

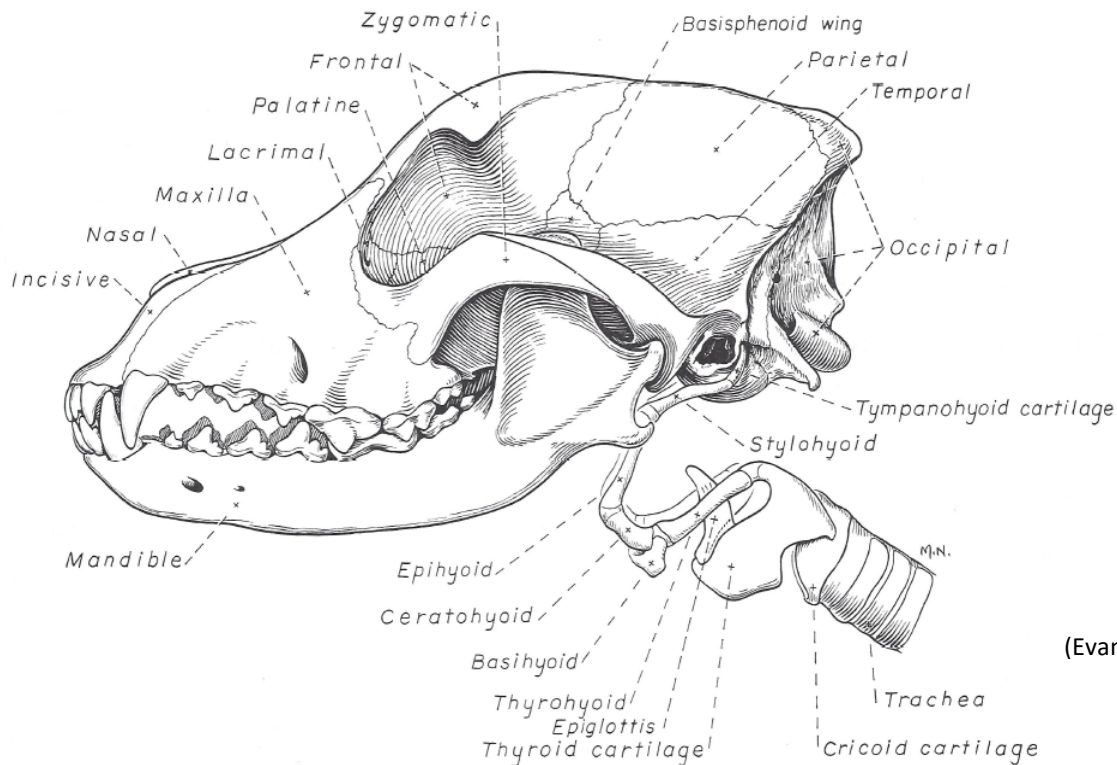
# DIGESTIVE SYSTEM

## LECTURE 2: TEETH AND TOOTH DEVELOPMENT

### Tooth Location:

Upper jaw: Maxilla and Incisive bones

Lower jaw: Mandible



(Evans 3<sup>rd</sup> Ed. P 156)

**FIGURE 4–41.** Bones of the skull, hyoid apparatus, and laryngeal cartilages, lateral aspect.

Alveolar bone is the bone that contains the tooth sockets: alveolus = socket

### Tooth Surfaces:

Vestibular: The vestibule is the space between the lips and cheeks and the dental arcades

- labial: the tooth surface facing the lips

- buccal: the tooth surface facing the cheek

Occlusal: the masticatory surface – comes into contact with teeth of opposite jaw

Lingual: (aka glossal) faces the tongue – used for both upper and lower arcade

Palatine: of the upper arcade only – faces the palate

Interproximal/Interdental: facing adjacent teeth in same arcade/row. *The terms Mesial: facing towards the midline and Distal: away from midline – used for teeth in arc such as seen in carnivores, are less appropriate for cheek teeth that are in a row - as seen in herbivores – in the case of these teeth 'mesial' would be the equivalent of the rostrally facing interdental surface and 'distal' the caudal facing interdental surface.*

**Brachydont teeth:** 'short crowned' teeth

Sole tooth type in carnivores,

Have a limited period of growth and eruption

**Hypsodont teeth:** 'high crowned' teeth

Found in herbivores and may form part of the dentition in omnivores— are teeth adapted for high rates of wear

Prolonged growth and eruption period, has a body/anatomical crown and a root.

The root develops sometime after eruption commences and this may be many years after the tooth first begins to erupt.

Some hypsodont teeth never form roots, e.g. the incisors of rabbits and rodents, and these continue to grow throughout life. These are called aradicular hypsodont (aradicular=no roots) or hypselodont teeth.

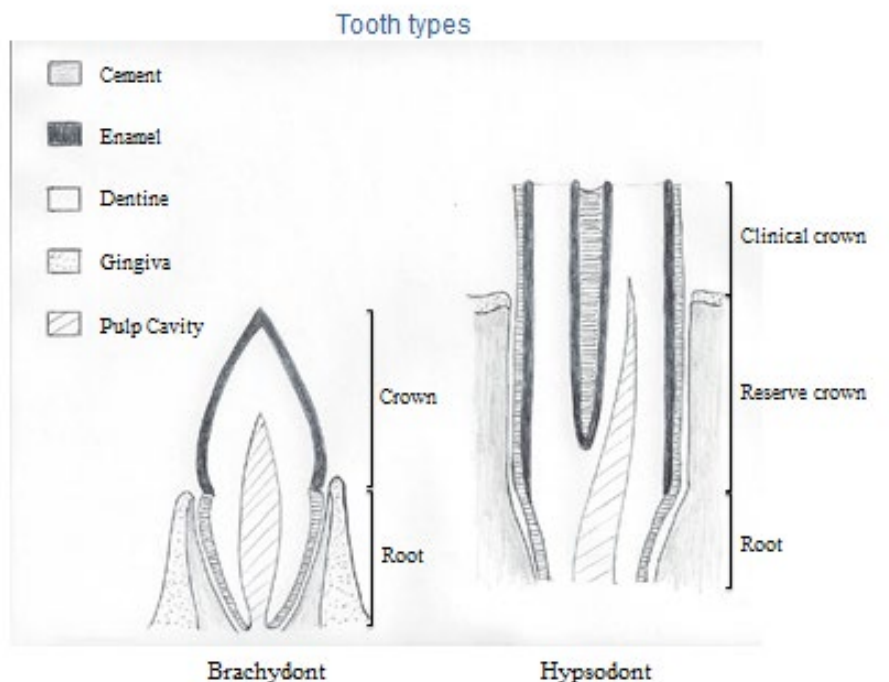


Image: C Murray

## Parts of the tooth

**Crown:** the part of the tooth that is covered by enamel

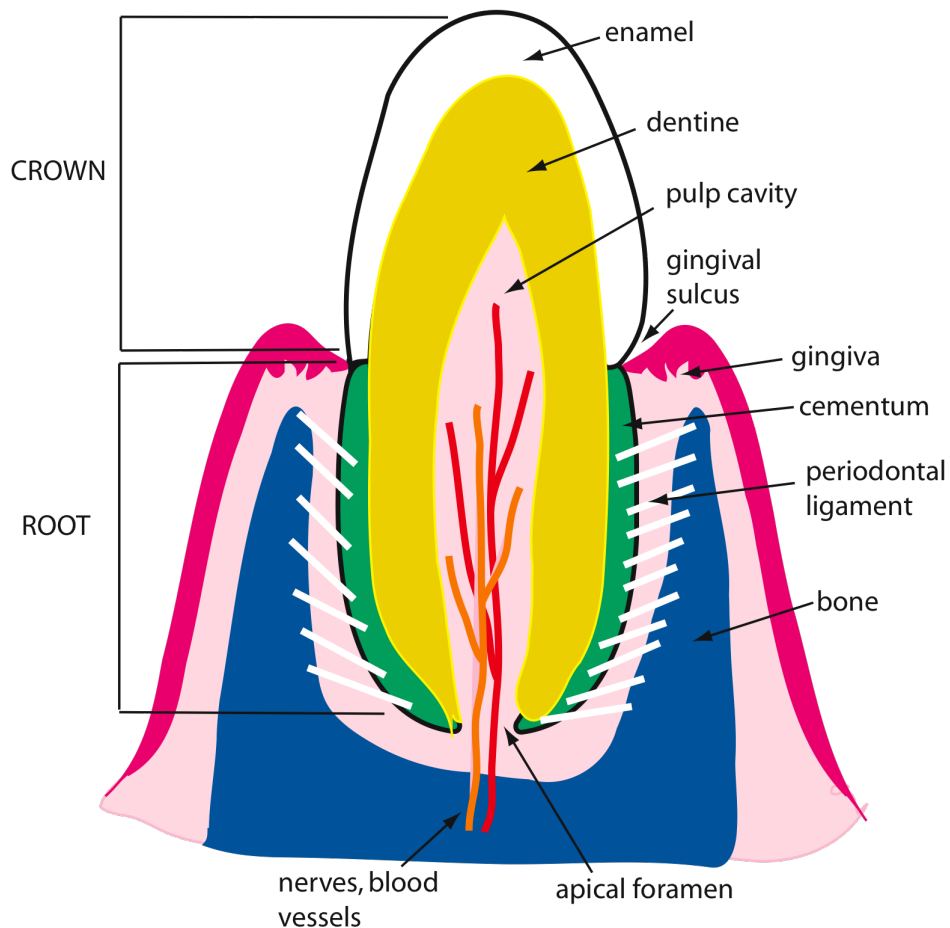
In brachydont teeth, comprises the entire tooth above the neck

In hypsodont teeth: the 'anatomical crown' (body): comprises the clinical crown – the part that has erupted and the reserve crown – the part still beneath the gum line

**Neck:** A slight constriction at the cemento-enamel junction, which is covered by free gingiva in normal healthy tooth. Present in brachydont teeth, absent in hypsodont.

Root: Located within and anchored to the alveolus. Has no enamel. Has a foramen at its apical end through which vessels and nerves enter to supply the tooth.

### Tooth Structure: brachydont tooth



### Enamel

- crown only
- synthesized by cells called ameloblasts, which are found on the surface and lost after eruption  
⇒ no repair
- hardest biological material, 96-98% mineral content – chiefly hydroxyapatite – a calcium phosphate complex that is the inorganic constituent of bones and teeth
- The crystal structure differs between enamel, dentine and cementum

### Dentine (Dentin)

- Produced by odontoblasts - forms the majority of the hard material of the tooth
- Types of dentine:
  - Primary – the outermost layer of dentine, is produced by the odontoblasts (see below) while they are located closest to the enamel layer during tooth formation.

- Secondary – Laid down slowly and results in narrowing of pulp cavity with age. In brachydont teeth is produced after root formation complete. In horse teeth prevents pulp exposure at occlusal surface arising from normal wear.
- Tertiary – Produced in response to injury or damage. May also be laid down in horse teeth to protect tip of pulp cavity from exposure.
- Sensitivity: odontoblasts sit at outer margin of pulp cavity and their processes extend into the dentine. Injury to dentine can result in transmission of pain via these processes to the pulp cavity. Dentine at occlusal surface in horse is not sensitive – possibly due to calcification of processes at this level, but significant trimming can result in pain
- mineralised extracellular matrix similar to bone - approximately 70% mineral content, 30% organic components (including collagen fibres and mucopolysaccharides)
- no cells embedded in dentine

### **Cementum (Cement)**

- produced by cementoblasts – some of which remain embedded within the cementum
- surrounds and protects dentine of root and anchors the periodontal ligament
- In hypsodont teeth may also contribute to bulk and strength of the crown
- not as readily degraded as bone (e.g. during orthodontic work)
- mineralised extracellular matrix similar to bone – approx 60-65% mineral content

### **Dental pulp**

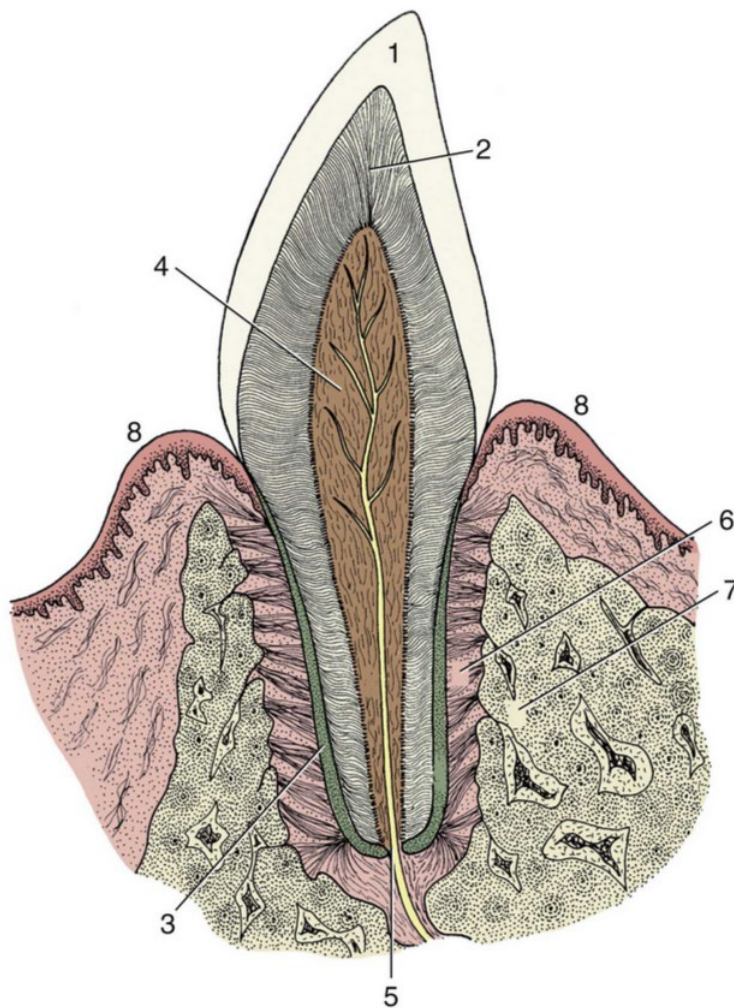
- connective tissue with abundant blood vessels
- nerves (some sensory, others regulate blood vessel diameter)
- vessels and nerves enter through apical foramen
- superior and inferior alveolar arteries, veins and nerves through jaws
- superior alveolar nerves from maxillary branch of trigeminal nerve, and inferior alveolar nerves from mandibular branch of trigeminal nerve (the trigeminal nerve is the cranial nerve that supplies somatic sensory innervation to most of the structures of the head)

### **Alveolus (socket)**

- The alveolar process is the part of the jaw that contains the sockets
- Alveolar bone proper is the layer of bone lining the socket – also called the lamina dura
- The periodontal ligament is embedded in the alveolar bone proper
- The socket follows the shape of root (may be branched)

### **Periodontal ligament**

- Ligament that suspends tooth in alveolus.
- Allows some movement of tooth in socket and has some shock absorbing function to accommodate compression during chewing
- Comprised of collagen fibre bundles called Sharpey's fibres that connect lamina dura to cementum



**FIG. 3.13** Schematic longitudinal section of a simple tooth. 1, Enamel; 2, dentin; 3, cement; 4, pulp; 5, apical foramen; 6, periodontal ligament; 7, socket (alveolus); 8, gum.

(Singh 2018)

### Gingiva (gum)

- Covers the alveolar bone and surrounds the teeth
- Comprises
  - free gingiva – forms collar around the crown and is separated from the tooth by a space called the gingival sulcus
  - attached gingiva - extends apically from the free gingiva to merge with the oral mucosa at the muco-gingival margin (junction between tough keratinised gingival mucosa and soft oral mucosa), is bound by collagen fibres to the underlying bone
- Depth of sulcus may be measured when assessing the health of the tooth
- Interdental papilla is gingival peak between adjacent teeth

### SETS OF DENTITION:

Most mammals have two sets of dentition: are 'diphyodont'

Temporary (deciduous)

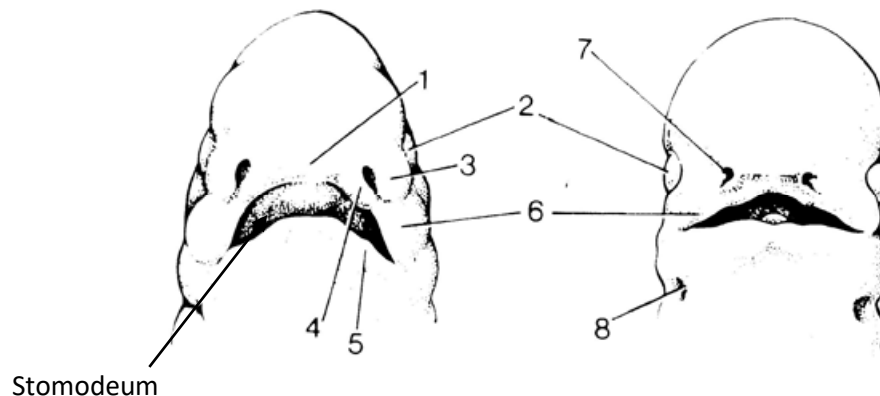
Permanent – This set is stronger and better adapted to the larger jaw and increased chewing requirements of the adult animal

*Some mammals have only one set of dentition: are monophyodont e.g. most species of rodents*

*Some mammals have more than 2 sets of teeth: are polyphyodont e.g. elephants – This type of dentition (multiple succession) is also seen in most other vertebrates.*

## TOOTH DEVELOPMENT:

**Stomodeum:** The primitive oral cavity in the early embryo. Is lined by ectoderm (epithelial layer), which overlies mesenchyme (the embryonic connective tissue layer)



**Development of the face** (Dyce et al, 1987, Fig. 3-51, p. 135)

1. The oral ectoderm thickens into two parallel ridges along the inner margins of the maxillary and mandibular processes: the outer ridge is the vestibular lamina that goes on to form the vestibule and the inner ridge forms the dental lamina
2. Bud stage: The dental lamina forms a series of thickenings called tooth buds. At the same time the mesenchymal cells beneath the buds begin to proliferate
3. Cap stage: The dental buds expand to form the cap shaped enamel organ that partly encloses the mesenchymal condensation now called the dental papilla

The deciduous teeth and permanent molars (there are no deciduous molars) will develop from these enamel organs - the other permanent teeth will form from separate enamel organs that develop from the buds that form on the lingual aspect of the dental lamina.

4. Bell stage: with further invagination of the dental papilla the enamel organ becomes more concave. The mesenchymal cells around the outside of the enamel organ condense to form the dental sac. Cell differentiation begins:

The ectodermal cells lining the concave aspect of the enamel organ become the internal enamel epithelium

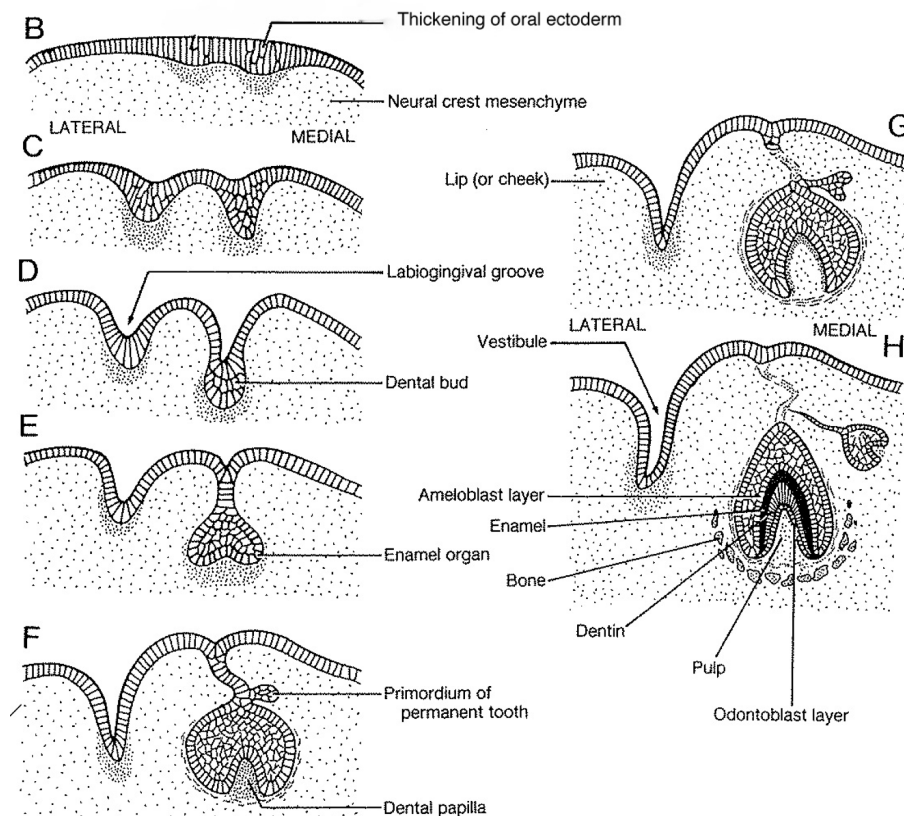
Cells lining the convex aspect become the external enamel epithelium

Between these two layers the cells become the star shaped cells of the stellate reticulum – functions to support enamel development

The uppermost layer of cells in the dental papilla become the odontoblasts which begin to produce dentine

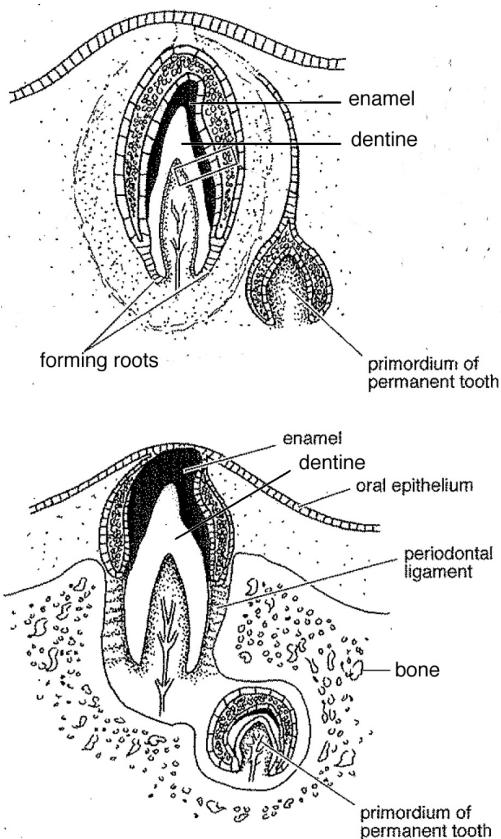
The internal enamel epithelial cells differentiate into ameloblasts that begin to produce enamel

The cells secrete enamel and dentine as an extracellular matrix of proteins and mucopolysaccharides that is then mineralised. The cells retreat in opposite directions away from their secretions as they are produced so that they don't become embedded in them.



(Noden & de Lahunta, Fig. 9, p. 177)

5. Root formation: After crown formation is complete the internal and external enamel epithelial cells at the neck region proliferate downwards to form the epithelial root sheath around the outside of the papilla. The underlying cells of the papilla form odontoblasts that produce dentine. The root sheath breaks down and the inner layer of dental sac cells in contact with the dentine differentiates into cementoblasts that then lay down cement.



With dentine production the pulp cavity is reduced to a narrow root canal.

6. The middle layer of the dental sac gives rise to fibroblasts that form the periodontal ligament and the outer layer of the dental sac gives rise to osteoblasts that form the alveolar bone.

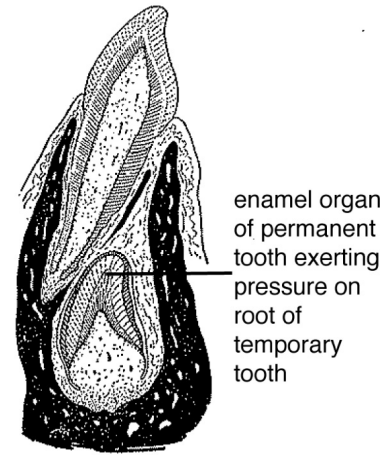
7. As teeth develop the root pushes against bone, moving the tooth towards oral cavity as it grows. The tooth follows remnants of ectoderm connecting the enamel organ to the lining of the oral cavity, so it grows towards the surface and the crown erupts through the oral epithelium. Enamel production ceases when the enamel organ is shed, so lost enamel cannot be replaced. Odontoblasts do continue to produce dentine through the life of the tooth, so if enamel is damaged, it can be replaced by dentine.

(McGeady et al., 2006, Fig. 19.10, p. 281)

8. As the temporary tooth erupts, the permanent tooth bud migrates into the socket of temporary and the permanent enamel organ starts to form.

The permanent enamel organ exerts pressure on the root of the temporary tooth, causing degradation of the root and loosening and shedding of temporary tooth.

The permanent tooth then erupts as its root forms.



(Arey, 1974, Fig. 181, p. 224)

### **Hypsodont teeth - differences:**

The enamel organ is longer and its surfaces may be folded.

Eruption is slow and commences before root formation.

In brachydont teeth the cementoblasts are confined to the region of the root, but in hypsodont teeth such as in the horse the dental sac cells over the crown also convert into cementoblasts, so that cement is deposited over the entire crown, including the future occlusal surface just prior to tooth eruption. The cement on the occlusal surface is soon worn away after eruption. How thick the layer of cement is depends on a variety of factors including location on the tooth, type of tooth as well as rate of growth/eruption.

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\*Available as an e book via the University Library in addition to hard copies.