
KINGDOM - FUNGI

FUNGUS/FUNGI

Eucaryotic, heterotrophic, osmotrophic (absorptive) organisms, which have cell walls, typically reproduce asexually and/or sexually by producing spores, and grow either reproductively by budding* or nonreproductively by hyphal tip elongation.**

Vegetative structure(s) = thallus/thalli

* budding ⁺--> yeast cells: ⁺also "fission" of "fission yeasts"

** tip elongation --> hypha/hyphae (mold/molds)

Definition doesn't exclude some fungal-like protists that produce zoospores*** in a cell called a sporangium.****

*** zoospores , nonwalled flagellated cells with mitotically-derived nuclei, which must encyst and acquire dormancy qualities before they become spores.

**** sporangium/sporangia⁰ = cell/cells in which reproductive cells with mitotically-derived nuclei are produced by vesicle-mediated, cytoplasmic cleavage to produce zoospores or sporangiospores.++

++ sporangiospores⁰ = walled reproductive cells produced in a sporangium, which have dormancy qualities

⁰technically mitosporangia & mitospores vs meiosporangia & meiospores

The Three (3) Disciplines of TAXONOMY

A. Identification

(recognition)

B. Classification*

(determining relationships)

C. Nomenclature

(naming)

* reflects phylogeny (evolutionary history)

Classification Hierarchy and Fungal Suffixes

Kingdom	Fungi/Mycota
Subkingdom	mycotera
Phylum	mycota
SubPhylum	mycotina
Class	mycetes
Subclass	mycetidae
Order	ales
Family	aceae
Genus*	<i>Saccharomyces</i>
Species*	<i>S. cerevisiae</i>

Organisms in the same taxon are more related than are organisms in different taxa.

*Genus and species names in italics because they are in a foreign language (Latin).

Review of Some Points about Fungal and Fungal-like Protist Classification

1. As few as about 30 years ago, "Fungi" represented a heterogenous grouping of absorptive, heterotrophic eukaryotes
2. Now we realize that these organisms represent members of 4 to 10 Phyla in three Kingdoms
3. Fungi can be thought of as:
 - a) mitosporangial = "lower fungi" {zoosporic & nonzoosporic sporangial
 - b) nonmitosporangial = "higher fungi" {nonsporangial
4. All sporangial fungi and sporangial fungal-like protists were once erroneously classified into the single, now obsolete, fungal class Phycmycetes
5. Today "phycmycetous" fungi are distributed among the 4+ Phyla and 3+ Kingdoms:

Chromista (Stramenopiles)		Protoctista/Protozoa (fungal-like animals)
Oomycota		Plasmodiophoromycota
Hyphochytridiomycota		DAPA
		(Zoosporic)
		Lysine
	Fungi	
Chytridiomycota		Mastigomycotera
Zygomycota		Amastigomycotera
Glomeromycota		(Nonzoosporic)

6. Non-sporangial fungi represent 3 Phyla:

Ascomycota		Eumycotera
Basidiomycota		(ascosporic/sexual)
Fungi Imperfecti		(basidiosporic/sexual)
		Lysine
		(asexual)

Major Diagnostic Feature(s) of the Natural (Phylogenetic) Phyla of Fungal-like Protists and Fungi

Kingdom Protoctista/Protozoa

Plasmodiophoromycota - zoospore with one whip-last flagellum and one stub

Kingdom Chromomista/Stramenopiles

Hyphochytridiomycota - zoospore with an anterior tinsel flagellum

Oomycota - zoospore with a tinsel and whip-lash flagellum

Kingdom Fungi

Mastigomycotera

Chytridiomycota - zoospore with a posterior whip-lash flagellum

Amastigomycotera

Zygomycota - nonmotile sporangiospores &/or zygospores

Glomeromycota (arbuscular plant symbionts)

Eumycotera

Ascomycota - Asci (meiosporangia) form endogenous meiospores called Ascospores

Basidiomycota - Basidia (meiosporangia) form exogenous meiospores called Basidiospores

Kingdom Fungi

Subkingdom - Eumycotera (Dikaryomycotera)

- 1. Ascomycota = fungi that are regularly septate hyphal fungi or yeast fungi, which produce endogenous meiospores called ascospores in a cell(s) called an ascus (asci)***
- 2. Basidiomycota = fungi that are regularly septate hyphal fungi or yeast fungi, which produce exogenous meiospores called basidiospores on a cell(s) called a basidium(basidia)****
- 3. Fungi Imperfecti* = fungi that are regularly septate hyphal fungi or are yeast fungi which are not known to produce meiospores(no ascospores or basidiospores)**

*meiosporangia of Ascomycota.

** meiosporangia of Basidiomycota

- **Deuteromycota of many authors, mitosporic and anamorphic fungi of others. The "asexual" fungi?**

Plasmogamy → karyogamy → meiosis
Species specific in ascus or basidium
sex

N + N 2N N (X 4 and with subsequent mitoses multiples of 4)

Ascomycota Classification

SUBKINGDOM – EUMYCOTERA/DIKARYOMYCOTA

PHYLUM - ASCOMYCOTA

SUBPHYLUM - HEMIASCOMYCOTINA/SACCHAROMYCOTINA*

CLASS - HEMIASCOMYCETES/SACCHAROMYCETES

ORDER - SACCHAROMYCETALES

SUBPHYLUM - ARCHIASCOMYCOTINA/TAPHRENOMYCOTINA**

CLASS – ARCHIASCOMYCETES/SCHIZOSACCHAROMYCETES

ORDER – SCHIZOSACCHAROMYCETALES

CLASS - PNEUMOCYSTIDIOMYCETES

ORDER – PNEUMOCYSTIDALES

CLASS - TAPHRINOMYCETES

ORDER - TAPHRINALES

SUBPHYLUM - EUASCOMYCOTINA/PEZIZOMYCOTINA***

CLASS - PLECTOMYCETES/EUROTOMYCETES

CLASS - PYRENOMYCETES/SORDARIOMYCETES

CLASS - DISCOMYCETES/PEZIZOMYCETES

CLASS - LOCULASCOMYCETES/DOTHIDIOMYCETES*****

& CHAETOTHYRIOMYCETES*****

CLASS - LICHENOMYCETES

= ascocarp type*****

cleistothecium

perithecium

apothecium

loculoascostroma

***Hemiascomycotina = nonascocarpic ascomycetes I**

****Archiascomycotina = nonascocarpic ascomycetes II**

*****Euascomycotina = ascocarpic ascomycetes**

******ascocarp/ascoma = a multihyphal aggregate in which or on which asci form.**

*******Loculoascomycetes I**

*******Loculoascomycetes II; many now include these fungi in the subclass Chaetothyriomycetidae of the class Eurotiomycetes**

Basidiomycota Classification

Phylum - Basidiomycota

Subphylum - Heterobasidiomycotina*, **

Class - Urediniomycetes/Teliomycetes (rusts)

Order - Uredinales

Class - Ustomycetes/Ustilaginomycetes (smuts)

Order - Ustilaginales

Order - Malasseziales

*basidia from teliospores (dikaryotic spores)

**no "mushroom-like" basidiocarps

Subphylum - Holobasidiomycotina/Basidiomycotina

Class - Phragmobasidiomycetes/Tremellomycetes (jelly fungi; septate basidial fungi, etc)

Order - Tremellales (have "cruciate septate" basidia)

Order - Filobasidiales

Order - Auriculariales (have transversely septate basidia)

Class - Holobasidiomycetes***, ****(about 20 to 25 orders that include many poisonous "mushrooms/toadstools")

Order - Dacrymycetales (have "tuning fork-type" basidia)

Order - Tulasnellales (have holobasidia with swollen sterigmata)

Order - Schizophyllariales

Order - Agaricales (gill fungi)

Order - Lycoperdales (puffballs)

Order - Porales (woody pore fungi)

Order - Exobasidiales

Order - Aphylophorales

Order - Hymenogastrales

Order - Melanogastrales

Order - Gautierales

Order - Phallales (the stinkhorns)

Order - Tulostomatales

Order - Sclerodermatales

Order - Nidulariales (the bird's nest fungi)

***most have different kinds of woody or nonwoody mushroom-like basidiocarps

****most have typical holobasidium

**Septation Patterns of Various Hyphal Fungi
or Fungal-like Protists**

1. aseptate - without septa

hyphal Oomycota*
Chytridiomycota*

2. irregularly septate (having few-to-many septa at "random" positions)

Zygomycota*
Glomeromycota

3. regularly septate (having septa at relatively regular intervals)

Ascomycota, Basidiomycota septation structure
Fungi Imperfecti sometimes suggests phylogeny

* except complete septa (w/o pores) to wall off reproductive cells, e.g. mitosporangia, meiosporangia

Note: all hyphal fungi tend to be coenocytic (multinucleate)

Relevance of Septal Patterns & Septation Types to Fungal Taxonomy

Fungal-like protists &	tend to be aseptate except to delimit reproductive cells (e.g. sporangia, gametangia)
Chytridiomycota	septa when formed "complete" (no pores)
Zygomycota	tend to be aseptate or have septa formed at irregular intervals in their hyphae (septa when formed "complete")
Ascomycota & Basidiomycota yeasts	tend to form complete septa or micropore septa between mother and daughter cells
Ascomycota filamentous fungi	tend to form hyphal septa at relatively regular intervals septa are "simple septa" with a central septal pore & Woronin Bodies
Basidiomycota filamentous fungi	tend to form hyphal septa at regular intervals septa are "dolipore" or "pulley wheel" type with central pore, parenthesome membranes or pulley wheel plug, etc.; many also produce clamps to perpetuate the dikaryotic (N+N) condition.

Relevance of Growing Hyphal-tip* Cytology to Fungal Taxonomy

**Hyphal Oomycota -
random dispersion of apical vesicles**

**Hyphal Zygomycota -
concentrated vesicles in tip**

Hyphal Ascomycota, Basidiomycota and Fungi Imperfecti; microvesicles concentrated among macrovesicles into mass called a "Spitzenkorper"

***Tips of hyphae actively growing by vesicle-mediated plasma membrane and cell wall extension**