AP® Biology Mammalian Structure and Function Dissection
The Skeletal System

Dissection Activity

Some observations of the cat skeletal system can be made from your dissected specimen, but many skeletal system observations are best accomplished using a mounted cat skeleton and a disarticulated cat skeleton.

1. Examine the mandible of your dissected specimen. If possible, move the mandible up and down and take note of how the upper and lower teeth mesh. Observe the movement of the mandible at the joint where it articulates with the skull. Observe the movement of the posterior teeth as the mandible moves up and down.

2. Starting at the anterior end of the mouth, identify type and number of teeth. Refer to Figure 29.

3. Examine the skull. Count the number of bones that compose the skull. Examine the margins where these bones connect.

4. Examine the connection of the vertebral column and the skull.

5. Identify the four different types of vertebrae, as shown in Figure 30.

6. Observe how the ribs are attached to the thoracic vertebrae and the sternum.

7. Examine the forelimbs and hind limbs. Examine their articulation with the scapula and innominate.
Figure 29. Mandible (right lateral view).

Figure 30. Skeleton.
Structure and Function Overview: The Skeletal System

While the cat skeleton clearly demonstrates the basic features of the mammalian skeleton, it also shows several adaptations for the carnivorous, predatory life typical of the domestic cat and its relatives. The skeleton has two main parts, the axial skeleton and the appendicular skeleton. The axial skeleton consists of the skull, vertebral column, tail, ribs, and sternum. The appendicular skeleton includes the forelimbs, hind limbs, and the bones that support and articulate the limbs with the axial skeleton.

The most anterior portion of the axial skeleton is the skull. The skull is a complex structure. It consists of many bones fused together to form a sturdy braincase or cranium, which protects the brain, and facial bones, which provide support for the sense organs and anterior portions of the digestive and respiratory systems. The cranium is formed by the fusion of several bones. The margins of these bones are often marked by distinct lines or sutures, where separate embryonic bones have grown together during development. See figures 31 and 32.

The principal bones on the dorsal side of the cranium are two large anterior frontals and two large posterior parietales. The sides of the braincase lateral to the parietales are enclosed by two temporal bones. Posterior to each temporal bone is the large occipital, which forms the back of the braincase. Turning the skull to observe the posterior surface reveals a large opening, the foramen magnum, through which the spinal cord connects with the brain. On each side of the foramen magnum is a rounded occipital condyle, which articulates with the cervical vertebrae and allows movement of the head.

On the ventral surface of the skull, a pair of palatine bones forms the hard palate. Dorsal to the palatine bones is the vomer, a median unpaired bone that forms the nasal septum between the nares and also forms part of the roof of the nasal cavity.

Posterior to the palatines are the unpaired presphenoid and basisphenoid bones. Lateral extensions of the basisphenoid extend into the orbits and are perforated by three openings or foramina. On each side of the basisphenoid is a rounded tympanic bulla, a ventral portion of the temporal bone that forms the lower surface of the tympanic cavity of the ear.

The lateral opening on the side of the tympanic bulla is the external auditory meatus, which leads to the middle and inner ears. The principal facial bones are the anterior paired premaxillary bones, which bear the incisor teeth, and two nasal bones, which enclose the nasal cavities. The maxillary bones, which bear the remaining upper teeth, and the lacrimals, two small bones at the anterior margin of the orbit or eye socket, are also facial bones. The eyes lie in two large orbits, cavities found on opposite sides of the braincase. Each orbit is enclosed laterally by a zygomatic arch and is bordered by two postorbital processes, bony projections that extend downward from the top of the braincase and upward from the zygomatic arch.

Posterior to the large parietales is a single median interparietal bone, which bears a middorsal sagittal crest. The sagittal crest extends posteriorly to the rear of the skull. From the posterior end of the sagittal crest, a sharp ridge, the nuchal crest, extends laterally and ventrally on each side to the mastoid process on the tympanic bulla. The nuchal crest provides a large surface for the attachment of neck muscles that support the head.

The temporal fossa is the large opening posterior to the postorbital processes and anterior to the posterior part of the zygomatic arch. The large temporalis muscle extends through this opening from the sagittal crest to the lower jaw. The lower jaw, or mandible, articulates with the skull at the mandibular fossa, a smooth groove on the ventral surface of the zygomatic arch near its posterior edge. A large condyloid process at the posterior end on each side of the mandible provides a smooth surface for articulation with the skull. The mandible of mammals consists of a single dentary bone, which is formed during embryonic development by the fusion of a pair of dentary bones. On the medial surface of the mandible on each side is a large opening, the mandibular foramen. Two smaller openings, the mental foramina, appear on the lateral surface near the anterior end of the mandible. A branch of the fifth cranial nerve that supplies nerves to the teeth and skin of the lower jaw enters the mandibular foramen and emerges from the mental foramina.
The bony shelf that extends across the skull between the two lateral rows of teeth is the hard palate. It is made up chiefly of the paired palatine bones and portions of the two maxillary bones. In a living animal, a fleshy soft palate extends posteriorly from the hard palate and covers the posterior openings of the internal nostrils. The openings of the internal nostrils can be seen at the rear of the hard palate.

Teeth are borne on the premaxilla and maxilla bones and on the lower mandible. Cats and other mammals have two sets of teeth, a temporary set of deciduous or milk teeth in young animals, and a set of permanent teeth, which replace the milk teeth in adults. There are four kinds of teeth in mammals—incisors and canines for cutting and tearing, and premolars and molars for grinding.

Extending posteriorly from the skull is the vertebral column, which provides support for the body and protection for the spinal cord. All of the vertebrae have a similar basic structure, but those from different regions have some special modifications. The central body of an individual vertebra is the centrum, which is flattened on both anterior and posterior surfaces in mammals. Dorsal to the centrum is the neural arch, which forms a passageway, the neural canal, for the spinal cord. The neural spine is dorsal to the neural arch. Projecting laterally on each side at the base of the neural arch are the transverse processes. In the thoracic vertebrae that articulate with the ribs, there are often short lateral processes ventral to the transverse processes. Both processes articulate with the ribs.

There are five types of vertebrae in mammals. Most mammals have seven cervical vertebrae (see Figure 33) located in the neck region. The first cervical, the ringlike atlas (see Figure 36), has a large neural canal. It articulates with the occipital condyles of the skull and permits side-to-side motions. The second, the axis (see Figure 37), has a large projection, the odontoid process, attached to its anterior end. The cat has 13 thoracic vertebrae (see Figure 34). The thoracic vertebrae are larger than the cervicals and increase in size caudally. Their long spinal processes are directed caudally. Cats have 13 pairs of ribs: 9 true ribs that articulate with the sternum on one end and with the vertebrae on the other, and 3 false ribs whose cartilages articulate with the 9th rib cartilage. The 13th pair, the floating ribs, does not join with either the sternum or other ribs. Cats have seven lumbar vertebrae (see Figure 35) caudal to the thoracic vertebrae. Their transverse processes project cranially. The sacrum is formed by the fusion of three sacral vertebrae and forms a part of the pelvis. Modified transverse processes of the sacrum articulate with the innominate or hip bones. The caudal vertebrae of the cat vary in number between 21 and 25. They form the bony core of the tail.

The sternum is also part of the axial skeleton. The sternum is comprised of three portions—the anterior manubrium, the mesosternum, and the caudal xiphoi process. The sternum serves as the site of attachment of the ribs and protects the heart.

The appendicular skeleton consists of the bones of the pectoral girdle and forelimbs, and the pelvic girdle and hind limbs. The principal bone of the pectoral girdle is the scapula, a large, flat bone with a keel-like spine (see Figure 38). On the distal or ventral end of the scapula is a depression, the glenoid fossa, which permits articulation with the upper forelimb bone. The paired clavicles of the cat are small bones embedded in the muscles; they do not articulate with other bones. The appendages associated with the pectoral girdle are the forelimbs. The large bone of the upper limb is the humerus, whose rounded head articulates with the scapula. The opposite end of the humerus articulates with the lower limb at the elbow. The lower forelimb has two bones, the longer ulna and the shorter radius. The ulna has a U-shaped notch and articulates with the humerus. The radius also articulates with the humerus.

The wrist or carpus is a complex structure comprised of eight individual bones, the carpals. The chief bones of the paw are the five metacarpals. The cat has five digits or toes. The first digit is made up of two bones, the phalanges. The other four digits each have three phalanges.

The pelvic girdle is made up of two large innominate bones joined together ventrally at the pubic symphysis. The innominate bones are formed by three bones that fuse before birth—the ilium, the ischium, and the pubis (see Figure 39). The three bones join at the acetabulum, a deep lateral socket that articulates with the head of the femur. The large opening in each innominate bone is the obturator foramen.
The large upper bone of the hind limb is the femur, normally the strongest bone in the body. The distal end of the femur articulates with the bones of the lower leg at the knee. A small bone anterior to the knee is the patella or kneecap. The lower leg has two bones, the tibia and the fibula. The tibia is a large bone found on the anterior and medial side of the lower leg that articulates with the femur. On its lateral side is a depression for articulation with the fibula. The tibia also articulates with the bones of the ankle. The fibula is the long, slender bone on the lateral side of the tibia. Both ends articulate with the tibia. The tarsus, or ankle, consists of seven bones, the tarsals, arranged in two irregular rows. One tarsal, the talus, articulates with the tibia. The largest tarsal is the heel bone or calcaneus. Cats have four large metatarsals plus a vestigial one in each hind foot. There are four digits on each hind foot. Each digit has three phalanges and a sharp claw.

Figure 31. Skull (right lateral view).

Figure 32. Skull (ventral view).
Figure 33. Cervical vertebra (anterior view).

Figure 34. Thoracic vertebra and rib (posterior view).

Figure 35. Lumbar vertebra: (a) right lateral view; (b) anterior view.
Figure 36. Atlas (ventral view).

Figure 37. Axis (lateral view).

Figure 38. Left scapula: (a) lateral view; (b) anterior view.

Figure 39. Left innominate (lateral view).
Reflection Questions

1. The dental formula for an adult human is I 2/2, C 1/1, P 2/2, M 3/3 (I = incisors, C = canines, P = premolars, and M = molars). Determine the dental formula for an adult cat.

2. List the major bones that compose the skull. How are these bones connected?

3. What observations can be made about the articulation of the first two vertebrae in the vertebral column versus the remaining vertebrae?

4. List the type and number of vertebrae in the vertebral column. What differences do you observe in the structure of the different types of vertebrae? Why are all vertebrae not structurally the same?

5. How many pairs of ribs are there? What are the three types of ribs and how are they different?

6. Give the articulating surfaces for the following forelimb joints: shoulder, elbow, wrist.

7. Give the articulating surfaces for the following hind limb joints: hip, knee, ankle.

8. On the Cat Anatomy Skeleton Bioreview® worksheet, identify the structures shown in the diagram.