Veterinary Bioscience: Digestive System

PRACTICAL 1
SKELETON OF THE HEAD AND NECK

TEACHING STAFF

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LOCATION

- WEBS (Building 125) Dry Lab (Room 127/128) and OBLA (Room B106)

INTENDED LEARNING OUTCOMES

At the end of this class, you should be able to:

- Demonstrate competence in following anatomical descriptions.
- Identify the normal appearance of bony features of the upper neck associated with swallowing and prehension including the skull, atlas, axis, and hyoid apparatus.
- Apply skills in observation and deduction to identify and name the bones from different species.
- Apply appropriate descriptive names for major bone features such as crests, tuberosities, processes, fossae, and foramina.

MATERIALS

Available in the Dry Lab:

- Bone boxes of the head and neck of the dog
- Mounted skeleton of the dog

Available through the LMS:

- Colour-coded skull images from *Miller and Evans' Anatomy of the Dog*
- Radiographs from *Atlas of Normal Radiographic Anatomy and Anatomical Variants*
- Movie of a rotating skull, which shows all skull bones and their relative positions
- Two computer interactive modules:
    - Navigating the canine head and neck skeleton
    - Radiology of the canine head and neck

Available in the OBLA:

- Skulls from domestic species - some sectioned, some painted in coded colours
- Mandibles
- Dog articulated hyoids
- Mounted skeletons
    - Pony skeleton includes the hyoid apparatus

PROCEDURE

All the answers to the questions in this practical class may be found in the lecture notes, these notes, the computer slides, the references, or may be deduced from careful observation. Many of the questions will not have a single "correct" answer. They are to encourage you to practice answering questions using logic, observation, deduction, and your own knowledge as this is a critical skill in veterinary practice.

This practical class is divided into two sections. This does not reflect any required sequence and the sections can be worked through in any order that is convenient. Many of the subsections can be completed before the main class, however, the dog bone boxes will only be available during class.

Section 1. The skeleton of the head and neck of the dog

- **Skull and mandible**
- **Larynx and hyoid apparatus**
- **Cervical vertebrae**

Section 2. Comparative aspects of the skull

Practical material conceived by Dr Helen Davies and revised by Dr Janine Hofmann.

FURTHER READING

Hermanson, de Lahunta & Evans. *Miller and Evans' Anatomy of the Dog* (any edition).

Evans & de Lahunta. *Guide to the Dissection of the Dog* (any edition).

Singh. *Dyce, Sack & Wensing's Textbook of Veterinary Anatomy* (any edition).

König & Liebich. *Veterinary Anatomy of Domestic Mammals* (any edition).

Thrall. *Atlas of Normal Radiographic Anatomy and Anatomical Variants*, 2nd edition.

vet-Anatomy, the interactive atlas of veterinary anatomy by IMAIOS.

Available through the University Library: http://cat.lib.unimelb.edu.au/record=e1002019~S30

This is an extremely rich anatomical resource. It is an interactive platform where you can explore anatomy in 3 dimensions. You can rotate specimens, label specific structures, and focus on identifying features on anatomic and diagnostic images. There is also a quiz mode with labels removed to test your understanding.

We recommend this program to support your learning in anatomy and it is also recommended by the diagnostic imaging team for your studies in future years.

1. THE SKELETON OF THE HEAD AND NECK OF THE DOG

The skeleton of the head and neck includes the **skull, mandibles, hyoid apparatus, larynx** and **seven cervical vertebrae**.

These structures are the framework that protect and support the soft tissues of the head and neck and give the head its basic shape. They also provide surfaces for muscle attachment and landmarks that are used to determine the position of other structures.

SKULL AND MANDIBLES

The **skull** and **mandibles** (the jaw bones) form the major contours of the head. This means that you can tell the approximate shape of the dog's head in life from its skull and mandibles. Fit the skull and mandibles together in the correct position, using the reference material to help you.

The junction of two or more bones in the skeleton is known in anatomy as a joint or articulation.

Try to produce the same movements in the joint between the skull and mandibles as shown in the 'Movements' page of the 'Navigating the canine head and neck skeleton' section of 'The Canine Head and Neck Skeleton' learning module on Canvas.

What do you think the purpose of these movements might be? Crunching + tearing flesh (mechanical digestion)

Do you expect any other movements are possible between the skull and mandibles in a live dog?

Minimal horizontal movement

In a live dog, this joint - **temporomandibular joint** or **TMJ** - contains a small plate of fibrocartilage (a tough and springy material) between the bone surfaces, called a **meniscus**. What effect might this meniscus have on the movements of the TMJ?

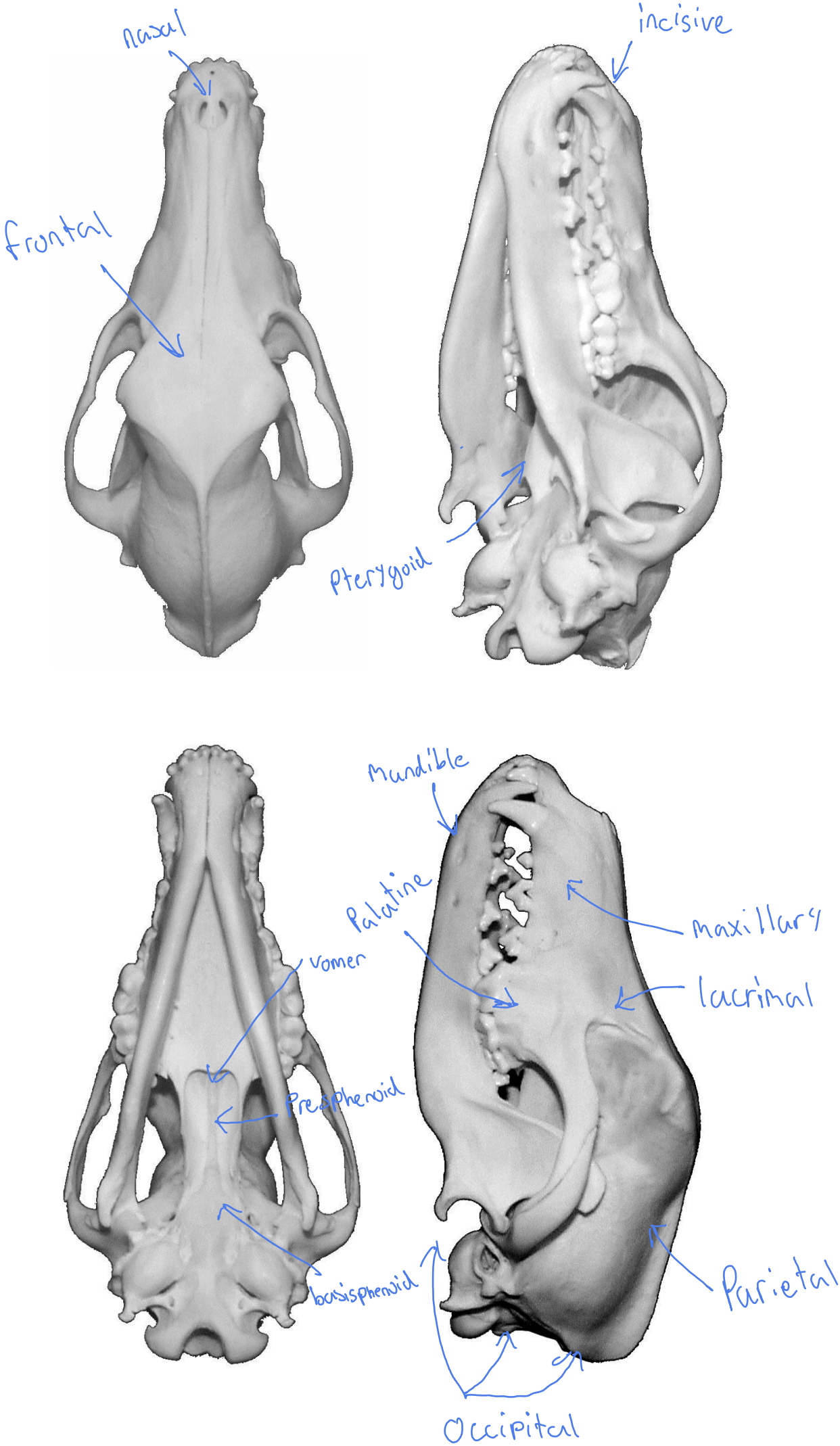
Reduce friction / prevent wear

The skull is made up of many bones joined with a special type of fibrous joint known as a **suture**. Suture lines appear as wriggly darker lines or sometimes small gaps between bone plates in the adult skull. Examine the suture lines in the prepared skulls. Which bones can you identify as being joined by suture lines? The movie of the skull bones may help you to identify the major bones of the skull.

Identify the bones of the skull on the following images:

- **Frontal** ✓
- **Incisive** ✓
- **Lacrimal**
- **Maxillary** ✓
- **Nasal** ✓
- **Occipital** ✓
- **Palatine** ✓
- **Parietal** ✓
- **Pterygoid** ✓
- **Sphenoid complex (basi & pre sphenoids)** ✓
- **Temporal (squamous, petrosal, and tympanic parts)**
- **Zygomatic**

Also identify the **mandible**. ✓


nasal
incisive
frontal
pterygoid
mandible
palatine
maxillary
lacrimal
vomer
presphenoid
basisphenoid
parietal
occipital

FEATURES OF THE SKULL AND MANDIBLE

The skull contains and protects the brain. The brain is part of the central nervous system and is the control centre for the whole body. The skull has many holes (**foramina**) through which nerves and blood vessels exit or enter the brain. Look at the sectioned skulls and locate the cavity where the brain lies during life (the cranial cavity). Indicate approximately where the cranial cavity lies under the bones in the skull pictures.

The **foramen magnum** is the large hole at the back (caudal aspect) of the skull that the **spinal cord** passes through to continue the central nervous system caudally through the body. Find the foramen magnum on the prepared skulls and the skull images.

The skull provides protection and support to the major sense organs, including the eye and the ear.

Can you visualise where the eyes lie in the skull? This space is called the **orbit**. In the dog, the top and side (dorsolateral) part of the orbit is completed by a fibrous ligament – this ligament is lost when the skulls are cleaned. Feel around your own orbit to appreciate that, unlike the dog, you have a complete bone ring around your eyes.

Note the many holes between the braincase and back of the eye sockets in the cleaned skulls.

Why might there be so many holes in this region? ….Cranial nerves……

One of these holes is the **optic canal** which carries the optic nerve. The optic nerve takes signals from the light-receiving retina of the eye to the brain, where the signals are processed into images.

The ear comprises of external, middle, and internal parts which are associated with parts of the temporal bone. The **external ear** is supported by cartilages so is also lost during the preparation of the bones. The internal and middle ear located within the bones of the skull.

On the outside of the skull, find the **tympanic part of the temporal bone** which contains some of the middle ear. Then locate the rounded **tympanic bulla**. The hole above (dorsal) to the tympanic bulla is the **external acoustic meatus**. In life, the thin **tympanic membrane** (ear drum) stretches across the external acoustic meatus, separating the middle ear from the external ear.

The **internal ear** is located within the **petrosal part of the temporal bone**, an irregular lump of bone not visible from the outside of the skill. The internal ear is important for balance and hearing. Identify the temporal bone from the outside, then look inside a sectioned skulls to locate the petrosal part. Where does the petrosal part of the temporal bone lie in relation to the tympanic bulla and the external acoustic meatus?
……Internal……

Locate the tympanic bulla in radiographs of the skull. In a radiograph, the bones appear white because they absorb x-rays and air appears black because they don't absorb x-rays. Soft tissues are somewhere between black and white depending on their thickness and density. That is, the colour correlates to how much of the x-rays they absorb. Hint: the tympanic bulla is an air-filled bone so it will have a white outline and a black interior on a radiograph.

In the sectioned skulls, you can see that there are quite a few air-filled spaces within the bones. You have already identified the tympanic bulla on the radiographs. Next, find the braincase (cranial cavity) – it is filled with soft tissue, not air, but soft tissue also looks dark on radiographs. What other air-filled spaces can you find?

Some of the spaces clearly connect with the outside (look at the sectioned skulls to decide which ones do this), the largest being the **nasal cavity**. The **nasal septum** is the thin plate of bone that divides the left and right sides of the nasal cavity into the left and right **nasal passages**. On the underside (ventrum) of the skull, you can see the caudal holes of the nasal passages. These are the **choanae** or **internal nares**.

The much thicker bone plate which divides the nasal cavity from the mouth is the **hard palate**. Why do you think the bone of the hard palate is thicker than the nasal septum? ……

More impact due to chewing

You may be able to distinguish some air-filled spaces alongside the nasal passages in the radiographs. Can you see these in the sectioned skulls?

They are the **paranasal sinuses**. Each paranasal sinus is named according to the bone in which it is found. Identify the **frontal** and **maxillary sinuses** in the prepared skulls, then draw their approximate position on the skull pictures.

At the back of the nasal cavity, look at the sectioned skull and note the many small holes in the ethmoid bone at the front (rostral extremity) of the braincase which separates it from the nasal cavity. This is the **cribriform plate of the ethmoid bone** where all the tiny olfactory nerves involved in smell pass between the brain and the nasal passages.

Try and identify the cribriform plate, the nasal conchae, and the choanae on radiographs.

The skull also provides support for the teeth and the muscles that open and close the jaw (muscles of mastication). Look at the radiographs and examine the extent of their roots.

Which teeth have the longest roots? ……Molars……

Deduce from the shape and fit of the teeth how the different teeth might act.

Which ones might a dog use to gnaw or shear apart meat and bone? ……Carnassial……

Imagine a dog eating a tough piece of food and try to visualise how the dog might position the food to use these specific teeth (the carnassial teeth).

Look at the hollows and projections on the bones around the mouth and see if you can determine where the major muscles of mastication lie. Muscles also provide shape to the body, along with the bones and cartilages. If there is a hollow in a bone in a region that looks filled and rounded in a live dog, then it is likely filled with a large muscle.

Can you identify a region like this on the skull? And another on the mandible (masseteric fossa)?

Additional activity if you have time:

The following is a list of the main features of the skull and mandible of the dog. You may find it helpful to practice using anatomical language to locate these features, some of which were described above. They will not be examined in this subject but will come up in other subjects.

<u>General features of the skull:</u> braincase, cranial cavity, face, zygomatic arch, hard palate, teeth, nasal cavity, nasal septum, nasal passages, paranasal sinuses (frontal and maxillary), cribriform plate.

<u>Openings and hollows:</u> orbit, optic canal, external acoustic meatus, foramen magnum, temporal fossa, infraorbital canal, mandibular fossa.

<u>Prominences:</u> nuchal crest, sagittal crest, zygomatic processes of the frontal and temporal bones, tympanic bullae, occipital condyles.

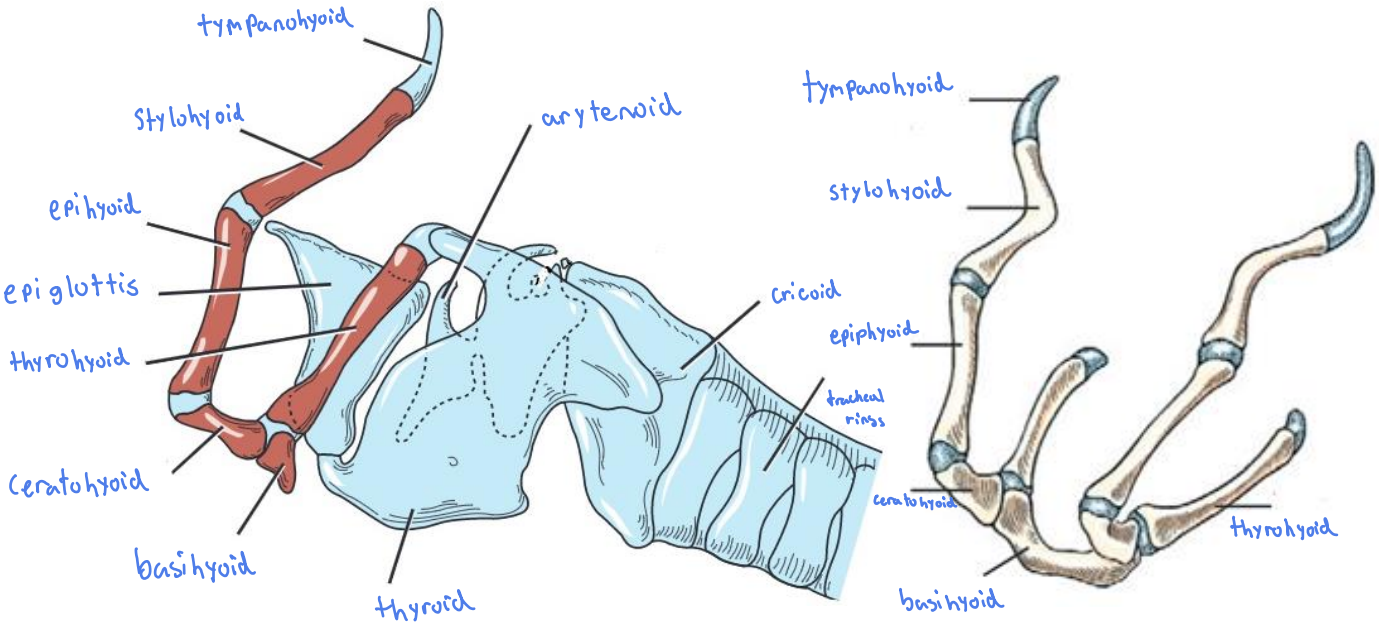
<u>Features of the mandible:</u> body, ramus, masseteric fossa, mandibular foramen, condylar process, temporomandibular joint.

THE LARYNX AND HYOID APPARATUS

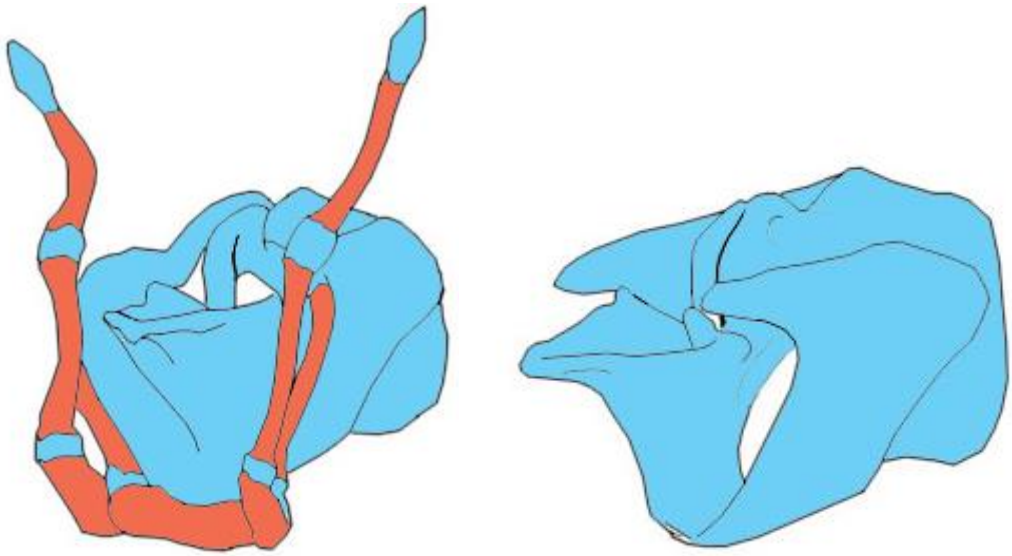
The **larynx** is a group of cartilages that lies at the back of the mouth and at the top (cranial) end of the windpipe (trachea). You may hear it referred to as the voice box or Adam's apple. The larynx helps to prevent food, drink, or anything other than air entering the trachea.

Feel your larynx moving up and forward, then down and back when you swallow. This movement is possible because the larynx is hung from the skull (from a point just caudal to the tympanic bulla each side) via a series of small bones and cartilage called the **hyoid apparatus**. The hyoid apparatus also supports the base of the tongue.

Label the 5 major cartilages of the larynx (3 single cartilages and 1 paired) and the main bones/cartilage of the hyoid apparatus on the following images.



Canine larynx and hyoid, lateral aspect (From Hermanson, de Lahunta & Evans. *Miller and Evans' Anatomy of the Dog*, 4th edition). Cartilage is shown in blue.



Line drawings of canine larynx and hyoid, …… aspect. (Drawn by Dr Helen Davies).

Bone shown in red, cartilage shown in blue.

How many bones are there in the dog's hyoid apparatus? 4

How many joints are there in the hyoid apparatus? 8

All joints can be named by joining together the names of the bones on either side of the joint, with the most proximal or dorsal bone first. For example, the articulation between the temporal bone and the mandibular bone is the temporomandibular joint.

By following this convention, work out what the joints in the hyoid apparatus are called and label the diagrams above.

The hyoid apparatus is generally lost during the production of mounted skeleton specimens, as are the os penis in the dog, and the os cordis in the ox. It can be seen between the mandibles in the pony skeleton in the museum (photographed below). It is also identifiable in most radiographs of the region.

Equine skull, mandible, and hyoid, ... aspect (Photo by Dr Helen Davies)

What is the function of the hyoid apparatus? Suspend tongue + larynx

What signs might you observe if a hyoid bone breaks e.g. the stylohyoid?

Wheezing, difficulty breathing, difficulty swallowing

What might cause the hyoid to break? Impact to the throat

THE CERVICAL VERTEBRAE

There are seven **cervical vertebrae** in the neck of the dog, known anatomically as the cervical region of the vertebral column. Vertebrae names are commonly abbreviated using the first letter of the region followed by the numbered from the head moving towards the tail (caudally). Thus, the first cervical vertebra is 'C1' and the second cervical vertebrae 'C2'. These two vertebrae are quite distinctive - they have characteristic shapes sculpted by their function and have names to reflect their specialised function.

C1 is specialised to support the head. It is called the **atlas** because in Greek mythology, Atlas holds up the sky. It has large transverse processes or wings (for muscle attachment) and a large articular surface which articulates with the occipital condyles of the skull. C2 is called **axis** because C1 and the skull rotate around it. It has a specialised process called the dens which protrudes forwards (cranially) into the base of the spinal canal of C1 and a large spinous process.

The joints between the occipital condyles of the skull and atlas allow nodding 'yes' movements, while the joint between atlas and axis allows rotation ('no' movements). Manipulate your bone specimens and see how these movements might be made without risking damage to the spinal cord that runs through vertebral foramen (the large holes in the vertebrae).

The remaining five cervical vertebrae (C3, C4, C5, C6, and C7) look more alike.

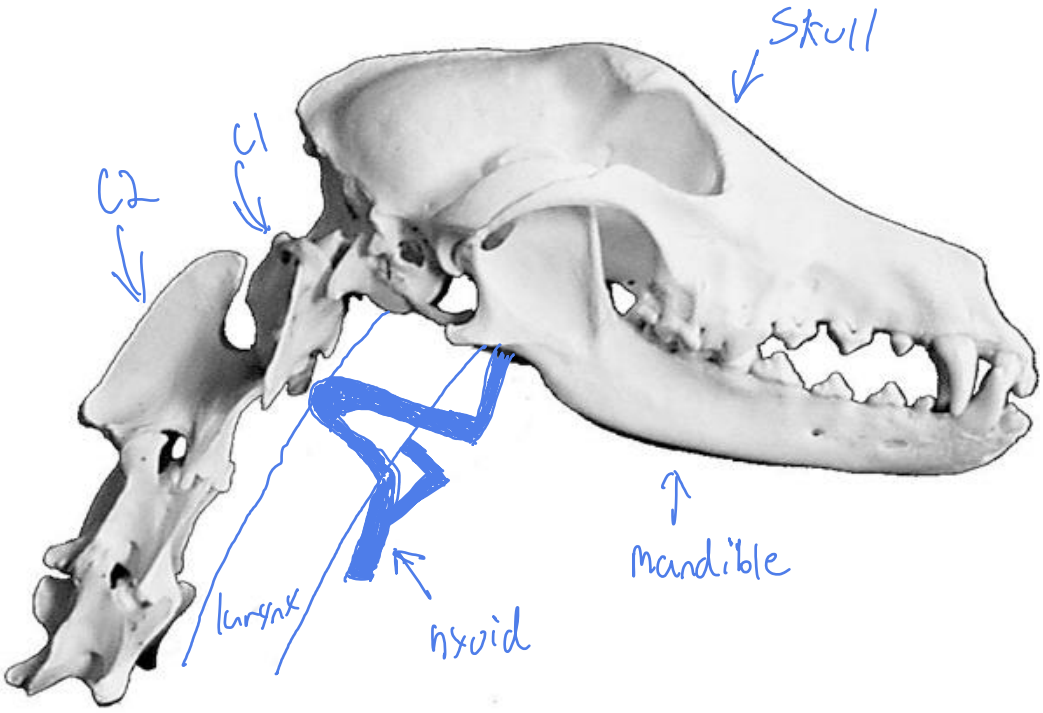
See if you can fit the vertebrae together, then explore what movements can be made between each vertebral pair. Note how each vertebra fits against the next through protruding articular facets (bony prominences involved in articulation with the neighbouring vertebrae), and how these restrict vertebral movements. Between the bodies of the last 5 cervical vertebrae (and all vertebrae in other regions), there are fibrocartilaginous discs ('intervertebral discs') which prevent large movements that could damage the spinal cord but allow small movements and some spine flexibility.

Why might there be no intervertebral discs present between C1 and C2, or C1 and the skull?

No need to articulate, stronger bond

From what you have learned above, identify these structures on the following image:

- Skull
- Mandibles
- Cervical vertebrae: atlas (C1); axis (C2); third and fourth cervical vertebrae (C3 & C4)



Look carefully at the prepared bones and the whole skeletons and try to visualise where the external skin of the dog would be. Mark where you would expect the skin surface to lie around the bones. Note where the bones and cartilages are likely to be near the surface and imagine this framework within a live dog. You may find that the radiographs help you with this exercise. Consider how you might relate something that you see on a radiograph to the live dog.

Draw the position of the hyoid and larynx in the above image too.

2. COMPARATIVE ASPECTS OF THE SKULL

Observe the colour coded skulls of the domestic species. Which one belongs to which animal?

Practice naming the major bones. Make yourself a colour key for the painted skulls e.g. which bone is painted yellow on all the skulls?

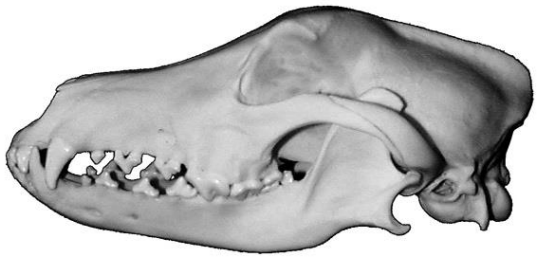
Hints: You may find it helpful to review the “flying skull” movie on the computer. Bones with the same names may have very different proportions in the different species but are in the same relationship to each other and have similar foramina, sinuses, processes, and other structural features.

There are a range of skulls available in the OBLA.

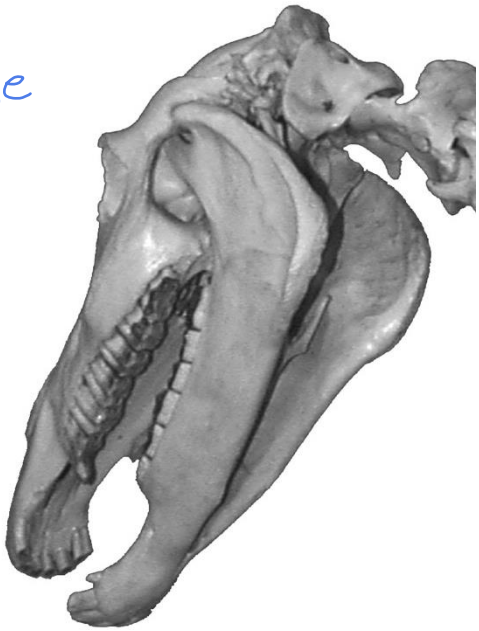
Label the following skulls with their respective species:

Goat

Canine



Horse



Pig

Look at the teeth and the regions of attachment for the muscles of mastication in the domestic and non-domestic species. You should be able to deduce the type of movements normally made during chewing from the shape and wear patterns on the teeth and the shape of the TMJ.

Visualise how a dog chews compared to a cow.

What is the difference between their teeth surfaces? herb = flat teeth

How do they compare to the non-domestic animal skulls? ……..

Based on their teeth, deduce which species are:

- herbivores ……..
- carnivores ……..
- less specialized in their diet (omnivores) from their teeth? ……

  ……..

Based on these assessments, what sort of diets might the non-domestic animals eat? ……..

……....

Note the size and shape and position of the braincase, nasal cavity, and paranasal sinuses in the sectioned skulls from different species and visualise their positions on the complete skulls. Identify the maxillary and frontal sinuses on the skull radiographs as well.

Using your skull anatomy knowledge, where could a hole be made to drain an infected frontal sinus?

……....

Look at where the cheek teeth are in relation to the sinuses, particularly in horses. One cause of an infected sinus is an infected tooth. Using your skull anatomy knowledge, where could a hole be made to drain an infected maxillary sinus?

……....

Using your skull anatomy knowledge, what different approaches to a cheek tooth are possible in a horse? This knowledge is helpful when considering how to approach a tooth being removed.

……..