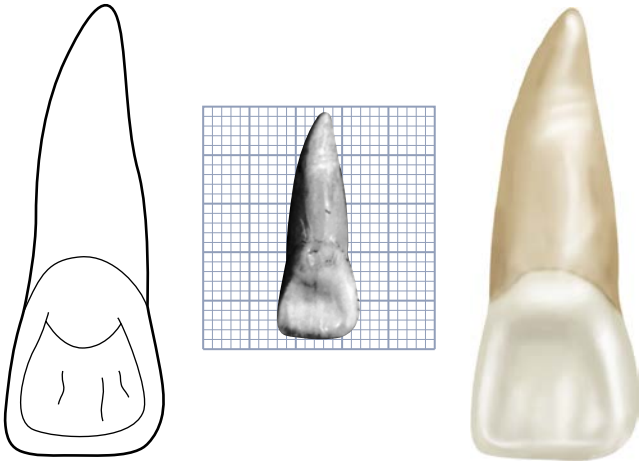
The form of embrasures serves two purposes: (1) it provides a spillway for food during mastication, a physiologic form that reduces the forces brought to bear on the teeth during the reduction of any material that offers resistance; and (2) it prevents food from being forced through the contact area. When teeth wear



• **Fig. 6.1** Maxillary right central incisor, lingual and incisal aspects. The labioincisal edge *(LIE [1])* and linguoincisal edge *(LIE [2])* border the incisal ridge. *C,* Cingulum; *CL,* cervical line; *DMR,* distal marginal ridge; *LF,* lingual fossa; *MMR,* mesial marginal ridge.

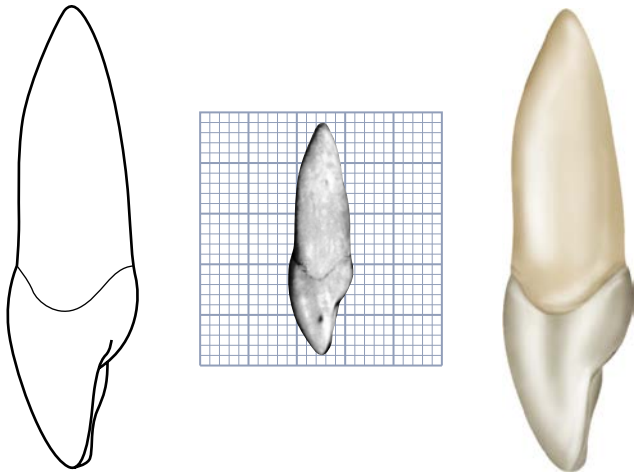


• **Fig. 6.2** Maxillary right central incisor, labial aspect. (Grid = 1 sq. mm.)

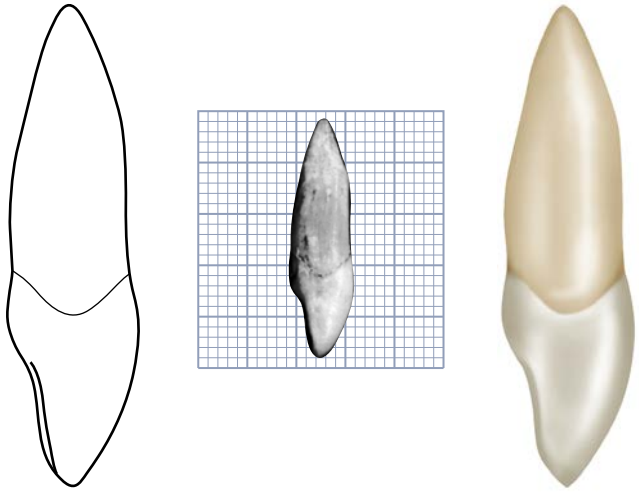


• **Fig. 6.3** Maxillary right central incisor, lingual aspect. (Grid = 1 sq. mm.)

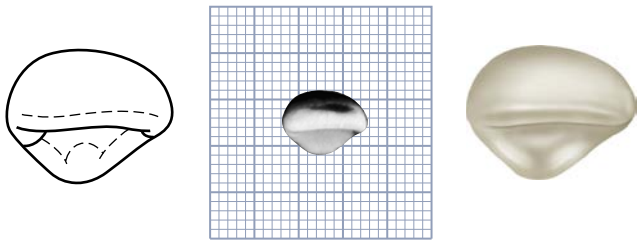
Although the **labial** surface of the crown is usually convex, especially toward the cervical third, some central incisors are flat at the middle and incisal portions. The enamel surface is relatively smooth. When the tooth is newly erupted or if little wear is evident, mamelons will be seen on the incisal ridge. The middle one is the smallest. The developmental lines on the labial surface



• **Fig. 6.4** Maxillary right central incisor, mesial aspect. (Grid = 1 sq. mm.)



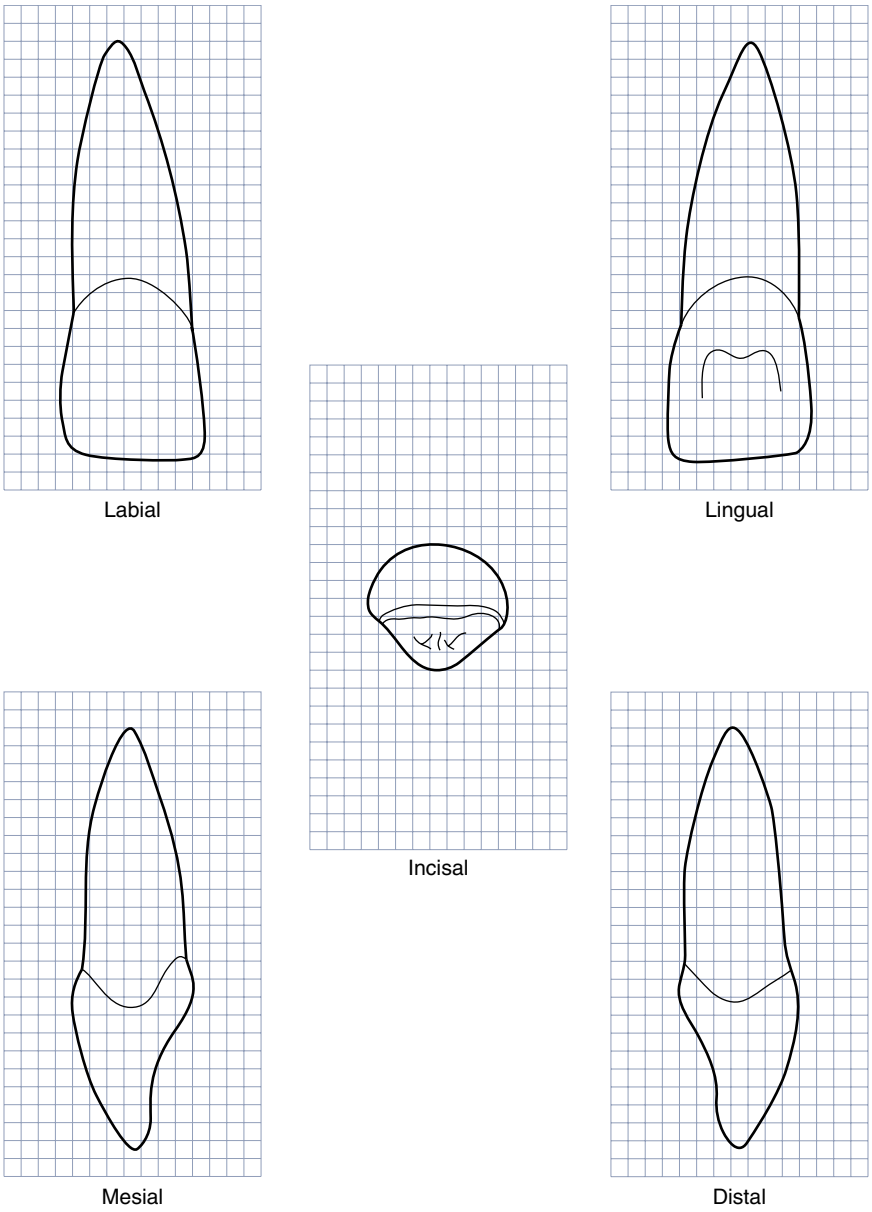
• **Fig. 6.5** Maxillary right central incisor, distal aspect. (Grid = 1 sq. mm.)



• **Fig. 6.6** Maxillary right central incisor, incisal aspect. (Grid = 1 sq. mm.)

that divide the surface into three parts are most noticeable at the middle portion if they can be distinguished at all (see Fig. 2.11).

Lingually, the surface form of the maxillary central incisor is more irregular. The largest part of the middle and incisal portions of the lingual area is concave. Mesial and distal marginal ridges border the concavity, the lingual portion of the incisal ridge, and the convexity apically to the cingulum. The lingual topography gives a scooplike form to the crown (see Fig. 6.3). An exaggeration of the marginal ridges, known as a *shovel-shaped incisor,* is a genetically determined variation seen in Mongoloid races, including North and South American Indians.[2–4]



• **Fig. 6.7** Maxillary right central incisor. Squared millimeter graph outlines of five aspects are shown. In the incisal view, the labial aspect is at the top of the drawing. (Grid = 1 sq. mm.)

The maxillary central incisor usually develops normally. One anomaly that sometimes occurs is a short root. Another variation is an unusually long crown (see Fig. 6.12, *4* and *5*). The maxillary central incisors are the most prominent teeth in the mouth. There are two basic forms: the first is relatively wide at the cervix, when viewed from the labial aspect, in comparison with the mesiodistal width at the contact areas (see Fig. 6.9, *1* and *4*); the second form is relatively narrow at the cervix, where the root joins the crown, in comparison with the mesiodistal width at the contact areas (see Fig. 6.9, *5, 7,* and *9*).

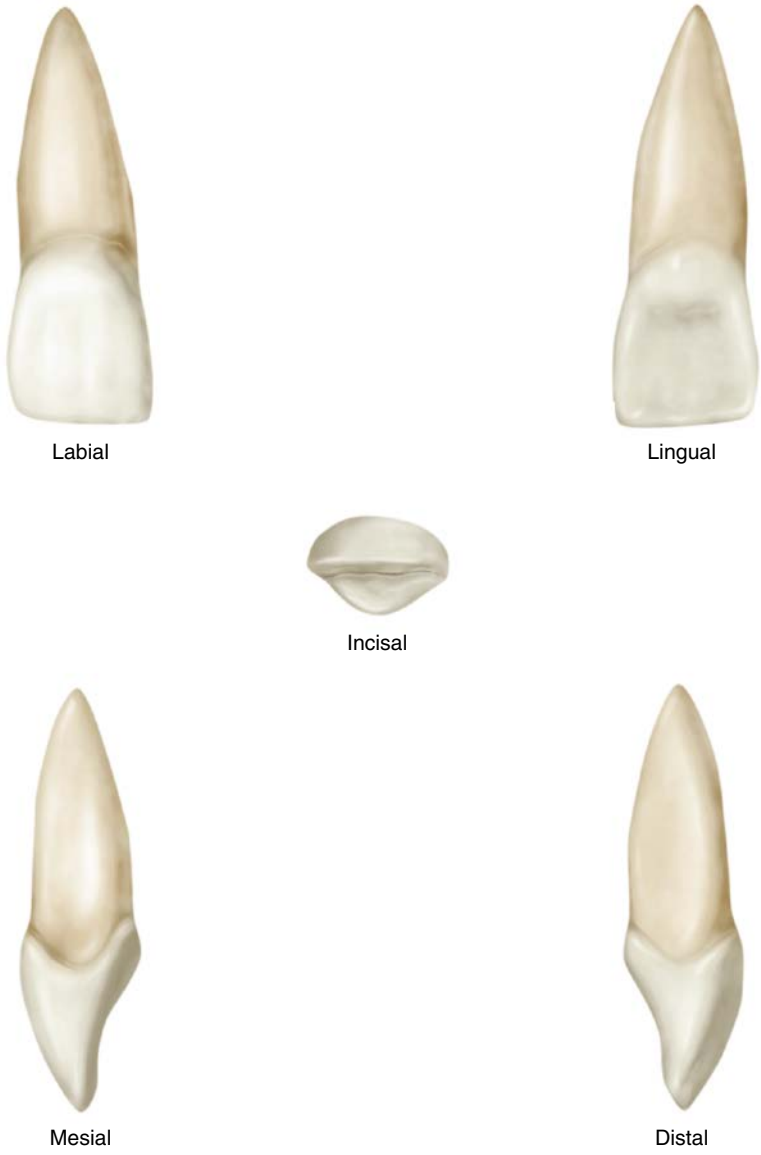
In the description of the central incisor, an attempt will be made to strike an average between the extremes of the two forms, keeping in mind that crown sizes are gender dimorphic, with male larger than female. The extent of dimorphism varies among populations.[5] However, gender-specific correlations between enamel thickness and crown width of dentin are low.[6]

Detailed Description of the Maxillary Central Incisor From All Aspects

Labial Aspect

The crown of the average central incisor will be 10 to 11 mm long from the highest point on the cervical line to the lowest point on the incisal edge (see Figs. 6.2 and 6.9). The mesiodistal measurement will be 8 to 9 mm wide at the contact areas. The mesiodistal measurement, where the root joins the crown, will be 1.5 to 2 mm less. The crests of curvature mesially and distally on the crown represent the areas at which the central incisor contacts its neighbors. Any change in the position of this crest of contour affects the level of the contact area (see Fig. 5.15A).

The mesial outline of the crown is only slightly convex, with the crest of curvature (representing the contact area) approaching the mesioincisal angle (see Chapter 5).



• **Fig. 6.8** Maxillary right central incisor.

The distal outline of the crown is more convex than the mesial outline, with the crest of curvature higher toward the cervical line. The distoincisal angle is not as sharp as the mesioincisal angle, the extent of curvature depending on the typal form of the tooth.

The incisal outline is usually regular and straight in a mesiodistal direction after the tooth has been in function long enough to obliterate the mamelons. The incisal outline tends to curve downward toward the center of the crown outline, so that the crown length is greater at the center than at the two mesial angles.

The cervical outline of the crown follows a semicircular direction with the curvature rootwise, from the point at which the root outline joins the crown mesially to the point at which the root outline joins the crown distally.

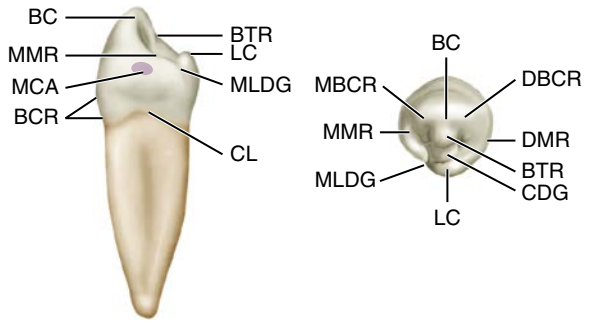
The root of the central incisor from the labial aspect is cone shaped, in most instances with a relatively blunt apex, and the outline mesially and distally is regular. The root is usually 2 or 3 mm longer than the crown, although it varies considerably (see illustrations of typical central incisors and those of variations from the labial aspects in Figs. 6.9 and 6.12).

A line drawn through the center of the root and crown of the maxillary central incisor tends to parallel the mesial outline of the crown and root.

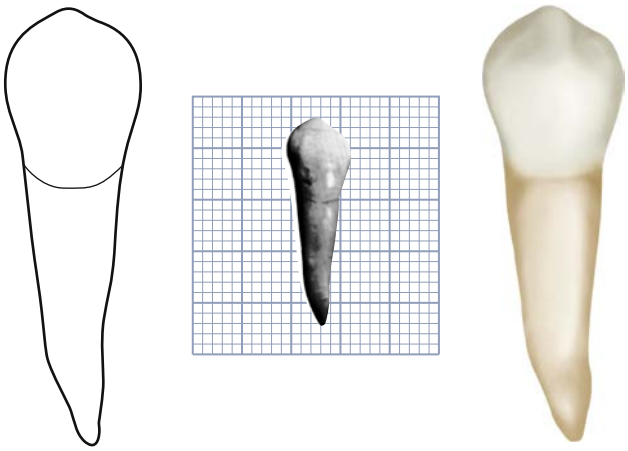
Lingual Aspect

The lingual outline of the maxillary central incisor is the reverse of that found on the labial aspect (see Fig. 6.3). However, the lingual aspect of the crown is different when we compare the surface of the lingual aspect with that of the labial aspect. From the labial aspect, the surface of the crown is smooth generally. The lingual aspect has convexities and a concavity. The outline of the cervical line is similar, but immediately below the cervical line a smooth convexity is to be found; this is called the **cingulum** (see Fig. 6.1).

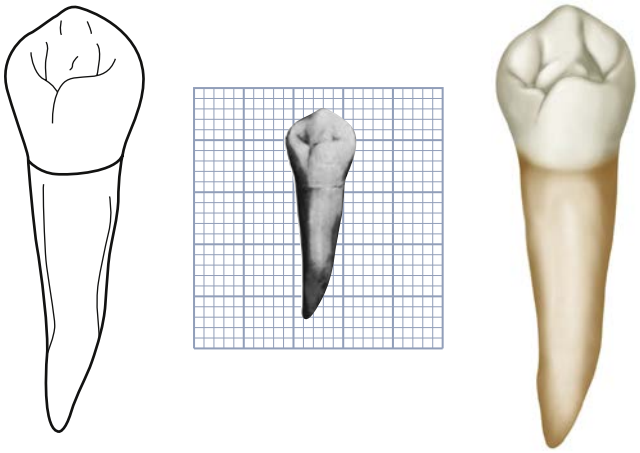
Mesially and distally confluent with the cingulum are the **marginal ridges.** Between the marginal ridges, below the cingulum, a shallow concavity is present called the **lingual fossa.** Outlining the lingual fossa, the linguoincisal edge is raised somewhat, being on a level with the marginal ridges mesially and distally, completing the lingual portion of the incisal ridge of the central incisor.



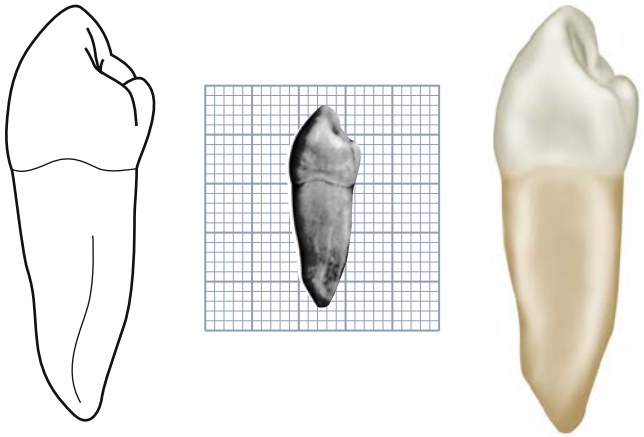
• **Fig. 10.1** Mandibular right first premolar, mesial and occlusal aspects. *BC,* Buccal cusp; *BCR,* buccal cervical ridge; *BTR,* buccal triangular ridge; *CDG,* central developmental groove; *CL,* cervical line; *DBCR,* distobuccal cusp ridge; *DMR,* distal marginal ridge; *LC,* lingual cusp; *MBCR,* mesiobuccal cusp ridge; *MCA,* mesial contact area; *MLDG,* mesiolingual developmental groove; *MMR,* mesial marginal ridge.



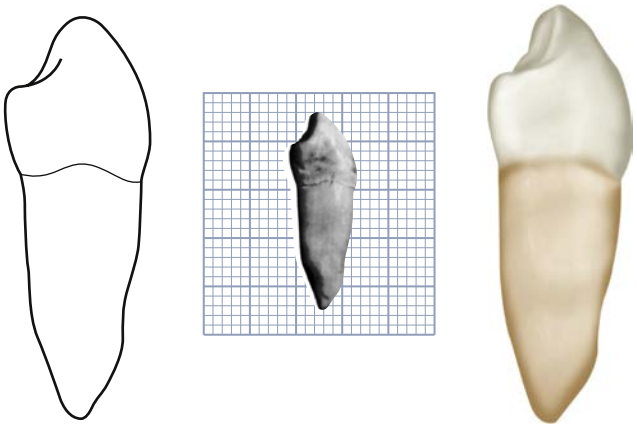
• **Fig. 10.2** Mandibular right first premolar, buccal aspect. The specimen in this photograph shows a mesial inclination of the root. Mandibular premolars and canines have this tendency, although most of the roots of these teeth will curve, if at all, in a distal direction. (Grid = 1 sq. mm.)



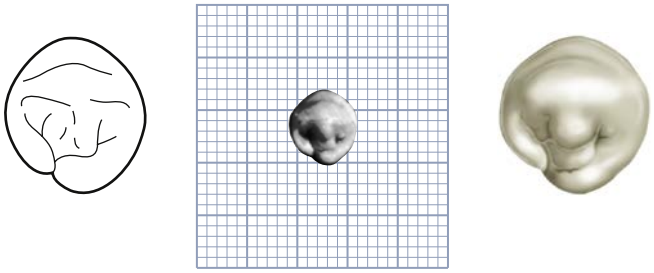
• **Fig. 10.3** Mandibular right first premolar, lingual aspect. (Grid = 1 sq. mm.)



• **Fig. 10.4** Mandibular right first premolar, mesial aspect. (Grid = 1 sq. mm.)



• **Fig. 10.5** Mandibular right first premolar, distal aspect. (Grid = 1 sq. mm.)



• **Fig. 10.6** Mandibular right first premolar, occlusal aspect. (Grid = 1 sq. mm.)

5. The outline form of the occlusal aspect resembles the outline form of the incisal aspect of the canine (compare Fig. 10.6 and Fig. 8.18).

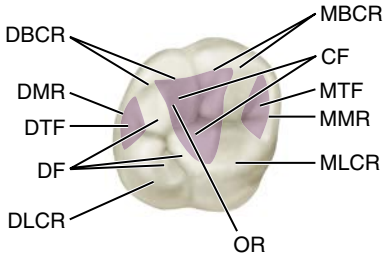
The characteristics that resemble those of the second mandibular premolar are as follows:

1. Except for the longer cusp, the outline of the crown and root from the buccal aspect resembles that of the second premolar.
2. The contact areas, mesially and distally, are near the same level.
3. The curvatures of the cervical line mesially and distally are similar.
4. The tooth has more than one cusp.

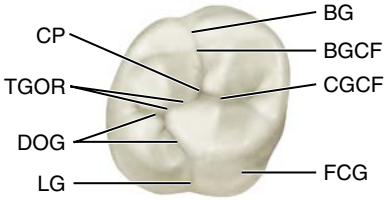
jaws. Subsequent chapters cover those phases. The mandibular molars are described in Chapter 12.

Maxillary First Molar

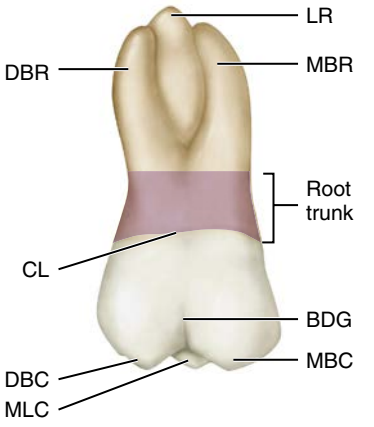
Figs. 11.1 through 11.18 illustrate the maxillary first molar from all aspects. The crown of this tooth is wider buccolingually than mesiodistally. Usually the extra dimension buccolingually is about 1 mm (Table 11.1). This, however, varies in individuals (see Fig. 11.17, *1, 5, 7,* and *9*). From the occlusal aspect, the inequality of the measurements in the two directions appears slight. Although the crown is relatively short, it is broad both



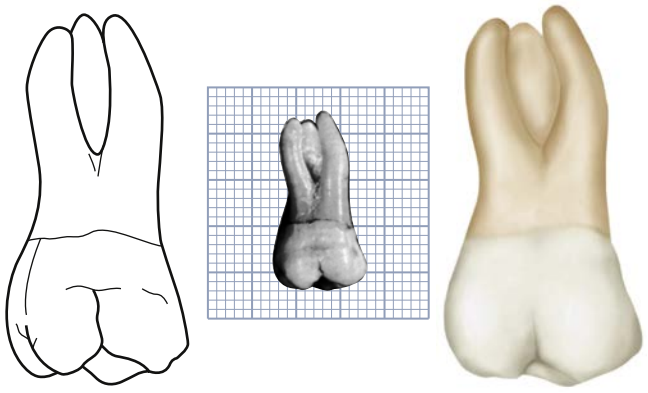
• **Fig. 11.1** Maxillary right first molar, occlusal aspect. *CF,* Central fossa *(shaded area); DBCR,* distobuccal cusp ridge; *DF,* distal fossa; *DLCR,* distolingual cusp ridge; *DMR,* distal marginal ridge; *DTF,* distal triangular fossa *(shaded area); MBCR,* Mesiobuccal cusp ridge; *MLCR,* mesiolingual cusp ridge; *MMR,* mesial marginal ridge; *MTF,* mesial triangular fossa *(shaded area); OR,* oblique ridge.



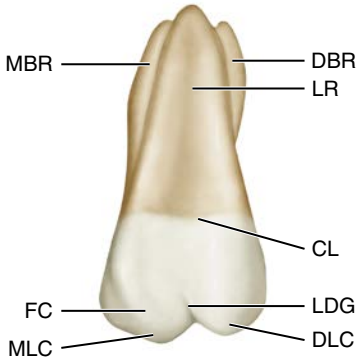
• **Fig. 11.2** Maxillary right first molar, occlusal aspect, developmental grooves. *BG,* Buccal groove; *BGCF,* buccal groove of central fossa; *CGCF,* central groove of central fossa; *CP,* central pit; *DOG,* distal oblique groove; *FCG,* fifth cusp groove; *LG,* lingual groove; *TGOR,* transverse groove of oblique ridge.



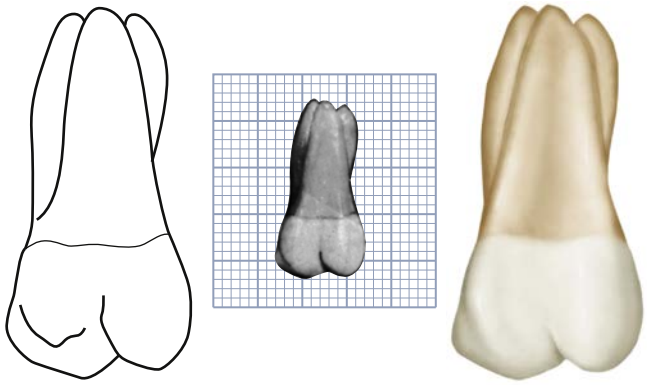
• **Fig. 11.3** Maxillary right first molar, buccal aspect. *BDG,* Buccal developmental groove; *CL,* cervical line; *DBC,* distobuccal cusp; *DBR,* distobuccal root; *LR,* Lingual root; *MBC,* mesiobuccal cusp; *MBR,* mesiobuccal root; *MLC,* mesiolingual cusp.



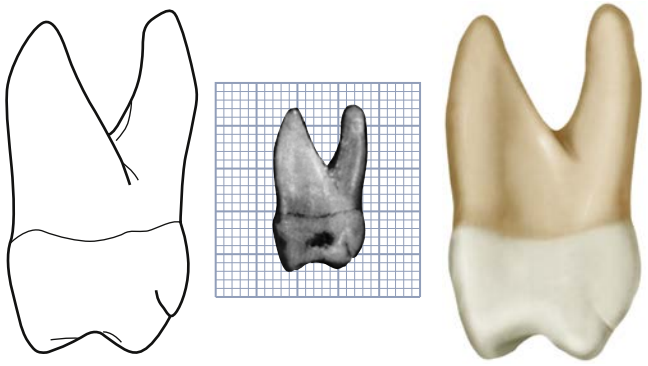
• **Fig. 11.4** Maxillary right first molar, buccal aspect. (Grid = 1 sq. mm.)



• **Fig. 11.5** Maxillary right first molar, lingual aspect. *CL,* Cervical line; *DBR,* Distobuccal root; *DLC,* distolingual cusp; *FC,* fifth cusp; *LDG,* lingual developmental groove; *LR,* lingual root; *MBR,* mesiobuccal root; *MLC,* mesiolingual cusp. (Grid = 1 sq. mm.)

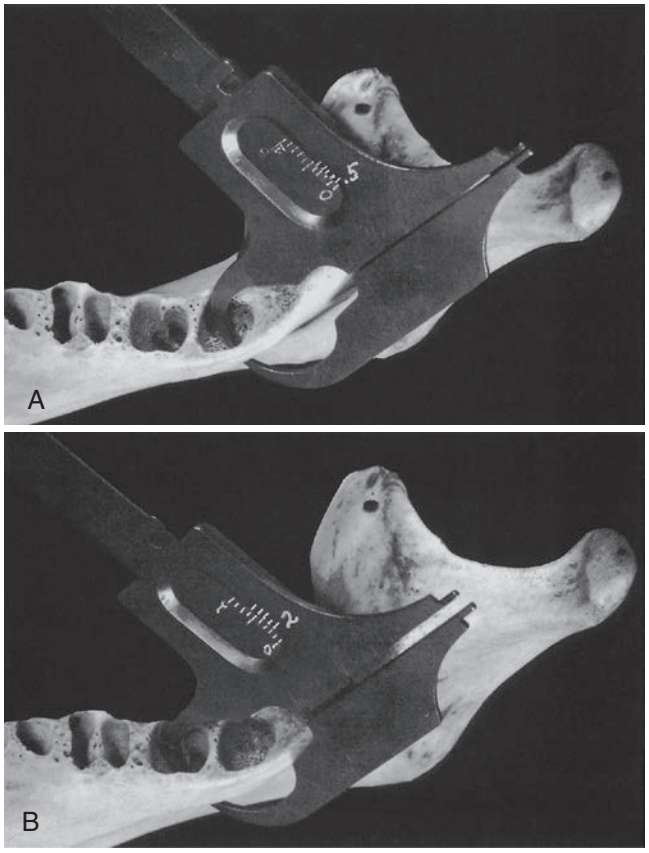


• **Fig. 11.6** Maxillary right first molar, lingual aspect. (Grid = 1 sq. mm.)



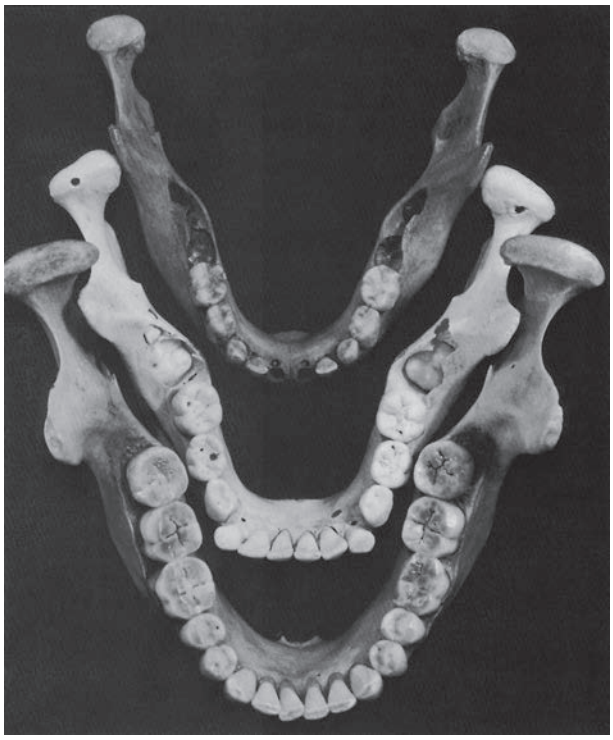
• **Fig. 11.7** Maxillary right first molar, mesial aspect. (Grid = 1 sq. mm.)

• **Fig. 14.21** Alveoli of the first, second, and third molars. Features for special attention include the thin and perforated surface of the retromolar triangular space distal to the third molar alveolus and the cancellous formation in the alveoli proper and also in the interdental septa, which would allow a rich blood supply.



• **Fig. 14.22** Illustration of the relative thickness of bone covering lingual mandibular second and third molar roots. (A) Measurement of the thickness of bony cover lingual to the apex of the third mandibular molar immediately below the mylohyoid ridge. It measures only 0.5 mm. (B) Repetition of measurement in the deepest portion lingually of the second molar alveolus. It measures fully 2 mm.

This ridge is the point of origin of the mylohyoid muscle, which forms the central portion of the floor of the mouth. Immediately posterior to the median line and above the anterior part of the mylohyoid ridge, a smooth depression called the **sublingual fossa** may be seen. The sublingual gland lies in this area.



• **Fig. 14.23** Comparison of the size and shape of mandibles at various ages. *Top*, Mandible of a 5-year-old. Notice the smoother, rounded bow-like form. Notice also the amount of space between the second deciduous molar and the ramus. *Middle*, Mandible of an approximately 70-year-old adult. Notice the wear of the occlusal surfaces of the teeth and periodontal bone loss. *Bottom*, Well-developed mandible of an individual approximately 50 years of age. The bone is regular in outline. The lingual constriction has lessened and has retreated to the third molar area.

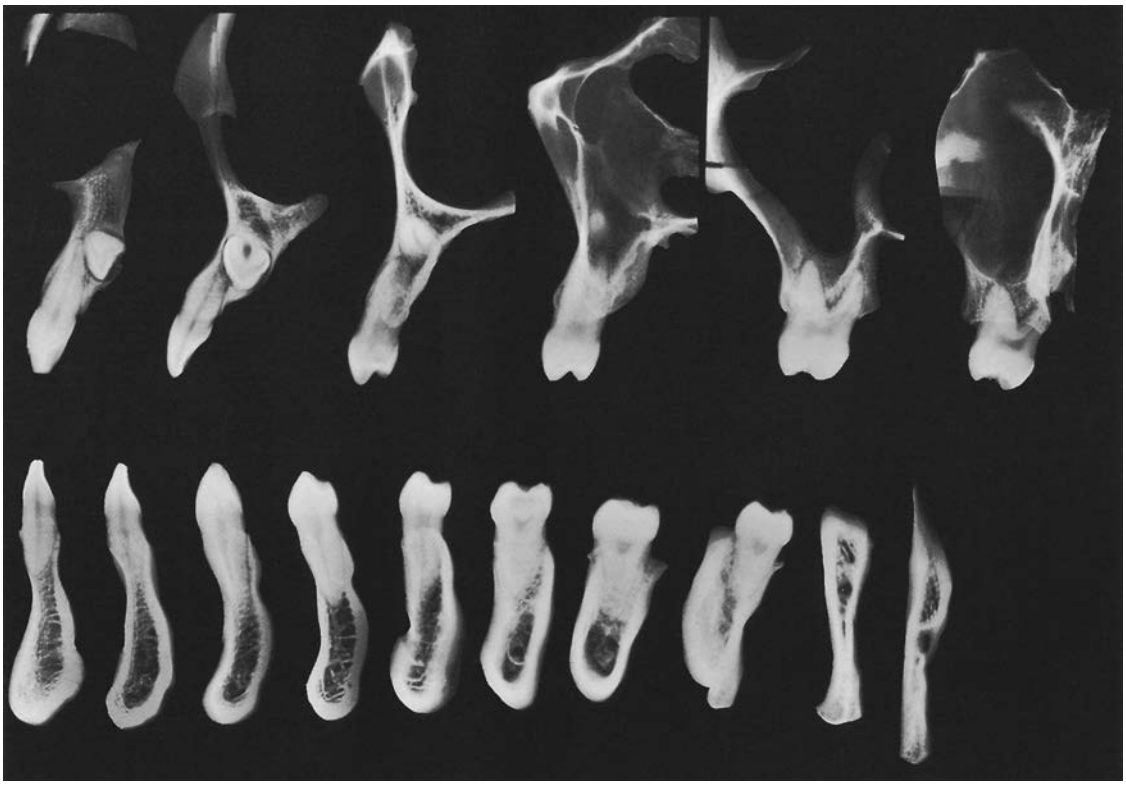
A small, roughened oval depression, the **digastric fossa**, is found on each side of the symphysis immediately below the mylohyoid line and extending onto the lower border. Toward the center of the body of the mandible, between the mylohyoid line and the lower border of the bone, a smooth oblong depression is located, called the **submandibular fossa**. It continues back on the medial surface of the ramus to the attachment of the lateral pterygoid muscle. The submandibular gland lies within this fossa.

The **mandibular foramen** is located on the medial surface of the ramus midway between the mandibular notch and the angle of the jaw and also midway between the internal oblique line and the posterior border of the ramus. The mandibular canal begins at this point, passing downward and forward horizontally.

The anterior margin of the foramen is formed by the **lingula**, or **mandibular spine**, which gives attachment to the **sphenomandibular ligament**. Coming obliquely downward from the base of the foramen beneath the lingula is a decided groove, the **mylohyoid groove**. Behind this groove toward the angle of the mandible, a roughened surface for the attachment of the medial pterygoid muscle may be seen.

Alveolar Process

The border of the alveolar process outlines the alveoli of the teeth and is very thin at its anterior portion around the roots of the incisor teeth but thicker posteriorly where it encompasses the roots of the molars. The alveolar process, which comprises the superior border of the body of the mandible, differs from the same process in the maxillae in one very important



• **Fig. 14.24** Some fine vertical sections of a skull made with radiographic problems in view. These radiographs of faciolingual sections show the extent of tooth attachment, the way in which individual teeth compare with each other, and the variances between cortical and cancellous bone in anchorage (see Figs. 14.25 to 14.32). The maxillary canine was impacted in this specimen. Maxillary third molars were missing. (From Updegrave WJ: Normal radiodontic anatomy, *Dent Radiogr Photogr* 31:57, 1958.)

particular: it is not as cancellous, and instead of the facial plate's being relatively thin, it is equally as heavy as the lingual plate. Although the bone over the anterior teeth, including the canine, is very thin and may be entirely missing over the cervical portion of the root, the bone that does cover the root is the compact type.

The inferior border of the mandible is strong and rounded and gives to the bone the greatest portion of its strength (see Fig. 14.15).

When one looks down on the mandible from a point above the alveoli of the first molars (see Fig. 14.18), it can be noticed that although the alveolar border may be thinner anteriorly than posteriorly, the body of the bone is uniform throughout. The lines of direction of the posterior alveoli are inclined lingually to conform to the lingual inclination of the teeth when they are in position. The anterior teeth, of course, have their alveoli tipped labially; therefore when one looks down on the mandible from above the alveolar process, more of the bone may be seen lingual to the anterior teeth than lingual to the posterior teeth. In contrast, posteriorly, more of the bone may be seen buccal to the teeth than lingual. *Therefore the outline of the arch of the teeth does not correspond to the outline of the arch of the bone.* The dental arch is narrower posteriorly than the mandibular arch.

The lingual walls of the alveoli of the second and third molars are relatively thin near the bottoms of the sockets, although the bone near the periphery is somewhat thicker and very compact. If a specimen of the mandible from which the third molar has been removed is held up to the light, the bone at the bottom of the socket is so thin that light will penetrate it. This thinness of bone is consistent with the submandibular fossa below the mylohyoid ridge (Fig. 14.24; see also Figs. 14.15 and 14.22A and B).

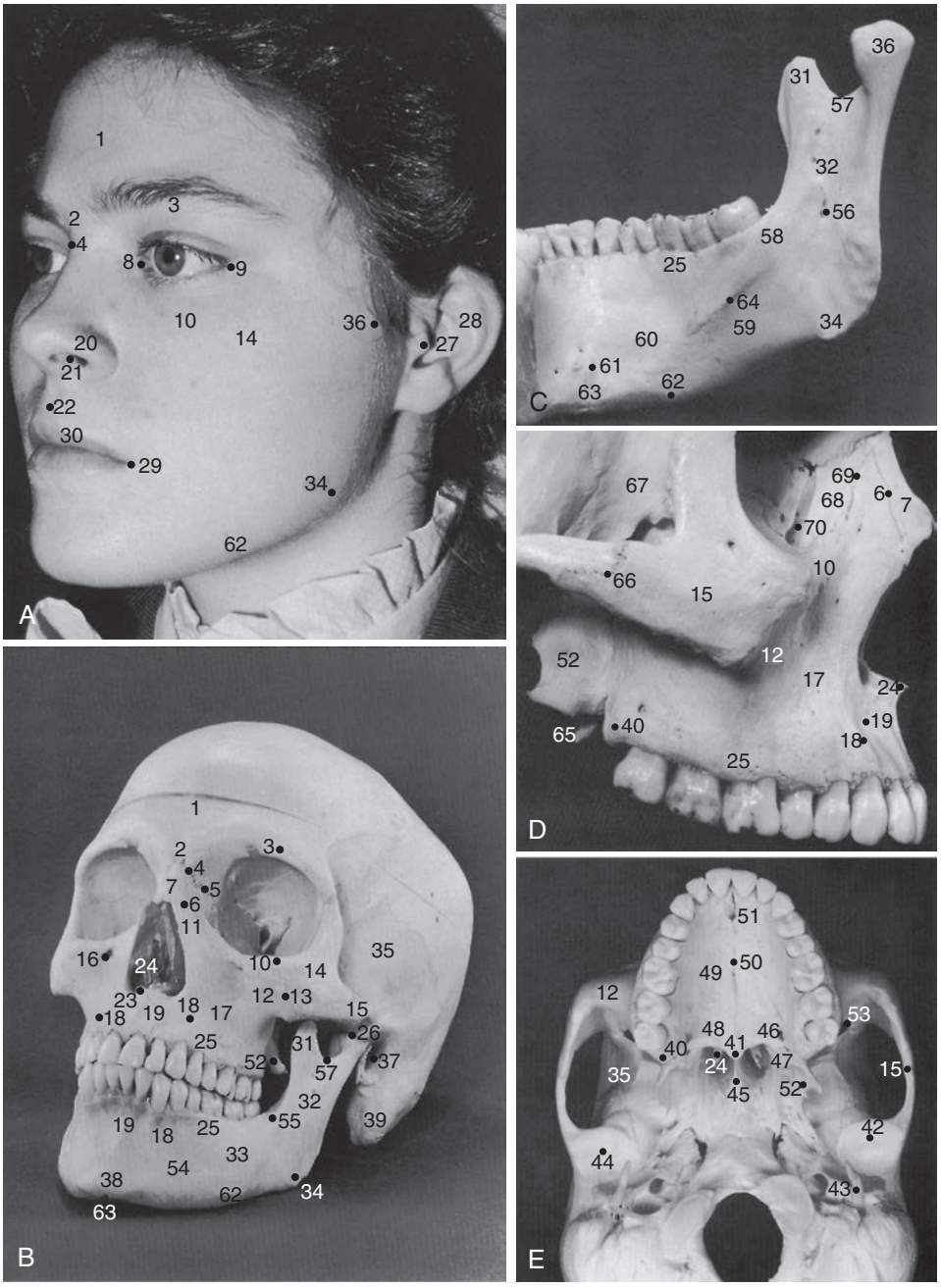
The bone buccal to the last two molars is very heavy and thick, being reinforced by the external oblique ridge. Posterior to the third molar, a triangular shallow fossa is outlined; it is called the **retromolar triangle** (see Fig. 14.17). The cortical plate over this fossa is not as heavy as the bone surrounding it, and it is more cancellous under the thin cortical plate covering it.

Alveoli

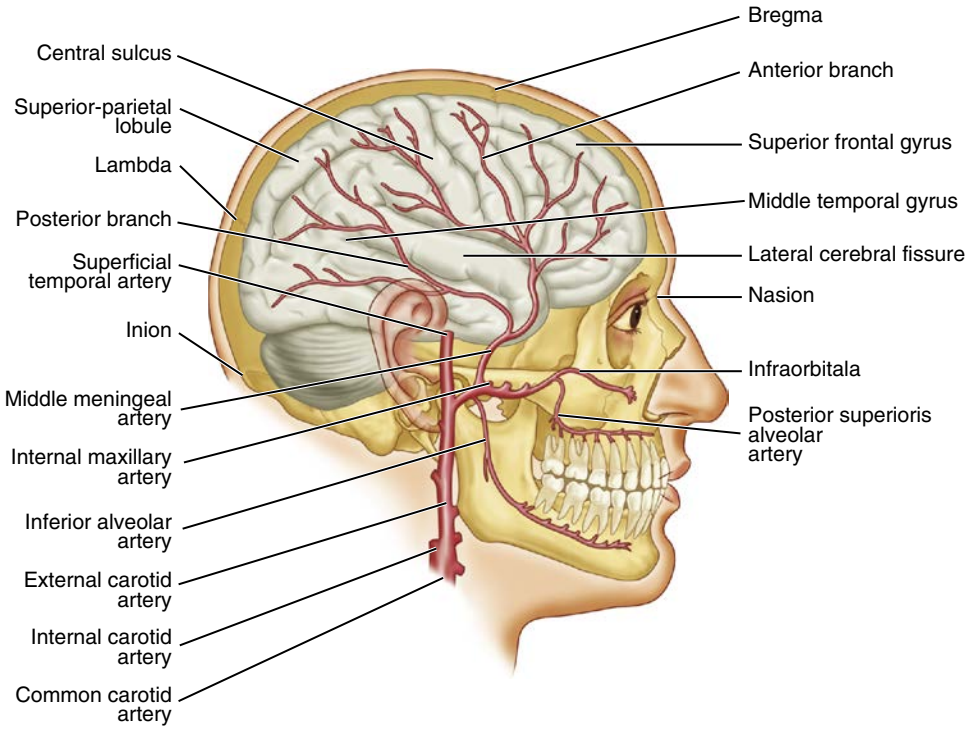
The first alveolus right or left of the median line is that of the first, or central, incisor. The periphery of the alveolus often dips down lingually and labially and exposes the root for part of its length. This arrangement makes an interdental spine out of the interdental septum separating the alveolus of the mandibular central incisors. The central incisor alveolus is flattened on its mesial surface and is usually somewhat concave distally to accommodate the developmental groove on the root (see Figs. 14.18 and 14.19).

The alveolus of the mandibular **second**, or **lateral**, **incisor** is similar to that of the central incisor. It usually has the following variations: the socket is larger and deeper to accommodate a larger and longer root; the periphery does not dip down as far on the lingual surface but may dip more on the labial aspect of the tooth, exposing more of the root of the lateral incisor. The interdental septum extends up just as high between the teeth as that between the central incisors.

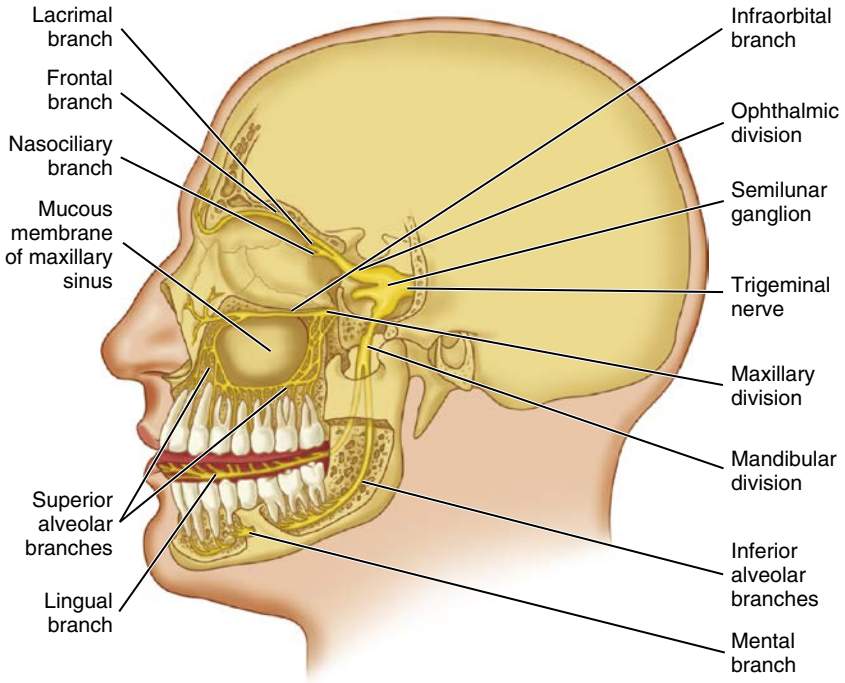
The **canine alveolus** is quite large and oval and, of course, deep to accommodate the root of the mandibular canine. The lingual



• **Fig. 14.34** Surface landmarks. Various dental structures in the patient's face can be quickly located by means of surface landmarks. Surface landmarks are identified in A. The photograph of the bony skull (B) was made from the same angle of view. Features of both are numbered and identified in the legend. The medial aspect of the mandible (C) shows anatomical details not clearly seen in the other illustrations. The maxilla and zygoma are shown in D. The bony anatomy of the hard palate and its adjoining structures is shown in E. *1,* Frontal bone (forehead); *2,* glabella; *3,* supraorbital ridge (superciliary ridge); *4,* frontonasal suture (bridge of nose); *5,* maxillofrontal suture; *6,* maxillonasal suture; *7,* nasal bone; *8,* medial canthus; *9,* lateral canthus; *10,* infraorbital ridge; *11,* frontal process of maxilla; *12,* zygomatic process of maxilla; *13,* zygomaticomaxillary suture; *14,* zygomatic bone (cheekbone); *15,* zygomatic arch; *16,* infraorbital foramen; *17,* canine fossa; *18,* canine eminence; *19,* incisive fossa; *20,* nasal ala; *21,* nares; *22,* philtrum; *23,* anterior nasal spine; *24,* inferior nasal concha; *25,* alveolar process; *26,* temporomandibular articulation; *27,* tragus of ear; *28,* auricula; *29,* labial commissure; *30,* vermilion border of lip; *31,* coronoid process of mandible; *32,* ramus of mandible; *33,* body of mandible; *34,* gonial angle of mandible; *35,* infratemporal fossa; *36,* condyle; *37,* external acoustic meatus; *38,* mental protuberance; *39,* mastoid process of temporal bone; *40,* maxillary tuberosity; 41, posterior nasal spine; *42,* articular eminence; *43,* styloid process of temporal bone; *44,* mandibular fossa; *45,* vomer; *46,* greater palatine foramen; *47,* lesser palatine foramen; *48,* palatine bone; *49,* palatine process of maxilla; *50,* midpalatal suture; *51,* incisive foramen; *52,* lateral pterygoid plate of sphenoid bone; *53,* inferior orbital fissure; *54,* mental foramen; *55,* oblique line; *56,* mandibular foramen; *57,* mandibular notch; *58,* internal oblique ridge; *59,* submandibular fossa; *60,* sublingual fossa; *61,* genial tubercle; *62,* inferior border of mandible; *63,* symphysis; *64,* mylohyoid line; *65,* hamular process of sphenoid bone; *66,* zygomaticotemporal suture; *67,* greater wing of sphenoid bone; *68,* lacrimal bone; *69,* maxillolacrimal suture; *70,* lacrimal fossa.



• **Fig. 14.35** Projection of maxillary artery and its branches in relation to brain, skull, and mandible, including the teeth.



• **Fig. 14.36** Distribution of the trigeminal nerve.

branches to the bone, periodontal membrane, and gingiva, the distribution being similar to that described for the arteries.

Mandibular Nerve

The mandibular nerve (see Fig. 14.37) leaves the skull through the foramen ovale and almost immediately breaks up into its several branches. The chief branch to the lower jaw is the **inferior alveolar nerve**, which at first runs directly downward across the medial surface of the lateral pterygoid, at the lower border of which it is directed laterally and downward across the outer surface of the medial pterygoid muscle to reach the mandibular foramen. Just before entering the foramen, it releases the mylohyoid branch, which is a motor branch to the mylohyoid muscle and anterior belly of the digastric muscle.

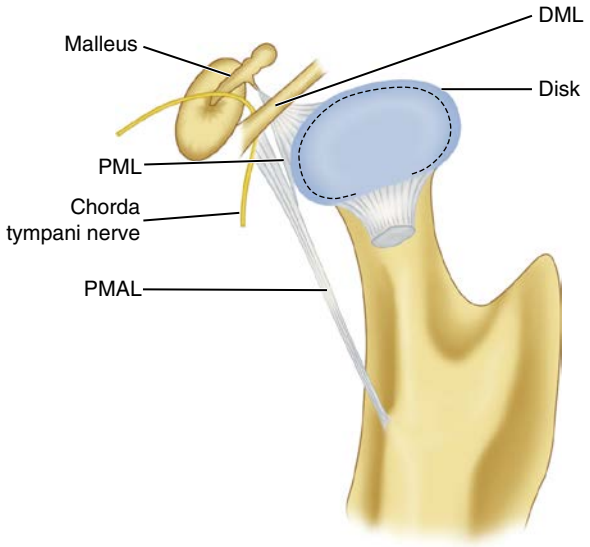
The maximum opening movement is 50 to 60 mm, depending on the age and size of the individual. An arbitrary lower limit for normal of 40 mm may be in error, inasmuch as some individuals may have no difficulty incising a large apple and have no history of TMJ muscle dysfunction. The maximum lateral movement in the absence of TMJ muscle dysfunction, including pain, is about 10 to 12 mm. The maximum protrusive movement is approximately 8 to 11 mm, again depending on the size of the subject and skull morphology. The retrusive range for adults and children is about 1 mm, although 2 to 3 mm may be observed infrequently.[7] The retrusive range, as measured from centric occlusion to centric relation, is considered a discrepancy between centric occlusion and centric relation. Border movements in the sagittal plane are shown in Fig. 15.13.

All values for border movements must be related to function—that is, a maximum lateral movement of 7 to 8 mm to the right (10 to 12 mm to the left) must be related to the occlusion and to whether translation of the left condyle occurs, because the latter may be "fixed" because of dysfunction or pain. Such values should also be related to other functions such as incising, chewing, swallowing, and speaking. However, if such values are made a part of every patient's dental record, any change can be evaluated in terms of dysfunction.

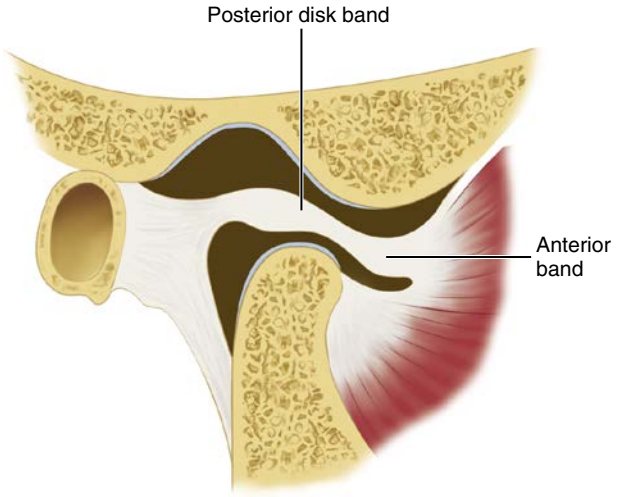
Muscles

Masticatory functions, speaking, yawning, and swallowing involve reflex contraction and relaxation of the muscles of mastication, whose activity is initiated voluntarily. It is impossible to determine clinically if a particular muscle is participating in a particular movement solely from its origin and insertion. Patterns of muscle contraction are complex and even in the same areas may have different functions.

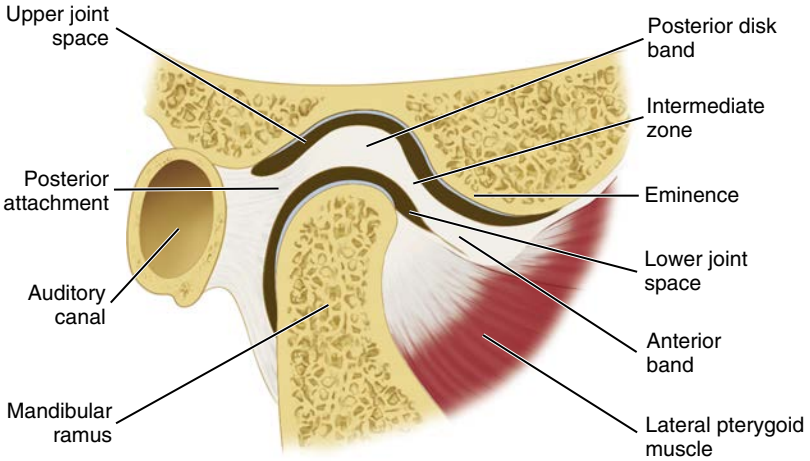
The complex movements of the TMJ suggest that muscles of mastication exhibit differential regional action and regional differences in their histochemical profiles. Thus, to consider a "muscle" as a contracting entity is an oversimplification. In reality, each muscle is a collection of motor units with different properties located in different parts of a single muscle and exhibiting different activities. However, for obvious reasons, the action of the various muscles will be given as a contracting entity.



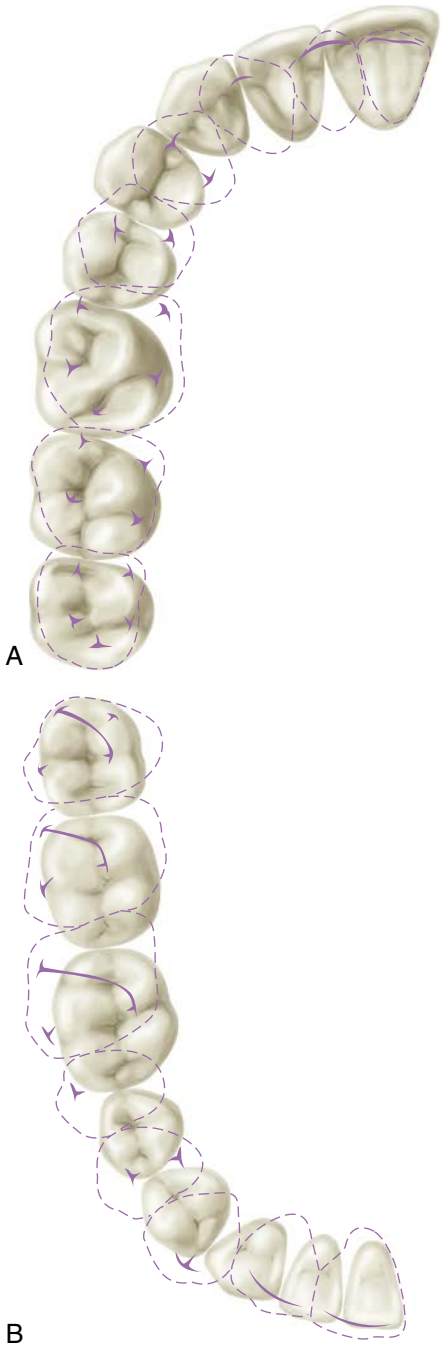
• **Fig. 15.9** Ligaments attached to the malleus. *DML,* Discomalleolar ligament fibers; *PML,* fibers from sphenomandibular ligament; *PMAL,* fibers from the discomalleolar and sphenomandibular ligament.



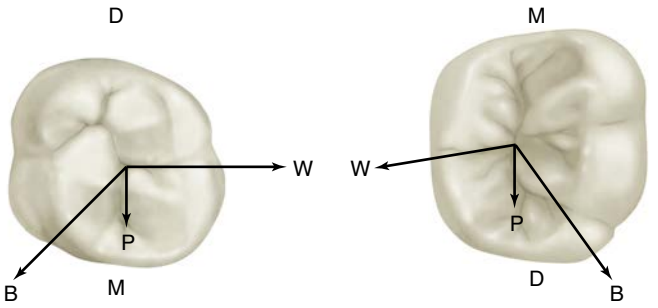
• **Fig. 15.11** Articular disk: jaw in open position.



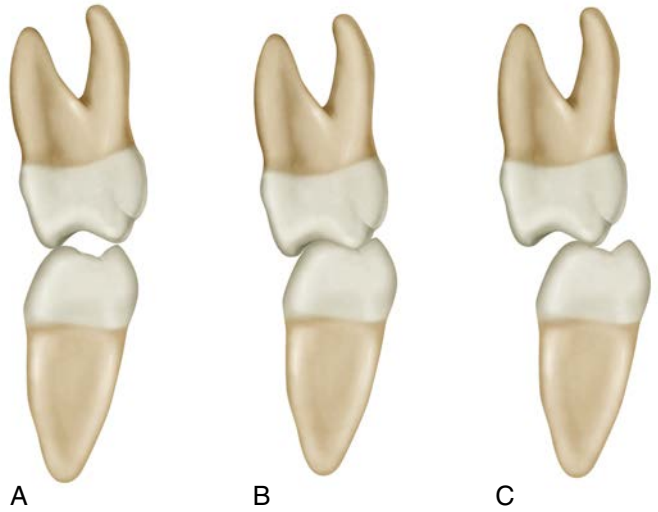
• **Fig. 15.10** Articular disk and associated structures.



• **Fig. 16.37** Contact relations in the intercuspal position (centric occlusion). (A) Maxillary teeth with dotted lines superimposed on mandibular teeth. Heavy lines and T shapes within dotted lines denote ridges and cusp tips. (B) Mandibular teeth, with dotted lines of maxillary teeth superimposed in occlusion. Note the slanted heavy lines of maxillary molars that mark the shape and location of oblique ridges.



• **Fig. 16.38** Projected protrusive *(P),* working *(W),* and balancing *(B)* side paths on maxillary and mandibular first molars made by supporting cusps, that is, mesiolingual cusp of the maxillary molar projected on the mandibular molar and distobuccal cusp of the mandibular molar on the maxillary molar. *D,* Distal; *M,* mesial.



• **Fig. 16.39** Right side contact relations of first maxillary and mandibular molars: (A) Right working side. (B) Centric occlusion (intercuspal position). (C) Nonworking side.

The cusp tip of the mandibular first premolar moves through the occlusal embrasure of the maxillary canine and first premolar (Figs. 16.47 and 16.48). Its mesiobuccal ridge contacts the distal cusp ridge of the maxillary canine, and its distobuccal cusp ridge contacts the mesio-occlusal slope of the buccal cusp of the maxillary first premolar.

The mandibular second premolar buccal cusp moves through the occlusal embrasure and then over the linguo-occlusal embrasure of the maxillary first and second premolars. Its mesiobuccal cusp ridge contacts the disto-occlusal slope of the buccal cusp of the maxillary first premolar, and its distobuccal cusp ridge contacts the mesio-occlusal slope of the buccal cusp of the upper second premolar.

The lingual cusps of all premolars are out of contact until centric relation is attained. Then the only lingual cusps in contact are those of the maxillary premolars, with the possible addition of the distolingual cusp of a mandibular second premolar of the three-cusp type. The molars have a more involved lateral occlusal relation because of their more complex design.

As noted previously, while describing the lateral occlusal relations of canines and premolars, the cusps, cusp ridges, sulci, and embrasures bear an interrelationship to each other. Cusps and elevations on the teeth of one arch pass between or over cusps and through embrasures or sulci. The tooth form and the alignment of the opposing teeth of both jaws make this possible. The cusps of the teeth of one jaw simply do not ride up and down the cusp slopes of the teeth in the opposing jaw. This explanation of the occlusal process has created wide misunderstanding. The cusp, ridge, fossa, and embrasure form of occlusion allow interdigitation without a "locked-in" effect. There is no clashing of cusp against cusp or any interference between parts of the occlusal surfaces if the development is proper.