

Overview

The order *Primates* includes humans, apes, monkeys, and prosimians. Many of them may be familiar, but it would not be surprising if you cannot immediately visualize prosimians (like the ring-tailed lemurs in the picture on the right). They are an ancient, relatively primitive group of primates which also includes such animals as lorises.

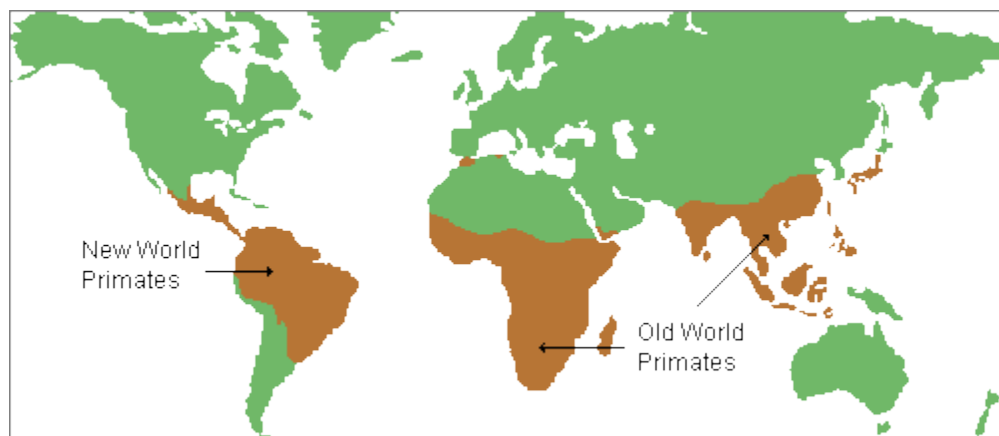


Ring-tailed lemurs

How many living primate [species](#) exist today is not clear. The number varies depending on whether closely related groups are considered to be varieties of each other or distinct species. Some [taxonomic](#) splitters classify up to 350 species, while lumpers include as few as 190. Most estimates are in the range of 230-270. This ambiguity may be partly resolved in the future with DNA sequencing data. Compounding the problem is the fact that every few years new kinds of primates are found. The tropical forests of South America, Africa, and Southeast Asia may still be hiding ones that are unknown to the scientific world. However, it is likely that all major groupings of primates have been discovered.

According to Conservation International, a Washington-based non-profit organization, 10% of the primate species are now acutely endangered and will likely become extinct during the next 20 years. Most of the other primate species are also at great risk. The primary cause is deforestation, driven ultimately by human population growth. Additional pressure is placed on primate populations by humans hunting them to sell for food and pets. Monkeys and apes are popular sources of "bush meat" in West Africa. Twenty-two species of primates and many other wild animals are being hunted in Africa for this purpose. Despite the fact that the sale of "bush meat" is outlawed in most countries, it is now being sold illegally in Europe and North America. It can be bought at stores that cater to African immigrants in Paris, New York, Chicago, San Francisco, Montreal, and some other major cities.

Today, non-human primates are limited in their natural habitats primarily to the tropical and subtropical areas of the [New and Old Worlds](#).



Natural range of non-human primates

General Characteristics of Primates

Primates are surprisingly variable in size. They range all the way from the mouse lemur that weighs only a few ounces, to the gorilla that grows to as much as 400 pounds (181 kg.) in the wild and even heavier in captivity. Still larger primates existed in the past but are now extinct.

Primates are generally lively, clever, and very successful at adapting to different environmental opportunities. Physically, however, they are relatively unspecialized compared to animals such as birds, horses, and cats. Primates are not particularly fast runners, they do not have the sharpest hearing, they cannot fly, nor are they efficient hunters.



Lowland gorilla



Spider monkey
(They have hands with 4 fingers and feet with 5 toes.)

With the exception of spider monkeys, all of the primates have retained the ancient [mammalian](#) trait of **pentadactylism**, which is having five fingers on each hand and five toes on each foot. An increasing refinement of the hands and feet for grasping objects has been a hallmark of primate evolution. Their fingers and toes are mobile and have very sensitive tactile pads at the tips, unlike most other mammals. At least some digits on all primates also have flat nails in place of rigid claws. This makes the manipulation of bits of food and other objects much easier.

The grasping, or **prehensile**, ability of primate hands varies significantly also with the degree of opposability of the thumb. Partially rotating the thumb and pressing it forcefully towards the fingers provides a secure grip for hanging on branches and for manipulating small objects. All primates, with the exception of humans, have prehensile feet in addition to hands. However, few have the high degree of thumb opposability and strength typical of humans.

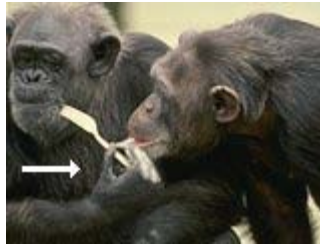
The small New World monkeys called marmosets and tamarins usually hang onto a tree branch by pressing against it with their palms and using all of their bent fingers together as counter pressure in a hook-like power grip. The more dexterous monkeys and apes can also use a secure **power grip** formed by the partial flexion of the fingers and the palm with counter force applied by the thumb. Humans and some apes also can employ **precision grips** formed by pinching with the tips of their flexed forefingers and the thumb. This allows their hands to be used effectively for manipulating even tiny objects.



Hook-like power grip
(cotton-top tamarin)



Secure power grip
(orangutan)



Precision grip
(chimpanzees)



Upright posture
(lowland gorilla)

All primates have a marked tendency towards erectness in their upper bodies. This can be seen in their sitting and standing postures as well as occasional [bipedalism](#). They also have shoulder joints that are unusually flexible for mammals. This is due to secure ball joints and strong collarbones, or **clavicles**, which have allowed them to use their arms very effectively in climbing trees. Clavicles are another ancient mammalian trait that primates have retained.

In primate evolution, there was a progressive reduction in nose size and in the [olfactory](#) areas of the brain. Lemurs are very much like the early primates 50-60 million years ago. Note the marked difference between lemur, monkey, and human noses in the photos below. Most monkeys and apes have evolved relatively small noses like us, while lemurs have long snouts similar to foxes and raccoons. It is not surprising that lemurs have a comparatively good sense of smell.

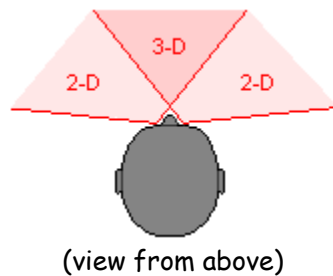


Comparison of ring-tailed lemur, patas monkey, and human noses

Most mammals have about the same number of genes that code for odor receptors in their nasal tracks. However, the majority of these genes in humans, and presumably other large primates, are no longer functional. Recent research has shown that of the approximately 1,000 human olfactory receptor genes, only 347 remain functional. The rest have mutations that deactivate them. Does this really mean that people have a poor sense of smell? The answer is both yes and no. We are poor at sensing short-chain chemical compounds but good at discriminating between complex long-chain ones such as those of many foods and flowers. Dogs are just the opposite in this. However, the smelling ability of dogs is far superior to people in one way. Fewer molecules of a substance are usually needed for dogs to detect it.

As the primate nose progressively shrank in size over millions of years, there was a corresponding increase in visual capabilities. As much as 50% of the [cerebral cortex](#) in some species of monkeys is involved in visual processing. Many primates have color vision comparable to our own. All have

[binocular vision](#) with fields of view that significantly overlap, resulting in true **three dimensional (3-D) depth perception**. At the same time, [peripheral vision](#) was reduced.



Human eyes have an overlapping field of view of about 120° . It is only in this field that we have stereoscopic vision. Beyond this 3-D area out to $160\text{--}180^\circ$, we see things only in two dimensions (2-D)--i.e., flat without depth. Monkeys and apes have about the same depth perception ability as humans, but the eyes of lemurs are farther apart resulting in a smaller overlapping field of view.

Compared to most other animals, primate brains are large relative to their body size. Those areas of the brain that are involved with controlling [manual dexterity](#), eye-hand coordination, and [stereoscopic vision](#) have particularly expanded. These traits were probably selected by nature mostly due to their usefulness in traveling in trees and getting food in that environment.

Primates generally have long **gestation** periods, or pregnancies, for animals of their size. For example, macaques, which are one of the most common groups of monkey species in the Old World, have 13.5-15.5 week gestations. Among comparable size domestic dog varieties, it is only about 9 weeks. Gorilla gestation periods are close to that of humans. The result of long gestations is that offspring are born more mature and, therefore, have a greater chance of survival. Primate mothers also are generally very protective and nurturing with their young. Subsequently, primates do not need to have many offspring to maintain their population numbers. Multiple births at any one time are rare.

There frequently is a correlation between body size and longevity in the animal kingdom. Species with larger bodies generally live longer. Primates have unusually long natural life spans for their size. The smallest primates, the mouse lemurs, live about 8 years. Only slightly smaller rodent mice rarely reach 2 years. Rats, which are slightly larger than mouse lemurs, can live 3 years. Big monkeys, such as baboons, live up to 30 years. With good medical care, chimpanzees can live nearly as long as people.

Most primates have adapted to an **arboreal**, or tree living, way of life. Even the [terrestrial](#) ones usually sleep in the trees. The most notable exceptions are humans and gorillas. Both of these species live on the ground with occasional tree climbing for fun, especially by children. Almost all primates are **diurnal**, which is to say, they are active during the day and sleep at night.

Generally, primates are highly social animals. Most of their waking hours are spent socializing with each other. This is made easier by complex [vocalizations](#) and [displays](#). In addition, they regularly groom each other, thereby keeping clean and satisfying psychological needs. **Grooming** is a very pleasurable activity for primates, including humans. It is important to note that the few [nocturnal](#) primate species are the least social.



Chimpanzees grooming



Humans grooming

Primates have been very successful animals due largely to the fact that they are intelligent and opportunistic in getting food. Most are unusually adaptable in diet. This has tremendous evolutionarily selective value. Many species are omnivorous, though vegetable foods usually make up the bulk of calories consumed by most primate species because they are easier to obtain. By comparison, animals such as koalas and giant pandas are generally less successful because they are extremely limited in the kinds of foods that they can or will eat. Koalas subsist on the leaves of a few species of eucalyptus, and giant pandas primarily eat the shoots of a small number of bamboo species. If these food sources are not available, koalas and giant pandas die. Not surprisingly, their highly limited range of foods restricts where they can live. This is not the case with many primate species.

Are Primates Good Pets?

Often people who have not had the responsibility of taking care of a monkey or ape in captivity think that they would be great pets. After all, they are cute when they are youngsters and remarkably human-like. However, they generally make very poor pets. As one monkey owner said "People find out when it's too late. After six months, they're like a two year-old that can fly." Because they are intelligent, very active, sometimes unpredictable, and easily bored, they frequently get into trouble when left alone. In addition to being destructive, most are as messy as human babies. Unlike humans, however, they remain this way all of their unusually long lives. Owning large apes in particular is a life-long commitment that takes considerable patience, energy, and money. Male chimpanzees can be surprisingly violent in their interactions with each other and humans.

Prosimians: Part I

The order Primates consists of two major suborders: the *Prosimii* and the *Anthropoidea*. The prosimians, were the first of the suborders to evolve. Subsequently, they are often called the "lower primates." The word prosimian literally means "pre-monkey."

The prosimians include the lemurs, lorises, and related animals. At one time they lived in most tropical regions of the planet, including North America. Today, they are found in the wild only in the [Old World](#). The lemurs have the most restricted range, being found exclusively on the island of Madagascar and the nearby Comoro Islands, where they do not have to contend with competition from the more advanced non-human primates. It is likely that the first lemurs on the Comoro Islands were brought there by humans.



Lemurs reached Madagascar early in primate evolution and became isolated reproductively from the African mainland about 250 miles (402 km.) away. Subsequently, they evolved into the 22 or more mostly [arboreal](#) species of today.

Elsewhere, they became extinct.



Ruffed black and white lemur



Red fronted lemur

The name lemur comes from an ancient Latin word, *lemures*, which refers to frightening spirits of the dead who haunt people at nighttime. This curious reference comes from the fact that people in Madagascar commonly believed that lemurs were ghosts. This belief was supported by their observations of lemur behavior--many of the species are only active at night and make eerie sounds.

There are five surviving families of lemurs. Species of the family *Lemuridae*, the **true lemurs**, range in size from that of a small to a large domestic cat. They have long bushy tails that are used for balancing as they jump from branch to branch. They have a well-developed sense of smell and often mark territorial limits with scent. They are herbivorous in diet, mostly eating fruit and some leaves. The larger species, such as those shown on the right, are primarily [diurnal](#). The true lemurs are unusually sociable for prosimians. This is especially true of the ring-tailed lemurs, which form groups of up to 25 individuals and spend almost as much time on the ground as in the trees. Unlike most other primate species, lemur females generally dominate males in their social interactions.

The family *Cheirogaleidae* consists of the smallest primate species, the **dwarf** and **mouse lemurs**. When full grown, some of them are only slightly larger than mice. They are [nocturnal](#) and relatively solitary. Their omnivorous diet consists mostly of fruit and easily obtainable animal prey such as insects, frogs, and baby birds in nests. They have large ears and very sensitive hearing, which is a valuable aid in hunting in the dark.



Sifaka

The family *Indriidae* includes three groups of species: **indris** , **avahis**, and **sifakas**. They are the most monkey-like of all of the prosimians in that they are relatively big. The indris are the largest in size, reaching about four feet from head to toe and weighing up to 29 pounds (13.2 kg.). During the early evening, Indris proclaim their territories in the tree tops with loud, piercing [vocalizations](#). By doing this, they space themselves out in the forest. They are also distinctive in having only a [vestigial](#) tail. The sifakas have long spring-like legs that allow them to jump dramatically over 30 feet (9 m.) from tree to tree. This

evolutionary specialization of their legs forces them to hop rather than walk when on the ground.

The extremely rare **aye-aye** is the only surviving species of the family *Daubentoniidae*. They are solitary and nocturnal. In addition, they have unusual hands and teeth for primates. Their elongated, narrow fingers have claw-like compressed nails that are used, along with their long, curved, rodent-like [incisor](#) teeth, to get at grubs under tree bark and other hard to reach delicacies. While they are primarily carnivorous, their prey only includes such things as insects, eggs, and newly hatched birds.



Aye-aye

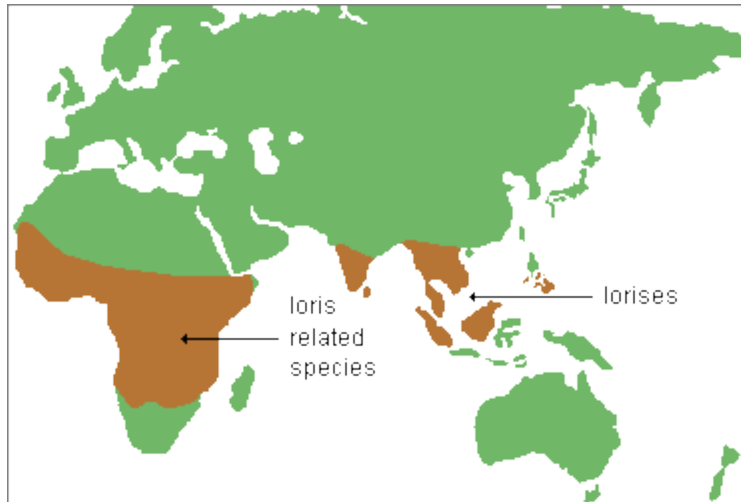


Aye-aye hand

More than half of the lemur species are on the verge of extinction due to habitat destruction. Their forests in Madagascar have mostly been burned down by impoverished farmers seeking new farmland and wood to make charcoal for cooking.

Prosimians: Part II

While the lemurs only live on the island of Madagascar, there are at least 11 species of prosimians living in mainland tropical forests of the Old World. They are the **lorises** of India and Southeast Asia as well as the **pottos**, **angwantibos**, and **galagos** of Africa. All of them are [arboreal](#) and [omnivorous](#). However, their hunting is largely limited to easy prey such as insects, eggs, and baby birds. The fact that they are strictly [nocturnal](#) has allowed them to largely avoid direct competition with the monkeys and apes, which are all [diurnal](#) in the Old World.



Natural range of the loris superfamily

The lorises and related African species are members of the superfamily *Lorisoidea*. The lemurs are in the superfamily *Lemuroidea*.

suborder:	Prosimii						
infraorder:	Lemuriformes						
superfamily:	<i>Lemuroidea</i>					<i>Lorisoidea</i>	
family:	Lemuridae	Lepilemuridae	Cheirogaleidae	Indriidae	Daubentoniidae	Loridae	Galagonidae
species:	ring-tailed and ruffed lemurs	sportive lemurs	dwarf and mouse lemurs	indris avahis sifakas	aye-ayes	lorises pottos angwantibos	Galagos

The families of the *Lorisoidea* can be distinguished based largely on [locomotor patterns](#). The Asian lorises and their close African relatives, the pottos and angwantibos, are slow, deliberate climbers and creepers on forest branches. They are the size of domesticated cats. In contrast, the smaller African galagos, or bush babies, are agile hoppers--they can jump 30 times their own body length. Both types of locomotion have advantages for survival. The slow cautious moving lorises and pottos are hard to spot by predators and the fast moving galagos are hard to catch.



Slow loris



Senegalese galago

Lorises have one other form of defense that makes up for their slow movements. They have unpleasant tasting somewhat poisonous saliva that they lick onto their fur. Mother lorises also lick the fur of their babies which helps to protect them from potential predators.

The galagos are the most numerous African primate other than people, however, few people see them because they live in dense forests and are only active at night.

The large rat-size tarsier of Southeast Asia is another unusual primate. Their classification is problematical because they have what appears to be a blend of prosimian and monkey traits, but they are genetically different from both groups of primates. Some researchers consider tarsiers to be in their own prosimian infraorder (*Tarsiiformes*). Others believe that they are genetically distinct enough only to be a separate suborder (*Tarsiioidea*) of *Lemuriformes*. The first of these two alternatives is used in this tutorial with the understanding that this issue has not yet been adequately resolved. Today, the tarsiers' range is mostly limited to the southern Philippines, Borneo, and the Celebes Islands to the east of Borneo.



Tarsier



The 3-7 surviving tarsier species have heavy dependence on vision and hearing but reduced ability to smell. Unlike lemurs and lorises, tarsiers lack a long snout and a **rhinarium**, or moist, hairless pad at the end that is often found on animals with a good sense of smell. Their ears and eyes are extraordinarily large for their heads. Adding to their already odd appearance, tarsiers can rotate their heads more than 180°, like some owls. They need to do this because their eye muscles apparently are not capable of moving the eyes very far from side to side. They have long hairless tails, except for tufts on the end, like kangaroo rats. They have elongated hind feet and legs, like galagos, which give them the ability to leap nearly 10 feet (3 meters) in a single jump. This provides an advantage in hunting insects and in avoiding predators. They are strictly nocturnal and carnivorous. They are usually found in the lower branches of trees and on the ground nearby where they find crickets and other insects to eat. They spend most of their lives alone except for mothers and their babies.

Let's take a moment to once again think about the framework of prosimian classification. Carefully study the table below...

Remember that there are two major primate suborders. The *Anthropoidea* will be the subject of the remainder of this tutorial.

order:	Primates								
suborder:	Prosimii							Anthropoidea	
infraorder:	Lemuriformes						Tarsiiformes		
superfamily:	Lemuroidea				Lorisoidea				
family:	Lemuridae	Lepilemuridae	Cheirogaleidae	Indriidae	Daubentoniidae	Loridae	Galagonidae	Tarsiidae	
species:	ring-tailed and ruffed lemurs	sportive lemurs	dwarf and mouse lemurs	indris avahis sifakas	aye-ayes	lorises pottos angwantibos	galagos	tarsiers	

Monkeys

There are at least 145 living species of the suborder *Anthropoidea*. Over 90% of them are monkeys. The remaining species are apes and humans. The **anthropoids** (members of the suborder *Anthropoidea*) have been the most successful primates in populating the earth. They are generally larger, more intelligent, and have more highly developed eyes than the prosimians.

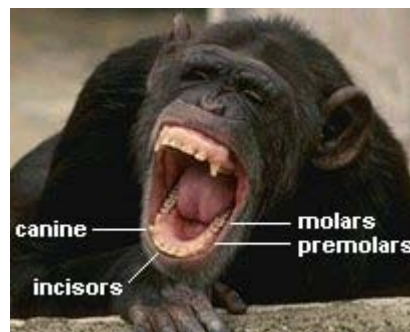
There are two distinct infraorders of *Anthropoidea* that have been evolving independent of each other for at least 30,000,000 years. They are the *Platyrrhini* ([New World](#) monkeys) and the *Catarrhini* ([Old World](#) monkeys, apes, and humans). These two diverse groups of species can be distinguished from each other most easily based on the form of their noses and by the number of specific types of teeth.

The platyrrhine nose (on the left below) is relatively flat with somewhat sideways projecting nostrils separated by a wide septum. In contrast, the catarrhine nose (on the right below) has more downward projecting nostrils separated by a small septum.



Nose comparison of an emperor tamarin (left)
and a Celebes black macaque (right)

All primates have essentially the same kinds of specialized mammalian teeth adapted to eating a wide variety of foods. Beginning at the front, each quadrant of the mouth has 2 incisors, 1 canine, and varying numbers of premolars and molars. The **incisors** are used like scissors for nipping off pieces of food. The pointed **canines** are for piercing and tearing. The **premolars** and **molars**, with their **cusps**, are used to grind and smash food. In platyrrhine species, there are 3 premolars and 2 or 3 molars. This results in a **dental formula** of 2.1.3.2 or 2.1.3.3. In contrast, all of the catarrhines have 2 premolars and 3 molars, making a **dental formula** of 2.1.2.3. The chimpanzee shown below is an Old World anthropoid species and, therefore, has a catarrhine dental formula.



Catarrhine 2.1.2.3 dental formula
(common chimpanzee)

All Old World monkeys, apes, and humans share this 2.1.2.3 dental formula. This not only sets us apart from New World monkeys and prosimians, but it also reflects the evolutionary closeness of the Old World anthropoid species. By comparison, the general **placental mammal** dental formula is 3.1.4.3.

In addition to these differences, New World monkeys are almost exclusively **arboreal** and most of them are smaller than Old World monkey species. Some Old World monkeys and apes are **semi-terrestrial**. If you see a group of monkeys casually walking around in a grassland environment (like those shown on the right), you can be sure that they are from the Old World.

Many of the larger New World monkeys have **prehensile**, or grasping, tails that are capable of being used as strong "third hands" for holding onto branches and supporting their bodies. None of the Old World monkeys or apes has this capability.



Patas monkeys in an African
grassland environment

Many species of Old World monkeys have **ischial callosities**, or hairless callous pads, on their rumps which may be adaptations for long periods of sitting or sleeping on rough branches and rocks. This trait is shared by the small apes of Southeast Asia (gibbons and siamangs). However, New World monkeys do not have it.

In some species of Old World monkeys and apes, adult females have **sexual skins or swellings**, which are nearly hairless large swollen patches of skin around the genital area that become very prominent when they are in [estrus](#). These areas swell with fluids and turn bright pink or red due to hormonal changes that occur in preparation for ovulation. The sexual skin also produces odors that excite males of the species. They become highly attentive to the females at this time. In the case of olive baboons, males are most attracted to females with the largest sexual skin bulge. Those females tend to have babies more often and subsequently pass on the genes for this impressive signal of sexual readiness.



Female hamadryas baboon in estrus (note the sexual skin)

New World Monkeys

New World monkeys are limited to tropical forest environments of southern Mexico, Central, and South America. All of these monkeys are predominantly [arboreal](#) and mostly [herbivorous](#). They eat leaves, fruits, nuts, gums, and occasional small prey such as insects. Today, there are at least 53 species commonly divided into two families--*Cebidae* and *Callitricidae* (also called *Callithricidae*).



Cotton-top tamarin



Pygmy marmoset

The *Callitricidae* consist of **marmosets** and **tamarins**.

They range in weight from only 1/3 to 2 pounds (140-900 g.),

but their thick fur and long tails deceptively make them look larger and heavier. The marmosets are the smallest of all monkey species. Both marmosets and tamarins are considered to be the most primitive monkeys. Their thumbs are not opposable. They have claws on all digits

except for their big toes, which have nails. They do not have [prehensile tails](#). They also lack the ability to change their facial expressions. Twin births are common. All other primate species usually give birth to only one child at a time. In addition, marmoset and tamarin infants are usually carried on their father's back and are generally only passed over to their mother for nursing. Apparently, marmosets are unable to maintain a very stable [core body temperature](#). It can vary as much as 8.5° F. (4° C.) over a day.

The favorite food of tamarins and marmosets is carbohydrate rich tree sap which they tap by gnawing holes in trunks. Their territories are centered on the trees that they regularly exploit in this way. Some tamarin species eat flower nectar as well. The smaller marmosets venture into the very top of forest canopies to hunt insects that are abundant there.

Most of the New World monkeys are in the family *Cebidae* which is commonly subdivided into four subfamilies:

1. *Cebinae* (squirrel and capuchin monkeys)
2. *Aotinae* (night and titi monkeys)
3. *Atelinae* (howler and spider monkeys)
4. *Pithecinae* (uakaris and sakis)



Prehensile tails
(spider monkeys)



Howler monkey

The *Cebidae* range in weight from 1.5 to 33 pounds (.7-14.5 kg.), which is significantly heavier than the marmosets and tamarins. The howler is the largest of the New World monkeys. Like the indris of Madagascar, they have developed the unusual habit of defending territory in the top branches of their forest canopies with vocalizations. The howlers do this with a specialized larynx and throat that expands like a balloon. Their deep, throaty sound is extraordinarily loud. In fact, a chorus of howler calls can carry for several miles if the winds are favorable.

Like the Old World monkeys, the *Cebidae* have nails on all of their fingers and toes. Social group size varies from that of the squirrel monkey, which lives in troops of up to 500 individuals, to that of the night (or owl) monkey, which lives in small [nuclear family](#) groups. The night monkey is also notable for being the only [nocturnal](#) monkey. Unlike the prosimians, most monkeys and all apes are [diurnal](#). Humans, of course, are by nature diurnal as well. Many of the larger *Cebidae* have strong [prehensile tails](#) that are largely hairless on the underside and have sensitive [tactile pads](#). No other family of primates in either the New or the Old World has tails that are strong enough to function in

this way as "third hands."

The *Cebidae* are generally very enterprising when it comes to obtaining food. For instance, capuchin monkeys venture out of the trees to hunt crabs, clams, and other small animals in mangrove swamps. They also hunt large insects and collect birds eggs in the trees in addition to eating leaves and fruit. Some capuchin groups collect palm nuts, dry them out over several days, and crack them with rocks to get at the food inside. During the rainy season when mosquitoes bother them, capuchins rub their fur with crushed millipedes that produce a chemical insect repellent. During the early 20th century, trained capuchin monkeys were popular assistants for Italian organ grinders on the streets of North American cities. In recent years, some have been trained to be helpers for quadriplegics. Capuchins are able to do this not only because of their typical primate manual dexterity but also because of their relatively high level of intelligence for monkeys. They have the largest brain-to-body size ratio of any primate other than humans. It is not surprising that capuchins have been observed using simple tools in getting food. They use rocks for digging up plants as well as cracking open seeds and smashing pieces of cacti, tubers, and lizards into bite-size

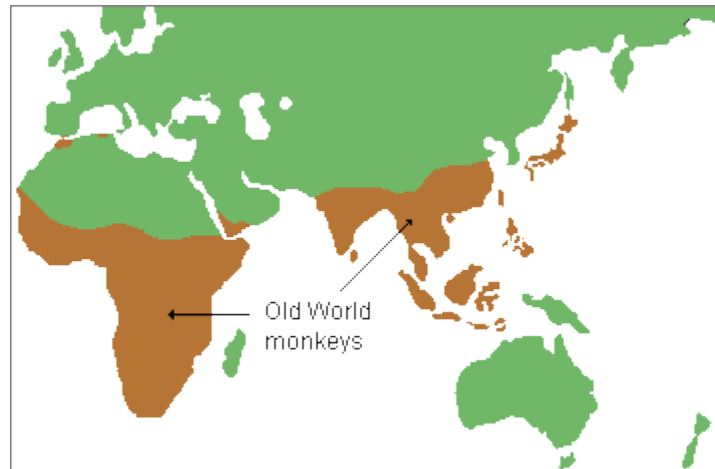


Capuchin monkey

pieces. In addition, they use twigs to get insects out of small, constricted crevices and other places.

Old World Monkeys

The Old World monkeys occupy a wide variety of environments in South and East Asia, the Middle East, Africa, and even Gibraltar at the southern tip of Spain. Some species inhabit tropical forests, while others live on arid grasslands and even mountainous areas with heavy winter snows.



Natural range of Old World monkeys

There are at least 78 species of Old World monkeys in two subfamilies---the *Cercopithecinae* and the *Colobinae* 🐒. Monkeys in both groups are relatively large, being about the size of small to medium-size dogs.

Cercopithecinae

Most Old World monkeys are *cercopithecines*. Included in this subfamily are the **baboons**, **mangabeys**, **mandrills**, **guenons**, **patas monkeys**, and **macaques**. These are all African species with the exception of the macaques which also live in Asia and Gibraltar.



Macaque
(Japan)



Patas monkey
(Africa)

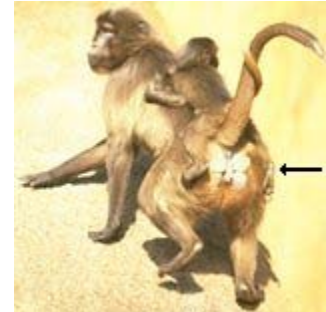
Many species of cercopithecines sleep in trees or on cliff faces and spend their days in large groups foraging for food on grasslands. Perhaps, the most familiar of these [semi-terrestrial](#) monkeys are the African baboons.



Diana guenon
(Africa)



Hamadryas baboon
(Africa)



Ischial callosities
(gelada baboons)

The semi-terrestrial cercopithecines are usually very [sexually dimorphic](#). In these species, adult males are often twice as large as females and much more aggressive. Male savanna baboons grow up to 80 pounds (36.3 kg.) and have powerful jaws with long canine teeth. These are useful traits for defense against predators, competition for mates, and occasional hunting.

The cercopithecines share two other identifiable anatomical characteristics--[ischial callosities](#) and [cheek pouches](#). The latter are cheeks that expand rather like those of hamsters to allow the secure temporary storage of food. This is a useful trait for these [omnivorous](#) monkeys since they compete with each other for desirable foods and are not inclined to share. Fruit and meat are particularly prized. Large male baboons aggressively hunt other monkeys, small chimpanzees, and even flamingos for food.

The females in some of the cercopithecine species develop prominent [sexual skins](#) around the time of ovulation. This is a signal to males that they are sexually receptive.

Colobinae

The second subfamily of Old World monkeys, the *Colobinae*, include the colobus of Africa, and the South Asian langurs and proboscis monkeys. All of them are [herbivores](#).



Juvenile colobus
(Africa)



Francois's langur
(South Asia)

The **colobines** lack cheek pouches. They also share in common the fact that they have **sacculated stomachs**. That is to say, their stomachs have "sacculles," or sack-like compartments, in which bacteria and unusual combinations of enzymes break down plant cellulose, thereby providing more useable calories. Their stomachs also contain more acid than do those of other monkeys. This speeds up digestion but results in delicate stomachs. The *Colobinae* have unusually long intestines that increase the absorption of nutrients. These are all adaptations to a predominantly low protein, fibrous leaf diet. Not surprisingly, the *Colobinae* are also referred to as the "leaf-eating monkeys."



Male proboscis monkey
(Borneo)

The proboscis ("nose") monkeys of Borneo have a peculiar form of sexual dimorphism. Adult males develop a long Pinocchio-like nose.

Review of Monkey Taxonomy

Let us take a moment to review the framework of monkey classification. To begin, they are members of the *Anthropoidea* suborder along with all of the apes and humans. However, the New World monkeys are sufficiently different from the others to warrant their placement in a separate infraorder (*Platyrrhini*).

ANTHROPOIDS

suborder:	Anthropoidea	
infraorder:	Platyrrhini	Catarrhini
species:	New World monkeys	Old World monkeys apes humans

The *Platyrrhini* are divided into three families. The *Callitricidae* are the most primitive monkeys. The *Cebidae* and *Atelidae* are larger and are also the only primates that have prehensile tails. All three families are almost entirely arboreal and vegetarian.

NEW WORLD MONKEYS

family:	Callitricidae	Cebidae
species:	marmosets tamarins	squirrel monkeys capuchins spider monkeys

		howler monkeys etc.
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The Old World monkeys are divided into two subfamilies. The *Cercopithecinae* have ischial callosities, cheek pouches, and are omnivorous. The *Colobinae* are herbivorous and have sacculated stomachs as well as elongated intestines that efficiently process leaves high in difficult to digest cellulose.

OLD WORLD MONKEYS

subfamily:	<i>Cercopithecinae</i>	<i>Colobinae</i>
species:	baboons guenons patas monkeys macaques	colobus langurs proboscis monkeys

NEWS: During the mid 17th century, French colonists brought vervet monkeys from West Africa as pets to the Caribbean Islands of St. Kitts and Nevis. As a result of turmoil caused by the French and English wars of the 18th century, some of these vervets escaped. Their descendents have multiplied rapidly over the last 30 generations since there were no natural predators on St. Kitts and Nevis. Today vervets outnumber the population of 40,000 people and regularly cause havoc by boldly eating much of the agricultural crops. In response, the national government now offers a \$20 bounty for each vervet that is killed. So far this locally popular action has not stemmed the growth in the vervet population.

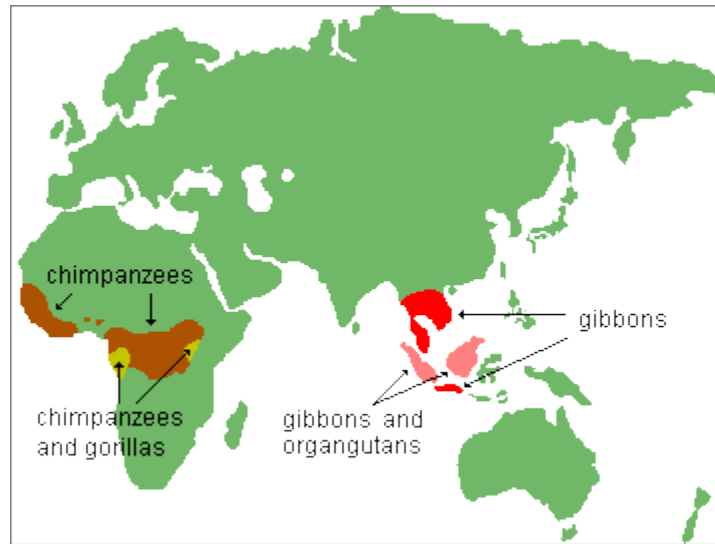
Apes

Apes and humans differ from all of the other primates in that they lack [external tails](#). They also are more intelligent and more dependent for survival on learned behavior patterns. There are several internal body differences as well, such as the absence of an appendix in monkeys.

The apes and humans are members of the same superfamily, the *Hominoidea*. Until the last few years, humans were separated into their own family within this superfamily because it was believed that we are significantly different from the apes. However, recent genetic studies and discoveries from the fossil record have made it clear that some of the apes are more similar to humans than previously believed. Subsequently, the living hominoids are now commonly classified into only two families with humans grouped with the [great apes](#):

1. Hylobatidae (gibbons)
2. Hominidae (orangutans, gorillas, chimpanzees, and bonobos, and humans)

Gibbons and orangutans live in Southeast Asia, while gorillas, chimpanzees, and bonobos are exclusively African apes. Humans originated in Africa as well.



Natural range of the apes

Asian Apes

The smallest and the most arboreal apes are the 12-13 species of **gibbons**. Because of their diminutive size, these members of the family *Hylobatidae* are also referred to as the "lesser apes." Most adult gibbons are only about 3 feet (90 cm.) tall standing upright and 12-20 pounds (5.5-9 kg.) in weight. Males in the biggest gibbon species, known as **siamangs**, are up to 30 pounds (13.5 kg.) and have longer arms. Siamangs are different enough from other gibbons to be in their own genus. All gibbons are very slender. Long bushy hair on their bodies makes them look stockier than they actually are. Unlike all of the larger ape species, gibbons have little sexual dimorphism in body size.

The long arms, permanently curved fingers, and light bodies of gibbons make them excellent **brachiators**. That is, they move around in trees by swinging under branches with a hand over hand motion. This is also referred to as **suspensory climbing**. At times, gibbons also walk **bipedally**, or two footed, on top of branches. However, they are more efficient at brachiation, and 90% of their locomotion is by this means. Each swing can transport a gibbon 20 feet (6 m.) at speeds approaching 35 miles (56 km.) an hour.

Siamang
brachiating



Gibbons are monogamous in their mating patterns and form **nuclear family groups**. That is to say, their communities consist of a single mating pair of adults with their juvenile offspring. They live in well defined territories in the tree tops and rarely go down to the forest floor. Adults regularly defend their territory against others of their species with piercingly loud whooping and hooting vocalizations, much like the indris of Madagascar and the howler monkeys of the New World, though the calls of the latter two primates sound very different. The calls of different gibbon species are easily distinguished from each other as well. When they are vocalizing, the front of the necks of gibbons and siamangs expand with air, much like the flexible bag on a bagpipe.



Siamang neck swollen
with air for vocalizing



Gibbon

Orangutans are the largest and the rarest of the Asian apes. Males often grow to 175-200 pounds (80-90 kg.) and 4½ feet (1.4 m.) tall. At this size, they are usually too large to cross from one tree to another by the branches and must go down to the ground and walk quadrupedally between them. There is marked sexual dimorphism among the orangutans. Males have huge fleshy pads framing the upper part of their faces. In addition, females weigh only about half as much as the males (73-99 lbs or 33-45 kg.). Being lighter, females and juveniles often stay in the trees and use a leaning form of brachiation--they

carefully shift their body weight to bend a supporting branch and then grab the next one before the first one breaks.



Adult male orangutan



Adult female orangutan



Leaning form
of brachiation
(young orangutan)



Orangutan mother with
child "fishing out" food
from a rock crevice

Orangutans are intelligent and generally peaceful animals. Most of the time they live solitary lives browsing fruits and leaves. Some also create simple stick tools to get honey out of bee hives in tree crevices.

Unfortunately, the orangutans are in danger of extinction in the wild because they are hunted for the illegal international pet trade. Their forest territories are also being rapidly cut down for the lumber and cleared by burning for farming, especially in Indonesia where most of them live. According to Conservation International, the 15,000 remaining Indonesian orangutans are currently disappearing at a rate of 1,000 per year. When population size decreases, there is a corresponding decrease in genetic diversity. Species that have little genetic diversity are more easily driven to extinction by a changing environment. The loss of habitat has decimated gibbons in Indonesia as well. However, they are not at as much a risk of becoming extinct because their range extends widely over Southeast Asia.

African Apes



The largest apes are the **gorillas** of Africa. Adult males are up to 6 feet (1.8 m.) tall and have 9-10 foot (2.7-3.0 m.) arm spans. They have massive heads with heavy, thick muscles on top that are used to close crushing jaws. Their bodies are stout and very muscular.

Like humans, gorillas are [terrestrial](#) animals. They are [quadrupedal](#) knuckle walkers. That is, they walk on the soles of their feet but not on the palms of their hands. They bend their fingers and support the head end of

Male lowland gorilla their bodies with their knuckles instead of their open palms.



Knuckle walking
(subadult male lowland gorilla)

They are shy, peaceful vegetarians who live in family groups consisting of a dominant adult male with several adult female mates and their children. [Subadult](#) males are tolerated in the family as long as they are not actively competing with the dominant male for mates. Gorillas are also very [sexually dimorphic](#). Adult males average about 350 pounds (160 kg.) and reach 400 pounds (181 kg.) in the wild, while most adult females are only about 155 pounds (70 kg.) and much less muscular.

There are three varieties, or subspecies, of gorillas. The rare mountain gorillas live at high altitude in sparse woodlands in the mountains of Central Africa, while the more numerous lowland gorilla varieties live in the dense forests of West Africa. Most zoo gorillas are of the lowland varieties.



Female lowland gorilla



Common chimpanzee

The **common chimpanzees** more closely resemble humans than do the gorillas. Male chimps grow to 5½ feet (1.7 m.) tall and average about 100 pounds (45 kg.) with 6 foot (1.8 m.) arm spans, while females are usually only around 82 lbs. (37 kg.) and are less muscular. However, like the other large apes, chimpanzees are more comfortable getting around quadrupedally. They are also



Peaceful allogrooming (common chimpanzees)

knuckle walkers like gorillas. The natural habitat of chimpanzees includes both tropical forests and bordering [savannas](#) in Africa.

Chimps are intelligent animals with generally pleasant personalities. However, the males are less peaceful than the smaller females. This behavior difference is typical of most primate species, including humans. The chimpanzee diet is usually at least 90% vegetarian. Males are more likely to eat meat than are females, although chimp hunting skills are relatively poor.

Chimpanzees live in fluid societies of 10-50 individuals. Membership changes through time as females move from one community to another. Males usually stay together and act as a group in defending their mutual territory. However, within each community, males frequently establish short-term alliances in order to compete for dominance. Chimpanzees do not form monogamous mating bonds. Females usually mate with different males throughout their lives.

Bonobos are close relatives of common chimpanzees in the same genus, *Pan*. They are sometimes referred to as pygmy chimpanzees. Despite this name, they are only slightly smaller than the common chimps. Bonobos usually have blacker hair with tufts at the side of their faces, longer arms and legs, as well as slimmer bodies. Their vocalizations are also quite different from those of the common chimpanzees. Like many of the Old World monkey species, adult female bonobos normally have prominent "sexual skins." However, unlike monkeys, bonobo females are sexually receptive most of the time and have large sexual skins throughout the year.



Female bonobo



Bonobo sexual skin

Bonobos have fluid social groupings similar to the common chimpanzees, although bonobos are less excitable and aggressive. Male-female alliances also are more important for bonobos. Older females at times even become group leaders. Bonobos are unique among nonhuman primates in primarily engaging in sexual intercourse face to face. Gorillas do it occasionally. Both heterosexual and homosexual intercourse are common among bonobos. Copulation occurs frequently as a means of reducing tension in the community and has become recreational for them. In this and other traits, bonobos are like humans.

Today, the bonobo range is limited to the forests south of the Zaire River in West Central Africa, and there are considerably fewer of them than the common chimpanzees.

Common chimpanzees are the most successful of all apes in that there are more of them and they have the widest geographic range. However, their numbers have been significantly reduced. A century ago, there were millions of them in the wild. Today, there are less than 200,000. This sharp decline apparently has been mostly due to the rapid increase in human populations and the accompanying natural habitat decimation. An additional factor has been the desire of many people in West and Central Africa to eat chimpanzees and other non-human primate species. At least 4,000 chimpanzees are killed for their meat every year. Apes and most monkeys are relatively large, noisy animals that are easy targets for hunters. Chimpanzees and gorillas have suffered devastating *Ebola* epidemics as well. During 2002 and 2003, approximately 5,000 gorillas succumbed to this highly contagious, almost always fatal disease. The bonobos are at an even greater risk of disappearing since there may be only about 6,000 of them remaining in the wild. Gorillas and both species of chimpanzees have the misfortune of living in nations in which wildlife protection has been severely disrupted by civil wars and the breakdown of effective national authority over the last two decades. It is unlikely that the populations of these apes would be able to spring back rapidly even if they were more carefully protected because they have low reproductive rates. Under the best conditions, adult female chimps usually only have one baby every 5 years. The other great apes are similar.

Primates At Risk

The great apes are not alone in being threatened by humans. In 2008, the International Primatological Congress estimated that 48% of primate species are in danger of extinction within the next decade. Many will disappear with little known about them. They are at their greatest risk in Asia. The percentage of threatened primate species is 79% in China, 83% in Laos, 84% in

Indonesia, 86% in Vietnam, and 90% in Cambodia. In most parts of the world, the main threat is loss of habitat due to forest clearance. However, conservation efforts have had some successes in Brazil. The numbers of Golden lion tamarins and black lion tamarins there have been increasing to the point that these species are no longer considered critically endangered. Also on the hopeful side is the recent discovery of approximately 125,000 western lowland gorillas in a largely unexplored forest region of northern Democratic Republic of Congo. Impacts on this area by humans have been minimal so far.

Humans

In addition to the great apes, the family *Hominidae* includes our species, *Homo sapiens*. In the past, there also were other species of humans as well as hominids more similar to us than the chimpanzees and bonobos today. They will be described in the last three tutorials of this series.

It has been historically difficult for people to accept that we are in fact just another primate species with African origins and that we differ physically only in degree from some of the others. The similarities can be seen throughout our bodies. For instance, humans and the African apes all lack external tails and have hands with a thumb that is sufficiently separate from the other fingers to allow them to be opposable for precision grips. Humans are also sexually dimorphic--males are 5-10% larger on average and have greater upper body muscular development. Like chimpanzees and bonobos, we are omnivorous. We kill other animals for food in addition to eating a wide variety of plants. Internally, our bodies are even more similar to the great apes. We have essentially the same arrangement of internal organs and bones. We share several important blood types. We also get many of the same diseases.



Typical human sexual dimorphism



Similar chimpanzee and human hands

The comparatively minor anatomical differences between humans and apes are largely a result of our habitual [bipedalism](#). A number of changes in our bodies were related to the development of this form of locomotion. Unlike apes, our arms are relatively short and weak compared to our legs. Our feet no longer have the ability to effectively grasp and manipulate objects because the big toe moved up into line with the others. Human feet also have lengthened and acquired an arch, making them better body supports. The human [pelvis](#) and spinal column also have been modified for an erect posture and bipedal locomotion. We are now essentially fully terrestrial animals. Nature very likely selected for longer legs in humans because it is more efficient for walking and especially running bipedally. Research done by Herman Pontzer of Washington University in St. Louis, Missouri indicates that longer legs require less up-and-down movement while running and, therefore, reduce the amount of energy needed to move rapidly. This relatively lower rate of energy consumption would also allow humans to travel farther with the same calorie expenditure.



Bipedal locomotion

With the exception of these few outward differences, we are quite similar to the African apes anatomically and genetically, especially to the chimpanzees and bonobos. Humans have 46 chromosomes in their cells while all of the great apes have 48. In reality, this difference is not as great as it would initially seem because the human chromosome 2 is a fusion of ape chromosomes 12 and 13 with most of the same genes.

Work on discovering the entire [genome](#) of common chimpanzees was completed in 2005. A comparison between this and the human genome (completed in 2001) shows that 98.77% of DNA base pairs of humans and chimpanzees are the same. However, there are an additional 2.7% differences between the two species in duplicated non-protein coding segments of DNA. Where we differ appears to be largely in the genes that control speech, smelling, hearing, digesting proteins, and susceptibility to certain diseases. These minor differences are to be expected given that we have been on essentially separate evolutionary tracks for 6-7 million years. During that time, we have been subject to somewhat different natural selection pressures. These differences led to bipedalism for our ancestors along with a much larger brain and, ultimately, speech.

The modern human brain is 3 times larger in volume than those of the great apes. More importantly, the human brain to body size ratio is significantly larger, and it has a much bigger [cerebral cortex](#) with a higher concentration of neurons. Recent research has suggested that our intelligence advantage may be due to evolutionary changes in the HAR1F regulator gene beginning about 6 million years ago in our pre-human ancestors but not in those of chimpanzees or other apes. This gene is involved in the production of brain tissue between the 7th and 19th week after conception. It is not surprising that there are some striking differences between the great apes and humans in mental abilities. People have much more complex forms of verbal communication than any other primate species. We are the only animal to create and use [symbols](#) as a means of communication. We also have more varied and complex social organizations. The most distinctive feature of humans is our mental ability to create new ideas and complex technologies. This has proven invaluable in the competition for survival. However, the great apes are remarkably intelligent, having mental levels equivalent to a 3-4 year old human child. This is sufficient to allow them to learn and use the sign language of deaf humans in at least a rudimentary way.

There are two additional curious differences between humans and all other primates that are worth noting. We are the only primate species that now lacks a thick insulating fur over our entire bodies. We are also the only species of primate in which all older females go through menopause and become sterile, often decades before dying of old age. Female chimpanzees, gorillas, and other non-human primates usually remain capable of conception and giving birth even when they are very old. In the wild, they usually live a relatively short amount of time following menopause if they go through it at all. One explanation for this difference in humans is that years of life following menopause has proven to have natural selection value for our species. Having raised their own children, post-menopausal women around the world often take care of their grandchildren while their daughters are working. It is argued that this increases the chances that the grandchildren will survive to adulthood because they receive this additional experienced and caring attention.

Let us review the classification of apes and humans. Both are members of the suborder *Anthropoidea*, the Infraorder *Catarrhini*, and the superfamily *Hominoidea*.

ANTHROPOIDS

suborder:	<i>Anthropoidea</i>		
infraorder:	Platyrrhini	<i>Catarrhini</i>	
superfamily:	Ceboidea	Cercopithecoidea	<i>Hominoidea</i>
species:	New World monkeys	Old World monkeys	apes humans

Within the superfamily *Hominoidea*, there are two families. People are closest to the African apes genetically, especially the chimpanzees and bonobos.

HOMINOIDS

superfamily:	Hominoidea				
family:	<i>Hylobatidae</i>	<i>Hominidae</i>			
subfamily:		Ponginae	Gorillinae	Homininae	
tribe:				Panini	Hominini
species:	gibbons	orangutans	gorillas	chimpanzees bonobos	humans
