

## Geographic Range







Mammals can be found on all continents, in all oceans, and on many oceanic islands of the world.

## Habitat










Different species of mammals have evolved to live in nearly all terrestrial and aquatic habitats on the planet. Mammals inhabit every terrestrial biome, from deserts to tropical rainforests to polar icecaps. Many species are arboreal, spending most or all of their time in the forest canopy. One group (bats) have even evolved powered flight, which represents only the third time that this ability has evolved in vertebrates (the other two groups being birds and extinct Pterosaurs).

Many mammals are partially aquatic, living near lakes, streams, or the coastlines of oceans (e.g., seals, sea lions, walruses, otters, muskrats, and many others). Whales and dolphins (Cetacea) are fully aquatic, and can be found in all oceans of the world, and some rivers. Whales can be found in polar, temperate, and tropical waters, both near shore and in the open ocean, and from the water's surface to depths of over 1 kilometer. (Nowak, 1991; Reichhoff, 1990a; Vaughan, Ryan, and Czaplewski, 2000)





### **These animals are found in the following types of habitat:**

temperate ; tropical ; polar ; terrestrial ; saltwater or marine ; freshwater .

### **Terrestrial Biomes:**

tundra ; taiga ; desert or dune ; savanna or grassland ; chaparral ; forest ; rainforest ; scrub forest ; mountains ; icecap.

### **Aquatic Biomes:**

pelagic ; reef ; lakes and ponds; rivers and streams; coastal ; brackish water .

**Wetlands:** marsh , swamp , bog .

### **Other:**

urban ; suburban ; agricultural ; riparian ; estuarine ; intertidal or littoral .

## Physical Description

All mammals have hair at some point during their development, and most mammals have hair their entire lives. Adults of some species lose most or all of their hair but, even in mammals like whales and dolphins, hair is present at least during some phase of ontogeny. Mammalian hair, made of a protein called keratin, serves at least four functions. First, it slows the exchange of heat with the environment (insulation). Second, specialized hairs (whiskers or "vibrissae") have a sensory function, letting an animal know when it is in contact with an object in its environment. Vibrissae are often richly innervated and well-supplied with muscles that control their position. Third, hair affects appearance through its color and pattern. It may serve to camouflage predators or prey, to warn predators of a defensive mechanism (for example, the conspicuous color pattern of a skunk is a warning to predators), or to communicate social information (for example, threats, such as the erect hair on the back of a wolf; sex, such as the different colors of male and female capuchin monkeys; or the presence of danger, such as the white underside of the tail of a white-tailed deer). Fourth, hair provides some protection, either simply by providing an additional protective layer (against abrasion or sunburn, for example) or by taking on the form of dangerous spines that deter predators (porcupines, spiny rats, others). (Klima and Maier, 1990; Vaughan, Ryan, and Czaplewski, 2000)

Mammals are typically characterized by their highly differentiated teeth. Teeth are replaced just once during an individual's life (a condition called diphyodonty). Other characteristics found in most mammals include: a lower jaw made up of a single bone, the dentary; four-chambered hearts; a secondary palate separating air and food passages in the mouth; a muscular diaphragm separating thoracic and abdominal cavities; a highly developed brain; endothermy and homeothermy; separate sexes with the sex of an embryo being determined by the presence of a Y or 2 X chromosomes; and internal fertilization. (Klima and Maier, 1990; Vaughan, Ryan, and Czaplewski, 2000)

Often, characteristics of skulls and dentition are used to define and differentiate mammalian groups. To make these easier to comprehend within the accounts of lower mammalian taxa, we provide links to dorsal, ventral, and lateral views of the skull of a dog on which the major bones, foramina, and processes have been labelled. Closeups of the basicranial region, orbital region, and lingual and labial views of a mandible are also available. A partially labeled full skeleton of a raccoon has also been prepared.

### Some key physical features:

endothermic; heterothermic; homiothermic; bilateral symmetry; polymorphic; venomous.

**Sexual dimorphism:** sexes alike, female larger, male larger, sexes colored or patterned differently, female more colorful, male more colorful, sexes shaped differently, ornamentation.

## Development

There are three major groups of mammals, each is united by a major feature of embryonic development. Monotremes (Prototheria) lay eggs, which is the most primitive reproductive condition in mammals. Marsupials (Metatheria) give birth to highly altricial young after a very short gestation period (8 to 43 days). The young are born at a relatively early stage of morphological development. They attach to the mother's nipple and spend a proportionally greater amount of time nursing as they develop. Gestation lasts much longer in placental mammals (Eutheria). During gestation, eutherian young interact with their mother through a placenta, a complex organ that connects the embryo with the uterus. Once born, all mammals are dependent upon their mothers for milk. Aside from these few generalities, mammals exhibit a diversity of developmental and life history patterns that vary among species and larger taxonomic groups. (Vaughan, Ryan, and Czaplewski, 2000)

## Reproduction







Generally, most mammalian species are either polygynous (one male mates with multiple females) or promiscuous (both males and females have multiple mates in a given reproductive season). Because females incur such high costs during gestation and lactation, it is often the case that male mammals can produce many more offspring in a mating season than can females. As a consequence, the most common mating system in mammals is polygyny, with relatively few males fertilizing multiple females and many males fertilizing none. This scenario sets the stage for intense male-male competition in many species, and also the potential for females to be choosy when it comes to which males will sire her offspring. As a consequence of the choices females make and the effort males put into acquiring matings, many mammals have complex behaviors and morphologies associated with reproduction. Many mammal groups are marked by sexual dimorphism as a result of selection for males that can better compete for access to females. (Apfelbach, 1990; Nowak, 1991; Vaughan, Ryan, and Czaplewski, 2000)

About 3 percent of mammalian species are monogamous, with males only mating with a single female each season. In these cases, males provide at least some care to their offspring. Often, mating systems may vary within species depending upon local environmental conditions. For example, when resources are low, males may mate with only a single female and provide care for the young. When resources are abundant, the mother may be able to care for young on her own and males will attempt to sire offspring with multiple females. (Apfelbach, 1990; Vaughan, Ryan, and Czaplewski, 2000)

Other mating systems such as polyandry can also be found among mammals. Some species (e.g. common marmosets and African lions) display cooperative breeding, in which groups of females, and sometimes males, share the care of young from one or more females. Naked mole rats have a unique mating system among mammals. Like social insects (Hymenoptera and Isoptera), naked mole rats are eusocial, with a queen female mating with several males

and bearing all of the young in the colony. Other colony members assist in the care of her offspring and do not reproduce themselves. (Apfelbach, 1990; Keil and Sachser, 1998; Lazaro-Perea et al., 2000; Stockley, 2003; Vaughan, Ryan, and Czaplewski, 2000)

**Mating systems:**

monogamous ; polyandrous ; polygynous ; polygynandrous (promiscuous) ; cooperative breeder ; eusocial .

Many mammals are seasonal breeders, with environmental stimuli such as day length, resource intake and temperature dictating when mating occurs. Females of some species store sperm until conditions are favorable, after which their eggs are fertilized. In other mammals, eggs may be fertilized shortly after copulation, but implantation of the embryo into the uterine lining may be delayed (“delayed implantation”). A third form of delayed gestation is "delayed development", in which development of the embryo may be arrested for some time. Seasonal breeding and delays in fertilization, implantation, or development are all reproductive strategies that help mammals coordinate the birth of offspring with favorable environmental conditions to increase the chances of offspring survival. (Vaughan, Ryan, and Czaplewski, 2000)

Some mammals give birth to many altricial young in each bout of reproduction. Despite being born in a relatively underdeveloped state, young of this type tend to reach maturity relatively quickly, soon producing many altricial young of their own. Mortality in these species tends to be high and average lifespans are generally short. Many species that exemplify this type of life history strategy can be found among the rodents and insectivores. At the other end of the life history spectrum, many mammals give birth to one or a few precocial young in each bout of reproduction. These species tend to live in stable environments where competition for resources is a key to survival and reproductive success. The strategy for these species is to invest energy and resources in a few, highly developed offspring that will grow to be good competitors. Cetaceans, primates and artiodactyls are examples of orders that follow this general pattern. (Vaughan, Ryan, and Czaplewski, 2000; Wilson and Reeder, 1993)

Among mammals, many reproductive strategies can be observed, and the patterns listed above are the extremes of a continuum encompassing this variation. Environmental factors, as well as physiological and historical constraints all contribute to the pattern of reproduction found in any population or species. Differences in these factors among species have led to the diversity of life history traits among mammals. (Vaughan, Ryan, and Czaplewski, 2000; Wilson and Reeder, 1993)

**Key reproductive features:**

semelparous; iteroparous; seasonal breeding; year-round breeding;  
 gonochoric/gonochoristic/dioecious (sexes separate); sexual; induced ovulation;  
 fertilization (internal); viviparous; oviparous; sperm-storing; delayed fertilization;  
 delayed implantation; embryonic diapause; post-partum estrous.

A fundamental component of mammalian evolution, behavior, and life history is the extended care females must give to their offspring. Investment begins even before a female's eggs become fertilized. All female mammals undergo some form of estrus cycle in which eggs develop and become ready for potential fertilization. Hormones regulate changes in various aspects of female physiology throughout the cycle (e.g., the thickening of the uterine lining) and prepare the female for possible fertilization and gestation. Once fertilization occurs, females nurture their embryos in one of three ways--either by attending eggs that are laid externally (Prototheria), nursing highly altricial young (often within a pouch, or "marsupium"; Metatheria), or by nourishing the developing embryos with a placenta that is attached directly to the uterine wall for a long gestation period (Eutheria). Gestation in eutherians is metabolically expensive. The costs incurred during gestation depend upon the number of offspring in a litter and the degree of development each embryo undergoes. (Vaughan, Ryan, and Czaplewski, 2000)

Once the young are born (or hatch, in the case of monotremes) females feed their newborn young with milk, a substance rich in fats and protein. Because females must produce this high-energy substance, lactation is far more energetically expensive than gestation. Once mammals are born they must maintain their own body temperatures, no longer being able to depend on their mother for thermoregulation, as was the case during pregnancy. Lactating females must provide enough milk for their offspring to maintain their body temperatures as well as to grow and develop. In addition to feeding their young, females must protect them from predators. In some species, young remain with their mothers even beyond lactation for an extended period of behavioral development and learning. (Vaughan, Ryan, and Czaplewski, 2000)

Depending upon the species and environmental conditions, male mammals may either provide no care, or may invest some or a great deal of care to their offspring. Care by males often involves defending a territory, resources, or the offspring themselves. Males may also provision females and young with food. (Apfelbach, 1990)

Mammalian young are often born in an altricial state, needing extensive care and protection for a period after birth. Most mammals make use of a den or nest for the protection of their young. Some mammals, however, are born well-developed and are able to locomote on their own soon after birth. Most notable in this regard are artiodactyls such as wildebeest or giraffes. Cetacean young must also swim on their own shortly after birth. (Vaughan, Ryan, and Czaplewski, 2000)

**Parental investment:**

pre-fertilization (provisioning, protecting: female); pre-hatching/birth (provisioning: female, protecting: female); pre-weaning/fledging (provisioning: male, female, protecting: male, female); pre-independence (provisioning: male, female, protecting: male, female); post-independence association with parents; extended period of juvenile learning; inherits maternal/paternal territory; maternal position in the dominance hierarchy affects status of young.

## Lifespan/Longevity

Just as mammals vary greatly in size, they also vary greatly in lifespan. Generally, smaller mammals live short lives and larger mammals live longer lives. Bats (Chiroptera) are an exception to this pattern, they are relatively small mammals that can live for one or more decades in natural conditions, considerably longer than natural lifespans of significantly larger mammals. Mammalian lifespans range from one year or less to 70 or more years in the wild. Bowhead whales may live more than 200 years. (Grzimek, 1990)

## Behavior



















Mammalian behavior varies substantially among species. As endotherms, mammals require more energy intake than ectotherms of a similar size, and mammalian activity patterns reflect their high energy demands. For example, thermoregulation plays an important role in dictating mammalian behavior. Mammals that live in colder climates must keep warm, while mammals that live in hot, dry climates must keep cool and conserve water. Behavior is an important way for mammals to help maintain physiological balance.

There are mammal species that exhibit nearly every type of lifestyle, including fossorial, aquatic, terrestrial, and arboreal lifestyles. Locomotion styles are also diverse: mammals may swim, run, bound, fly, glide, burrow, or climb as a means of moving throughout their environment.

Social behavior varies considerably as well. Some mammals live in groups of tens, hundreds, thousands or more individuals. Other mammals are generally solitary except when mating or raising young.

Activity patterns among mammals also cover the full range of possibilities. Mammals may be nocturnal, diurnal, or crepuscular. (Vaughan, Ryan, and Czaplewski, 2000)

### Key behaviors:

arboreal ; scansorial; cursorial; terricolous; fossorial ; flies; glides; saltatorial ; natatorial ; diurnal ; nocturnal ; crepuscular ; parasite ; motile ; nomadic ; migratory ; sedentary ; hibernation ; aestivation; daily torpor; solitary ; territorial ; social ; colonial ; dominance hierarchies .

## Communication and Perception

Generally, olfaction, hearing, tactile perception, and vision are all important sensory modalities in mammals. Olfaction plays a key role in many aspects of mammalian ecology, including foraging, mating and social communication. Many mammals use pheromones and other olfactory cues to communicate information about their reproductive status, territory, or individual or group identity. Scent-marking is commonly used to communicate among mammals. They are often transmitted through urine, feces, or the secretions of specific glands. Some mammals even use odors as defense against mammalian predators (e.g. skunks), which are especially sensitive to foul-smelling chemical defenses. (Apfelbach and Ganslosser, 1990; Vaughan, Ryan, and Czaplewski, 2000)





Typically, mammalian hearing is well-developed. In some species, it is the primary form of perception. Echolocation, the ability to perceive objects in the external environment by listening to echoes from sounds generated by an animal, has evolved in several groups. Echolocation is the main perception channel used in foraging and navigation in microchiropteran bats (Chiroptera) and many toothed whales and dolphins (Odontoceti), and has also evolved to a lesser degree in other species (e.g., some shrews). (Apfelbach and Ganslosser, 1990; Vaughan, Ryan, and Czaplewski, 2000)

Many mammals are vocal, and communicate with one another or with heterospecifics using sound. Vocalizations are used in communication between mother and offspring, between potential mates, and in a variety of other social contexts. Vocalizations can communicate individual or group identity, alarm at the presence of a predator, aggression in dominance interactions, territorial defense, and reproductive state. Communication using vocalizations is quite complex in some groups, most notably in humans. (Apfelbach and Ganslosser, 1990; Vaughan, Ryan, and Czaplewski, 2000)

Mammals also perceive their environment through tactile input to the hair and skin. Specialized hairs (whiskers or "vibrissae") have a sensory function, letting an animal know when it is in contact with an object in its external environment. Vibrissae are often richly innervated and well-supplied with muscles that control their position. The skin is also an important sensory organ. Often, certain portions of the skin are especially sensitive to tactile stimuli, aiding in specific functions like foraging (e.g., the fingers of primates and the nasal tentacles of star-nosed moles). Touch also serves many communication functions, and is often associated with social behavior (e.g., social grooming). (Vaughan, Ryan, and Czaplewski, 2000)

Vision is well-developed in a large number of mammals, although it is less important in many species that live underground or use echolocation. Many nocturnal animals have relatively large, well-developed eyes. Vision can be important in foraging, navigation, entraining biological rhythms to day length or season, communication, and nearly all aspects of mammalian behavior and ecology. (Apfelbach and Ganslosser, 1990; Vaughan, Ryan, and Czaplewski, 2000)


### **Communicates with:**

visual ; tactile ; acoustic ; chemical .

### **Other communication keywords:**

mimicry ; duets ; choruses ; pheromones ; scent marks ; vibrations .

### **Perception channels:**

visual ; tactile ; acoustic ; ultrasound ; echolocation ; vibrations ; chemical .

## Food Habits

As a group, mammals eat an enormous variety of organisms. Many mammals can be carnivores (e.g., most species within Carnivora), herbivores (e.g., Perissodactyla, Artiodactyla), or omnivores (e.g., many primates). Mammals eat both invertebrates and vertebrates (including other mammals), plants (including fruit, nectar, foliage, wood, roots, seeds, etc.) and fungi. Being endotherms, mammals require much more food than ectotherms of similar proportions. Thus, relatively few mammals can have a large impact on the populations of their food items.

### Primary Diet:

carnivore (eats terrestrial vertebrates, piscivore, eats eggs, sanguivore, consumes bodily fluids, scavenger, insectivore, molluscivore, eats non-insect arthropods); herbivore (folivore, nectarivore, frugivore, granivore, lignivore); omnivore; planktivore; mycophage; coprophage.

### Behaviors:

stores or caches food; filter-feeding.

## Predation

### Known predators

- Aves
- Reptilia
- Mammalia

Predation is a significant source of mortality for many mammals. Except for those few species that are top predators, mammals are preyed upon by many other organisms, including other mammals. Other groups that typically eat mammals are predatory birds and reptiles. Many species cope with predation through avoidance strategies such as cryptic coloration, by restricting foraging to times when predators may not be abundant, or through their sociality. Some mammals also have defensive chemicals (e.g., skunks) or bear some type of protective armor or physical defense (e.g., armadillos, pangolins, New World porcupines and Old World porcupines). (Vaughan, Ryan, and Czaplewski, 2000)

### Anti-predator adaptations::

aposematic; cryptic.




## Ecosystem Roles

The ecological roles, or niches, filled by the nearly 5000 mammal species are quite diverse. There are predators and prey, carnivores, omnivores, and herbivores, species that create or greatly modify their habitat and thus the habitat and structure of their communities [e.g., beavers damming streams, large populations of ungulates (Artiodactyla and Perissodactyla) grazing in grasslands, moles digging in the earth]. In part because of their high metabolic rates, mammals often play an ecological role that is disproportionately large compared to their numerical abundance. Thus, many mammals may be keystone predators in their communities



or play important roles in seed dispersal or pollination. The ecosystem roles that mammals play are so diverse that it is difficult to generalize across the group. Despite their low species diversity, compared to other animal groups, mammals have a substantial impact on global biodiversity. (Reichholf, 1990a; Vaughan, Ryan, and Czaplewski, 2000)

**Key ways these animals impact their ecosystem:**

disperses seeds; pollinates; creates habitat; biodegradation ; soil aeration ; keystone species .

## Conservation

Overexploitation, habitat destruction and fragmentation, the introduction of exotic species, and other anthropogenic pressures threaten mammals worldwide. In the past five centuries at least 82 mammal species have gone extinct. Currently, the International Union for Conservation of Nature and Natural Resources (IUCN) has listed about 1000 species (roughly 25% of all known mammals), as being at some risk of extinction. Several factors contribute to a species' vulnerability to human-induced extinction. Species that are naturally rare or require large home ranges are often at risk due to habitat loss and fragmentation. Species that are seen to threaten humans, livestock, or crops may be directly targeted for extirpation. Those species that are exploited by humans as a resource (e.g., for their meat or fur) but are not domesticated are often depleted to critically low levels. Finally, global climate change is adversely affecting many mammals. The geographic ranges of many mammals are shifting, and these shifts often correlate with changes in local temperatures and climate. As temperatures rise, which is especially pronounced in polar regions, some mammals are unable to adjust and are consequently at risk of losing their environment. (Reichholf, 1990c; Vaughan, Ryan, and Czaplewski, 2000)

## Conservation status

Least concern – near threatened – vulnerable – endangered – critically endangered – extinct in the wild – extinct

Source: IUNC (the International Union for Conservation of Nature)