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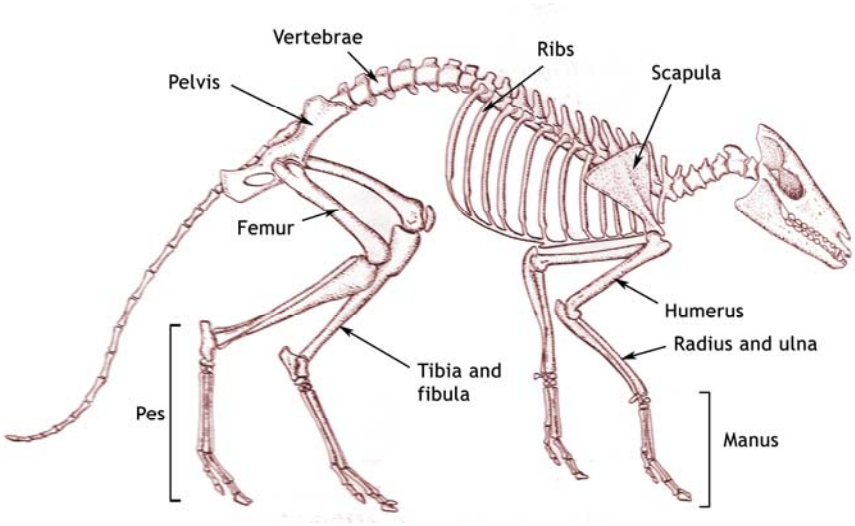
Lab 8. Vertebrate Diversity and Functional Morphology

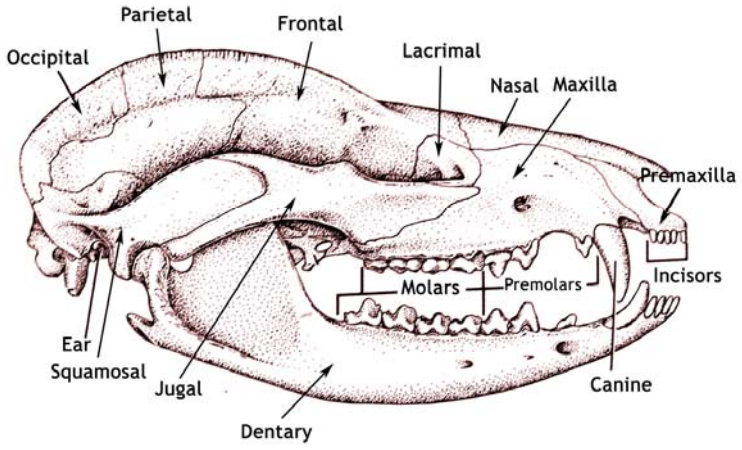
In this lab you will be introduced to the diversity of the vertebrate skeleton and to functional specializations in mammals. Feel free to look around and **gently** touch specimens.

Bones of the mammalian skeleton

Mammals have the simplest skeleton of all vertebrate groups. Their skull and limbs have fewer bones than reptiles, amphibians or fish (birds also have simplified skeletons). But these mammalian bones are found in most vertebrate groups, making it possible to identify most of the skeleton in all groups using knowledge of just mammals.



The skeleton of *Diacodexis*, an Eocene mammal.



The skull of the opossum, a marsupial mammal.

Interpreting Locomotion from the Skeleton

Generalized or Ambulatory Locomotion

Species that are not specialized for any special activity are categorized as "generalized" or "ambulatory." The raccoon is an example. Walking, running, climbing, and manipulating objects are all possible for these animals because they do not have skeletal specializations that limit any particular activity. Ambulatory mammals have mobile joints, ability to rotate the hand, five digits (often with opposable thumb or big toe), and a plantigrade to semi-digitigrade posture. The proportions of the three major limb segments are approximately equal. Ambulatory species range in body mass from small (e.g. mice) through medium (e.g. oppossums) to large (e.g. bears). The scapula is often triangular, the deltoid crest on the upper part of the humerus is often prominent and positioned well down the length of the shaft, the clavicle, or collar bone, is usually present, bottom of the humerus is wide, and radius and ulna are not fused.

Cursorial Specializations

Cursorial specializations allow fast running speeds. Horses, gazelles, and cheetahs are examples of mammals with well-developed cursorial traits. These animals typically have long limbs with the lower segments proportionally longer than upper ones. The posture of cursors is usually digitigrade or unguligrade. Limb joints, especially in the hindlimb, prohibit rotation of the joint to stabilize the legs during running. The scapula is long and the clavicle is often absent. The lower end of the humerus is narrow because there is little rotation of the forearm or wrist. The number of fingers and toes is reduced, down to only one in the horse

Saltatory Specializations

Some species have specializations for jumping, or saltation. Saltatory specializations in the hind limb are exaggerations of cursorial ones, including long lower limb segments, digit reduction, and rigidly hinged joints. The forelimbs of saltatory animals often resemble ambulatory species. In many salutatory species, a long, heavy tail counterbalances the weight of the forelimbs and head.

Scansorial and Arboreal Specializations

Scansorial, or climbing specializations include mobile limbs and the ability to grasp with the hands and feet. “Scansorial” is a general climbing locomotion, whereas “arboreal” means that the species exclusively lives in the trees. Scansorial locomotion is found in squirrels, monkeys. Some climbers suspend themselves from tree limbs, such as sloths or gibbons, and have elongated limbs; others, such as tree squirrels, scamper on limbs and climb by clinging to projections and irregularities, and yet others, such as tarsiers, spring from place to place in the trees. Some scansors spend their entire lives in trees, while some climb only occasionally. Universal scansorial features are thus difficult to identify. But most are plantigrade and have grasping feet and hands. In some cases the hands and feet are elongated. Suspensory species have long, curved claws for grasping. In almost all cases, the forelimb is capable of extensive rotation. The clavicle is often present to stabilize the shoulder, and the scapula is often triangular. Many scansorial mammals have prehensile tails.

Fossorial Specializations

Fossorial species have digging adaptations for use in obtaining food, in the construction of burrows, or tunnelling. Many insectivorous species, especially those that eat ants, have fossorial specializations to dig out their insect prey. The scapula has a long, backward pointing projection, the upper part of the humerus has a strong deltoid ridge, and the elbow projects backwards dramatically.

Natatorial and Aquatic Specializations

Species that are adapted to life in water are called natatorial. The most extreme examples are whales, icthyosuars, or plesiosaurs, but many other animals swim regularly, such as beavers, otters, water voles, and water shrews. Depending on the degree of specialization, mammals may be classified as natatorial (swimming) or aquatic. Natatorial features are similar semifossorial ones, but the hindlimbs are differently specialized. Swimmers require powerful

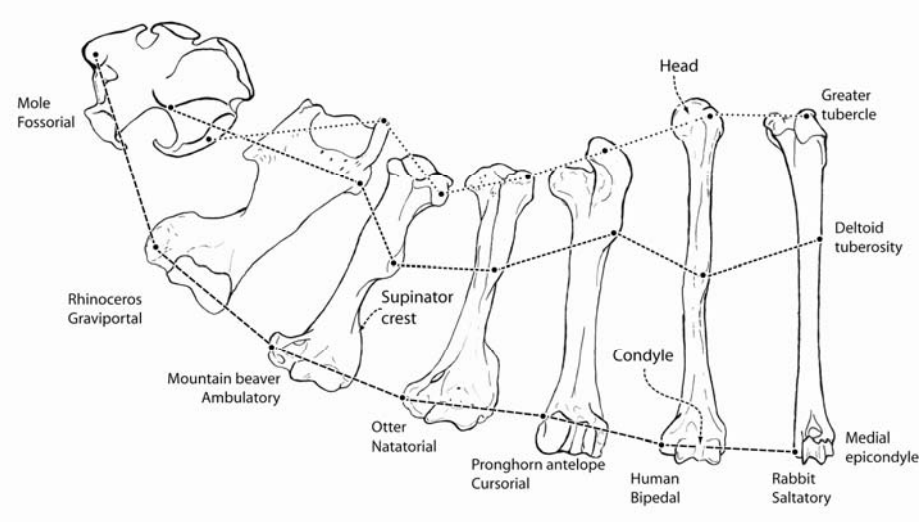
forelimb extension for pushing through water: the scapula has a long backward projection, the humerus is short, and the elbow is long. Swimmers have an elongated hand. The hind feet are often paddlelike. The clavicles are usually absent.

Graviportal Specializations

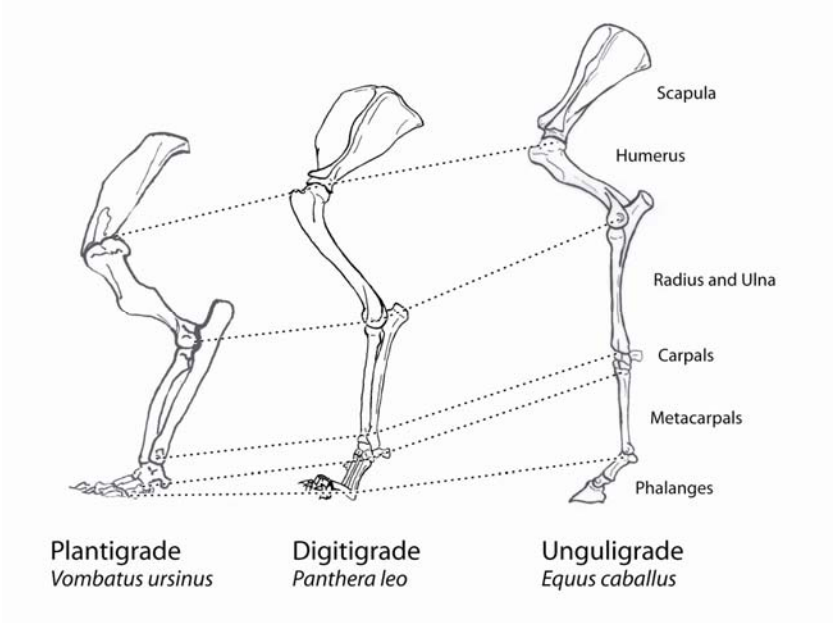
Extremely large species are graviportal. The diameter of the limb bones is disproportionately large, the pelvis is oriented vertically, the lower limb segments are short, and stance is digitigrade.

Bipedality

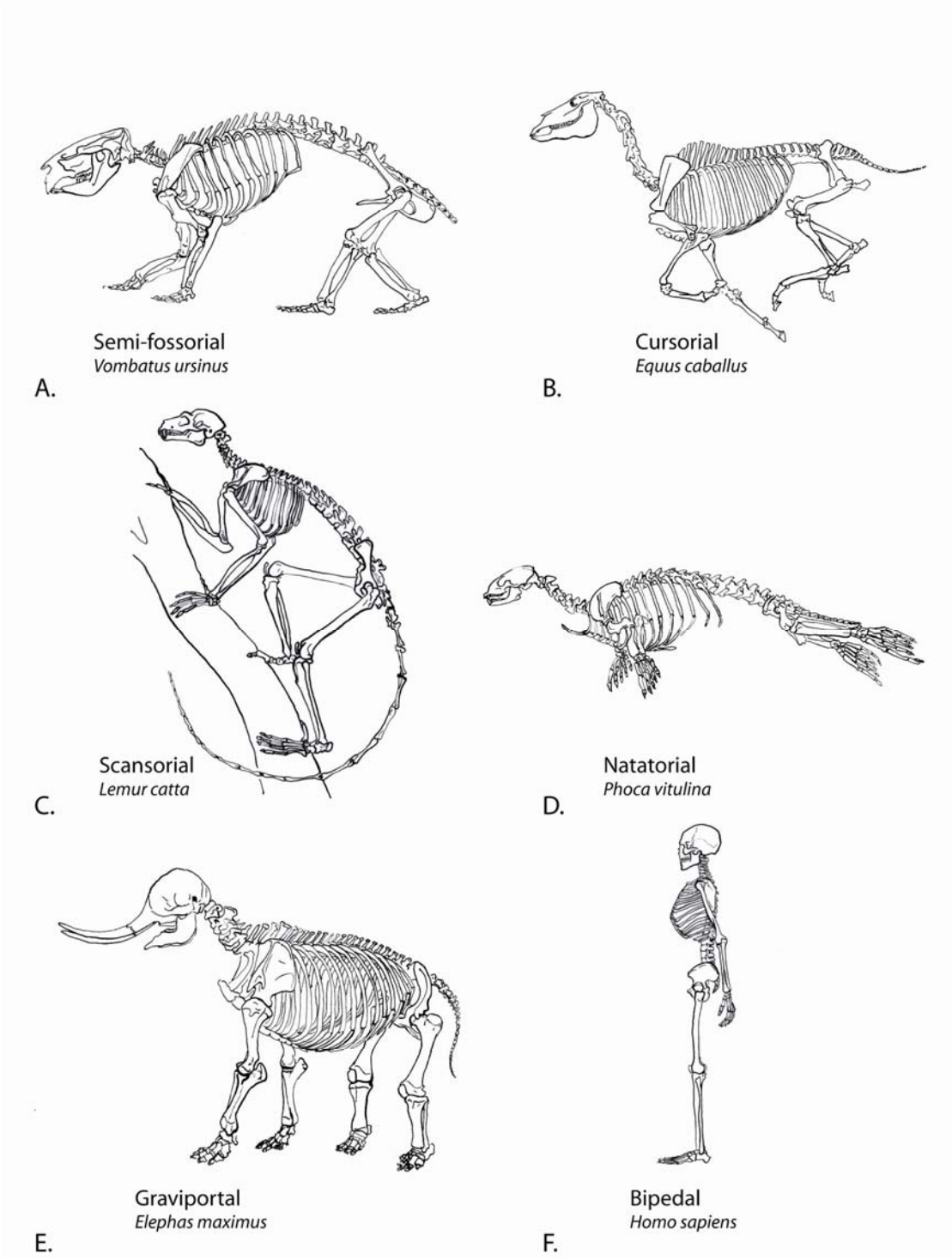
An unusual locomotory specialization is non-saltatory bipedalism. Humans are the only habitual nonjumping bipeds, although some other species, mostly primates and bears, are occasional bipeds. Bipeds are plantigrade, have short tails, and vertically oriented pelves. The human hindlimb has unique specializations for bipedalism, which include a short, flared pelvis, an extremely long femur, a down-turned heel, and a large, elongated big toe.



Humeri of several species showing specializations to different types of locomotion.

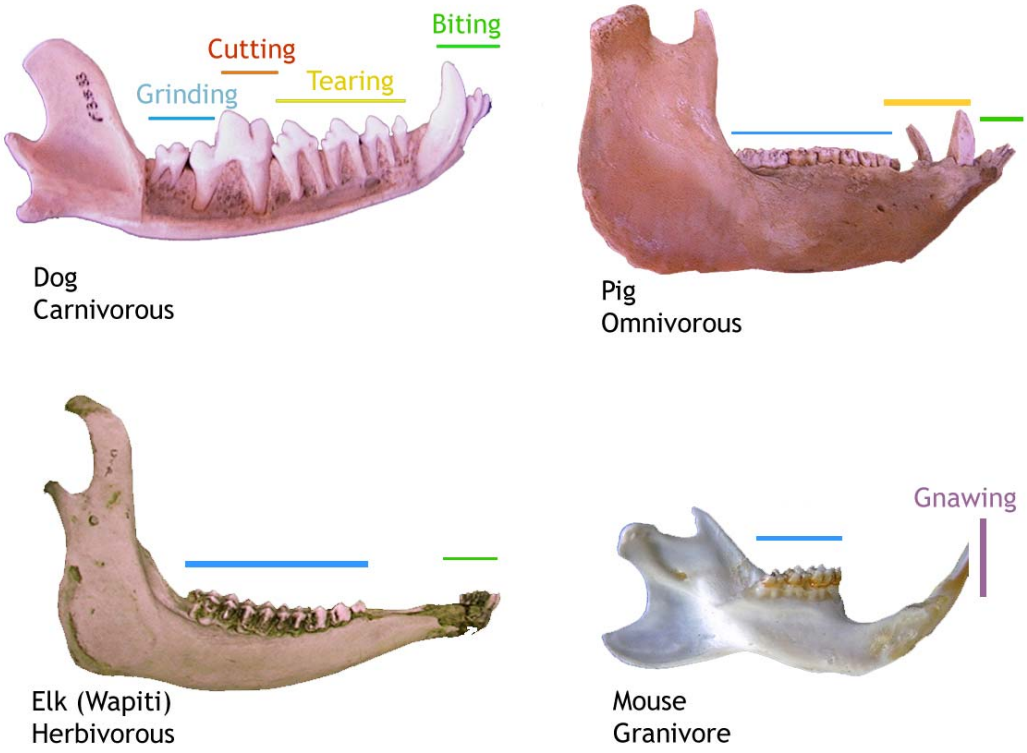


The front limb of plantigrade, digitgrade, and unguligrade species. The lower segments of the leg are proportionally longer in unguligrade and digitigrades species.



Skeletons illustrating specializations for different kinds of locomotion.

Dietary adaptations



The mandibles of four mammals showing specializations for diet. Note different configurations of tooth shape and height, as well as differences in the height of the back of the mandible, the position of the condyle (or jaw joint) relative to the teeth, and the differences in the lower angle at the back of the mandible.

Lab 8 Worksheet

1. Vertebrate diversity. Skeletons of a fish (Osteichthys), a frog (Amphibia), a lizard (Lepidosauria), a snake (Lepidosauria), a bird (Aves), and a mammal (Mammalia) have been placed out on the tables. Look at the differences in the limbs, body skeleton, and skull of these animals. Try to identify the individual bones based on the mammal skeleton shown on the first page of this handout.

Draw the bones of the front limb, including the scapula, of one of these animals (not the mammal or the snake) and label the bones that are the same as in mammals.

2. The humerus. The humerus of a zebra, goat, wolf, bat, squirrel, and wolverine have been placed on the table. For the horse, wolf, squirrel, and badger, categorize them with the best locomotor type from those described above and list features that support your interpretation.

Species	Category	Features
Zebra		
Wolf		
Squirrel		
Wolveriner		

3. Dietary specializations. Several mammal skulls have been placed on the tables to represent the diversity of dietary specialization. Examine them carefully, especially their size, the diversity of their teeth, and the proportions of the areas of muscle attachment on the mandible.

Draw the mandible of a carnivore and an herbivore, label as to which species and which diet, and indicate the features that are specialized for that diet.