


TEETH

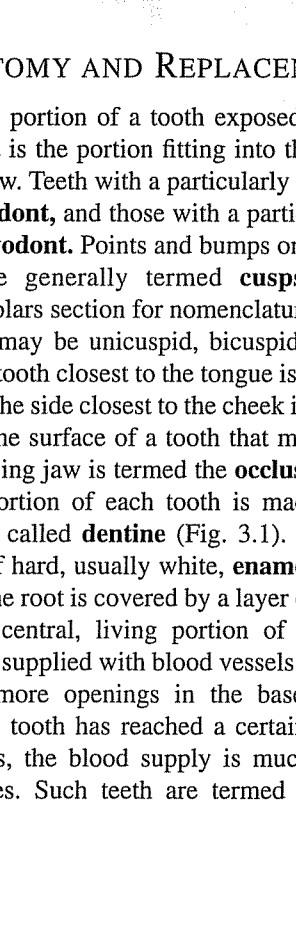


Although mammalian teeth are similar in basic components, they exhibit great diversity in number, size, and shape. The radiation of mammals into virtually every macrohabitat has resulted in evolutionary adaptations in tooth morphology to cope with varied diets. Teeth are readily fossilized, and many extinct mammals are known only from teeth. Thus, teeth are valuable tools in classifying, identifying, and studying mammals.

TOOTH ANATOMY AND REPLACEMENT

The **crown** is the portion of a tooth exposed above the gumline; the **root** is the portion fitting into the **alveolus** or socket in the jaw. Teeth with a particularly high crown are termed **hypodont**, and those with a particularly low crown are **brachyodont**. Points and bumps on the crown of the tooth are generally termed **cusps** (see the Premolars and Molars section for nomenclature of crown elements). Teeth may be unicuspid, bicuspid, tricuspid, etc. The side of a tooth closest to the tongue is termed the **lingual** side, and the side closest to the cheek is the **labial** or **buccal** side. The surface of a tooth that meets with a tooth in the opposing jaw is termed the **occlusal** surface.

The major portion of each tooth is made up of a bonelike material called **dentine** (Fig. 3.1). The crown has a thin layer of hard, usually white, **enamel** covering the dentine, and the root is covered by a layer of bonelike **cementum**. The central, living portion of a growing tooth, the **pulp**, is supplied with blood vessels and nerves through one or more openings in the base. In most species, when the tooth has reached a certain size, this opening constricts, the blood supply is much reduced, and growth ceases. Such teeth are termed **rooted**. In



some groups, the opening does not constrict and growth of the tooth continues throughout the life of the mammal. Such evergrowing teeth are termed **rootless**.

Most mammals are **diphyodont**, having only two sets of teeth. The **deciduous** or **milk teeth** present in immature mammals are usually replaced by a set of **permanent teeth** that are retained for life. Toothed cetaceans, Odontoceti, and a few other mammals are **monophyodont**, having only one set of teeth. Marsupials and some other mammals have only some of their milk teeth replaced, and others remain as a part of the adult dentition.

Some mammals, such as elephants, manatees, and kangaroos, have a slightly different system of tooth replacement. These mammals feed primarily upon harsh vegetation, and this diet makes for considerable wear on their teeth. In elephants, the alveoli of the cheek teeth converge into a groove, and tooth replacement occurs only at the posterior end of the tooth-row. As the anterior tooth is worn away, a new tooth develops from the rear, and the entire row moves forward (Fig. 3.2). A total of six cheek teeth are available to each quadrant, but only one or parts of two teeth are functional at any one time. Manatees have a similar system of tooth replacement with a potential number of 20 teeth per jaw, but only six to eight function at one time. In kangaroos, tooth replacement is primarily from the rear of the jaw, but the anterior two deciduous cheek teeth are replaced from below by a single tooth.

- 3-A Examine the internal structure of a sectioned tooth and compare with Figure 3.1.
- 3-B Examine a coyote or dog skull (genus *Canis*) and note the placement of teeth in the alveoli.

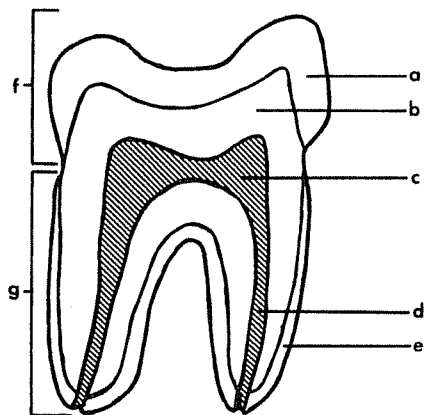


Figure 3.1 Diagrammatic cross section of a mammalian tooth. a, enamel; b, dentine; c, pulp; d, root canal; e, cementum; f, crown; g, root.

(L.P. Martin)

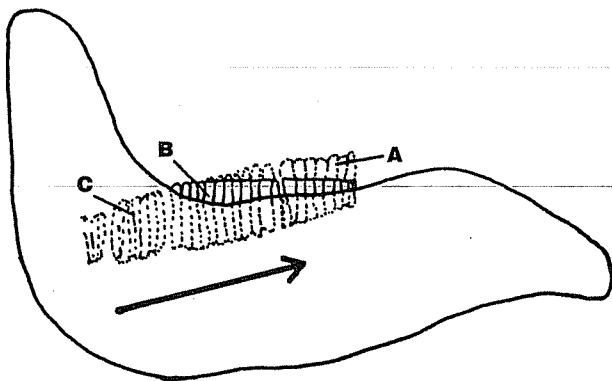


Figure 3.2 Diagram of tooth replacement in an elephant jaw. A, portion of tooth worn away; B, portion exposed; C, portion still embedded in the jaw. Arrow indicates direction of tooth replacement.

(A.F. DeBlase)

Examine a similar specimen from which the teeth have been removed. How many roots does each tooth have? How many cusps?

3-C Examine skulls of mammals that are in the process of shedding their deciduous teeth. How does replacement occur?

3-D Examine an elephant jaw. How many cheek teeth are present? Can you notice any difference in wear between the first and last tooth in each jaw (excluding tusks)?

THE KINDS OF TEETH

An individual mammal usually has two or more morphologically different kinds of teeth, a condition termed **heterodont**. This contrasts with the **homodont** dentition

of other vertebrates, in which all teeth in an individual resemble each other in shape. In mammals, four basic kinds of teeth are recognized: **incisors**, **canines**, **premolars**, and **molars**.

Incisors

Incisors are the teeth rooted in the premaxillary bone and the corresponding teeth in the lower jaw. Placental mammals never have more than three incisors in each jaw quadrant, but marsupials may have up to five in each half of the upper jaw and up to four in each half of the lower jaw. These are usually unicuspid teeth with a single root, but in some groups of mammals, accessory cusps, additional roots, or both may be present.

Incisors are generally chisel-shaped teeth that function primarily for nipping (e.g., a human biting an apple or a horse cropping grass). In cattle, deer, and their relatives, this nipping action has been modified by the loss of the upper incisors. Instead of nipping the vegetation between upper and lower incisors, these animals use their highly mobile lips and prehensile tongue to draw vegetation across the lower teeth, which cut it off in much the same way that a tape dispenser cuts tape. In rodents (see Fig. 23.2), lagomorphs (see Fig. 22.3), and certain other specialized forms, the number of incisors has been reduced, but the first incisors are stout chisel-edged teeth used in gnawing. These incisors are rootless and grow continually as they are worn away at the tips. In vampire bats, the first pair of incisors has a long, sharp edge (see Fig. 14.6B). These teeth are used to shave away a layer of skin to expose blood vessels. The blood that flows to the surface is then ingested. Elephants have incisors that are enlarged to form tusks (see Fig. 25.1). These are rootless and evergrowing and may be used for digging and removing bark from trees. Shrews have incisors that project anteriorly (see Fig. 12.1) and act as forceps in catching and holding insects and other prey.

3-E Examine the incisors of a shrew, vampire bat, monkey, rodent, horse, and cow, sheep, or deer. What can you deduce about the diet or feeding habits of each of these mammals?

3-F Examine the pectinate (comblike) lower incisors of a colugo (Dermoptera: Cynocephalidae). Compare these incisors with those of the ringtail lemur (Primates: Lemuridae). In what way are the incisors similar? How do they differ? What is their function?

Canines

Canines are the most anterior teeth rooted in the maxillae and the corresponding teeth of the lower jaw. They never number more than one per quadrant. Canines are usually long, conspicuous, unicuspid teeth with a single root.

However, some mammals may have canines with accessory cusps, additional roots, or both.

Canines are usually used to capture, hold, and kill prey. In herbivorous species, they are frequently reduced or absent. In some groups, such as the hogs and some deer, they are very long and sharp and used for fighting. Pig "tusks" are rootless and in some species arranged so they do not fully occlude. This minimizes wear and allows at least the upper tusks to grow very long. Walrus have been said to use their elongated canines to scrape the mollusks that they feed upon from the ocean floor, but evidence indicates that these conspicuous teeth are not used in this way (Miller 1975; Ray 1973).

Frequently canines and/or other teeth are absent, leaving a wide space between the anterior teeth and the cheek teeth. Any such wide gap between teeth is termed a **diastema**.

Note! In some species, the most conspicuous unicuspid tooth in the anterior part of the jaw is not the canine. Occasionally the last incisor is large and **caniniform**, and the canine is absent or small and resembles a premolar. Conversely, the first premolar is occasionally caniniform, and the canine is small and **incisiform**. In the upper jaw, these teeth are easily identified by locating the suture between the premaxilla and maxilla.

- 3-G Examine the canines of the following pairs of mammals. Can you suggest functions (if any) for the specializations?
- Peccary (*Tayassu*) and warthog (*Phacochoerus*)
 - Canis* and *Felis*
 - Human and baboon (*Papio*)

Premolars and Molars

Premolars are situated just posterior to the canines and generally some of all of them in each species differ from molars in having deciduous predecessors in the milk dentition. In all placentals (with the exception of tapirs) in which there are four premolars, the first premolar never has a deciduous precursor. In certain other mammals, in which there are fewer than four premolars, the first premolar in the sequence is also not replaced (Slaughter, et al. 1974). Molars are situated posterior to the premolars and never have deciduous predecessors. Authorities disagree as to whether molars are permanent teeth for which there are no corresponding milk teeth, or whether they are milk teeth that erupt late and are not replaced. Premolars are usually smaller than molars and have fewer cusps. However, without embryological investigation or a knowledge of the milk dentition of the species being studied, it is frequently impossible to distinguish between premolars and molars in an adult mammal. Therefore, these two tooth types frequently are referred to together as **cheek teeth**, **postcanine teeth**, or **molariform teeth**.

Placentals are regarded as having a "late primitive" maximum of four premolars and three molars. Marsupials have only a single tooth in each quadrant of the milk dentition. This milk tooth corresponds to the third premolar, above and below, in the adult dentition. Marsupials are regarded as having a "late primitive" maximum of three premolars and four molars. Teeth are absent in adult monotremes.

Because cheek teeth do the major job of masticating food, they are the teeth that exhibit the greatest diversity correlated with diet. Cheek teeth occur that are adapted for such a variety of foods as mollusks, meat, soft vegetation, tough grasses, hard-bodied insects, worms, and krill. The structure of the cheek teeth is one of the most important criteria in mammalian classification.

A standardized terminology for dental crown elements that is acceptable to all paleontologists and mammalogists is not presently available. The greatest obstacles to the development of a generally accepted terminology are questions of homology of cusps between early and later groups of mammals. Our terminology is derived, in part, from information presented by Patterson (1956), Van Valen (1966), Szalay (1969), and Hershkovitz (1971).

Simple Tribosphenic Cheek Teeth

The earliest known tribosphenic cheek teeth were present in early marsupials and placentals of the Cretaceous. A simple **tribosphenic** upper molar (Fig. 3.3A) has a trigon, whereas the lower molar (Fig. 3.3B) has both a trigonid and a talonid. The triangle-shaped trigon of an upper tribosphenic upper molar has three main cusps with the protocone at the apex along the labial edge of the crown (Fig. 3.3A). The other cusps are an anterior **paracone** and a posterior **metacone** (Fig. 3.3A). The **stylar shelf**, a broad ledge situated labial to the paracone and metacone, has several cusps, including the most anterior, the **parastyle**, which provides a convenient reference point to orient a tooth for study. *1. usual*

The lower tribosphenic molar (Fig. 3.3B) consists of a high-cusped **trigonid** and lower-cusped **talonid**, the latter of which helps to square the outline of the tooth. Three of the cusps of the talonid enclose a depression known as the **talonid basin** that receives the protocone of the trigon during occlusion.

Modified Tribosphenic Cheek Teeth

The simple tribosphenic cheek tooth has been modified in various lineages of mammals. For convenience, some authors (Butler 1941; Hershkovitz 1971; Turnbull 1971) divide the simple and derived tribosphenic molars into three main groups: zalambdodont, dilambdodont, and euthemorphic. Although these modifications apply to molars and some premolars, particularly the most posterior premolars in a series, the discussion that follows is based on molars. A **zalambdodont** upper molar (Fig. 3.4) is characterized by a V-shaped ectoloph. An **ectoloph** is a series of **cristae**, or crests, connecting the paracone

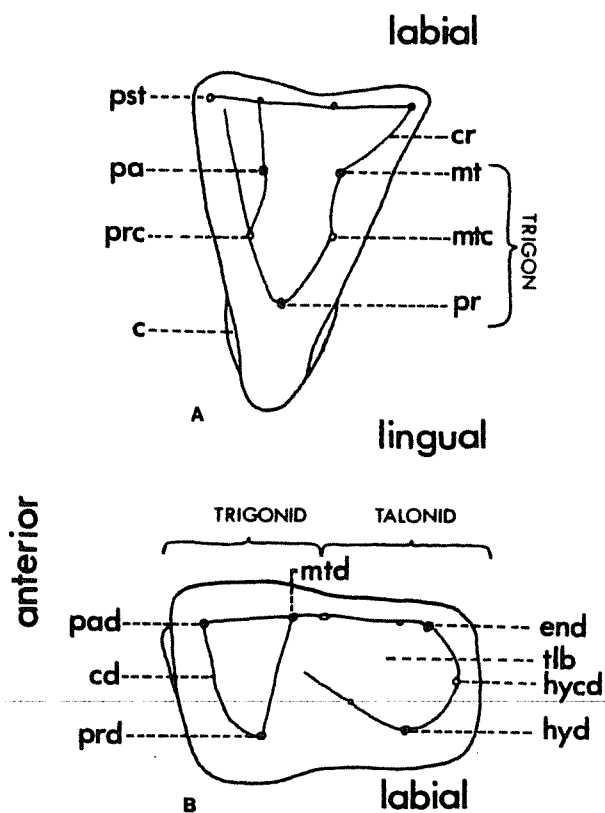


Figure 3.3 Occlusal views, somewhat diagrammatic, of simple tribosphenic left upper (A) and left lower (B) molars. *Upper crown elements:* c, cingulum; cr, crista; mt, metacone; mtc, metaconule; pa, paracone; pr, protocone; prc, paraconule; pst, parastyle. *Lower crown elements:* cd, cristid; end, entocoid; hyd, hypoconid; hycd, hypoconulid; mtd, metaconid; pad, paraconid; prd, protoconid; tlb, talonid basin. Major cusps in solid black. Based on information in Van Valen (1966) and Szalay (1969). (Modified from Van Valen 1966)

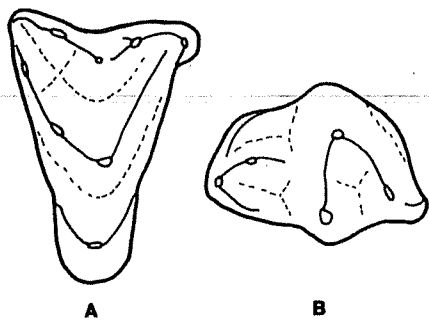


Figure 3.4 Occlusal view of zalambdodont right upper (A) and left lower (B) molars of the otter shrew, *Potamogale*. (Modified from Butler 1941)

(and sometimes the metacone) with cusps on the stylar shelf. Typically the zalambdodont molar lacks a protocone, and the paracone (sometimes combined with the metacone) is located at the lingual apex of the crown. This type of molar is found in many Insectivora and in

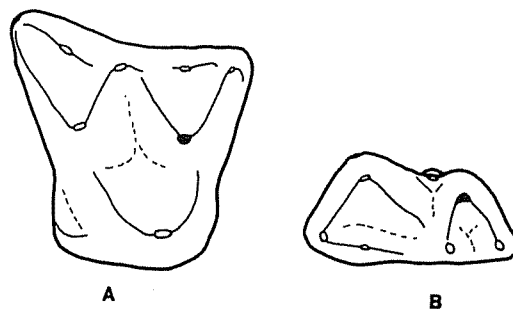


Figure 3.5 Occlusal view of dilambdodont right upper (A) and left lower (B) molars of a tree shrew, *Tupaia*. (Modified from Butler 1941)

the marsupial “mole,” *Notoryctes*. A **dilambdodont** upper molar (Fig. 3.5) has a W-shaped occlusal surface with the protocone near the lingual apex of the trigon. The W-shaped pattern is formed by an ectoloph connecting the metacone and paracone with cusps on the stylar shelf. The molars of the opossums (Didelphidae) and tree shrews (Tupaiaidae) are examples of the dilambdodont type. A **euthemorphic** upper molar usually has a square or quadrate crown. The square outline results from the addition of a main cusp, the **hypocone**, to the posterior lingual side of the crown. In certain molars, the hypocone area is identified as the **talon**.

A euthemorphic upper molar with four main cusps is termed **quadritubercular**. Upper and lower molars may become fully **quadrate**, or square, by loss or reduction of some cusps (e.g., in the lower dentition the paraconid is generally lost). Most living mammals have basically euthemorphic molars, although the teeth may be modified in several ways (see next section).

3-H Examine the upper and lower tribosphenic molars of an opossum (Didelphidae). Identify the trigon, trigonid, talonid, talonid basin, and the major cusps. Observe the shearing and crushing actions that occur as the upper and lower jaws are brought into occlusion.

3-I Examine a zalambdodont upper molar of Chrysochloridae, Solenodontidae, or Tenrecidae. Locate the ectoloph and position of the paracone (or fused paracone-metacone).

3-J Examine a dilambdodont upper molar of Didelphidae, Talpidae, or Tupaiaidae. Locate the ectoloph, paracone, metacone, and protocone.

3-K Examine upper and lower euthemorphic molars of a pig, human, various rodents, and a horse. In which species do molars show well-defined cusps? In which are the molars quadritubercular? In which are the molars quadrate?

Specializations of Cheek Teeth

The bunodont tooth is found in many mammals that are basically omnivorous. The **bunodont** tooth is eutheromorphic, quadrate, frequently brachyodont, and has four major rounded cusps (Fig. 3.6). It is considered to have developed from a tribosphenic tooth by the bulging out of the side between the protocone and metacone and the development of a new cusp, the hypocone, in this area (hypoconid in the lower teeth). Other smaller cusps may develop between the larger ones. For example, a small **paraconule** (=protoconule) may develop between the protocone and paracone, and a small **metaconule** may develop between the metacone and hypocone. In the lower cheek teeth, a **hypoconulid** is situated on the posterior margin of the talonid between the hypoconid and entoconid. The crowns of bunodont teeth oppose each other directly, and the paraconid is lost. Humans and hogs are examples of mammals with bunodont teeth used for an omnivorous diet.

In mammals that tend toward an herbivorous diet, the cheek teeth are frequently hypsodont. The abrasive action of plant material quickly erodes teeth, so the higher the crown, the longer the tooth will last. Some herbivorous mammals (particularly grazers) have cheek teeth that are rootless and continue to grow throughout life as they are worn away at the top. Many herbivorous mammals have **lophodont** teeth (Fig. 3.7) in which cusps fuse to form elongated ridges termed **lophs**. These ridges create elongated abrasive surfaces for the grinding of plant materials. A **selenodont** tooth (Fig. 3.8) functions in much the same manner but in it each ridge is formed by the elongation of a single cusp. The ridges of selenodont teeth are always crescent-shaped and longitudinally oriented (Fig. 3.8), whereas those of lophodont teeth are variable in shape and may be transversely oriented (see Fig. 3.7). In these teeth, the hard ridges of enamel wear away more slowly than the surrounding tissues and provide a grinding surface similar to that of a millstone. Some mammals such as the horses, Equidae, have complex **selenolophodont** teeth that combine aspects of both lophodont and selenodont teeth.

The cheek teeth of rodents show numerous modifications from the basic quadritubercular plan. These may

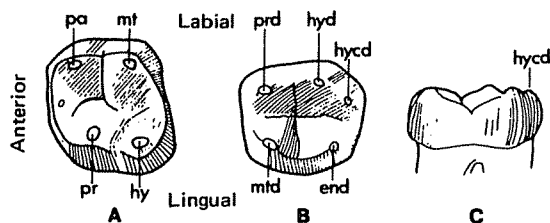


Figure 3.6 Bunodont left upper (A) and right lower (B and C) molars of human, *Homo sapiens*, a modified eutheromorphic molar. (A) and (B) are occlusal views; (C) is a labial view. *Upper*: hy, hypocone; mt, metacone; pa, paracone; pr, protocone. *Lower*: end, entoconid; hyd, hypoconid; hycd, hypoconulid; mtd, metaconid; prd, protoconid.

(Modified from Osborn 1907)

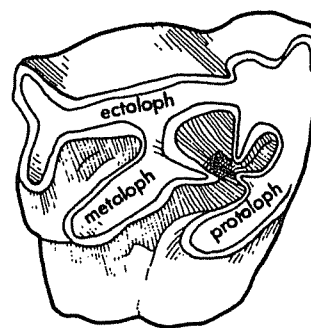


Figure 3.7 Lophodont molar tooth of a rhino (order Perissodactyla), occlusal view. Note the fusion of cusps into transverse and longitudinal lophs.

(Modified from Osborn 1907)

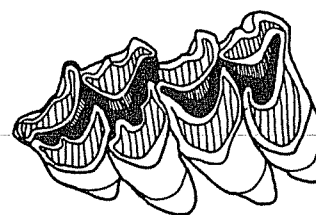


Figure 3.8 Selenodont upper molars of *Capreolus capreolus*, the roe deer. Note the crescent-shaped patterns on the occlusal surface of each molar.

(Modified from Gromova 1962)

include simplification of the occlusal pattern, fusion of cusps, or infoldings along the margins of the teeth. Many of these modifications are described and illustrated in Chapter 23. Taxonomic studies of certain rodents, particularly members of the family Muridae, require a detailed knowledge of cusp and crown morphology, but this knowledge is not required to use the keys in this manual. Further details on the crown elements that may be found in the cheek teeth of murid rodents, where this information is most important, can be found in publications by Hershkovitz (1962) and Reig (1977).

Cheek teeth modified for a carnivorous diet generally are reduced secondarily to two major cusps. The upper and lower teeth, working together, provide a scissors action for shearing flesh (see Fig. 19.2). *Note!* The term **carnassial** has two meanings: **carnassial** or **secodont dentition** is the general type of dentition found in mammals whose principal diet is flesh. The **carnassial pair** or **carnassial teeth**, found only in the order Carnivora, are the two teeth on each side that do most of the shearing. In living carnivores, these teeth are the fourth upper premolar and the first lower molar in the adult dentition and the third upper and fourth lower premolars in the milk dentition.

Many bats have modified tribosphenic teeth (dilambdodont or quadritubercular) in which the three cusps elongate into sharp crescent-shaped cristas (see Fig. 14.19), sometimes termed **commissures**. These

cristas are useful in cutting and crushing the hard chitinous exoskeletons of insects. Similar specializations are present in the teeth of many Insectivora.

Many fish-eating mammals such as sea lions and porpoises have cheek teeth reduced to a series of sharp unicuspid for holding their slippery food (see Figs. 19.8 and 20.26). The sea otter, *Enhydra lutris*, that feeds primarily on mollusks and echinoderms, and the walrus, *Odobenus rosmarus*, that feeds on mollusks, both have flat brachyodont cheek teeth that crush their food (see Figs. 19.4 and 19.5). A highly specialized cheek tooth is found in the Antarctic crab-eating seal, *Lobodon carcinophagus*. This species feeds upon krill, small planktonic shrimp-like crustaceans, in the cold Antarctic waters. Each cheek tooth of *L. carcinophagus* has three to five long, curving cusps in a straight line reminiscent of the teeth of members of the †Triconodonta. These teeth collectively form a sieve (Fig. 3.9) for straining krill from the ocean.

Many diverse groups of mammals have adapted to diets in which teeth serve little or no major function. In many of these—including bats (e.g., *Leptonycteris nivalis*) and marsupials (e.g., *Tarsipes spenserali*) that feed upon pollen and/or nectar, sloths that feed upon soft buds (see Fig. 17.6), and armadillos (see Fig. 17.5) and aardwolves (see Fig. 19.12) that feed upon soft-bodied insects—the entire dentition is degenerate, and frequently the teeth are reduced to a series of simple flat-topped or unicuspid pegs. The echidnas (see Fig. 10.4), anteaters (see Fig. 17.4), and pangolins (see Fig. 18.2), all of which feed on large numbers of small insects, and the platypus (see Fig. 10.3), which feeds on aquatic invertebrates, tadpoles, and small fish (Nowak 1999), are **edentulate** (i.e., lack teeth entirely). The baleen whales are also edentulate and instead use **baleen** plates to filter krill from the ocean water (see Figs. 20.3 and 20.4).

- 3-L Examine a *Canis* skull and identify the incisors, canines, premolars, and molars. For what function is each type of tooth modified?
- 3-M Examine the molars of a primate, hog, or both. Locate and identify the four major cusps on each

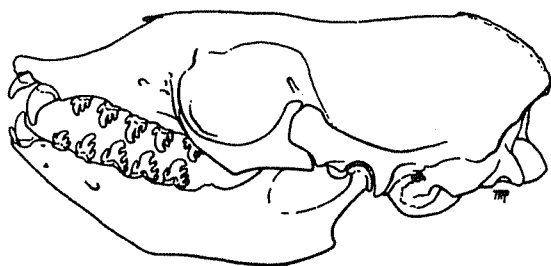


Figure 3.9 Skull of a crab-eating seal, *Lobodon carcinophagus*, showing teeth that resemble those of the †triconodonts.
(Hatt 1946)

molar. Which, if any, smaller cusps are present? Compare the occlusion of these teeth with those of an opossum.

- 3-N Examine the dentition of as many of the following mammals as possible. Identify the kinds of teeth in each species and ascertain the probable diet associated with each dentition.

Mammal	Order	Genus	Probable Diet Based on Dentition
Shrew	Insectivora		
Vampire bat	Chiroptera	<i>Desmodus</i>	
Nectar-feeding bat	Chiroptera		
Vespertilionid bat	Chiroptera		
Anteater	Xenarthra		
Armadillo	Xenarthra		
Sloth	Xenarthra		
Rabbit	Lagomorpha		
Rat	Rodentia		
Deer mouse	Rodentia		
Vole	Rodentia		
Sea otter	Carnivora	<i>Enhydra</i>	
Mink	Carnivora		
Cat	Carnivora		
Crab-eating seal	Carnivora	<i>Lobodon</i> (see Fig 3.9)	
Sea lion	Carnivora		
Walrus	Carnivora	<i>Odobenus</i>	
Porpoise	Cetacea		
Aardvark	Tubulidentata	<i>Orycteropus</i>	
Elephant	Proboscidea		
Horse	Perissodactyla	<i>Equus</i>	
Deer	Artiodactyla		
Cow	Artiodactyla	<i>Bos</i>	

DENTAL FORMULAS

The **dental formula** is a shorthand method used by mammalogists to indicate the numbers of each kind of tooth in a particular mammal. The complete dental formula for *Canis*, showing the number of each kind of tooth in each half of each jaw, is written:

$$\text{incisors } \frac{3-3}{3-3} \quad \text{canines } \frac{1-1}{1-1} \quad \text{premolars } \frac{4-4}{4-4} \quad \text{molars } \frac{2-2}{3-3} = \frac{20}{22} = 42$$

The numbers above the line represent the teeth in the upper jaw, and those below the line represent those in the lower jaw. Because the two halves of each jaw normally have identical numbers of teeth, the dental formula is usually written to show only one side. The total number of teeth is found by multiplying by 2. Thus, the above formula may be abbreviated as:

$$I \frac{3}{3} C \frac{1}{1} P \frac{4}{4} M \frac{2}{3} = 42$$

or, because the four kinds of teeth are always recorded in the order shown above, the formula can be further abbreviated by deleting the initials for the tooth types:

$$\frac{3}{3} \frac{1}{1} \frac{4}{4} \frac{2}{3} = 42$$

If a particular type of tooth is not represented in a species, a zero is used. Thus, the dental formula for a Norway rat, *Rattus norvegicus*, is:

$$I \frac{1}{1} C \frac{0}{0} P \frac{0}{0} M \frac{3}{3} = 16$$

or

$$\frac{1}{1} \frac{0}{0} \frac{0}{0} \frac{3}{3} = 16$$

Primitive Dental Formulas

Placental mammals have a maximum of three incisors and one canine per quadrant, and usually have no more than four premolars and three molars per quadrant. Marsupials have a maximum of five upper and four lower incisors on each side and one canine per quadrant. They usually have no more than three premolars and four molars per quadrant. These tooth numbers are considered to represent the ancestral condition. The following dental formulas represent the primitive tooth numbers for marsupials and placentals:

$$\text{Marsupial} \quad I 5/4 C 1/1 P 3/3 M 4/4 = 50$$

$$\text{Placental} \quad I 3/3 C 1/1 P 4/4 M 3/3 = 44$$

Although reduction in tooth number from the primitive formula is common, an increase in this number is rare. Among marsupials, only the banded anteater, *Myrmecobius fasciatus* (see Fig. 11.11), has more than 50 teeth. Among placental mammals, only the giant armadillo, *Priodontes maximus*, the African bat-eared fox, *Otocyon megalotis*, and most of the toothed whales (e.g., see Figs. 20.24 and 20.30) have more than 44 teeth. *Priodontes* has up to 100 unicuspid, peglike teeth. *Otocyon* has additional molars to make a total of 46 teeth (occasionally 48 to 50). Some toothed whales have up to 260 unicuspid, essentially homodont teeth. In the manatees, Trichechidae, up to 80 teeth develop during the life

of the animal, but usually only 24 (occasionally up to 32) are visible at any one time (see Fig. 25.7).

3-O Examine the teeth in a hog (*Sus*, a placental) skull and write the dental formula. How do you know which cheek teeth are premolars and which are molars?

3-P Examine the teeth of an opossum (*Didelphis*, a marsupial) skull and write the dental formula. How do you know which cheek teeth are premolars and which are molars?

3-Q Examine the teeth in a cat (*Felis* or *Lynx*) skull and write the dental formula.

How do you know which cheek teeth are premolars and which are molars?

3-R Examine the dentition of a porpoise. How many incisors are present? What is the total number of teeth? Can you identify the canines? Why or why not?

Grouped Dental Formulas

Because premolars and molars are frequently impossible to distinguish in the skull of an adult, these two kinds of teeth are sometimes grouped in writing a dental formula. Such a grouped formula for the common harbor seal, *Phoca vitulina*, is:

$$I 3/2 C 1/1 P + M 5/5 = 34$$

A similarly grouped formula for a typical nine-banded armadillo, *Dasypus novemcinctus*, is:

$$I 0/0 C 0/0 P + M 7/7 = 28$$

However, because the nine-banded armadillo is a placental mammal with a maximum potential of four premolars and three molars, and because seven postcanine teeth are present, it is possible to write a standard dental formula:

$$I 0/0 C 0/0 P 4/4 M 3/3 = 28$$

In shrews and some other groups, the posterior incisors, the canines, and the anterior premolars may all be simple, single-cusped teeth that are difficult to distinguish from one another. These are collectively termed the "unicuspids," and a particular tooth may be referred to as, for instance, the third upper unicuspid. Some authors write a standard dental formula for these animals, but Choate (1975) recommended using a formula that identifies the known incisors and premolars and lumps the remaining incisors, canines, and premolars as unicuspid. His formula for *Cryptotis* is "first incisor, 1/1; unicuspid, 4/1; fourth premolar, 1/1; molars, 3/3."

- 3-S Examine a beaver (*Castor*) skull. There is a total of 20 teeth, and only the last premolar is present. Write a dental formula combining the cheek teeth.

Write a standard dental formula.

- 3-T Write a dental formula grouping cheek teeth for the porpoise examined in 3-S above.
- 3-U Examine a shrew skull. How many unicuspid are present? (You will need a binocular microscope or a hand lens to see them clearly.) Write a dental formula grouping the unicuspid.

Formulas Identifying Missing Teeth

Occasionally a dental formula is written to indicate exactly which teeth have been lost. For *Canis*, this type of formula is:

$$I \frac{123}{123} \quad C \frac{1}{1} \quad P \frac{1234}{1234} \quad M \frac{120}{123} = 42$$

Here each number represents a particular tooth. The zero indicates that the last upper molar is absent. A similar dental formula for the Norway rat is:

$$I \frac{100}{100} \quad C \frac{0}{0} \quad P \frac{0000}{0000} \quad M \frac{123}{123} = 16$$

The last incisors and last molars are usually lost before the first of either of these kinds of teeth, whereas the first premolars are usually lost before the last premolars. Thus, if a mammal has only one incisor or one molar, it is usually I 100/100 or M 100/100 rather than I 003/003 or I 020/020. If a mammal has only two premolars, these are usually P 0034/0034 rather than P 1200/1200 or P 0230/0230. However, this is a usual trend and not a rule! Teeth are sometimes lost from the opposite end or from the middle of a series.

- 3-V Write a dental formula for a cat (*Felis* or *Lynx*) that shows which teeth are absent. (Remember that the carnassial pair in adults is always the last upper premolar and the first lower molar.)

Notation for Single Teeth

P² is a shorthand method of saying "the second upper premolar," and M₃ is a shorthand method of saying "the third lower molar." This use of the tooth-type initial combined with a superscript or subscript is in common usage in scientific literature and is used throughout this manual. Some

authors use a capital letter to represent a tooth in the upper jaw and a lowercase letter to represent a tooth in the lower jaw. By this system, P² is the second upper premolar, and m₃ is third lower molar. A lowercase letter may also be used to refer to a tooth in the deciduous dentition, but the letter "d" usually accompanies such a designation. For example, the fourth upper deciduous premolar could be termed p⁴, dp⁴, or pd⁴. *Note!* If a mammal has a dental formula of:

$$I \ 123/123, \ C \ 1/1, \ P \ 0234/0234, \ M \ 120/123 = 38$$

and an author refers to P³, he/she may be referring to the third upper premolar present in the specimen, or he/she may be referring to the third upper premolar that is potentially present based upon the primitive dental formula. In this manual, a shorthand note such as P³ will always refer only to the teeth actually present in the particular species.

Variation in Formulas

The dental formula is generally considered to be a characteristic of a genus or a higher taxon, but there are certain genera in which there is variation in dental formulas. For instance, the gray squirrel, *Sciurus carolinensis*, has a tiny upper premolar, giving a dental formula of:

$$I \ 1/1, \ C \ 0/0, \ P \ 2/1, \ M \ 3/3 = 22$$

whereas the closely related fox squirrel, *Sciurus niger*, lacks this tiny premolar, giving a dental formula of:

$$I \ 1/1, \ C \ 0/0, \ P \ 1/1, \ M \ 3/3 = 20$$

There is also variation of dental formulas within certain species. This variation is frequently associated with secondary sexual differences, as when canines are developed in the male but are absent in the female or with age as with the late eruption of the last molars (wisdom teeth) in humans. In certain other species (usually, though not always, those with a degenerate homodont dentition) the number of teeth may vary among individuals without regard to sex or age.

- 3-W Compare the dentition of a gray squirrel with that of a fox squirrel.

- 3-X Write and compare the dental formulas of a male (ungelded) and female horse.

Ungelded

male horse:	I	C	P	M	=
Female horse:	I	C	P	M	=

- 3-Y Compare the tooth counts in a series of armadillo and/or black bear skulls.