General Vertebrate Diversity Lab

Lab 1

External Characteristics of Vertebrates

Objectives

1. List the major groups of vertebrates.
2. Describe the defining characteristics of vertebrates.
3. Use external characteristics to distinguish between the major vertebrate groups.

Introduction

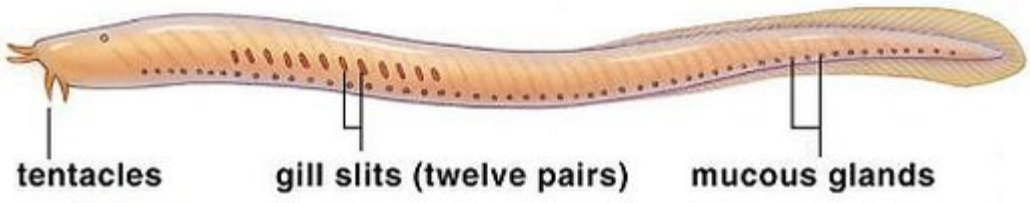
Vertebrates are a unique lineage of organisms that descended from a common ancestor dating back the Cambrian over 500 million years ago. Today, all vertebrates possess certain characteristics inherited from that common ancestor. Over time, vertebrates have evolved into multiple lineages, each with unique derived characters. As you work through this lab, observe the similarities and differences between these vertebrate groups.

Jawless Fish - Agnatha

I. Myxinoidea – Hagfish

Hagfish are jawless scavengers that feed upon dying and dead fishes and whales. There are 75 known species of hagfish, all found in marine environments. Examine the specimen of the hagfish and be able to locate and know the function of the labeled structures.

1. Slime glands, which occur on each side, one per segment. Slime glands are often most evident in the posterior region (but can be hard to see).
2. External gill openings. Gill slits vary in number from 1-15 pairs.
3. Oral tentacles or barbels. What might be the function of these oral tentacles?



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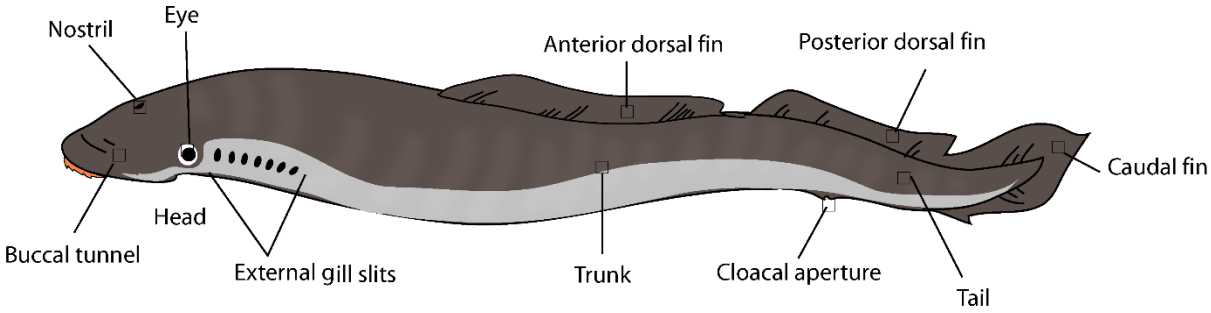
II. Petromyzontoidea - Lamprey

The approximately 40 species of jaw less lampreys range in size from 25 cm to about 1 meter. Many species are born in fresh water, spending 5 or more years in a larval form before they metamorphose into adult form and migrate to marine habitats. Some species are found exclusively in freshwater. Many species, including the specimens in lab, are parasitic. They can be seen attached to the outside of their hosts, which are often other fishes.

The body can be divided into three regions:

1) Head (extending through the gill area)
2) Trunk (gills to) cloaca),
3) Tail (posterior to cloaca).

Observe the two dorsal fins and caudal fin. At the front of the head, observe the buccal tunnel that is fringed with papillae and lined with horny teeth. A single, median nostril is located far back on the top of the head. Just behind the nostril is the pineal eye or cornea. It is an oval area that is often slightly depressed and generally a lighter color than the rest of the skin. On the sides of the head is a pair of lidless eyes. Behind the eyes are located seven pairs of external gill slits.



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Gnathostome – Jawed Fishes

III. Chondrichthyes-Cartilaginous fish/Sharks

Sharks and rays (Elasmobranchii) and ratfishes (Holocephali) are members of the taxon Chondrichthyes, which includes over 900 species. All but 28 species are found in marine habitats and most are predatory carnivores (though several feed on plankton). Examine the dogfish shark specimens and the microscope slides to identify and learn the general function of the labeled structures. The body is divided into the head, trunk, and caudal regions.

On the head locate:

1) The mouth,
2) The eyes,
3) The spiracles,
4) The nostrils (each of which is partially sub-divided by a flap of skin that Separates the stream of water flowing into and out of the nostril)
5) The ampullae of Lorenzini
6) External gill slits, Forming the division between the head and trunk are the. How many pairs of gill slits does the dogfish shark possess?

On the trunk of the shark locate

7) The paired pectoral fins
8) Pelvic fins. The pelvic fins will vary between the males and females. Males will have stiff, grooved copulatory organs called claspers on the medial sides of the pelvic fins. All Chondrichthyes have internal fertilization and development.
9) Anterior dorsal fin. The dorsal fin has a large spine in front of it, which is defensive.
10) The lateral line is found along the sides of the body look for a fine, light-colored stripe that is.
11) Placoid scales. Note the roughness of the skin when you run your fingers from the posterior to the anterior end. How does the structure of the scales of shark resemble a tooth?

On the tail end of the shark locate

12) The cloaca forms the division between the trunk and tail of the shark.
13) On the dorsal side of the tail is the posterior dorsal fin with a spine.
14) The tail ends in the large heterocercal caudal fin. Note how the body axis turns up into the dorsal lobe of the caudal fin.

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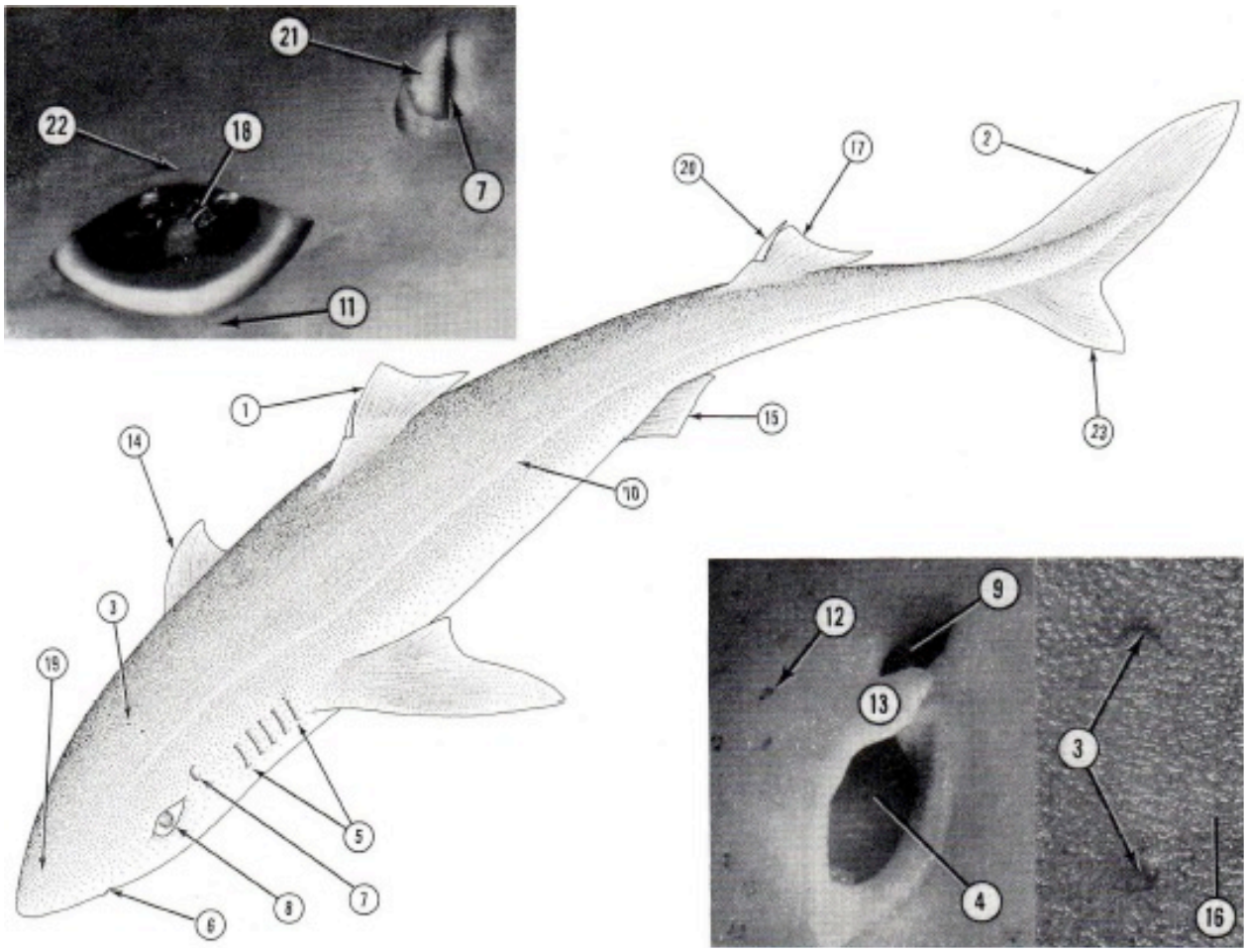

1. Anterior dorsal fin
2. Dorsal lobe of Caudal fin
3. Endolymphatic pores
4. Excurrent aperture of naris
5. External gill slits
6. External naris
7. External spiracular pore
8. Eye
9. lncurrent aperture of naris
10. Lateral line
11. Lower eyelid
12. Mucous pores of Ampullae of Lorenzini
13. Nasal flap
14. Pectoral fin
15. Pelvic fin
16. Placoid scales
17. Posterior dorsal fin
18. Eye
19. Snout
20. Spine of dorsal fin
21. Spiracular valve with Pseudo-branch on posterior wall
22. Upper eyelid
23. Ventral lobe of Caudal fin

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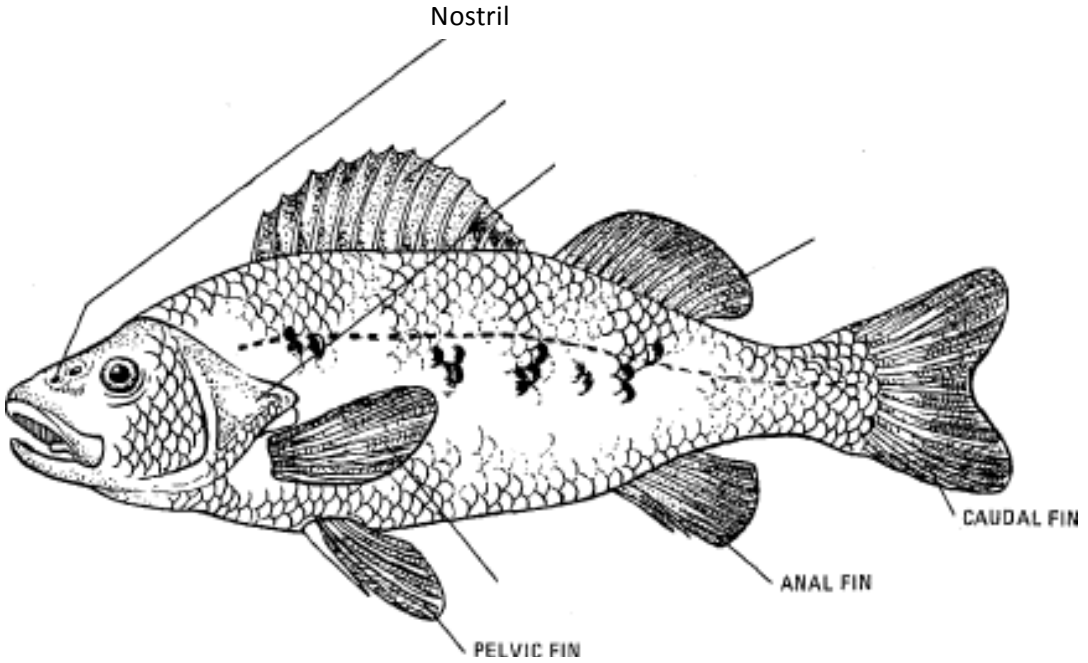
IV. Osteichthyes - Bony fish

Osteichthyes is the most diverse group of vertebrates (ca. 26,000-30,000 species) and includes two major groups: Actinopterygii, the ray-finned fishes, and Sarcopterygii, the lungfishes and the coelacanth. In lab we will focus on the Actinopterygii. Actinopterygian fishes have fins that are supported entirely by dermal fin rays. The different groups of Actinopterygian fishes are differentiated by a number of external characters including type of caudal fin (heterocercal or homo-cercal) and type of scale (ganoid, ctenoid, cycloid). In general, the more primitive Actinopterygii possess a heterocercal tail and ganoid scales and the more derived lineages possess homocercal tails and cycloid or ctenoid scales. Examine the specimens and microscope slides to locate and describe the general function of the labeled structures.

On the gar specimen, which represents a more primitive group of Actinopterygii, observe the

1) Heterocercal caudal fin and the position of the mouth.
2) The ganoid scales under the microscope. Ganoid scales are composed of enamel (ganoin) on the upper surface and bone on the lower.

The most diverse group of Actinopterygii is the Teleosti, which includes most of the familiar fish (e.g., eel, perch, herring, pike, salmon, trout, guppy, flounder, tuna, sunfish, etc.). Observe the perch specimens. The body is divided into the head, trunk, and tail.



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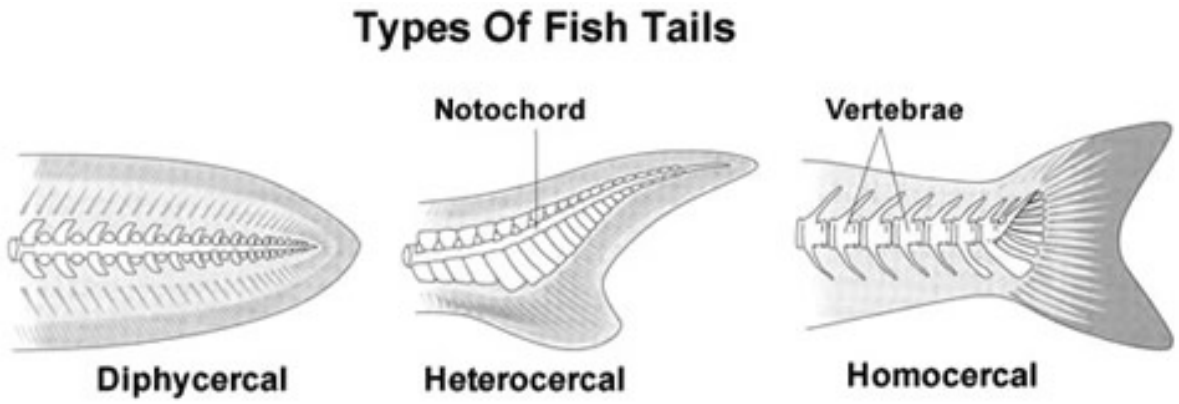
On the head, locate the position of

3) The mouth.
4) The nostrils
5) Eyes (note how they protrude from the sides of the fish).
6) The operculum.

On the trunk of the fish locate

7) the paired pectoral fins
8) Pelvic fins.
9) The anterior and posterior dorsal fins.
10) The lateral line.
11) The trunk ends at the cloaca.
12) The caudal fin that is located at the end of the homocercal tail. The vertebral column does not extend into tail caudal fin.
13) The more advanced bony fishes have either cycloid or ctenoid scales. These are thin and flexible and are arranged in overlapping rows. Examine the examples of cycloid and ctenoid scales under the microscope.



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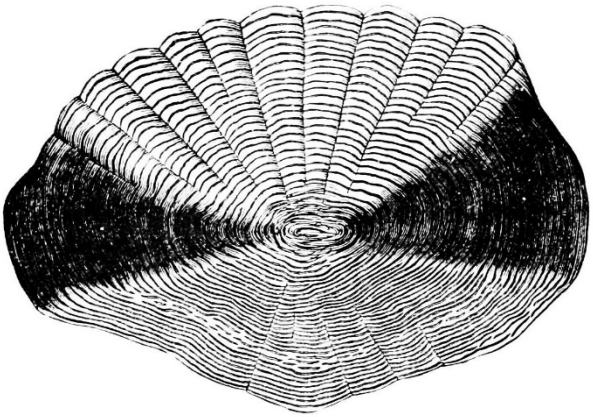
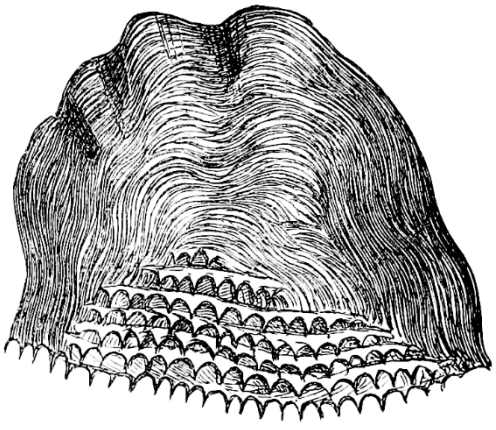
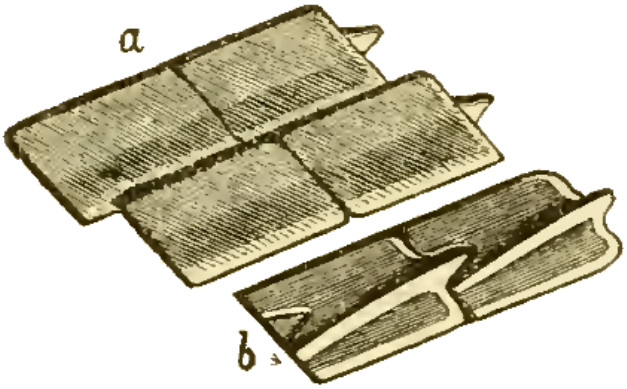


Cycloid scales are typically circular in nature. The scales grow in concentric layers and have a smooth outer margin. They are found in the more derived ray-fin fish, the teleost.

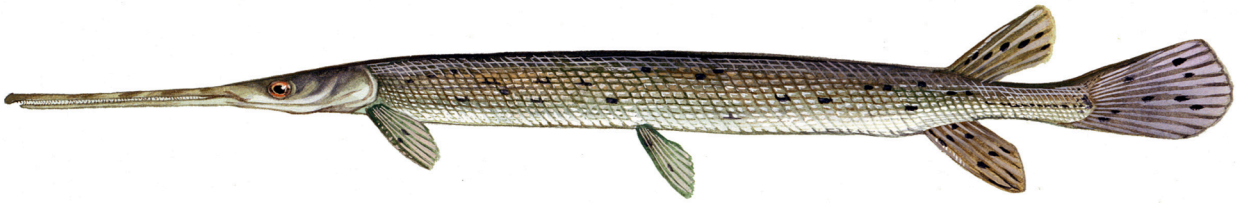
Cycloid scales are found often found in fish with soft rays, including this River Carpsucker *(Carpoides carpio).* Ctenoid scales are often found in fish with spiny fin rays like this green sunfish *(Lepomis cyanelis)*

Ctenoid scales resemble cycloid scales, except they have small teeth on their outer edges. Similar to cycloid scales, they also grow in concentric layers and are found in teleost

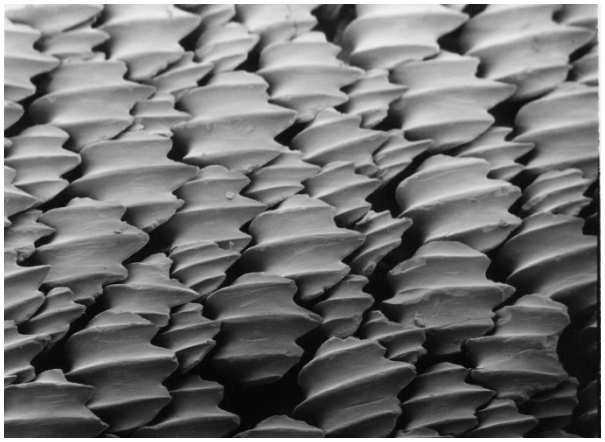


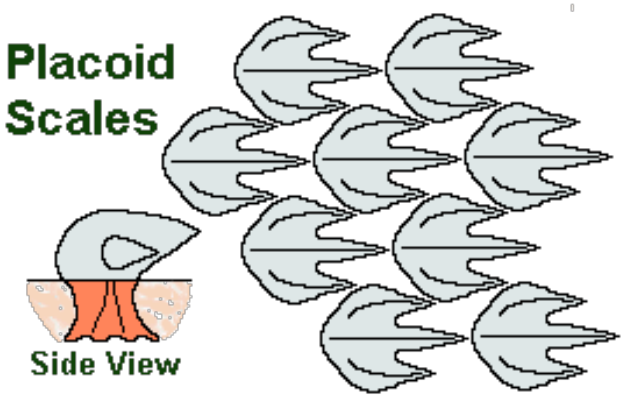


Ganoid Scales are typically thick and not overlapping and connected by peg-and-socket joints. They are found in non-teleost ray-finned fish (gars, bichirs, bowfins, and sturgeons, and paddlefish). In gars, the scales are greatly enlarged to form armor plates.



Longnose Gar





Placoid scales are found in the Chondrichthyes or cartilaginous fish including the sharks, skates, and rays. Placoid scales are basically miniature teeth, possessing pulp supplied by blood vessels, surrounded by a layer of dentine. As the fish grows in size, more scales are added.

Tetrapods

V. Amphibia-Amphibians

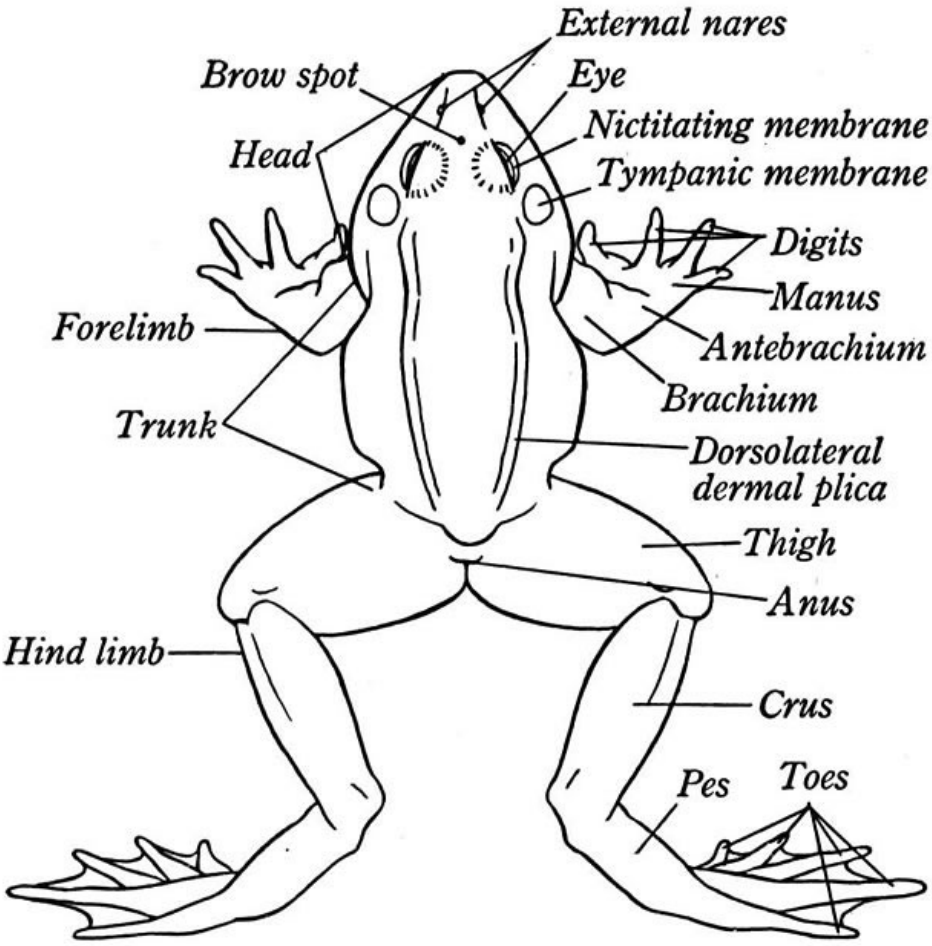
Amphibians are an ancient lineage dating back to 370 million years ago. All modern amphibians are classified as the Lissamphibia, which includes about 7,000 extant species comprising 3 main groups: Gymnophiona (caecilians), Anura (frogs), and Urodela (salamanders). Shared external characteristics for these groups include 1) skin that is specialized for gas exchange and possess poison glands, and 2) forelimbs with 4 digits (frogs and salamanders). In lab, we have specimens of frogs, salamanders, and caecilians.

Gas exchange through the skin is very important for amphibians allowing them to remain submerged for extended periods of time. Its function is dependent upon the proximity of blood capillaries to the surface and a moist skin surface. Moist skin is maintained by the presence of many mucous glands in the skin. Poison glands in the skin produce noxious or toxic substances used in defense against predation.

The eggs of amphibians lack shells and must develop in a moist environment. Many (but not all) amphibians go through a larval stage. Some amphibians retain larval features into sexual maturity; this is called neoteny. Observe the gills of the mudpuppy

Amphibians are the most primitive of the living tetrapods. Observe 4) forelimbs with 4 digits (fingers) on each and 5) the hind limbs. Observe the differences in limb structure between the salaman-ders and frogs. How have the limbs of the latter been modified? Observe 6) the tail of the mudpuppy (Necturus). Anurans lack a tail. All tetrapods (as well as the lungfish) possess choanae or internal nares. Using the probe pro-vided, gently examine the 7) nostrils of the frog.

Observe the eyes of the frog and locate the clear 8) nictitating membrane. Behind the eye, locate the round 9) tympanic membrane. Does the mudpuppy have a nictitating membrane or tympanic membrane?



Amniotes

VI. Testudinata-Turtles

Testudinata includes about 327 species of extant turtles that are found in terrestrial, freshwater, and marine habitats. There are two groups of turtles: Cryptodira includes about 200 species and Pleurodira about 50 species. The groups are distinguished by the way they retract their heads into their shells. Cryptodires retract their heads into their shells by bending their necks in a vertical S-shape; pleurodires retract their heads by bending the neck laterally. Cryptodires are the only turtles in North America. Turtles are unique in that the pelvic and pectoral girdles are located behind the ribcage.

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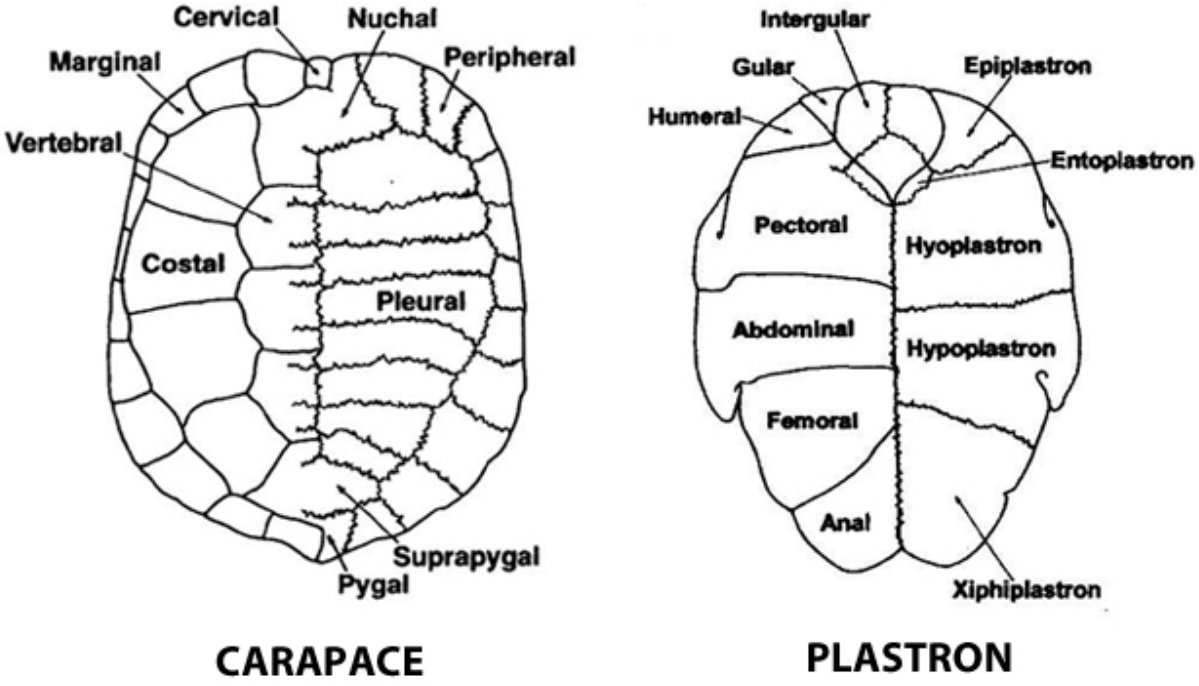
Examine the specimen of the turtle. The shell of the turtle is divided into the dorsal 1) carapace and the ventral 2) plastron The carapace and plastron are connected by 3) the bridge.



VII. Lepidosauria-Squamata-Lizards/Snakes

Squamata includes the approximately 9,000 species of lizards and snakes. One shared character of lizards and snakes is the presence of hemipenes (dual copulatory organs) in males. Although snakes lack external paired appendages they are considered tetrapods because their ancestors possessed limbs and because the skeletons of some snakes still have vestigial (very reduced) girdles. Limb reduction has evolved repeatedly among lizards, perhaps as many as 62 times. As you examine the specimens of the lizards and snakes observe both the similarities and differences.

All squamates possess 1) epidermal scales. Examine the different lizard and snake specimens to see how the shapes and sizes of the epidermal scales can vary. Examine the 2) eyes of the lizards and snakes. Most lizards have moveable eyelids whereas the eyes of snakes are covered with a transparent cap. Look behind the eyes of both the snake and the lizard, on which one do you see 3) an external ear slit?

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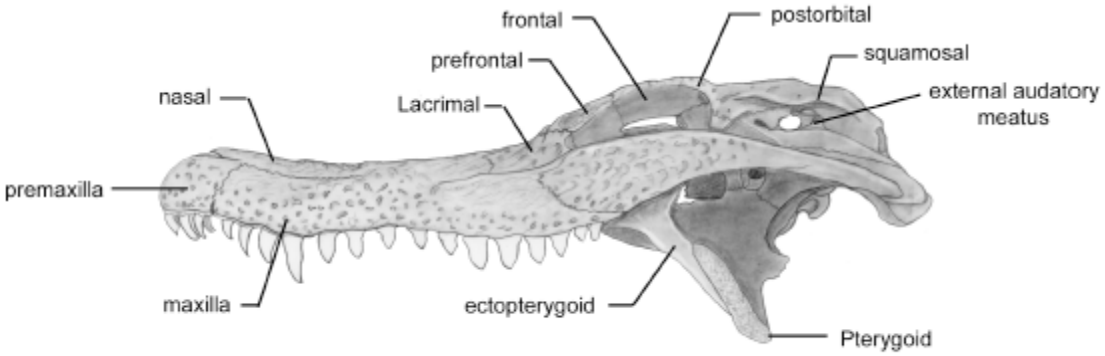
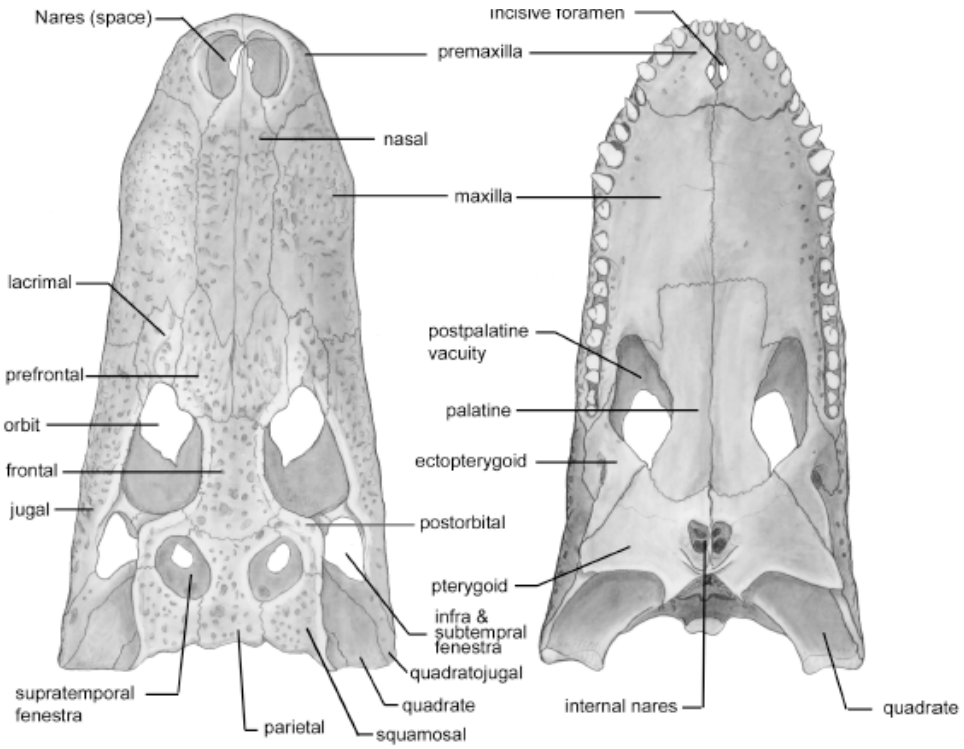
VIII. Crocodilia-Alligators/Crocodiles

There are 23 species of crocodilians in three groups (Alligatoridae, Crocodylidae, Gavialidae). These groups are distinguished by the snout shape.

Examine the alligator skull and observe the elongate snout with 1) nostrils on the dorsal tip of snout. The nostrils on the dorsal tip of the snout combined with a complete secondary palate (like mammals have) allow crocodilians to breathe when the mouth is underwater (or full of food). Look at the skull to see the 2) secondary palate. Also look on the skull to observe the 3) laterally compressed teeth. The teeth of crocodilians are very similar to those of the dinosaurs. Crocodilians are also characterized by 4) a triangular eye orbit. Crocodilians have epidermal scales that appear "armor-like" due to the presence of osteoderms (a dermal bone located under and supporting an epidermal scale-but not part of the scale itself).



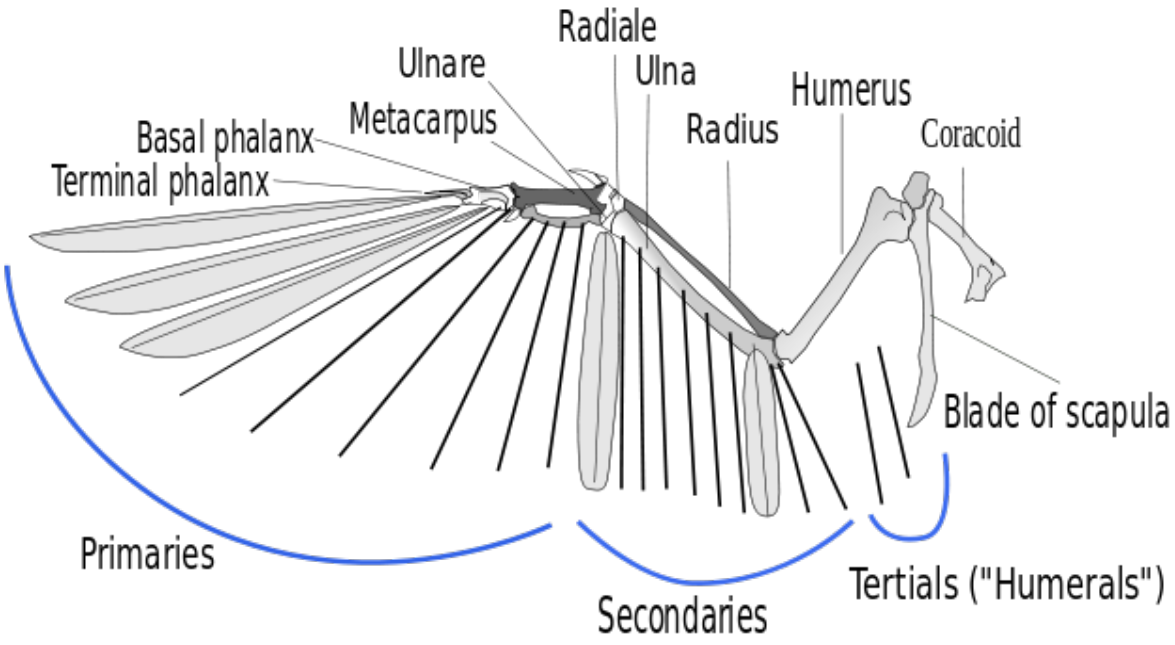


IX. Aves-Birds

Aves is a diverse group that includes more than 9,700 species. Most species are specialized for flight, and even those that have abandoned flight for strictly aquatic or terrestrial lifestyles retain those characters that readily distinguish a bird from other vertebrates.

Birds are the only vertebrates to possess 1) feathers. On the body of the birds observe 2) the contour feathers that form the contour or out-line of the bird's body. These feathers have been variously modified to serve different functions. On 3) the wings, there are several types of feathers that serve different purposes. Observe the wing mounts to distinguish 4) the primary feathers from 5) the secondary feathers. The bases (close to the bone) of both the primary and second-ary feathers are covered by 6) the wing coverts. What functions do these different feathers serve? On the tail of the bird, observe 7) the retrices. What role do the retrices play in flight? How do the tail feathers of different birds (e.g., woodpecker, pheasant) compare? Depending upon the species, time of year, and age of the bird, 8) down feathers can be found underneath the contour feathers. Observe the down feathers on display. What functions do down and contour feathers serve?

Birds lack teeth and have 9) horny beaks of different sizes and shapes. Birds are bipedal (walk on two hind legs). Observe the elongated 10) tarsus that is covered with 11) epidermal scales.



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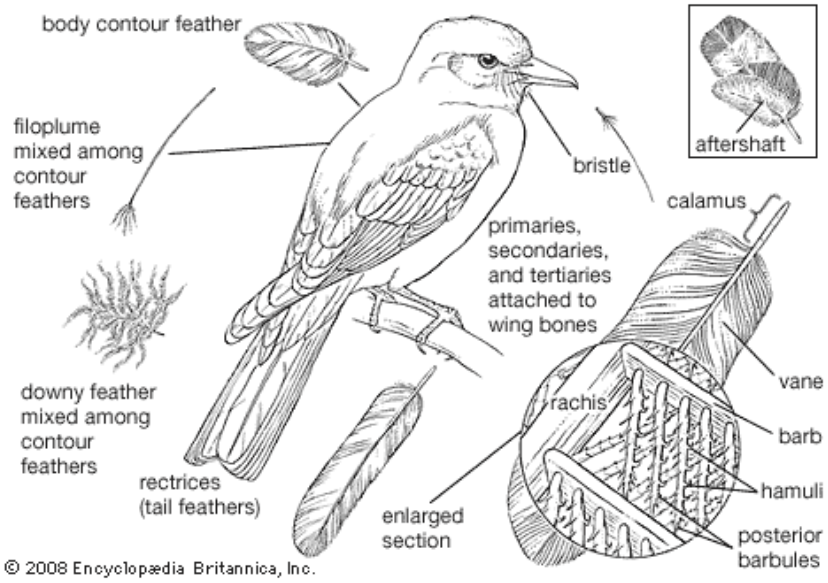
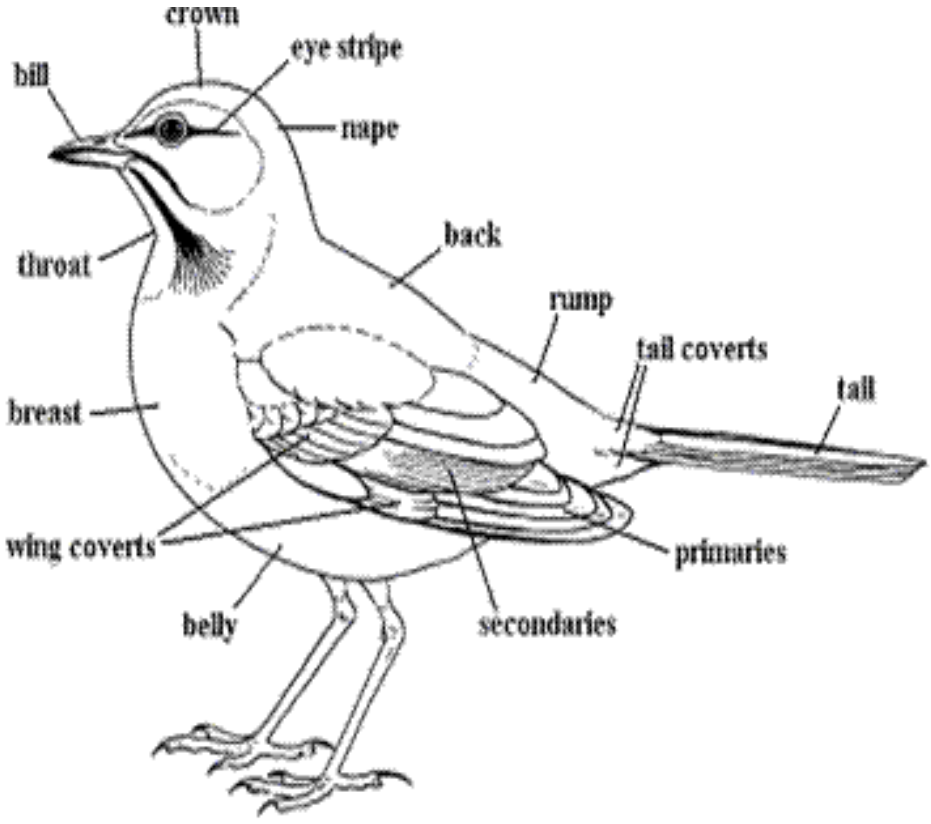
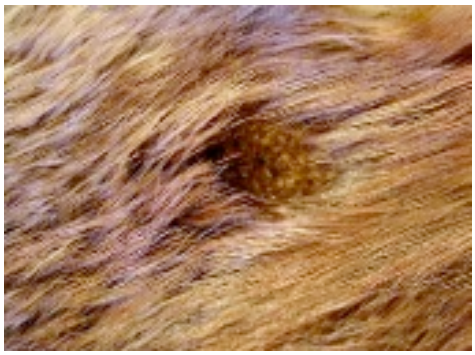




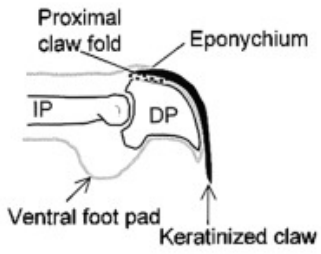
X. Mammalia-Mammals

The approximately 5488 species of mammals range in size from 15 ml to 30 m. Mammals are divided into 3 main groups: Monotremata (echidna and platypus), Marsupialia (marsupials), and Eutheria (New Beast). There are several defining characteristics of mammals, including the presence of mammary glands in females that produce milk for their young.

Hair, a unique feature of mammals, is an epidermal structure that has been modified to serve different functions, including thermal regulation. Examine the mammal specimens and compare the length and texture of hairs. On the coyote or fox specimen, find the 1) underfur, 2) guard hairs, and 3) vibrissae. How do the functions of these hair types differ?



The distal ends of the digits of most mammals possess either 4) nails, 5) claws, or 6) hooves. All are composed of a fibrous protein called keratin, but differ in structure and placement. Examine the different specimens (and your own fingers) to distinguish between nails, claws, and hooves.



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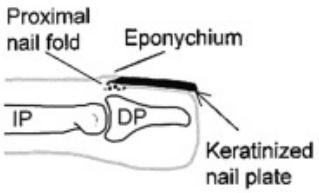

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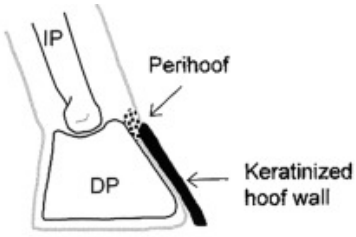

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a) Claw – found in most amniotes.
b) Fingernail – Found in primates, including humans.
c) Hoof – The tip of the toe found in ungulates.

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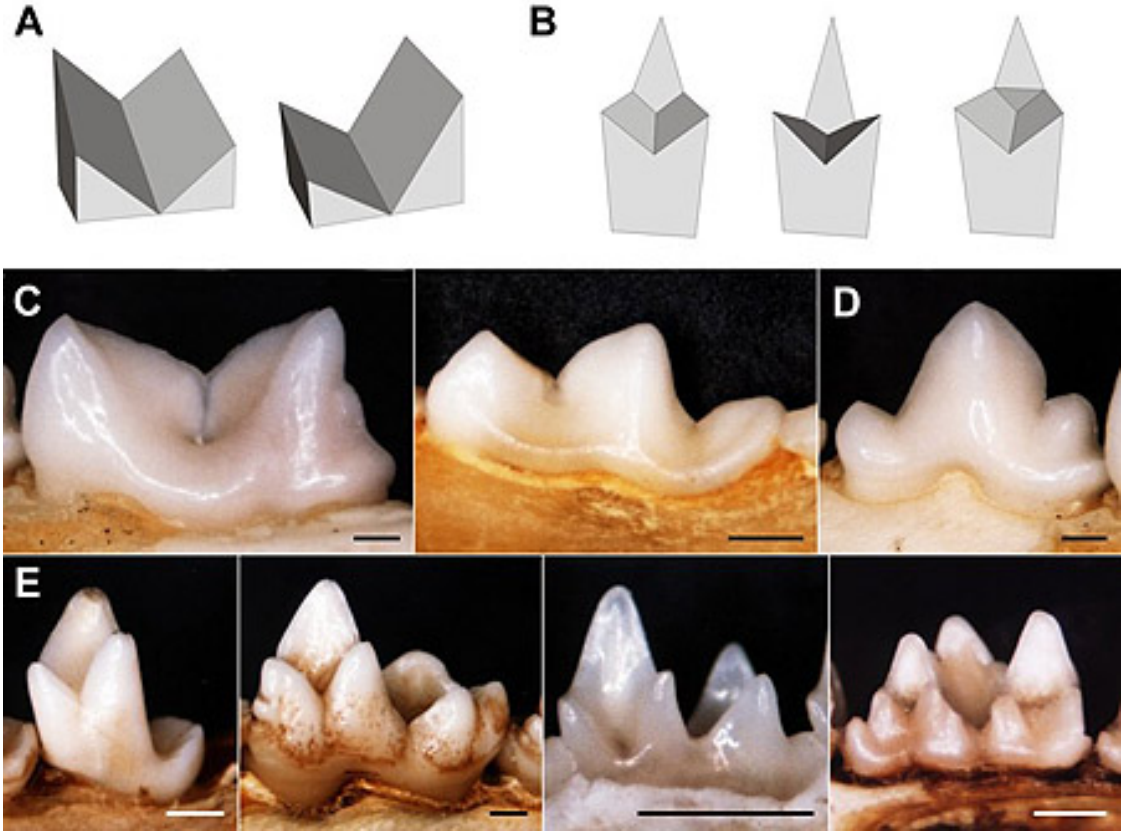
The teeth of most mammals are highly modified and very efficient at grinding, shearing, and chewing food. Observe the skull of the coyote and the monkey to distinguish the incisors, the canines, and the molars. The top and bottom teeth of mammals are closely aligned, allowing the jaws to close bringing the teeth together.



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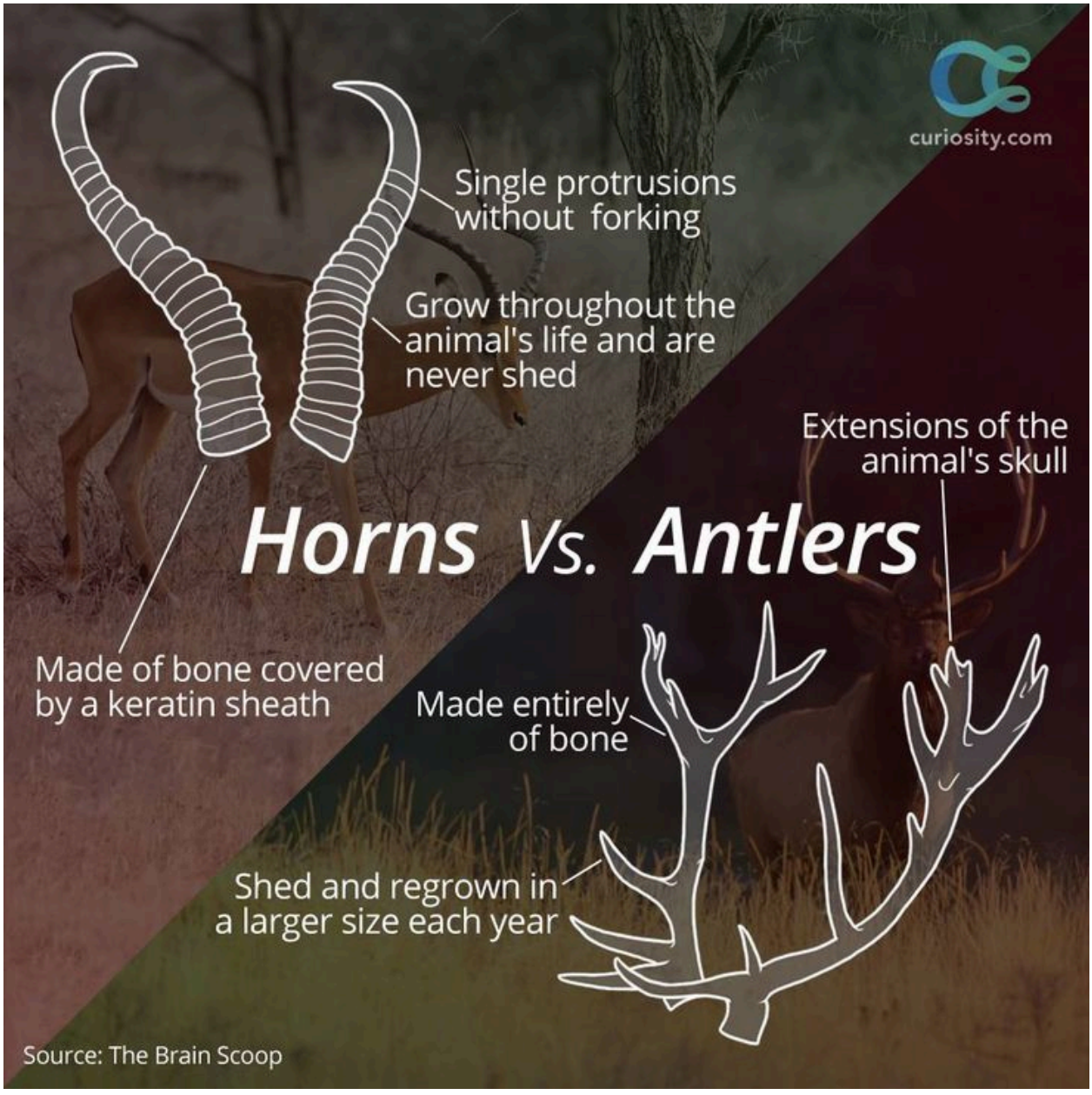
The skulls of many ungulates (hoofed mammals) are adorned with either antlers or horns. Examine the skulls of the deer and pronghorn as well as the other mammal heads in lab to observe antlers and horns, respectively. How do horns and antlers differ with respect to permanency (shed annu-ally versus permanent) and structure?



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Lab Assignment 1: (10 pts)

Dichotomous Key to Vertebrate Groups-External Features

Each vertebrate lineage possesses unique features that can be used to identify them. Dichotomous keys are useful to help biologists identify unfamiliar organisms and understanding their evolutionary relationships. Using the key external characteristics that distinguish the different vertebrate groups observed in lab, construct a dichotomous key to the following vertebrate groups.

I.	**Myxinoidea**	**VI.**	**Testudinata**
II.	**Petromyzontoidea**	**VII.**	**Squamata**
III.	**Chondrichthyes**	**VIII.**	**Crocodilia**
IV.	**Osteichthyes**	**IX.**	**Aves**
V.	**Amphibia**	**X.**	**Mammalia**

You can begin by using the list of characters provided. NOTE: This list of characters is NOT exhaustive; you will have to include other characters to distinguish the vertebrate groups in your key.

Characters:

lower jaw	ctenoid	feathers
dermal scales	cycloid scales	bony operculum
epidermal scales	heterocercal caudal fin	tympanum
placoid scales	choanae	

A dichotomous key is basically a series of paired, unambiguous questions that can be used to subdivide a group of organisms (or objects) into unique entities. The title of a key will first limit the group of organisms to be identified. For example, a key to the reptiles in North America would include a much larger group to be identified than a key to the reptiles of Bernalillo County. As you construct you key, visualize a process dividing the entire group into smaller and smaller divisions until each division contains only one entity. For example, if you had 8 objects of 4 shapes, different sizes, and two colors your key could look like this:

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It often helps to construct a data table of the external features that you are using. Below is an example for the groups you are studying today.

Name of animal	Appendage			Body covering				Breathing mechanism	
	Fins	Four limbs	Wings	Smooth Skin	Scales	Feathers	Fur	Gills	Lungs
Hagfish									
Lamprey									
Chondrichthyes									
Osteichthyes									
Amphibia									
Testudines									
Squamates									
Crocodilia									
Aves									
Mammals									

Keys are due at the end of the first lab. Your grades will be based on

1) completeness (does your key distinguish each group?),

2) concise logic of key (does your key differentiate between the different groups efficiently?),

3) concise descriptions of characters used, and

4) presentation (is your key neat and in requested format?).