KINGDOM - FUNGI

FUNGUS/FUNGI
Eucaryotic, heterotrophic, osmiotrophic (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 that must encyst and acquire dormancy qualities before they become spores.**
******** **sporangium/sporangia^{0} = cell/cells in which mitotically derived reproductive cells are produced by vesicle-mediated, cytoplasmic cleavage to produce zoospores or sporangiospores.++**
++ sporangiospores^{0} = walled reproductive cells produced in a sporangium, which have dormancy qualities

^{0}technically 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**
Order	**ales**
Family	**aceae**
Genus*	***Saccharomyces***
Species*	***S. cerevisiae***

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 20 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, <u>now obsolete</u>, fungal class Phycomycetes**

5. **Today "phycomycetous" 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** **AAA**
Zygomycota		**Amastigomycotera**
		(Nonzoosporic)

6. Non-sporangial fungi represent 3 Phyla:

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

Major Taxa of
Sporangial Fungal-like Protists and Sporangial Fungi

Kingdom - Protozoa/Protoctista/Eumycetozoa
Phylum - Plasmodiophoromycota* **some zoosporic fungal-like protists**
Kingdom - Chromista/Stramenopiles
Phylum - Hyphochytriomycota**
Phylum - Oomycota***

Kingdom Fungi
Subkingdom - Mastigomycotera (zoosporic fungi)
Phylum - Chytridiomycota****

Subkingdom - Amastigomycotera (sporangiosporic fungi)
Phylum - Zygomycota*****

***** **zoospores have one whip-lash flagellum & one stub**

****** **zoospores have one anterior tinsel flagellum**

******* **zoospores have one whip-lash and one tinsel flagellum**

******** **zoospores have one posterior whip-lash flagellum**

********* **sporangiospores have cell walls and dormancy qualities (true spores)**

Sporangium/Sporangia
of Fungi and Fungal-like Protoctista
cell(s) that produce(s) endogenous, mitotically derived reproductive cells

Sporangial protoctistan phyla (fungal-like protoctista)
Hyphochytridiomycota - anterior tinsel
Oomycota - 1 tinsel, 1 whip-lash
Phycomycetes***
Sporangial fungal phyla (lower fungi)
Sub-kingdom Mastigomycotera*(zoosporic)
Chytridiomycota - posterior whip-lash
Sub-kingdom Amastigomycotera**
Zygomycota - sporangial cells (sporangiasporic) nonmotile, true spores

*** zoospores = motile mitosporic cells** sporangiospores = nonmotile mitosporic cells**
*****obsolete class; members now distributed among <u>at least</u> 4 phyla of fungi or fungal * protoctista**

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
Eumycotera
Ascomycota - Asci (meiosporangia) form endogenous meiospores called Ascospores
Basidiomycota - Basidia (meiosporangia) form exogenous meiospores called Basidiospores

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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 in 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

Ascomycota Classification

SUBKINGDOM – EUMYCOTERA/DIKARYOMYCOTA	
PHYLUM - ASCOMYCOTA	
SUBPHYLUM - HEMIASCOMYCOTINA/SACCHAROMYCOTINA*	
CLASS - HEMIASCOMYCETES/SACCHAROMYCETES	
ORDER - SACCHAROMYCETALES	
SUBPHYLUM - ARCHIASCOMYCOTINA/TAPHRENOMYCOTINA**	
CLASS – ARCHIASCOMYCETES/SCHIZOSCCHAROMYCETES	
ORDER – SCHIZOSACCHAROMYCETALES	
CLASS - PNEUMOCYSTIDIOMYCETES	
ORDER – PNEUMOCYSTIDALES	
CLASS - TAPHRINOMYCETES	
ORDER - TAPHRINALES	
SUBPHYLUM - EUASCOMYCOTINA/PEZIZOMYCOTINA***	**= ascocarp type********
CLASS - PLECTOMYCETES/EUROTIOMYCETES	**cleistothecium**
CLASS - PYRENOMYCETES/SORDARIOMYCETES	**perithecium**
CLASS - DISCOMYCETES/PEZIZOMYCETES	**apothecium**
CLASS - LOCULASCOMYCETES/DOTHIDIOMYCETES****	
& CHAETOTHYRIOMYCETES*****	**loculoascostroma**
CLASS - LICHENOMYCETES	

***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**
********Loculoacomycetes II**

Basidiomycota Classification

Phylum - Basidiomycota
Subphylum - Heterobasidiomycotina*, **
Class - Urediniomycetes/Teliomycetes (rusts)
Order - Uredinales
Class - Ustomycetes/Ustilaginomycetes (smuts)
Order – Ustilanginales
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 "cruciately 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 - Exobasidials
Order - Aphyllophorales
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*

3. regularly septate (having septa at 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 & Chytridiomycota	**tend to be aseptate except to delimit reproductive cells (e.g. sporangia, gametangia)**
	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 & Basidiomy-cota yeasts	**tend to form complete septa or micropore septa between mother and daughter cells**
Ascomycota -	**tend to form hyphal septa at regular intervals**
	septa are "simple septa" with a central septal pore & Woronin Bodies
Basidiomycota-	**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 extention**