Reference Guide to the Classification of Fungi and Fungal-like Protists, with Emphasis on the Fungal Genera with Medical Importance (circa 2009)

This outline lists some common genera of fungi and fungal-like protists, which are classified into a number of phyla, subphyla, classes, subclasses and in most cases orders and families. The classification is patterned after the broad schemes of Hawksworth et al. (1), Kirk et al. (2), Eriksson et al. (3), Alexopoulos et al. (4), and Blackwell et al (5) and was devised by PJS to reflect his perception of the relationships of the various organisms traditionally studied by mycologists and included in textbooks and manuals dealing with mycology. The classification ranks below class reflect interpretations of Alexopoulos et al. (7), and PJS. It should be noted that different biologists until recently have had varying opinions on which organisms to include in the Kingdom Fungi and on what rank should be accorded each major group. This classification outline distributes the fungi and fungal-like organisms often dealt with in traditional mycology among the three kingdoms, Protozoa, Chromista and Fungi. With only a relatively few exceptions, the genera listed are very common or are of medical importance. However, not all genera of the Kingdom Fungi involved in human and animal medical mycology are listed.

Kingdom: Protozoa/Amebozoa/Eumycetozoa (collection of numerous phyla of eukaryotic, generally wall-less, unicellular, plasmodial, or colonial phagotrophic microorganisms, which includes at least four fungal-like phyla that are no longer considered to be part of the Kingdom Fungi). These have all been reclassified and renamed to reflect their nonfungal nature (see for example Reading Sz 5, which discusses the reclassification of *Rhinosporidium seeberi* into the additional new Phylum Mezomycetozoea).

Phylum: Acrasiomycota (acasid cellular slime molds)
Phylum: Dictyosteliomycota (cellular or social slime molds)
Phylum: Myxomycota (plasmodial or true slime molds)
Phylum: Plasmodiophoromycota (endoparasitic plasmodial water molds)
Phylum: Labyrinthulomycota (net slime molds)

Kingdom: Chromista/Stramenopiles/Chromalveolata (collection of eukaryotic walled microorganisms that produce heterokont wallless cells in their life cycles, and which includes two fungal-like groups that are not currently considered to be monophyletic ancestors of any members of the Kingdom Fungi.

Phylum: Hyphochytridiomycota (hyphochytrids)
Phylum: Oomycota (egg-bearing aquatic phycomycetes) or Peronomycota
Class: Oomycetes/Peronosporomycetes
Order: Peronosporales (damping-off fungi, white rusts, downy mildews)
Family: Pythiaceae
Pythyium insidiosum (agent of swamp cancer of horses and phythiosis in man)

Kingdom: Fungi (collection of eukaryotic walled microorganisms, which includes four or five Phyla that are mostly amastigote [lack undulopodia (eukaryotic flagella) except for the Chytridiomycota] and usually form walled spores during their life cycle)

Subkingdom: Mastigomycotera (flagellate sporangial fungi, flagellate lower fungi, flagellate phycomycetes; aquatic phycomycetes)
Phylum: Chytridiomycota (chytrids, posteriorly uniflagellate fungi)
Class: Chytridiomycetes (3-5 orders, some of which are being raised to Phylum rank; see bolded orders)
Order: Chytridiales (also **Blastocladiales**, Monoblepharidales, Spizellomycetales, Rhizophydiales, **Neocallimasticales, Microsporidiales**)
Family: unnamed
Batrachochytridium (newly described genus for agents of chytridiomycosis of amphibians)

Subkingdom: Amastigomycotera (nonflagellate sporangial fungi, nonflagellate lower fungi, nonflagellate phycomycetes; nonaquatic phycomycetes)
Phylum: Zygomycota (nonaquatic phycomycetes, spore-forming sporangial fungi)

Subphylum: Mucormycotina
Class: Zygomycetes
Order: Mucorales (mucors, black bread molds; many agents of zygomycosis)
Family: Mucoraceae
Absidia
Mucor
Rhizopus
Family: Pilobolaceae
Pilobolus
Family: Coanephoraceae
Cokeromyces
Family: Cunninghamellaceae
Cunninghamella
Family: Mortierellaceae
Mortierella
Family: Saksenaeceae
Saksenaea
Subphylum: Entomophthoromycotina
Class: Entomophthomycetes
Order: Entomophthorales (many pathogens of insects)
Family: Entomophthoraceae
Conidiobolus
Family: Basidiobolaceae
Basidiobolus
Class: Trichomycetes
Phylum: Glomeromycota (the endomycorrhizal fungi)[8]
Class: Glomeromycetes
Order: Glomerales, etc.
Glomus
Subkingdom: Eumycotera/Dikariomycotera (higher fungi, septomycetes)
Phylum: Ascomycota (ascus fungi)
Subphylum: Sacchromycotina/Hemiascomycotina (nonascocarpic ascomycetes I)
Class: Hemiascomycetes/Saccharomycetes, (contains known or suspected candidiasis agents)
Order: Saccharomycetales (ascomycetous yeasts, mostly)
Family: Saccharomycetaceae
Debaromyces, teleomorphic genus of some *Candida sp.*
Kluyveromyces, teleomorphic genus of some *Candidasp.*
Lodderomyces, teleomorphic genus of some *Candida sp.*
Pichia, teleomorphic genus of some *Candida sp.*
Saccharomyces (budding yeasts)
Subphylum: Taphrinomycotina/Archiascomycotina (nonascocarpic ascomycets II)
Class: Schizosaccharomycetes/Archiascomycetes
Order: Schizosaccharomycetales
Family: Schizosaccharomycetaceae
Schizosaccharomyces (fission yeasts)
Class: Pneumocystidiomycetes
Order: Pneumocystidiales
Family: Pneumocystideaceae
Pneumocystis jirovecii (agent of human *Pneumocystis* pneumonia (PCP)
Class: Taphrinomycetes
Order: Taphrinales
Taphrina
Subphylum: Euascomycotina/Pezizomycotina (ascocarpic ascomycetes)
Class: Plectomycetes/Eurotiomycetes (cleistothecial ascomycetes)
Subclass: Eurotiomycetidae
Order: Eurotiales

Family: Eurotiaceae
Eurotium, *Emericella*, *Neosartorya* teleomorphic genera of some *Aspergillus*
Talaromyces, teleomorphic genus of some *Penicillium*
Order: Onygenales
Family: Gymnoascaceae/Ajellomycetaceae
Ajellomyces, teleomorphic genus of *Blastomyces dermatitidis* and *Histoplasma capsulatum*; possibly also *Lacazia loboi* and *Paracoccidioides braziliensis*
Family: Gymnoascaceae/ Arthrodermataceae
Arthroderma, teleomorphic genus of sexual *Microsporum*, *Trichophyton* and probably *Epidermophyton* anamorphs; possible teleomorphic family of *Uncinocarpus*, a possible teleomorphic kin of *Coccidioides immitis*
Subclass: Chaetothyriomycetidae/Loculoascomycetes II
Order: Chaetothyriales, possible teleomorphic orders of some Dematiaceae
Family: Herpotrichileaceae, possible teleomorph family of such Dematiaceae form-genera as *Cladophialophora, Exophiala, Fonsecea, Phialophora, Rhamichloridium, Wangiella*
Class: Sordariomycetes/Pyrenomycetes (perithecial ascomycetes)
Subclass: Hypocreomycetidae
Order: Microascales
Family: Microascaceae
Pseudalleschia, teleomorphic genus of *Scedosporium apiospermum*
Order: Hypocreales, possible order for many *Fusarium* species
Order: Clavicipitales
Family: Clavicipitaceae
Claviceps, ergot alkaloids (causes St. Anthony's Fire)
Subclass: Sordariomycetidae
Order: Ophiostomatales
Family: Ophiostomataceae
Ophiostoma, possible teleomorphic genus of *Sporothrix schenckii*
Class: Pezizomycetes/Discomycetes (apothecial ascomycetes)
Subclass: Pezizomycetidae
Order: Pezizales (epigean, operculate discomycetes)
Family: Helvellaceae
Gyromitra (false morels) causes ascomycete mushroom poisoning
Class: Dothidiomycetes/Loculoascomycetes I
Subclass: Dothideomycetidae
Order: Dothideales, possible teleomorphic order for *Hortaea werneckii*
Family: Piedraiaceae
Piedraia hortae (agent of black piedra)
Order: Pleosporales, possible teleomorhic order for *Maderella grisea*
Class: Lichenomycetes (class that contains the fungal partners of lichens) [8]
Phylum: Basidiomycota (basidial fungi)
Subphylum: Ustilaginomycotina/Heterobasidiomycotina I ("lower" basidiomycetes)
Class: Ustilaginomycetes (smuts)
Order:Malasseziales, possible teleomorphic order for *Malassezia furfur*
Subphylum: Pucciniomycotina/Heterobasidiomycotina II (rusts)
Class: Urediniomycetes
Subphylum: Agaricomycotina/Basidiomycotina/Holobasidiomycotina ("higher" basidiomycetes)
Class: Tremellomycetes/Phragmobasidiomycetes (jelly fungi, some with septate basidia)
Order: Trichosporonales (some have "cruciately-septate" basidia), possible teleomorphic order of *Trichosporon asahii*
Order: Filobasidiales
Family: Filobasidiaceae
Filobasidiella, the teleomorphic genus of *Cryptococcus neoformans* & *C. gattii*
Order: Auriculariales (have "transversely septate" basidia)
Class: Dacrymycetes (jelly fungi, with "tuning fork-type" basidia)
Order: Dacrymycetales

Class: Agaricomycetes/Holobasidiomycetes/Hymenomycetes (many orders of mushrooms, etc)
Order: Tulasnellales (have holobasidia with swollen sterigmata)
Order Schizophyllales
Family: Schizophyllaceae (split gill fungi)
Schizophyllum - rare infections
Order: Agaricales (gill fungi)
Family: Amanitaceae
Amanita (death angel genus) - most important mushroom poisoning genus
Family: Agaricaceae
Coprinus - mushroom poisonings
Lepiota - mushroom poisonings
Order: Lycoperdales (puffballs)
Family: Lycoperdaceae
Lycoperdon (snuff)
Order: Porales (woody pore fungi)

Phylum: Fungi Imperfecti/Deuteromycota (imperfect fungi, asexual fungi, anamorphic fungi, mitosporic fungi; fungi that cannot be classified by traditional means, because sexual states are unobserved or unknown, although they are now being classified very well using molecular means).

Form-class: Blastomycetes (contains the imperfect yeasts, the common infectious yeast form-genera)
Form-order: Cryptococcales
Form-family: Cryptococcaceae
Candida, *Cryptococcus*, *Malassezia*, *Pityrosporum*, *Rhodotorula*, *Trichosporon*

Form-class: Hyphomycetes (asexual hyphal form-genera that do not form multihyphal aggregates in association with their conidiophores and conidia; cause many infections, allergies and mycotoxicosis)
Form-order: Moniliales (conidial and synnematous imperfects)
Form-family: Moniliaceae (abbreviated list of form-genera that produce mostly colorless vegetative growth, at least when young)
Aspergillus, Blastomyces, Coccidioides, Epidermophyton. Geotrichum, Histoplasma, Microsporum, Paracoccidioides, Penicillium, Sporothrix, Trichophyton, etc.
Form-family: Dematiaceae (abbreviated list of asexual form-genera that produce dark brown or black vegetative growth throughout their life cycle)
Alternaria, Bipolaris, Cladophialophora, Curvularia, Exophialia, Fonsecea, Helminthosporium Phialophora, Wangiella
etc.
Form-family: Tuberculariaceae

Form-class: Coleomycetes (asexual form-genera that produce multihyphal structures in association with their conidia and conidiophores)
Phoma

Form-class: Mycelia Sterilia (asexual form-genera that produce hyphae but no conidia)

References

1. Hawksworth, Kirk, Sutton and Pegler, 1995. Ainsworth and Bisby's Dictionary of the Fungi (8th ed.).
2. Eriksson, O. E. et al., Notes on ascomycete systematics. Myconet. (see http://www.umv.se/myconet/new.html)
3. Kirk, Cannon, David and Stalpers. 2001. Dictionary of the Fungi, 9th Edition..
4. Alexopoulos, C. J., C. W. Mims, and M. Blackwell. 1996. Introductory Mycology, (4th ed.), John Wiley & Sons, Inc., New York.
5. Blackwell et al., 2006. Research coordinationnetworks: a phylogeny of kingdom Fungi (deep hyphae).Mycologia, 98:829-837.