Pages 163-170 in your textbook cover general primate characteristics or features that all primates share. Humans, of course, are primates. Choose ***three*** of these characteristics, name them, and describe what they are. ***Also,*** describe how these traits can be seen in humans. You can use yourself as an example if you want. For example, you can say "When I look in the mirror I see X which is a primate characteristics". Or, you can say something like "When I look around me at a crowd of people I can see X". Or you can say "Everyone knows that X is very common in humans".

Please answer the question above in the form of a 1-2 page, typed, **double-spaced** paper submitted on Canvas as a Word **document or PDF** by 6 PM on **Sunday, March 12.** You should write in complete sentences with correct spelling, grammar, and punctuation. I will be looking for evidence that you understood the assigned reading, were able to apply information from class to the assigned reading, and used the assigned reading to answer the question in the assignment.

nonhuman primates nonetheless exhibit an amazing variety of size and form. Adult body weights range from less than 2 ounces (40 g) in mouse lemurs to more than 450 pounds (200 kg) in gorillas (Figure 6.3). Body shapes range from the graceful arm-swinging gibbon to the bizarre aye-aye.

Figure 6.3 Primate body size and shape vary widely from the 440-lb. (200-kg) gorilla to the 2-oz. (40-g) mouse lemur.

What Exactly Is a Primate?

Primates are mammals with grasping hands, large brains, a high degree of learned rather than innate behavior, and a suite of other traits. However, the primates are a diverse group, and not all species share the same set of traits. The order Primates is divided into two suborders: the **Strepsirhini,** or **strepsirhine** primates (lemurs and lorises), and the **Haplorhini,** or **haplorhine** primates (tarsiers, monkeys, apes, and humans) (Figure 6.4). We should not consider strepsirhines more primitive than haplorhines; both groups have been evolving on their own paths for more than 60 million years. But many of their adaptations are holdovers from the early days of the Primate order (Figure 6.5 on pages 164–165). Many taxonomists use a more traditional naming system, which is based on aspects of anatomy, for the major primate groups: the **prosimian** and **anthropoid** suborders. We'll see how the strepsirhine–haplorhine classification differs from the prosimian–anthropoid classification later in the chapter.

strepsirhine (Strepsirhini)
Suborder of the order Primates that includes the prosimians, excluding the tarsier.

haplorhine (Haplorhini)
Suborder of the order Primates that includes the anthropoids and the tarsier.

prosimian
Member of the primate suborder Prosimii that includes the lemurs, lorises, galagos, and tarsiers.

anthropoid
Members of the primate suborder Anthropoidea that includes the monkeys, apes, and hominins.

Anatomical Traits

We distinguish primates from other mammals by a set of traits that all primates share.

GENERALIZED BODY PLAN The primate body plan is generalized, not specialized. Many mammals have extremely specialized body designs; consider a giraffe's neck, a seal's flippers, or an elephant's trunk. Primates typically lack such specializations. Their generalized body plan gives them versatility; most primate species engage in a wide variety of modes of travel, for instance, from arm-swinging (in apes) to running, leaping, and walking (Figure 6.5).

Figure 6.4 The major groupings of living primates.

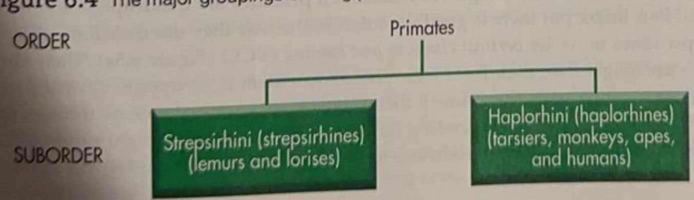
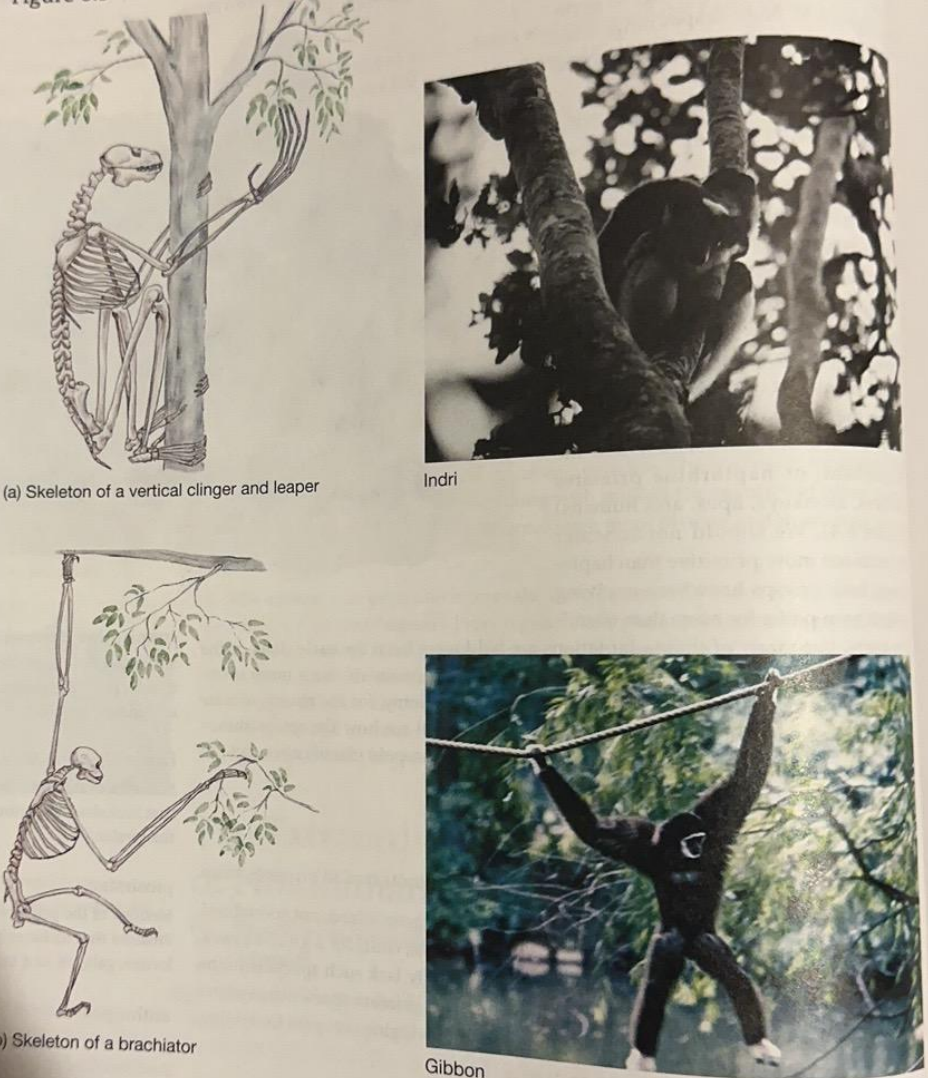


Figure 6.5 The Primate order displays a diversity of ways of moving around.



(a) Skeleton of a vertical clinger and leaper

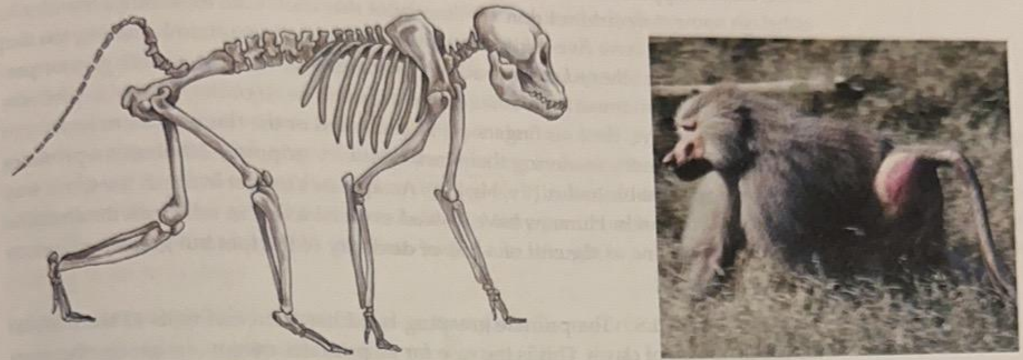
Indri

(b) Skeleton of a brachiator

Gibbon

Because primates evolved from ancient mammalian stock, they have inherited the many traits of that lineage. All nonhuman primates are quadrupeds and walk on all four limbs, but there is great variation in the way they use their limbs. Many strepsirhines move by *vertical clinging and leaping* (VCL) (Figure 6.5a). Their hind limbs are longer than their front legs. This allows them to sit upright against a tree trunk or bamboo stalk, then launch themselves from a vertical posture through the air, turning as they leap and landing upright against a nearby upright support. For instance, sifakas bound from tree trunk to tree trunk at high speed using this locomotion technique.

Figure 6.5 (Continued)



(c) Skeleton of a terrestrial quadruped

Baboon

(d) Skeleton of an arboreal quadruped

Uakari

Contrary to the commonly depicted image of them swinging through treetops, monkeys actually walk and run (on the ground and in trees) in much the same way that dogs, cats, and other four-legged mammals do (Figure 6.5d). Rather than arm-swing, monkeys run and leap along branches, their arms and legs moving in a limited plane of motion. The palms of their hands and feet make contact with the surface they are walking on. The skeleton of a monkey such as a baboon, which lives both on the ground and in trees, shows this clearly (Figure 6.5c). The running motion of any four-legged animal, whether a dog or a monkey, features a limited range of motion of the limbs, which are adapted for fast forward running, not three-dimensional climbing. The shoulder blade, or scapula, is oriented vertically across the upper arm and shoulder, allowing the arms to swing back and forth in a rapid pendulum motion but not to rotate. Although a few monkey species use their arms in what appears to be a semi-arm-swinging motion, this is by no means a widespread or well-developed adaptation in monkeys.

By contrast, an ape's arm has a full range of motion (Figure 6.5b on page 164). As we shall see, this is an adaptation to arm-hanging for feeding. Arm-hangers need a scapula that is oriented across the back rather than on the sides of the upper arms to allow this freedom of motion. Apes also possess a cone-shaped rib cage and torso; long, curved digit bones; small thumbs; and long arms to aid in arm-swinging.

GRASPING HANDS WITH OPPOSABLE THUMBS OR BIG TOES The grasping hand with an opposable thumb is believed to be the fundamental primate adaptation, although some strepsirhines don't fully exhibit this trait. Like most other mammals, primates typically have five digits per hand or foot. Having a thumb and big toe that are opposed to the other four digits allows primates to grasp objects with greater precision than other mammals. In some primates, such as colobine monkeys, gibbons, and spider monkeys, the four fingers are so elongated or the thumb is so reduced that the digits do not meet, rendering them less useful for gripping. Nonhuman primates also have an opposable hallux (the big toe). An ape uses its feet in much the same way that we use our hands. Humans have instead evolved a foot in which all the toes line up in the same plane, at the cost of a loss of dexterity of the foot but greater efficiency in bipedal striding.

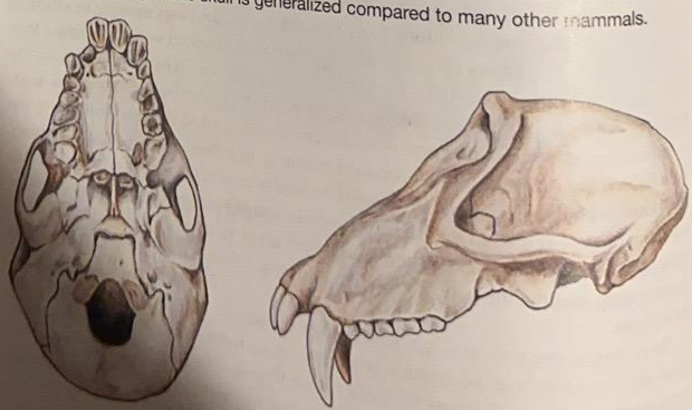
FLATTENED NAILS The primate grasping hand has flattened nails at the ends of the digits instead of claws. This is the case for all primates except one group, the marmosets and tamarins who have secondarily evolved claws from their nail structures. In addition, many strepsirhines have a combination of nails and a single clawed digit on their hands and feet.

FORWARD-FACING EYES WITH STEREOSCOPIC VISION Consider the way you see the world and compare it with the view of most other mammals (Figure 6.6). For example, a horse has eye sockets mounted on either side of its head. It has a field of vision that extends nearly 360 degrees, except for a blind spot directly behind. However, the horse's forward vision is not very good because the fields of vision of its two eyes don't fully overlap in front. Now consider your own vision. Like those of nonhuman primates, your eyes are mounted flush on the front of your head; your peripheral vision to the sides and behind you is severely constrained by this anatomy. But your forward field of vision is covered by both eyes. This stereoscopic view enables you to have excellent *depth perception* because the overlapping fields of vision provide a three-dimensional view of the world.

Stereoscopic vision, grasping hands, opposable thumbs, and nails rather than claws seem like an obvious suite of adaptations to life in the trees. This was the thinking of Frederic Wood-Jones and George Elliot-Smith, two British anatomists who proposed the idea in the 1920s. Their **arboreal hypothesis** was widely accepted and stood unchallenged for a half-century. But in the 1970s, Matthew Cartmill pointed out some key flaws in that model. Squirrels, he noted, lack the primate stereoscopic

arboreal hypothesis
Hypothesis for the origin of primate adaptation that focuses on the value of grasping hands and stereoscopic vision for life in the trees.

Figure 6.6 The primate skull is generalized compared to many other mammals.



vision and grasping hand with nails, yet they scamper up and down trees with great agility. To understand primate origins, Cartmill argued, we should consider how the very earliest primates and their close kin lived. The fossil record shows that early on, primates were anatomically very much like modern insectivores. Today, such small creatures live in the tangled thickets that grow around the base of tropical forest trees, where they live by stalking and capturing insects and other fast-moving prey. Cartmill hypothesized that these creatures are a useful analog for early primates; his **visual predation hypothesis** proposed that forward-facing eyes, depth-perceptive vision, and grasping hands for catching their prey, not for climbing in trees, were the key adaptations of ancient primates (Cartmill, 1974). Many predators have forward-facing eyes—eagles, owls, and cats, for instance—which are thought to aid them in precisely homing in on their prey.

visual predation hypothesis Hypothesis for the origin of primate adaptation that focuses on the value of grasping hands and stereoscopic vision for catching small prey.

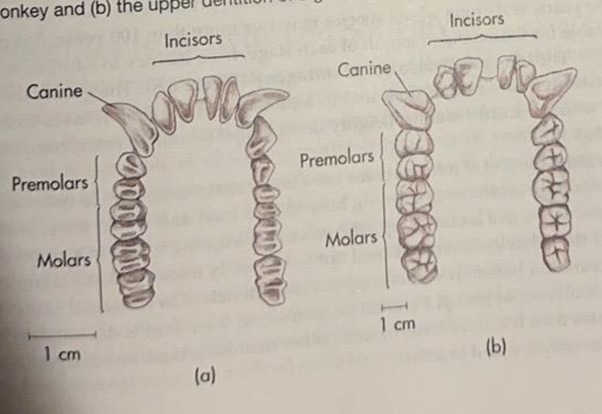
GENERALIZED TEETH Teeth are an extraordinarily important part of a nonhuman primate from an anthropologist's perspective. Their shape tells us a great deal about everything from a species' diet to its mating system (Figure 6.7). Fossilized teeth also allow us to cautiously infer patterns of behavior and diet in extinct primates we study. Most nonhuman primates eat a diet that is some combination of leaves, fruit, and other plant products, with occasional animal protein in the form of insects, small mammals, or other animals. Only one, the tarsier, eats mainly animal protein.

Nonhuman primates do not possess enormous canine teeth for tearing food, as carnivores do, nor do they have the heavy grinding molars that grazing animals have. Scientists believe that nonhuman primates have undergone an evolutionary reduction in the degree of specialization of the teeth, evident in the small canines and incisors and the rounded molars of most of them. If we consider the **dental arcade**, the arc of teeth along either the bottom or top of the mouth, beginning at the midline of the mouth there are four types of teeth arranged in the following dental formula: two incisors, one canine, two premolars (what your dentist calls bicuspids), and three molars. The exceptions to this pattern are most of the New World monkeys, which have a third premolar, and the strepsirhines, which have varying dental formulas.

dental arcade The parabolic arc that forms the upper or lower row of teeth.

PETROSAL BULLA The petrosal bulla is the tiny bit of the skeleton that covers and protects parts of the inner ear. Its importance to primate taxonomists is that this is the single bony trait that is shared by all primates, living or extinct, which occurs in no other mammalian group. When a fossil of questionable status is uncovered, researchers examine the ear portion carefully in search of the petrosal bulla.

Figure 6.7 The primate dental formula illustrated for (a) the lower dentition of an Old World monkey and (b) the upper dentition of a gorilla.



ENCLOSED BONY EYE ORBITS IN THE SKULL Primates also have an apparent anatomical adaptation to the importance of vision: enclosed (or partially enclosed) bony eye orbits in the skull, which may protect the eye more effectively than the open orbit of lower mammals (Figure 6.6 on page 166). This orbital closure is more complete in haplorhines than it is in strepsirhines who tend to have just a bony ring around the orbit.

Life History Traits

The life history of mammals—their trajectory from conception to death—varies widely. In general, mammals that reproduce slowly, live long lives, and acquire information about their world through learning and not their genes, have delayed maturation and drawn-out life histories. Primates take this trend to an extreme.

SINGLE OFFSPRING Nearly all primates give birth to single offspring. Many mammals, especially smaller species, give birth to litters or twins. The only exception among nonhuman primates is the marmosets and tamarins, which give birth to twins. Single births, combined with the long maturation period and the amount of time and energy mothers invest in their offspring, represent a strategy in which investment of time and energy in a few babies has replaced the more primitive mammalian pattern of litters of offspring that receive less intensive care.

neocortex
The part of the brain that controls higher cognitive function; the cerebrum.

LARGE BRAINS Primates have large brains. They possess a high degree of *encephalization*, or evolved increase in the volume of the **neocortex** of the brain, which is involved in higher cognitive processes. This is more obvious in the brains of haplorhine primates than in strepsirhines, and we see it in the greater number of convolutions that compose the ridges and fissures (sulci and gyri) of the brain's surface. These convolutions increase the effective surface area of the brain and are believed to contribute to higher cognitive function.

There is much debate among scientists about the reasons for the evolutionary expansion of brain volume in primates and for the survival value of a big brain itself. The primate brain is such a large, metabolically expensive organ to grow and maintain that it must have important survival and reproductive benefits. We will consider these in Chapter 7.

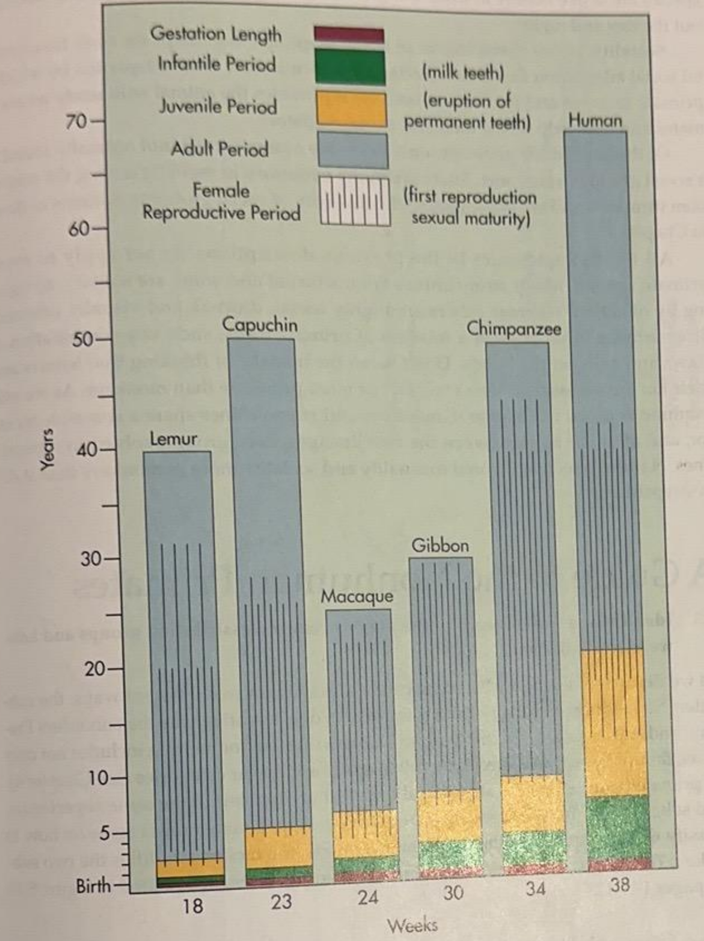
EXTENDED ONTOGENY Primates live by learned behaviors as much as they do on hardwired instinct. For example, many primates live in social groups, so a baby monkey or ape must learn how to be a member of a social group if it intends to successfully court a mate and rear offspring itself; these are largely learned behaviors. Thus it is important for primates to be socialized within their communities, a process that can take up a large proportion of their infancy and maturation.

Many animals live much longer life spans than primates do. Giant tortoises may live 150 years, and some whale species may live more than 100 years. But primates are notable for the extended length of each stage, from infancy to adulthood, of their life cycle. The life cycle is also called **ontogeny** (Figure 6.8). The gorilla life span is about twenty times longer than that of a mouse, but the time it takes from gestation to sexual maturity is almost eighty times longer (about 15 years, compared with 10 weeks). Why?

ontogeny
The life cycle of an organism from conception to death.

Consider the sort of information a growing primate must learn in order to survive in the world. In addition to learning how to find food and water, the primate must learn how to live in a social group. The process of learning to live in a group is a long one, and the behaviors involved tend not to be purely instinctual. An infant monkey or ape reared in isolation will end up severely deficient in the social skills it needs to be part of a social group. Parental investment in the infant is dramatically greater in primates than it is in rodents or most other mammals because social skills require years of maturation and practice.

Figure 6.8 Primates exhibit prolonged life histories, spending more time in each stage of life than most other mammals do.



Behavioral Traits: Activity and Sociality

ACTIVITY PATTERNS Most primate species are active during daylight hours, possess color vision, and have limited olfactory senses. Many mammal species are nocturnal and rely on their sense of smell to negotiate their physical and social environment. Consider a cat, rat, or wolf, all of which are primarily nocturnal and have a sense of smell thousands of times more powerful than that of any haplorhine primate. Many strepsirhines are **nocturnal** (active at night), but all haplorhines except one, the night monkey *Aotus*, are **diurnal** (active during the daylight hours). Primates made a fundamental shift from an olfactory-based lifestyle to a visually based one. This entailed shifting from being primarily nocturnal to being diurnal. Diurnal animals have a greater need for color vision, and haplorhine primates in particular use their eyes to find plant foods, including brightly colored fruits, in a complex forest environment. At the same time, diurnal primates evolved complex patterns of visual communication,

nocturnal
Active at night.

diurnal
Active during daylight hours.

such as bright colors and communicative behaviors, in place of the scent-marking communication that nocturnal primates use. In addition, some nonhuman primate species are active mainly at dusk and dawn, and others are active irregularly throughout the day and night.

sociality
Group living, a fundamental trait of haplorhine primates.

Sociality, or the characteristic of living in groups, is perhaps the most fundamental social adaptation that characterizes most primates. It is the adaptation by which a primate survives and reproduces because it provides the animal with ready access to mates and may help it find food and avoid predators.

Of the haplorhine primates, only one—the orangutan—is not normally found in a social group of some sort. There are many variations in sociality among the nonhuman primates, and we will examine the diversity of social grouping patterns in detail in Chapter 7.

All the characteristics in the previous descriptions do not apply to every primate species. Many strepsirhines are nocturnal and some are solitary, navigating by olfaction, whereas others are highly social, diurnal, and visually oriented. Strepsirhines often possess a mixture of primate traits, such as a combination of claws and nails on the hands. Don't make the mistake of thinking that lemurs and their kin are necessarily "less evolved" or more primitive than monkeys. As we will examine in detail in Chapter 9, monkeys and strepsirhines share a common ancestor, and after the split between the two lineages, each group evolved in separate lines. Natural selection favored diurnality and sociality more in monkeys than it did in strepsirhines.

A Guide to the Nonhuman Primates

6.3 Identify and explain each of the major primate classification groups and how we identify them.

As we discussed, the order Primates can be classified in two different ways: the suborders Strepsirhini and Haplorhini (Figure 6.9), or alternatively as the suborders Prosimii and Anthropoidea. Recall that the Linnaean system for naming includes not only order, family, genus, and species but also higher and lower categories (see Chapter 4). So primate families that are anatomically similar are lumped in the same superfamily, and subgroups of families are called subfamilies. Not all taxonomists agree on how to classify the primates, and one nonhuman primate, the tarsier, straddles the two suborders. The geographic distribution of nonhuman primates is presented in Figure 6.10 on pages 172–173.

The Strepsirhines

The primates of the suborder Strepsirhini include the lemurs of Madagascar and the lorises and galagos of mainland Africa and tropical Asia. Linnaeus originally subdivided the primates into two major groups—the prosimians (sometimes called the lower primates) and the anthropoids (higher primates)—based on a number of anatomical features. *Strepsirhine* and *prosimian* are not completely synonymous; one prosimian primate, the tarsier, is a haplorhine, not a strepsirhine. But all strepsirhines and prosimians share some common anatomical features: a reliance on olfaction, nocturnality, and a lack of complex social behavior patterns. Their incisor teeth protrude from the front of the mouth to form a comblike surface, known as the *tooth comb*, used for grooming. Many also have specialized clawed toes that serve as grooming tools. Long believed to be largely solitary, even the nocturnal strepsirhines such as lorises and dwarf lemurs live in a wide array of societies, ranging from pairs and social clusters to a few solitary species. Some lemurs violate these general traits, however, as we shall see next.