

VIVEKANANDA COLLEGE
THAKURPUKUR
KOLKATA – 700 063
NAAC ACCREDITED, 'A' GRADE



TOPIC: DENTITION IN MAMMALS

COURSE TITLE: COMPARATIVE ANATOMY OF VERTEBRATES

: COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY

PAPER: ZOOA-CC4-8-TH / ZOOG-CC2-2-TH

UNIT: 2 (HONS) / 2 (GENERAL)

SEMESTER: 4 (HONS) / 2 (GENERAL)

NAME OF TEACHER: DR. JAYANTA SINHA

NAME OF DEPARTMENT: DEPARTMENT OF ZOOLOGY

Introduction:

Endothermy is vital to the life of mammals. Mammals must wring as many calories as feasible from the foods they consume so as to deliver enough energy to heat their bodies. Thus is the teeth that becomes important to the life of mammals.

Due to different food habits we get dental diversity of mammalian teeth in both marsupials and placentals. Both of these mammalian groups display a diversity of species and dental adaptations that elucidate the connections between species richness, diet, and teeth.

Mammalian teeth is one of the finest examples of convergent evolution, which tender comprehensions both into relationships between form and function.

Teeth are the dermal derivatives of integument They are formed consequent to calcification in the mucous membrane of the buccal cavity..

The teeth are existent in more or less in all the mammals excluding in a few mammals In whale, the teeth are fused into plates and lost in the adult stage of Ant eaters. But in Echidna (spiny ant eater) the teeth are not even found in the embryo.

Structure of mammalian teeth:

Structure of tooth: Each typical mammalian tooth is placed in the socket over the jaw bone. It is distinguished into three main parts.

1) **Root** - It is the basal part embedded in the bony socket of jaw.

2) **Neck** - it is the part above the root enclosed by the gum.

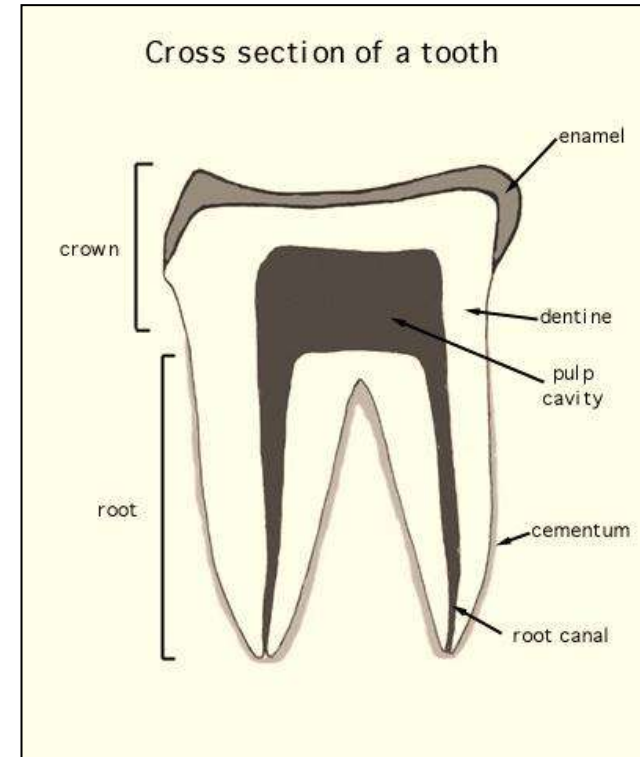
3) **Crown** - It is the upper part beyond the surface of the gum. The tooth is separated from the socket by a vascular periodontal membrane. The vertical section tooth consists of the following parts.

I) **Pulp cavity:** The entire tooth encloses a central pulp cavity surrounded by a layer of odontoblast cells filled with soft pulp. It is made up of connective tissue, blood vessels and nerve fibers.

II) **Dentin:** A substance chemically similar to bone- dentine forms the major part of the tooth. But the dentine is permeated by numerous thin canaliculi.

III) **Enamel:** It is present over the dentine in the crown and neck regions of the tooth. It is hardest and contains only traces of living matter.

IV) **Cement:** It surrounds the dentine of the root portion of the tooth. It is bony in nature.



Structure of mammalian teeth.

Development of teeth:

The tooth develops partially from the epidermis and partially from the mesenchyme of dermis.

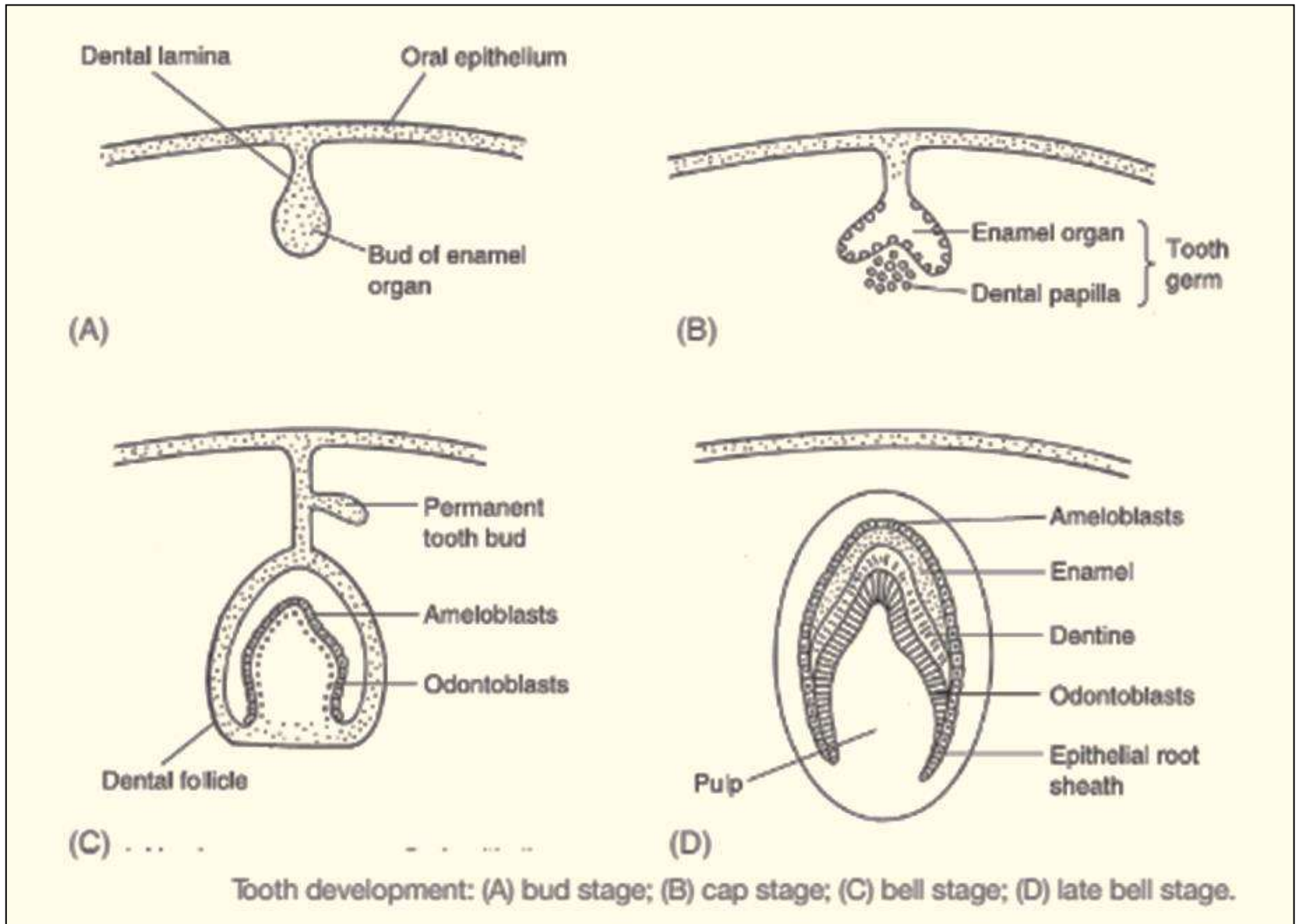
Its enamel is derivative of the epidermis and the remaining parts develops from the mesenchyme. Mammalian are **diphyodont**. The milk or deciduous teeth are formed from the buccal epithelium of the gums which are substituted later by the permanent teeth.

Steps in teeth formation:

1. In the start, the **buccal epithelitim** of the gum sinks down forming the ridge.
2. At the same time, the cells of **malpighian layer** of epidermis grow and move into the epidermis establishing the **dental lamina**.
3. Along the dental Lamina, the **mesenchymal cells** proliferate and condense into a **dental papilla** or tooth bud (**Budding stage**).
4. This grows upwards and pushes the dental .Thereby an inverted cup form is assumed.
5. The malpighian cells become distinctly columnar and are identified as **ameloblasts**. The mesenchymal cells are further differentiated into a layer of **odontoblast cells**.
6. The tooth bud formed from the dental lamina is now known as '**enamel organ**'(**Cap stage**).
7. Enamel organ subsequently produce the enamel crowns of the teeth
8. To be precise ameloblast cells secrete '**enamel**' about their inner side, whereas the odontobiasts secrete '**dentine**'. The enamel surrounds the upper part of dentine like a cap.
9. Hence, dentine, **cementum** and **pulp** of each tooth are derived from the dental papilla.
10. The permanent molars arise from an extension of the dental lamina posterior to the deciduous molars.

Contd..

9. The residual mesenchyme cells of the dental papilla develop the 'pulp' and the cavity of the enamel organ transforms into the pulp cavity.
10. More rapidly, the development of the tooth is completed. The jaw bone shapes a socket or alveolus throughout its base.
11. The tooth grows in size by the secretion of further amount dentine and ultimately emerges out from the gum.
12. The odontoblasts immediately secrete **cement** around the neck and root of the tooth limiting the pulp cavity.



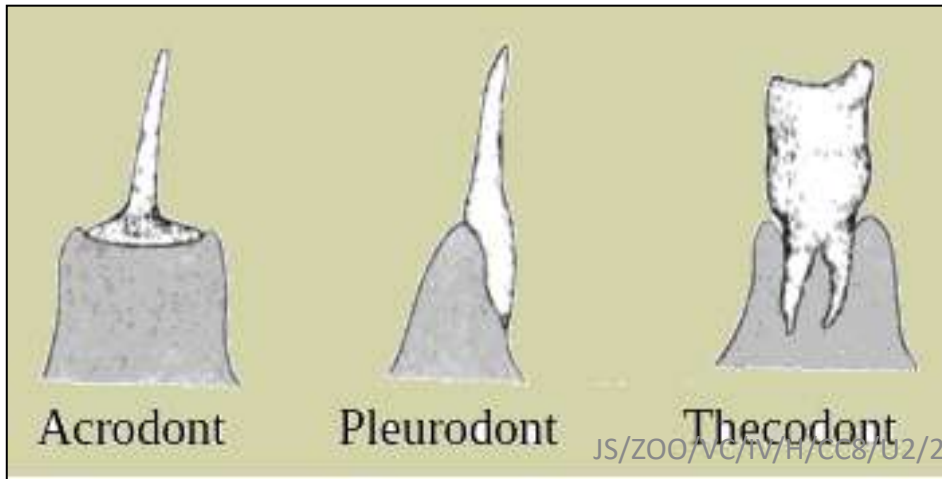
Tooth development : a. bud stage, b. cap stage, c. bell stage, d. late bells tage

Types of Dentition

A. Based on the attachment of teeth in the jaw bone:

Based on the types of teeth, teeth are classified into two types, namely Homodont Heterodont

1. **Acrodont** : In this type of dentition, the teeth are devoid of roots and they are merged to the edge of the jaw bone. Acrodont dentition is found in lower vertebrates like amphibians (*Pleurodeles waltl*; Caudata) and reptiles (*Calotes*, *Draco*, *Uromastix*) but not in mammals.
2. **Pleurodont** : In pleurodont dentition, the teeth are attached to the rim of jaw. This type of dentition is observed in lizards (*Iguana*, *Anguinae*, *Helodermatidae*) and not in mammals.
3. **Thecodont** : In thecodont dentition, the teeth are with root and the roots are implanted in sockets of jaw bone. Thecodont dentition is observed in all mammals.



Types of teeth on the basis of attachment.

B. Based on the number of sets of teeth that develops during the life time:

- 1. Monophyodont:** In some mammals, only one set of teeth develops during the life time and this condition is called monophyodont. Eg. Moles and squirrels.
- 2. Diphyodont:** In diphyodont condition, two sets of teeth are found to develop during the life time of an animal. The first set of dentition is termed as '**milk dentition or lacteal dentition**'. This milk dentition is later replaced by the '**permanent dentition**'. In bats and guinea pigs, the milk dentition is lost even before birth. In *Homo sapiens sapiens* (man), the milk teeth are substituted by the permanent teeth around the age of 7 years.
- 3. Polyphyodont:** In lower vertebrates, multiple sets of teeth develop during the life period. This kind of dentition is termed as polyphyodont.

C. Based on the types of teeth:

1. Homodont :Homodont type of dentition is a condition where the teeth are similar in shape (look alike). Homodont ('same teeth') dentition is the *plesiomorphic* (or primitive) state for vertebrates, and is frequent in elasmobranchs, bony fish, amphibians, and most reptiles and also in some mammals, eg. Dolphins.

2. Heterodont: In heterodont, the teeth are of different in shape and function and are present in the same animal. In heterodont type, teeth are differentiated into four types, namely incisors, canines, premolars and molars.

Mammals have evolved heterodont dentitions:

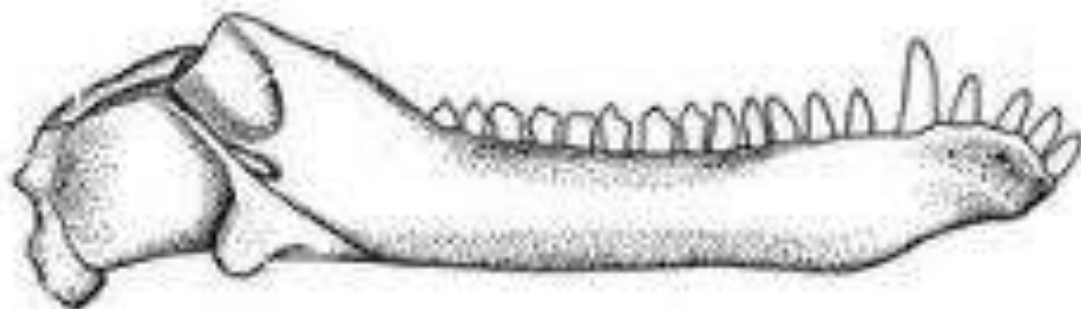
They are exclusive in having four tooth classes: incisors, canines, premolars and molars. Each type is made by 1-5 cusps, which are round projections of the crown and points toward the opposing tooth.

a. **Incisors** are the most medial and anterior teeth. They differ in number from none in armadillos, to 18 in opossums. They are broad and flat in shape, and these have single cusp that forms a broad cutting line termed the **incisal edge**. The main function of incisors is grabbing food and biting off pieces of food items. Mammals that gnaw, like rabbits and mice, bear comparatively large incisors lacking on the posterior surface. Elephants are armed with highly specialized incisors that evolved into a round shape and extended out of the mouth to form **tusks**.

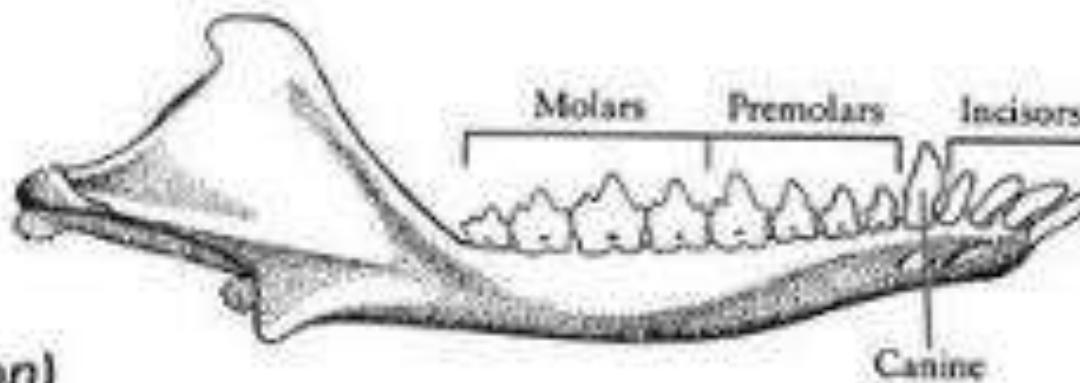
b. **Canines** are round and pointy in shape , often being the longest teeth of mammals. These are single cusped and are also called **cuspid**s. Mammals have 0-4 canines, which are employed to puncture and penetrate the food item during biting, producing a firm hold helping to kill prey. Herbivores commonly deficient of canines, or have them modified into **tusks**, like walruses and pigs, to serve as weapons or have other uses.

Early mammals had **premolars** with a single cusp(monocuspids) and **molars** with three cusps (tricuspid)s, but they later evolved premolars with up to three cusps and molars with four or five cusps. These teeth handle the food in the mouth by cutting, slicing or grinding.

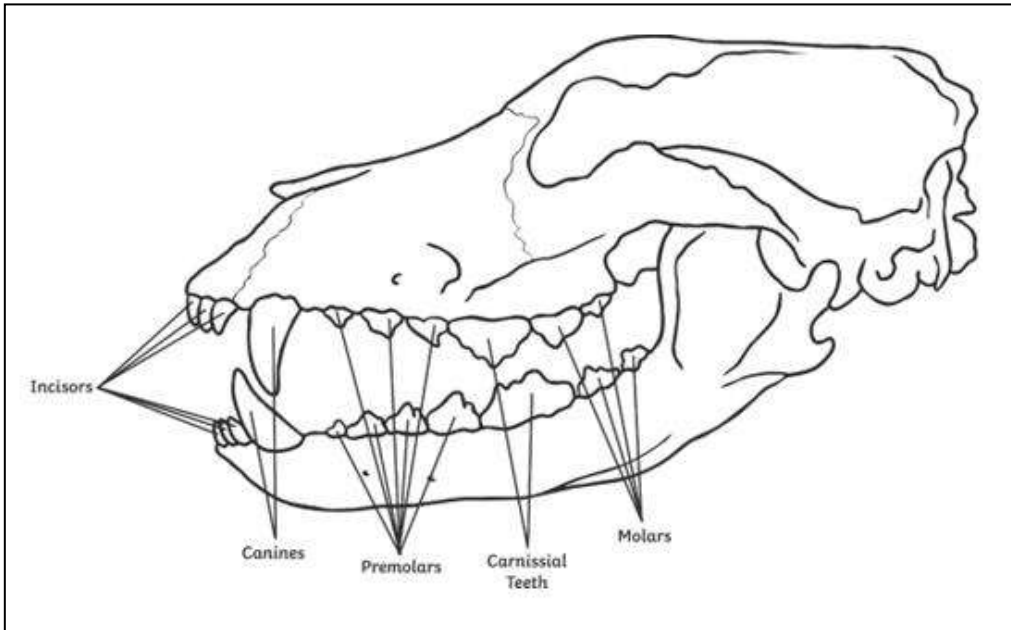
Homodont
(cynodont)



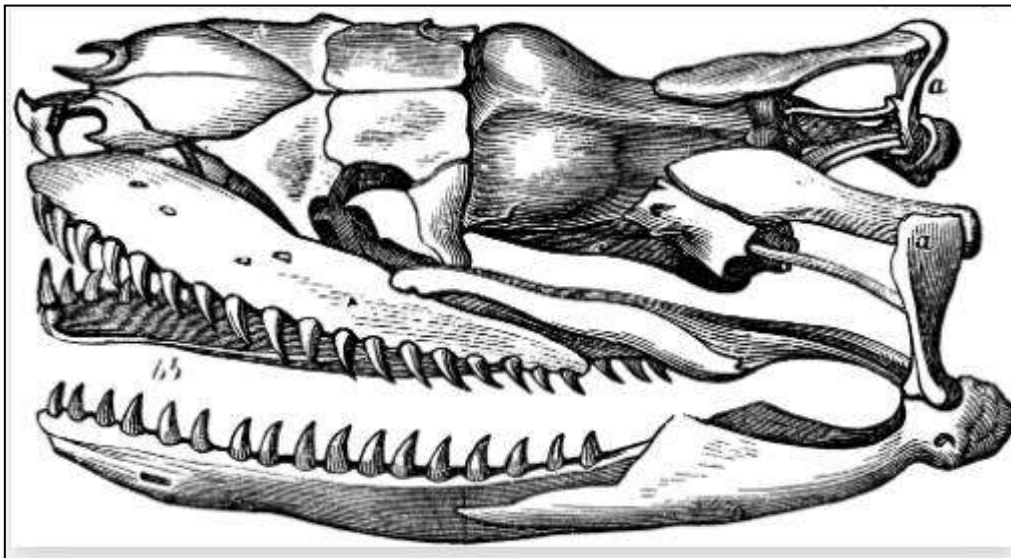
Heterodont
(*Morganucodon*)



Homodont and Heterodont dentition.



Heterodont dentition ; skull of a dog.



Homodont dentition ; skull of *Boa constrictor*.

Source : Sarah Cooper Animal Life (New York, NY: Harper & Brothers, Franklin Square, 1887)

Cusps:

The molars exhibit many cusps on their surface. Upper molar cusps are known as **cones**, while lower molar cusps are known as **conids**. Name of the teeth is prefixed to specify their position on the tooth. These prefixes are *proto-*, *para-*, *meta-*, *hypo-*, and *ento-*. A **paracone** is thus the anterior external cusp of a maxillary molar.

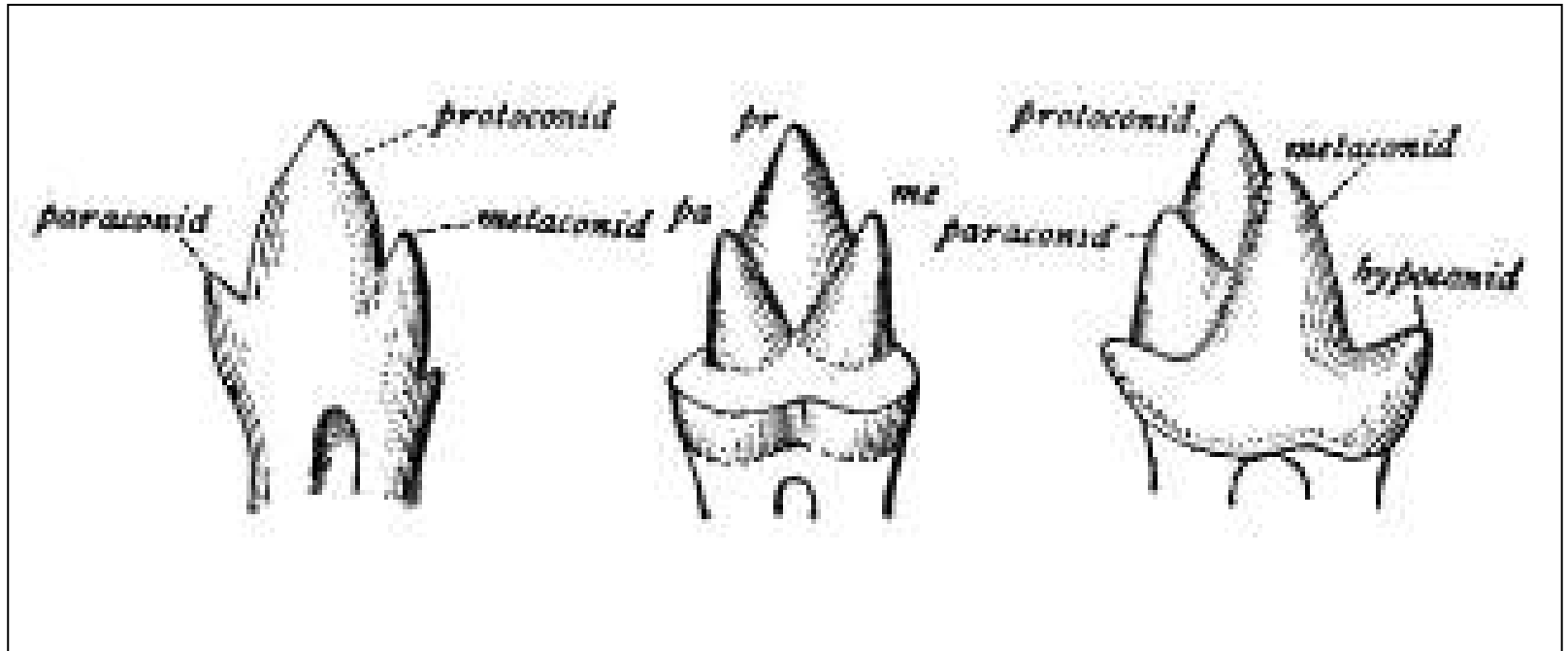
On the basis of the number and shape of the cusps different types of teeth have been distinguished. These are:

1. **Monocuspid**: This is characterized by the presence of only a single cusp.
2. **Bicuspid**: This is characterized by the presence of two cusps.
3. **Tricuspid**: These are molars having three cusps.

Tribosphenic molars are with three cusps were seen in early mammals (fossils) and are still found in insectivores and monotremes. Many modern mammals such as primates (humans), racoons and hedgehogs have quadrate molars nonetheless, containing four or five cusps.

The **tritubercular molar** consists fundamentally of three cusps, forming what may be termed as the primitive triangles.

Tritubercular is a term that is sometimes referred to an upper tribosphenic molar.



Tribosphenic (Left and Middle) and Quadritubular (Right).

Types of teeth on the basis of cusps of molars.

1. Bunodont:

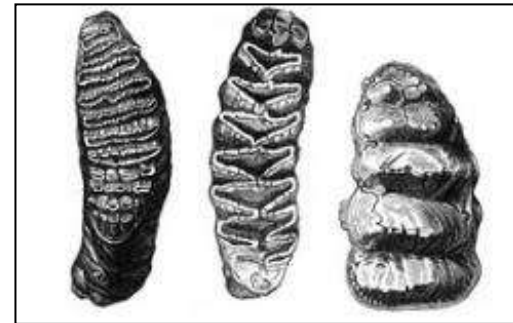
The cusps are rounded instead of being sharp or pointed. These molars are most familiar among omnivores viz., pigs, bears and humans. Bunodont molars are effectual crushing devices and often quadrate in shape.



Pig molars are bunodont teeth.

2. Lophodont:

- i. These teeth are recognized by the enamel patterns of ridges or lophes of enamel interconnecting the cusps upon the crowns. Found in most herbivores, these patterns of lophes can be a plain ring-like edge, as in mole rats, or have a complicated layout of series of ridges and cross-ridges, eg. in odd-toed ungulates (Perissodactyla), such as horses, tapirs and rhinoceroses.
- ii. Lophes oriented either along or perpendicular to the dental row. Lophodont molars are frequent in herbivores that grind their food exhaustively. Examples include tapirs, manatees, and many rodents.
- iii. When two lophes form transverse, often ring-shaped, ridges on a tooth, the arrangement is termed **bilophodont** for e.g. in primates, and also found in lagomorphs (hare, rabbits, and pikas) and some rodents.
- iv. Extreme forms of lophodonty in elephants and some rodents (such as *Otomys*) is known as **loxodonty**.



Molars of the Asian elephant (*Elephas*; left), African elephant (*Loxodonta*; center) and *Mastodon* (right).

3. Selenodont:

The major cusp in this type of molar is extended into a crescent-shaped ridge. This is observed in most even-toed ungulates (Artiodactyla), such as cows and deer.



Selenodont teeth of a mountain goat.

4. Secodont:

Many carnivorous mammals have expanded and blade-like teeth exclusively adapted for slicing and chopping called **carnassials**. A general term for such blade-like teeth is secodont or **plagiaulacoid**. These are found in dogs, cats, wolf, tiger, lions etc.

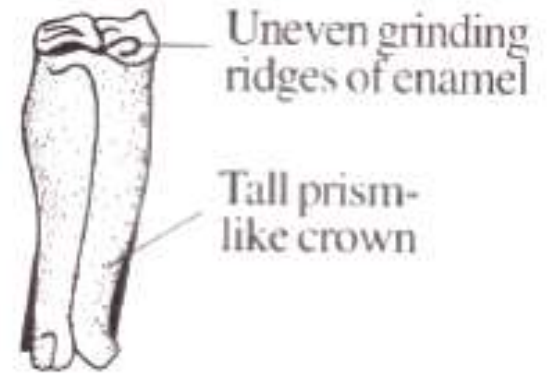
Source: <https://cnx.org/contents/Mw1rkOh8@30.1:AaJRXKYK@1/Heterodont-animals>



Carnassials of a Eurasian wolf.

5. Hypsodont:

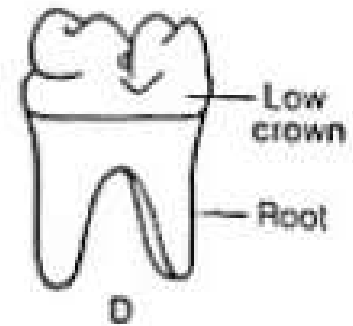
These are molars have high crowns and short roots with enamel that outspreads far past the gum line within the bone. The cusps have crescent-shaped. These teeth are mostly found in grazing herbivores because they afford extra material for wear and tear. The tooth keeps coming up slowly as it is worn off. Animals with hypsodont teeth are cows and horses.



**Hypsodont dentition ;
grazing herbivores.**

6. Brachydont:

It is a type of dentition distinguished by low-crowned teeth (brachys = short). Human teeth are brachydont. The tooth is with a crown above the gingival (gum) line and a neck just beneath it, and no less than one root. A cap of enamel jackets the crown and spreads down to the neck. Cementum is only noticed below the gingival line, covering the root.



**Brachydont dentition;
human.**

Dental Formula:

- ❖ Mammalian heterodont dentition is expressed by a 'dental formula'. The number and arrangement of teeth in each half of the upper and lower jaws is invariable (identical) and same.
- ❖ Hence the teeth can be expressed by using the initials - I, C, Pm and M for incisors, canines, premolars and molars respectively. The number of teeth varies in the various orders of mammals and reflects their 'feeding habits'.
- ❖ Typical number of teeth in the mammals is 44.
- ❖ The numerator indicates the number of teeth on one side of upper jaw. The denominator indicates the number of teeth on one side of the lower jaw.
- ❖ While the two halves of each jaw have identical number and kind of teeth, the number of teeth on one side alone is usually expressed in the formula.

Dental formula of different mammals

a) Man & Monkey $I \frac{2}{2}, C \frac{1}{1}, Pm \frac{2}{2}, M \frac{3}{3} = \frac{2123}{2123} \times 2 = 32$

b) Rabbit $I \frac{2}{1}, C \frac{0}{0}, Pm \frac{3}{2}, M \frac{3}{3} = \frac{2033}{1023} \times 2 = 28$

c) Cow & Goat $I \frac{0}{3}, C \frac{0}{1}, Pm \frac{3}{3}, M \frac{3}{3} = \frac{0033}{3133} \times 2 = 32$

d) Dog $I \frac{3}{3}, C \frac{1}{1}, Pm \frac{4}{4}, M \frac{3}{2} = \frac{3142}{3143} \times 2 = 42$

e) Rat & Mouse $I \frac{1}{1}, C \frac{0}{0}, Pm \frac{0}{0}, M \frac{3}{3} = \frac{1003}{1003} \times 2 = 16$

f) Elephant $I \frac{1}{0}, C \frac{0}{0}, Pm \frac{3}{3}, M \frac{3}{3} = \frac{1033}{0033} \times 2 = 26$

g) Kangaroo $I \frac{3}{2}, C \frac{1}{0}, Pm \frac{2}{2}, M \frac{4}{4} = \frac{3124}{?4} \times 2 = 34$

h) Sheep $I \frac{0}{3}, C \frac{0}{1}, Pm \frac{3}{3}, M \frac{3}{3} = \frac{0033}{3133} \times 2 = 32$