Outline of Mammal Biology
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Contents

Note: To look up references, see the Consciousness Bibliography, listing 10,000 books and articles, with full journal and author names, available in text and PDF file formats at http://www.outline-of-knowledge.info/Consciousness_Bibliography/index.html.

BIOL>Zoology>Kinds>Mammal

mammal

Mammals {mammal} evolved from therapsids.

types

Mammals (Eutheria) are extinct multituberculates, monotremes like platypus, marsupials like kangaroo, and placental mammals (Placentalia).

evolution

Eutheria evolved from Theria. Early mammals included 30-gram Megazostrodon [-220000000] and Triconodon.

behavior

Early mammals hunted alone, signaled, and had territoriality. Voluntary muscles allowed rapid locomotion and good control.

body temperature

More food and oxygen allowed higher metabolic rate, more muscle action, and warm-bloodedness {homoiothermic, mammal}. Body temperature was higher than surroundings but lower than humans have now. Homeostasis allowed wider territory ranges and longer maturation times. Because early mammals were nocturnal, they only needed heating. Panting and sweating to cool body came later.

body temperature: hair

Mammals have hair, rather than scales, plates, or feathers, covering skin, to aid thermoregulation and insulation. They have sweat glands.

respiration

Diaphragm, bony palate, and turbinals allowed more oxygen and better respiration. Specialized red-blood-cell erythrocytes carry heme to provided better energy and oxygen management. Only warm-blooded animals can have erythrocytes.

reproduction

Reproductive-tract and digestive-tract openings became separate, allowing better and more reproduction and childcare varieties. Early mammals had birth rituals, courtship rituals, and sexual intercourse.

reproduction: mammaries

Sweat glands evolved into mammary glands, which provided balanced nutrition to young. Only warm-blooded animals can make milk. Milk redefined mother and father roles relative to children and allowed longer maturation and more brain growth. Mothers cared for babies until weaning.

teeth

Mammals have three teeth types: incisor, canine, and molar. They have two teeth sets, baby and adult, instead of continuous replacement, allowing head to be greater size in early life. Deciduous baby teeth and permanent adult teeth,

rather than having continual replacement, allowed more teeth variety and more chewing. Head can be greater size in early life.

nervous system

Hippocampus and archicortex replaced some thalamus functions. Larger cerebellum allowed more sensorimotor coordination.

nervous system: involuntary muscle

Automatic circuits in ganglia and paleocortex control involuntary muscles, as in reptiles and birds. In lower mammals, archicortex and mesocortex or paleocortex add a supragranular layer to lower-animal granular and subgranular layers. In middle mammals, both supragranular and granular layers thicken, but subgranular layer stays the same.

nervous system: neocortex

In higher mammals, neocortex thickens, cellular complexity increases, newborn unmyelinated areas increase, and brain has more fissures. Paleocortex extension above ganglia forms neocortex to control voluntary muscles. All mammals have four lobes and three fissures in neocortex. Neocortex had four layers with minicolumns and interconnected specialized modules, to make maps for more complex local processing and more integration. Larger cerebrum allowed more spatial and temporal integration.

Higher mammals try alternate strategies to reach goals and identify object and event categories, such as individuals, selves, space, and time. Some mammals learn abstract symbols and categories. Some mammals generalize from specifics and specify objects from general categories. Some mammals learn relationships but cannot use analogies, metaphors, similes, parables, and mental models. Mammals have pleasant and unpleasant dreams. Mammals are curious, sentient, and know object categories, not just specific objects.

senses

Animals evolved new sensation abilities [Dawkins, 1987] [Griffin, 1974] [Griffin, 2001] [Griffin and Speck, 2004] [Haugeland, 1997].

senses: smell

Smell sense developed first, in amygdala and forebrain paleocortex.

senses: vision

At first, small eyes bulged out, as in tree shrews. Optic tectum allowed better object localization and size detection. Mammals typically have no or limited color vision, except for primates.

senses: hearing

Maleus evolved from cynodont articular jawbone, and incus evolved from cynodont quadrate jawbone, to work with stapes. Stapedius muscle controlled stiffness. Outer hair cells paralleled inner hair cells. These allowed hearing frequencies above 10000 Hertz and so high-frequency insect noises and baby cries. Outer hair cells can also change shape quickly, changing frequencies to which inner hair cells respond best. Early mammals had ear pinnae.

pedomorphism

Mammals developed from juvenile therapsid cynodonts that matured quickly {pedomorphism}|.

domesticated animal

People modified animals {domesticated animal}.

In Eurasia and north Africa, cow and ox came from auroch.

In west and central Asia, sheep came from Asiatic mouflon sheep.

In west Asia highlands, goat came from bezoar goat.

In Eurasia and north Africa, pig came from wild boar.

In south Russia, horse came from wild horses.

In Andes mountains, llama and alpaca came from guanaco.

In north Africa, donkey came from African wild ass.

In southeast Asia, bali cattle came from banteng, which relates to auroch.

In India and Burma, mithan came from gaur, which relates to auroch.

Arabian camel was in Arabia. Bactrian camel was in central Asia.

Reindeer were in north Eurasia. Water buffalo was in southeast Asia. Yak was in Himalayas and Tibet.

fine-branch niche

Primates live on ground or in small tree branches {fine-branch niche}|, like Australia and South America small nocturnal prosimians and arboreal marsupials.

vibrissae
Early placental mammals had long, sensitive snouts with large hairs {vibrissae} and good smell sense.

BIOL>Zoology>Kinds>Mammal>Gender

dam as female
female quadruped {dam}.

BIOL>Zoology>Kinds>Mammal>Group

drove
flock or herd {drove}|.

litter of pups
Animals can have babies {pup, litter} each mating season {litter, pup}|.

pride of lions
Lions live in groups {pride}| with two or three males and five to ten females and cubs.

BIOL>Zoology>Kinds>Mammal>Brain

handedness in mammals
Mammals besides humans show paw preferences {handedness, mammal} but equally to left or right.

multisensory
Mammal superior colliculus can integrate multiple senses {multisensory} at same spatial location, while other structures maintain distinct sensations for each sense [O'Regan and Noë, 2001].

pair bonding
Arginine vasopressin aids pair bonding {pair bonding, arginine vasopressin}.

sonar in animals
Vocalization echoes give information. Dolphins and bats expanded this ability. Dolphins and bats use sonar {sonar, animal} to locate and categorize objects. They can project known signals into environment, receive reflected signals, and interpret altered signals. Signaling evolved from vocalization. Receiving evolved from auditory-brain sound processing, which locates and categorizes sounds.

suffering in animals
Animals that are smart enough to suffer include horse, dog, apes, elephants, and dolphins, because they can do something about conditions that make them suffer {suffering, animal}.

BIOL>Zoology>Kinds>Mammal>Rhythm

biological rhythm
Animal rhythms {biological rhythm}| depend on year, lunar month, tides, and day.
brain clock
Brain can time intervals {brain clock} using striato-cortical loops and frontal-cortex, caudate-putamen, and thalamus dopamine neurons. Clocks can be neuron circuits for each time interval, or neuron populations can code all intervals. Somatosensory lemniscal system can backdate events.
millisecond rhythm
Biochemical reactions have millisecond intervals. Coupled reaction systems can have cycles up to 100 seconds.
second rhythm
Heartbeat has ultradian rhythm regulated by pacemaker-neuron membrane-potential changes by voltage-sensitive K-channels.
minute rhythm

Cycles can repeat every few seconds or minutes for sessile, burrowing, and boring animals. Protein regulates cell 12-minute growth cycles. Inositol-trisphosphate receptor regulates calcium release in C. elegans in fifty-second intervals.

day rhythm

People can live on 23-hour and 25-hour cycles.

development rhythm

Reaction-cycle superpositions cause development cycles, which have intervals from minutes to hours to days.

month rhythm

Biological rhythms can be monthly, for hormones and temperature. Sex-hormone levels vary over lunar month. Marine organisms feed or rest with lunar tides. Shore-living invertebrates typically have tidal cycles and long-term rhythms related to Moon cycles.

year rhythm

Biological rhythms can be yearly, for migrations and moods. Yearly rhythms include hibernation and estivation. Breeding seasons typically are yearly. In autumn, plants can die or start low-metabolism state {dormancy, plant}.

biological clock

In mammals, Mop3 gene product is main component of 24-hour biological clocks {biological clock}|, in hypothalamus, eye, testis, ovary, liver, heart, lung, and kidney, which work by positive and negative feedback among proteins. Mammals can rest themselves according to environment. Mutant Mop3 requires homozygosity. Clock-gene product acts as a pacemaker in hypothalamus suprachiasmatic nucleus (SCN), which synchronizes other organ clocks. CLOCK, PER, and MOP3 proteins have PAS domains. Circadian rhythm affects albumin D-element-binding protein {mDbp}, which does not regulate circadian rhythm.

central pattern generator

Neuron networks {central pattern generator} control breathing, walking, and swimming.

circadian rhythm

Body has daily activity patterns {circadian rhythm}|. Internal mechanisms for daily cycles have 24-hour cycles.

functions

Body temperature, activity, blood pressure, blood pulse rate, blood volume, hormone levels, eosinophil levels, ACTH concentration, cortisol concentration, magnesium concentration, calcium concentration, 17-hydroxycorticosteroid concentration, sodium concentration, potassium concentration, catecholamine concentration, and phosphate concentration vary over day.

functions: time of day

Labor is most frequent and T lymphocytes are most at 1 AM. Growth hormone and deep sleep are greatest at 2 AM. Asthma attacks are most frequent at 4 AM. Body temperature is lowest at 4:30 AM. Menstruation starts most frequently at 6 AM. Insulin, blood pressure, heart rate, and cortisol are lowest at 6 AM, but melatonin is highest. Blood pressure starts to rise at 6:45 AM. Hay fever is worst at 7 AM. Melatonin production stops at 7:30 AM. Heart attack and stroke are most frequent at 8 AM. Rheumatoid arthritis is worst at 8 AM. T lymphocytes are fewest at 8 AM. Bowel movements are most likely at 8:30 AM. Alertness is highest at 10 AM. Blood hemoglobin concentration is highest at 12 PM. Coordination is best at 2:30 PM. Respiration is fastest, reflexes are quickest, and hand grip is strongest at 3 PM to 3:30 PM. Body temperature, heart rate, and blood pressure are highest at 4 PM. Muscle strength is greatest at 5 PM. Urination is most frequent at 6 PM. Blood pressure is highest at 6:30 PM. Body temperature is highest at 6:30 PM. Sensitivity to pain is greatest at 9 PM. Melatonin production starts at 9 PM, induces sleep at night, and maximizes just before morning. Bowel movements stop at 10:30 PM. Allergic reaction is most frequent at 11 PM.

cycle

Light affects retinal ganglion-cell melanopsin receptors, which catabolize PERIOD (PER) and TIMELESS (TIM) protein complexes in cytoplasm. Six hours later, catabolism is complete and CYCLE and CLOCK proteins bind. Then combined proteins bind to PER and TIM genes in cell nucleus, to start transcription. Six hours later, PER and TIM proteins bind in cytoplasm to form complex that blocks binding of CYCLE and CLOCK in cell nucleus.

jet lag

After several days {jet lag}|, travelers can adjust to new local time. Travel across time zones can cause disturbances in sleep, digestion, and daily activity rhythms, and disturbances are unpleasant, impair performance, and last several days.

ultradian rhythm

People have 90-minute to 100-minute cycles {ultradian rhythm}|. Desire to eat, desire for sex, sleep phases, daydreams, dreams, alertness, stomach contractions, and instinctual drives in general have ultradian rhythms. Infants have 60-minute movement and inactivity cycles.

BIOL>Zoology>Kinds>Mammal>Rhythm>Day

crepuscular
Animals can have twilight activity {crepuscular}|.

diurnal
Animals can have daytime activity {diurnal}|.

nocturnal activity
Animals can have nighttime activity {nocturnal}|.

BIOL>Zoology>Kinds>Mammal>Rhythm>Season

estivation
Yearly rhythm is deep suspended animation, with low temperature, slow heartbeat, and slow breathing, for summer {estivation}|.

hibernation
Yearly rhythm is deep suspended animation, with low temperature, slow heartbeat, and slow breathing, for winter {hibernation}|.

BIOL>Zoology>Kinds>Mammal>Tribosphenida

Tribosphenida
Main ancient mammals {Tribosphenida} had special-shape molar teeth {tribosphenic molar}.

BIOL>Zoology>Kinds>Mammal>Monotreme

monotreme
Duck-billed platypus and spiny anteater {monotreme}| (Monotrema) are small. Monotremes evolved by pedomorphism from juvenile cynodonts that matured quickly. Monotremes lay eggs. Eggs hatch, and infants drink milk from mammary glands. Duck-billed platypus finds buried molluscs and insects by electric potentials.

BIOL>Zoology>Kinds>Mammal>Theria

Theria as class
Mammals {Theria} can have live births, rather than eggs laid outside body, and mammary glands. Eggs develop inside body. Babies emerge in fetal stage, requiring care of young during gestation and after birth. Parental care causes adult-behavior imitation. Theria developed from monotremes. Theria include Eutheria and marsupials.

BIOL>Zoology>Kinds>Mammal>Marsupial

marsupial
Kangaroo, koala, wombat, wallaroo, and opossum {marsupial}| (Marsupia) {pouched mammal} have embryos that develop inside body and bear live young, at fetal stage, that crawl to pouch on abdomen outside, to drink milk from mammary glands and develop. Marsupials care for young. Theria developed from monotremes. Marsupials came from early Theria.

banded anteater
small, Australia, long snout, claws, termite eater {banded anteater}.

kangaroo as animal

plant eater, Australia and New Guinea, large hind legs, long thick tail {kangaroo}.

koala
Australia, arboreal, gray, furry ears, no tail {koala}.

opossum
nocturnal, arboreal, long tail {opossum} (Didelphis) (Didelphidae).

phalanger
small, fur, Australia, arboreal, long prehensile tail {phalanger}.

platypus
Australia, aquatic, egg-laying, duck-like flexible bill, web feet, gray fur {platypus} (Ornithorhynchus anatinus).

Tasmanian devil
small, carnivorous, black, long tail {Tasmanian devil}.

wallaby
kangaroo-like but smaller {wallaby} (Macropodidae).

wombat
burrowing, plant eater, Australia, medium size, dense hair, short tail, flat snout {wombat}.

BIOL>Zoology>Kinds>Mammal>Placental

placental mammal
In Cretaceous, 150 million years ago to 100 million years ago, small, nocturnal insect-eaters {placental mammal}| (Placentalia) evolved.

anatomy: placenta
Tissue {placenta}, in which mother blood vessels commingle with embryo vessels, surrounds embryo inside uterus, allowing food and waste exchange. This allows more embryo growth, by improving nutrition and respiration.

anatomy: senses
First Eutheria had large ears and good hearing. They had vibrissae and good smell sense. They had small eyes, on head sides.

anatomy: nervous system
First Eutheria had larger brains than same-size reptiles.

biology: signal
Mammals other than primates have 10 to 40 different signals.

biology: children
All Eutheria have live birth. Eutheria have fewer births per mother, birth at later stage, and more care of young. Culture transmission requires relatively few young. Adults must outnumber young to preserve culture.

types
The 23 placental-mammal orders include bats, carnivores, cetacea, edentates, hooved, insectivores, primates, proboscids, rodents, scienia, and simple hooved. Carnivores include cat, dog, bear, and seal. Edentates include sloth, anteater, and armadillo. Insectivores include hedgehog, insectivore shrew, and mole. Primates include tree shrew, lemur, tarsier, and monkey. Lemurs and tarsiers are similar.

clades
Placental mammals have four clades. Clade I {Afrotheria} includes elephants, manatees, aardvarks, and elephant shrews. Clade II {Xenarthra} includes sloths, anteaters, and armadillos. Clade III {Euarchontoglires} {Supraprimates} includes rodents, primates, flying lemurs, and tree shrews. Clade IV {Laurasiatheria} includes cetaceans, bats, carnivores, hedgehogs, insectivore shrews, and moles.

clades: evolution
Afrotheria was first. Afrotheria and Xenarthra, clades I and II, split 103 to 105 million years ago, in Cretaceous, perhaps from South America and Africa separation.

Early superorder {Boreoeutheria}, of clades III Euarchontoglires and IV Laurasiatheria, split from Xenarthra 84 to 95 million years ago.

Euarchontoglires and Laurasiatheria {Epitheria} split 60 million years ago.

clades: I Afrotheria

Afrotheria is in Africa and includes golden mole (Chrysochloridae), otter shrew/tenrec, elephant shrew/sengi (Macroscelidea), aardvark (Tubulidentata), hyrax (Hyracoidea), mantee/dugong (Sirenia), and elephant (Proboscidea).

Tenrec (Tenrecidae) and otter shrew (Potamogalinae) have cloaca and can look like shrews, hedgehogs, mice, or otters. Golden mole lives in south Africa, eats insects, burrows, and looks like moles. Golden mole and otter shrew/tenrec are order (Afrosoricida).

Elephant shrew or jumping shrew (Macroscelididae) has long nose and looks like shrews.

Hyrax, mantee/dugong, and elephant are clade (Paenungulata). Hyrax lives in Africa and Middle East, looks like rabbit or guinea pig, and ferments food in cecum {copraphage}.

clades: II Xenarthra

Xenarthra developed in South America and includes armadillo (Cingulata), anteater (Vermilingua), and tree sloth (Folivora), which have strange joints {xenarthra}. Anteater includes silky anteater, giant anteater, and tamandua. Tree sloth includes two-toed and three-toed sloths. Anteater and tree sloth are group (Pilosa).

clades: III Euarchontoglires

Squirrel, mouse, and other rodents (Rodentia); rabbit, hare, and pika (Lagomorpha); treeshrew (Scandentia); coluga (Dermoptera); and primates are superorder (Euarchontoglires) (Supraprimates).

Coluga (Cynocephalidae) or cobego or flying lemur can glide from trees and lives in southeast Asia. Coluga, primate, and treeshrew are order (Euarchonta).

Pika (Ochotonidae), rock rabbit, or coney is like hamsters and squeaks {whistling hare}. Rodents and lagomorphs are order (Glires).

clades: IV Laurasiatheria

Laurasiatheria developed in Laurasia and are bats, hedgehogs, cetaceans, even-toed ungulates, odd-toed ungulates, carnivores, and scaly anteaters.

Hedgehogs (Erinaceinae) live in Eurasia and Africa. Gymnures or moonrats live in southeast Asia. Hedgehogs and gymnures are early order (Erinaceomorpha).

Shrews (Soricidae) include white-toothed shrews, red-toothed shrews, and African white-toothed shrews. Moles (Talpidae) include Talpinae, Scalopinae, and Uropsilinae. Solenodons (Solenodontidae) look like large shrews, are insectivores, and live in Cuba and Haiti. Moles, shrews, and solenodons (Soricomorpha) are order.

Artiodactyla order of even-toed ungulates includes pigs, hippopotamus, camels, giraffe, deer, antelope, cattle, sheep, and goats. Cetacea order includes whales, dolphins, and porpoises. Cetaceans probably evolved from hippopotamus (Whippomorpha) (Cetancodonta). Cetaceans and even-toed ungulates are order (Cetartiodactyla).

Even-toed and odd-toed ungulates are a group.

Order (Pegasoferae) is in Africa and south Asia and includes pangolins or scaly anteaters (Pholidota), carnivores (Carnivora), bats (Chiroptera), and odd-toed ungulates (Perissodactyla), such as horses. Carnivores and scaly anteaters are group (Ferae).

BIOL>Zoology>Kinds>Mammal>Placental>Social

dominance hierarchy

Mammals accept that individuals can have authority, resulting in different ranks {dominance hierarchy}|. Animals in groups have ranks or roles, relatively dominant or subordinate. Older males typically dominate.

authority

Different species use different authority symbols.

hierarchy

All societies have status hierarchies and/or resource controls.

change

Primates form alliances based on obligations and contact, to gain higher rank. Ranks are always shifting. Dominance fights are not deadly. Animals can try to act differently than rank. Others must catch and punish offenders. Animals can try to deceive, but only higher apes seem to try to make others' beliefs be wrong.

effects

Dominance hierarchy causes hostility to strangers, maintains peace in society, decreases new behaviors, and causes threats from younger males toward older males.

factors

Dominance behaviors increase at breeding times. Dominance behaviors increase at higher population densities.

laughter in humans
Only humans laugh {laughter, human}, but other mammals appear happy.

BIOL>Zoology>Kinds>Mammal>Placental>Parts

blubber
Fat layer {blubber}| can protect body from cold.

grasping hand
Insectivores have hands with opposing thumb across from fingers {grasping hand}|, which allows better grip and more hand-eye coordination.

spermaceti
Some whales have oil {spermaceti}.

trunk of animal
Proboscids have long trunk {trunk}| from nose.

tusk
Proboscids have elongated incisor teeth {tusk}|.

BIOL>Zoology>Kinds>Mammal>Placental>Senses

forward vision
Insectivores have eyes facing front {forward vision}|, rather than on side, allowing better vision and eye-hand coordination and more space for brain frontal lobes.

nose leaves
Some echolocating bats, like horseshoe bat, scan for sound and then focus sound using nose structures {nose leaves}.

tapetum
Cats have mirror-like layer {tapetum} behind retina to reflect light back through retina.

BIOL>Zoology>Kinds>Mammal>Placental>Reasoning

deontic reasoning
Individuals at rank must know to do some things and not do other things {deontic reasoning}.

indicative reasoning
Individuals in society attend to and remember rule breaking and act on previous-situation knowledge {indicative reasoning}.

BIOL>Zoology>Kinds>Proboscid

proboscid
Proboscids {proboscid}| (Proboscidea) have nose trunk, thick and loose skin, and tusks. They include elephant, mastodon, and wooly mammoth. Elephants can make infrasonic sounds.

pachyderm
elephant, rhinoceros, hippopotamus {pachyderm}.

elephant
five-toes, trunk, thick skin, big ears, herbivorous {elephant}.

mammoth as mammal

extinct elephant-like mammal {mammoth}.

mastodon
extinct elephant-like mammal {mastodon}.

wooly mammoth
extinct elephant-like mammal {wooly mammoth}.

BIOL>Zoology>Kinds>Sirenia

Sirenia
Manatees, dugong, and sea cows {Sirenia} are aquatic herbivores. Forelimbs are fins. They have no hind limbs.

dugong
cetaceous, tusks, flat tail, aquatic, herbivorous {dugong} (Halicore dugong).

manatee
plant eater, aquatic, Florida and Caribbean or West Africa, paddle front flippers, flat tail {manatee} (Trichechus).

sea cow
dugong or manatee {sea cow}.

BIOL>Zoology>Kinds>Edentate

edentate
Edentates {edentate} (Edentata) have few or no teeth, eat insects, and include sloth, anteater, and armadillo.

aardvark
burrowing, south Africa, stocky body, hair, large ears, long snout {aardvark} (Orycteropus afer) (Orycteropodidae) (Tubulidentata).

anteater
south Africa and Asia, horny scales, long snout {anteater} {giant anteater}.

armadillo
burrowing, nocturnal, horny shell, omnivorous {armadillo} (Dasypodidae).

pangolin
Asia and Africa Pholidota mammals {pangolin} can eat ants and termites with a sticky tongue. Pangolins have a long tail.

sloth animal
Tree sloths or three-toed sloths {sloth, mammal} have long claws and hang upside down from tree branches.

BIOL>Zoology>Kinds>Bat

bat as mammal
Bats {bat, mammal} (Chiroptera) can fly and glide. One-fifth of mammal species are bats.
anatomy
Bats have skin from long fingers to body and legs. They have elongated forearms and fingers, with short thumb. They have heel bone {calcar} to hold wing skin. Bats have long stylohyal bone from skull base to hyoid in throat and voice box. Bats have bulbous malleus.
location
Bats are everywhere except Antarctica.
size
Smallest is five centimeters, and largest is two meters.

food
Bats eat fruit, eat insects, eat meat, and suck nectar. Vampire bats lick blood.
echolocation
Bats use echoes from ultrasound-producing vocal chords to find and recognize objects by echolocation. All bats have echolocation, except Old World fruit bats, such as flying fox, which lost it.
Fruit bats and vampire bats send one frequency. Most bats vary sound frequency. They typically use downward sound, because echoes from nearby objects have lower frequency than from farther objects. Acuity is greatest for small frequency range. Bats adjust sent-signal frequency, so echoes are in that small frequency range. Most bats make sound pulses. Some bats use slow emission rate until they get close to something. Some bats protect ears during sound emission. Some bats can calculate approach speed using Doppler shift.
types
Bats are Old World (Desmodontidae) or New World bats.
types: Old World
Old World fruit bats, horseshoe bats, Old World leaf-nosed bats, false vampire bats, bumblebee bats, and mouse-tailed bats are Old World bats. Old World fruit bats are flying foxes.
types: New World
Slit-faced bats and sheath-tailed bats are group of New World bats.
New World leaf-nosed bats, leaf-chinned bats, fishing bats, smoky bats, disk-winged bats, New Zealand short-tailed bats, and sucker-footed bats are group of New World bats.
Evening bats, long-fingered bats, free-tailed bats, and funnel-eared bats are group of New World bats.
evolution
Bats are early Laurasiatheria. Bats flew before they could echolocate.

fruit bat
large, fruit eater {fruit bat} (Desmodontidae).

vampire bat
tropical, Americas, biting, blood drinker {vampire bat} (Desmodontidae).

BIOL>Zoology>Kinds>Carnivore

carnivore
Carnivores {carnivore, animal}| (Carnivora) have long, sharp-pointed canine teeth.
cats
Cats include lion, tiger, leopard, cheetah, cougar or mountain lion, and jaguar.
dogs
Dogs include hyena, wolf, and fox.
seals
Sea lion, seal or fur seal, and walrus live in arctic seas. Sea otter eats sea urchins and abalone.
other
Other carnivores are bear, otter, mink, weasel, and skunk.
white color
Transparency causes white-furred animals to look white.

BIOL>Zoology>Kinds>Carnivore>Bear

bear
large, claws, carnivorous, brown/black/white {bear, animal}.

black bear
large bear {black bear}.

bruin
bear {bruin}.

grizzly bear

large bear {grizzly bear}.

panda
Large bears {panda} can have white fur and black eye areas.

polar bear
large white bear {polar bear}.

BIOL>Zoology>Kinds>Carnivore>Cat

bobcat
North America, lynx, spotted, red-brown, ear tufts, short tail {bobcat} (Lynx rufus).

catamount
mountain lion {catamount}.

cheetah
large, fast {cheetah}.

cougar
large, tawny {cougar}.

feline
cat {feline}.

jaguar
large, tawny {jaguar}.

leopard
large, tawny with black spots {leopard}.

lion
large, tawny {lion}. Males have manes.

lynx
medium size {lynx}.

mountain lion
medium size, tawny {mountain lion}.

ocelot
small, nocturnal, Central America and South America, dark spots, brown {ocelot}.

panther
large, tawny or black {panther}.

puma
medium size, tawny {puma}.

saber-toothed tiger
large, extinct in late Tertiary, long upper canine teeth {saber-toothed tiger} {sabre-toothed tiger}.

snow leopard
large, white {snow leopard}.

tiger

large, tawny or white {tiger, mammal}.

wildcat mammal
cat-sized wild cat {wildcat, cat}.

BIOL>Zoology>Kinds>Carnivore>Cat>Breed

Maltese cat
fluffy {Maltese cat}.

manx cat
short hair, no tail {manx cat}.

Persian cat
long white fur {Persian cat}.

Siamese cat
short fur {Siamese cat}.

tabby cat
fluffy house cat {tabby cat}.

BIOL>Zoology>Kinds>Carnivore>Civet

viverrine
Civet family (Viverridae) has civet, genet, fossa, and binturong. Civets {viverrine} are small and cat-like.

civet cat
raccoon-like, omnivore, Mexico and southwest USA, long bushy tail with black and white rings, nocturnal, musk {bassarisk} {civet cat}.

mongoose
Asian viverrine, carnivorous {mongoose} (Herpestes).

BIOL>Zoology>Kinds>Carnivore>Dog

dog
Dogs {dog, animal} can understand 65 words or phrases and 25 signals or gestures. Dogs have 25 vocalizations and 305 different gestures but have no syntax or grammar.

canine dog
Dog-like animals {canine, dog} (Canidae) have pointed conical teeth.

arctic fox
thick fur, arctic, brown in summer and white in winter {arctic fox}.

coyote
small wolf, west USA {coyote} (Canis latrans).

fox mammal
carnivorous, pointed muzzle, pointed ears, bushy tail {fox, mammal}.

hyena
dog-like, nocturnal, Africa and south Asia, eats carrion {hyena} (Crocuta) (Hyaenidae).

jackal

wild, medium size, scavenger {jackal} (Canis).

lobo
gray wolf {lobo}.

timber wolf
large, gray, forest, north North America {timber wolf} {timberwolf}.

wolf
northern, carnivorous, large, dog-like {wolf} {gray wolf} (Canis lupus).

BIOL>Zoology>Kinds>Carnivore>Dog>Breed

Afghan dog
large {Afghan, dog}.

Airedale
large {Airedale}.

basset hound
medium size {basset hound}.

beagle
medium size {beagle}.

bloodhound
large {bloodhound}.

borzoi
large, sleek {borzoi}.

boxer as dog
medium size {boxer}.

bulldog dog
medium size {bulldog}.

chihuahua
small, thin {chihuahua}.

Cocker spaniel
medium size {Cocker spaniel}.

collie
large {collie}.

dachshund
medium size {dachshund}.

dalmatian
large, spotted {dalmatian}.

Doberman
large {Doberman}.

German shepherd

large {German shepherd}.

golden retriever
large {golden retriever}.

Great Dane
large {Great Dane}.

greyhound
large {greyhound} {grayhound}.

Irish setter
large {Irish setter}.

Labrador retriever
large {Labrador retriever}.

mastiff
large {mastiff}.

Pekinese
small {Pekinese}.

police dog
large {police dog}.

Pomeranian
small {Pomeranian}.

poodle
medium size {poodle}.

retriever
large {retriever}.

saluki
large, sleek {saluki}.

Samoyed dog
large {Samoyed, dog}.

schnauzer
medium size {schnauzer}.

Scottish terrier
medium size {Scottish terrier}.

setter
large {setter}.

sheep dog
large {sheep dog}.

Skye terrier
medium size {Skye terrier}.

spaniel
medium size {spaniel}.

spitz
Pomeranian or Samoyed {spitz}.

St. Bernard
large {St. Bernard}.

terrier
medium size {terrier}.

BIOL>Zoology>Kinds>Carnivore>Mustelid

mustelid
ferret, mink, otter, raccoon, skunk, weasel, and wolverine {mustelid} (Mustela).

badger animal
burrowing, claws {badger, mammal}.

ermine
Northern weasels {ermine} (Mustela erminea) can have black tail tips and dark brown fur in summer and white fur in winter.

ferret mammal
weasel, North America {ferret, mammal} (Mustela nigripes).

marten
slender, weasel-like, arboreal, larger than weasel {marten}.

mink
small, short-legged weasel {mink}.

otter
freshwater, web feet, claws {otter}.

polecat
skunk {polecat}.

raccoon
North America, nocturnal {raccoon} (Procyon lotor).

sable mammal
north Europe and Asia, soft dark fur {sable, mammal} (Martes zibellina).

sea otter
marine otter {sea otter}.

skunk animal
medium size, New World, bushy tail, black fur, white lengthwise stripes {skunk} (Mephitis).

weasel
small, short legs, long body, long neck, brown {weasel}.

wolverine
burrowing, northern forest {wolverine} (Gulo gulo).

BIOL>Zoology>Kinds>Carnivore>Pinniped

pinniped
Sea lion, seal, and walrus {pinniped} have backward hind limbs.

seal
swimmer and diver, marine, hind limbs turned backward {seal}.

elephant seal
north Atlantic Ocean, earless, seal, overhanging snout {elephant seal} (Mirounga angustirostris).

sea lion
large ear, marine, seal, long neck, long limbs {sea lion} (Zalophus californianus).

walrus
northern, marine, ivory tusk, tough hide, thick blubber {walrus}.

BIOL>Zoology>Kinds>Cetacean

Cetacea
Dolphins (Sotalia) (Delphinus) (Tursiops) and whales {Cetacea} live in ocean and have blubber.
limbs
Forelimbs are fin-like. They have no hind limbs.
respiration
Cetaceans have one or two blowholes on head top.
teeth or baleen
Some Cetacea (Odontocetes) have teeth: sperm, pilot, and beluga whales, and dolphins and porpoises. Some Cetacea (Mysticetes) have baleen: blue and fin whales. Extinct ancestors belong to Archaeocetes.
whales
Sulfur-bottom whale is 150 tons and 35 meters long. Narwhal has long horn. Humpback whale, finback whale, gray whale, and blue whale are other whales.
dolphins
Dolphin has directional sonar, useful up to mile. Porpoise is like dolphin. Orca or killer whale is large dolphin. Dolphins shed soft flaky skin every two hours.
evolution
Cetacea evolved from artiodactyls.

BIOL>Zoology>Kinds>Cetacean>Dolphin

dolphin
smooth skin, pointed snout, tail flips up and down, makes sounds {dolphin} (Tursiops) (Delphinidae).

bottle-nosed dolphin
rounded forehead, beak, north Atlantic and Mediterranean {bottle-nosed dolphin} (Tursiops).

orca
black and white, largest dolphin {orca} {killer whale}.

porpoise
smaller than dolphin, blunt snout {porpoise} (Phocaena) (Lagenorhynchus).

BIOL>Zoology>Kinds>Cetacean>Whale

whale mammal
Whales {whale, mammal} are baleen or toothed whales.

leviathan
whale {leviathan}.

narwhal
small, Arctic whale, male {narwhal} (Monodon monoceros). Male has large long twisted elongated tooth.

sperm whale
largest toothed whale {sperm whale}. Head cavity contains spermaceti and oil.

BIOL>Zoology>Kinds>Cetacean>Whale>Baleen

baleen whale
marine, large, two blowholes, filter feeder {baleen whale} (Mysticeti). Rorqual whales are finback whale, blue whale, and humpback whale. Other whales are gray whale, right whale, and Sei whale. Elastic, horny material makes fringed plates {baleen} {whalebone} down from upper jaws.

right whale
baleen whale, arctic {right whale}.

BIOL>Zoology>Kinds>Cetacean>Whale>Baleen>Rorqual

rorqual whale
Large marine filter-feeder baleen whales {rorqual whale} include finback whale, blue whale, and humpback whale.

blue whale
large, baleen whale, rorqual whale {blue whale}.

finback whale
baleen whale, large, flat head, throat furrows, rorqual whale {finback whale}.

humpback whale
baleen whale, rorqual whale {humpback whale}.

BIOL>Zoology>Kinds>Artiodactyla

simple hooved mammal
Simple hooved mammals {simple hooved mammal} (Artiodactyla) have hooves with even number of digits. They are herbivores. They include camel, hippopotamus, whales, cow, sheep, pig, giraffe, deer, wildebeest, antelope, and bighorn sheep. They include ruminants. Hippos evolved from swamp-dwelling anthracotheres. Artiodactyla have hooves and were formerly in Ungulata order.

ungulate
Artiodactyla and Perissodactyla have hooves and formerly were an order {ungulate}| (Ungulata).

ferungulate
Ferungulates {ferungulate} are simple hooved mammals like cow and whale, hooved mammals like horse and rhinoceros, and carnivores like cats and seals.

ruminant
Mammals {ruminant} (Ruminantia) can have stomachs with four parts and chew regurgitated cud. They have hooves with even-numbered toes. Males have horns. They include cows, sheep, goats, deer, and giraffes.

cervid
deer, elk, moose, reindeer, and caribou {cervid}| (Cervidae).

bovid
cow, buffalo, sheep, goat, and antelope {bovid}| (Bovidae).

giraffe
Africa, ruminant, long neck, long legs, tan with brown spots {giraffe} (Giraffa camelopardalis) (Giraffidae).

hippopotamus
very large, thick skin, herbivorous, river, tropical Africa {hippopotamus} (Hippopotamus amphibius) (Hippopotamidae).

BIOL>Zoology>Kinds>Artiodactyla>Antelope

antelope
brown or gray, two-toe hooves, unbranched horns, fast, Africa and Asia {antelope}.

eland
African antelope {eland}.

gazelle
small, antelope, Africa and Asia, spiral horns, large eyes {gazelle}.

gnu
large, Africa, antelope, horns, long tufted tail {gnu}.

pronghorn antelope
America {pronghorn antelope}.

springbok
South Africa, gazelle, springs {springbok}.

wildebeest
gnu {wildebeest}.

BIOL>Zoology>Kinds>Artiodactyla>Camel

camel mammal
one or two humps, long neck, ruminant, Asia {camel, animal} (Camelus).

alpaca llama
llama {alpaca llama}.

Bactrian camel
two humps, central Asia {Bactrian camel}.

dromedary camel
single hump, large, even-toed, ungulate {dromedary camel} (Camelus).

llama animal
small camel-like mammal {llama, animal} (Lama) (Camelidae).

BIOL>Zoology>Kinds>Artiodactyla>Cow

cow
domesticated cattle {cow, animal} (Bovidae).

calf of cow

baby cow {calf, cow}.

dogie
cow being herded {dogie}.

heifer
young cow {heifer}.

milch cow
milk cow {milch cow}.

steer as cow
male cattle {steer}.

Aberdeen Angus cattle
domesticated, meat {Aberdeen Angus cattle}.

bison
buffalo {bison}.

Brahma bull
large-shouldered bull for bull riding {Brahma bull}.

buffalo cow
large, shaggy, brown, bison, North American plains {buffalo, mammal} (Bison bison).

Guernsey cow
domesticated, milk {Guernsey cow}.

Hereford cattle
domesticated {Hereford cattle}.

Jersey cow
domesticated, milk {Jersey cow}.

longhorn cattle
domesticated, meat {longhorn cattle}.

musk-ox
arctic, bovid, thick coat {musk-ox}. It is not an ox.

water buffalo
Asian buffalo, typically domesticated draft animal {water buffalo, animal} (Bubalus bubalis).

BIOL>Zoology>Kinds>Artiodactyla>Cow>Bos

ox
adult castrated bull {ox} (Bos), or cattle-family draft animal.

yak as ox
large ox, shaggy hair, ox, central Asian mountains {yak, mammal} (Bos grunniens).

zebu
Asian and east African ox {zebu} can have a large hump and loose dewlap hanging under throat and neck.

BIOL>Zoology>Kinds>Artiodactyla>Deer

deer
Deer {deer, animal} are similar to Bovidae, but male has solid deciduous horns {antler}.

buck as deer
male deer {buck}.

doe
female deer {doe}.

caribou
North America, arctic, same as reindeer {caribou}. Both sexes have large antlers.

elk
largest deer, north Europe, broad antlers on bulls, same as moose {elk}.

hart
male deer or male red deer over five years old {hart}.

hind
female red deer {hind}.

moose
largest deer, north America and Canada, broad antlers on bulls, same as elk {moose} (Alces alces).

reindeer
Europe and Asia, arctic, same as caribou {reindeer}. Both sexes have large antlers.

stag deer
adult male deer {stag, mammal}.

wapiti
large, North America, large and branched antlers {wapiti}.

BIOL>Zoology>Kinds>Artiodactyla>Goat

goat
ruminant, beard, straight horns, related to sheep {goat, animal}.

Angora goat
goat {Angora goat}.

billy goat
male goat {billy goat}.

ibex
large, ridged, curved-over horns {ibex}.

kid as goat
young goat {kid}.

nanny goat
female goat {nanny goat}.

BIOL>Zoology>Kinds>Artiodactyla>Pig

pig
short legs, cloven hooves, bristly hair, cartilaginous snout {pig, animal} (Suidae).

shoat
young pig {shoat}.

sow
female pig {sow}.

swine
pig {swine}.

boar
wild pig, narrow body, tusks, snout bristles {boar}.

hog
pig {hog}.

warthog
Africa, face warts, large tusks {warthog}.

wild boar
boar {wild boar}.

BIOL>Zoology>Kinds>Artiodactyla>Sheep

sheep
wool, horns, ruminant, related to goat {sheep}.

ewe
female sheep {ewe}.

lamb as mammal
young sheep {lamb, mammal}.

ram
male sheep {ram}.

Barbary sheep
north Africa {aoudad} {Barbary sheep}.

bighorn sheep
light color, large curled horns, Canadian mountains {bighorn sheep}.

BIOL>Zoology>Kinds>Perissodactyla

hooved mammal
Hooved mammals {hooved mammal} (Perissodactyla) have hooves with odd number of digits, are herbivores, and include horse, zebra, tapir, and rhinoceros.

rhinoceros
very large, herbivorous, ungulate, southeast Asia and Africa, thick skin, one or two snout horns {rhinoceros} (Rhinocerotidae).

tapir
herbivorous, related to rhinoceros, large, nocturnal, ungulate, tropical {tapir}.

BIOL>Zoology>Kinds>Perissodactyla>Horse

horse mammal
solid hoof, herbivorous, short hair, mane, long tail {horse} (Equus caballus) (Equidae).

charger as horse
horse used in war {charger}.

colt
young horse {colt}.

courser
horse used for racing {courser}.

dobbin
farm horse {dobbin}.

draft horse
horse used to pull load {draft horse}.

filly
young female horse {filly}.

foal
first-year horse {foal}.

gelding
emasculated horse {gelding}.

mare as horse
female horse {mare}.

mount as horse
horse used for riding {mount, horse}.

nag as horse
old horse {nag}.

pinto as horse
Horse with large brown patches or black and white patches {pinto} {paint, horse}.

pony
small horse {pony, horse}.

saddle horse
riding horse {saddle horse}.

stallion
male horse {stallion}.

steed
horse used for riding {steed}.

wheelhorse
strong horse {wheelhorse}.

yearling
first-year horse {yearling}.

BIOL>Zoology>Kinds>Perissodactyla>Horse>Kinds

appaloosa horse
medium size, various colors {appaloosa horse}.

Arabian horse
large {Arabian horse}.

ass as horse
small horse-like mammal, donkey or wild ass {ass, horse-like}.

burro
small donkey {burro}.

clydesdale
large horse used to pull wagons {clydesdale}.

donkey
domesticated ass {donkey} (Equus asinus).

mule
female-horse and male-donkey sterile son or daughter {mule, mammal}.

mustang
small feral horse, North American west {mustang}.

palomino
gold, white mane, white tail {palomino}.

quarter horse
small, stocky, short head, small muzzle, gold, white mane, white tail {quarter horse}.

Shetland pony
small horse {Shetland pony}.

zebra mammal
horse-like, Africa, black and white vertical stripes {zebra}.

BIOL>Zoology>Kinds>Lagomorph

rabbit as mammal
Burrowing domesticated rodents {rabbit} (Leporidae) can have long ears and short tails.

coney
European rabbit {coney}.

cottontail
rabbit {cottontail}.

hare

long ear, larger than rabbit, divided upper lip, long hind legs {hare} (Lepus).

jackrabbit
large hare, west North America {jackrabbit}.

snowshoe hare
northern hare {snowshoe hare}.

BIOL>Zoology>Kinds>Rodent

rodent
Rodents {rodent, animal}| (Rodentia) have sharp, chisel-like incisor teeth. They include squirrel, chipmunk, beaver, rat, mouse, porcupine, hamster, guinea pig, and chinchilla.

beaver mammal
large, aquatic, thick brown fur, webbed hind feet, flat tail {beaver} (Castor).

chinchilla
squirrel-like, South American mountains, silver-gray fur {chinchilla} (Chinchilla laniger).

chipmunk
small, striped, ground, squirrel {chipmunk} (Tamias) (Eutamias).

gerbil
small, Asian, burrowing, desert, long fur, light color, long hind legs {gerbil} (Gerbillus).

gopher
burrowing, small, short tail, furry cheek pouches {gopher}.

ground hog animal
woodchuck {ground hog}.

guinea pig
small, short ears, no tail {guinea pig, animal} (Cavia).

hamster
small, Europe and Asia, large cheek pouches, short tail {hamster} (Mesocricetus auratus) (Cricetinae).

hedgehog
large, insectivore, sharp erectile bristles {hedgehog} (Erinaceidae).

lemming
small, short tail, furry, moves in group {lemming} (Lemmus).

marmot
coarse fur, burrowing, short legs, small ears, short bushy tail, thick body {marmot} (Marmota).

mole-rat
eusocial, tropical {mole-rat} (Bathyergidae).

mouse
small size, long hard tail {mouse, mammal}.

muskrat
large, flat scaly tail, aquatic {muskrat}.

pack rat
small, North America, nest filled with small items {pack rat} (Neotoma).

porcupine
large, sharp erectile bristles {porcupine} (Erethizon dorsatum) (Erethizontidae).

prairie dog
North America, prairie, burrowing, squirrel, light brown, warning call, large colony {prairie dog} (Cynomys).

rat
medium size, long hard tail {rat}.

squirrel rodent
arboreal, long bushy tail {squirrel} (Sciurus).

woodchuck
red-brown, burrowing, north and east North America, short legs, thick body, marmot {groundhog} {woodchuck} (Marmota monax).

BIOL>Zoology>Kinds>Insectivore

insectivore
150 million years ago to 100 million years ago, mammals {insectivore}| (Insectivora) evolved that ate insects. Early ones {primitive insectivores} look like tree shrews.
vision
Insectivores have forward vision, with eyes facing front rather than on side, allowing stereoscopic vision and space for larger frontal lobes.
hand
Insectivores have grasping hands, with opposing thumb across from fingers, for more eye-hand coordination and precise hand and arm movements.
evolution
Primitive insectivores evolved from placental mammals. Primates evolved from primitive insectivores.
types
Insectivores include mole, hedgehog, and shrew.

mole as mammal
Mammals {mole, mammal} (Phacoschoerus) (Talpidae) (Chrysochloridae) can live underground, be nocturnal, and have front digging paws. Star-nosed moles have quickly moving touch organ in front. 22 arms have 25,000 Eimer's organs, which are similar to Pacinian corpuscles and contain touch receptors. Free-nerve-ending touch receptors are for vibration and contact. Merkel-cell touch receptors are for pressure. Both are in all mammals. Moles have free nerve endings in a circle, used for detecting texture. The most-sensitive arm matures first and is larger in embryos. Skin surfaces probably had such strips in mammal predecessors.

shrew as insectivore
Small mouse-like mammals {shrew, primate} {tree shrew} (Soricidae) can have a long pointed snout.

BIOL>Zoology>Kinds>Primate

primate as class
Insectivore mammals {primate} include prosiminan, New World monkey, Old World monkey, ape, and human. Primates can learn new behaviors, are curious, are vigilant, have short attention span, easily distract, and have many stereotypical activities that last for long periods.
evolution
Primates arose from primitive insectivores in early Eocene, 65 million years ago.
Strepsirhines arose 60 million years ago. They include loris, lemur, and galago.

Haplorhines {anthropoid apes} arose 55 million years ago. They include tarsiers, bush babies, monkeys, apes, and humans.

Prosimians include Strepsirhines and early Haplorhines.

Haplorhine monkeys became Old World monkeys {Catarrhini} and New World monkeys {Platyrrhini} 40 million years ago. New World monkeys include spider monkeys. Old World monkeys (Cercopithecidae) include rhesus monkeys, capuchins, macaques, and baboons.

Old World monkeys and gibbons (Hylobates) separated 30 million years ago.

Gibbons and anthropoid apes (great apes) (hominids) (Hominidae) separated 17 to 19 million years ago. Anthropoid apes include Pongo pan with orangutans, Gorilla with gorillas, Pan troglodytes with chimpanzees, Pan paniscus {pygmy chimpanzee}, and Homo with humans. Note: An older classification put humans into a hominid family (Hominidae) and all hominids except humans into pongid family (Pongidae).

Orangutans began 16 million years ago.

Gorillas separated from orangutans 8 to 9 million years ago.

Chimpanzees separated from gorillas 6.2 to 6.7 million years ago.

A family (hominins) (Homininae) with genuses Australopithecus, Paranthropus, Ardipithecus, and Homo began 6 million years ago.

Genus Homo began 2 million years ago.

food

Primates were predators, but some are now savanna vegetarians.

society

Primates live in territorial groups of 100 or less, with males dominating females. The six species vary greatly in social organization. Primates have long maternal care of young. All primate societies have aggressive dominance systems, scaling in behavior, socialization, matrilineal social organization, and game playing.

society: signals

Social organization depends on signaling. Primates have rudimentary vocal-signal languages. For example, gibbons have 12 standardized, meaningful calls.

hands and feet

Primates can have prehensile hands and feet. They have opposing thumb and can have opposing toe. They have nails instead of claws. They have grasping hands. They developed better hand movements and hand-eye-body coordination.

movement control

In primates, posterior parietal lobe is for movement control.

DNA transposition

Primate DNA-transposition rate is lower than mice rate.

brain

Neocortex has enlarged occipital and temporal lobes.

senses

Primates have olfactory systems similar to those in other placental mammals.

senses: vision

Primates have large eyes in front in large bony sockets. They have fovea high ganglion-cell concentration.

Optic tectums see only visual-field contralateral half, unlike other vertebrates. Primates integrate binocular input in optic tectum, laminated dorsal lateral geniculate nucleus, and primary visual cortex maps.

Primates have dorsolateral visual area (DL), adjacent to medial temporal lobe. They have fusiform gyrus on occipital-lobe underside.

Nocturnal visual predators, such as owls and cats, orient body so prey is in front and then move forward, using forelimbs and jaws to attack. Stereoscopic vision detects prey distance and discriminates camouflaged prey from background.

BIOL>Zoology>Kinds>Primate>Anatomy

lateral prefrontal cortex

Primates have lateral prefrontal cortex {lateral prefrontal cortex}, but lower mammals do not.

rhinarium

Strepsirhines have furless, moist, mucous tissue {rhinarium, primate} with cleft down middle between upper lip and nostrils, as in most mammals.

BIOL>Zoology>Kinds>Primate>DNA

DNA repeat primate
Alu repeats {DNA repeat, primate} are only in primates, repeat million times in different locations, are 10% of DNA, have internal promoter, and are similar in sequence to ribosome gene.

BIOL>Zoology>Kinds>Prosimian

prosimian
Prosimians {prosimian}| include tarsiers, bush babies, lorises, lemurs, and galagos. They are small, live in fine-branch niches, eat fruit and/or insects, have short muzzles and short noses, have fingernails, have large and widely spaced eyes, and have more than 32 teeth.
smell
They have scent glands, like most primitive mammals, and use scent-marking behaviors for social communication.
vision
Optic tectums receive only from visual-field left or right half, whereas in lower mammals optic tectums receive from left and right.
evolution
Prosimians developed from primitive insectivores.

BIOL>Zoology>Kinds>Prosimian>Family

Strepsirhines
First primate family {Strepsirhines} includes lorises, lemurs, and galagos but not bush babies or tarsiers. They have furless, moist, mucous tissue with cleft down middle between upper lip and nostrils {rhinarium, Strepsirhines}, as in most mammals. They have simple social organization. In Strepsirhines and primitive mammals, main input to amygdala is from olfactory bulb.

Haplorhines
Second primate family {Haplorhines} includes tarsiers, monkeys, apes, and humans. It has furry rhinarium {rhinarium, Haplorhines} and movable upper lip for facial expressions. It uses gestures and has complex social organization. In Haplorhines, main input to amygdala is from visual inferotemporal cortex.

BIOL>Zoology>Kinds>Prosimian>Kinds

bush baby
moist nose {bush baby}.

lemur
Madagascar, arboreal, mostly nocturnal {lemur} (Lemuridae).

tarsier
nocturnal, Indonesia, dry nose {tarsier}.

BIOL>Zoology>Kinds>Monkey

monkey
Monkeys {monkey} include New World monkeys and Old World monkeys. Monkeys evolved from prosimians. First monkeys were like New World monkeys.

simian
ape or monkey {simian}.

BIOL>Zoology>Kinds>Monkey>Food

folivore

Smaller monkeys are diurnal and eat leaves {folivore}.

frugivore
Monkeys can be larger, be active day and night, and eat fruit {frugivore}|. Primate frugivores have larger brains with more neocortex than same-size primate folivores. Fruit supply and type always varies, because different plants bear fruit at different times and locations in tropical forest. Frugivores require better visual perception and memory.

BIOL>Zoology>Kinds>Monkey>New World

New World monkey general
Marmosets, tamarins, squirrel monkeys, and spider monkeys {New World monkey}| were first monkeys.
evolution
New World monkeys came from Africa to South America on floating vegetation. Parapithecus was ancestor of Old World monkeys.
habitat
New World monkeys live in trees.
anatomy: tail
New World monkeys have prehensile tails.
anatomy: nostrils
New World monkeys have upward-pointing nostrils (Platyrrhini) and broad flat noses.
brain: striate cortex
Primate striate cortex can differ from motor cortex {giant Betz cell} in laminar organization, cell number, cell types, and general connectivity patterns.
brain: ventral premotor area
Ventral premotor area aids visually guided hand movements and learning by watching.
brain: Wernicke's area
Monkeys have Wernicke's area at vision, audition, and somaesthetic cortical junction.
senses
In monkeys, object perception uses one sense pathway involving all senses. Humans use this pathway only at birth.
senses: vision
Fovea allows sharp vision in visual-field center. Brain pathway for shapes and brain pathway for movement and contrast evolved. Brain area V1 has blobs and interblobs. V4, V8, and MT brain areas evolved.
self
Tamarin monkeys are curious about their bodies and movements they see in mirrors, unlike cats and dogs. Monkeys can have sense of self [Hauser, 2000].
mother
Monkeys normally cling to mothers for contact and security. If mother was absent from monkey infants, infants stayed afraid of strange objects and did not explore them. Later, the monkeys had sexual and mothering problems. If monkeys have no play and no mother, they have more aggression and wariness. Baby monkeys cling to cloth monkeys as mother substitutes [Harlow and Harlow, 1949].
suffering
Monkeys can suffer, because they can do something about conditions that make them suffer [Povinelli, 1998].
signal
Vervet monkeys make different alarm calls for eagles, leopards, and snakes and use grunts in social interactions [Cheney and Seyfarth, 1990] [Seyfarth and Cheney, 1992].
Putty-nosed monkeys make alarm calls for crowned eagles that make other monkeys stand still. Calls for leopards cause them look at ground. They can combine the calls to signal group to leave place.

arboreal
Marmosets, tamarins, squirrel monkeys, and spider monkeys live in trees {arboreal}| and have prehensile tails.

BIOL>Zoology>Kinds>Monkey>New World>Kinds

marmoset
Small monkeys {marmoset} have soft fur, come from South America and Central America, and have claws instead of nails.

rhesus monkey
monkey {rhesus monkey}.

spider monkey
monkey {spider monkey}.

squirrel monkey
monkey {squirrel monkey}.

BIOL>Zoology>Kinds>Monkey>Old World

Old World monkey general
African monkeys {Old World monkey} include capuchin, macaque, baboon, and mandrill. Macaques include rhesus monkeys (Macaca mulatta) and crab-eating monkeys (Macaca fascicularis). Old World monkeys are arboreal.
nostrils
Old World monkeys (Cercopithecidae) have down-pointing nostrils and short narrow noses (Catarrhini), allowing better vision and more space for frontal lobes.
sitting pads
Old World monkeys sit upright on sometimes colored buttock sitting pads.
tailless
Old World monkeys have no prehensile tails.
reproduction
Old World monkeys have sexual dimorphism and male rivalry.
digestion
Old World monkeys ate fruit and had 32 teeth.
senses
Short narrow noses had nose openings pointed down (Catarrhini), for better vision and more space available for frontal lobes. They had three cone types and full color vision. Postorbital septum isolated eyes from temporal muscles.
evolution
Old World monkeys differentiated from New World monkeys in Oligocene epoch.
types
Xenopithecus was ancient Old World Monkey. Aegyptopithecus was Old-World monkey in Fayum deposits in Egypt.

BIOL>Zoology>Kinds>Ape

ape
Apes {ape, animal} came from Old World monkeys.
cognition: causation
Apes understand that acting on one object can cause connected-object motion.
cognition: deception
Apes practice deception by distracting attention, so they can steal food or mates [Byrne and Whiten, 1988] [Whiten and Byrne, 1997].
cognition: laughing
Only humans laugh, but young chimpanzees puff air when they play, similar to laughing. Apes can also appear happy. Chimpanzees smile when submitting, but not from happiness. Perhaps, laughter is for alliance making.
cognition: mirror
Some apes can touch body spots they see in mirrors. Some apes seem to recognize themselves in mirrors after a while. Chimpanzees, orangutans, bonobos, and humans over two years old can use their reflections in mirrors to perceive body and direct actions. They can recognize themselves and have sense of self. Gorillas, monkeys, and children less than two years old do not [Gallup, 1970] [Gallup, 1998]. Chimps, bonobos, and orangutans can recognize themselves in mirrors immediately or after several-days experience, but gorillas, baboons, and most other primates cannot [Napier, 1976] [Napier, 1977].
cognition: play
Apes like to play.

cognition: self

Chimpanzees have no sense of self and no consciousness of mental states, though they can inspect their bodies using mirrors [Heyes and Galef, 1996] [Heyes, 1998].

cognition: suffering

Apes can suffer, because they can do something about conditions that make them suffer.

biology: parental care

Apes have parental care over long childhoods.

biology: palm walking

Apes used palm walking, not knuckle walking as in monkeys.

biology: reflex

Adult apes have Babiniski reflex, to grasp tree branches with toes.

biology: one sense pathway

In apes, object perception uses one sense pathway involving all senses, as humans do at birth.

biology: pheromone and sex

Sex-hormone-derived pheromones are in skin secretions [Savic et al., 2001] [Savic, 2002] [Sobel et al., 1999].

biology: pheromone receptivity

Baboons secrete female pheromones during receptivity. Community living can synchronize ovulation through olfactory signal. Small pheromone amounts work [Gangestad et al., 2002] [McClintock, 1998] [Schank, 2001] [Stern and McClintock, 1998] [Weller et al., 1999] [Pantages and Dulac, 2000].

biology: serotonin reuptake

Anthropoid apes have different promoter sequence for serotonin reuptake transport gene than humans do.

biology: evolution

Proconsul was lesser ape and was hominid ancestor. It was ape-like in shoulder, elbow, cranium, and teeth dentition. It was monkey-like in long trunk, backbone, pelvis, arm, and hand. At least four species weighed from 10 to 80 kilograms.

communication: sign language

After four years of training, the chimpanzee Washoe acquired over 100 American Sign Language signs. It heard no other language. Some signs were for general classes, rather than just objects and events. Some signs changed or extended. Washoe used sign order. Washoe substituted signs with similar meanings or shapes.

However, no primates develop signing themselves. Humans have to teach them. Humans cue chimpanzees to make signs, and chimpanzees sign to get rewards. Chimpanzees sign to each other socially but not for rewards [Gardner and Gardner, 1969].

communication: signals

Chimpanzees and gorillas cannot learn to use expressions with interruptions. Animal communications always repeat. Behavior, display, or signal redundancy and ritualization increase communication efficiency. Animals often use opposite signals, such as high and low, or loud and soft, for opposite intentions or behavior. Animals can modify signals in different contexts, but they do not rearrange symbol order deliberately nor assign meaning to signal order.

communication: symbol

Apes have 150 to 200 non-linguistic symbols, such as facial expressions, danger and location calls, courtship rituals and displays, grooming, group or family signals, and personal communication between individuals. Humans have 150 to 200 non-linguistic symbols.

communication: word

The bonobo Kanzi used and understood 150 words, typically to express desires or refer to present objects. Learning was instrumental association, with no grammar. Perhaps, it was not referential [Savage-Rumbaugh, 1986].

society

Ape societies have 10 to 100 animals.

missing link

Human ancestors {missing link}| can fill fossil gap between apes and humans.

flanges

Male orangutans have cheek pads {flanges}.

gracile ape

Australopithecus were not always robust {gracile}|.

BIOL>Zoology>Kinds>Ape>Face

klinorhynchy
Dryopithecus had face that tilted down {klinorhynchy, face}. Orangutans, gibbons, and siamangs have airorhynchy.

airorhynchy
Orangutans, gibbons, and siamangs have faces that tilt up {airorhynchy, face}. Dryopithecus had klinorhynchy.

BIOL>Zoology>Kinds>Ape>Pongid

pongid
Lesser apes {ape, lesser} {lesser ape} {pongid}| {hylobatid} (Hylobates) separated from Old World monkeys [-22000000]. Proconsul in Kenya, Afropithecus in Kenya, Kenyapithecus in Kenya, and Morotopithecus in Uganda lived in early Miocene. Early lesser apes were like siamang and gibbon, except they walked on all fours on branch tops. Apes have broad chests and large brains. They weigh from 3 to 80 kilograms.
development
Apes grow more slowly than monkeys.
reproduction
Apes reproduced less than monkeys.
skeleton
Apes have more flexible hips, shoulders, wrists, ankles, hands, and feet than monkeys.
digestion
Some apes eat leaves. Some apes eat fruit and nuts.
tailless
Having no tail allows sitting, more sexual intercourse positions, and new spinal shapes.
posture
Apes have semi-erect posture. Apes can hold arms above heads and so hang, using opposing thumbs.
face
Apes have movable upper lips, allowing facial expressions.

BIOL>Zoology>Kinds>Ape>Gibbon

gibbon
ape, small, arboreal, muzzle, southeast Asia and East Indies, long arms {gibbon} (Hylobates).

BIOL>Zoology>Kinds>Ape>Baboon

baboon
ape, large, black, terrestrial, bare colored buttocks, Africa and Asia {baboon} (Papio) (Cercopithecidae).

mandrill
west Africa baboon {mandrill}.

BIOL>Zoology>Kinds>Ape>Great

great ape
Apes {great ape} evolved.
skeleton
Great apes have shoulder blades on back, while lesser apes have shoulder blades on sides. Great apes have shallow ribcages, while lesser apes have deep ribcages. Great apes have flexible hips, while lesser apes have restricted movement.
skeleton: spine
Great apes have short stiff S-shaped spines with two curves, rather than straight or single-curve spines, for more upright posture. S-shaped spine is more flexible, allows running, and aids balance. Great-ape vertebrae projections point out back, while lesser-ape vertebrae projections point to side.
arm

Great apes have big hands, while lesser apes have small hands. Great apes can make rapid arm movements similar to hammering, clubbing, and throwing. Great apes can extend elbow joint fully, while lesser apes cannot make arm straight. Great apes have arms longer than legs, while lesser apes have equal lengths.

tools

Great apes make and use tools.

hunting

Great apes hunt, but not with tools.

society

Great apes live in societies, which increase opportunities for learning, experience, and knowledge.

senses

Great apes do not correlate senses.

evolution

Apes and great apes split 15 million years ago. Great apes evolved from Proconsul-like lesser apes.

orangutan

Pongo pygmaeus {orangutan} are great apes, are solitary, have no tail, live in trees in nest, and are in Borneo and Sumatra rain forests. They are safe in treetops. They can live for 60 years.

sex

Males become mature at 12 to 14 years, are twice as big as females, have flanges, have throat sac for yelling {long call}, and have long orange hair. Puberty is at age 7 to 9. If group has dominant male, young males can stay pubescent.

tools

In swamp forests of Sumatra and Borneo, where food is abundant, they can learn to use tools at 7 years old.

BIOL>Zoology>Kinds>Ape>Anthropoid

anthropoid apes

Anthropoid apes {anthropoid ape} (hominids), such as gorillas and chimpanzees, differentiated from apes in hands, feet, arms, and legs.

types

Propliopithecus was first anthropoid ape and direct ancestor of all hominids.

hand

Anthropoid apes have grasping hands.

walking

Anthropoid apes walk upright, requiring mechanisms for balance, allowing farther and greater lateral vision, and requiring learned gait. Anthropoid apes have wider territory and shared or secured territory.

habitat

Gorillas live on ground, and others live in trees.

communication

Anthropoid apes communicate, using dozens of meaningful sounds, about objects but do not have mental states.

vision

Color vision can see ripe fruits in forest and recognize faces.

brain

Delay system in frontal lobe between senses and motor nerves possibly allows decision-making. Anthropoid apes are curious, reason, have emotions, have social instincts, and imitate. Great apes have neurons in anterior cingulate that have apical dendrite and dendrite near axon and look like spindles.

gorilla

largest anthropoid ape, black, terrestrial, vegetarian, equatorial West Africa {gorilla} (Gorilla gorilla).

BIOL>Zoology>Kinds>Ape>Anthropoid>Pan

Pan ape

Genus Pan apes {Pan, ape} split from gorillas and was like chimpanzee, pygmy chimpanzee, or bonobo. Pan apes weigh 30 to 60 kilograms. They eat fruit and have large canine teeth with thin enamel. They have long arms and legs. They are arboreal. They are knuckle walkers on all fours. They are sexually dimorphic and have polygynous social structure. They are hairy.

bonobo
pygmy chimpanzee {bonobo}|.

chimpanzee
Chimpanzees {chimpanzee} are great apes. Chimpanzees can communicate using complex sign or symbol systems and have more than 30 meaningful vocalizations. Chimpanzees can cooperate. Chimpanzees can deceive others. Chimpanzees have concept of self. Chimpanzees use and make tools. Given puzzles, they manipulate pieces, even without reward.

BIOL>Zoology>Kinds>Hominin

hominins
Hominins {hominin}| (Homininae) (Hominidae) {hominin} vary from anthropoid apes (great apes) (hominids) (Hominidae) in locomotion, hands, tools, sight, sociability, and language.
evolution
Hominins differentiated from Pan ancestors six million years ago.
habitat
Australopithecus lived in savannas, rather than forests, and used more animal food than apes. Perhaps, necessity to eat seeds and nuts aided hand evolution. Hominins developed environments, with more energy available for brain maintenance. Free-ranging energetic environments and multiply skilled bodies allowed energy-intensive cortex to vary, grow, and integrate senses.
anatomy: tailless
Hominins had no tail, allowing more variations in intercourse position, sitting, and spinal shape.
anatomy: face
Hominins have nosebridges and nose tips, jutting chins, short canine teeth, and lips with median furrow that rolls outward.
anatomy: arm
Hominins have shorter arms than great apes and throw accurately.
anatomy: foot
Hominins have feet that arch across and lengthwise. They do not have opposed big toes.
anatomy: hair
Hominins are relatively hairless.
anatomy: posture
Hominins have erect posture.
reproduction
Hominins mature sexually earlier than other great apes, as measured by teeth eruption.
senses
Sense integration allows tracking individuals that are not present, mapping environments, and remembering.
nervous system
Brains were two to three times bigger than great-ape brains.
communication
Hominins blend the dozen meaningful ape sounds to produce new sounds related to objects far away in time or place. They possibly use nouns, verbs, and modifiers with simple syntax. They recall memories.
communication: larynx
Larynx became lower and opened throat space {supralaryngeal space}, which allows more speech sounds.

Australopithecus
Varied and separated habitats isolated four hominin species {Australopithecus} {australopithecenes}: first Australopithecus afarensis, then gracile Australopithecus africanus, robust Australopithecus robustus, and robust Australopithecus boisei.
habitat
Australopithecus lived on ground in woodlands and savannas. Perhaps, it slept in trees or cliffs.
digestion
Australopithecus ate vegetables and later meat and had ape-like dentition.
behavior

Australopithecus foraged.

tools

Australopithecus used pumice flakes and stone choppers as rooting tools.

arm

Australopithecus had large hands, long fingers, and short arms.

walking

Australopithecus was bipedal, had short stride, ran slowly, and had no knuckle walking.

development

Maturation time was short.

brain

Brain was one-third modern human size.

Australopithecus afarensis

Early hominins {Australopithecus afarensis} were gracile, weighed 35 kilograms, and were one meter tall.

evolution

Australopithecus afarensis came from Australopithecus anamensis and was Australopithecus-gahri ancestor.

tools

Australopithecus afarensis used pebble tools.

climbing

Australopithecus afarensis had climbing adaptations in fingers, hands, wrists, elbows, and shoulders, with long arms and short legs.

walking

Australopithecus afarensis was bipedal with full striding gait, putting body weight over one leg while other leg moved. It had arched feet and non-opposable big toes, like modern human feet. It had knee valgus angle. It had great pelvic width. Perhaps, width was for pelvic rotation in walking. It had short, broad, backward, extended, iliac blades.

hand

Australopithecus afarensis had shorter thumbs.

society

Perhaps, Australopithecus afarensis had large kin-related and many-male groups, with some non-kin females.

digestion

Australopithecus afarensis had large and flat cheek teeth, suggesting fruit and leaf diet.

face

Australopithecus afarensis had big faces.

brain

Australopithecus afarensis had 400-cc brains, with 3.1 encephalization quotient. It had forward-placed and downward-directed foramen magnum, indicating head was upright on spine. Bipedalism led to an enlarged occipital-marginal-sinus system, which forced new blood hydrostatic pressures on vertebral venous plexus.

Australopithecus africanus

Second Australopithecus {Australopithecus africanus} [first found 1924] was gracile, weighed 35 kilograms, and was four feet tall.

evolution

Australopithecus africanus came from Australopithecus anamensis and was Australopithecus-robustus ancestor.

habitat

Australopithecus africanus lived in grasslands, not forests, and probably lived in one place for long periods. Perhaps, it used windbreaks.

hunting

Australopithecus africanus hunted animals, ate raw meat, cut skins, smashed bones, and took meat home.

tools

Australopithecus africanus selected stones, carried them home, and chipped to make hand-held choppers.

hand

Australopithecus africanus had flattened fingertips.

spine

S-shaped spines, with two curves, allowed more back flexibility and so more upright walking, more erect posture, faster running, and better balance. Upright posture allowed wider and farther vision.

digestion

Australopithecus africanus had no canine teeth and lean jaws, like humans, reflecting different diet.

brain

Australopithecus africanus had low skulls, with 500-cc to 800-cc brains. Many anastomotic channels with emissary veins near foramen magnum take blood to vertebral venous plexus. Perhaps, expanded neocortex frontal lobes allowed improved memory, spatial orientation, temporal orientation, and multisensory abilities.

Australopithecus robustus

Paranthropus hominins {Australopithecus robustus} (Paranthropus robustus) were not on human line, were 45 kilograms, were heavyset, and were vegetarian. Paranthropus robustus came from Australopithecus africanus. Perhaps, Australopithecus aethiopicus preceded it. Brain was 500 cc.

Australopithecus boisei

Paranthropus hominins {Australopithecus boisei} (Paranthropus boisei) were not on human line, were robust, weighed 50 kilograms, and lived in east Africa. Paranthropus had vegetarian diets, as shown by dentition and face. Brain was 500 cc to 530 cc.

Homo genus

Humans {Homo} {human} are vertebrates, mammals, and primates and share their fundamental behaviors.

evolution

Humans evolved from australopithecines. Strong sexual selection, complex social lives, changing environments, cultural effects, social contacts, increased population density, agriculture, food surpluses, and wars emphasize aggression, fitness, and intelligence. Humans evolved faster than apes. Humans evolved through pedomorphism, accounting for greater brain size, because children have relatively bigger brains.

evolution: environment

Early humans had direct competition with similar species and had predators.

development

Human life span is as expected for great apes with human size and brain.

behavior: hand

Hands have opposing thumbs and many available grips. Humans can gesture.

behavior: walking

Humans walk upright on strong legs. Upright walking requires mechanisms for balance, allows farther vision and greater lateral vision, requires learning gait, allows wider territory and means of sharing territory, and allows hand, foot, arm, and leg differentiation.

behavior: society

Humans live in organized groups. They have faces and know facial expression meaning. They perceive others' needs and desires. They know action effects on others. They react to others' behaviors and communications. They can have rapport. They can influence. They kiss.

behavior: language

Human language probably developed from graded primate vocalizations. Humans can pronounce 40 phonemes. They use voice modulation. They express feelings. Speech depends on upright posture, which allows tongue-position shifts and pharyngeal-tract lengthening. Humans use symbolic thought and language to plan and form strategies. Memories allow using and transmitting past knowledge. Humans have music.

senses

Humans use sight as dominant sense.

brain

In evolving to humans, supragranular layer became upper three cortical layers, middle layer thickened, subgranular layer divided into lower two layers, and secondary and tertiary sulci had increased associational areas.

handedness

Right-handedness first appeared in Lower Old Stone Age, when tool making became common. Starting 300,000 years ago, humans probably had cerebral dominance, because skulls are asymmetric and people inherit brain and skull shape. Human skulls mold to brains. Right-handers typically support and orient objects in left hand, without using visual feedback, and perform fine movements with right fingers, using visual feedback. Most people use right hand for gesticulation.

handedness: abilities

Performance by right-handers and left-handers is equal on all tasks. No special ability or disability distinguishes left-handers.

handedness: factors

Handedness inherits. Social pressures or early experience, especially with objects designed for right-handers, affects handedness. Brain damage before or after birth can shift cerebral dominance or prevent hemispheric specialization. Subnormal and epileptic people have more left-handedness.

handedness: anatomy

In right-handers, left cerebral hemisphere has sense and motor connections to both body sides, and right hemisphere connects to only one side. In left-handers, cerebral lateralization is less. In right-handers, left side has fewer skills, poorer timing and coordination, more variability, and more frequent and slower corrections.

handedness: ratio

Left-handers are 4% to 36% of people in different races and cultures.

handedness: mammals

Mammals besides humans show paw preferences but equally to left or right.

Homo habilis

First humans {Homo habilis} split from Australopithecus.

size

Homo habilis was 1.35 to 1.5 meters tall and weighed 50 kilograms.

culture

Homo habilis formed Lower-Paleolithic Oldowan Culture. Perhaps, it had labor division, cooperation, and reciprocity.

culture: tools

Homo habilis chipped sharp flakes from larger stone cores. Perhaps, it carved wood tools.

digestion

Homo habilis ate plants and meat.

hunting

Perhaps, Homo habilis scavenged, hunted, and had food sharing.

body

Homo habilis had curved finger bones, long arms, short legs, and modified pelvic and leg bones.

walking

Upright walking on arched feet allowed better running, jumping, balance, and flexibility.

reproduction

No estrus in females allowed continuous sexual receptivity. Intervals between births are shorter for humans than for great apes.

skin

Few body hairs allowed skin sensitivity.

head

Homo habilis had post-orbital septum and thin brow ridges. Skull back was round.

brain

Large left-brain Broca's motor speech area indicates speech. Advanced vocal cords and brain language areas allowed better communication. Bigger frontal and parietal lobes were in 700-cc brains, with 4.0 encephalization quotient. Brain had sulci and gyrus patterns like Homo sapiens. Two more cell layers in neocortex increased processing complexity and information distribution.

senses

Homo habilis had reduced smell sense and integrated senses.

Homo ergaster

Early African Homo erectus hunter-gatherers {Homo ergaster} ate meat. Homo ergaster weighed three times more and was two times taller than Australopithecus. Homo ergaster came from Homo habilis.

Homo erectus

Early Homo species {Homo erectus} was 1.65 meters tall.

evolution

Homo erectus came from Homo habilis and was ancestor of Homo floresiensis and archaic Homo sapiens.

anatomy: body

Homo erectus had narrow bowl-shaped pelvis and conical thorax. Homo sapiens has barrel shaped thorax.

anatomy: head

Homo erectus had heavy eyebrows, no chins, big jaws, and low skulls. Extra bone was on skull midline {sagittal keel}.

anatomy: senses

Homo erectus had sense organs like modern humans. Skull indents behind eyes, so eye sockets protrude.

anatomy: brain

Brains were 1000 cc, two-thirds of modern brains, with six-layer brain cortex, specialized right and left brain hemispheres, and association areas. Encephalization quotient was 5.5.

anatomy: teeth

Perhaps, Homo erectus gripped and tore using front teeth by prognathism.

anatomy: hand

Homo erectus held fingers to palm and had precision grips.

anatomy: arm

Homo erectus had large femoral heads like Homo sapiens.

anatomy: leg

Arched feet allowed better running and jumping, better balance, and more flexible movements. Arched feet had no grasping.

anatomy: sexual dimorphism

Male and female body sizes were more equal than in Homo habilis.

walking

Homo erectus walked fully erect.

reproduction

Homo erectus had sexual intercourse but no longer had estrus, so females were always sexually ready.

development

Babies were immature at birth, like Homo sapiens.

culture

Homo erectus had Acheulean culture of Lower Paleolithic. Groups with social organization lived in caves or later wood or bone houses and had territories. Homo erectus had birth rituals, long childhood with rites of passage to adulthood, and courtship rituals.

culture: communication

Homo erectus signaled and used simple speech. It planned for events far away in space and time. It realized world of individual things and people existed.

culture: fire

Starting 200,000 years ago, Homo erectus used fire for warming, lighting, scaring animals out of caves, hunting, hardening wood, cooking plants, cooking bones for marrow, and building community. It had specialized fire builders.

culture: tools

Homo erectus used flaked stone tools, chipped hand axes from large stone cores [-1500000], and had stone symmetrical hand axes with two sides [-750000]. Homo erectus carved wooden spears and wooden bowls.

culture: hunting

Homo erectus killed large animals, coordinated hunts, and gathered foods. Savanna had enough food to support two people per square mile. Hunting societies had one leader. Males were hunters and dominated life. Male friendship developed. Females did domestic work. Perhaps, aquatic societies lived on fish and shellfish, shared among all, had no leader, and lived near oceans or fresh water.

prognathism

Homo erectus possibly used gripping and tearing by front teeth {prognathism}.

Homo heidelbergensis

Archaic Homo sapiens {Homo heidelbergensis} came from Homo erectus. Homo heidelbergensis had larger brains, flatter faces, and smaller brow ridges. It invented prepared-core technique.

Homo neanderthalensis

Neanderthals {Homo neanderthalensis} were strong.

evolution

Neanderthals came from archaic Homo sapiens [-700000 to -500000]. They became extinct [-35000]. They are not human ancestors, because Neanderthal mitochondrial DNA is not like Homo-sapiens mitochondrial DNA (Svante

Pääbo), though genomes are 99.5 percent the same. Interbreeding among humans and Neanderthals stopped by 370,000 years ago.

posture

Neanderthals had same postures and body movements as Homo sapiens.

body

Neanderthals had barrel chests and short and large limb bones.

head

Neanderthals had reduced skull thickness, low skulls, no chins, broad noses, heavy jaws, low and sloped foreheads, and heavy arched brow ridges.

teeth

Neanderthals had human teeth, which they used as clamps or vises.

handedness

Neanderthals had handedness.

brain

Brain was 900 cc to 1100 cc, with expanded parietal lobes. Special brain language areas were on left side, with right-left brain asymmetry.

language

Neanderthals spoke. Perhaps, Neanderthal throat anatomy inhibited good speech.

walking

Neanderthals walked erect.

habitat

Neanderthals lived in caves in cold climates.

culture

Neanderthals had Upper or Late Acheulian Culture of Lower Paleolithic and Mousterian Culture of Middle Paleolithic. They had customs and laws for societies.

culture: hunting

Neanderthals were big-game hunters, used wood spears with fire-hardened points [-50000], used flint weapons, and wore animal skins.

culture: fire

Neanderthals used fire [-500000] in Zhoukoudian cave in north China and had hearths.

culture: burial

Neanderthals buried the dead [-100000].

culture: painting

Neanderthals gathered red ocher.

Homo sapiens

Advanced humans {Homo sapiens} probably began in Africa 100,000 to 200,000 years ago. African and non-African Homo sapiens then diverged.

habitat

Early Homo sapiens lived in caves.

brain

Early Homo sapiens had brains the same size as now, with 7.6 encephalization quotient. It had new associational-cortex and frontal-lobe development. It had consciousness.

culture: tools

Early Homo sapiens used chipped stone tools and built tools to make tools.

culture: language

Early Homo sapiens probably spoke and knew symbols and language.

culture: clothing

Early Homo sapiens wore clothing.

culture: fire

Homo sapiens used sustained fire [-40000].

culture: domestication

Homo sapiens domesticated plants and animals [-8000]. Homo sapiens used medicinal herbs in Iraq [-8000].