[Template:Other uses](/wiki/Template:Other_uses" \o "Template:Other uses) [Template:Redirect](/wiki/Template:Redirect) [Template:Pp-move-indef](/wiki/Template:Pp-move-indef) [Template:Automatic taxobox](/wiki/Template:Automatic_taxobox)

**Mammals** ([class](/wiki/Class_(biology)) **Mammalia** [Template:IPAc-en](/wiki/Template:IPAc-en) from [Latin](/wiki/Latin_language) [*mamma*](/wiki/Wikt:mamma#Latin) "breast") are a [clade](/wiki/Clade) of [endothermic](/wiki/Endotherm) [amniotes](/wiki/Amniote) distinguished from [reptiles](/wiki/Reptile) and [birds](/wiki/Bird) by the possession of a [neocortex](/wiki/Neocortex) (a region of the brain), [hair](/wiki/Hair), three [middle ear bones](/wiki/Ossicles) and [mammary glands](/wiki/Mammary_gland).

Mammals include the largest animals on the planet, the [great whales](/wiki/Baleen_whale), as well as some of the most [intelligent](/wiki/Animal_cognition), such as [elephants](/wiki/Elephant), [primates](/wiki/Primate) and [cetaceans](/wiki/Cetacean). The basic body type is a terrestrial [quadruped](/wiki/Quadruped), but some mammals are adapted for [life at sea](/wiki/Marine_mammal), in [the air](/wiki/Aerial_locomotion), [in trees](/wiki/Arboreal_locomotion), [underground](/wiki/Fossorial) or [on two legs](/wiki/Biped). The largest group of mammals, the placentals, have a [placenta](/wiki/Placenta), which enables the feeding of the fetus during gestation. Mammals range in size from the [Template:Convert](/wiki/Template:Convert) [bumblebee bat](/wiki/Bumblebee_bat) to the [Template:Convert](/wiki/Template:Convert) [blue whale](/wiki/Blue_whale). With the exception of the five [species](/wiki/Species) of [monotreme](/wiki/Monotreme) (egg-laying mammals), all modern mammals give birth to live young. Most mammals, including the six most species-rich [orders](/wiki/Order_(biology)), belong to the placental group. The three largest orders in number of species are [Rodentia](/wiki/Rodent): [mice](/wiki/Mouse), [rats](/wiki/Rat), [porcupines](/wiki/Porcupine), [beavers](/wiki/Beaver), [capybaras](/wiki/Capybara) and other gnawing mammals; [Chiroptera](/wiki/Chiroptera): bats; and [Soricomorpha](/wiki/Soricomorpha): [shrews](/wiki/Shrew), [moles](/wiki/Mole_(animal)) and [solenodons](/wiki/Solenodon). The next three biggest orders, depending on the [biological classification](/wiki/Biological_classification) scheme used, are the [Primates](/wiki/Primate) including the [great apes](/wiki/Great_ape) and [monkeys](/wiki/Monkey); the [Cetartiodactyla](/wiki/Cetartiodactyla) including [whales](/wiki/Whale) and [even-toed ungulates](/wiki/Even-toed_ungulates); and the [Carnivora](/wiki/Carnivora) which includes [cats](/wiki/Cat), [dogs](/wiki/Dog), [weasels](/wiki/Weasel), [bears](/wiki/Bear) and [seals](/wiki/Pinniped).

The word "[mammal](/wiki/Wikt:mammal)" is modern, from the scientific name *Mammalia*, coined by [Carl Linnaeus](/wiki/Carl_Linnaeus) in 1758, derived from the [Latin](/wiki/Latin) [*mamma*](/wiki/Wikt:mamma#Latin) ("teat, pap"). All [female mammals](/wiki/Female#Mammalian_female) nurse their young with milk, which is secreted from special [glands](/wiki/Gland), the mammary glands. According to [*Mammal Species of the World*](/wiki/Mammal_Species_of_the_World), 5,416 species were known in 2006. These were grouped in 1,229 [genera](/wiki/Genus), 153 [families](/wiki/Family_(biology)) and 29 orders. In 2008 the [International Union for Conservation of Nature](/wiki/International_Union_for_Conservation_of_Nature) (IUCN) completed a five-year, 1,700-scientist Global Mammal Assessment for its [IUCN Red List](/wiki/IUCN_Red_List), which counted 5,488 species. In some classifications, extant mammals are divided into two subclasses: the [Prototheria](/wiki/Prototheria), that is, the order Monotremata; and the [Theria](/wiki/Theria), or the infraclasses [Metatheria](/wiki/Metatheria) and [Eutheria](/wiki/Eutheria). The [marsupials](/wiki/Marsupial) constitute the [crown group](/wiki/Crown_group) of the Metatheria, and include all living metatherians as well as many extinct ones; the placentals are the crown group of the Eutheria. While [mammal classification](/wiki/Mammal_classification) at the family level has been relatively stable, several contending classifications regarding the higher levels—subclass, infraclass and order, especially of the marsupials—appear in contemporaneous literature. Much of the changes reflect the advances of [cladistic analysis](/wiki/Cladistic_analysis) and [molecular genetics](/wiki/Molecular_genetics). Findings from molecular genetics, for example, have prompted adopting new groups, such as the [Afrotheria](/wiki/Afrotheria), and abandoning traditional groups, such as the [Insectivora](/wiki/Insectivora).

The early [synapsid](/wiki/Synapsid) mammalian ancestors were [sphenacodont](/wiki/Sphenacodontia) [pelycosaurs](/wiki/Pelycosaur), a group that produced the non-mammalian [*Dimetrodon*](/wiki/Dimetrodon). At the end of the [Carboniferous](/wiki/Carboniferous) period, this group diverged from the [sauropsid](/wiki/Sauropsida) line that led to today's [reptiles](/wiki/Reptile) and [birds](/wiki/Bird). The line following the stem group [Sphenacodontia](/wiki/Sphenacodontia) split-off several diverse groups of non-mammalian synapsids—sometimes referred to as mammal-like reptiles—before giving rise to [the proto-mammals](/wiki/Dimetrodon#Clade_Synapsida) ([Therapsida](/wiki/Therapsida)) in the early [Mesozoic](/wiki/Mesozoic) era. The modern mammalian orders arose in the [Paleogene](/wiki/Paleogene) and [Neogene](/wiki/Neogene) periods of the [Cenozoic](/wiki/Cenozoic) era, after the [extinction of non-avian dinosaurs](/wiki/Cretaceous–Paleogene_extinction_event), and have been among the dominant terrestrial animal groups from 66 million years ago to the present.

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## Classification[[edit](/index.php?title=(none)&action=edit&section=1)]

[Template:Main article](/wiki/Template:Main_article) [Template:See also](/wiki/Template:See_also) [thumb|300px|The orders](/wiki/Image:Mammal_species_pie_chart.png) [Rodentia](/wiki/Rodent) (blue), [Chiroptera](/wiki/Chiroptera) (red) and [Soricomorpha](/wiki/Soricomorpha) (yellow) together comprise over 70% of mammal species.

[George Gaylord Simpson's](/wiki/George_Gaylord_Simpson) "Principles of Classification and a Classification of Mammals" (AMNH *Bulletin* v. 85, 1945) was the original source for the taxonomy listed here. Simpson laid out a systematics of mammal origins and relationships that was universally taught until the end of the 20th century. Since Simpson's classification, the [paleontological record](/wiki/Fossil_record) has been recalibrated, and the intervening years have seen much debate and progress concerning the theoretical underpinnings of systematization itself, partly through the new concept of [cladistics](/wiki/Cladistics). Though field work gradually made Simpson's classification outdated, it remained the closest thing to an official classification of mammals.<ref name=Szalay>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

### Definitions {{Anchor|variations}}[[edit](/index.php?title=(none)&action=edit&section=2)]

The word "[mammal](/wiki/Wikt:mammal)" is modern, from the scientific name *Mammalia* coined by [Carl Linnaeus](/wiki/Carl_Linnaeus) in 1758, derived from the [Latin](/wiki/Latin) [*mamma*](/wiki/Wikt:mamma#Latin) ("teat, pap"). In an influential 1988 paper, Timothy Rowe defined Mammalia [phylogenetically](/wiki/Phylogenetics) as the [crown group](/wiki/Crown_group) of mammals, the [clade](/wiki/Clade) consisting of the [most recent common ancestor](/wiki/Most_recent_common_ancestor) of living [monotremes](/wiki/Monotreme) ([echidnas](/wiki/Echidna) and [platypuses](/wiki/Platypus)) and [therian](/wiki/Theria) mammals ([marsupials](/wiki/Marsupial) and [placentals](/wiki/Placental)) and all descendants of that ancestor.[[1]](#cite_note-1) Since this ancestor lived in the [Jurassic](/wiki/Jurassic) period, Rowe's definition excludes all animals from the earlier [Triassic](/wiki/Triassic), despite the fact that Triassic fossils in the [Haramiyida](/wiki/Haramiyida) have been referred to the Mammalia since the mid-19th century.[[2]](#cite_note-2) If Mammalia is considered as the crown group, its origin can be roughly dated as the first known appearance of animals more closely related to some extant mammals than to others. [*Ambondro*](/wiki/Ambondro_mahabo) is more closely related to monotremes than to therian mammals while [*Amphilestes*](/wiki/Amphilestes) and [*Amphitherium*](/wiki/Amphitherium) are more closely related to the therians; as fossils of all three genera are dated about [Template:Ma](/wiki/Template:Ma) in the [Middle Jurassic](/wiki/Middle_Jurassic), this is a reasonable estimate for the appearance of the crown group.[[3]](#cite_note-3) T. S. Kemp has provided a more traditional definition: "[synapsids](/wiki/Synapsid) that possess a [dentary](/wiki/Dentary)–[squamosal](/wiki/Squamosal_bone) jaw articulation and [occlusion](/wiki/Occlusion_(dentistry)) between upper and lower molars with a transverse component to the movement" or, equivalently in Kemp's view, the clade originating with the last common ancestor of [*Sinoconodon*](/wiki/Sinoconodon) and living mammals.[[4]](#cite_note-4) The earliest known synapsid satisfying Kemp's definitions is [*Tikitherium*](/wiki/Tikitherium), dated [Template:Ma](/wiki/Template:Ma), so the appearance of mammals in this broader sense can be given this [Late Triassic](/wiki/Late_Triassic) date.[[5]](#cite_note-5)[[6]](#cite_note-6)

### McKenna/Bell classification[[edit](/index.php?title=(none)&action=edit&section=3)]

In 1997, the mammals were comprehensively revised by [Malcolm C. McKenna](/wiki/Malcolm_McKenna) and Susan K. Bell, which has resulted in the McKenna/Bell classification. Their 1997 book, *Classification of Mammals above the Species Level*,[[7]](#cite_note-7) is the most comprehensive work to date on the systematics, relationships and occurrences of all mammal taxa, living and extinct, down through the rank of genus, though molecular genetic data challenge several of the higher level groupings. The authors worked together as [paleontologists](/wiki/Paleontologist) at the [American Museum of Natural History](/wiki/American_Museum_of_Natural_History), [New York](/wiki/New_York). McKenna inherited the project from Simpson and, with Bell, constructed a completely updated hierarchical system, covering living and extinct taxa that reflects the historical genealogy of Mammalia.<ref name=Szalay/>

[Extinct](/wiki/Extinct) groups are represented by a [dagger](/wiki/Dagger_(typography)) (†).

**Class Mammalia**

* **Subclass** [**Prototheria**](/wiki/Prototheria): monotremes: [echidnas](/wiki/Echidna) and the [platypus](/wiki/Platypus)
* **Subclass** [**Theriiformes**](/wiki/Theriiformes): live-bearing mammals and their prehistoric relatives
  + Infraclass †[Allotheria](/wiki/Allotheria): multituberculates
  + Infraclass †[Eutriconodonta](/wiki/Eutriconodonta): eutriconodonts
  + Infraclass [Holotheria](/wiki/Holotheria): modern live-bearing mammals and their prehistoric relatives
    - Superlegion †[Kuehneotheria](/wiki/Kuehneotheria)
    - Supercohort [Theria](/wiki/Theria): live-bearing mammals
      * Cohort [Marsupialia](/wiki/Marsupialia): marsupials
        + Magnorder [Australidelphia](/wiki/Australidelphia): Australian marsupials and the [monito del monte](/wiki/Monito_del_monte)
        + Magnorder [Ameridelphia](/wiki/Ameridelphia): New World marsupials. Now considered paraphyletic, with [shrew opossums](/wiki/Shrew_opossum) being closer to australidelphians.[[8]](#cite_note-8)[[9]](#cite_note-9)\*\*\*\*Cohort [Placentalia](/wiki/Placentalia): placentals
        + Magnorder [Xenarthra](/wiki/Xenarthra): xenarthrans
        + Magnorder [Epitheria](/wiki/Epitheria): epitheres

Superorder [Anagalida](/wiki/Anagalida): [lagomorphs](/wiki/Lagomorpha), [rodents](/wiki/Rodent) and [elephant shrews](/wiki/Elephant_shrew)

Superorder [Ferae](/wiki/Ferae): [carnivorans](/wiki/Carnivora), [pangolins](/wiki/Pangolin), †[creodonts](/wiki/Creodont) and relatives

Superorder [Lipotyphla](/wiki/Lipotyphla): [insectivorans](/wiki/Insectivora)

Superorder [Archonta](/wiki/Archonta): [bats](/wiki/Bat), [primates](/wiki/Primate), [colugos](/wiki/Colugo) and [treeshrews](/wiki/Treeshrew)

Superorder [Ungulata](/wiki/Ungulata): ungulates

Order [Tubulidentata](/wiki/Tubulidentata) [*incertae sedis*](/wiki/Incertae_sedis): [aardvark](/wiki/Aardvark)

Mirorder [Eparctocyona](/wiki/Eparctocyona): †[condylarths](/wiki/Condylarth), [whales](/wiki/Whale) and [artiodactyls](/wiki/Artiodactyla) (even-toed ungulates)

Mirorder †[Meridiungulata](/wiki/Meridiungulata): South American ungulates

Mirorder [Altungulata](/wiki/Altungulata): [perissodactyls](/wiki/Perissodactyla) (odd-toed ungulates), [elephants](/wiki/Elephant), [manatees](/wiki/Manatee) and [hyraxes](/wiki/Hyrax)

### Molecular classification of placentals[[edit](/index.php?title=(none)&action=edit&section=4)]

Molecular studies based on [DNA](/wiki/DNA) analysis have suggested new relationships among mammal families over the last few years. Most of these findings have been independently validated by [retrotransposon](/wiki/Retrotransposon) [presence/absence data](/wiki/Retrotransposon_marker).<ref name=Kriegs2006>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Classification systems based on molecular studies reveal three major groups or lineages of placental mammals- [Afrotheria](/wiki/Afrotheria), [Xenarthra](/wiki/Xenarthra) and [Boreoeutheria](/wiki/Boreoeutheria)- which diverged in the [Cretaceous](/wiki/Cretaceous). The relationships between these three lineages is contentious, and all three possible different hypotheses have been proposed with respect to which group is [basal](/wiki/Basal_(phylogenetics)). These hypotheses are [Atlantogenata](/wiki/Atlantogenata) (basal Boreoeutheria), [Epitheria](/wiki/Epitheria) (basal Xenarthra) and [Exafroplacentalia](/wiki/Exafroplacentalia) (basal Afrotheria).<ref name=Nishiharaetal2009>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Boreoeutheria in turn contains two major lineages- [Euarchontoglires](/wiki/Euarchontoglires) and [Laurasiatheria](/wiki/Laurasiatheria).

Estimates for the divergence times between these three placental groups range from 105 to 120 million years ago, depending on type of DNA (such as [nuclear](/wiki/Nuclear_DNA) or [mitochondrial](/wiki/Mitochondrial_DNA))[[10]](#cite_note-10) and varying interpretations of [paleogeographic](/wiki/Paleogeographic) data.<ref name=Nishiharaetal2009/>

[Template:Clade](/wiki/Template:Clade) [Cladogram](/wiki/Cladogram) based on Tarver *et al*. (2016)[[11]](#cite_note-11) **Group I:** [**Afrotheria**](/wiki/Afrotheria)

* Clade [Afroinsectiphilia](/wiki/Afroinsectiphilia)
  + Order [Macroscelidea](/wiki/Macroscelidea): elephant shrews (Africa)
  + Order [Afrosoricida](/wiki/Afrosoricida): tenrecs and golden moles (Africa)
  + Order [Tubulidentata](/wiki/Tubulidentata): aardvark (Africa south of the Sahara)
* Clade [Paenungulata](/wiki/Paenungulata)
  + Order [Hyracoidea](/wiki/Hyracoidea): hyraxes or dassies (Africa, Arabia)
  + Order [Proboscidea](/wiki/Proboscidea): elephants (Africa, Southeast Asia)
  + Order [Sirenia](/wiki/Sirenia): dugong and manatees ([cosmopolitan](/wiki/Cosmopolitan_(species)) tropical)

**Group II:** [**Xenarthra**](/wiki/Xenarthra)

* Order [Pilosa](/wiki/Pilosa): sloths and anteaters (neotropical)
* Order [Cingulata](/wiki/Cingulata): armadillos and extinct relatives (Americas)

**Group III:** [**Boreoeutheria**](/wiki/Boreoeutheria)

* **Clade:** [**Euarchontoglires**](/wiki/Euarchontoglires) **(**[**Supraprimates**](/wiki/Supraprimates)**)**
  + Superorder [Euarchonta](/wiki/Euarchonta)
    - Order [Scandentia](/wiki/Scandentia): treeshrews (Southeast Asia).
    - Order [Dermoptera](/wiki/Dermoptera): flying lemurs or colugos (Southeast Asia)
    - Order [Primates](/wiki/Primate): lemurs, bushbabies, monkeys, apes, humans (cosmopolitan)
  + Superorder [Glires](/wiki/Glires)
    - Order [Lagomorpha](/wiki/Lagomorpha): [pikas](/wiki/Pika), [rabbits](/wiki/Rabbit), hares (Eurasia, Africa, Americas)
    - Order [Rodentia](/wiki/Rodent): rodents (cosmopolitan)
* **Clade** [**Laurasiatheria**](/wiki/Laurasiatheria)
  + Order [Eulipotyphla](/wiki/Eulipotyphla): shrews, hedgehogs, moles, [solenodons](/wiki/Solenodon)
  + Clade [Ferungulata](/wiki/Ferungulata)
    - Clade [Cetartiodactyla](/wiki/Cetartiodactyla)
      * Order [Cetacea](/wiki/Cetacea): whales, dolphins and porpoises
      * Order [Artiodactyla](/wiki/Artiodactyla): even-toed ungulates, including [pigs](/wiki/Pig), [hippopotamus](/wiki/Hippopotamus), [camels](/wiki/Camel), [giraffe](/wiki/Giraffe), [deer](/wiki/Deer), [antelope](/wiki/Antelope), [cattle](/wiki/Cattle), [sheep](/wiki/Sheep), [goats](/wiki/Goat) (Note that [Artiodactyla](/wiki/Artiodactyla) is paraphyletic to [Cetacea](/wiki/Cetacea))
    - Clade [Pegasoferae](/wiki/Pegasoferae)
      * Order [Chiroptera](/wiki/Chiroptera): bats (cosmopolitan)
      * Clade [Zooamata](/wiki/Zooamata)
        + Order [Perissodactyla](/wiki/Perissodactyla): odd-toed ungulates, including [horses](/wiki/Horse), [donkeys](/wiki/Donkey), [zebras](/wiki/Zebra), [tapirs](/wiki/Tapir) and [rhinoceroses](/wiki/Rhinoceros)
        + Clade [Ferae](/wiki/Ferae)

Order [Pholidota](/wiki/Pholidota): pangolins or scaly anteaters (Africa, South Asia)

Order [Carnivora](/wiki/Carnivora): carnivores (cosmopolitan), including [cats](/wiki/Felis) and [dogs](/wiki/Canis)

### Statistics[[edit](/index.php?title=(none)&action=edit&section=5)]

Most mammals, including the six most species-rich [orders](/wiki/Order_(biology)), belong to the placental group. The three largest orders in numbers of species are [Rodentia](/wiki/Rodent): [mice](/wiki/Mouse), [rats](/wiki/Rat), [porcupines](/wiki/Porcupine), [beavers](/wiki/Beaver), [capybaras](/wiki/Capybara) and other gnawing mammals; [Chiroptera](/wiki/Chiroptera): bats; and [Soricomorpha](/wiki/Soricomorpha): [shrews](/wiki/Shrew), [moles](/wiki/Mole_(animal)) and [solenodons](/wiki/Solenodon). The next three biggest orders, depending on the [biological classification](/wiki/Biological_classification) scheme used, are the [Primates](/wiki/Primate) including the [great apes](/wiki/Great_ape) and [monkeys](/wiki/Monkey); the [Cetartiodactyla](/wiki/Cetartiodactyla) including [whales](/wiki/Whale) and [even-toed ungulates](/wiki/Even-toed_ungulates); and the [Carnivora](/wiki/Carnivora) which includes [cats](/wiki/Cat), [dogs](/wiki/Dog), [weasels](/wiki/Weasel), [bears](/wiki/Bear) and [seals](/wiki/Pinniped).<ref name=MSW3intro>[Template:MSW3](/wiki/Template:MSW3)</ref> According to [*Mammal Species of the World*](/wiki/Mammal_Species_of_the_World), 5,416 species were known in 2006. These were grouped in 1,229 [genera](/wiki/Genus), 153 [families](/wiki/Family_(biology)) and 29 orders.[[12]](#cite_note-12) In 2008 the [International Union for Conservation of Nature](/wiki/International_Union_for_Conservation_of_Nature) (IUCN) completed a five-year, 1,700-scientist Global Mammal Assessment for its [IUCN Red List](/wiki/IUCN_Red_List), which counted 5,488 species.[[13]](#cite_note-13)

## Evolutionary history[[edit](/index.php?title=(none)&action=edit&section=6)]

[Template:Life timeline](/wiki/Template:Life_timeline) [Template:Details](/wiki/Template:Details) [Synapsida](/wiki/Synapsida), a clade that contains mammals and their extinct relatives, originated during the [Pennsylvanian subperiod](/wiki/Pennsylvanian_(geology)), when they split from reptilian and avian lineages. Crown group mammals evolved from earlier mammaliaforms during the [Early Jurassic](/wiki/Early_Jurassic).

The cladogram following takes Mammalia to be the crown group.<ref name=Liaoconodon2011>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

[Template:Clade](/wiki/Template:Clade)

|  |
| --- |
| **Mammaliaformes classification** |
| [Template:Clade](/wiki/Template:Clade)   * Mammaliaformes   + †[*Tricuspes*](/wiki/Tricuspes) von Huene 1933 [? non-mammaliaform chiniquodontoid]   + †[*Repenomamus*](/wiki/Repenomamus) Li et al. 2001 {Repenomamidae Li et al. 2001} [?gobiconodont] * Mammalia Linnaeus 1758 sensu stricto Rowe 1988 (true mammals)   + †[*Reigitherium bunodontum*](/wiki/Reigitherium) Bonaparte 1990 {Reigitheriidae Bonaparte 1990}   + †[*Tikitherium copei*](/wiki/Tikitherium) Datta 2005 * Trechnotheria   + †[*Argentoconodon fariasorum*](/wiki/Argentoconodon) Rougier et al. 2007   + †[*Austrotriconodon mckennai*](/wiki/Austrotriconodon) Bonaparte 1986 {[Austrotriconodontidae](/wiki/Austrotriconodontidae) Bonaparte 1990}   + †[*Dyskritodon*](/wiki/Dyskritodon) Sigogneau-Russell 1995   + †[*Hallautherium schalchi*](/wiki/Hallautherium) Clemens 1980   + †[*Liaotherium gracile*](/wiki/Liaotherium) Zhou, Cheng & Wang 1991   + †[Jeholodentidae](/wiki/Jeholodentidae) Luo et al. 2007 * [Paraphyletic](/wiki/Paraphyletic) Symmetrodonta Simpson 1925   + †[*Thereuodon*](/wiki/Thereuodon) Sigogneau-Russell 1989 [Dryolestida, or Zatheria indet., milk tooth (Averianov, 2002)]   + †[*Atlasodon*](/wiki/Atlasodon) Sigogneau-Russell 1991 [Dryolestida, or Zatheria indet., milk tooth (Averianov, 2002)]   + †[*Eurylambda aequicrurius*](/wiki/Eurylambda)   + †[*Peralestes longirostris*](/wiki/Peralestes)   + †[*Tribactonodon bonfieldi*](/wiki/Tribactonodon) Sigogneau-Russell, Hooker & Ensom 2001   A [cladogram](/wiki/Cladogram) compiled by Mikko Haaramo based on individual cladograms of After Rowe 1988; Luo, Crompton & Sun 2001; Luo, Cifelli & Kielan-Jaworowska 2001, Luo, Kielan-Jaworowska & Cifelli 2002, Kielan-Jaworowska, Cifelli & Luo 2004 and Luo & Wible 2005.[[14]](#cite_note-14) |

### Evolution from amniotes[[edit](/index.php?title=(none)&action=edit&section=7)]

[thumb|The original synapsid skull structure contains one](/wiki/Image:Skull_synapsida_1.png) [temporal opening](/wiki/Temporal_fenestrae) behind the [orbitals](/wiki/Eye_socket), in a fairly low position on the skull (lower right in this image). This opening might have assisted in containing the jaw muscles of these organisms which could have increased their biting strength.

The first fully terrestrial [vertebrates](/wiki/Vertebrate) were [amniotes](/wiki/Amniote). Like their amphibious [tetrapod](/wiki/Tetrapod) predecessors, they had lungs and limbs. Amniotic eggs, however, have internal membranes that allow the developing [embryo](/wiki/Embryo) to breathe but keep water in. Hence, amniotes can lay eggs on dry land, while amphibians generally need to lay their eggs in water.

The first amniotes apparently arose in the [Late Carboniferous](/wiki/Pennsylvanian_(geology)). They descended from earlier [reptiliomorph](/wiki/Reptiliomorpha) amphibious tetrapods,[[15]](#cite_note-15) which lived on land that was already inhabited by [insects](/wiki/Insect) and other invertebrates as well as [ferns](/wiki/Fern), [mosses](/wiki/Moss) and other plants. Within a few million years, two important amniote lineages became distinct: the [synapsids](/wiki/Synapsid), which would later include the common ancestor of the mammals; and the [sauropsids](/wiki/Sauropsid), which now include [turtles](/wiki/Turtle), [lizards](/wiki/Lizard), [snakes](/wiki/Snake), [crocodilians](/wiki/Crocodilian), [dinosaurs](/wiki/Dinosaur) and [birds](/wiki/Bird).[[16]](#cite_note-16) Synapsids have a single hole ([temporal fenestra](/wiki/Temporal_fenestra)) low on each side of the skull. One synapsid group, the [pelycosaurs](/wiki/Pelycosaur), included the largest and fiercest animals of the early [Permian](/wiki/Permian).[[17]](#cite_note-17) Nonmammalian synapsids are sometimes called "mammal-like reptiles".<ref name=Kemp2006/><ref name=Bennett1986/>

[Therapsids](/wiki/Therapsid) descended from pelycosaurs in the Middle Permian, about 265 million years ago, and became the dominant land vertebrates.<ref name=Kemp2006>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> They differ from basal [eupelycosaurs](/wiki/Eupelycosauria) in several features of the skull and jaws, including: larger skulls and [incisors](/wiki/Incisor) which are equal in size in therapsids, but not for eupelycosaurs.<ref name=Kemp2006/> The therapsid lineage leading to mammals went through a series of stages, beginning with animals that were very similar to their pelycosaur ancestors and ending with [probainognathian](/wiki/Probainognathia) [cynodonts](/wiki/Cynodont), some of which could easily be mistaken for mammals. Those stages were characterized by:[[18]](#cite_note-18)\*The gradual development of a bony secondary [palate](/wiki/Hard_palate).

* Progression towards an erect limb posture, which would increase the animals' stamina by avoiding [Carrier's constraint](/wiki/Carrier's_constraint). But this process was slow and erratic: for example, all herbivorous nonmammaliaform therapsids retained sprawling limbs (some late forms may have had semierect hind limbs); Permian carnivorous therapsids had sprawling forelimbs, and some late Permian ones also had semisprawling hindlimbs. In fact, modern monotremes still have semisprawling limbs.
* The [dentary](/wiki/Dentary) gradually became the main bone of the lower jaw which, by the Triassic, progressed towards the fully mammalian jaw (the lower consisting only of the dentary) and middle ear (which is constructed by the bones that were previously used to construct the jaws of reptiles).

### First mammals[[edit](/index.php?title=(none)&action=edit&section=8)]

The [Permian–Triassic extinction event](/wiki/Permian–Triassic_extinction_event), which was a prolonged event due to the accumulation of several extinction pulses, ended the dominance of carnivores therapsids.[[19]](#cite_note-19) In the early Triassic, most medium to large land carnivore niches were taken over by [archosaurs](/wiki/Archosaur)[[20]](#cite_note-20) which, over an extended period of time (35 million years), came to include the [crocodylomorphs](/wiki/Crocodylomorpha),[[21]](#cite_note-21) the [pterosaurs](/wiki/Pterosaur) and the [dinosaurs](/wiki/Dinosaur);[[22]](#cite_note-22) however, large cynodonts like [*Trucidocynodon*](/wiki/Trucidocynodon) and [traversodontids](/wiki/Traversodontidae) still occupied large sized carnivorous and herbivorous niches respectively. By the Jurassic, the dinosaurs had come to dominate the large terrestrial herbivore niches as well.[[23]](#cite_note-23) The first mammals (in Kemp's sense) appeared in the Late Triassic epoch (about 225 million years ago), 40 million years after the first therapsids. They expanded out of their nocturnal [insectivore](/wiki/Insectivore) niche from the mid-Jurassic onwards;[[24]](#cite_note-24) The Jurassic [*Castorocauda*](/wiki/Castorocauda), for example, had adaptations for swimming, digging and catching fish.[[25]](#cite_note-25) Most, if not all, are thought to have remained nocturnal (the [Nocturnal bottleneck](/wiki/Nocturnal_bottleneck)), accounting for much of the typical mammalian traits.[[26]](#cite_note-26) The majority of the mammal species that existed in the [Mesozoic Era](/wiki/Mesozoic) were [multituberculates](/wiki/Multituberculata), [eutriconodonts](/wiki/Eutriconodonta) and [spalacotheriids](/wiki/Spalacotheriid).<ref name=Luo2007>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> The earliest known [metatherian](/wiki/Metatherian) is [*Sinodelphys*](/wiki/Sinodelphys), found in 125 million-year-old [Early Cretaceous](/wiki/Early_Cretaceous) [shale](/wiki/Shale) in China's northeastern [Liaoning Province](/wiki/Liaoning_Province). The fossil is nearly complete and includes tufts of fur and imprints of soft tissues.[[27]](#cite_note-27)[thumb|Restoration of](/wiki/File:Juramaia_NT.jpg) [*Juramaia sinensis*](/wiki/Juramaia), the oldest known [Eutherian](/wiki/Eutheria) The oldest known fossil among the Eutheria ("true beasts") is the small shrewlike [*Juramaia sinensis*](/wiki/Juramaia), or "Jurassic mother from China", dated to 160 million years ago in the late Jurassic.<ref name=Juramaia>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> A later eutherian, [*Eomaia*](/wiki/Eomaia), dated to 125 million years ago in the early Cretaceous, possessed some features in common with the marsupials but not with the placentals, evidence that these features were present in the last common ancestor of the two groups but were later lost in the placental lineage.[[28]](#cite_note-28) In particular, the [epipubic bones](/wiki/Epipubic_bone) extend forwards from the pelvis. These are not found in any modern placental, but they are found in marsupials, monotremes, nontherian mammals and [*Ukhaatherium*](/wiki/Ukhaatherium), an early Cretaceous animal in the eutherian order [Asioryctitheria](/wiki/Asioryctitheria). This also applies to the [multituberculates](/wiki/Multituberculata).[[29]](#cite_note-29) They are apparently an ancestral feature, which subsequently disappeared in the placental lineage. These epipubic bones seem to function by stiffening the muscles during locomotion, reducing the amount of space being presented, which placentals require to contain their [fetus](/wiki/Fetus) during gestation periods. A narrow pelvic outlet indicates that the young were very small at birth and therefore [pregnancy](/wiki/Pregnancy_(mammals)) was short, as in modern marsupials. This suggests that the placenta was a later development.

The earliest known monotreme was [*Teinolophos*](/wiki/Teinolophos), which lived about 120 million years ago in Australia.[[30]](#cite_note-30) Monotremes have some features which may be inherited from the original amniotes such as the same orifice to urinate, defecate and reproduce ([cloaca](/wiki/Cloaca)) – as lizards and birds also do –[[31]](#cite_note-31) and they lay [eggs](/wiki/Egg_(biology)) which are leathery and uncalcified.[[32]](#cite_note-32)

### Earliest appearances of features[[edit](/index.php?title=(none)&action=edit&section=9)]

[thumb|Phylogenetic relationships of](/wiki/File:Spinolestes_Cladogram.jpg) [*Spinolestes*](/wiki/Spinolestes) and patterns of mammalian integumentary structure in early mammalian evolution. [*Hadrocodium*](/wiki/Hadrocodium), whose fossils date from approximately 195 million years ago, in the early Jurassic, provides the first clear evidence of a jaw joint formed solely by the squamosal and dentary bones; there is no space in the jaw for the articular, a bone involved in the jaws of all early synapsids.<ref name=jawbone2006>[Template:Cite book](/wiki/Template:Cite_book)</ref>

The earliest clear evidence of hair or fur is in fossils of [*Castorocauda*](/wiki/Castorocauda), from 164 million years ago in the mid-Jurassic. In the 1950s, it was suggested that the foramina (passages) in the [maxillae](/wiki/Maxilla) and [premaxillae](/wiki/Premaxilla) (bones in the front of the upper jaw) of cynodonts were channels which supplied blood vessels and nerves to vibrissae [(whiskers)](/wiki/Whiskers) and so were evidence of hair or fur;[[33]](#cite_note-33)[[34]](#cite_note-34) it was soon pointed out, however, that foramina do not necessarily show that an animal had vibrissae, as the modern lizard [*Tupinambis*](/wiki/Tupinambis) has foramina that are almost identical to those found in the nonmammalian cynodont [*Thrinaxodon*](/wiki/Thrinaxodon).<ref name=Bennett1986>Bennett, A. F. and Ruben, J. A. (1986) "The metabolic and thermoregulatory status of therapsids"; pp. 207–218 in N. Hotton III, P. D. MacLean, J. J. Roth and E. C. Roth (eds), "The ecology and biology of mammal-like reptiles", Smithsonian Institution Press, Washington.</ref>[[35]](#cite_note-35) Popular sources, nevertheless, continue to attribute whiskers to *Thrinaxodon*.[[36]](#cite_note-36) Studies on [Permian](/wiki/Permian) [coprolites](/wiki/Coprolites) suggest that non-mammalian [synapsids](/wiki/Synapsids) of the epoch already had fur, setting the evolution of hairs possibly as far back as [dicynodonts](/wiki/Dicynodont).<ref name=piotr>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

When [endothermy](/wiki/Endothermy) first appeared in the evolution of mammals is uncertain, though it is generally agreed to have first evolved in non-mammalian [therapsids](/wiki/Therapsids).<ref name=piotr/>[[37]](#cite_note-37) Modern monotremes have lower body temperatures and more variable metabolic rates than marsupials and placentals,[[38]](#cite_note-38) but there is evidence that some of their ancestors, perhaps including ancestors of the therians, may have had body temperatures like those of modern therians.[[39]](#cite_note-39) Likewise, some modern therians like afrotheres and xenarthrans have secondarily developed lower body temperatures.[[40]](#cite_note-40) The evolution of erect limbs in mammals is incomplete — living and fossil monotremes have sprawling limbs. The parasagittal (nonsprawling) limb posture appeared sometime in the late Jurassic or early Cretaceous; it is found in the eutherian *Eomaia* and the metatherian *Sinodelphys*, both dated to 125 million years ago.[[41]](#cite_note-41) [Epipubic](/wiki/Epipubic) bones, a feature that strongly influenced the reproduction of most mammal clades, are first found in [Tritylodontidae](/wiki/Tritylodontidae), suggesting that it is a synapomorphy between them and [mammaliformes](/wiki/Mammaliformes). They are omnipresent in non-placental mammaliformes, though [*Megazostrodon*](/wiki/Megazostrodon) and [*Erythrotherium*](/wiki/Erythrotherium) appear to have lacked them.[[42]](#cite_note-42) It has been suggested that the original function of lactation (milk production) was to keep eggs moist. Much of the argument is based on monotremes, the egg-laying mammals.[[43]](#cite_note-43)[[44]](#cite_note-44)

### Rise of the mammals[[edit](/index.php?title=(none)&action=edit&section=10)]

Mammals took over the medium- to large-sized ecological niches in the [Cenozoic](/wiki/Cenozoic), after the [Cretaceous–Paleogene extinction event](/wiki/Cretaceous–Paleogene_extinction_event) emptied ecological space once filled by non-avian dinosaurs and other groups of reptiles.[[45]](#cite_note-45) Then mammals diversified very quickly; both birds and mammals show an exponential rise in diversity.[[45]](#cite_note-45) For example, the earliest known bat dates from about 50 million years ago, only 16 million years after the extinction of the dinosaurs.[[46]](#cite_note-46) Molecular phylogenetic studies suggest that most placental orders diverged about 100 to 85 million years ago and that modern families appeared in the period from the late [Eocene](/wiki/Eocene) through the [Miocene](/wiki/Miocene).[[47]](#cite_note-47) However, no placental fossils have been found from before the end of the Cretaceous.[[48]](#cite_note-48) The earliest undisputed fossils of placentals comes from the early [Paleocene](/wiki/Paleocene), after the extinction of the dinosaurs.[[48]](#cite_note-48) In particular, scientists have identified an early Paleocene animal named [*Protungulatum donnae*](/wiki/Protungulatum_donnae) as one of the first placental mammals.[[49]](#cite_note-49) The earliest known ancestor of [primates](/wiki/Primate) is [*Archicebus achilles*](/wiki/Archicebus_achilles)[[50]](#cite_note-50) from around 55 million years ago.[[50]](#cite_note-50) This tiny primate weighed 20–30 grams (0.7–1.1 ounce) and could fit within a human palm.[[50]](#cite_note-50)

## Anatomy and morphology[[edit](/index.php?title=(none)&action=edit&section=11)]

### Distinguishing features[[edit](/index.php?title=(none)&action=edit&section=12)]

Living mammal species can be identified by the presence of [sweat glands](/wiki/Sweat_gland), including [those that are specialized](/wiki/Mammary_gland) to [produce](/wiki/Lactation) [milk](/wiki/Milk) to nourish their young.[[51]](#cite_note-51) In classifying fossils, however, other features must be used, since soft tissue glands and many other features are not visible in fossils.[[52]](#cite_note-52) Many traits shared by all living mammals appeared among the earliest members of the group:

* [**Jaw joint**](/wiki/Jaw) - The [dentary](/wiki/Dentary) (the lower jaw bone, which carries the teeth) and the [squamosal](/wiki/Squamosal) (a small [cranial](/wiki/Cranium) bone) meet to form the joint. In most [gnathostomes](/wiki/Gnathostomata), including early [therapsids](/wiki/Therapsida), the joint consists of the [articular](/wiki/Articular) (a small bone at the back of the lower jaw) and [quadrate](/wiki/Quadrate_bone) (a small bone at the back of the upper jaw).<ref name=jawbone2006/>
* [**Middle ear**](/wiki/Middle_ear) - In crown-group mammals, sound is carried from the [eardrum](/wiki/Eardrum) by a chain of three bones, the [malleus](/wiki/Malleus), the [incus](/wiki/Incus) and the [stapes](/wiki/Stapes). Ancestrally, the malleus and the incus are derived from the articular and the quadrate bones that constituted the jaw joint of early therapsids.[[53]](#cite_note-53)\* **Tooth replacement** - Teeth are replaced once or (as in toothed whales and [murid](/wiki/Muridae) rodents) not at all, rather than being replaced continually throughout life.[[54]](#cite_note-54)\* **Prismatic enamel** - The [enamel](/wiki/Tooth_enamel) coating on the surface of a tooth consists of prisms, solid, rod-like structures extending from the [dentin](/wiki/Dentin) to the tooth's surface.[[55]](#cite_note-55)\* [**Occipital condyles**](/wiki/Occipital_condyle) - Two knobs at the base of the skull fit into the topmost [neck vertebra](/wiki/Cervical_vertebrae); most other [tetrapods](/wiki/Tetrapod), in contrast, have only one such knob.[[56]](#cite_note-56)

For the most part, these characteristics were not present in the [Triassic](/wiki/Triassic) ancestors of the mammals.[[57]](#cite_note-57) Nearly all mammal groups possess an [epipubic](/wiki/Epipubic) bone, the exception being modern placentals.<ref name=schulkin/>

### Biological systems[[edit](/index.php?title=(none)&action=edit&section=13)]

[thumb|Bellows lungs being manually inflated during a dissection on a raccoon](/wiki/File:Lung_expansion_simulation_with_Raccoon.gif) The majority of mammals have seven [cervical vertebrae](/wiki/Cervical_vertebrae) (bones in the neck), including [bats](/wiki/Bat), [giraffes](/wiki/Giraffe), [whales](/wiki/Whale) and [humans](/wiki/Human). The exceptions are the [manatee](/wiki/Manatee) and the [two-toed sloth](/wiki/Two-toed_sloth), which have just six, and the [three-toed sloth](/wiki/Three-toed_sloth) which has nine cervical vertebrae.[[58]](#cite_note-58) The lungs of mammals are spongy and honeycombed. Breathing is mainly achieved with the [diaphragm](/wiki/Diaphragm_(anatomy)), which divides the thorax from the abdominal cavity, forming a dome convex to the thorax. Contraction of the diaphragm flattens the dome, increasing the volume of the lung cavity. Air enters through the oral and nasal cavities, and travels through the larynx, trachea and [bronchi](/wiki/Bronchi), and expands the [alveoli](/wiki/Alveoli). Relaxing the diaphragm has the opposite effect, decreasing the volume of the lung cavity, causing air to be pushed out of the lungs. During exercise, the abdominal wall [contracts](/wiki/Muscle_contraction), increasing pressure on the diaphragm, which forces air out quicker and more forcefully. The [rib cage](/wiki/Rib_cage) is able to expand and contract the chest cavity through the action of other respiratory muscles. Consequently, air is sucked into or expelled out of the lungs, always moving down its pressure gradient.[[59]](#cite_note-59)<ref name=bellows/> This type of lung is known as a **bellows lung** due to its resemblance to blacksmith [bellows](/wiki/Bellows).<ref name=bellows>[Template:Cite book](/wiki/Template:Cite_book)</ref>

All mammalian brains possess a [neocortex](/wiki/Neocortex), a brain region unique to mammals.[[60]](#cite_note-60) Placental mammals have a [corpus callosum](/wiki/Corpus_callosum), unlike monotremes and marsupials.[[61]](#cite_note-61) The [integumentary system](/wiki/Skin) is made up of three layers: the outermost [epidermis](/wiki/Epidermis_(skin)), the [dermis](/wiki/Dermis) and the [hypodermis](/wiki/Hypodermis). The [epidermis](/wiki/Epidermis_(skin)) is typically 10 to 30 cells thick; its main function is to provide a waterproof layer. Its outermost cells are constantly lost; its bottommost cells are constantly dividing and pushing upward. The middle layer, the dermis, is 15 to 40 times thicker than the epidermis. The dermis is made up of many components, such as bony structures and blood vessels. The hypodermis is made up of [adipose tissue](/wiki/Adipose_tissue). Its job is to store lipids, and to provide cushioning and insulation. The thickness of this layer varies widely from species to species.<ref name=hair/>[Template:Rp](/wiki/Template:Rp) Although other animals have features such as whiskers, [feathers](/wiki/Feathers), [setae](/wiki/Setae), or [cilia](/wiki/Cilia_(entomology)) that superficially resemble it, no animals other than mammals have [hair](/wiki/Hair). It is a definitive characteristic of the class. Though some mammals have very little, careful examination reveals the characteristic, often in obscure parts of their bodies.<ref name=hair>[Template:Cite book](/wiki/Template:Cite_book)</ref>[Template:Rp](/wiki/Template:Rp)

### Color variation in mammals[[edit](/index.php?title=(none)&action=edit&section=14)]

[Template:Multiple images](/wiki/Template:Multiple_images) Mammalian hair, also known as [pelage](/wiki/Pelage), can vary in color between populations, organisms within a population, and even on the individual organism. Light-dark color variation is common in the mammalian taxa. Sometimes, this color variation is determined by age variation, however, in other cases, it is determined by other factors. Selective pressures, such as ecological interactions with other populations or environmental conditions, often lead to the variation in mammalian coloration.[[62]](#cite_note-62) These selective pressures favor certain colors in order to increase survival. Camouflage is thought to be a major selection pressure shaping coloration in mammals, although there is also evidence that sexual selection, communication and physiological processes may influence its evolution as well.[[63]](#cite_note-63)Camouflage is the most predominant mechanism for color variation, as it aids in the concealment of the organisms from predators or from their prey. Sloths sometimes appear to have green fur and blend into their green jungle environment, but this color is caused by [algal](/wiki/Algal) growths.[[64]](#cite_note-64) Coat color can also be for intraspecies communication such as warning members of their species about predators, indicating health for reproductive purposes, communicating between mother and young and intimidating predators.[[63]](#cite_note-63)Studies have shown that in some cases, differences in female and male coat color could indicate information nutrition and hormone levels, which are important in the mate selection process.[[62]](#cite_note-62) For example, some primates and marsupials have shades of violet, green, or blue skin on parts of their bodies, which indicates some distinct advantage in their largely [arboreal](/wiki/Arboreal) habitat due to [convergent evolution](/wiki/Convergent_evolution).[[65]](#cite_note-65) Another mechanism for coat color variation is physiological response purposes, such as temperature regulation in tropical or arctic environments.[[63]](#cite_note-63) Although much has been observed about color variation, much of the genetic that link coat color to genes is still unknown. The genetic sites where pigmentation genes are found are known to affect phenotype by altering the spatial distribution of pigmentation of the hairs, and altering the density and distribution of the hairs.[[66]](#cite_note-66) Although the genetic sites are known, it is largely unknown how these genes are expressed.[[62]](#cite_note-62)

### Reproductive system[[edit](/index.php?title=(none)&action=edit&section=15)]

[Template:Main article](/wiki/Template:Main_article) [thumb|](/wiki/Image:Goat_family.jpg)[Goat](/wiki/Goat) kids will stay with their mother until they are weaned. Most mammals are [viviparous](/wiki/Vivipary), giving birth to live young. However, the five species of monotreme, the [platypus](/wiki/Platypus) and the four species of [echidna](/wiki/Echidna), lay eggs. The monotremes have a [sex determination system](/wiki/Sex_determination_system) different from that of most other mammals.[[67]](#cite_note-67) In particular, the [sex chromosomes](/wiki/Sex_chromosome) of a platypus are more like those of a chicken than those of a therian mammal.[[68]](#cite_note-68) The [mammary glands](/wiki/Mammary_gland) of mammals are specialized to produce milk, the primary source of nutrition for newborns. The monotremes branched early from other mammals and do not have the [nipples](/wiki/Nipple) seen in most mammals, but they do have mammary glands. The young lick the milk from a mammary patch on the mother's belly.[[69]](#cite_note-69) Viviparous mammals are in the subclass Theria; those living today are in the marsupial and placental infraclasses. Marsupials have a short [gestation](/wiki/Gestation) period, typically shorter than its [estrous cycle](/wiki/Estrous_cycle) and gives birth to an undeveloped newborn that then undergoes further development; in many species, this takes place within a pouch-like sac, the [marsupium](/wiki/Pouch_(marsupial)), located in the front of the mother's [abdomen](/wiki/Abdomen). This is the [plesiomorphic](/wiki/Symplesiomorphy) condition among viviparous mammals; the presence of [epipubic](/wiki/Epipubic) bones in all non-placental mammals prevents the expansion of the torso needed for full pregnancy.<ref name=schulkin>[Template:Cite book](/wiki/Template:Cite_book)</ref> Even non-placental eutherians probably reproduced this way.[[70]](#cite_note-70) The placentals are unusual among mammals in giving birth to complete and fully developed young, usually after long gestation periods.[[71]](#cite_note-71)

## Physiology[[edit](/index.php?title=(none)&action=edit&section=16)]

### Endothermy[[edit](/index.php?title=(none)&action=edit&section=17)]

Nearly all mammals are endothermic ("[warm-blooded](/wiki/Warm-blooded)"). Most mammals also have hair to help keep them warm. Like birds, mammals can forage or hunt in weather and climates too cold for nonavian reptiles and large insects. Endothermy requires plenty of food energy, so mammals eat more food per unit of body weight than most reptiles.[[72]](#cite_note-72) Small insectivorous mammals eat prodigious amounts for their size. A rare exception, the [naked mole-rat](/wiki/Naked_mole-rat) produces little metabolic heat, so it is considered an operational [poikilotherm](/wiki/Poikilotherm).[[73]](#cite_note-73) Birds are also endothermic, so endothermy is not unique to mammals.[[74]](#cite_note-74)

### Intelligence[[edit](/index.php?title=(none)&action=edit&section=18)]

[Template:See also](/wiki/Template:See_also) In intelligent mammals, such as [primates](/wiki/Primate), the [cerebrum](/wiki/Cerebrum) is larger relative to the rest of the brain. [Intelligence](/wiki/Intelligence) itself is not easy to define, but indications of intelligence include the ability to learn, matched with behavioral flexibility. [Rats](/wiki/Rat_IQ), for example, are considered to be highly intelligent, as they can learn and perform new tasks, an ability that may be important when they first colonize a fresh [habitat](/wiki/Biome). In some mammals, food gathering appears to be related to intelligence: a deer feeding on plants has a brain smaller than a cat, which must think to outwit its prey.[[75]](#cite_note-75) [Brain size](/wiki/Brain_size) was previously considered a major indicator of the intelligence of an animal. Since most of the brain is used for maintaining bodily functions, greater ratios of [brain to body mass](/wiki/Brain-to-body_mass_ratio) may increase the amount of brain mass available for more complex cognitive tasks. [Allometric](/wiki/Allometric) analysis indicates that mammalian brain size scales at approximately the ⅔ or ¾ exponent of the body mass. Comparison of a particular animal's brain size with the expected brain size based on such allometric analysis provides an [encephalisation quotient](/wiki/Encephalization_quotient) that can be used as another indication of animal intelligence.[[76]](#cite_note-76) [Sperm whales](/wiki/Sperm_whale) have the largest brain mass of any animal on earth, averaging [Template:Convert](/wiki/Template:Convert) and [Template:Convert](/wiki/Template:Convert) in mature males.[[77]](#cite_note-77) [Self-awareness](/wiki/Self-awareness) appears to be a sign of abstract thinking. Self-awareness, although not well-defined, is believed to be a precursor to more advanced processes such as [metacognitive reasoning](/wiki/Metacognition). The traditional method for measuring this is the [mirror test](/wiki/Mirror_test), which determines if an animals possesses the ability of self-recognition.[[78]](#cite_note-78) Mammals that have 'passed' the mirror test are:

* Asian elephants, however not all subjects have passed. Three female elephants were tested, but only one passed, and two other elephants tested in another study also failed to pass.[[79]](#cite_note-79)\*Chimpanzees, but mirror tests with a juvenile (11 months old) male chimpanzee failed to reveal self-recognition.<ref name=robert>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>
* Bonobos [[80]](#cite_note-80)\*Bornean orangutan <ref name=orangutan>[Template:Cite book](/wiki/Template:Cite_book)</ref>
* Sumatran orangutan <ref name=orangutan/>
* Humans, which show signs of self-recognition at 18 months ([mirror stage](/wiki/Mirror_stage))[[81]](#cite_note-81)\*Bottlenose dolphins, since they don't have arms and can't touch the marked areas, decreased latency to approach the mirror, repetitious head circling and close viewing of the marked areas were considered signs of self-recognition [[82]](#cite_note-82)\*Killer whales [[83]](#cite_note-83)\*False killer whales <ref name=Delfour/>

### Social structure[[edit](/index.php?title=(none)&action=edit&section=19)]

[Template:Main article](/wiki/Template:Main_article) [thumb|upright|250px|Female elephants live in stable groups, along with their offspring.](/wiki/File:Borneo_elephants.png) [Eusociality](/wiki/Eusociality) is the highest level of social organization. These societies have an overlap of adult generations, the division of reproductive labor and cooperative caring of young. Usually insects, such as [bees](/wiki/Bee), [ants](/wiki/Ant) and [termites](/wiki/Termite), have eusocial behavior, but it is demonstrated in two rodent species: the [naked mole-rat](/wiki/Naked_mole-rat)[[84]](#cite_note-84) and the [Damaraland mole-rat](/wiki/Damaraland_mole-rat).[[85]](#cite_note-85) Presociality is when animals exhibit more than just sexual interactions with members of the same species, but fall short of qualifying as eusocial. That is, presocial animals can display communal living, cooperative care of young, or primitive division of reproductive labor, but they do not display all of the three essential traits of eusocial animals. Humans and some species of [Callitrichidae](/wiki/Callitrichidae) are unique among primates in their degree of cooperative care of young.[[86]](#cite_note-86) [Harry Harlow](/wiki/Harry_Harlow) set up an experiment with [rhesus monkeys](/wiki/Rhesus_monkey), presocial primates, in 1958. He gave them a choice of a wire mother with a food bottle attached and a similar wire mother wrapped in [terry towelling](/wiki/Terrycloth). He found that for 18 hours a day the monkeys cling to the wire mother with terry towelling, so concluded that attachment is not always about food and feeding but that attachment exist when contact comfort is present. The contact comfort is the comfort that is derived from physical closeness with a caregiver. Results from this study showed that social encounters are necessary in order for the young monkeys to develop both mentally and sexually.<ref name=Harlow71>Harlow, H.F. and Suomi, S.J. (1971). ["Social Recovery by Isolation-Reared Monkeys"](http://www.pnas.org/cgi/content/abstract/68/7/1534), Proceedings of the National Academy of Sciences of the United States of America, 68(7): 1534-1538</ref>

Presocial animals may also gather in large colonies with hierarchical systems. One example is the [vampire bat](/wiki/Vampire_bat). They are extremely sociable animals which tend to live in colonies in dark places, such as caves, old wells, hollow trees and buildings. Vampire bat colony numbers can range in the thousands in roosting sites. The basic social structure of roosting bats is made of harems, which are composed of females and their offspring and a few adult males, known as "resident males" and a separate group of males, known as "non-resident males". In hairy-legged vampire bats, the hierarchical segregation of non-resident males is less strict than in common vampire bats. Nonresident males are accepted into the harems when the ambient temperature lowers. This behavior suggests social thermoregulation.[[87]](#cite_note-87)

### Locomotion[[edit](/index.php?title=(none)&action=edit&section=20)]

[Template:Main article](/wiki/Template:Main_article)

#### Terrestrial[[edit](/index.php?title=(none)&action=edit&section=21)]

[Template:Main article](/wiki/Template:Main_article) [thumb|](/wiki/File:Muybridge_race_horse_animated.gif)[Running gait](/wiki/Running) Most vertebrates—the amphibians, the reptiles and some mammals such as [humans](/wiki/Human) and [bears](/wiki/Bear)—are [plantigrade](/wiki/Plantigrade), walking on the whole of the underside of the foot. Many mammals, such as [cats](/wiki/Cat) and [dogs](/wiki/Dog) are [digitigrade](/wiki/Digitigrade), walking on their toes, the greater stride length allowing more speed. Digitigrade mammals are also often adept at quiet movement.[[88]](#cite_note-88) Some animals such as [horses](/wiki/Horse) are [unguligrade](/wiki/Unguligrade), walking on the tips of their toes. This even further increases their stride length and thus their speed.[[89]](#cite_note-89) A few mammals, namely the [great apes](/wiki/Great_ape), are also known to [walk on their knuckles](/wiki/Knuckle-walking), at least for their front legs. [Giant anteaters](/wiki/Giant_anteater)[[90]](#cite_note-90) and platypuses[[91]](#cite_note-91) are also knuckle-walkers.

Animals will use different gaits for different speeds, terrain and situations. For example, horses show four natural gaits, the slowest [horse gait](/wiki/Horse_gait) is the [walk](/wiki/Horse_gait#Walk), then there are three faster gaits which, from slowest to fastest, are the [trot](/wiki/Trot_(horse_gait)), the [canter](/wiki/Canter) and the [gallop](/wiki/Horse_gait#Gallop). Animals may also have unusual gaits that are used occasionally, such as for moving sideways or backwards. For example, the main [human gaits](/wiki/Gait_(human)) are bipedal [walking](/wiki/Walking) and [running](/wiki/Running), but they employ many other gaits occasionally, including a four-legged [crawl](/wiki/Crawling_(human)) in tight spaces.<ref name=dagg>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Mammals show a vast range of [gaits](/wiki/Gait), the order that they place and lift their appendages in locomotion. Gaits can be grouped into categories according to their patterns of support sequence. For quadrupeds, there are three main categories: walking gaits, running gaits and [leaping gaits](/wiki/Leaping_gaits).[[92]](#cite_note-92) [Walking](/wiki/Walking) is the most common gait, where some feet are on the ground at any given time, and found in almost all legged animals. [Running](/wiki/Running) is considered to occur when at some points in the stride all feet are off the ground in a moment of suspension.<ref name=dagg/>

#### Arboreal[[edit](/index.php?title=(none)&action=edit&section=22)]

[Template:Main article](/wiki/Template:Main_article) [thumb|left|upright|](/wiki/File:Brachiating_Gibbon_(Some_rights_reserved).jpg)[Gibbons](/wiki/Gibbon) are very good [brachiators](/wiki/Brachiation) because their elongated limbs enable them to easily swing and grasp on to branches. Arboreal animals frequently have elongated limbs that help them cross gaps, reach fruit or other resources, test the firmness of support ahead and, in some cases, to [brachiate](/wiki/Brachiation).<ref name=Cartmill>Cartmill, M. (1985). Climbing. In Functional Vertebrate Morphology, eds. M. Hildebrand D. M. Bramble K. F. Liem and D. B. Wake), pp. 73–88. Cambridge: Belknap Press.</ref> Many arboreal species, such as [tree porcupines](/wiki/Porcupine), [chameleons](/wiki/Chameleon), [Silky Anteaters](/wiki/Silky_Anteater), [spider monkeys](/wiki/Spider_monkey) and [possums](/wiki/Possum), use [prehensile tails](/wiki/Prehensile_tail) to grasp branches. In the [spider monkey](/wiki/Spider_monkey), the tip of the tail has either a bare patch or adhesive pad, which provides increased friction. Claws can be used to interact with rough substrates and re-orient the direction of forces the animal applies. This is what allows [squirrels](/wiki/Squirrel) to climb tree trunks that are so large to be essentially flat from the perspective of such a small animal. However, claws can interfere with an animal's ability to grasp very small branches, as they may wrap too far around and prick the animal's own paw. Frictional gripping is used by primates, relying upon hairless fingertips. Squeezing the branch between the fingertips generates frictional force that holds the animal's hand to the branch. However, this type of grip depends upon the angle of the frictional force, thus upon the diameter of the branch, with larger branches resulting in reduced gripping ability. To control descent, especially down large diameter branches, some arboreal animals such as [squirrels](/wiki/Squirrel) have evolved highly mobile ankle joints that permit rotating the foot into a 'reversed' posture. This allows the claws to hook into the rough surface of the bark, opposing the force of gravity. Small size provides many advantages to arboreal species: such as increasing the relative size of branches to the animal, lower center of mass, increased stability, lower mass (allowing movement on smaller branches) and the ability to move through more cluttered habitat.<ref name=Cartmill/> Size relating to weight affects gliding animals such as the [sugar glider](/wiki/Sugar_glider).[[93]](#cite_note-93) Some species of [primate](/wiki/Primate), [bat](/wiki/Bat) and all species of [sloth](/wiki/Sloth) achieve passive stability by hanging beneath the branch. Both pitching and tipping become irrelevant, as the only method of failure would be losing their grip.<ref name=Cartmill/>

#### Aerial[[edit](/index.php?title=(none)&action=edit&section=23)]

[Template:Main article](/wiki/Template:Main_article) [thumb|300px|Slow-motion and normal speed of](/wiki/File:Israeli_Bats_-_26_September_2015.webm) [Egyptian fruit bats](/wiki/Egyptian_fruit_bat) flying [Bats](/wiki/Bat) are the only mammals that can truly fly. They fly through the air at a constant speed by moving their wings up and down (usually with some fore-aft movement as well). Because the animal is in motion, there is some airflow relative to its body which, combined with the velocity of the wings, generates a faster airflow moving over the wing. This will generate a lift force vector pointing forwards and upwards, and a drag force vector pointing rearwards and upwards. The upwards components of these counteract gravity, keeping the body in the air, while the forward component provides thrust to counteract both the drag from the wing and from the body as a whole.[[94]](#cite_note-94)

#### Fossorial[[edit](/index.php?title=(none)&action=edit&section=24)]

[Template:See also](/wiki/Template:See_also) Fossorial creatures live in subterranean environments. Many fossorial mammals were classified under the, now obsolete, order [Insectivora](/wiki/Insectivora), such as shrews, hedgehogs and moles. Fossorial mammals have a fusiform body, thickest at the shoulders and tapering off at the tail and nose. Unable to see in the dark burrows, most have degenerated eyes, but degeneration varies between species; [pocket gophers](/wiki/Pocket_gopher), for example, are only semi-fossorial and have very small yet functional eyes, in the fully fossorial [marsupial mole](/wiki/Marsupial_mole) the eyes are degenerated and useless, [talpa moles](/wiki/Talpa_(genus)) have [vestigial](/wiki/Vestigial) eyes and the [cape golden mole](/wiki/Cape_golden_mole) has a layer of skin covering the eyes. External ears flaps are also very small or absent. Truly-fossorial mammals have short, stout legs as strength is more important than speed to a burrowing mammal, but semi-fossorial mammals have [cursorial](/wiki/Cursorial) legs. The front paws are broad and have strong claws to help in loosening dirt while excavating burrows, and the back paws have webbing, as well as claws, which aids in throwing loosened dirt backwards. Most have large incisors to prevent dirt from flying into their mouth.[[95]](#cite_note-95)

#### Aquatic[[edit](/index.php?title=(none)&action=edit&section=25)]

[Template:Main article](/wiki/Template:Main_article) [thumb|A pod of](/wiki/File:Living-on-the-Edge-Settlement-Patterns-by-the-Symbiotic-Barnacle-Xenobalanus-globicipitis-on-Small-pone.0127367.s001.ogv) [short-beaked common dolphins](/wiki/Short-beaked_common_dolphin) swimming Fully aquatic mammals, the [cetaceans](/wiki/Cetacean) and [sirenians](/wiki/Sirenia), have lost their legs and have a tail fin to propel themselves through the water. Flipper movement is continuous. Whales swim by moving their tail fin and lower body up and down, propelling themselves through vertical movement, while their flippers are mainly used for steering. Their skeletal anatomy allows them to be fast swimmers. Most species have a [dorsal fin](/wiki/Dorsal_fin) to prevent themselves from turning upside-down in the water.[[96]](#cite_note-96)[[97]](#cite_note-97) The flukes of sirenians are raised up and down in long strokes to move the animal forward, and can be twisted to turn. The forelimbs are paddle-like flippers which aid in turning and slowing.[[98]](#cite_note-98) [Semi-aquatic](/wiki/Semi-aquatic) mammals, like [pinnipeds](/wiki/Pinniped), have two pairs of flippers on the front and back, the fore-flippers and hind-flippers. The elbows and ankles are enclosed within the body.<ref name=Berta63>Berta, pp. 62–64.</ref>[[99]](#cite_note-99) Pinnipeds have several adaptions for reducing [drag](/wiki/Drag_(physics)). In addition to their streamlined bodies, they have smooth networks of [muscle bundles](/wiki/Muscle_fascicle) in their skin that may increase [laminar flow](/wiki/Laminar_flow) and make it easier for them to slip through water. They also lack [arrector pili](/wiki/Arrector_pili_muscle), so their fur can be streamlined as they swim.<ref name=Riedman3/> They rely on their fore-flippers for locomotion in a wing-like manner similar to [penguins](/wiki/Penguin) and [sea turtles](/wiki/Sea_turtles).[[100]](#cite_note-100) Fore-flipper movement is not continuous, and the animal glides between each stroke.[[99]](#cite_note-99) Compared to terrestrial carnivorans, the fore-limbs are reduced in length, which gives the locomotor muscles at the shoulder and elbow joints greater mechanical advantage;<ref name=Berta63/> the hind-flippers serve as stabilizers.<ref name=Riedman3>[Template:Cite book](/wiki/Template:Cite_book)</ref> [Other semi-aquatic mammals](/wiki/Aquatic_mammal) include [beavers](/wiki/Beaver), [hippopotamuses](/wiki/Hippopotamus), [otters](/wiki/Otter) and [platypuses](/wiki/Platypus).[[101]](#cite_note-101) Hippos are very large semi-aquatic mammals, and their barrel-shaped bodies have [graviportal](/wiki/Wikt:graviportal) skeletal structures,[[102]](#cite_note-102) adapted to carrying their enormous weight, and their [specific gravity](/wiki/Specific_gravity) allows them to sink and move along the bottom of a river.[[103]](#cite_note-103)

### Feeding[[edit](/index.php?title=(none)&action=edit&section=26)]

[thumb|The](/wiki/File:Myresluger2.jpg) [insectivorous](/wiki/Insectivorous) [giant anteater](/wiki/Giant_anteater) consumes 30,000 insects per day[[104]](#cite_note-104) To maintain a high constant body temperature is energy expensive – mammals therefore need a nutritious and plentiful diet. While the earliest mammals were probably predators, different species have since adapted to meet their dietary requirements in a variety of ways. Some eat other animals – this is a [carnivorous](/wiki/Carnivore) diet (and includes insectivorous diets). Other mammals, called [herbivores](/wiki/Herbivore), eat plants. An herbivorous diet includes subtypes such as [granivory](/wiki/Granivory) (seed eating), [folivory](/wiki/Folivory) (leaf eating), [frugivory](/wiki/Frugivory) (fruit eating), [nectivory](/wiki/Nectivory) (nectar eating), [gummivory](/wiki/Gummivory) (gum eating) and [mycophagy](/wiki/Mycophagy) (fungus eating). Some mammals may be [coprophagous](/wiki/Coprophagous), and consume [feces](/wiki/Feces), usually to consume more nutrients.<ref name=hair/>[Template:Rp](/wiki/Template:Rp) An [omnivore](/wiki/Omnivore) eats both prey and plants. Carnivorous mammals have a simple [digestive tract](/wiki/Digestive_system) because the [proteins](/wiki/Protein), [lipids](/wiki/Lipid) and [minerals](/wiki/Mineral) found in meat require little in the way of specialized digestion. Plants on the other hand contain complex [carbohydrates](/wiki/Carbohydrate), such as [cellulose](/wiki/Cellulose). The digestive tract of an herbivore is therefore host to [bacteria](/wiki/Bacteria) that ferment these substances, and make them available for digestion. The bacteria are either housed in the multichambered [stomach](/wiki/Stomach) or in a large [cecum](/wiki/Cecum).[[105]](#cite_note-105) The size of an animal is also a factor in determining diet type ([Allen's rule](/wiki/Allen's_rule)). Since small mammals have a high ratio of heat-losing surface area to heat-generating volume, they tend to have high energy requirements and a high [metabolic rate](/wiki/Metabolism). Mammals that weigh less than about 18 oz (500 g) are mostly insectivorous because they cannot tolerate the slow, complex digestive process of an herbivore. Larger animals, on the other hand, generate more heat and less of this heat is lost. They can therefore tolerate either a slower collection process (those that prey on larger vertebrates) or a slower digestive process (herbivores).[[106]](#cite_note-106) Furthermore, mammals that weigh more than 18 oz (500 g) usually cannot collect enough [insects](/wiki/Insect) during their waking hours to sustain themselves. The only large insectivorous mammals are those that feed on huge colonies of insects ([ants](/wiki/Ant) or [termites](/wiki/Termite)).[[75]](#cite_note-75)

## Hybrid mammals[[edit](/index.php?title=(none)&action=edit&section=27)]

[Template:Main article](/wiki/Template:Main_article)

Hybrids are offspring resulting from the breeding of two genetically distinct individuals, which usually will result in a high degree of heterozygosity, though hybrid and heterozygous are not synonymous. The deliberate or accidental hybridizing of two or more species of closely related animals through captive breeding is a human activity which has been in existence for millennia and has grown for economic purposes ([Domestication syndrome](/wiki/Domestication_of_animals#Domestication_syndrome)).[[107]](#cite_note-107) Hybrids between different subspecies within a species (such as between the [Bengal tiger](/wiki/Bengal_tiger) and [Siberian tiger](/wiki/Siberian_tiger)) are known as intra-specific hybrids. Hybrids between different species within the same genus (such as between lions and tigers) are known as interspecific hybrids or crosses. Hybrids between different genera (such as between sheep and goats) are known as intergeneric hybrids.[[108]](#cite_note-108) Natural hybrids will occur in [hybrid zones](/wiki/Hybrid_zone), where two populations of species within the same genera or species living in the same or adjacent areas will interbreed with each other. Some hybrids have been recognized as species, such as the [red wolf](/wiki/Red_wolf) (though this is controversial).[[109]](#cite_note-109)[Template:Multiple image](/wiki/Template:Multiple_image) [Artificial selection](/wiki/Artificial_selection), the deliberate [selective breeding](/wiki/Selective_breeding) of [domestic](/wiki/Domestication) animals, is being used to [breed back](/wiki/Breeding_back) [recently extinct](/wiki/Holocene_extinction) animals in an attempt to achieve an animal breed with a [phenotype](/wiki/Phenotype) that resembles that extinct [wildtype](/wiki/Wildtype) ancestor. A breeding-back (intraspecific) hybrid may be very similar to the extinct wild type in phenotype, ecological niche and to some extent genetics, but the initial [gene pool](/wiki/Gene_pool) of that wild type is lost forever with its [extinction](/wiki/Extinction). As a result, some breeds, like [Heck cattle](/wiki/Heck_cattle), are vague look-alikes of the extinct wildtype [aurochs](/wiki/Aurochs).[[110]](#cite_note-110) Hybrid mammals include:

* [Equid hybrids](/wiki/Equid_hybrid)
  + [Mule](/wiki/Mule), a cross of female [horse](/wiki/Horse) and a male [donkey](/wiki/Donkey).
  + [Hinny](/wiki/Hinny), a cross between a female donkey and a male horse. [Mule](/wiki/Mule) and [hinny](/wiki/Hinny) are examples of reciprocal hybrids.
  + [Zebroids](/wiki/Zebroid)
    - Zeedonk or Zonkey, a [zebra](/wiki/Zebra)/[donkey](/wiki/Donkey) cross.
    - Zorse, a zebra/horse cross
    - Zony or Zetland, a zebra/[pony](/wiki/Pony) cross ("zony" is a generic term; "zetland" is specifically a hybrid of the Shetland pony breed with a zebra)
  + hybrid ass, a cross between a [donkey](/wiki/Donkey) and an onager or [Asian wild ass](/wiki/Asian_wild_ass).
* [Bovid hybrids](/wiki/Bovid_hybrid)
  + [Dzo](/wiki/Dzo), zo or yakow; a cross between a domestic [cow/bull](/wiki/Cattle) and a [yak](/wiki/Yak).
  + [Beefalo](/wiki/Beefalo), a fertile cross of an [American bison](/wiki/American_bison) and a domestic [cow](/wiki/Cattle).
  + [Żubroń](/wiki/Żubroń), a hybrid between [wisent](/wiki/Wisent) ([European bison](/wiki/European_bison)) and domestic [cow](/wiki/Cattle).
* [Sheep-goat hybrid](/wiki/Sheep-goat_hybrid) is the cross between a [sheep](/wiki/Sheep) and a [goat](/wiki/Goat), which belong to different genera.
* [Ursid hybrids](/wiki/Ursid_hybrid), such as the [grizzly-polar bear hybrid](/wiki/Grizzly-polar_bear_hybrid), occur between black bears, brown bears and polar bears.
* [Felid hybrids](/wiki/Felid_hybrid)
  + [Savannah cat](/wiki/Savannah_cat) is a fertile hybrid developed originally from a cross between the serval, *Leptailurus serval* and a domestic cat, *Felis catus*.
  + [Pumapards](/wiki/Pumapard) are the hybrid crosses between a [puma](/wiki/Cougar) and a [leopard](/wiki/Leopard).

[thumb|A](/wiki/File:Liger.jpg) [liger](/wiki/Liger), a cross between a male lion and female tiger

* + [Ligers](/wiki/Liger) and [tigons](/wiki/Tiglon) (crosses between a [lion](/wiki/Lion) and a [tiger](/wiki/Tiger) - the difference in name due to what species the mother and father were - ligers have a lion father and a tiger mother) and other [Panthera hybrids](/wiki/Panthera_hybrid) such as the [lijagulep](/wiki/Lijagulep). Various other wild cat crosses are known involving the [lynx](/wiki/Lynx), [bobcat](/wiki/Bobcat), [leopard](/wiki/Leopard), [serval](/wiki/Serval), etc.
    - [Liligers](/wiki/Liliger) are the hybrid cross between a male [lion](/wiki/Lion) and a [ligress](/wiki/Liger).
  + [Bengals](/wiki/Bengal_cat) are a fertile breed developed originally from a cross between the Asian leopard cat, *Prionailurus bengalensis* and the domestic cat, *Felis catus*.
* Fertile [canid hybrids](/wiki/Canid_hybrid) occur between [coyotes](/wiki/Coyote), [wolves](/wiki/Wolf), [dingoes](/wiki/Dingo), [jackals](/wiki/Jackal) and [domestic dogs](/wiki/Dog).
* Hybrids between [black](/wiki/Black_rhinoceros) and [white rhinoceroses](/wiki/White_rhinoceros) have been recognized.
* [Hybrid camel](/wiki/Hybrid_camel), a cross between a [bactrian camel](/wiki/Bactrian_camel) and a [dromedary camel](/wiki/Dromedary_camel)[[111]](#cite_note-111)\* [Cama](/wiki/Cama_(animal)), a cross between a [camel](/wiki/Camel) and a [llama](/wiki/Llama), also an intergeneric hybrid.
* [Wholphin](/wiki/Wholphin), a fertile but very rare cross between a [false killer whale](/wiki/False_killer_whale) and a [bottlenose dolphin](/wiki/Bottlenose_dolphin).
* At [Chester Zoo](/wiki/Chester_Zoo) in the United Kingdom, a cross between an [African elephant](/wiki/African_elephant) (male) and an [Asian elephant](/wiki/Asian_elephant) (female). The male calf was named [Motty](/wiki/Motty). He died of an umbilical infection after ten days.[[112]](#cite_note-112)\* [Bornean](/wiki/Bornean_orangutan) and [Sumatran orangutan](/wiki/Sumatran_orangutan) hybrids have occurred in captivity.

## See also[[edit](/index.php?title=(none)&action=edit&section=28)]

[Template:Div col](/wiki/Template:Div_col)

* [List of recently extinct mammals](/wiki/List_of_recently_extinct_mammals) – during recorded history
* [List of prehistoric mammals](/wiki/List_of_prehistoric_mammals)
* [List of monotremes and marsupials](/wiki/List_of_monotremes_and_marsupials)
* [List of placental mammals](/wiki/List_of_placental_mammals)
* [Prehistoric mammals](/wiki/Prehistoric_mammal)
* [List of mammal genera](/wiki/List_of_mammal_genera) – living mammals
* [List of mammalogists](/wiki/List_of_mammalogists)
* [Lists of mammals by population size](/wiki/Lists_of_mammals_by_population)
* [Lists of mammals by region](/wiki/Lists_of_mammals_by_region)
* [List of threatened mammals of the United States](/wiki/List_of_threatened_mammals_of_the_United_States)
* [Mammals described in the 2000s](/wiki/Mammals_described_in_the_2000s)

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## References[[edit](/index.php?title=(none)&action=edit&section=29)]

[Template:Reflist](/wiki/Template:Reflist)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=30)]

* [Template:Cite journal](/wiki/Template:Cite_journal)
* [Khalaf-von Jaffa, Norman Ali Bassam Ali Taher (2006). Mammalia Palaestina: The Mammals of Palestine.](http://www.webcitation.org/query?url=http://www.geocities.com/jaffacity/Mammalia_Palaestina.html&date=2009-10-26+00:38:56) Gazelle: The Palestinian Biological Bulletin. Number 55, July 2006. pp. 1–46.
* McKenna, Malcolm C., and Bell, Susan K. 1997. *Classification of Mammals Above the Species Level.* Columbia University Press, New York, 631 pp. ISBN 0-231-11013-8
* [Template:BibISBN](/wiki/Template:BibISBN)
* [Template:Cite journal](/wiki/Template:Cite_journal)
* William J. Murphy, Eduardo Eizirik, Mark S. Springer et al., *Resolution of the Early Placental Mammal Radiation Using Bayesian Phylogenetics*,Science, Vol 294, Issue 5550, 2348–2351, 14 December 2001.
* Springer, Mark S., Michael J. Stanhope, Ole Madsen, and Wilfried W. de Jong. 2004. "Molecules consolidate the placental mammal tree". *Trends in Ecology and Evolution,* **19**:430–438. ([PDF version](http://www.zi.ku.dk/evolbiology/courses/ME04/7_9/springer200-phyl.pdf))
* Vaughan, Terry A., James M. Ryan, and Nicholas J. Capzaplewski. 2000. *Mammalogy: Fourth Edition*. Saunders College Publishing, 565 pp. ISBN 0-03-025034-X (Brooks Cole, 1999)
* [Template:Cite journal](/wiki/Template:Cite_journal)
* David MacDonald, Sasha Norris. 2006. *The Encyclopedia of Mammals*, 3rd edition. Printed in China, 930 pp. ISBN 0-681-45659-0

## External links[[edit](/index.php?title=(none)&action=edit&section=31)]

[Template:Sister project links](/wiki/Template:Sister_project_links) [Template:Wikibooks](/wiki/Template:Wikibooks) [Template:TaxonIds](/wiki/Template:TaxonIds)

* [BBC Wildlife Finder – video clips from the BBC's natural history archive](http://www.bbc.co.uk/nature/class/Mammal)
* [Biodiversitymapping.org – All mammal orders in the world with distribution maps](http://www.biodiversitymapping.org/mammals.htm)
* [Paleocene Mammals](http://paleocene-mammals.de/), a site covering the rise of the mammals, paleocene-mammals.de
* [Evolution of Mammals](http://www.enchantedlearning.com/subjects/mammals/Evolution.shtml), a brief introduction to early mammals, enchantedlearning.com
* [Mammal Species](http://www.learnanimals.com/mammals.php), collection of information sheets about various mammal species, learnanimals.com
* [European Mammal Atlas EMMA](http://www.european-mammals.org/php/mapmaker.php) from Societas Europaea Mammalogica, European-mammals.org
* [Marine Mammals of the World](https://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Publications/Jeffersonetal93(14).pdf)—An overview of all marine mammals, including descriptions, both fully aquatic and semi-aquatic, noaa.gov
* [Mammalogy.org](http://www.mammalogy.org) The American Society of Mammalogists was established in 1919 for the purpose of promoting the study of mammals, and this website includes a mammal image library

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