

# 10. Biological Classification and the Living Primates

## OBJECTIVES

- Become familiar with the basis for biological classification
- Understand the concept of homology and its use in classifying living organisms
- Know the characteristics of the primate order
- Distinguish characteristics of the major groups and subgroups of primates
- Learn to identify primate groups based on skeletal features

## “Have you ever wondered...?”

- ☞ What is the difference between a monkey and an ape?

All living things are related. Some groups share a more recent common ancestry than others, and the farther back in time the common ancestor for two groups goes, the fewer features the descendants will share with each other. Fleas are in the Kingdom Animalia, along with bears—and humans. Animals comprise a diverse group. This will become clear as you think about some characteristics humans share with fleas and some characteristics we share with bears.

### Establishing Evolutionary Relationships

Our shared ancestry with the flea can be traced far back in time, before humans, bears, or even mammals or vertebrates existed. Our shared ancestor is found early in the Paleozoic Era, which began about 600 million years ago. Many types of invertebrates existed at that time, but this was long before the first vertebrate appeared.

Over time, vertebrates evolved and diversified into various groups. One of the groups evolved into a creature with live-bearing young, fur, relatively large brain, teeth specialized for different functions, and a constant internal body temperature. These mammals originated within the Mesozoic Era, more than 200 million years ago. Mammals diversified, giving rise to the groups that included the taxonomic Order Carnivora, of which bears are a member, and the Order Primates, the order in which humans are a member.

Thus, the more distant shared ancestry of the human and the flea resulted in few shared features, but the more recent common ancestry of the bear and the human resulted in more shared features, which also are shared with many other mammalian species. The features that groups share as a result of common ancestry are called **homologous features**, or **homologies**. Figure 10.1 illustrates some of the species within the Kingdom Animalia, with a homologous feature (the humerus) illustrated.

The group called the vertebrates contains a bony internal skeleton. It forms the **Subphylum Vertebrata**. Because similar characteristics are used to group (classify) organisms, we have to know how the characteristics that form the basis for our classifications arose in the first place. Similarities between groups of organisms can arise in two primary ways, analogies and homologies.

### Analogies

The fish and the dolphin in Figure 10.1 are superficially similar in body form, reflecting adaptations to similar conditions rather than descent from a common ancestor possessing



FIGURE 10.1 Various Members of the Kingdom Animalia

that body form. This is an example of an **analogy**, in which a feature evolves independently in different groups as a result of similar evolutionary pressures resulting in similar adaptations. Dolphins evolved from land mammals but converged upon a fish body form as a result of their gradually adapting to an aquatic environment. **Convergent evolution** caused analogous features to appear in fish and dolphins, which share a distant ancestry.

The bird's wing and the bat's wing provide another good example of an analogous character that arose independently in the two groups. Other examples of analogies are the body form of a rabbit and that of a bandicoot (an Australian

marsupial), and aquatic adaptations of seals and sea lions, each of which evolved separately from land-adapted mammals.

### Homologies

Alternatively, the features of the two groups may be similar because their common ancestor had the feature and both descendant groups inherited it. As mentioned above, a feature deriving from a common ancestor is termed a **homology**. For example, dogs and bears both have a humerus because they share a common ancestor (some early carnivore) that had a humerus. Cats and crocodiles both have femurs because they share a common ancestor (some early reptile of the Mesozoic Era) that had a femur. The lack of a tail in humans and in apes is another feature in the common ancestry of these groups. *Homologous features are useful for classification, because they reflect evolutionary relationships.*

### Primitive Features Versus Derived Features

Two other concepts important in understanding evolutionary relationships are **primitive features** and **derived features**. A vertebral column is a primitive feature for vertebrates; the common ancestor of vertebrates had a vertebral column. Within the vertebrate group are the mammals, those features shared by and unique to mammals among the vertebrates are termed derived features. Derived features are distinct and changed from those of the common ancestor. For example, only primates have opposable thumbs, so this is a derived feature shared only by other primates, not with all mammals.

## LAB EXERCISE 10.1

NAME \_\_\_\_\_ SECTION \_\_\_\_\_ DATE \_\_\_\_\_

Of the array of varied creatures within the Kingdom Animalia, some fly, some crawl, some leap, and some swim. This exercise asks you to place a number of them into taxonomic groups and decide which groups are related most closely to which other groups.

1. Start with a small sample to work with first, consisting of: fish, horse, frog, dolphin, butterfly, pigeon, dog, and bat. You could dissect them to see the underlying structures, or refer to Figure 10.1 for the illustrations of various animals in the Kingdom Animalia, with part of the forelimb visible for comparison.

2. What separation would you make first? Which has an ancestry that is the most distant from the others?

\_\_\_\_\_. Once that creature is separated from the others, all seven of the other species stand together in a group. What is an important feature common to all seven?

3. Of those seven remaining animals, now figure out which ones are mammals. Which of the following characteristics would help you decide, and why?

fur

vertebral column

limbs

mammary glands

opposable thumbs

homeothermy (warm-blooded)

4. Is the bird and bat humerus an example of analogy or homology? (Check with your instructor on this one!)



## Biological Classification

Classifications are information-retrieval systems that order objects into groups on the basis of similarities. These hierarchical systems consist of sets with subsets, each lower set sharing an increasing number of characteristics. Biological classification specifically orders living organisms into groups and subgroups based on their evolutionary relationships.

**John Ray** (British), **Casper Bauhin** (Swiss), and **Carl Linnaeus** (Swedish) each devised a biological classification system independently. Although Ray and Bauhin lived and worked in an earlier time than Linnaeus did, the latter's work alone is what is remembered. The system of **binomial nomenclature** uses two names, the **genus** and the **species**. For example, in *Australopithecus africanus*, *Australopithecus* is the genus and *africanus*, the most basic unit, is the species.

The **binomen** is a combination of names for genus and species that is unique and universal. Latin, which is no longer the primary language of any country, enables scientists worldwide to communicate without favoring one language over another. Although common names differ among countries, scientific names are the same everywhere. For example, dog is *perro* in Argentina and Mexico, *chien* in Quebec and France, but *Canis familiaris* is the term used by scientists all over the world.

The biological classification hierarchy for the orangutan looks like this:

Kingdom	Animalia
Phylum	Chordata
Subphylum	Vertebrata
Class	Mammalia (mammals—not birds, reptiles)
Order	Primates (prosimians, monkeys, apes)
Family	Pongidae (ape family)
Genus	<i>Pongo</i>
Species	<i>Pongo pygmaeus</i>

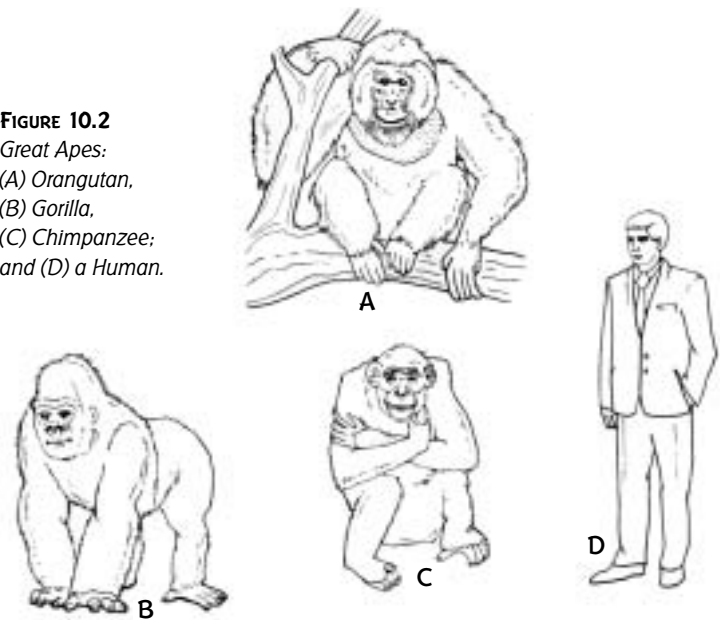
## Alternative Classification Schemes

The science of naming organisms is called **taxonomy**. A **taxon** (*pl: taxa*) is a taxonomic group. At higher levels of classification, members of a taxon share fewer characteristics and a common ancestor farther back in time. At lower levels, members of a taxon share increasing numbers of characteristics and a more recent common ancestor. Groups of species are classified on the basis of their evolutionary relationships. Alternative ways of classifying organisms are based on two facets of such relationships:

1. Recency of divergence—how recently two groups shared a common ancestor
2. To what extent the groups diverged—how much change has occurred in each group in the time since they shared a common ancestor

Figure 10.2 presents illustrations of three apes and a human. Through biochemical and fossil evidence, we know that orangutans diverged from the evolutionary line leading to African apes (chimpanzees and gorillas) and humans more than 15 million years ago. Therefore, African apes and humans share a more recent common ancestor with one another and are more closely related to each other than any of the three are to the orangutan. Humans, however, have diverged much more since the time of the common ancestor. We differ more from the common ancestor in appearance and (presumably!) in behavior than any of the other great apes.

**FIGURE 10.2**  
Great Apes:  
(A) Orangutan,  
(B) Gorilla,  
(C) Chimpanzee;  
and (D) a Human.



The more traditional classification, based upon the school of thought called **evolutionary taxonomy**, would place humans apart from all of the great apes because we have diverged more than the other apes since our split from the common ancestor. The newer (now more common) school of thought is **cladistics**, which emphasizes the actual timeframe of evolutionary divergence.

## The Order Primates

The primates constitute an order of mammals. Examples of other orders within the Class Mammalia are

- ☞ Rodentia (rodents)
- ☞ Chiroptera (bats)
- ☞ Artiodactyla and Perissodactyla (the two hoofed mammal orders).

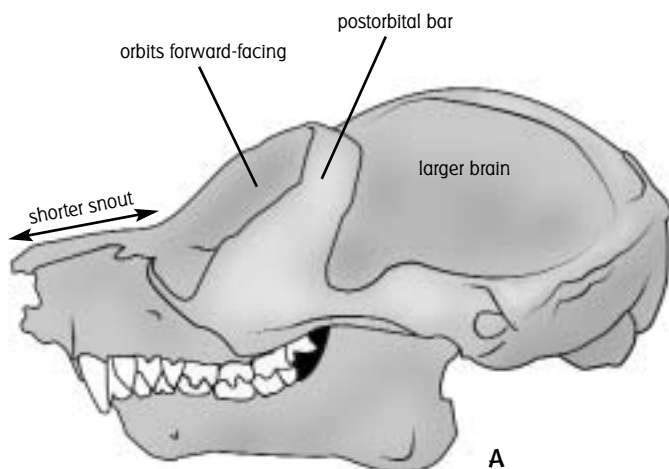
It is thought that the Order **Primates** originated from insectivore-like (shrew/hedgehog order) stock approximately

65 million years ago. The evolution of primates is discussed further in Chapter 12.

Homologous skeletal features can be used to classify the primates in terms of their place in the Class Mammalia, and their subgroupings within the primate order. Although we now can also use a number of genetics techniques for classification, in this lab we will cover skeletal features that are useful for grouping the primates. The following is a list of primate characteristics, or evolutionary trends of the order. Figure 10.3 illustrates some of these features that serve to distinguish *most* primates from *most* other mammalian orders. Although some other groups possess some of these features, primates have all or most of these as a *suite* of characteristics.

- \*1. Unique ear region
  - petrosal bulla (*Atlas*, p. 9, Figure 1.15)
- \*2. Retention of unspecialized limb skeleton
  - retention of five fingers and five toes and retention of clavicle; this is unlike hoofed mammals, for example, which have lost most of their digits and have no clavicle
- \*3. Nails (rather than claws) on digits; tactile pads
- \*4. Grasping hind feet with opposable first toes; grasping hands; some with opposable thumb
- \*5. Increased emphasis on vision:
  - forward-facing eyes allowing for better depth perception
  - expanded occipital and temporal lobes (visual centers)
  - color vision (in most primates)
- \*6. Complete ring of bone around orbit: postorbital bar
- \*7. Enlarged brain relative to body size; complex, more elaborate neocortex

\*Features that are especially important because they also can be observed in the fossil record.



- \*8. Decreased emphasis on olfaction:
  - shortened snout
  - small olfactory bulbs
- \*9. Decrease in number of teeth; primitive cusp pattern preserved
- 10. Longer fetal nourishment, intrauterine development, prolonged stages of lifespan
- 11. Longer period of infant dependency and parental care
- 12. Most are gregarious (live in social groups) with well-developed communication systems

### Distribution, Habitat, Diet

Extant (living) primates are distributed throughout much of the tropics and subtropics, although their numbers are drastically declining, mostly a result of habitat encroachment. They occur in tropical Africa, India, and Southeast Asia, as well as South and Central America (and a few even in North America, in Mexico)—see Figure 10.4. The primate inhabitants of Madagascar, besides the relatively recent addition of humans, are a diverse group that includes all lemur-like forms.

Primates inhabit a variety of habitats, from wet rainforest to quite dry savanna. As an order, primates are highly adaptable and sometimes coexist successfully with humans. Most primates eat a basically vegetarian diet, but they may specialize in certain classes of foods. These dietary types are:

☞ **folivory** (leaf-eating)

☞ **frugivory** (fruit-eating)

☞ **gramnivory** (seed-eating)

☞ **gummivory** (gum-eating)

Some are primarily *insectivorous*. Many are *omnivorous* and eat a variety of plant and animal matter. As you saw in Chapter 9, dietary adaptations are reflected in the dentition.

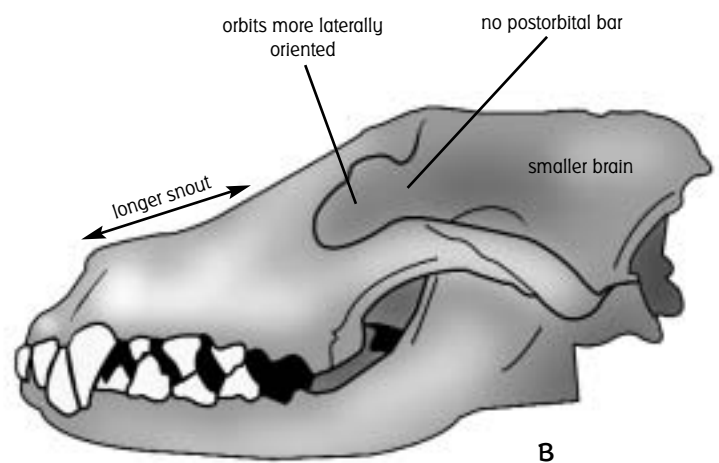


FIGURE 10.3 Some Comparative Features of (A) Primate and (B) Nonprimate



**FIGURE 10.4** *Primate Distribution*



# L A B E X E R C I S E 1 0 . 2

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In examining a number of mammal skeletons—for example, bear, lion, opossum, wolf, raccoon, pig, and elephant, in addition to several primate species—what characteristics would you use to decide whether a skeleton is a primate or not?

1. Circle the characteristics you would use.

fur	opposable thumbs
forward-facing eyes	relatively small olfactory bulbs
relatively large brain	mammary glands

2. For the characteristics you did not circle, why didn't you think they would be useful to differentiate primates from nonprimates?

3. Fill out the chart below, using the photos on the next page or skulls in your lab collection.

	<b>Dog</b>	<b>Monkey</b>
Postorbital bar?		
Cranium size relative to body size (or face)		
Emphasis on vision versus olfaction		
Type of teeth		
*Opposable first toes or thumbs?		
*Nails or claws?		
*Not observable from the photo		



Dog skull



Monkey skull

4. Look at the photos below or your lab specimens and *note the form* of the listed features in the chart below. You later will use your answers to place the specimens into suborders (Strepsirhini and Haplorhini).



Specimen	Fused mandibular symphysis? (Is the mandible one bone or two)	Cranium size relative to face	Fully enclosed orbit?	Toothcomb? (Lower incisors jut forward)
A				
B				
C				
D				
E				













**Primate Classification**

The primates can be divided into two suborders, the **Strepsirhini** and the **Haplorhini**, named for the form of their nose. Strepsirhini refers to the “turned nose” (comma-shaped nostrils), as contrasted with Haplorhini, the “simple nose.” Each of these two suborders is made up of richly varied primates that can be subclassified into various infraorders, superfamilies, families, and so forth.

- ☞ Strepsirhines exhibit a number of primitive characteristics that are shared by most mammals, but they are united by two important **derived features** (unique to the group): a toothcomb and a grooming claw. The best-known example of a strepsirhine is a lemur.
- ☞ The haplorhines are more obviously “human-like” and include monkeys of both the New World (the Americas) and the Old World (Africa and Asia), the apes (chimpanzees, gorillas, orangutans and gibbons), and humans.

Figure 10.5 shows selected examples of these suborders.

**Suborders** The traditional classification of the primates split the primates into two suborders— **Prosimii** (*G pro* – before; *L simia* – ape) and **Anthropoidea** (*G anthrop* – man; *oid* - like)—instead of Strepsirhini and Haplorhini. The primate members of the two groups in both the traditional and the newer classification are virtually the same, with the exception of the tarsier (discussed next).

Suborder Strepsirhini	Suborder Haplorhini
 <p>Moist rhinarium; Split upper lip</p>	 <p>Dry nose; Continuous upper lip</p>
Tapetum lucidum (reflective cell layer on retina; allows better night vision)	Lack of tapetum lucidum
 <p>Bicornuate uterus</p>	 <p>Unicornuate uterus</p>
Epitheliochorial placenta (placental membranes diffuse in uterus; fetal circulation more separated from maternal circulation)	Haemochorial placenta (placenta localized into a disk form; greater intimacy between fetal and maternal circulation results in more efficient transmission of nutrients to fetus)
 <p>No postorbital closure (unenclosed orbits)</p>	 <p>Postorbital closure (enclosed orbits)</p>
 <p>Metopic suture; Unfused mandibular symphysis (two-bone mandible)</p>	 <p>Metopic suture fuses after infancy; Fused mandibular symphysis (one-bone mandible)</p>
 <p>*Toothcomb</p>	 <p>Lack of toothcomb</p>
 <p>*Grooming claw on second digit of foot</p>	 <p>Nails on all digits</p>

**FIGURE 10.5** Selected Characteristics of the Primate Suborders

\*derived features for strepsirhines

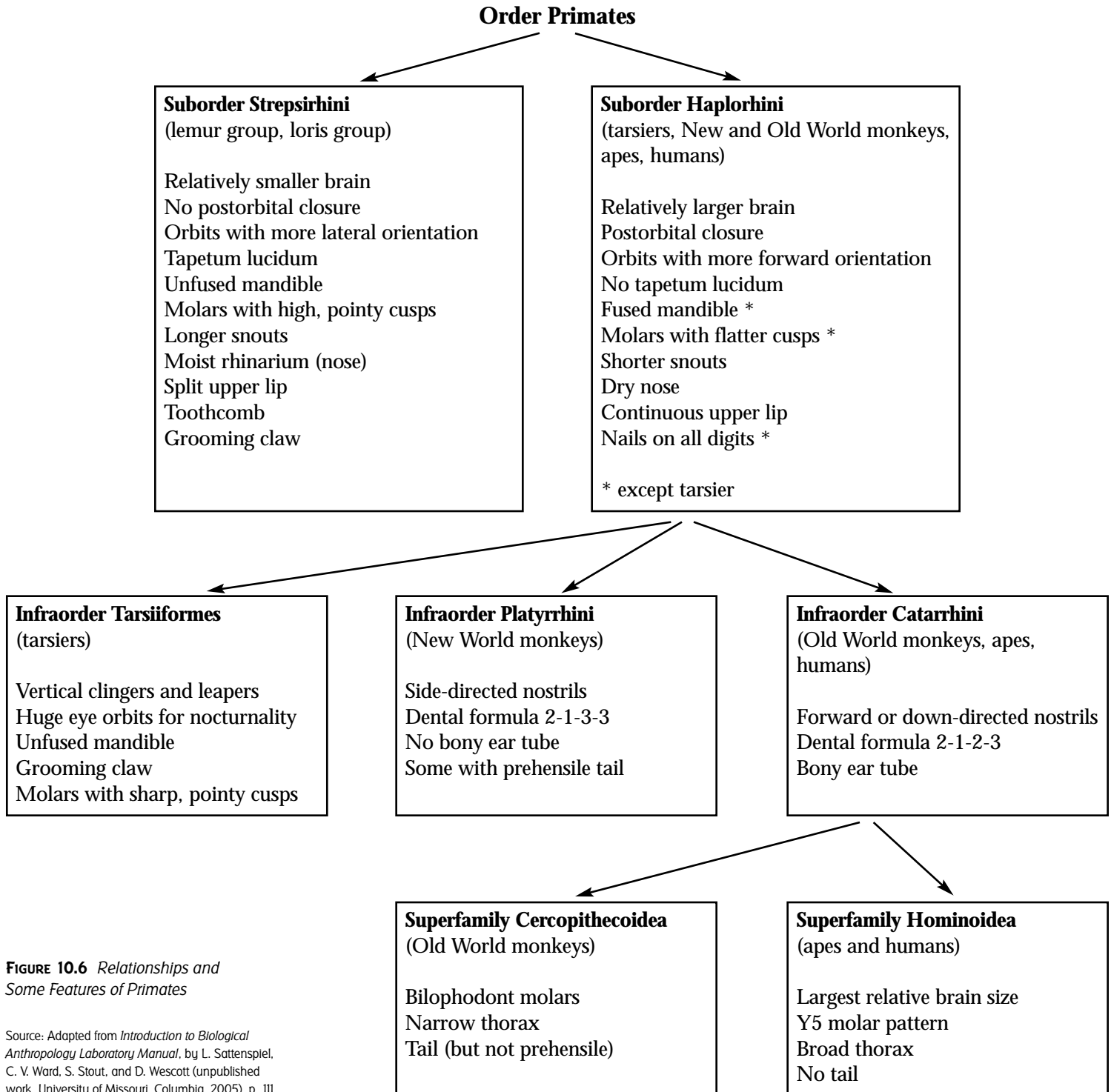
**Infraorder Levels** Strepsirhines and haplorhines each include infraorders and lower-level taxa, but we will focus on the haplorhines only, as they are more closely related to us.

Figure 10.6 is a partial classification of the primate order.

The Haplorhini has three infraorders:

1. **Tarsiiformes** (tarsiers)
2. **Platyrrhini** (*G plat:* broad; *rhin:* nose)
3. **Catarrhini** (*G cat:* downward; *rhin:* nose)

Tarsiers (see Photo 10.1) are distinct from the other haplorhines and were traditionally classified with the strepsirhines in the old suborder Prosimii. The platyrrhines (New World monkeys) and catarrhines (Old World monkeys, apes, and humans) are more similar to each other. Important differences are found those of the ear region shown in Photo 10.2 (note the bony ear tube, the ectotympanic tube, on the catarrhine), and the nose, in Figure 10.7.



**FIGURE 10.6** Relationships and Some Features of Primates

Source: Adapted from *Introduction to Biological Anthropology Laboratory Manual*, by L. Sattenspiel, C. V. Ward, S. Stout, and D. Wescott (unpublished work, University of Missouri, Columbia, 2005), p. III.

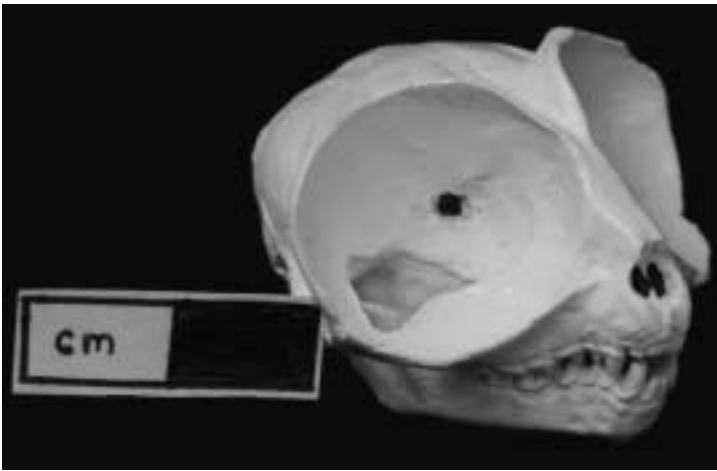


PHOTO 10.1 Tarsier skull

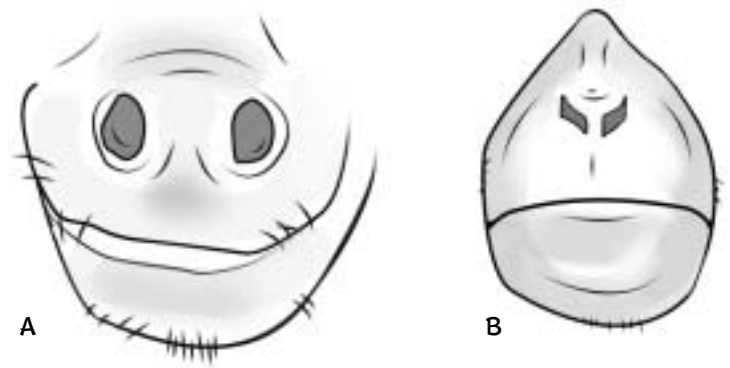


FIGURE 10.7 Nose Shape and Nostril Orientation in Platyrrhines and Catarrhines

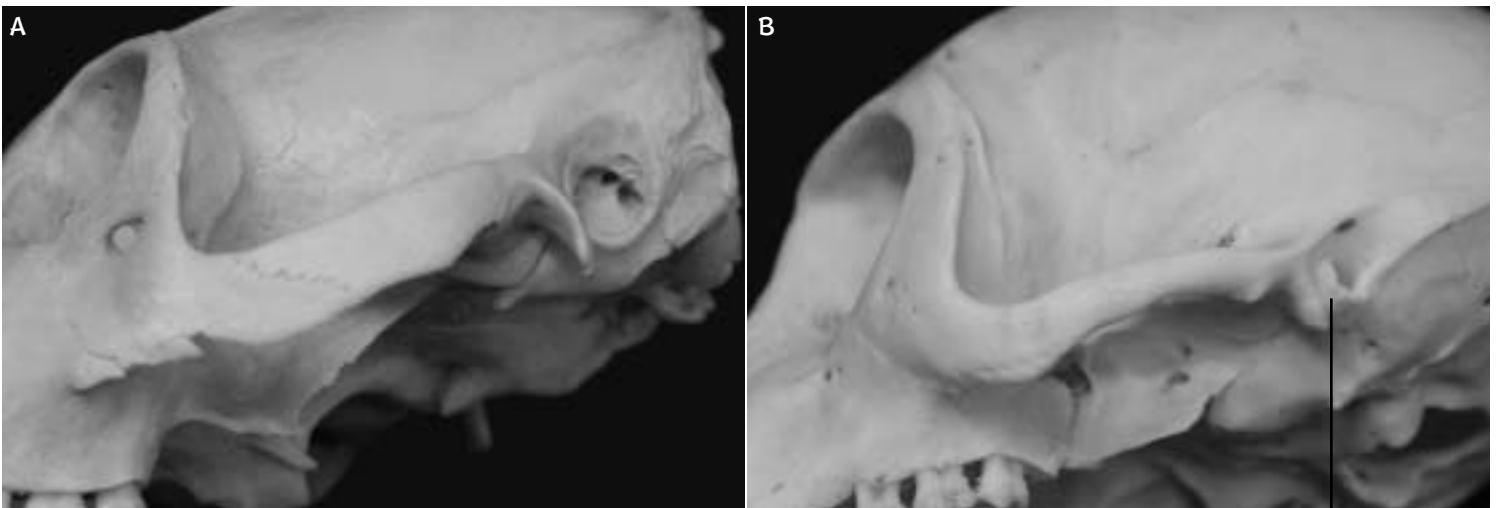


PHOTO 10.2 (A) Platyrrhine and (B) catarrhine ear region.

bony ear tube

**Superfamily Level** As we move down to lower levels in the biological classification system, members of the taxa share more features. We will continue to focus on the haplorhines, keeping in mind that the strepsirhines also have taxonomic sub-groupings.

Within the Platyrrhini, there is only one superfamily of New World monkeys, the **Ceboidea**. We will not classify the lower levels within the Ceboidea. Examples of New World monkeys include spider monkeys, capuchins, squirrel monkeys, marmosets, and tamarins.

Within the Catarrhini, there are two superfamilies: the **Cercopithecoidea** (Old World monkeys) and the **Hominoidea** (ape and human group). Some differences between the two superfamilies are given in Figure 10.6 and are observable in Figure 10.8.

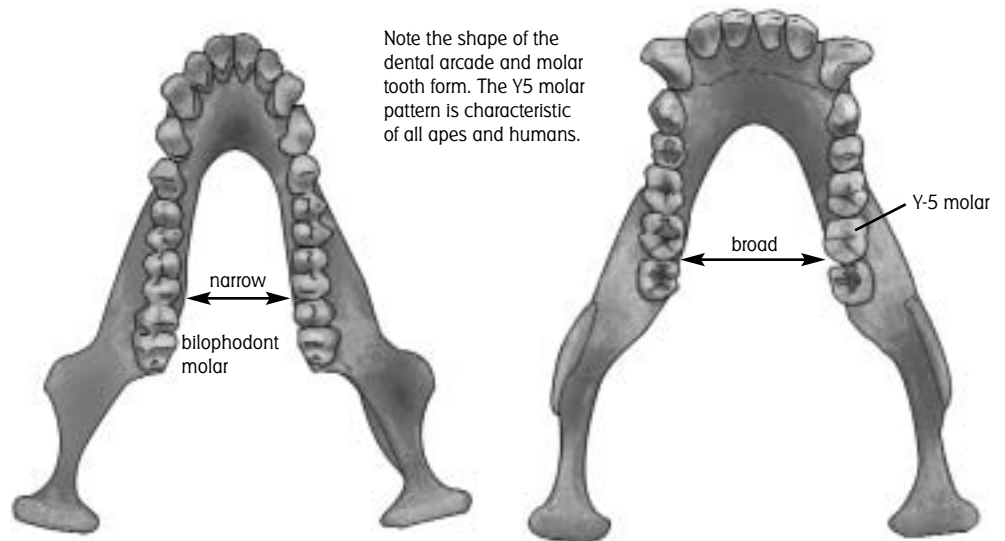


FIGURE 10.8 Examples of Differences Between (A) a Cercopithecoidea and (B) a Hominoidea.



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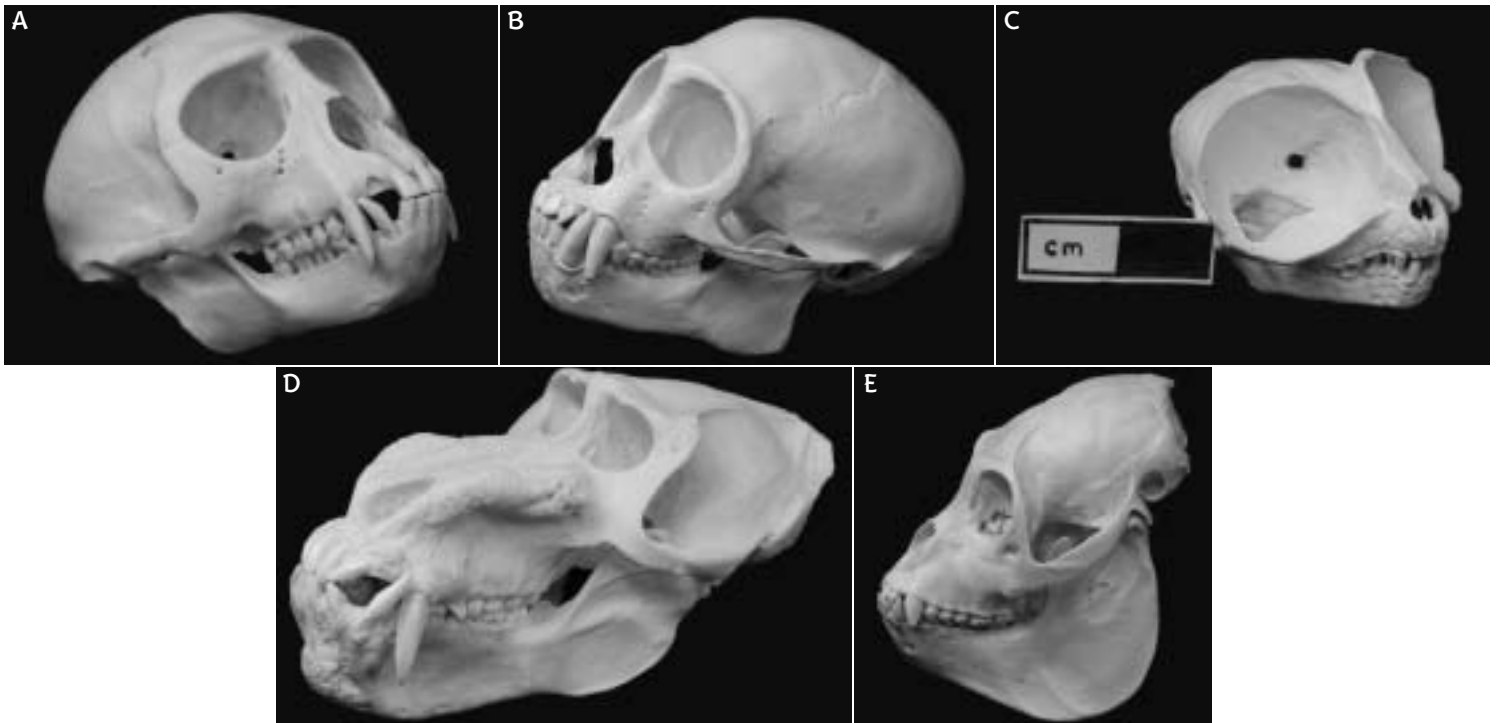
1. Using Figure 10.5 as guide, decide which of the specimens in photos A–E on page 190 are strepsirhines and which are haplorhines. List them below.

Strepsirhines:

Haplorhines:

2. Fill out the chart with reference to the photos A–E, shown below:

Specimen	Size of orbits relative to brain size (small or large)	Fused mandibular symphysis?	Fully enclosed orbits?	Dental formula (if observable)	Bony ear tube? (if observable)
A					
B					
C					
D					
E					



3. Which of the specimens are haplorhines? \_\_\_\_\_

Which are strepsirhines? \_\_\_\_\_

4. Is one of these specimens a tarsier? \_\_\_\_\_ If so, which one? \_\_\_\_\_

5. Which are platyrrhines \_\_\_\_\_, and which are catarrhines? \_\_\_\_\_

6. Using the last set of photos below, answer these questions for each. Be careful to use characteristics that are *distinguishing for that group* at that *specific level in the taxonomic hierarchy!* For example, if deciding whether an animal is a platyrrhine or a catarrhine, be sure to name features that distinguish members of Platyrrhini from Catarrhini.



*Photo A*

1. Is this a primate? \_\_\_\_\_ Why or why not?

2. Is this a strepsirhine or a haplorhine? \_\_\_\_\_ How do you know?

3. If a haplorhine, is it a tarsier, a platyrrhine or a catarrhine? \_\_\_\_\_. How do you know?

*Photo B*

1. Is this a primate? \_\_\_\_\_ Why or why not?

2. Is this a strepsirhine or a haplorhine? \_\_\_\_\_ How do you know?

3. If a haplorhine, is it a tarsier, a platyrrhine or a catarrhine? \_\_\_\_\_

How do you know?

*Photo C*

1. Is this a primate? \_\_\_\_\_ Why or why not?

2. Is this a strepsirhine or a haplorhine? \_\_\_\_\_ How do you know?

3. If a haplorhine, is it a tarsier, platyrrhine or catarrhine? \_\_\_\_\_. How do you know?



6. Name two strepsirhine characteristics that differentiate them from haplorhines.

a.

b.

7. Name two catarrhine characteristics that differentiate them from platyrrhines.

a.

b.

8. Name two haplorhine characteristics (that differentiate them from strepsirhines).

a.

b.

9. Name two platyrrhine characteristics (that differentiate them from catarrhines).

a.

b.

10. Name two differences between hominoids and cercopithecoids.

a.

b.