

DIGESTIVE SYSTEM

LECTURE 3: COMPARATIVE DENTITION

ARRANGEMENT OF TEETH

Mammalian teeth differ in their shape and function in different parts of the mouth, so they can better perform particular tasks. (This characteristic is called 'heterodonty').

In rostral to caudal order the teeth are the incisors, canines, premolars and molars. The upper incisors are embedded in the incisive bone and the upper canines are the most rostral teeth in the maxilla. Teeth of the lower arcade are embedded in the mandible.

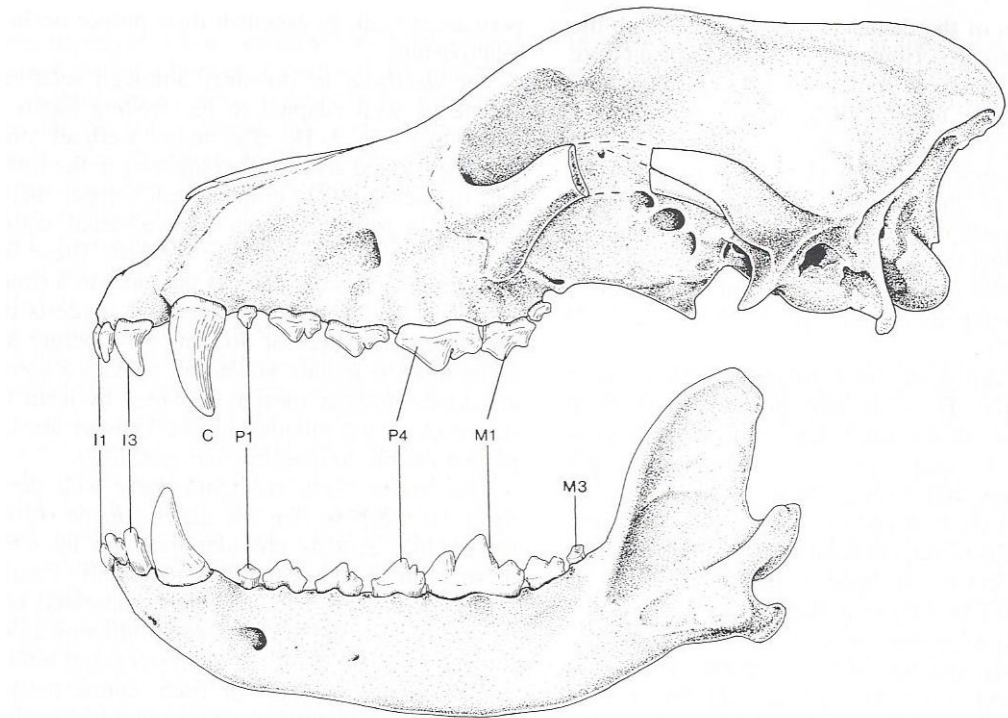


FIGURE 3–18. Lateral view of the permanent dentition of the dog.

Dyce, 1996, p112

DENTAL FORMULA

– describes the number of each type of tooth on one side of the upper and lower dental arcades and multiplies the sum of these numbers by two for the total number of teeth.

Upper dentition (one side): $\left(\begin{array}{cccc} I & C & P & M \end{array} \right)$ x2
Lower dentition (one side): $\left(\begin{array}{cccc} I & C & P & M \end{array} \right)$ x2

Carnivores

Dog:

$$\left(\begin{array}{cccc} 3 & 1 & 4 & 2 \\ \hline 3 & 1 & 4 & 3 \end{array} \right) \times 2 = 42$$

All teeth are brachydont. Dentition adapted for attacking prey, tearing food and crushing bones. Food does not remain long in mouth before being swallowed.

(NB. The domestic dog eats a meat-based diet but has evolved with domestication to be able to digest certain plant-based nutrients so may be termed a facultative carnivore or an omnivore - classification is the subject of ongoing debate. Dentition is carnivore.)

- Incisors
 - tricuspid (loss of definition with age)
 - sharp for holding and tearing
 - single root
- Canines
 - weapons for attack and defence
 - root much longer than crown
- Molars and premolars
 - cutting food, crushing bones
 - only occlude caudally \Rightarrow cannot grind
 - P1 (upper and lower) and lower M3 - 1 root
 - upper P2 and P3 and rest of lower cheek teeth - 2 roots
 - rest of upper teeth (i.e. P4, M1, M2) - 3 roots \Rightarrow need to divide crown before extraction
 - upper P4 and lower M1 are known as the 'carnassial teeth'
 - rostrally sharp for cutting
 - caudally flat, blunt for crushing
 - upper carnassial often infected due to crown damage

Cat: $\left(\begin{array}{cccc} 3 & 1 & 3 & 1 \\ \hline 3 & 1 & 2 & 1 \end{array} \right) \times 2 = 30$

The cat is an obligate carnivore – i.e. must derive essential nutrients from meat. Structure and function of teeth similar to those of the dog, except there are no blunt crushing surfaces. Lack upper and lower premolar 1 and lower premolar 2. Only one upper and one lower molar.

Omnivores

Pig: $\left(\begin{array}{cccc} 3 & 1 & 4 & 3 \\ \hline 3 & 1 & 4 & 3 \end{array} \right) \times 2 = 44$

- Incisors
 - 'Needle teeth' – piglets are born with 8 fully erupted deciduous teeth – these are the 4 third incisors and the 4 canines. Some farmers clip these to reduce injuries – there are welfare concerns with this procedure
 - lower incisors project forward for digging, are brachydont teeth

- Canines = 'tusks'
 - Hypsodont with much longer growth period (much later root formation) in males
 - Used for fighting – inter male competition, defence - tearing/slashing (directed laterally)
 - Larger in males - in breeding boars require regular trimming (embryotomy wire)
- Cheek teeth
 - for crushing and grinding, have rounded cusps
 - are brachydont teeth

Herbivores

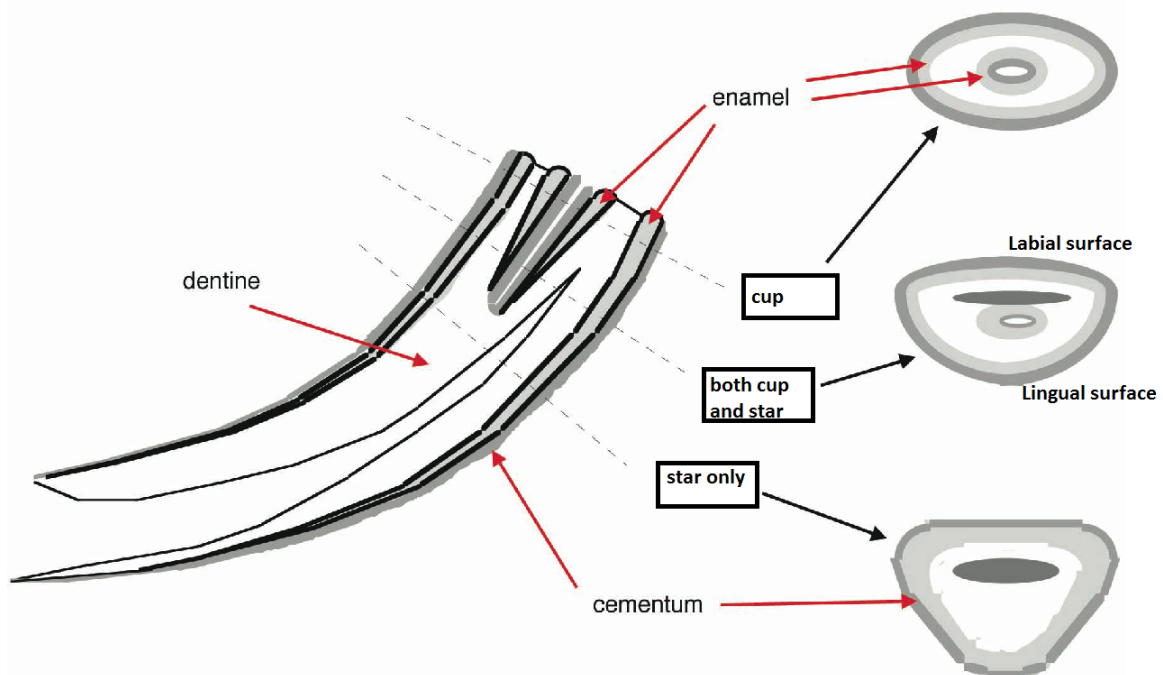
Herbivores have hypsodont teeth that are adapted to compensate for an abrasive diet of food materials that require extensive crushing and grinding – prolonged eruption to compensate for attrition (wear) of teeth.

Horse: $\left[\begin{array}{ccc} 3 & 1(0) & 3(4) & 3 \\ 3 & 1(0) & 3(4) & 3 \end{array} \right] \times 2 = 36-44$

Hypsodont teeth in the horse continue to grow (laying down of new tooth in its apical part) until the age of 17, but eruption (protrusion through the gum from the alveolus) continues for life. Teeth growth and eruption must compensate for occlusal wear of 2-3mm/year.

- Incisors
 - Hypsodont teeth
 - From medial to lateral: I1: 'central,' I2: 'middle' and I3: 'corner' incisors
 - enamel not continuous over occlusal (grinding) surface \Rightarrow exposure of dentine
 - infundibulum = 'cup' or 'mark' - disappears with age
 - pulp cavity - appears with age (protected by 2° and 3° dentine) = 'star'

Incisor occlusal surface with increasing age:



- Canines
 - Most (but not all) males (stallions and geldings) have four that erupt from 4-6 years of age. Most mares – canines are absent or rudimentary

- Lie in the diastema between the incisors and premolars (diastema= space between adjacent teeth –a long diastema between the incisors and premolars is a normal feature in herbivores)
- Usually classified as brachydont. They do have features of hypsodont teeth such as long reserve crown that makes extraction difficult, but they do not continue to grow
- Function unclear – may be related to fighting
- Cheek teeth (Premolars and molars)
 - First premolar – ‘wolf tooth’. A vestigial brachydont tooth that may be present in some animals (13-32% reported, possibly F>M), upper more common than lower. Usually erupts at 6-12 months of age and has no deciduous precursor. May require removal.
 - Remaining premolars and molars considered together as cheek teeth due to morphological similarity - these are hypsodont teeth that together form a continuous grinding surface – ‘table’
 - Enamel is not continuous over occlusal surface, some dentine is exposed and cementum is present around the enamel crown
 - have a convoluted enamel pattern on table \Rightarrow abrasive enamel ridges due to different rates of wear of enamel compared with dentine and cementum
 - Maxillary teeth are wider apart than mandibular – may result in formation of sharp points on buccal aspect of maxillary and lingual aspect of mandibular cheek teeth that require filing down (‘floating’). Maxillary teeth are also wider than mandibular. This arrangement results in an occlusal or grinding surface angled between 15 and 35°.

Ox: $\left(\begin{array}{cccc} 0 & 0 & 3 & 3 \\ 3 & 1 & 3 & 3 \end{array} \right) \times 2 = 32$

- Incisors and canines
 - no upper incisors or canines - replaced by hard fibrous dental pad
 - grip food between incisors and dental pad and tear by head movement
 - no continuous eruption – are brachydont
 - lower canines are incisor in form so dental formula may classify as incisor
 - from medial to lateral: I1: ‘central’, I2: ‘middle’ I3: ‘lateral’ and C: ‘corner’ incisors
- Cheek teeth – premolars and molars
 - increase in size from rostral to caudal
 - similar to horse – are hypsodont
 - arrangement of enamel ridges slightly different from horse, enamel stands out more

Sheep: $\left(\begin{array}{cccc} 0 & 0 & 3 & 3 \\ 3 & 1 & 3 & 3 \end{array} \right) \times 2 = 32$

Dentition is similar to that of ox – naming of incisors and classification of the lower canines is the same

Alpaca/Llama: $\left(\begin{array}{cccc} 1 & 1 & 1(2) & 3 \\ 3 & 1 & 1(2) & 3 \end{array} \right) \times 2 = 28-32$

- Incisors and canines
 - Have a dental pad instead of some of the upper incisors, but retain the upper third incisor that is canine in appearance
 - Third upper incisor and upper and lower canines comprise the 'fighting teeth'
 - Fighting teeth present in males and females. Larger in males and can cause serious injury as a result of fighting so are often trimmed (embryotomy wire or Dremel tool). Trimming is necessary in younger males up to about 7 years of age when tooth growth ceases. Extraction not used due to the difficulty posed by long roots and risk of injury to jaw or adjacent teeth*.
 - Lower incisors in alpacas (not llamas) are hypsodont and may require trimming if overgrown - usually as a result of malocclusion between incisors and dental pad
- Cheek teeth
 - Brachydont, but do have folded enamel ridges so may require 'floating' (filing down) if malocclusion – look for signs of condition loss as ability to grind food is affected

(*NB Camels, which are camelids, but not lamoids, have a slightly different dentition resulting in 5 fighting teeth (3 upper and 2 lower) – these may be extracted in camels when young.)

Rabbits:

$$\left(\begin{array}{cccc} 2 & 0 & 3 & 3 \\ 1 & 0 & 2 & 3 \end{array} \right) \times 2 = 28$$

- Have aradicular hypsodont (hypsodont) incisors and cheek teeth – these grow and erupt continuously for the life of the animal and do not form roots – adapted for highly abrasive diet and prolonged chewing
- Diphyodont, with all temporary teeth replaced by day 35 after birth
- Canines are absent – there is a long diastema between incisors and cheek teeth
- Incisors
 - enamel only rostrally \Rightarrow sharp, chisel-shaped incisors
 - function to tear off vegetation, gnaw harder materials such as roots and bark
 - 4 upper incisors – the smaller 'peg teeth' lie immediately caudal to the first incisors in the upper arcade. Two lower incisors
 - Pulp cavity extends only approx 3mm distal to gingival margin –so incisors 'can' be clipped in conscious animal if overgrown– but possible underlying problem further caudal in mouth must be ruled out/treated. Must also use appropriate technique.
 - rapid growth rate – up to 8-10mm per month (incisors), 3-4mm/month (cheek teeth)

Rodents:

- Have two upper and two lower incisors, as in rabbits these are hypselodont
- Herbivorous rodents eg. guinea pig – cheek teeth also hypselodont
- Omnivorous rodents eg. old world rat, mouse – cheek teeth are brachydont
- Most rodents (not guinea pigs) have a yellow-orange pigment in the superficial enamel layer on the incisors. Most species are also monophyodont (single set of teeth)

AGEING OF ANIMALS USING DENTITION

NB Eruption times provided in the tables in this section are for information only – are not examinable in this subject.

General: factors affecting the accuracy of ageing

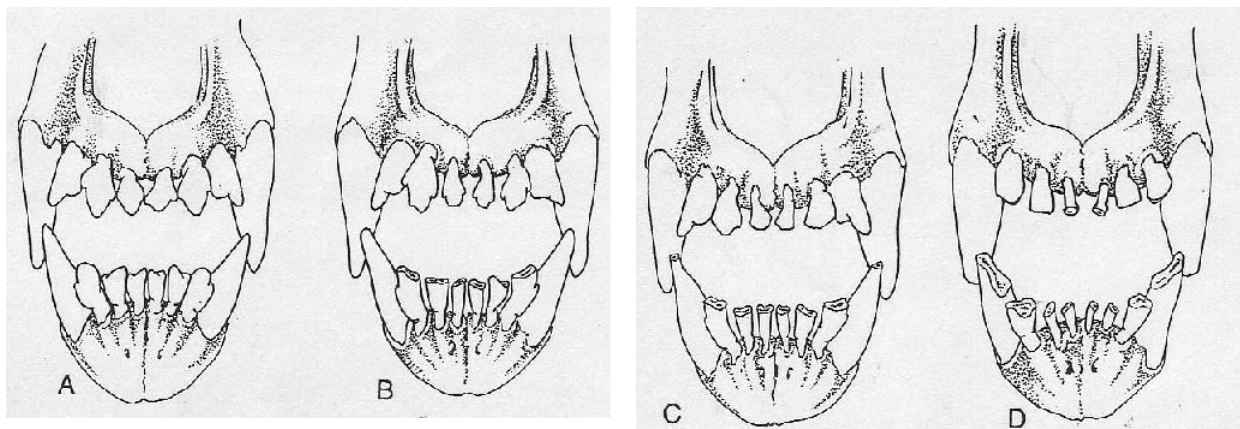
The features that are used to make an estimation of age may be affected by the breed of an animal, its individual genetics, its age, whether there is malocclusion of the teeth, whether there has been filing/trimming of teeth and dietary, environmental and behavioural factors.

Dog/cat

- No teeth erupted at birth

Eruption times:

	Dog		Cat	
	Deciduous	Permanent	Deciduous	Permanent
Incisor 1	4-5 wk	4 mo	2-3 wk	4-7 mo
Incisor 2	4-5 wk	4.5 mo	3-4 wk	4-7 mo
Incisor 3	3-4 wk	5 mo	3-4 wk	4-7 mo
Canine	3-4 wk	5-6 mo	3-4 wk	4-7 mo
Premolar 1		4-5 mo		
Premolar 2	4-6 wk	5-6 mo	5-6wk -upper only	4-7mo-upper only
Premolar 3	4-6 wk	5-6 mo	5-6 wk	4-7 mo
Premolar 4	4-6 wk	5-6 mo	5-6 wk	4-7 mo
Molar 1		4-5 mo		4-7 mo
Molar 2		5-6 mo		
Molar 3		6-7 mo		



Changes in the incisors with increasing age (Dyce et al, 1987, Fig. 11-9, p. 378).

A. Six months. B. About 2 1/2 years. C. About 6 years. D. About 10 years

Pig

- Charts with eruption times are available, but a lot of variability between breeds

Horse

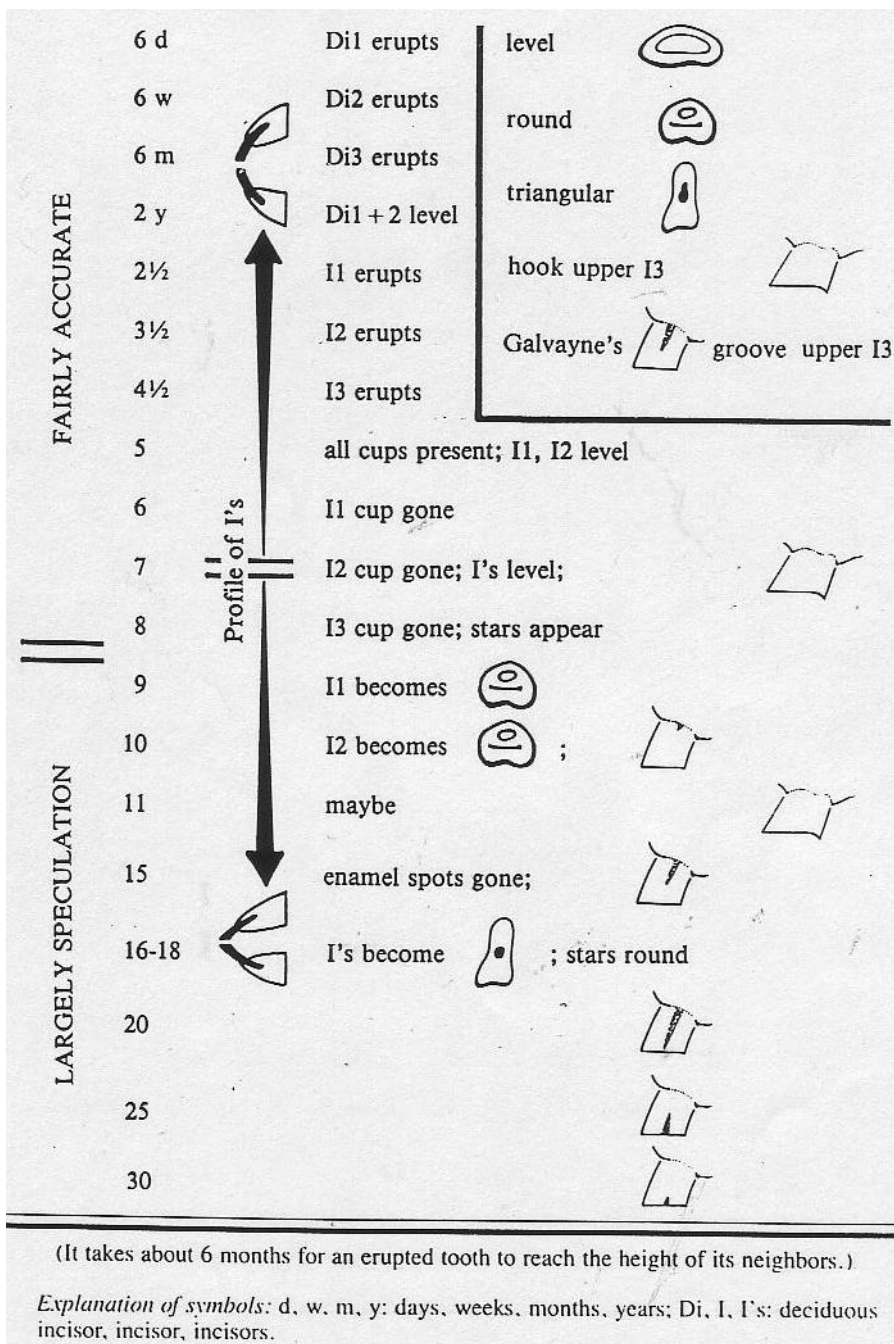
- Eruption dates of incisors and changes in occlusal morphology of permanent incisors are the main criteria used to age horses.
- Eruption of incisors
 - Deciduous incisors are smaller than permanents and the crown is white. Permanent incisors are larger and more rectangular and the crown appears yellowish due to the cementum covering.
 - Time from eruption of permanent incisors to tooth 'in wear' 6 months

Eruption times:

	Deciduous	Permanent
Incisor 1	0-1 wk	2.5 yr
Incisor 2	4-6 wk	3.5 yr
Incisor 3	6-9 mo	4.5 yr
Canine	<i>Present but does not erupt</i>	4.5-5 yr (males)
Premolar 1		5-6 mo (wolf tooth)
Premolar 2	0-2 wk	2.5 yr
Premolar 3	0-2 wk	3 yr
Premolar 4	0-2 wk	4 yr
Molar 1		9-12 mo
Molar 2		2 yr
Molar 3		4 yr

- Changes to the incisor occlusal surface: (occur first in centrals, then middles then corners)
 - Dental star:
 - between the labial edge of the incisor and the infundibulum, appears when tooth worn down to tip of pulp cavity
 - Consists of dentine that occludes the pulp cavity as the tooth is worn down
 - Changes shape and position with age
 - Next most accurate feature after eruption times
 - Dental cup/mark:
 - the infundibulum – when empty is the 'cup', when worn down to cement filled bottom of infundibulum is called the 'mark'. Eventually disappears – times not reliable due to variation in the depth of the infundibulum
 - Changes in shape of occlusal surface:
 - The cross-section changes shape from oval (mesiodistal direction), through trapezoid then triangular and finally oval in a labiolingual direction
 - A useful feature but not accurate due to gradual change
- Shape of upper corner incisor:
 - Between 5 and 9 years: crown wider than tall
 - 9-10 years: upper corner appears square in most horses
 - Over 10: becomes taller than it is wide as age progresses
- Curvature of dental arch of lower incisors:
 - Goes from semicircle in young horses to become straighter in older horses
- Angle of incisors
 - The caudal angle between the upper and lower incisors goes from 180° to become progressively smaller in older horses

- The lower incisors become oblique a little before the upper incisors. This may result in:
- Hook on upper corner incisor:
 - Occurs when the caudal edge of the upper incisor exceeds that of the lower incisor for a period of time
 - Now considered irrelevant for age estimation as not associated with any particular age
- Galvayne's Groove:
 - Longitudinal groove in labial surface of upper corner incisor
 - Said to appear at 10, be halfway down at 15 and full length at 20 – now proven not reliable
 - Now also shown to be absent in more than 50% of horses –so now considered to have little value for age estimation



A rough guide for the ageing of the horse by its teeth (Dyce et al, 1987, Fig. 18-1, p. 476):

Ox

- Appearance of the incisors and eruption times of the permanent incisors are used
- Some incisors may already be erupted at birth, eruption of all deciduous incisors complete by week 4
- Deciduous incisors are smaller and narrower, with a more triangular shape (narrower base) than permanent incisors
- Deciduous incisors are initially short and broad, but become longer and narrower as the animal approaches 15-18 months of age
- Stages are 'milk tooth' (no permanents), '2 tooth' (centrals erupted), '4 tooth' (middles) '6 tooth' (laterals) and '8 tooth' or 'full mouth' (corners)
- By 5 years all incisors are in wear and then the occlusal table is observed for 'levelling' (the ridges on the lingual surface disappear and the surface becomes smooth and convex): 6 years (centrals) 7 years (middles) 8 years (laterals) and 9 years old (all incisors levelled)
- **Eruption times:**

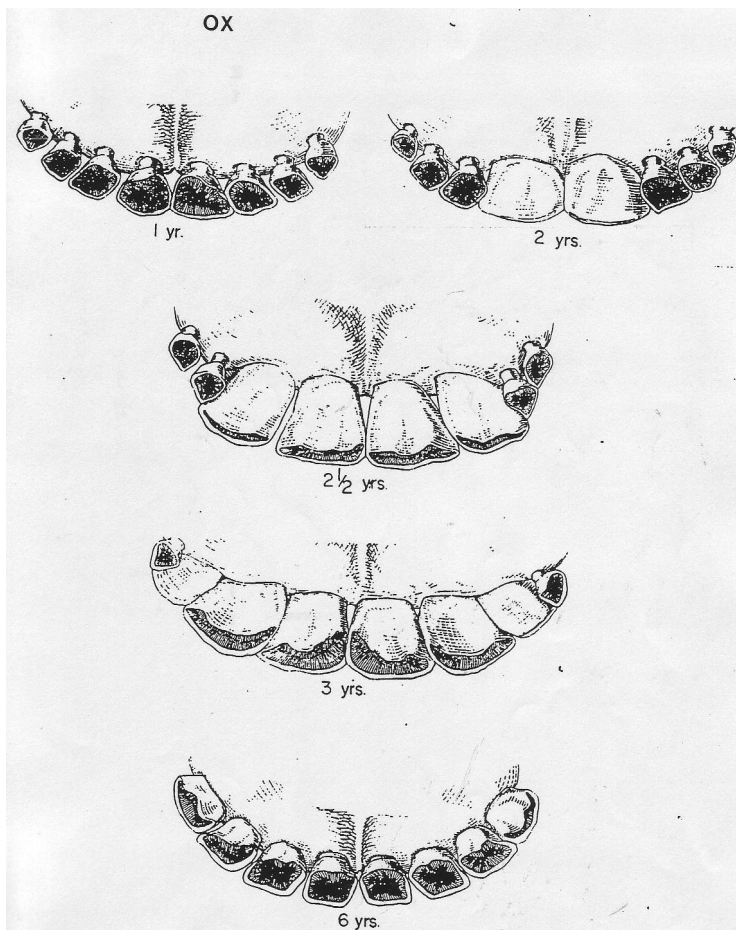
	Deciduous	Permanent
Incisor 1	0-2 wk	1.5 -2 yr (two tooth)
Incisor 2	0-2 wk	2-2.5 yr (four tooth)
Incisor 3	0-2 wk	3 yr (six tooth)
Canine/Incisor 4	0-2 wk	3.5-4yr (full mouth)
Premolar 1		
Premolar 2	0-3 wk	2-2.5 yr
Premolar 3	0-3 wk	2-2.5 yr
Premolar 4	0-3 wk	2.5-3 yr
Molar 1		5-6 mo
Molar 2		1-1.5 yr
Molar 3		2-2.5 yr

Sheep

- Usually no teeth at birth
- Australian 'lamb' definition was changed in 2019 – now = an ovine animal that does not have any permanent incisors in wear – permanent centrals can be erupted but not yet in wear
- Appearance of teeth similar to that of ox
- **Eruption times:**

	Deciduous	Permanent
Incisor 1	0-1 wk	1 -1.5 yr (two tooth)
Incisor 2	1-2 wk	1.5-2 yr(four tooth)
Incisor 3	2-3 wk	2-3 yr(six tooth)
Canine/Incisor 4	3-4 wk	2.5-4yr (full mouth)
Premolar 1		
Premolar 2	0-4 wk	1.5-2 yr
Premolar 3	0-4 wk	1.5-2 yr
Premolar 4	0-4 wk	1.5-2 yr
Molar 1		3-6 mo
Molar 2		9-12 mo
Molar 3		1.5-2 yr

- After the eight tooth/full mouth stage the next stage is 'broken mouth' – rate of dental deterioration depends on dietary and environmental factors so ageing difficult
- After all teeth have fallen out the sheep is known as 'gummy mouth'



A rough guide for the ageing of the ox by its teeth (de Lahunta and Habel, 1986, Fig. 1-6, p. 11; Fig. 1-7, p. 12):

References

De Lahunta A, Habel RE: Applied Veterinary Anatomy. Philadelphia, Saunders, 1986

Easley J, Dixon, PM, Schumacher, J (eds): Equine Dentistry 3rd ed, Edinburgh, Saunders, 2011

Hermanson JW, de Lahunta A and Evans HE, Miller and Evans Anatomy of the Dog 5th Ed. 2020 - also previous editions of Millers Anatomy of the Dog

König HE and Leibich H-G: Veterinary Anatomy of Domestic Animals: Textbook and Colour Atlas, 7th ed. Georg Thieme Verlag, 2020 – also previous editions

NSW Dept of Primary Industries: AGFACTS -how to tell the age of sheep

http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/179797/aging-sheep.pdf accessed Dec 2013

Popowicz TE and Herring SW: *Teeth, jaws and muscles in mammalian mastication* in Bels, V (ed.) Feeding in Domestic vertebrates: From Structure to Function, 2006

Singh B, Dyce Sack and Wensing's Textbook of Veterinary Anatomy, Elsevier 2018 – also previous editions of Dyce Sack and Wensing Textbook of Veterinary Anatomy

Dept of Agriculture: Using Dentition to Age Cattle.

http://www.fsis.usda.gov/OFO/TSC/bse_information.htm accessed Dec 2013