Taxonomic classification of parasites

Taxonomic classification systems are intended to show phylogenetic relationships between life-forms, reflecting their evolution by descent. Many taxonomic characters have been used to show differences and similarities between organisms, moving from conventional phenotypic characters (such as morphology, biology, geography) to contemporary genotypic characters (DNA and protein characterization). After several centuries of considered debate and informed revision, the taxonomic classification of organisms now generally adheres to a three-domain system: recognizing the Archaea, Eubacteria and Eukaryota as profoundly different organisms, nonetheless with common ancestry. Four kingdoms of Eukaryota ('true-nucleated' organisms) are generally recognized: the Protista, Fungi, Animalia and Plantae. Parasites are found in each kingdom.

Kingdom: Protista (unicellular eukaryotes)
Subkingdom: Protozoa (motile protists)

Supergroup: Excavata (with conspicuous ventral feeding groove)

Group: Metamonad (amitochondriate flagellates with karyomastigonts)

Phylum: Fornicata (diplomonads)
Order: Diplomonadida (with 1-2 karyomastigonts (each with 4 basal bodies/flagella associated with nucleus))
Family: Hexamitidae (2 karyomastigonts arranged in binary axial symmetry)
Giardia vertebrates, small intestines, direct (faecal-oral)
Hexamita (+ *Spironucleus*), vertebrates, intestines/organs/skin, direct (faecal-oral, water-borne)

Phylum: Parabasalia (anaerobic flagellates with parabasal body supporting Golgi cisternae or dictyosome, trichomonads, hypermastigids, retortamonads)
Class: Hypermastigia (Cristamonadea) (with multiple flagella)
Order: Trichomonadida (with 3-5 anterior flagella, and single recurrent flagellum)
Family: Monocercomonadidae (simplest forms, costa absent, most without undulating membrane, some aflagellate)
Histomonas birds, caeca/liver, direct (+ nematode PH)
Dientamoeba humans/rodents, gut, direct (faecal-oral)
Family: Trichomonadidae (stout axostyle, costa present, supporting undulating membrane)
Trichomonas mammals/birds, gut/urogenital tract, direct
Family: Cochlosomatidae (cells with anterior adhesive disc, lateral groove, 6 flagella, axostyle)
Cochlosoma birds, intestines, direct

Group: Discoba (diverse group supported robustly by molecular studies)

Phylum: Heterolobosea (diverse group, incl. amoebo-flagellates, most form cysts or clusters of fruiting bodies)
Order: Schizopyrenida (no fruiting bodies)
Family: Vahlkampfidae (eruptive limax amoeboid form cylindrical, most form temporary flagellated stages)
Naegleria human, CNS, opportunist (normally free-living)

Phylum: Euglenozoa (flagella inserted in anterior pocket, some heterotrophs, some autotrophs (with chloroplasts))
Class: Kinetoplastea (heterotrophs, with extranuclear DNA (= kinetoplast) associated with mitochondrion)
Subclass: Prokinetoplastina (small group supported by molecular studies)
Family: Ichthyobodonidae (2 heterodynamic flagella arising from pocket that continues as a groove)
Ichthyobodo (= *Costia*) fish, gills/skin, direct (water)
Subclass: Metakinetoplastina (large polyphyletic group supported by molecular studies)
Order: Parabodonida (biflagellated, recurrent flagellum attached or free)
Family: Parabodonidae (Cryptobiidae, Trypanoplasmatidae) (epizoic or endozoic in invertebrates and/or fish)
Cryptobia fish, gills/skin, direct (water)
Trypanoplasma fish, blood, indirect (leech vector)
Order: Trypanosomatida (parasitic, single anterior flagellum, often forming undulating membrane)
Family: Trypanosomatidae (monogenetic forms in insects/plants, digenetic forms in vertebrates & arthropods)
Trypanosoma vertebrates, blood/tissues, indirect (fly/bug vectors)
Leishmania vertebrates, tissues, indirect (sandfly vectors)

Supergroup: SAR (Stramenopiles + Alveolata + Rhizaria)

Group: Alveolata (with cortical alveoli)

Phylum: Protalveolata (incl. perkinsids parasitic in molluscs)
Class: Perkinsea (parasitic in marine bivalves and abalone, form biflagellated zoospores)
Order: Perkinsorida (with characters of class)
Family: Perkinsidae (with characters of order)
Perkinsus shellfish, tissues, direct (water-borne)

Phylum: Dinoflagellata (with unique mesokaryotic nuclei (lacking histones), autotrophs and heterotrophs)
Class: Blastodiniophyceae (extracellular athecate parasites of zooplankton, algae, crustacea and fish)
Order: Blastodiniales (uninucleate trophonts with chloroplasts)
Family: Oodiniaceae (trophont fusiform with rhizoid-like invasive organelle)
Amyloodinium/Crepidoodinium/Piscinoodinium fish, skin, direct (water)
Class: Syndiniophyceae (multinucleate plasmodial trophonts)
Order: Syndiniales (parasitic in copepods, appendicularians, crabs, radiolaria and fish eggs)
Family: Syndiniaceae (multinucleate trophonts without chloroplasts)
Haematodinium/Ichthyodinium crustaceans, fish, tissues, direct (water)

Phylum: Apicomplexa (with apical complex, all parasitic, sexual development (gamogony))

Class: Gregarinomorphea (gregarines, gamogony and sporogony in aquatic hosts, trophonts with specialized attachment apparatus, epimerite or mucron, syzygy)
Subclass: Cryptogregaria (epicellular parasites of vertebrates with feeder organelle but lacking apicoplast)
Family: Cryptosporidiidae (oocysts with 4 naked sporozoites, mucosal parasites in vertebrates)
Cryptosporidium vertebrates, intestines/stomach/lungs, direct (faecal-oral)

Class: Coccidiomorphea [Conoidasida] (with conoid)
Subclass: Coccidia [Coccidiasina] (small intracellular gamonts)
Order: Eucoccidiorida (cyclic merogony (schizogony), gamogony, sporogony)

Suborder: Adeleina (syzygy, 1-4 microgametes)
Family: Haemogregarinidae (ookinete, gamonts in blood cells, invertebrate vectors)
Haemogregarina reptiles/amphibia/fish, tissues/blood, indirect (leech/arthropod vectors)
Hepatozoon mammals/birds/reptiles, tissues/blood, indirect (ingestion of arthropod vector)
Family: Klossiellidae (zygote inactive, sporocysts formed (rather than oocysts))
Klossiella mammals, kidney, direct

Suborder: Eimeriorina (no syzygy, many microgametes)
Family: Eimeriidae (monoxenous, endogenous intracellular merogony and gamogony, exogenous sporogony)
Caryospora birds/reptiles/mammals, gut, direct (faecal-oral)
Cyclospora mammals/reptiles, gut, direct (faecal-oral)
Isospora (+ *Atoxoplasma*), birds/reptiles, intestines, direct (faecal-oral)
Eimeria non-carnivorous vertebrates, intestines + tissues, direct (faecal-oral)
Epieimeria fish, gut/intestines, direct (faecal-oral, water)
Goussia fish, gut, direct (faecal-oral, water)
Family: Sarcocystidae (heteroxenous, oocysts with two sporocysts, tissue cyst formation in intermediate hosts)
Subfamily: Cystoisosporinae (monozoic cysts in paratenic transport hosts, sporocysts without Stieda bodies)
Cystoisospora carnivores/omnivores, gut/tissues, direct/indirect
Subfamily: Sarcocystinae (metrocytes present in cysts, simple/elaborate cyst walls)
Sarcocystis mammals/birds/reptiles, gut/muscles, indirect (predator-prey)
Frenkelia birds/mammals/reptiles, gut/tissues, indirect (predator-prey)
Subfamily: Toxoplasmatinae (metrocytes not present, thin cyst walls)
Besnoita mammals/reptiles, gut/tissues, indirect (predator-prey)
Hammondia mammals, gut/tissues, indirect (predator-prey)
Neospora dogs/herbivores, gut/muscles/CNS, indirect (predator-prey)
Toxoplasma cats/vertebrates, gut/muscles/CNS, indirect (predator-prey + vertical)

Class: Aconoidasida (without conoid)

Order: Haemosporida (pleomorphic stages in blood of vertebrates, insect vectors. motile zygote (ookinete))
Family: Plasmodiidae (schizogony in tissues then blood cells, gamonts in blood cells, haemozoin pigment)
Plasmodium mammals/birds/reptiles, liver/erythrocytes, indirect (mosquito vectors)
Family: Haemoproteidae (schizogony in tissues, gamonts in blood cells, haemozoin pigment)
Haemoproteus birds, endothelia/erythrocytes, indirect (hippoboscid fly vectors)
Family: Leucocytozoidae (schizogony in tissues, gamonts in blood cells, no haemozoin pigment)
Leucocytozoon (+ *Akiba*), birds, tissues/leucocytes, indirect (simuliid fly vectors)

Order: Piroplasmida (pear-shaped stages in blood cells of vertebrates, tick vectors)
Family: Babesiidae (merogony in erythrocytes, trans-stadial + trans-ovarian transmission in ticks)
Babesia mammals, erythrocytes, indirect (ixodid tick vectors)
Family: Theileriidae (merogony in leucocytes then erythrocytes, trans-stadial transmission in ticks)
Theileria ruminants, leucocytes/erythrocytes, indirect (ixodid tick vectors)

Phylum: Ciliophora (with cilia, nuclear dualism, pellicular alveoli, reproductive conjugation)
Subphylum: Intramacronucleata (microtubules occur inside macronuclear envelope during division))

Class: Litostomatea (simple mouths, special somatic kineties)
Subclass: Trichostomatia (endosymbionts, holotrichous ciliation)
Order: Vestibuliferida (distinct oral depression (= vestibulum))
Family: Balantidiidae (monoxenous symbiotes, in vertebrates, sometimes histophagous)
Balantidium pigs/primates, large intestine, direct (faecal-oral)

Class: Phyllopharyngea (cytopharynx with leaf-like phyllae)
Subclass: Phyllopharyngia (cyrtos, ventral cilia)
Order: Chlamydodontida (body dorsoventrally flattened, ventral cilia thigmotactic)
Family: Chilodonellidae (reniform body dorsoventrally flattened, two fields of dorsal ciliary rows)
Chilodonella fish, gills/skin, direct (water)

Class: Oligohymenophorea (distinct oral ciliature, comprising right paroral membrane and 3 left membranelles)

Subclass: Scuticociliatia (with scuticum or scuticovestige)
Order: Philasterida (short paroral dikinetid membrane)
Family: Uronematidae (membranelles aligned with long axis, anterior pole non-ciliated)
Uronema fish, tissues, opportunist (normally free-living)

Subclass: Hymenostomatida (right paroral dikinetid plus 1-3 left polykinetids)
Order: Hymenostomatida (preoral suture, somatic monokinetids)
Suborder: Ophryoglenina (with organelle of Lieberkuhn (watchglass organelle))
Family: Ichthyophthiriidae (monoxenous ectoparasites, form encysted tomonts which release swarmers/theronts)
Ichthyophthirius (+ *Cryptocaryon*), fish, skin/gills, direct (water)
Suborder: Tetrahymenina (organelle of Lieberkuhn absent)
Family: Tetrahymenidae (pyriform body, longitudinal ciliary rows)
Tetrahymena fish, skin/gills/organs, direct (water)

Subclass: Peritrichia (lacking somatic kineties, oral cilia extend from infundibulum)
Order: Mobilida (mature trophont mobile, aboral holdfast organelle)
Family: Trichodinidae (stout cylindrical body, posterior adhesive disc with denticular ring)
Trichodina fish, skin/gills, direct (water)
Order: Sessilida (attached to substrate with scopula (specialized flattened thigmotactic area) with or without stalk)
Family: Epistylididae (scopula produces noncontractile stalk, retractile lip encircles elevated peristomial disc)
Apiosoma fish, skin/gills, direct (water)
Epistylis fish/crustacea, exoskeleton, direct (water)
Family: Scyphidiidae (solitary ciliates, attached by scopula)
Riboscyphidia syn *Scyphidia* fish/crustacea, exoskeleton, direct (water)
Ambiphrya fish/crustacea, exoskeleton, direct (water)
Family: Vorticellidae (solitary, gregarious or colonial, retractile stalks with central myoneme)
Vorticella fish/crustacea, exoskeleton, direct (water)
Carchesium fish/crustacea, exoskeleton, direct (water)
Family: Zoothamniidae (solitary or colonial, retractile stalks with shared myonemes)
Genus: *Zoothamnium* fish/crustacea, exoskeleton, direct (water)

Group: Rhizaria (various amoebae and flagellates)
Division: Cercozoa (biflagellated and/or amoeboid, usually with filopodia, plus Ascetospora)

Phylum: Ascetospora (haplosporidian and paramyxean parasites forming unique spores)

Class: Haplosporea (haplosporosomes present)
Order: Haplosporida (spore with one sporoplasm, spore orifice covered externally by operculum or internally by diaphragm)
Family: Haplosporididae (spores with operculum)
Haplosporidium/Minchinia/Urosporidium oysters, tissues, direct
Bonamia oysters, haemocytes, direct

Class: Paramyxea (form unique multicellular spores with cells enclosed within each other)
Order: Marteilida (internal cleavage of secondary cells then sporonts)
Family: Marteiliidae (sporonts contain 2-4 tricellular spores)
Marteilia oysters, tissues, direct
incertae sedis "Microcells" (uninucleate microcells, no spores, no plasmodia, no haplosporosomes)
Mikrocytos oysters, tissues, direct?

Supergroup: Amorphea (unikonts with single flagellum, or nonflagellated amoebae)

Phylum: Amoebozoa (locomotion by noneruptive pseudopodia, asexual development)

Subphylum: Conosa (archamoebae & mycetozoa, many flagellated forms, flagellar root with microtubular cone)
Class: Archamoebae (amoebae (no flagellates), cysts rounded, uni-/multi-nucleate, amitochondriate)
Family: Entamoebidae (uninucleate amoeboid forms, symbiotic in digestive tract of vertebrates)
Entamoeba mammals, colon (liver/brain), direct (faecal-oral)

Subphylum: Lobosa (with lobose pseudopodia)
Class: Discosea/Flabellinea (flattened forms, protoplasmic flow polyaxial)
Order: Dactylopodida (tapering finger-like subpseudopodia (= dactylopodia), most do not form cysts)
Family: Vexilliferidae (long slender subpseudopodia, spiny appearance, many with glycostyles/scales on cell surface, paramoebids with parasomes (Nebenkorper) near nucleus)
Neoparamoeba/Paramoeba fish, gills, direct (water)
Class: Longamoebea (flattened elongated cells with pointed subpseudopodia)
Order: Centramoebida (finely-tapering subpseudopodia (= acanthopodia), most form cysts)
Family: Acanthamoebidae (trophozoites flattened, prominent subpseudopodia, cysts stellate)
Acanthamoeba human, CNS, direct (water)
Balamuthia mammals, CNS, direct (soil/water)

Group: Opisthokonta (stages with single posterior flagellum)

Subgroup: Nucletmycea (Holomycota, fungi and relatives)

Kingdom: Fungi (with chitinous walls, includes microsporidia)
Division: Microsporidia (form unicellular spores, with coiled polar tubes, amitochondriate, all parasitic)

Class: Microsporea (polar filament well-formed, oval spores)
Order: Microsporida (polaroplast present)
Suborder: Apansporoblastina (sporophorous vesicle absent)
Family: Nosematidae (all stages diplokaryotic)
Nosema insects (bees), tissues, direct?
Family: Unikaryonidae (all stages unikaryotic, in cell cytoplasm or in parasitophorous vacuole)
Encephalitozoon mammals, tissues, direct?
Enterocytozoon mammals, gut, direct?
Suborder: Pansporoblastina (sporophorous vesicle present)
Family: Glugeidae (all stages unikaryotic, numerous sporoblasts formed in vesicles)
Glugea fish, tissues, direct?
Pleistophora fish, muscles, direct (water)
Trachipleistophora fish, tissues, direct?
Pseudoloma fish, nervous system, direct (water, carnivorism
Family: Thelohaniidae (meronts diplokaryotic, spores unikaryotic, 8 spores formed in each vesicle)
Thelohania crustaceans/insects, tissues, direct?

Group: Holozoa (metazoans, filasterans, ichthyosporeans, choanomonads)

Kingdom: Metazoa (Animalia) (multicellular eukaryotes, heterotrophs, notably animals)

Phylum: Cnidaria (diploblastic, radial symmetry, cnidocytes with nematocysts, sea anemones, corals, jellyfish, hydrozoa, myxozoa)

Subphylum: Myxozoa (form multicellular valved spores with polar filaments)
Class: Myxosporea (spores with 1-2 sporoplasms, 1-6 polar capsules)
Order: Bivalvulida (spores with two valves)
Suborder: Platysporina (polar capsules in sutural plane)
Family: Myxobolidae (spores flattened, suture forms elevated ridge, one polar capsule smaller than the other)
Myxobolus fish, tissues, direct + indirect?
Order: Multivalvulida (radially symmetrical spores, 3-7 valves, 3-7 polar capsules grouped together at apex)
Family: Kudoidae (four valves and polar capsules, mainly histozoic in muscles of marine fish)
Kudoa fish, muscles, direct/indirect?
Family: Trilosporidae (three valves and polar capsules, coelozoic/histozoic in marine fish)
Unicapsula fish, muscles, direct/indirect?

Group: Protostomia (triploblastic, spiral cleavage)

Subgroup: Lophotrochozoa (lophophore feeding structure or trochophore larva or neither)

Phylum: Platyhelminthes (flatworms, acoelomate, free-living/parasitic, most parasites hermaphroditic, prominent attachment organs)

Clade: Neodermata (syncytial tegument = neodermis)

Class: Trematoda (flukes, most with dorsoventrally flattened bodies, sac-like gut)

Subclass: Digenea (two or more hosts (one a mollusc), cycle involves larval miracidium, sac-like sporocyst/redia stages in snail, cercariae/metacercariae)
Order: Diplostomatida (most 'strigeids', blood and intestinal flukes mainly of tetrapods, some fish, infection usually by cercerial penetration)
Suborder: Diplostomata (furcocercous (fork-tailed) cercariae)
Superfamily: Schistosomatoidea (parasites in fish and tetrapod DH, miracidium penetrates gastropod, bivalve, annelid IH, sporocysts formed, fork-tailed cercariae, penetrates DH)
Family: Schistosomatidae (blood flukes, cylindrical bodies, in blood vessels of alimentary/urinary tract, separate sexes, male with gynaecophoric canal to hold female)
Schistosoma mammals/birds, blood vessels, indirect (freshwater snail IH)
Trichobilharzia, Austrobilharzia birds, blood vessels, indirect (snail vectors)
Order: Plagiorchiida ('echinostomatids', plagiorchiids', mainly fish hosts, some tetrapods, infection often by ingestion of cercariae or metacercariae)
Suborder: Pronocephalata (fish, tetrapod DH, gastropod IH, sporocyst and redia formed; simple-tailed cercariae, encysts in open, metacercariae eaten by DH)
Superfamily: Paramphistomoidea (rumen flukes, miracidium penetrates gastropod IH)
Family: Paramphistomidae (thick fleshy worms, conical shape, ventral sucker near posterior end, redial with appendages, cercariae with two eyespots)
Paramphistomum cattle/sheep, rumen/reticulum, indirect (planorbid snail IH)
Gastrodiscoides pig/humans, large intestine, indirect (snail IH)
Suborder: Echinostomata (fish, tetrapod DH, miracidium penetrates gastropod IH, redia formed, simple-tailed cercariae, encysts in open or in second IH, metacercariae eaten by DH)
Superfamily: Echinostomatoidea (slender worms, adult with collar of peglike spines)
Family: Echinostomidae (in piscivores, acetabulum near oral sucker, rediae with appendages, cercariae without eyespots and with simple tail, miracidia with one pair protonephridia)
Echinostoma birds/mammals, gut, indirect (snail IH-1, molluscs/planaria/fish/tadpoles IH-2)
Family: Fasciolidae (large leaf-shaped flukes, in herbivores, conical anterior end, ventral sucker at level of shoulders)
Fasciola mammals, liver, indirect (freshwater snail IH)
Fasciolopsis man/pig, intestines, indirect (planorbid snail IH)

Suborder: Opisthorchiata (fish, tetrapod DH, egg eaten by gastropod IH, rediae formed, simple-tailed cercariae, encysts in second IH, metacercariae eaten by DH)
Superfamily: Opisthorchioidea (small-medium flukes, often spinose, piscivorous DH)
Family: Heterophyidae (tiny pyriform flukes, in intestines of mammals/birds, two IH (snails and fishes/frogs))
Heterophyes carnivores, intestines, indirect (fw snail IH-1, fw fish IH-2)
Metagonimus dogs/cats/pigs/humans, small intestines, indirect (snail IH-1, fish IH-2)
Family: Opisthorchidae (medium leaf-shaped flukes, in bile ducts of mammals, rediae without appendages, cercariae with two eyespots, metacercariae in second IH)
Opisthorchis piscivorous mammals, liver, indirect (fw snail IH-1, fw fish IH-2)
Clonorchis carnivores, liver, indirect (fw snail IH-1, fw fish IH-2)
Metorchis cat/dog/fox/seal, liver, indirect (snail IH-1, fish IH-2)
Suborder: Xiphidiata (xiphidiocercariae with penetrating stylet in anterior margin of oral sucker)
Superfamily: Gorgoderoidea (fish or tetrapod DH, miracidia penetrate gastropod, bivalve IH, sporocysts and rediae formed, simple-tailed cercariae with stylet, encysts in open or in second IH, metacercariae eaten by DH)
Family: Dicrocoeliidae (small lancet-like flukes, eggs ingested by snails, no redial stage, two-three IH)
Dicrocoelium ruminants, liver, indirect (terrestrial snail IH-1, ant IH-2)
Family: Paragonimidae (thick oval flukes, scale-like spines, miracidia, snail IH-1, crustacean/insect IH-2)
Paragonimus carnivores, lungs, indirect (fw snail IH-1, fw crustaceans IH-2)

Class: Monogenea (monoxenous ectoparasites, sac-like gut, hermaphroditic, direct cycles, oncomiracidium with 3 ciliary bands)
Order: Monopisthocotylea (posterior haptor comprising a single symmetrical attachment unit, no haptoral clamps)
Family: Gyrodactylidae (small worms, posterior haptor with pair of large central hooks and 16 small marginal hooks; viviparous, sometimes hyperviviparity (Russian nested dolls))
Gyrodactylus fish, skin/fins/gills, direct (water)
Family: Dactylogyridae (small worms, posterior haptor with 2 pairs large ventral anchors and 14 small marginal hooks, oviparous)
Dactylogyrus fish, gills, direct (water)
Family: Capsalidae (large worms, haptor with pair anterior suckers and two pairs of posterior hooks)
Benedenia fish, skin/gills, direct (water)

Class: Cestoda (tapeworms, gut absent, anterior scolex, proglottid segments, heteroxenous, predator-prey cycles)
Subclass: Eucestoda (larvae hexacanth (with six hooks))

Order: Cyclophyllidea (terrestrial species, scolex with four suckers, often bearing hooks, eggs release oncospheres)
Family: Taeniidae (tapeworms of carnivores/humans, scolex often armed, proglottids with unpaired reproductive organs and single genital pore, fluid-filled cystic metacestodes)
Taenia carnivores/omnivores, intestines/tissues, indirect (predator-prey)
Multiceps dog/herbivores, muscle/brain, indirect (predator-prey)
Echinococcus dogs/omnivores, gut/tissues, indirect (predator-prey)
Family: Anoplocephalidae (tapeworms of hoofed animals, scolex unarmed, cysticercoid in arthropods)
Anoplocephala, Anaplocephaloides, Equinia, Moniezia, Thysaniezia herbivores, intestines, indirect (soil mite/insect IH)
Family: Dipylidiidae (armed scolex, proglottids with paired reproductive organs and two lateral genital pores)
Dipylidium dog/cat, small intestines, indirect (flea/louse IH)
Family: Dilepididae (tapeworms of dog/cat and fowl, armed scolex, genital pores alternate, cysticercoid larva)
Amoebotaenia birds, small intestines, indirect (earthworms IH)
Choanotaenia birds, small intestines, indirect (beetle/fly IH)
Family: Davaineidae (tapeworms of birds, large rostellum with hammer-shaped hooks and spiny suckers)
Davainea birds, small intestines, indirect (terrestrial mollusc IH)
Raillietina birds, small intestines, indirect (ants/beetles/cockroaches IH)
Family: Hymenolepididae (tapeworms of birds/rodents/humans, slender strobilia, 1-4 testes, cysticercoid larva)
Hymenolepis mammals/birds, small intestines, indirect (arthropod/annelid/mollusc IH)

Order: Diphyllobothriidea (= Pseudophyllidea) (aquatic host species, unarmed scolex, with two grooves (bothria), genital organs and pores centrally placed, indirect cycles with two IH)
Family: Diphyllobothriidae (eggs release coracidium, more than one IH (procercoid in copepods, pleroceroids in frogs and other aquatic vertebrates) and often PHs)
Diphyllobothrium piscivorous mammals, small intestines, indirect (copepod IH-1/fw fish IH-2)
Dibothriocephalus piscivorous mammals, small intestines, indirect (copepod IH-1/fw fish IH-2)
Spirometra carnivores, small intestines, indirect (copepod IH-1/frogs IH-2)

Order: Bothriocephalidea (aquatic hosts (fish, amphibians), 2 bothria)
Family: Bothriocephalidae (eggs, hexacanth coracidia, procercoid larvae in copepods)
Bothriocephalus fish, intestines, indirect (copepod IH-1)
Schyzocotyle fish, intestines, indirect (copepod IH-1)

Clade: Gnathifera (small cuticular jaws, except Acanthocephala)
Group: Syndermata (eutelic syncytial epidermis)

Phylum: Acanthocephala (thorny-headed worms, pseudocoelomate, unsegmented, anterior retractable proboscis with numerous hooks, lack gut, indirect cycles, eggs with acanthor, acanthella develops in arthropod IH (or PH))
Class: Archiacanthocephala (oval thick-shelled eggs, body wall lacunar canals dorsal & ventral (or just dorsal))

Order: Oligacanthorhynchida (proboscis subspherical, short rows of several hooks, protonephridial organs present)
Family: Oligacanthorhynchidae (single family)
Macracanthorhynchus pig, small intestines, indirect (beetle IH)
Oncicola cats/foxes/dingoes, small intestines, indirect (beetle IH + bird PHs)
Class: Palaeacanthocephala (elongate eggs, sometimes with polar thickenings, body wall lacunar canals lateral)
Order: Polymorphida (trunk wrinkled, proboscis bulbous/cylindrical, with numerous hooks in alternating rows)
Family: Polymorphidae (spinose trunk, proboscis bulbous, double-walled proboscis receptacle)
Polymorphus ducks, small intestines, indirect (copepod IH)

Subgroup: Ecdysozoa (cuticle moulted = ecdysis)

Clade: Nematoidea (collagenous cuticle without microvilli)

Phylum: Nematoda (unsegmented, pseudocoelomate roundworms, hydrostatic skeleton, tubular digestive tract, longitudinal musculature, dioecious, free-living/symbiotic species)

Class: Enoplea (Aphasmidea, Adenophorea) (gland-bearers, cylindrical oesophagus, no phasmids, setae, two testes)

Subclass: Dorylaimia (five or more oesophageal glands, buccal stylet (odontostyle), free-living or parasitic)

Order: Trichinellida (Trichocephalida, Trichurida) (single spicule, stichosome oesophagus, L1 with buccal stylet)

Superfamily: Trichinelloidea (oesophagus with short muscular anterior portion and long glandular posterior portion)
Family: Trichinellidae (males with copulatory pseudobursae, spicules absent, viviparous, juveniles and adults can occur in same host, juveniles intracellular in skeletal muscle nurse cell)
Trichinella mammals, small intestines/muscles, direct (carnivorism)
Family: Trichuridae (whipworms, sudden transition in width, slender anteriorly, barrel-shaped eggs with polar plugs)
Trichuris mammals, caeca, direct (faecal-oral)
Family: Capillariidae (gradual transition in width, in gut/respiratory tract of mammals/birds, eggs with polar plugs)
Capillaria (*Eucoleus*) mammals/birds, various tissues, direct (faecal-oral) + earthworm PH
Pseudocapillaria fish, intestines, direct (water) + indirect oligochaete PHs

Class: Chromadorea (spiral amphids, 3 oesophageal glands, usually annulated bodies, free-living and parasitic)

Order: Rhabditida (Secernentea, Phasmidea) (secretors, phasmids present, amphids anterior, setae absent on females, single testis in males, cuticle 2-4 layers, oesophagus divided into bulbs)

Suborder: Rhabditina (free-living or parasitic in invertebrates/lower vertebrates)

Infraorder: Rhabditomorpha ('rod'shaped' buccal cavity)

Superfamily: Rhabditoidea (open tube stoma, excretory system with lateral canals)
Family: Rhabditidae (protandrous hermaphrodite (male becomes female), parasitic and free-living generations)
Rhabditis animals, skin, direct (faecal-oral, transdermal)
Pelodera animals, skin, direct (faecal-oral, transdermal)

Superfamily: Strongyloidea (bursate males, prominent buccal capsules, parasites of mammals, some birds)
Family: Ancylostomatidae (hookworms, large buccal capsule bent dorsally, armed with teeth/cutting plates, infection usually by percutaneous/transdermal penetration of infective L3)
Ancylostoma humans/dogs/cats, small intestines, direct (faecal-oral, transdermal)
Globocephalus pigs, small intestines, direct (faecal-oral)
Uncinaria dogs/foxes/cats, small intestines, direct (faecal-oral)
Necator humans/pigs, small intestines, direct (faecal-oral, transdermal)
Bunostomum ruminants, small intestines, direct (transdermal, faecal-oral)
Gaigeria sheep, small intestines, direct (transdermal)
Family: Metastrongylidae (infection of pigs by ingestion of earthworm/molluscan IH carrying L3)
Metastrongylus pigs, lungs, indirect (molluscan IH)
Family: Protostrongylidae (infection of ruminants by ingestion of earthworm/molluscan IH carrying L3)
Protostrongylus sheep/goats, lungs, indirect (mollusc IH)
Muellerius sheep/goats, lungs, indirect (mollusc IH)
Parelaphostrongylus cervids, brain, indirect (snail IH)
Elaphostrongylus cervids, muscles, indirect (snail IH)
Family: Angiostrongylidae (no buccal cavity, infection of vertebrates by ingestion of earthworm/molluscan IH)
Aelurostrongylus cats, lungs, indirect (mollusc IH) + PHs
Angiostrongylus dog, rat, lungs, blood vessels, indirect (mollusc IH) + PHs
Parastrongylus rat, pulmonary artery, indirect (mollusc IH) + PHs
Family: Filaroididae (direct cycle, infection of carnivores by ingestion of L1)
Filaroides dogs/mustelids, lungs, direct (faecal-oral)
Oslerus dogs, trachea, direct (faecal-oral)
Family: Strongylidae (strongyles, large buccal capsules, often with teeth/leaf crown, infection by ingestion of L3three pairs of branches in dorsal ray, equid hosts,)
Subfamily: Strongylinae (large strongyles, red-worms, globular buccal capsules)
Strongylus equines, caecum/colon, direct (faecal-oral)
Subfamily: Cyathostominae (small strongyles, cylindrical buccal capsule)
Cyathostomum equines, caecum/colon, direct (faecal-oral)
Poteriostomum equines, caecum/colon, direct (faecal-oral)
Triodontophorus equines, caecum/colon, direct (faecal-oral)
Oesophagodontus equines, caecum/colon, direct (faecal-oral)
Craterostomum equines, caecum/colon, direct (faecal-oral)
Family: Chabertiidae (nodular worms, two pairs of branches in dorsal ray)
Chabertia ruminants, caecum/colon, direct (faecal-oral)
Oesophagostomum ruminants/pigs/humans, caecum/colon, direct (faecal-oral)
Family: Stephanuridae (kidney-worm, in pigs)
Stephanurus pig, kidneys, direct (faecal-oral, transdermal) + earthworm PHs
Family: Syngamidae (gapeworm, in trachea of birds and mammals)
Syngamus birds, trachea, direct (faecal-oral) + earthworm/mollusc PHs
Family: Trichostrongylidae ((hair-like trichostrongyles, found in gut, infection by ingestion of L3, oesophagus lacking bulb, bursate males, lips reduced/absent, females lay thin-shelled eggs in morula stage, direct cycles)
Trichostrongylus herbivorous mammals/birds, gut, direct (faecal-oral)
Haemonchus ruminants, abomasum, direct (faecal-oral)
Ostertagia cattle, abomasum, direct (faecal-oral)
Teladorsagia sheep/goats, abomasum, direct (faecal-oral)
Cooperia ruminants, small intestines, direct (faecal-oral)
Nematodirus ruminants, small intestines, direct (faecal-oral)
Hyostrongylus pig, stomach, direct (faecal-oral)
Family: Dictylocaulidae (lung worms, direct cycle, infection by ingestion of L3)
Dictylocaulus ruminants/equids/camelids, lungs, direct (faecal-oral)
Family: Ollulanidae (head with spiral coil, female tail with cusps, viviparous (develop to L3 in uterus))
Ollulanus cat/fox/pig, stomach, direct (ingestion of vomitus)
Family: Heligmosomatidae (adults filiform, reddish in colour, direct cycle)
Nippostrongylus rodents, small intestines, direct (percutaneous)

Suborder: Spirurina (mostly parasitic, males often with coiled tail)
Incertae sedis

Superfamily: Dracunculoidea (elongate parasites of vertebrate tissues, freshwater crustacean IH)
Family: Dracunculidae (buccal capsule reduced, female highly enlarged, filled with L1)
Dracunculus humans, subcutaneous tissues, indirect (copepod IH)

Infraorder: Ascaridomorpha (large roundworms, mouth opening surrounded by three large lips, numerous caudal papillae)

Superfamily: Ascaridoidea (ascarids, eggs thick-shelled, direct cycle but larvae undertake hepato-pulmonary migration)
Family: Ascarididae (large pale roundworms, in terrestrial mammals)
- *Ascaris* humans/pigs, small intestines, direct (faecal-oral)
- *Parascaris* horses, small intestines, direct (faecal-oral)
- *Toxascaris* dogs/foxes/cats, small intestines, direct (+ PHs)
- *Toxocara* dogs/cats/bovids, small intestines, direct (vertical + faecal-oral) + PHs

Family: Anisakidae (large stout worms, in marine mammals/fishes/birds)
- *Anisakis* dolphins/whales, gut, indirect (copepod IH) + fish PHs

Superfamily: Heterakoidea (preanal sucker anterior to cloaca in males, direct cycle, infection by ingestion of eggs)
Family: Heterakidae (worms with lateral alae, oesophagus with rounded terminal bulb)
- *Heterakis* birds, caeca, direct (faecal-oral) + earthworm PHs

Family: Ascaridiidae (slender club-shaped oesophagus without rounded terminal bulb)
- *Ascaridia* birds, small intestines, direct (faecal-oral) +earthworm PHs

Infraorder: Gnathostomatomorpha ('jaw-mouthed' due to unique bulbous armed heads)

Superfamily: Gnathostomatoidea (first IH copepod, often use paratenic hosts)
Family: Gnathostomidae (swollen anterior head bulb, covered with rows of hooks, two lateral lips, four cervical sacs)
- *Gnathostoma* cats/pigs, stomach, indirect (copepod IH) + vertebrate PHs

Infraorder: Oxyuridomorpha (small pinworms, pointed tails, oesophagus with terminal bulb, males with single spicule)

Superfamily: Oxyuroidea (common in mammals, birds, reptiles, amphibians)
Family: Oxyuridae (direct cycle, females deposit sticky eggs around anus, infection by ingestion of egg)
- *Oxyuris* horse, large intestines, direct (faecal-oral)
- *Enterobius* humans, large intestines, direct (faecal-oral)
- *Passalurus* rabbits, large intestines, direct (faecal-oral)
- *Syphacia* rodents, large intestines, direct (faecal-oral)

Family: Heteroxynematidae (direct cycle, females deposit eggs in faeces, infection by ingestion of egg/larva)
- *Aspiculuris* rodents, large intestines, direct (faecal-oral)

Infraorder: Spiruromorpha (enigmatic clade linked by molecular characters, indirect cycles with IHs)

Superfamily: Acuarioidea (small parasites mostly of birds, with cephalic cordons, ptilina or serrated shields)
Family: Acuariidae (cephalic cordons, grooved cuticular structures)
- *Acuaria* birds, gizzard, indirect (water fleas/grasshoppers/beetles IH)
- *Dispharynx* birds, gizzard, indirect (water fleas/grasshoppers/beetles IH)

Superfamily: Camallanoidea (conspicuous phasmids, L1 with dorsal prominence/tooth, ovoviviparous, L1-L3 in copepod)
Family: Camallanidae (buccal capsule well-developed, with pair sclerotized valves, male with caudal alae)
- *Camallanus* fish, intestines, indirect (copepod IH)

Superfamily: Filarioidea (tissue-dwelling filarial parasites, lack lips, infect subcutaneous/intermuscular tissues, blood vessels or lymphatic systems of hosts, indirect cycles with arthropod IH)
Family: Filariidae (numerous anterior papillae and cuticular ridges, lay eggs with L1 already fully formed)
- *Parafilaria* horses/cattle, connective tissue, indirect (muscid flies IH)
- *Stephanofilaria* cattle, skin, indirect (buffalo flies IH)

Family: Onchocercidae (adults loose in tissues or in nodules, viviparous (live birth of L1 microfilariae))
- *Onchocerca* humans/cattle/horses, connective tissue, indirect (ceratopogonid/simuliid IH)
- *Wuchereria* humans, lymphatics, indirect (mosquito IH)
- *Brugia* humans/cats, lymphatics, indirect (mosquito IH)
- *Mansonella* humans, body cavities, indirect (midges IH)
- *Dipetalonema* dogs/camelids/humans, connective tissue, indirect (fleas/lice IH)
- *Acanthocheilonema* dogs/camelids/humans, connective tissue, indirect (fleas/lice IH)
- *Dirofilaria* dogs/cats/humans, heart, indirect (mosquito IH)
- *Loa* humans, subcutaneous, indirect (fly IH)
- *Setaria* sheep/cattle/horses, peritoneum/eye/scrotum, indirect (mosquito IH)

Superfamily: Habronematoidea (unique head structures with small pseudolabia and median lips)
Family: Habronematidae (pharynx with dorsal and ventral tooth, indirect cycle involving ingestion of fly)
Habronema horses, stomach, indirect (muscid flies IH)
Draschia horses, stomach, indirect (muscid flies IH)
Family: Tetrameridae (extravagant sexual dimorphism, females swollen, coloured bright red)
Tetrameres birds, proventriculus, indirect (water fleas/grasshoppers IH)

Superfamily: Physalopteroidea (stomach worms in mammals, insect IH)
Family: Physalopteridae (two large lateral pseudolabia, armed with teeth, lips with basal collar, caudal alae on males)
Physaloptera cats, stomach, indirect (crickets IH) + vertebrate PHs

Superfamily: Spiruroidea ((oesophagus divided into anterior muscular and posterior glandular portions, never with bulb, coiled tail in males, two spicules invariably dissimilar, indirect cycles, arthropod IHs, two prominent trilobed lips (pseudolabia), infect oesophagus/stomach (crop/gizzard))
Family: Gongylonematidae (anterior cuticle covered with large bosses or irregular scutes arranged in 8 rows)
Gongylonema cattle/sheep, oesophagus, indirect (beetle/cockroach IH)
Family: Spirocercidae (stout pink-red worm, well-developed buccal capsule, with 6 rudimentary lips)
Spirocerca dog, oesophagus/aorta, indirect (beetle IH) + vertebrate PHs
Ascarops pigs, stomach, indirect (beetles IH) + vertebrate PHs
Physocephalus pigs, stomach, indirect (beetles IH) + vertebrate PHs
Cylicospirura cats/foxes/dasyurids, stomach, indirect (beetle IH)
Cyathospirura cats/foxes/dasyurids, stomach, indirect (beetle IH)

Superfamily: Thelazioidea (eye-worms of birds and mammals, transmitted by insects)
Family: Thelaziidae (hexagonal mouth, lacking lips, conspicuous transverse anterior striations, live on surface of eye)
Thelazia cattle/horses, conjunctiva, indirect (muscid flies IH)
Oxyspirura birds, eye, indirect (cockroaches IH)

Suborder: Tylenchina (fungal, plant and animal parasites)

Infraorder: Panagrolaimomorpha (free-living or parasitic (insects, reptiles, amphibians, mammals))

Superfamily: Strongyloidoidea (dauer stages, lip region without processes, striated cuticle)
Family: Strongyloididae (threadworms, parasitic parthenogenetic females, free-living sexual generations)
Strongyloides mammals/birds, small intestines, direct (faecal-oral + transmammary)

Clade: Panarthropoda (with haemocoel, ventrolateral appendages)

Phylum: Arthropoda (coelomate metameric invertebrate animals, chitinous exoskeleton, segmented body, jointed limbs, moults (ecdyses) between instars, metamorphosis common)

Subphylum: Chelicerata (2 tagmata (cephalothorax + abdomen), chelicera, no antennae)

Class: Arachnida (spiders, scorpions, ticks, mites, two tagmata, 4 pairs of legs, no antennae, slit sensilla, incomplete metamorphosis)

Subclass: Acari (Acarina) (ticks & mites, segmentation inconspicuous/absent, sac-like body, mouth and appendages on capitulum)

Superorder: Parasitiformes (ticks and some mites, with posterior stigmata)

Order: Ixodida (= Metastigmata) (ticks, macroscopic, spiracles/stigmata posterior to legs, hypostome toothed, exposed, obligate blood-feeding ectoparasites of vertebrates)
Family: Argasidae (soft ticks, lack dorsal scutum, capitulum covered by body, hide in cracks/crevices)
Argas birds, skin, direct
Ornithodorus mammals, skin, direct
Otobius mammals, ears, direct

Family: Ixodidae (hard ticks, with dorsal scutum, capitulum projects anteriorly, attach and feed on 1, 2 or 3 hosts)
Ixodes mammals/birds, skin, direct
Rhipicephalus (*Boophilus*) mammals, skin, direct
Haemaphysalis mammals, skin, direct
Amblyomma (incl. *Aponomma p.p.*) mammals/reptiles, skin, direct
Bothriocroton (incl. *Aponomma p.p.*) reptiles/mammals, skin, direct
Dermacentor mammals, skin, direct
Hyalomma mammals, skin, direct

Order: Mesostigmata (gamesid mites, legs grouped anteriorly, spiracles/stigmata between second and fourth legs)
Family: Macronyssidae (large blood-sucking ectoparasites, only protonymph and adults feed, relatively long legs)
Ornithonyssus birds, skin/feathers, direct
Family: Dermanyssidae (large blood-feeding ectoparasites, greyish-white bodies becoming red when engorged)
Dermanyssus mammals/birds, skin/feathers, direct
Family: Halarachnidae (obligate parasites in respiratory tracts or ears of mammals)
Pneumonyssoides dogs/primates, nasal passages/sinuses, direct
Family: Raillietiidae (parasitic in ears of mammals)
Raillietia mammals, ears, direct
Family: Rhinonyssidae (parasites of nasopharynx of birds)
Sternostoma birds, nasal passages, direct
Family: Varroidae (bee mites, flat button shape, red-brown colouration, suck haemolymph)
Varroa bees, cuticle, direct

Superorder: Acariformes (diverse mites, without posterior stigmata)

Order: Prostigmata [Trombidiformes] (with stigmata on capitulum, distinct setae on body/legs)

Family: Demodecidae (small follicle mites, elongate cigar-shaped body, 4 pairs stumpy legs at front of body)
Demodex mammals, hairs, direct
Family: Cheyletiellidae (predatory and parasitic mites, body with waist, palps enlarged, legs terminate in combs)
Cheyletiella dogs/cats/rabbits, skin, direct
Family: Myobiidae (parasitic on fur-bearing mammals, esp. bats, body with lateral bulges)
Myobia mice, skin/hair, direct
Family: Psorergatidae (body circular, legs regularly spaced, long posterior setae, legs with inward-curved spines)
Psorobia, Psorergates sheep, skin, direct
Family: Trombiculidae (only larval stages parasitic, nymphs and adults free-living)
Trombicula, Eutrombicula, Neotrombicula, Leptotrombicula
mammals/birds, skin, direct

Order: Astigmata [Sarcoptiformes] (mange mites, without spiracles, respire through body surface, first two pairs of legs separated from posterior pairs, lack claws, with sucker-like modifications)

Family: Psoroptidae (non-burrowing mites, oval bodies, third and fourth pairs of legs project beyond body margin)
Psoroptes ruminants/horses/rabbits, skin, direct
Otodectes cats/dogs/foxes/ferrets, ear, direct
Chorioptes horses/sheep/cattle, skin, direct
Family: Sarcoptidae (burrowing mites, circular bodies, third and fourth legs do not project beyond body margin)
Sarcoptes humans/dogs, skin, direct
Notoedres cats/rabbits/rats, skin, direct
Trixacarus guinea pigs, skin, direct
Family: Ctyoditidae (respiratory parasites of birds, chelicerae absent, palps fused to form sucking organ)
Cytodites birds, air sacs, direct
Family: Listrophoridae (parasitic on fur-bearing mammals, distinct dorsal shield, legs modified for grasping hairs)
Lynxacarus cats, skin, direct
Leporacarus rabbits/hares, skin, direct
Chirodiscoides guinea pigs, skin, direct
Family: Myocoptidae (parasitic on fur of rodents, anterior legs pincer-like)
Myocoptes mice, skin/hair, direct
Family: Knemidokoptidae (burrowing scaly leg and face mites, round body, no dorsal spines, short stubby legs)
Knemidocoptes, Neoknemidocoptes birds, skin, direct
Family: Laminosioptidae (small mites, smooth elongated body, few setae, affect muscles of birds)
Laminosioptes birds, subcutaneous tissues, direct

Subphylum: Crustacea (chitinous cuticle, gills, 2 pairs antennae, mouthparts comprise pair mandibles and 2 pairs maxillae, segments with pair biramous extremities (podia), metamorphosis involving larval nauplius/zoea)

Class: Maxillipoda (nauplius with maxillipodan eye, 5 cephalic, 6 thoracic and usually 4 abdominal segments plus telson)

Subclass: Copepoda (elongate body, thorax with 7 somites (first few fused with head to form cephalothorax), gradual metamorphosis with series of copepodid instars succeeding naupliar instars, some ectoparasitic forms)

Order: Cyclopoida (antennules short with 10-16 articles, buccal cavity open)
Family: Lernaeidae (females insert anterior attachment organ into host tissues, develop paired egg sacs, free-swimming naupliar stage, five copepodid stages and adults on hosts)
Lernaea fish, gills, direct (water)
Order: Poecilostomatoida (simple parasitic forms of fishes to bizarre symbiotic forms of invertebrates)
Family: Ergasilidae (antennae modified into powerful organs of prehension, parasitic in freshwater and marine fishes)
Ergasilus fish, gills, direct (water)

Subclass: Branchiura (head with flattened bilobed cephalic fold, antennae reduced, carapace expands laterally to form respiratory alae, blood suckers on fish)

Order: Argulidea (single order)
Family: Argulidae (fish lice, discoid body, attaches using hooks/suckers/barbs, stylus inserted to feed on blood)
Argulus fish, skin/gills, direct

Subclass: Pentastomatida (tongue worms, crustacean-related parasites, lost virtually all appendages, elongate, segmented, anterior end with mouth and two pairs of tiny claws (penta-stome appearance))

Order: Porocephalida (horizontally-aligned hooks, posterior genital openings)
Family: Porocephalidae (cylindrical adults, parasites of snakes)
Porocephalus, Armillifer snakes, respiratory passages, indirect (rodent IH)
Order: Cephalobaenida (obliquely-paired hooks, medial genital openings)
Family: Linguatulidae (spatulate adults, parasites of mammals)
Linguatula mammals, respiratory passages, indirect (mammalian IH)

Subphylum: Hexapoda (3 tagmata (head+thorax+abdomen), 3 pairs uniramous legs, whole-limb mandibles)

Class: Insecta (three body regions (head, thorax, abdomen), ectognathous mouthparts (bases lie outside head capsule), six legs, single pair antennae, free-living and parasitic species)

Subclass: Pterygota (with wings)

Infraclass: Neoptera (wings fold back over body)

Superorder: Hemipterodea (= Exopterygota) (young resemble adults, have externally developing wings, piercing/sucking mouthparts)

Order: Hemiptera (true bugs/aphids/scale insects, mouthparts with stylet-like mandibles/maxillae, gradual metamorphosis)
Suborder: Heteroptera (some plant-feeders, some predatory on other arthropods, some blood-feeders on vertebrates)
Family: Cimicidae (small wingless bugs, incl. bedbugs, blood feeders on animals)
Cimex mammals/birds, skin, direct
Family: Reduviidae (large winged cone-nose/kissing/assassin bugs, incl. triatome bugs, blood feeders on animals)
Triatoma, Panstrongylus, Rhodnius mammals, skin, direct

Order: Phthiraptera (lice, small wingless insects, permanent obligate ectoparasites, dorsoventrally flattened, stout legs and claws, incomplete metamorphosis (eggs, nymphs, adults))

Suborder: Anoplura (sucking lice, narrow pointed head, pierce skin and feed on fluids (solenophagy))
Family: Haematopinidae (short-nosed lice, ectoparasites of domestic animals, claws on ends of legs of similar size)
Haematopinus horses/cattle/pig, skin/hair, direct
Family: Linognathidae (long-nosed lice, claws on first leg smaller than those on other legs)
Linognathus ruminants/dogs/foxes, skin/hair, direct
Solenoptes cattle, skin/hair, direct

Family: Pediculidae (head/body lice of primates)
Pediculus primates, skin/hair, direct
Family: Pthiridae (pubic lice of primates)
Pthirus humans, skin/hair, direct

Suborder: Mallophaga (= wool-eating) (chewing lice, broad rounded head, feed on keratin, host/site specific)

Superfamily: Ischnocera (without maxillary palps, prominent filiform antennae, keratin feeders (hairs/feathers))
Family: Trichodectidae (parasitize mammals, 3-segmented antennae, single claw on tarsi)
Trichodectes dogs, skin/hair, direct
Bovicola, Damalinia sheep/cattle/horses, skin/fleece/hair, direct
Felicola cats, skin/hair, direct
Family: Philopteridae (parasitize birds, five-segmented antennae, paired claws on tarsi)
Lipeurus, Goniocotes birds, skin/feathers, direct

Superfamily: Amblycera (with maxillary palps, large rounded heads, 4-segmented antennae in antennal grooves)
Family: Menoponidae (parasitize birds)
Menopon, Menacanthus birds, skin/feathers, direct
Family: Boopiidae (parasitize mammals/marsupials)
Heterodoxus dogs/macropods, skin/hair, direct

Superorder: Holometabola (= Endopterygota) (young do not resemble adults, holometabolous (complete) development, with internally developing wings)

Group: Panorpoid (complex of orders)

Order: Siphonaptera (fleas, wingless (=-aptera), adults feed on blood ("siphon-), laterally compressed, third pair of legs adapted for jumping, complete metamorphosis with vermiform larvae, pupation in silk cocoons)
Family: Pulicidae (parasites of mammals)
Pulex humans/dogs/cats, skin, direct
Echidnophaga mammals/birds, skin, direct
Ctenocephalides dogs/cats/humans, skin, direct
Xenopsylla rats/dogs/cats/humans, skin, direct
Spilopsyllus rabbit, skin, direct
Family: Ceratophyllidae (parasites of small rodents and birds)
Ceratophyllus small rodents/birds/humans, skin, direct
Nosopsyllus rats, skin, direct
Family: Tungidae (chigoes/jiggers/chiggers/chique/sand fleas, females burrow under skin, enclosed in sinus)
Tunga mammals, skin, direct

Order: Diptera (true flies, midges, mosquitoes, with single pair of membranous forewings (diptera), hindwings modified into halteres, complete metamorphosis with vermiform larvae)

Suborder: Nematocera (small midges/mosquitoes, long filamentous segmented antennae (= nemato-cera), aquatic life-cycles (larval/pupal stages associated with water), female adults require blood meal before they can lay eggs)
Family: Culicidae (mosquitoes, elongate mouthparts form proboscis, slender wings with scales on veins/margins)
Subfamily: Culicinae (scutellum with trilobed posterior margin, scaly abdomen, larva with prominent air-tube)
Culex, Aedes, Mansonia mammals/birds, skin, direct
Subfamily: Anophelinae (scutellum rounded or straight, abdominal sternites lack scales, larva lacks air-tube)
Anopheles mammals/birds, skin, direct
Family: Ceratopogonidae (small biting midges/sand flies, narrow spotted wings, maritime species associated with mangroves/swamps; native species associated with freshwater; introduced species associated with dung)
Culicoides mammals/birds, skin, direct
Family: Simuliidae (small black flies/buffalo gnats, characteristic humped backs, wings not patterned or hairy)
Simulium, Austrosimulium mammals/birds, skin, direct
Family: Psychodidae (moth flies/sand flies, incl. phlebotomines, characteristically hairy bodies and wings)
Phlebotomus/Lutzomyia mammals/birds, skin, direct

Suborder: Brachycera (large tabanid/March flies, with stout and fewer antennal segments (= brachy-cera), antennae often with aristae, females with slashing-sponging mouthparts to pierce skin and feed on pool of blood (telmophagy))

Infraorder: Tabanomorpha (larval head capsule incomplete posteriorly (only anterior parts sclerotized))
Family: Tabanidae (large stout horse/deer/March flies, often brightly coloured, painful bite, daytime feeders)
Tabanus, Chrysops, Haematopota mammals, skin, direct

Infraorder: Muscomorpha **(**Cyclorrhapha) (small-medium sized flies, sponging/biting mouthparts, cyclorrhaphous (circular-seamed) pupa, larva lacks sclerotized head capsule, short pendulous antennae composed of 3 segments usually with feather-like arista, some cause larval myiases)
Division: Schizophora (head with frontal suture (lunule))
Section: Calyptratae (calypters cover halteres)
Family: Glossinidae (tsetse flies, biting mouthparts, characteristic proboscis bulb, both sexes blood-feeders)
Glossina mammals, skin, direct
Family: Hippoboscidae (flat/louse flies, leathery abdomen, piercing mouthparts, strong claws on feet)
Melophagus sheep, skin/fleece, direct
Hippobosca mammals, skin, direct
Family: Muscidae (house/bush/stable/buffalo flies, nuisance flies, synanthropic (associated with human activity))
Subfamily: Muscinae (with sucking mouthparts adapted to feeding on decaying organic matter)
Musca mammals, nonparasitic
Subfamily: Stomoxinae (with elongate biting mouthparts adapted to blood feeding)
Stomoxys mammals, skin, direct
Haematobia bovines, skin, direct
Family: Calliphoridae (blow flies, often metallic, larvae cause myiases (flystrike/screw-worm infestation))
Lucilia (primary), *Calliphora* (secondary)
mammals, skin/subcutaneous tissues, direct
Cochliomyia (primary screw-worm) *Chrysomya* (Old World screw-worm, primary/secondary))
mammals, skin/subcutaneous tissues, direct
Cordylobia (tumbu fly) mammals, skin/subcutaneous tissues, direct
Family: Sarcophagidae (flesh flies, not metallic, breed in excrement/carrion/decomposing organic matter)
Sarcophaga mammals, skin/subcutaneous tissues, direct
Wohlfahrtia mammals, skin/subcutaneous tissues, direct
Family: Oestridae (large hairy bot flies, third larval stage or bot resemble small sausages, larvae cause myiases)
Subfamily: Cuterebrinae (skin bot flies)
Dermatobia cattle/humans, skin, direct
Subfamily: Oestrinae (head maggots)
Oestrus sheep, nasal sinuses, direct
Subfamily: Hypodermatinae (cattle grubs, ox warbles, heel flies)
Hypoderma cattle, subcutaneous tissues, direct
Subfamily: Gasterophilinae (stomach bots)
Gasterophilus equines, stomach, direct