

LAB 5: CHIROPTERA, PRIMATES

Sources: Martin et al., Ch. 14 (pp. 85-93), Ch. 16 (96-102); this handout

In General:

The order Chiroptera has recently received a great deal of attention owing to contention regarding its monophyletic status. There is some evidence that bats are diphyletic and that flying adaptations evolved twice in mammals, once in the large fruit bats (megachiropterans) and once in the small bats (microchiropterans). Megabats might be more closely related to primates and/or dermopterans than to microbats. However, there is persuasive evidence to support the traditional view of a single origin of mammalian flight and a monophyletic origin of bats.

Order CHIROPTERA

Diagnosis: flying mammals with well-developed wings; hand and forefingers greatly elongated (except digit 1 - the thumb); dentition heterodont and rooted, never more than two pairs of upper incisors, maximum complement of milk teeth 22, permanent set from 20-38; baculum present

Range: cosmopolitan except for polar regions

Suborder MEGACHIROPTERA (fruit bats or flying foxes)

Diagnosis: foredigit 2 retains degree of independence (not markedly appressed against finger 3), and often clawed; mandible with angular process broad and low or practically absent; postorbital process well-developed; bony palate extended posteriorly beyond last molar; molariform teeth with relatively blunt cusps; never more than two pairs of lower incisors; dental formula $2/2, 1/1, 3/3, 2/3 = 34$ (*Pteropus*, *Rousettus*) to $1/0, 1/1, 3/3, 1/2 = 24$ (*Nyctimene*); tragus absent and nose leaf absent; eyes well-developed.

Range: tropical regions of Australasia, southern Asia and Africa, incl. Madagascar and extending well out into the western Pacific islands.

Family: Pteropidae

Family Pteropidae (fruit bats or flying foxes)

Diagnosis: same as for suborder

Habits: frugivorous or nectivorous; crepuscular and/or nocturnal; usually locate food by smell; have excellent vision; cannot echolocate (except for *Rousettus* which uses a "primitive" type of echolocation); hibernation not possible, but some species migratory; long life span with low reproductive potential (usually one, rarely two young per year); large species can fly up to 240 km over water and 100 km in a single night.

Range: Same as for suborder

Genera: *Pteropus, Rousettus, Dobsonia, Nyctimene, Epomophorus, Syconycteris, Macroglossus, Eidolon, Myonycteris, Boneia, Acerodon, Neopteryx, Pteralopex, Styloctenium, Aroteles, Harpyionycteris, Plerotes, Hypsignathus, Epomops, Micropteropus, Nanonycteris, Scotonycteris, Casinycteris, Cynopterus, Megaerops, Ptenochirus, Dyacopterus, Ghironax, Thoopterus, Sphaerias, Balionycteris, Aethalops, Pethalops, Penthetor, Haplonycteris, Otopteropus, Alionycteris, Latidens, Paranyctimene, Eonycteris, Megaloglossus, Melonycteris, Notopterus,*

Specimens: *Rousettus* (independently evolved SONAR)
Pteropus

Know: **Pteropidae**

Suborder MICROCHIROPTERA (microbats)

Diagnosis: foredigit 2 scarcely, if at all, independent, closely adpressed against third finger and lacking a claw; mandible with angular process well-developed and usually long and narrow; postorbital processes usually absent or rudimentary, but occasionally well-developed; bony palate usually not extended posteriorly to beyond last molars; molariform teeth with sharp cusps; often three pairs of lower incisors; tragus often present and nose leaf sometimes present; eyes relatively small; effective echolocation mechanisms in all groups.

Range: cosmopolitan except for polar regions and more remote oceanic islands

Families:

Craseonycteridae	Natalidae
Desmodontidae	Noctilionidae
Emballonuridae	Nycteridae
Furipteridae	Phyllostomidae
Megadermatidae	Rhinolophidae (incl. Hipposideridae)
Molossidae	Rhinopomatidae
Mormoopidae	Thyropteridae
Mystacinidae	Vespertilionidae
Myzopodidae	

Superfamily Phyllostomoidea

Family Phyllostomatidae (New World leaf-nosed bats)

Diagnosis: muzzle with well-developed single nose leaf generally present; no postorbital processes; premaxillae fused to each other and to maxillae; foredigit 2 with a well-developed metacarpal and a small phalanx; foredigit 3 with three phalanges; tragus present; tail variable; eyes relatively large for a microbat

Habits: diet highly variable, various species feeding on insects, fruit, pollen, nectar, lizards, other bats, rodents, and birds; non-hibernators; mostly have one young per year, but some species have litter of two; some polyestrous.

Range: tropical South America and Central America extending into southwestern United States

Genera: 44 genera, 133 species (2nd largest family), usually grouped within five subfamilies: Phyllostomatinae, Glossophaginae, Carollinae, Sturnirinae, Stenoderminae

Specimens: *Macrotus*
Artibeus (neotropical fruit bats)
Glossophaga (long-tongued bat)

Know: **Phyllostomatidae**

Family Noctilionidae (bulldog or fishing bats)

Diagnosis: muzzle pointed with strongly projected pad, without leaf-like growth; full lips forming distinct cheek pouches; nares opening anteriorly, somewhat tubular; skull without postorbital processes; premaxillae fused with each other and with maxillae in adults, the nasal branches unusually long and well-developed, the palatal branches short and scarcely visible from below; second manal digit with metacarpal as long as that of digit 3, and with single phalanx rudimentary; digit 3 and digit 4 each with two phalanges; tragus present; dental formula $2/1, 1/1, 1/2, 3/3 = 28$; tail well-developed; tibia and foot equaling 40-60% of total leg length; hind claws more or less enlarged to form sharp, gaff-like hooks.

Habits: insectivorous and piscivorous; roost in small colonies, usually in deep narrow fissures or hollow trees and usually close to water; slow flyers and good swimmers; bear one young per year.

Range: tropical Americas and West Indies

Genus: *Noctilio*

Specimens: *Noctilio* (fishing bat)

Know: **Noctilionidae**

Family Desmodontidae (vampire bats)

Diagnosis: upper incisors large, blade-like, fitting into deep grooves in the inner side of the mandible behind the lower incisors; molars absent or rudimentary; no conspicuous nose leaf; interfemoral membrane short; no tail; foredigits 2 and 3 as in phyllostomatids; dental formula $2/2, 1/1, 1/2, 2/2 = 26$ (*Diphylla*) or $1/2, 1/1, 2/3, 0/0 = 20$ (*Desmodus*)

Habits: feed exclusively on blood of mammals and birds, the blood ingested through grooves on underside of tongue with a "lapping" action; can walk rapidly and with agility; prefer dark limestone caves as retreats; some species may produce more than one young per year.

Range: tropical South America north through subtropical Mexico

Genera: *Desmodus*, *Diaemus* (formerly within *Desmodus*), *Diphylla*

Specimen: *Desmodus*

Know: **Desmodontidae**

Superfamily Vespertilionoidea

Family Vespertilionidae (common bats)

Diagnosis: foredigit 3 with three phalanges, foredigit 2 with metacarpal and one small phalanx; nose-leaf absent or rudimentary in some subfamilies; tragus present and well-developed; premaxillae separate; no postorbital processes; tail long, extending to end of wide interfemoral membrane; crowns of lower incisors trifold; molars always 3/3 with well-developed W-shaped ectoloph; dental formula varies from 1/2, 1/1, 1/2, 3/3 = 28 to 2/3, 1/1, 3/3, 3/3 = 38.

Habits: usually insectivorous, a few piscivorous; migration and hibernation widespread; one young produced per year usually but a few species have up to four; some species polyestrous in tropics; may live as long as 24 yrs; generally distributed in all habitats

Range: cosmopolitan except for polar regions and some remote oceanic islands

Genera: 36 genera, 314 spp. usually grouped into five subfamilies: Vespertilioninae, Miniopterinae, Murinae, Nyctophilinae, Tomopeatinae

Specimens: Most of our local bats are vespertilionines:

Pipistrellus subflavus (eastern pipistrelle)

Lasiurus borealis (red bat)

L. cinereus (hoary bat)

Lasionycteris noctivagans (silver-haired bat)

Eptesicus fuscus (big brown bat)

Myotis lucifugus (little brown bat)

M. septentrionalis (northern long-eared bat) (sometimes *M. keeni*)

Plecotus (long-eared bat)

Nyctophilinae:

Antrozous (pallid bats)

Know: *Pipistrellus*, *Lasiurus*, *Lasionycteris*, *Eptesicus* and *Myotis* to genus;
Plecotus and *Antrozous* to family (**Vespertilionidae**)

Family Natalidae (funnel-eared bats)

Diagnosis: thumb short, nearly wholly enclosed in antebrachial membrane, but with well-developed claw; tail enclosed in interfemoral membrane, wing membranes extending from inferior surface of distal end of tibia and from base of calcaneum; ears large, funnel-shaped, the surface of conch studded with glandular papillae; tragus short, more or less triangular; muzzle elongate, no nose-leaf;

premaxillae with palatal and nasal branches fused with maxillae, the slender palatal branches fused medially, leaving two small lateral foramina; foredigit 2 with metacarpal but no phalanges; foredigits 3, 4, 5 with phalanges; dental formula 2/3, 1/1, 3/3, 3/3 - 38.

Habits: inhabit tropical lowlands; colonial, usually roost in mines or caves

Range: American tropics and West Indies

Genera: *Natalus*

Specimen: *Natalus*

Know: **Natalidae**

Family Molossidae (free-tailed bats, mastiff bats)

Diagnosis: muzzle broad and obtuse; foredigit 3 with three phalanges; lips large, upper lip often furrowed by vertical wrinkles; ears usually large and broad and often united across forehead; tragus present but small; interfemoral membrane narrow with tail extending far beyond distal edge; foredigit 5 shortened, scarcely equal to half length of 3; no postorbital processes; premaxillae with or without palatal branches, and with palatal foramina either separate or confluent; dental formula varies from 1/1, 1/1, 1/2, 3/3 = 26 to 1/3, 1/1, 2/2, 3/3 = 32.

Habits: insectivorous; inhabit caves, buildings or other similar structures; fast fliers (recorded up to 95 km/hr); some species migratory; some species hibernate but generally not as good hibernators as vespertilionids; one young per year; most species colonial, with colony size of 20 million known for *Tadarida brasiliensis*.

Range: widespread in tropical and subtropical parts of the world; occur throughout Africa except Sahara and throughout Australia; in New World extend from 45° S. lat. to roughly southern half of United States

Genera: *Tadarida*, *Otomops*, *Meoplatymops*, *Platymops*, *Sauromys*, *Myopterus*, *Molossops*, *Eumops*, *Promops*, *Molossus*, *Cheiromeles*

Specimen: *Tadarida* (free-tailed bat)

Know: **Molossidae**

Superfamily Rhinolophoidea

Family Rhinolophidae (horse shoe bats)

Diagnosis: muzzle with conspicuous and complex cutaneous outgrowths (usually two leaves with several lobes); premaxillae fused medially and extending freely between anterior ends of maxillae; no postorbital process; skull with distinct sagittal and lambdoidal crests; foredigit 2 with well-developed metacarpal only; foredigit 3 with two phalanges; tragus absent; tail contained within

interfemoral membrane (or at least not extending more than one quarter of its length beyond posterior margin) and may be rudimentary; dental formula $1/2, 1/1, 1-2/2-3, 3/3 = 28-32$.

Habits: insectivorous; usually sleep in caves, hollow trees, or other protected cavities; some species migrate, some known to hibernate; some species occur in large colonies; one or two young per year; occur in wide range of habitats.

Range: Temperate and tropical parts of Old World

Genera: *Rhinolophus*

Specimen: *Rhinolophus*

Know: **Rhinolophidae**

Order PRIMATES

(KNOW ALL PRIMATES TO FAMILY AND GENUS)

Diagnosis: plantigrade; phytophagous, omnivorous, or rarely insectivorous or carnivorous; mostly arboreal, but some terrestrial; fundamentally pentadactyl, but in some brachiating forms pollex reduced or lost, and in some specialized graspers (lorises) the first digit of manus reduced or lost; hallux (except in *Homo*) and pollex more or less opposable and used in grasping; distal phalanges usually bearing nails (claw-like in callitrichids); radius and ulna unfused, permitting free pronation and supination; dentition heterodont; dental formula $0-2/1-2, 0-1/0-1, 2-4/2-4, 2-3/2-3 = 18-36$; incisors reduced or lost in some or enlarged; premolars reduced to three or fewer, typically bicuspid, rarely becoming caniniform or molariform; molars primitively brachydont and tuberculo-sectorial, but becoming more bunodont in advanced groups; mandibular symphysis firmly ossified in advanced groups; orbits more or less directed forward and separated from temporal fossa by post-orbital bar or plate; nasal region and olfactory lobes of brain progressively reduced; auditory bulla petrosal in origin; brain progressively enlarged and elaborated; braincase becoming relatively large and facial region relatively small; uterus bicornuate or simplex; placenta non-deciduous and diffuse or deciduous and discoidal; penis often pendulous; testes either scrotal or subintegumental; baculum usually present except in *Tarsius*, some ceboids, and *Homo*; mammae usually in a single pectoral pair; seldom more than a single young.

Range: pantropical, except for Australia; *Homo* is cosmopolitan

Classification: **Suborder Strepsirhini** (informally known as 'prosimians')

Family Cheirogaleidae

Family Lemuridae

Family Megaladapidae (formerly Lepilemuridae)

Family Indridae

Family Daubentoniidae

Family Loridae

Family Galagonidae

Suborder Haplorhini (informally known as 'anthropoids')

Infraorder Tarsiiformes

Family Tarsiidae
Infraorder Platyrrhini
Family Callitrichidae
Family Cebidae
Infraorder Catarrhini
Family Cercopithecidae
Family Hylobatidae
Family Hominidae

Know: Groups in bold type above

Suborder Strepsirhini (“prosimians”—probably not monophyletic)

Family Lemuridae (lemurs)

Diagnosis: generally 36 permanent teeth, dental formula 0-2/2, 1/1, 3/3, 3/3 = 32-36; upper incisors absent or small, peg-like and separated by medial diastema; lower canine incisiform; first lower premolar caniniform; rostrum moderately conspicuous; cranium elongate; baculum present; pelage generally woolly; tail long; ears short to moderate in length and generally concealed in fur; facial vibrissae present; one to three pairs of mammae.

Habits: herbivorous or omnivorous; some aestivate; are active and restless; use non-prehensile tail in balancing; use hand to place food in mouth and in grooming; walk, leap, or run quadrupedally; diurnal, crepuscular, or nocturnal; seasonally polyestrous and bear usually one or two young; solitary or occur in pairs or even large groups; are endangered by habitat destruction

Range: Madagascar and adjacent Comoro Islands

Genera: *Lemur*, *Haplemur*, *Varecia*

Know: *Lemur* (skull)

Family Loridae (lorises, pottos)

Diagnosis: incisors and canines having same specializations as lemuroids; upper and lower molars quadritubercular; dental formula 1-2/2, 1/1, 3/3, 3/3 = 34 or 36 (lateral upper incisors sometimes absent in *Nycticebus*); occipital region laterally expanded; constriction between facial and neurocranial parts of skull; facial region reduced, premaxillae of small size; orbits large, directed anterodorsal; postorbital bar present; bullae well-developed, ectotympanic fused with rim of meatus; reduction in number of phalanges on manus sometimes; all digits have nails except second digit of pes where always claw-like; pes haired below heel; uterus bicornuate; optic lobes of brain enlarged; tail absent or reduced; limbs subequal; head rounded; eyes large; ears variable; vibrissae present but fewer than in lemurs; snout shorter than in lemurs; baculum present; two or three pairs of mammae.

Habits: insectivorous and carnivorous, but will eat eggs and vegetable matter; use hands to grab prey; use lower incisor teeth for scraping while feeding, but not in grooming as in lemurs; locomotion primarily by brachiation; movement slow and deliberate; arboreal; nocturnal; seasonally polyestrous, one to two young per pregnancy; solitary or in groups; varied vocal repertoire

Range: Africa south of Sahara and southeast Asia

Genera: *Loris*, *Arctocebus*, *Nycticebus*, *Perodicticus* (potto)

Know: *Loris* (skull)
Perodicticus (skin)

Family Galagonidae (bushbabies, galagos)

Diagnosis: as for Loridae, but with long, bushy tail; ears well-developed; locomotion by leaping

Genera: *Galago*, *Otolemur*, *Euoticus*, *Galagoides*

Know: *Galago* (skull)
Otolemur (skin)

Suborder Haplorhini ('anthropoids')

Family Cebidae (New World monkeys)

Diagnosis: small to medium in size; arboreal; nails on digits; pollux only slightly opposable or absent; tail short to long with moderately to highly developed prehensility; face short and flat or somewhat prognathous (as in *Alouatta* - howler monkey); internarial septum broad, nostrils well separated and laterally directed ("platyrrhine"); no cheek pouches or ischial callosities; skull usually rounded and without prominent occipital projection; little postorbital constriction; tympanic ring not extended as tube; dental formula usually 2/2, 1/1, 3/3, 3/3 = 36; molars usually quadrangular, quadricuspidate, and without distinct cross-lophs

proportions of body and appendages vary with subfamily; third and fourth manal digits commonly subequal; ears generally small; facial vibrissae present but reduced; placenta bidiscoidal or monodiscoidal and haemochorial; orbits large and forwardly directed; palate shorter in comparison with basicranium than in catarrhines; bullae formed from petrosal and ectotympanic; jugal contributes to postorbital plate and meets parietal; orbito-temporal foramen large; baculum present or absent

Habits: primarily herbivorous, but also eat eggs, insects, and other small animals; usually live and travel in territorial family groups or larger parties; arboreal, climb quadrupedally; swing with feet or tail (prehensile species), or leap; use hands to obtain food, break food and convey it to mouth; diurnal or nocturnal; give birth to single young per year ; have long life span (up to 25 years recorded); engage in personal and social grooming; extremely vocal; possess well-developed color vision

Range: Amazon basin of South America, north to southern Mexico

Genera: *Saimiri*, *Aotus*, *Callicebus*, *Alouatta*, *Pithecia*, *Chiropotes*, *Cacajao*,
Cebus, *Lagothrix*, *Ateles*, *Brachyteles*

Know: *Cebus* (skulls)

Alouatta (skin + skull)
Ateles (skin + skull)
Saimiri (skins + skull)
Aotus (skull)

Family Callitrichidae (marmosets, tamarins)

Diagnosis: small, arboreal, ceboid primates having pointed falcate claws on all digits except hallux, which has a flat nail; pollux not opposable; tail long, non-prehensile; dental formula 2/2, 1/1, 3/3, 2/2 or 3/3 = 32 or 36; tympanic ring not extended as a tube; skull long, narrow, rounded; head, eyes and teeth relatively small; nostrils well separated and laterally directed; body slender, limbs short, plantar and palmar surfaces relatively long, toes relatively short; forelimb only slightly longer than hind limb; facial vibrissae present but not conspicuous; no ischial callosities; jugal articulates with parietal; baculum present; upper molars somewhat triangular, last molar the smaller; premolars bicuspid; canines well-developed; medial incisors chisel-like, lateral incisors more pointed.

Habits: chiefly insectivorous, but also eat birds, fruit and seeds; climb like squirrels with quick movements; do not brachiate; diurnal; may ovulate in both ovaries at once; bear one to three young after gestation period of 140-150 days; commonly live in family groups; engage in mutual grooming; ocular movement restricted so move head to orient eyes; vocal.

Range: Amazonian basin of South America, north to Panama

Genera: *Cebuella*, *Callithrix*, *Saguinus*, *Leontopithecus*

Know: *Callithrix* (skin + skulls)
Leontopithecus (skin)
Saguinus (skin + skull)

Family Cercopithecidae (Old World monkeys)

Diagnosis: medium sized, arboreal to semiterrestrial, having flattened nails on all digits; pollex opposable unless much reduced or absent; tail absent or present, never prehensile; face more or less prominent, and rostrum sometimes lengthened; internarial septum narrow, nostrils nearly together and directed forward or downward ("catarrhine"); ischial callosities present; cheek pouches present in some; skull generally with distinct bony crests; ectotympanic extended as bony canal or tube; dental formula 2/2, 1/1, 2/2, 3/3 = 32; molars quadrangular, usually quadricuspidate (last lower molar pentacuspidate), having two transverse lophs and tending to become elongate

body proportions variable, tendency to stockier build and shorter tail in terrestrial forms; forelimbs slightly longer than hind limbs; hand shorter than foot; third manal digit longest; placenta bidiscoidal and haemochorial; palate longer in comparison with basicranium than in platyrrhines; canines tend to enlarge with small diastema between canines and upper incisors; auditory bullae rudimentary with little or no inflation; nasals fuse precocially; upper incisors often broadly spatulate; upper premolars have three roots, lower premolars two; cones well-developed for color vision; about 40% of optic nerve fibers not crossing at optic chiasma providing for good stereoscopic vision.

Habits: omnivorous or primarily leaf eaters; feed on ground or in trees; social organization well-developed; variety of vocalizations, mostly for social interaction; usually diurnal, but some crepuscular or nocturnal; usually bear a single offspring (rarely two) after a gestation period of 140-

210 days, at any time of year; menstruate, and may have a period of estrous as long as one-fourth of the length of the cycle; life spans of 50+ years known; some have been widely used in scientific and medical research, notably *Macaca* (usually referred to in the clinical literature as the cynomolgus monkey)

Range: Old World from Africa east through southern Asia; also Gibraltar.

Genera: *Miopithecus*, *Cercopithecus*, *Erythrocebus*, *Allenopithecus*, *Cercocebus*, *Macaca*, *Papio*, *Theropithecus*, *Presbytis*, *Pygathrix*, *Nasalis*, *Colobus*

Know: ***Macaca*** (skull)
Theropithecus (skull)
Papio (skull)

Family Hominidae (great apes)

Taxonomic notes: In older (paraphyletic, or non-monophyletic) classifications the non-human apes are placed in their own family, Pongidae. However, since *Homo sapiens* is either most closely related to *Pan*, or *Pan* + *Gorilla*, with *Pongo* (the orangutan) outside these, Pongidae is a paraphyletic family, i.e. it contains a common ancestor but not all of its descendants (because it excludes *Homo* which is placed in its own family). Therefore, we now recognize a single family Hominidae for all the great apes, including humans. Gibbons (Hylobatidae) are the sister group of the great apes.

Diagnosis: (**excluding humans**) medium to large, arboreal to terrestrial, having flattened nails on all digits; pollex opposable unless reduced (in *Pongo*); hallux opposable; tail absent; face prominent and prognathous; narial region catarrhine; ischial callosities absent; skull longer than wide and tending to develop bony crests; ectotympanic extended as bony canal; dental formula 2/2, 1/1, 2/2, 3/3 = 32; maxillary and mandibular tooth rows tending to be parallel; teeth in general large, molars quadrangular, hypoconulid present on all lower molars but forming less conspicuous heel on last molar than in cercopithecids; molars not bilophodont and not tending to elongation; symphyseal region of mandible strengthened by bony shelf; canines relatively large; forelimbs distinctly longer than hind limbs; hands longer than feet; third manual digit longest; head rounded, face long, zygomatic arches wide; ears rounded, small to prominent; placenta a single disc, deciduous, haemochorial; baculum present

Habits: primarily herbivorous, but will eat small animals and eggs; gather food and convey it to mouth by hands; live and travel in family bands or larger groups; vocalization varies; brachiation characteristic but chimps and gorillas spend most of their time on ground where locomotion is quadrupedal or rarely bipedal; primarily diurnal; females usually bear single young after gestation of 200-260 days, at any time of year, have an estrous cycle of 28 days and menstruate; reach puberty in 5-10 years; may live as long as 50 years

Range: Southeast Asia and equatorial Africa

Genera: *Pongo*, *Pan*, *Gorilla*, *Homo*

Know: ***Pongo*** (skull cast)
Gorilla (skull cast)
Pan (skull cast, skull)
Homo (skull, skeleton + skin)