Skull anatomy

The skull can be divided into the fused bones of the calvarium, the upper jaw, and the lower jaw. The cranial portion of the calvarium consists of the paired frontal bones, which articulate cranially with the nasal bones and maxillae, and caudally with the parietal bones. The nasal cavity contains an ethmoid bone and is bordered dorsally by the incisive, nasal and frontal bones, laterally by the incisive, maxilla, lacrimal, frontal and palatine bones, ventrally by the incisive, maxilla, and palatine bones and caudally by a single vomer bone which lies ventral to the ethmoid and dorsal to the hard palate. The lateral surface of the frontal bone shapes the dorsomedial and caudal aspect of the orbit. The medial and ventral part of the orbit is completed by articulation of the frontal bone with the lacrimal, ethmoid, maxilla, presphenoid and palatine bones. The zygomatic bone forms the lateral boundary of the orbit. The temporal process of the zygomatic bone articulates with the zygomatic process of the temporal bone, forming the zygomatic arch. Caudal to the frontal bones and forming the caudal portion of the cranial vault are the paired parietal bones, which articulate caudally with the occipital bone. Ventrally, the parietal bone joins the temporal and basisphenoid bones.

The upper jaw includes the incisive, maxillary, and palatine bones. The paired incisive bones form approximately one-sixth of the hard palate, and three incisors are rooted in each incisive bone. The incisive bones are bordered dorsally by the nasal bones, caudally by the vomer bone and laterally and caudally by the maxillae. The maxillae extend to the caudal border of the hard palate laterally, but are joined medially by the paired palatine bones to complete the hard palate. The roots of the canine tooth, three premolar teeth, and a single molar tooth are embedded within the alveolar process of each maxilla.

The lower jaw is composed of two mandibles, which are joined rostrally at the cartilaginous symphysis and form a synchondrosis. Each mandible consists of a body and a ramus. The three mandibular incisors, canine tooth, two premolars and single molar are anchored in the dorsal alveolar border of the body of the mandible. The ramus of the mandible contains three processes: the coronoid process, the condylar process, and the angular process. The coronoid process forms the most dorsal part of the mandibular ramus and the angular process is located at the caudoventral aspect of the ramus. The temporomandibular joint is formed by the condylar process of the mandible which articulates in the mandibular fossa of the squamous part of the temporal bone. The condylar process is bar-shaped in the cat, which is typical for carnivores. The mandibular fossa is bordered rostrally by the articular eminence and caudally by the retroarticular process. Both of these bony prominences are well developed in the cat, which creates a very deep mandibular fossa and normally prevents any movement of the mandibular condyle beyond these prominent bony processes.

The temporomandibular joint (TMJ) is a condylar synovial joint, which is separated into a dorsal and ventral compartment by a thin articular disk. The disc attaches around its entire periphery to the joint capsule which creates two separate articular spaces. Normally, when the mouth is opened, the medial aspect of the mandibular condyle is seated firmly in the mandibular fossa. The lateral aspect of the joint capsule is thickened in cats and tenses at maximum jaw opening which functions to limit lateral motion of the condyle. A caudal capsular reinforcement has also been demonstrated in the cat. Construction of the feline TMJ reduces rotary and lateral grinding movements.

Muscles of mastication

The muscles of mastication in the cat include the temporalis, masseter, medial and lateral pterygoids and rostral and caudal digastricus. The masseter, temporalis and pterygoid muscles close the jaw and the digastricus muscle opens the mouth.

Blood supply

The majority of blood supply to the feline oral cavity is provided by the maxillary artery. In the mandible the maxillary artery branches into the mandibular (inferior alveolar) artery which enters the mandibular canal through the mandibular foramen. The mandibular (inferior alveolar) artery courses rostrally within the mandibular canal and then exits laterally through the caudal, middle and rostral mental foramina. Blood supply to the maxilla is provided by the major palatine and infraorbital branches of the maxillary artery. The major palatine artery courses through the caudal nasal cavity, passes though the palate foramen and courses on the ventral surface of the hard palate midway between midline and the maxillary arcade. The infraorbital artery branches from the maxillary artery and enters the infraorbital canal.

Innervation

Motor innervation to the muscles of mastication is supplied by the mandibular branch of the trigeminal nerve (except the caudal belly of the digastricus which is innervated by the facial nerve). Sensory innervation is received from the maxillary and mandibular branches of the trigeminal nerve. The maxillary nerve courses through the pterygopalatine fossa to enter the infraorbital canal. The
palatine nerves branch from the maxillary nerve prior at the caudal limit of the infraorbital canal. The caudal maxillary alveolar nerve branches from the maxillary nerve prior to it entering the infraorbital canal. The maxillary nerve becomes the infraorbital nerve when it enters the infraorbital canal. The middle and rostral maxillary alveolar nerves branch from the infraorbital nerve within the canal. The infraorbital nerve exits the infraorbital canal and innervates the lateral and dorsal cutaneous structures of the rostral maxilla and upper lip.

The mandibular branch of the trigeminal nerve enters the mandibular foramen on the lingual side of the mandible, travels in the mandibular canal and exits laterally as the caudal, middle and rostral mental nerves. The middle mental foramen is located in the diastema between the mandibular canine tooth and mandibular third premolar tooth halfway between the dorsal and ventral cortex of the mandible.

**Salivary glands**
The major salivary glands of the cat are the parotid, zygomatic, mandibular, and sublingual. The parotid salivary duct exits at the papilla which is located in the alveolar mucosa just caudal to the maxillary fourth premolar. The zygomatic salivary duct orifice opens in the alveolar mucosa near the maxillary first molar. The mandibular and sublingual salivary duct orifice opens on a small sublingual papilla located lateral to the rostral end of the tongue frenulum. There are two sets of molar salivary glands in the cat. The lingual molar glands are located linguodistal to the mandibular first molars. The buccal molar salivary glands empty into the oral cavity through several small ducts.

**Tooth anatomy**

- **Crown** is the portion of the tooth that is covered by enamel which is visible above the gumline.
- **Root** is the portion of the tooth that is covered by cementum located within the alveolus beneath the gingival tissue.
- **Apex** is the area of the root which is the deepest in the alveolar bone.
- **Enamel** is the hardest substance in the body which is the outer layer of the tooth crown. Enamel is formed by ameloblasts within the tooth bud prior to eruption. If enamel is damaged it is incapable of repair.
- **Cementum** is the outer layer of the tooth root which provides a surface for attachment of the periodontal ligament to the tooth.
- **Cementoenamel junction** is the neck of the tooth where the crown meets the root.
- **Periodontal ligament** is the fibrous connective tissue that surrounds the root of the tooth, separating it from and attaching it to the alveolar bone and serving to hold the tooth in place. The periodontal ligament also acts as a shock absorber.
- **Pulp cavity** is the central cavity of the tooth consisting of the pulp chamber and root canal containing blood vessels, nerves, lymph vessels and other cells (odontoblasts). The pulp chamber of the cat lies very close to the enamel surface, so any fracture in a cat’s tooth requires endodontic or exodontic treatment.
- **Dentin** is the living tissue that comprises the bulk of the tooth surrounding the pulp cavity and covered by cementum and enamel. Dentin is 70% inorganic and 30% organic. Dentin is porous containing dentinal tubules which extend from the dentin-cementum or dentin-enamel surfaces of the tooth to the pulp and are responsible for transmission of painful stimuli if the dentin is exposed.
  - **Primary dentin** forms before tooth eruption.
  - **Secondary dentin** is produced by odontoblasts within the pulp after tooth eruption causing the dentin walls to thicken.
  - **Tertiary or reparative dentin** is morphologically irregular dentin that forms in response to an irritant.
- **Alveolar bone** is the thin layer of the mandibular and maxilla that comprises the ‘tooth socket’ and contains teeth.
- *Lamina dura* is a sheet of compact alveolar bone that lies adjacent to the periodontal ligament space. Radiographically it appears as a ‘white line’.

**Gingiva anatomy**
- *Marginal gingiva* is the free gingival tissue that forms the gingival margin surrounding the crown of the tooth.
- *Attached gingiva* is located apical to the marginal gingiva and is tightly adhered to underlying alveolar bone. The attached gingival tissue is coronal to the mucogingival line. The attached gingiva is widest at the maxillary canine teeth in the cat.
- *Mucogingival line* is the junction between the alveolar mucosal tissue and the attached gingival tissue. The mucogingival line remains stationary although the gingival tissues around it may change in size or height (gingival enlargement or gingival recession).
- *Gingival sulcus* is the crevice surrounding the tooth located between the external tooth surface and the marginal gingival tissue. Normal sulcus depth in a cat is less than 1 mm.
- *Junctional epithelium* attaches to the enamel of the most apical portion of the crown. The floor of the gingival sulcus is on the most coronal portion of the junctional epithelial cells.
- *Interdental papilla* is the gingival peak between adjacent teeth.
- *Periodontium* consists of the tissues that surround and support the teeth, including the gingiva, periodontal ligament, cementum and alveolus.

**Types of teeth**
- *Incisors (I)* are small single rooted teeth located in the front of the mouth. They are utilized for cutting, picking up objects and grooming. Cats have six maxillary and six mandibular incisors.
- *Canines (C)* are large single rooted teeth, commonly called ‘fang’ teeth. They are utilized for holding prey, slashing and tearing. The lower canine teeth assist in holding the tongue in place. Cats have a right and left maxillary canine tooth and a right and left mandibular canine tooth.
- *Premolars (PM)* are located on the side of the mouth behind the canines. They are utilized for holding food and for breaking food into smaller pieces. Cats do not have a maxillary first premolar or mandibular first and second premolars. In each maxillary quadrant there is a single rooted second premolar, a two rooted third premolar and a three rooted fourth premolar. In each mandibular quadrant there is a two rooted third and fourth premolar.
- *Molars (M)* are in the back of the mouth and are used for grinding food. Cats have one maxillary first molar and one mandibular first molar.

**Tooth eruption times**

<table>
<thead>
<tr>
<th></th>
<th>Deciduous teeth (weeks)</th>
<th>Permanent teeth (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisor</td>
<td>2-3</td>
<td>3-4</td>
</tr>
<tr>
<td>Canine</td>
<td>3-4</td>
<td>4-5</td>
</tr>
<tr>
<td>Premolars</td>
<td>3-6</td>
<td>4-6</td>
</tr>
<tr>
<td>Molars</td>
<td></td>
<td>4-6</td>
</tr>
</tbody>
</table>

Remember there are no deciduous precursors for the molar teeth in a cat. The maxillary teeth usually erupt prior to their mandibular counterparts. The incisors generally erupt first, followed by the canine teeth then premolars and molars.

**Feline dental formulas**

- **Deciduous**
  - $3 \ 1 \ 3$
  - $3 \ 1 \ 2$
- **Permanent**
  - $3 \ 1 \ 3 \ 1$
  - $3 \ 1 \ 2 \ 1$

**Feline dental formulas**

- total teeth = 26
- total teeth = 30

**Permanent tooth development**

At the time of permanent tooth eruption, the apex is incomplete and there is a very wide pulp cavity with primary dentin present. As the tooth continues to develop the apex closes and secondary dentin is produces by odontoblasts within the pulp cavity. As the cat continues to mature the pulp cavity continues to get smaller as the secondary dentin layer increases in thickness.

©veterinarydentistryce.com
Directional Nomenclature
- Mesial – toward the midline of the dental arch
- Distal – farthest away from the midline of the dental arch
- Vestibular – next to or toward the lips; buccal and labial are also acceptable
- Labial – next to or toward the lips
- Buccal – toward the cheek
- Lingual – next to or toward the tongue
- Palatal – toward the palate
- Apical – toward the apex (root)
- Coronal – toward the crown
- Rostral – anatomical term applicable to the head referring to a structure closer to the most forward structure of the head
- Caudal – anatomical term applicable to the head referring to a structure closer to the tail

Occlusion

Class 0 normal occlusion
- Scissors bite with the maxillary incisors overlapping, but touching the mandibular incisors in a scissor-type fashion. The maxillary incisors should be slightly rostral to the mandibular incisors. A level bite is also acceptable in cats.
- The mandibular canine teeth interdigitate in the interproximal space equidistant between the maxillary lateral incisor and canine tooth.
- The maxillary premolars interdigitate with the mandibular premolars in a “pinking shears” fashion.
- Cusp of the maxillary fourth premolar should be buccal to the mandibular first molar.

Class 1 malocclusion
- Neutrocclusion, normal jaw lengths
- Individual teeth are malaligned
- Lingually displaced mandibular canine tooth, mesioversion maxillary canine tooth, rostral crossbite, caudal crossbite

Class 2 malocclusion (mandibular distocclusion)
- Mandible is shorter than the maxilla (mandibular brachygnathism)’overbite’ ‘parrot mouth’

Class 3 malocclusion (mandibular mesiocclusion)
- Maxilla is shorter than the mandible (mandibular prognathism)’underbite’

Class 4 asymmetrical malocclusion
- Can occur in a rostro-caudal, side-to-side, or dorso-ventral direction

Triadan tooth identification system
The modified Triadan system (3 numbers for each tooth) is considered to be the tooth numbering system of choice in veterinary dentistry.

The first number indicates the quadrant that the tooth is in and whether the tooth is a permanent or deciduous tooth
- Permanent tooth first numbers
  - 1 – Right maxilla
  - 2 – Left maxilla
  - 3 – Left mandible
  - 4 – Right mandible
- Deciduous tooth first numbers
  - 5 – Right maxilla
  - 6 – Left maxilla
  - 7 – Left mandible
  - 8 – Right mandible

The second and third digits indicate the tooth position within the quadrant with the sequence starting at the midline. So, 01 is the first tooth on the midline (the first incisor) and the numbering continues sequentially away from the midline.
- Rules to remember Rule of 4, 8 and 9
  - 04 is always the canine tooth
  - 08 is always the fourth premolar
  - 09 is always the first molar

Remember there is not a maxillary right or left first premolar in the cat (105, 205) and there is not a mandibular right or left first or second premolar in the cat (405, 406, 305, 306).

Knowledge of normal anatomy of the cat skull and oral cavity allows the veterinarian to properly evaluate and treat oral and maxillofacial diseases.