Dentition in Mammals

Contents:

Meaning of Dentition in Mammals: The arrangement of teeth in the upper and lower jaws, mainly on the premaxilla, maxilla and dentary bones, is called dentition.

Absence of teeth:

Modern turtles and birds lack teeth. Teeth are present in all mammals though a secondary toothless condition is found in some mammals. The adult platypus (Ornithorhynchus) bears epidermal teeth but no true teeth are present. In platypus embryonic teeth are replaced by horny epidermal teeth in adult. In Echidna or spiny ant-eater (Tachyglossus) the teeth are absent in all stages of life.

In certain ant-eaters of the New World (e.g., Myrmecophaga, Tamandua and Cyclopes) and' in adult whale-bone whale, Balaena (Right whale), Caperea (Pygmy right whale), Eschrichtius (Grey whale), Balaenoptera (Rorqual whale), Megaptera (Humpback whale)—teeth are absent.

Origin and Structure of Teeth in Mammals:

Teeth have evolved from denticles which are released from armour near the margins of the mouth as ossification in the integument. A typical mammalian tooth can be distinguished mainly into two regions — crown and root. The crown is the exposed part of the tooth and situated above the root and in the old age it is generally subject to wear.

The root is the hidden part in the gum which is anchored in the socket or alveolus of the jaw bone. The tooth encloses a pulp cavity that contains blood vessels, nerves, and connective tissue (Fig. 10.127). The junction of crown and root is called neck.

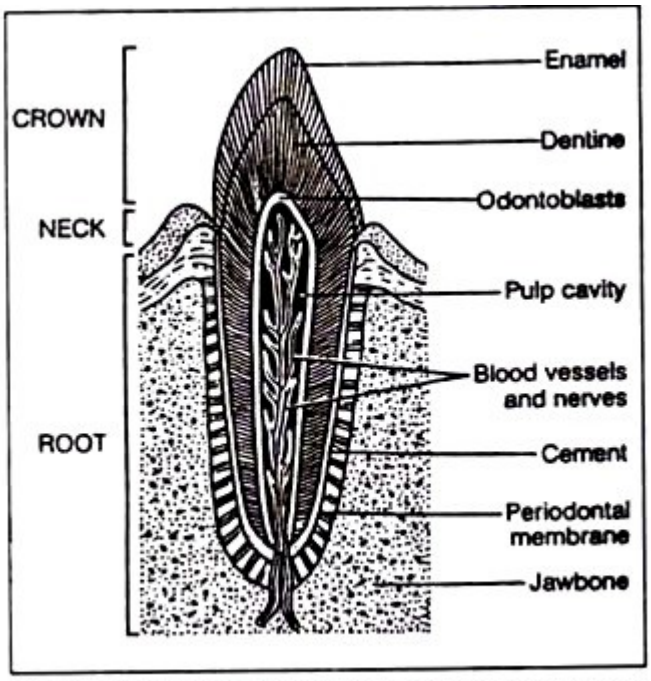

Fig. 10.127 : Structure of a tooth showing its relation with the jaw bone.

There are three kinds of tissues in a typical tooth. They are enamel, dentine and cement. Unworn crown is covered by a thin, very hard, glistening layer, called enamel. It is the hardest and heaviest tissue of the vertebrates and is composed of crystals of hydroxyapatite [$3(Ca_3PO_4)_2$. $Ca(OH)_2$). It is ectodermal in origin and totally acellular.

Below enamel, a hard dermal bony substance layer is found, called dentine. It is harder than bone but softer than enamel. The ivory is a specialised dentine and hard creamy-white substance, found in elephant, hippopotamus, walrus and narwhals tusks. The human dentine is composed of mainly calcium phosphate and fluoride 66.72%, organic matter 28.01% and calcium carbonate.

The root of tooth is covered by a thin layer of cement (cementum or Crusta petrosa) and a vascular periodentai membrane of strong connective tissue fibres (Sharpey's fibres).

Cement is a nonvascular bone and usually acellular. It is softer than dentine and is rich in collagenous fibres. It wears rapidly when exposed. The pulp cavity is lined by a layer of bone cells, called odontoblasts. Both dentine and cement are mesodermal in origin.

Types of Dentition in Mammals:

A. Classification According to the Shape and Size of the Teeth:

Homodont:

Homodont or isodont type of teeth is a condition where the teeth are all alike in their shape and size, e.g., the toothed whales (Odontoceti). Pinnipedians show a tendency towards homodont condition. Fishes amphibians reptiles and in the extinct toothed birds, the homodont or isodont condition is observed.

Heterodont:

Heterodont condition is the usual feature in mammals, i.e. the teeth are distinguished according to their shape, size and function. The function is also different at different parts of the tooth row. Except mammals heterodont condition is found in Port Jackson Shark (Heterodontus), in several reptiles, specially among mammal-like reptiles.

B. According to the Mode of Attachment of Teeth:

Thecodont type dentition is the rule among mammals. In this condition, the teeth are lodged in bony sockets or alveoli of the jaw bone and capillaries and nerves enter the pulp cavity through the open tips of the hollow roots (Fig. 10.128).

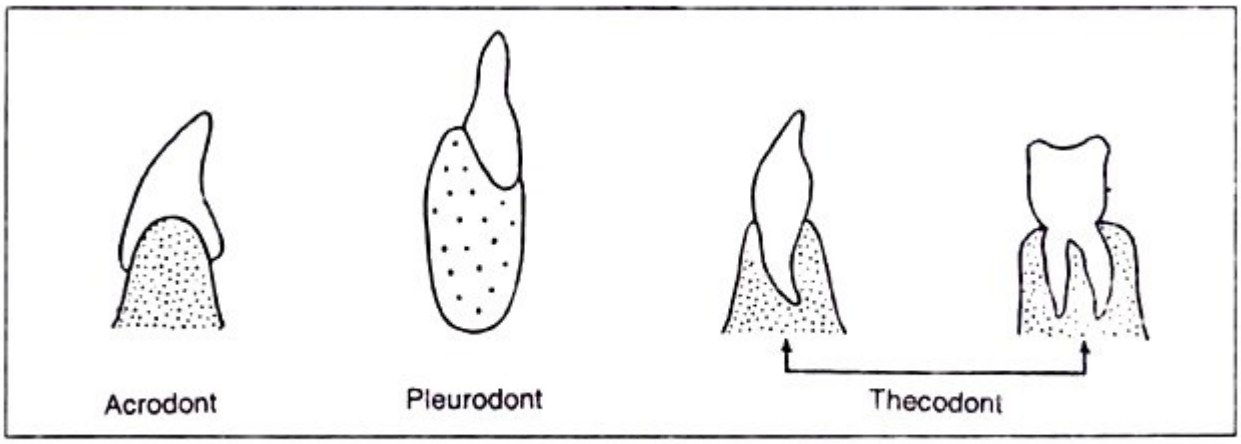

Fig. 10.128 : Mode of attachment of teeth.

Except mammals, thecodont type of teeth is found in crocodiles and in some fishes (Haddock, Garpike and Barracuda). Among vertebrates except thecodont, acrodont and pleurodont type of dentition is found.

Acrodont:

The teeth are fused to the surface of the underlying jawbone. They have no roots and are attached to the edge of the jawbone by fibrous membrane (Fig. 10.128) e.g., fishes, amphibians and some reptiles.

In amphibians if teeth are present, they are acrodont and homodont except Necturus. All reptiles do not possess acrodont type of teeth. The acrodont-possessing reptiles are Sphenodort, Calotes, Draco, Agama, Uromastix, Moloch horridus and some snakes.

Remark:
The teeth in modern amphibians are attached in the pleurodont style to the outer wall in a broad alveolar groove of the jaw bone. The teeth of modern amphibians are pleurodont and supported by pedicels of dental origin to which they are attached by zones of soft tissue.

Pleurodont:
Here the teeth are attached to the inner-side of the jawbone. The tooth touches the bone only with the outer surface of its root (Fig. 10.128). In acrodont and pleurodont types of dentition, there are no roots, and nerves and blood vessels do not enter the pulp cavity at the base, e.g., Necturus (Amphibia) and some reptiles.

Among reptiles the following families possess the pleurodont type teeth: Iguanidae (Iguana), Xenosauridae (Xenosaurus, Mexico), Zonuridae (Africa), Anguidae (Anguis, Ophisaurus), Lacertidae (Lacerta), Scincidae (Mabuya), Helodermatidae (Heloderma, Mexico), Varanidae (Varanus), Cerrhosauridae (Africa) and many snakes.

C. According to the Succession or Replacement of Teeth:
The teeth can be divided into three categories:
(i) Monophyodont

(ii) Diphyodont and

(iii) Polyphyodont.

Among mammals the first two categories are found.

(i) Monophyodont:
In some mammals, only one set of teeth develops in their life time and this condition is called Monophyodont, e.g., Marsupials retain all their milk teeth

except last premolars, the toothed whales (Odontoceti), some rodents (e.g., squirrels), certain insectivores (e.g., moles). Among platypus, sirenians and toothless whales develop only one set of teeth (monophyodont dentition). These teeth may not erupt (some whales) or, if they develop are usually shed shortly afterward.

(ii) Diphyodont:

In most mammals two sets of teeth are found. The first temporary set of teeth, called deciduous teeth, milk teeth or lacteal teeth, are lost or replaced by a second set of teeth, termed permanent teeth. In bats and guinea-pigs the milk teeth are lost even before birth. In milk teeth the molars are absent.

(iii) Polyphyodont:

In this condition, the teeth are replaced continuously throughout life, e.g., most lower vertebrates replace their teeth, generation following generation (Dogfish, snakes).

Types of teeth:

In heterodont condition the teeth can be distinguished into 4 types. They are incisors, canines, premolars and molars.

(i) Incisors:

They are situated anteriorly on the premaxilla in upper jaw and tips of dentaries in lower jaw. They are conical, single-rooted and monocuspid. They are used for cutting or cropping. Incisors may be totally absent in sloth or absent on upper jaw in sheep and ox. In rodents and lagomorphs the incisors are chisel-shaped, open rooted and continue to grow throughout life.

(ii) Canines:

Canines lie immediately behind the incisors. They are single in each half of the jaw. They are large-pointed, long-crowned with a single root. They are used for piercing and tearing the flesh of the prey (dog). Sometimes the canines are used in holding the prey, mainly seen in carnivorous mammals.

In rodents and lagomorphs, the canine is absent, leaving a space in-between incisors and premolars, called diastema. Any gap within the dental series is called diastema. In horses, the canines are relatively small. In carnivores (dogs, tigers and lions) the canines become spear-shaped and used for piercing and tearing the

flesh. They are generally used for holding and piercing in relation to both feeding and fighting.

(iii) Premolars:
Following the canines there are premolars or bicuspid teeth. These have two roots and two cusps. The premolars are used for grinding the food materials.

(iv) Molars:
Molars lie behind the premolars. They have two or more roots and several cusps. Molars are used for crushing food; premolars and molars are collectively called "Cheek teeth".

In carnivores the number of cheek teeth is often reduced and in some cases (Fissipedia) last upper premolar and first molar in lower jaw are modified into chisel-shaped sharp cusps, called Carnassial teeth, used for cracking bones and shearing tendons. The molars is each jaw of man are called wisdom teeth and its eruption is often delayed.

Cusp patterns of cheek teeth:
The molars contain many cusps on their surface. The cusps are raised tiny structures or ridges on the occlusal surface. The cusps are called cones. Depending on the number and shape of the cusps, molars are recognised in different names.

[Among fossil mammals]
(i) Triconodont:
In this condition molars possess 3 cones or cusps arranged in anteroposterior lines. This type of molar teeth are found in the fossil Mesozoic mammals (Fig. 10.129A), e.g., Triconodon.

(ii) Trituberculate:
Here the molars contain three cones or tubercles, arranged in the form of a triangle (Fig. 10.129B). It is also found among fossil Mesozoic mammals, e.g., Spalacotherium.

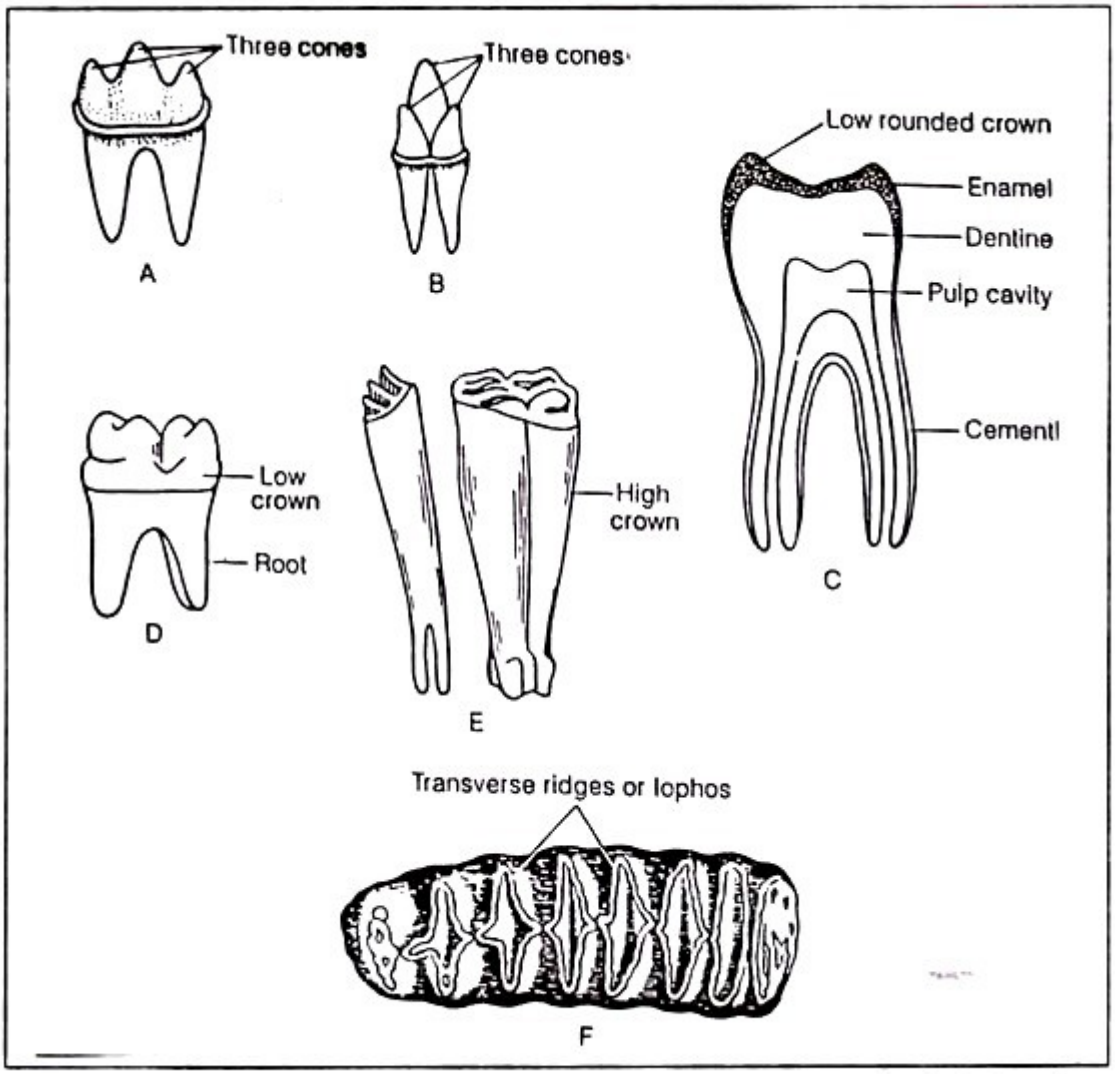

Fig. 10.129 : Modifications of cheek teeth : A. **Triconodont tooth**. B. Tritubercular tooth. C. V.S. of a **bunodont** molar. D. Brachydont molar. E. Hypsodont molar. F. Lophodont teeth.

Depending upon the feeding habit and the type of food taken (trophic specialization), the premolars and molars of recent eutherians have undergone changes in their shape, and cheek teeth are recognised into the following names.

(i) Bunodont:

When the cusps in the cheek teeth remain separate and rounded, the tooth is called bunodont (mound + tooth). In man and in some omnivore mammals the cheek teeth are bunodont type and they are used in grinding the food material (Fig. 10.129C).

(ii) Lophodont:

If the cusps are joined to form ridges or lophs, the tooth is called lophodont. The cheek teeth of elephant are of lophodont type. There is an intricate folding of enamel and dentine (Fig. 10.129F). These type of teeth are used to grind all sorts of plants, and also grasses.

(iii) Secodont:
When the cheek teeth are with sharp cutting crowns, the teeth are called secodont. This condition of teeth is present in terrestrial carnivores. These teeth possess cutting edges and are used for cutting and shearing the flesh.

(iv) Selenodont:
Cheek teeth with crescent-shaped cusps are known as selenodont. In ruminants and horses (perissodactyla), the teeth are selenodont (crescent shaped moon + tooth) type and are used for grinding the plant matter.

(v) Brachydont:
A tooth with a low crown and comparatively long root is called brachydont (short + tooth) (Fig. 10.129D), e.g., Man.

Hypsodont:
When the crown is high and the roots are short and open (Fig. 10.129E), e.g., Horse, incisor of elephants.

Modification of Teeth Based on Diet:
The teeth of mammals are modified according to their food habit.

Herbivorous mammals:
Herbivores include oxen, sheep, goats, deer, antelopes, camels, rodents, elephants, and members of the uneven toed mammals. Their food consist of mainly grasses and plant material which require long mastication for digestion. In artiodactyles the grinding teeth possess broad crown, complicated by ridges and folds of hard enamel. Premolars are not used for grinding purposes.

The grinding function is occupied by very elongated hypsodont molars. The effective grinding surface is maintained by the persistence of harder enamel. The incisors of the upper jaw are lost and the canine teeth are rudimentary or absent. The incisors and canines of the lower jaw are present and are used for grass-

cropping apparatus. The check teeth of ruminants and horses are of selenodont type.

Rodents have no canines. Only incisors are used for gnawing, scraping and nibbling. The incisors are sharp and chisel-shaped, used for cutting purposes. Enamel are absent on the posterior surface of the incisors and as a result, the body of the incisors wears quickly.

As the incisors are provided with persistent open roots they grow throughout life. They have 3 molars or grinders on each side of the jaw. The cusps of the broad surfaces of the molars are joined in pairs to form ridges.

Elephants have lost all canine teeth and all the incisors except the second pair in the upper jaw which have developed into tusks. The jaws have six hypsodont molars in each jaw and are used as grinding teeth. Out of 6, only two molars remain functional at a time.

The surfaces of the molars consist of a series of deep plates composed of a dentine and enamel, bound together in a solid mass by cement. These three elements wear at different rates, leaving a rough surface. As the dentine wears, the enamel of the crowns of the molars appears a series of transverse ridges.

In horses, all the cheek teeth are hypsodont with crescent shaped cusps, known as selenodont used for grinding purposes. The enamel, dentine and cement of the cheek teeth wear at different rates, leaving a rough surface for grinding the grasses.

Carnivorous mammals:
In carnivorous mammals, the canines are large, sharp and pointed which are used for tearing purposes and incisors are pierced into the body of the victim. These teeth are supported by powerful jaw muscles. Incisors and canines are used for seizing, holding and biting.

The last upper premolar and first lower molar are developed into sharp chisel-shaped structures, called carnassial teeth and used for cutting the flesh. These carnassial teeth act against each other like the blades of a pair of incisors. The

cheek teeth of carnivores are secodont type because these teeth possess sharp cutting crowns.

Omnivorous mammals:
The omnivorous mammals consume mixed diet including vegetables and meat. Many mammals including monkeys, man and true civets fall in this group. Cheek teeth of these mammals are bunodont type.

The cusps on the cheek teeth remain separate and are rounded in shape. The incisors are used for cutting the food material. The true civets subsist on meat and vegetable matter. They have broad-crowned many cusped molars. The molars are designed to cut the flesh and to grind the vegetable matter.

Aquatic mammals:
Among mammals, cetacean pinnipeds and sea cows are aquatic. The sea cows have teeth which are greatly reduced in size. They are grazers and teeth are little used. The well- developed lips are used for grazing purpose. The pinnipeds have teeth which have laterally compressed cones and three cusps in a row which helps to prevent escape of the slippery prey.

Cetaceans have two groups — whale bone whales (Mysticeti) and toothed whales (Odontoceti). Toothed whales have homodont type teeth. The teeth are used to hold the prey. In whale bone whales (Mysticeti) the teeth are completely absent. Instead, transversely arranged triangular plates of keratin hang from the roof of the mouth, called baleen (Fig. 10.130).

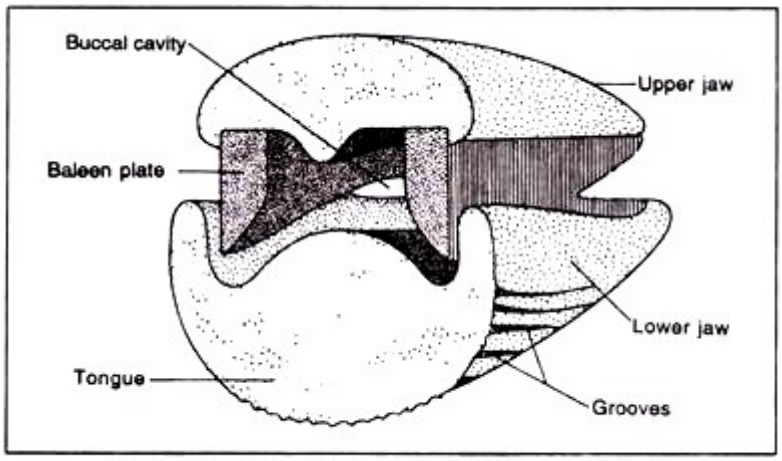

Fig. 10.130 : Sectional view of the head of a rorqual whale.

The number of plates is about 300 and varies in colour in different species. The outer surface of the baleen is smooth and straight but inner surface has a hairy fringe to trap the food when water is expelled. These plates help to strain the minute planktonic food.

Dental Formula:

The number of teeth in any particular species remains constant but varies in different species. So the number of teeth is expressed by a sort of equation and is called dental formula. The maximum number of teeth in heterodont mammals is 44. There are mammals with teeth less than 44. This is due to the reduction in the number of one or more types.

This constancy of the number of teeth has become a tool to the taxonomists for the purpose of classification. The dental formula is expressed by the number of each type of teeth in each half of the jaws. The teeth of the upper jaw are placed as numerators and in the lower jaw as denominators.The numerators and denominators are separated by a horizontal line. The kind of teeth is indicated by initial letters i, c, Pm, m indicating incisor, canine, premolar and molar, respectively.

Kangaroo (*Macropus*) $\frac{3.1.2.4}{1.0.2.4} = 34.$

Australian native cat (*Dasyurus*) $\frac{4.1.2.4}{3.1.2.4} = \frac{11}{10} = 42.$

American opossum (*Didelphys*) $\frac{5.1.3.4}{4.1.3.4} = 50.$

Family Suidae (e.g., Pigs) and horses bear primitive eutherian type of teeth.

Horses and Pigs $\frac{3.1.4.3}{3.1.4.3} = 44.$

Bat $\frac{2.1.0.4}{3.1.0.5} = 32.$

Old world monkeys $\frac{2.1.2.3}{2.1.2.3} = 32.$

Sheep, cow and goat $\frac{0.0.3.3}{3.1.3.3} = \frac{6}{10} = 32.$

New World monkeys $\frac{2.1.3.3}{2.1.3.3} = 36.$

Except common marmoset, *Callithrix* $\frac{2.1.3.2}{2.1.3.2} = 32.$

Cat $\frac{3.1.3.1}{3.1.2.1} = \frac{8}{7} = 30.$

Dog and Bears $\frac{3.1.4.2}{3.1.4.3} = \frac{10}{11} = 42.$

For further simplification the initial letters are often omitted. When a certain type of tooth is absent, a zero is used to indicate the fact.

Dental formula of some mammals:
A typical primitive eutherian mammal possesses 44 teeth and it is expressed.

$I^3/_3$, $c^1/_1$, $Pm^4/_4$, $m^3/_3$ = 22 x 2 = 44.
In simpler forms it may be expressed

3.1.4.3/3.1.4.3 = 22 x 2 = 44.

Among monotremes, Tachyglossus does not possess teeth at any stage. The adult platypus (Ornithorhynchus) bears no teeth.

Seals $\frac{3.1.4.1}{2.1.4.1} = \frac{9}{8} = 34.$

Walrus $\frac{1.1.3.0}{0.1.3.0} = \frac{5}{4} = 18.$

Rat $\frac{1.0.0.3}{1.0.0.3} = 16.$

Guinea-pig $\frac{1.0.1.3}{1.0.1.3} = 20.$

Hare and Rabbit $\frac{2.0.3.3}{2.0.2.3} = \frac{8}{7} = 30.$

Hyrax $\frac{1.0.4.3}{2.0.4.3} = \frac{8}{9} = 34.$

Elephant $\frac{1.0.0.3}{0.0.0.3} = \frac{4}{3} = 14.$

In marsupials the milk dentition persists except the last premolar. In adult marsupials the number of incisors in upper and lower jaws always varies except in burrowing wombats (phascolomys).

Unusual Teeth in Mammals:
(i) Elephant's tusk:

The elephant's tusks are the second pair of incisors in the upper-jaw. The lower incisors disappeared. The tusks are made of ivory which is a specialized dentine. The upper incisors have no root and they grow to form tusk. Both sexes of African elephants have tusks but in India only males bear tusks. Tusks are used in offence and defense.

(ii) Pig's tusk:
In wild boar the upper canines are enlarged to form stout tusks. The warthog (Phacochoerus) of Africa bears 4 upward curving tusks. These are transformed canines of both jaws. These are used for digging in the soil for storage roots and tubers of the plants.

(iii) Barking deer's tusk:
The male muntjaks and musk deer possess tusks which are the enlarged form of upper canine teeth (Fig. 10.131 A). These are used for self defence.

(iv) Walrus's tusk:
They are the modified form of upper canines (Fig.10.131B). The primary function of the tusks is to break the clams on the ocean floor.

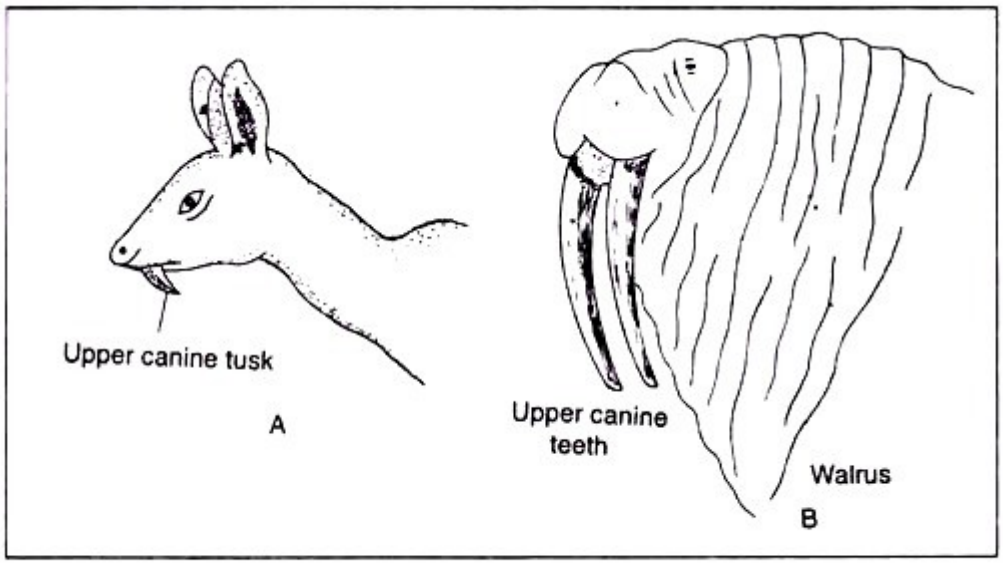

Fig. 10.131 (A–B) : A. Tusk of male musk deer, B. Tusk of walrus. The tusks are modified upper canine teeth in both cases.

Origin and Evolution of Molars in Mammals:
The origin of the complex cheek teeth of mammals was a controversial issue for a long time. The simple and single-rooted incisor and canine show little

modifications and are not taken into consideration in any discussion on the origin of cheek teeth. Two theories have been put forward to explain the origin of the complex cheek teeth.

a. Concrescence Theory of Kukenthal and Rose:
This theory was postulated by Kukenthal and Rose in 1890. This theory advocates that the cheek teeth (multi-cuspid teeth) originated by the fusion of two or more conical teeth. In dugong several enamel organs fuse to form the molar teeth.

Remarks:
As the theory is not supported by embryological evidences and the condition found in dugong is considered as exception, so this theory has been discarded.

b. Differentiation Theory of Cope and Osborn:
This theory was presented in 1880 by Cope and Osborn and was revised by Gregory in 1934. This theory holds that starting with a primitive conical tooth, two additional projections or buds developed giving rise to the so-called triconodont shape (Fig. 10.132).

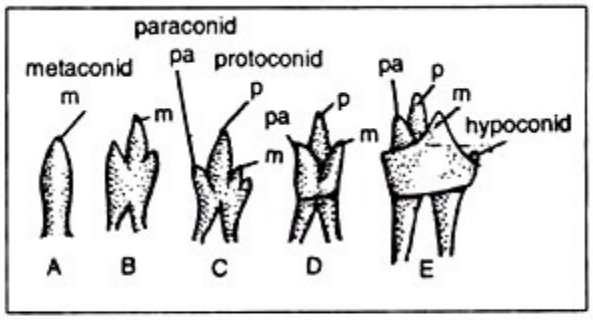

Fig. 10.132 : Showing the evolution of mammalian cheek teeth from simple conical reptilian tooth. A. Reptile B. *Dromatherium* C. *Microconodon* D. *Spalacotherium*. E. *Amphitherium*.

In the second phase these cones shifted so as to give rise to separate tubercles or cusps arranged in a triangle. This has been called tritubercular position. Still later other parts may have developed from these three original tubercles so as to form additional cusps or folds and thus arrived the varied types of mammalian cheek teeth that exist today.

Remarks: Due to abundant embryological and palaeontological evidences, most zoologists are in favour of this theory.