Dentition in mammals

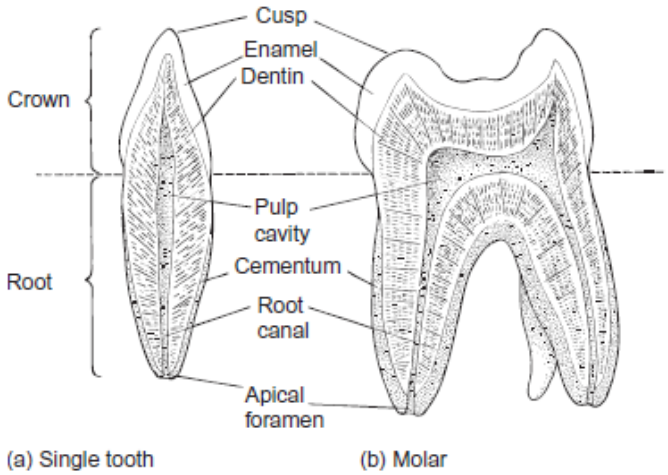
The arrangement of teeth in the upper and lower jaws, mainly on the premaxilla, maxilla and dentary bones, is called dentition.

Teeth in Vertebtates:

- Teeth are derivatives of bony dermal armors.
- Teeth are unique among vertebrate animals.
- Teeth like placoid scales are composed of **dentin,** a variety of bone, surmounted by a crown of **enamel or enameloid.**
- Inductive interaction between embryonic epidermis and neural-crest-derived mesenchyme is required to form teeth. In general, cells derived from epidermis make the tooth enamel whereas the mesenchyme makes the dentine.
- Teeth help catch and hold prey.
- They also offer strong opposing surfaces that jaws work to crush hard shells of prey.
- In mammals and a few other vertebrates, mechanical digestion begins in the mouth.
- Even in vertebrates that do not chew their food, sharp teeth puncture the surface of the prey, creating sites through which digestive enzymes penetrate when food reaches the alimentary canal.

Tooth Anatomy:

- The part of the tooth projecting above the gum line, or **gingiva,** is the **crown;** the region below is the **base.**
- When the base fits into a hole, or **socket** (alveolus) within the jaw bone, the base is referred to as a **root.**
- Within the crown, the **pulp cavity** narrows when it enters the root, forming the **root canal,** and opens at the tip of the root as the **apical foramen.**
- Mucous connective tissue, or **pulp,** fills the pulp cavity and root canal to support blood vessels and nerves that enter the tooth via the apical foramen.
- The **occlusal surface** of the crown makes contact with opposing teeth.
- The **cusps** are tiny, raised peaks or ridges on the occlusal surface.



Three hard tissues compose the tooth: enamel, dentin, and cementum.

1. **Enamel :** It is the hardest substance in the body and forms the surface of the tooth crown. Concentric rings seen under microscopic examination are believed to result from pulses of calcium salt deposits before tooth eruption, and no further enamel is deposited on the crown after the tooth erupts.

2. **Dentin** resembles bone in chemical composition but it is harder. It lies beneath the surface enamel and cementum, and forms the walls of the pulp cavity. Even after tooth eruption, new dentin is laid down slowly throughout the life of an individual. Growth occurs by daily apposition along the walls of the pulp cavity, so that in very old animals, dentin may almost fill the entire cavity. The daily layers of dentinal growth are called the **incremental lines of von Ebner.**

3. **Cementum,** has both cellular and acellular regions. Cementum rests upon the dentin and grows in layers on the surface of the roots. In many herbivores, cementum can extend up along the crown to between the enamel folds and actually contribute to the occlusal surface of high crowned teeth.

- Cells within the cementum, termed **cementocytes,** elaborate the matrix but in seasonally related pulses, so that cementum increases irregularly with age. The result is the production of **cemental annuli,** concentric rings that characterize the cementum layer.

- The appearance of these annuli changes predictably with mechanical properties of food (hard), nutritional state (lean times), and season (winter).

4. The **periodontal membrane** (periodontal ligament) consists of thick bundles of collagenous fibers that connect the cementum-covered root to the bone of the socket.

Development of teeth in mammals:

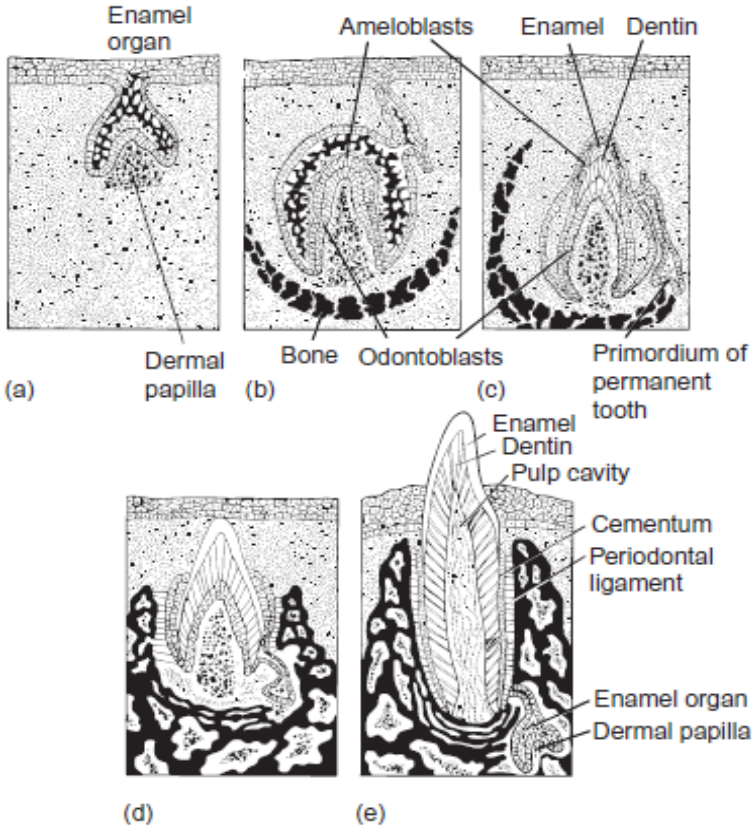
- Inductive interaction between embryonic epidermis and neural-crest-derived mesenchyme is required to form teeth. In general, cells derived from epidermis make the tooth enamel whereas the mesenchyme makes the dentine.

- The earliest indication of the development of the socketed teeth is ingrowth of the longitudinal ridge of the ectoderm **the dental lamina** into the dermis.
- Beneath the dental lamina, a linear series of **dermal papillae** (each designating the site of future teeth) forms at intervals indenting the lamina and organizing blood vessels necessary for the further development of the tooth primordium.
- The cells at the periphery of each papilla become organized into a definitive layer of **odontoblasts** which give rise to dentin in future.

In course of deposition, the odontoblasts slowly withdraw towards the centre of the primordium which is becoming a pulp cavity containing the components of the dermal papillae.

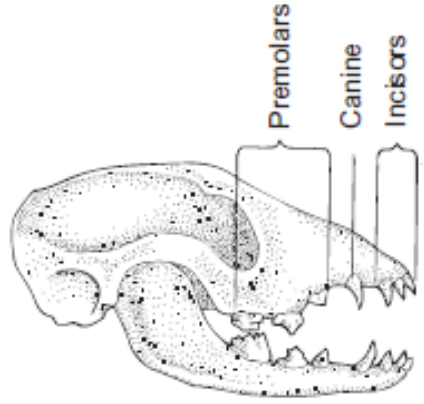
- Meanwhile the ectoderm of the dental lamina organizes into **enamel organ,** cells within the enamel organ form a specialized layer of **ameloblasts,** which secrete enamel.
- A thin layer of **cementum** eventually anchors the tooth to the bone of the jaw.
- The crown of the tooth forms first, and then shortly before eruption, the root begins to develop. The cementum and periodontal ligament develop last.

- The details of tooth development and emergence, time of initiation of different stages and the ultimate fate of eruption vary within species.

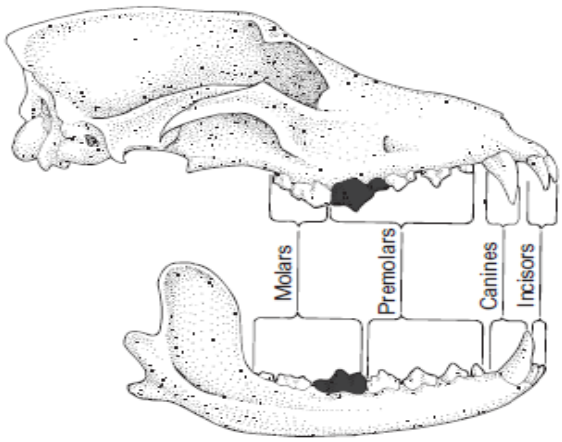


(a) Enamel organ (from the epidermis) and dermal papilla (from the dermis) appear. (b) Ameloblasts are the source of tooth enamel and form from the enamel organ. Odontoblasts are the source of dentin and form from the dermal papilla. Bone appears and begins to delineate the socket in which the tooth will reside. (c) The primordium of the permanent tooth appears. (d) Tooth growth continues. (e) The deciduous tooth erupts and is anchored in the socket by a well-established periodontal ligament. The enamel organ and dermal papilla of the permanent tooth primordium will not begin to form the tooth until shortly before the deciduous tooth is lost.

Dentition in mammals:



(a) Puppy



(b) Adult dog

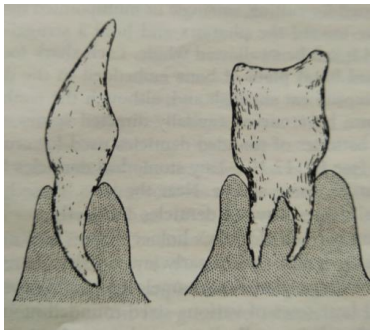
- **Monophyodont dentition**: A few mammals develop only a the first set of teeth.

Example: a. In Platypus, the deciduous set of teeth is replaced by horny epidermal teeth.

b. In toothless whales, the first set although formed may not erupt, and if they do they are usually shed.

c. The fresh water manatee from the Amazon river and Australian Rock Wallaby do not have sets, but teeth is replaced throughout the life, by the forward migration of the new teeth formed at the rear of the jaws. Rate of migration may be 1-2mm /month.

- **Thecodont dentition:** teeth occupy bony sockets or alveoli which are deepest in mammals.



- All but a very few mammals, have **heterodont dentition,** where teeth differ in general appearance throughout the mouth i.e. from front to rear being incisors, canine, premolar and molar.

Most marine mammals of today like cetaceans (Blue whale, humpback whale), sirenians (Sea cow) and some marine carnivores (seals, walruses) have reverted to homodont dentition.

Morphological variants of teeth:

- **Incisors:**

I. Located on either side of the mandibular symphysis having one horizontal cutting edge and a single root.

II. Best developed in herbivorous mammals, which use them for holding, cropping and gnawing.

III. Variation in different animals: *Rodents* have a single pair of large chisel like incisors whereas *lagomorphs* have a small 2nd pair of incisors behind not lateral to the front pair. These incisors grow throughout the life. In *bovine mammals* incisors are lacking in the upper jaw and in *vampire bat* they are absent in the lower jaw or may be completely absent in *sloth*. *Elephant and mastodon tusks* are modified incisors and grow throughout the life as in rodent incisors.

- **Canines:**

I. Teeth lying next to the incisors.

II. In generalized mammals, incisors and canines scarcely differ in appearance.

III. In carnivore mammals, canines are spear like and used for piercing flesh.

IV. In walrus the tusks are the modified canines.

V. Canine teeth are absent in lagomorphs and the blank space or the toothless interval is known as **diastema**.

- **Premolars:**

I. In most mammals other than ungulates usually have two prominent cusps, hence they are bicuspids.

II. They usually have one or two roots and the number of roots may differ on the upper and lower jaw and among different individuals of the same population including humans.

- **Molars:**

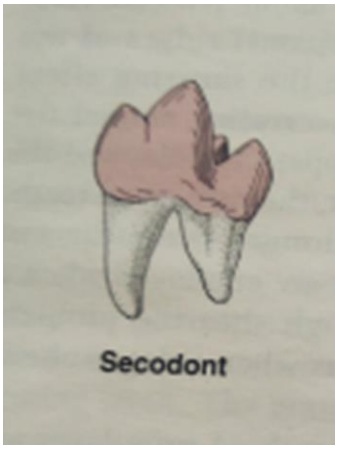
I. Molars have 3 or more cusps; hence they are tricuspids.

II. They usually have 3 roots, but they are occasional molars with 4 or 5. Molars are not replaced by a 2nd set but are the late arrivals of the 1st set.

Morphological variants of the cheek teeth:

1. **Secodont teeth:**

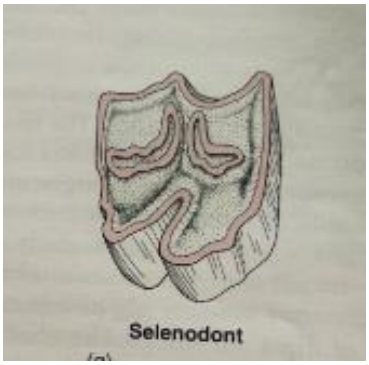
- The crown of the cheek teeth of carnivores are laterally compressed and two or three cusps are interconnected by sharp ridges of the enamel and have long roots.
- They are spaced on the jaw in such a fashion that the cusps of the teeth on the upper jaw fit between the cusps of the teeth on the lower jaw. This provides necessary shearing effect for macerating animal tissues.



. Selenodont teeth:

- The cheek teeth of the ungulates are specialized for grinding and thus are wider and longer than those of the carnivores having a broad surface for grinding.
- The crowns consist of crescentic columns of dentin, each column surrounded by enamel and the columns are embedded in additional dentin that is devoid of an enamel overlay.
- The dentin being softer leave sharp crescentric enamel ridges with a wide variety of configuration and help in macerating vegetables with side to side and forward-backward chewing movements.
- Teeth with enamel disposed in crescentic ridges are called selenodont teeth.

Example: Bovine cheek teeth.



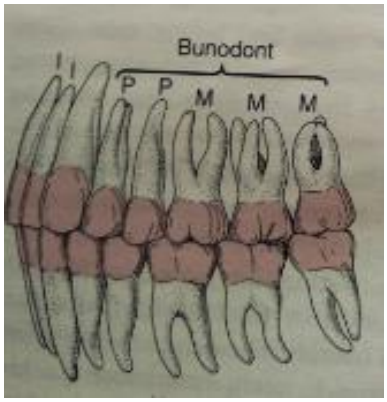
Lophodont teeth:

- Specialised grinding tooth type where the enamel and the dentin are intricately interfolded and the enamel is disposed on ridges (lophs) on enormous plateaus of naked dentin.
- They can reach a length of about a foot and one third of a foot in width.
- Example: Proboscideans.

4. Bunodont teeth:

In omnivores and some herbivores, the crowns of the cheek teeth may lack sharp and pointed edges/cusps instead have low rounded cusps.

Example: human being, rhinoceros, hogs etc.



Tricodont teeth:

Crown of the cheek teeth have 3 cone like prominences arranged in a straight line. Example: Early prototherians

6. Trituberculate teeth:

When the cones in cheek teeth are arranged in a triangle. Example: Early therians.

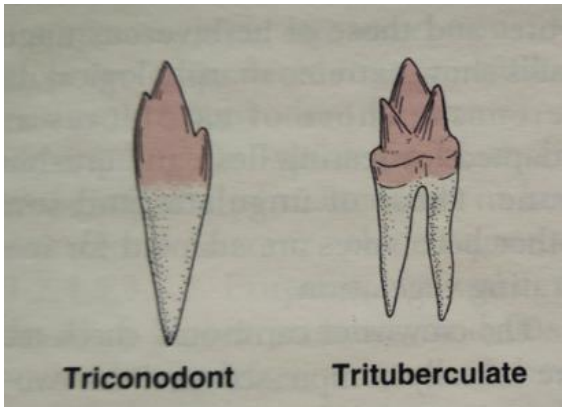
7. Hypsodont: Teeth with high crown. Example: Horse

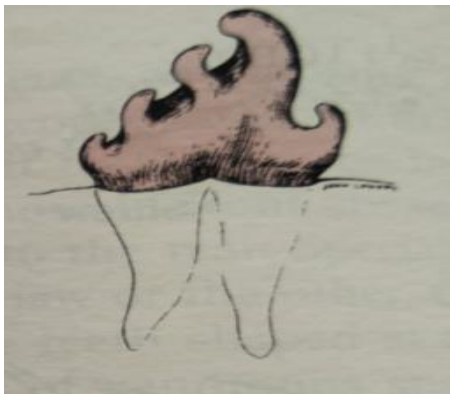
8. Brachyodont: Teeth with low crown. Example human, pigs.

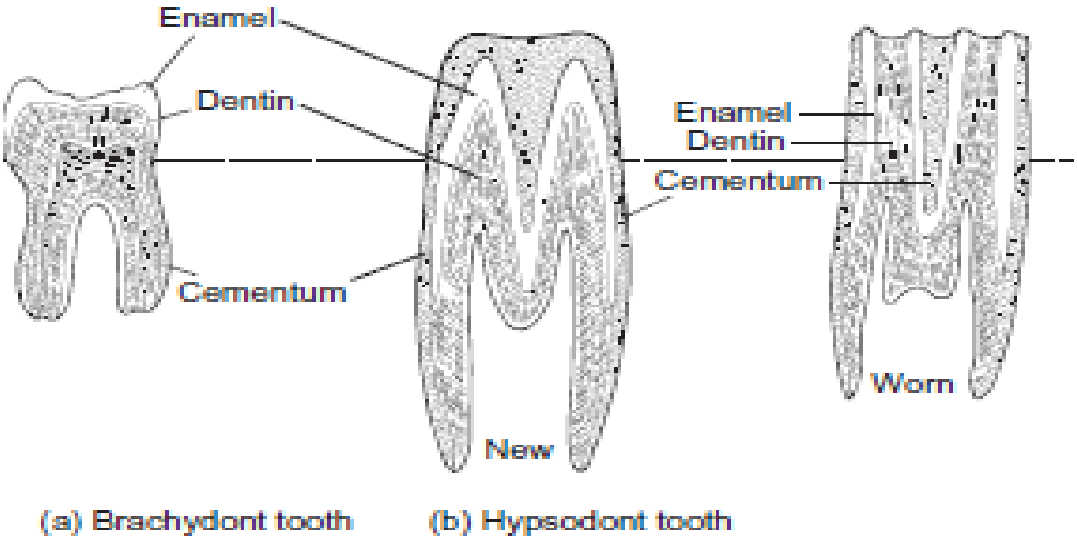
7. Teeth of the crab eater whales:

Their teeth are employed to strain small crustaceans and other planktons out of mouthfuls of sea water as it spills back into the sea.

Rodents *have the most variety of diets and exhibit largest variety of teeth. For example low crowned with long roots in squirrels, high crowned with short roots in wood rats.*



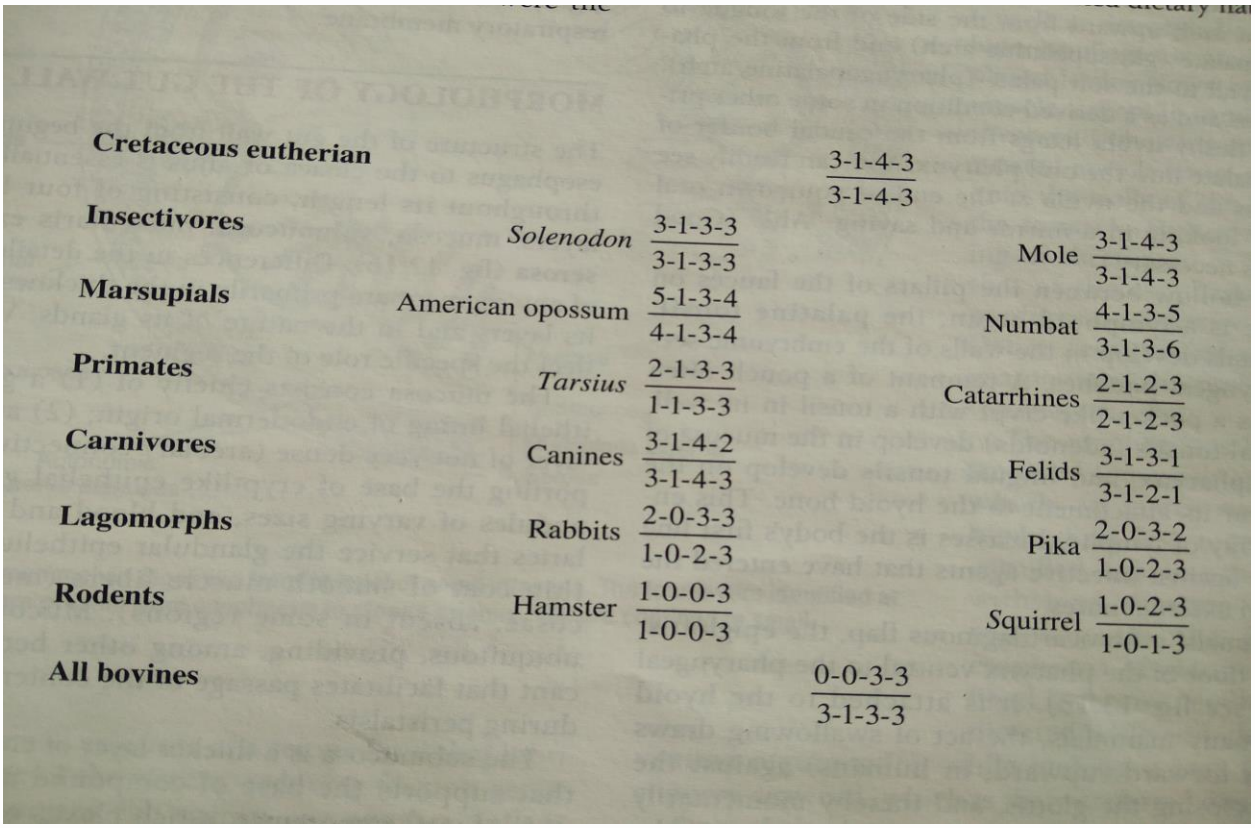




Dental formula:

Every mammal's teeth are specialised for different functions, many mammal groups have lost teeth not needed in their adaptation. Tooth form has also undergone evolutionary modification as a result of natural selection for specialised feeding or other adaptations. Over time, different mammal groups have evolved distinct dental features, both in the number and type of teeth, and in the shape and size of the chewing surface.

- The number of teeth of each type is written as a dental formula for one side of the mouth, or quadrant, with the upper and lower teeth shown on separate rows. The number of teeth in a mouth is twice that listed as there are two sides.
- In each set, incisors (I) are indicated first, canines (C) second, premolars (P) third, and finally molars (M), giving I:C:P:M. So for example, the formula 2.1.2.3 for upper teeth indicates 2 incisors, 1 canine, 2 premolars, and 3 molars on one side of the upper mouth. The deciduous dental formula is notated in lowercase lettering preceded by the letter d: for example: di:dc:dp.
- An animal's dentition for either deciduous or permanent teeth can thus be expressed as a dental formula, written in the form of a fraction, which can be written as I.C.P.MI.C.P.M, or I.C.P.M / I.C.P.M.



Cretaceous eutherian			$\frac{3\text{-}1\text{-}4\text{-}3}{3\text{-}1\text{-}4\text{-}3}$	
Insectivores	*Solenodon*	$\frac{3\text{-}1\text{-}3\text{-}3}{3\text{-}1\text{-}3\text{-}3}$		Mole $\frac{3\text{-}1\text{-}4\text{-}3}{3\text{-}1\text{-}4\text{-}3}$
Marsupials	American opossum	$\frac{5\text{-}1\text{-}3\text{-}4}{4\text{-}1\text{-}3\text{-}4}$		Numbat $\frac{4\text{-}1\text{-}3\text{-}5}{3\text{-}1\text{-}3\text{-}6}$
Primates	*Tarsius*	$\frac{2\text{-}1\text{-}3\text{-}3}{1\text{-}1\text{-}3\text{-}3}$		Catarrhines $\frac{2\text{-}1\text{-}2\text{-}3}{2\text{-}1\text{-}2\text{-}3}$
Carnivores	Canines	$\frac{3\text{-}1\text{-}4\text{-}2}{3\text{-}1\text{-}4\text{-}3}$		Felids $\frac{3\text{-}1\text{-}3\text{-}1}{3\text{-}1\text{-}2\text{-}1}$
Lagomorphs	Rabbits	$\frac{2\text{-}0\text{-}3\text{-}3}{1\text{-}0\text{-}2\text{-}3}$		Pika $\frac{2\text{-}0\text{-}3\text{-}2}{1\text{-}0\text{-}2\text{-}3}$
Rodents	Hamster	$\frac{1\text{-}0\text{-}0\text{-}3}{1\text{-}0\text{-}0\text{-}3}$		*S*quirrel $\frac{1\text{-}0\text{-}2\text{-}3}{1\text{-}0\text{-}1\text{-}3}$
All bovines			$\frac{0\text{-}0\text{-}3\text{-}3}{3\text{-}1\text{-}3\text{-}3}$	

Dental Eruption Sequence:

- There is a specific sequence in which the teeth erupt and the order in which teeth emerge through the gums is known as the **dental eruption sequence**.
- Numbering the permanent set in human beings 1 to 8 from front to rear and the sequence of eruption is 6,1,2,4,5,3,7,8. The number 8 indicates for the last molar and its eruption is delayed in higher primates, designated as Wisdom teeth.
- The later that tooth emergence begins, the earlier the anterior teeth (I1–P4) appear in the sequence.

Epidermal Teeth:

- The Monotremes have a temporary horny egg tooth that is used for cracking the shell.
- After a baby platypus is born and its first set of bony teeth is lost, horny teeth replace them and remain throughout life.