Biology of Fungi

The Diversity of Fungi and Fungus-Like Organisms

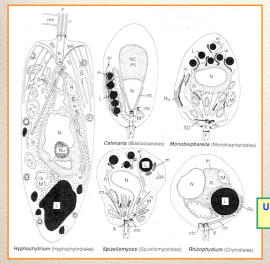
The Kingdom Fungi

- Kingdom Fungi (Mycota)
  - Phylum: Chytridiomycota
  - Phylum: Zygomycota
  - Phylum: Glomeromycota
  - Phylum: Ascomycota
  - Phylum: Basidiomycota
  - Form-Phylum: Deuteromycota (Fungi Imperfecti)

The Chytridiomycota

- 'Chytrids' are considered the earliest branch of the true fungi (Eumycota)
- Cell walls contain chitin and glucan
- Only true fungi that produce motile, flagellated zoospores
  - Usually single, posterior whiplash type
  - Some rumen species have multiple flagella

The Chytridiomycota (cont.)



Ultrastructure of chytrid zoospores. Source: Kendrick, 2003

- Zoospore ultrastructure is taxonomically important within this phylum

The Chytridiomycota (cont.)

- Commonly found in soils or aquatic environments, chytrids have a significant role in degrading organics
- Exhibit many of the same thallus structure types and arrangements as hyphochytrids (e.g., eucarpic; rhizoidal; endobiotic; etc.)

The Chytridiomycota (cont.)

- A few are obligate intracellular parasites of plants, algae, and small animals (e.g., frogs)

Unstained specimen showing a number of oval-shaped chytrids (arrow) infecting the skin of a frog. Source: www.jcu.edu.au/school/phtm/PHTM/frogs/anzcarrt.htm

The Chytridiomycota (cont.)

- Very few economically important species (*Synchytrium endobioticum* causes potato wart disease)
- More important (and fascinating) as biological models (e.g, *Allomyces*)

Gametophyte stage of *Allomyces*. Source: www.bsu.edu/classes/ruch/msa/blackwell.html

The Chytridiomycota (cont.)

- Isolation of chytrids is not easy
  - Requires 'baiting' techniques
  - Appears to be species-substrate specificity/ preference presumably due to specific receptor molecules on the zoospore surface membrane

The Chytridiomycota (cont.)

- Five orders within the chytrids, based largely on zoospore ultrastructure
  - Chytridiales and Spizellomycetales
    - Similar to one another
      - Spizellomycetales live in soil
      - Chytridiales live in aquatic environments
    - These Orders do not produce hyphae
    - Unique to the chytrids, Spizellomycetales zoospores exhibit amoeboid movement

The Chytridiomycota (cont.)

- Blastocladiales
  - Produces true hyphae and narrow rhizoids
  - Some species (e.g., *Allomyces*) exhibit alternation of generations (i.e., rotating from haploid and diploid phases)
    - Haploid thalli of *Allomyces* produce gametes in specialized gametangia
    - Diploid thalli of *Allomyces* produce flagellated zoospores and resting sporangia
    - *Allomyces* also exhibits anisiogamy - two different sizes of gametes (small, highly mobile ['male'] and larger, less mobile ['female'])

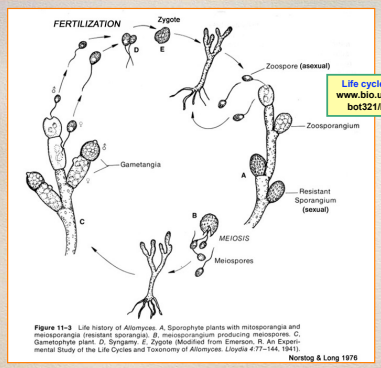


Figure 11–3 Life history of *Allomyces*. *A*, Sporophyte plants with mitosporangia and meiosporangia (resistant sporangia). *B*, meiosporangium producing meiospores. *C*, Gametophyte plant. *D*, Syngamy. *E*, Zygote (Modified from Emerson, R. An Experimental Study of the Life Cycles and Taxonomy of *Allomyces*. *Lloydia* 4:77–144, 1941).
Norstog & Long 1976

Life cycle of *Allomyces*. Source: www.bio.utexas.edu/faculty/laclaire/bot321/handouts/AllomyLH.jpg

The Chytridiomycota (cont.)

Gametophyte stage of *Allomyces* (right) and the sporophyte stage (left). Source: www2.una.edu/pdavis/kingdom_fungi.htm

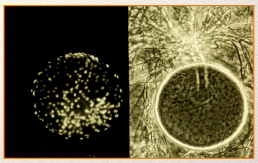
The Chytridiomycota (cont.)

- Monoblepharidales
  - Unique among the true fungi for its means of sexual reproduction via oogamy
  - Not of economic importance

Thallus of a *Monoblepharella* sp. with antheridia and oogonia (the globose bodies (arrow) are probably mature oospores). Source: www.bsu.edu/classes/ruch/msa/barr.html

The Chytridiomycota (cont.)

- Neocallimastigales
  - Obligate anaerobes
  - No mitochondria, but instead produce energy via a hydrogenosome
  - Often found in animal rumens; highly cellulytic
  - Multiflagellated zoospores

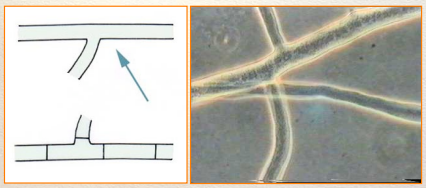


DAPI-stained nuclei (left) from the mature thallus with spherical zoosporangium of the rumen fungus, *Neocallimastix*. Source: www.bsu.edu/classes/ruch/msa/wubah.html

The Zygomycota

- Five features of Phylum Zygomycota
  - Cell walls contain chitin, chitosan, and polyglucuronic acid
  - Some members typically bear multinucleate, coenocytic hyphae, i.e., without cross walls (septa; sing., septum)
    - When present, septa are simple partitions
    - Some Orders have regular septations that are flared having a centrally plugged pore

The Zygomycota



Diagrammatic comparison of a coenocytic hypha (arrow) with a septated form [left figure] and a photomicroscopic image of coenocytic hyphae from a zygomycetous fungus [right figure].

Sources: www.apsnet.org/education/IllustratedGlossary/PhotosA-D/coenocytic.htm and www-micro.msb.le.ac.uk/MBChB/6a.htm

The Zygomycota (cont.)

- Produce zygospores (meiospore) via sexual reproduction (gametangial fusion)
- Asexual spores (mitospores), termed sporangiospores, form through cytoplasmic cleavage within a sac-like structure termed a sporangium
- Haploid genome

The Zygomycota (cont.)

- Importance of the zygomycetous fungi
  - Organic degraders/recyclers
  - Useful in foodstuffs/fermentations
  - Pathogens of insects/other animals

The Zygomycota (cont.)

- Generalized life cycle
  - Asexual stage (anamorphic; imperfect)
    - Hyphae develop erect branches termed sporangiophores

Development of erect sporangiophores. Source: Kendrick, 2003

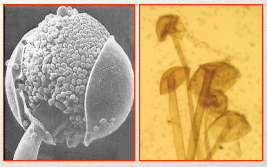
The Zygomycota (cont.)

- Asexual stage (cont.)
  - A thin-walled sac (sporangium) is walled off at the tip and fills with cytoplasm containing multiple nuclei (with columella underneath sac)

Mature sporangia (left image) and a visible columella (right image). Source: Kendrick, 2003

The Zygomycota (cont.)

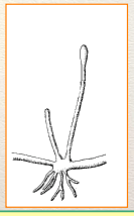
- Asexual stage (cont.)
  - Cytoplasmic cleavage and separation of nuclei into walled units produces sporangiospores
  - Thin sporangial wall (peridium) breaks releasing sporangiospores



Ruptured peridium and underlying sporangiospores (left image) and remaining columella following complete spore dispersal (right image). Source: Kendrick, 2003

The Zygomycota (cont.)

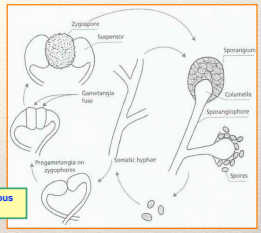
- Asexual stage (cont.)
  - Cytoplasmic cleavage and separation of nuclei into walled units produces sporangiospores
  - Thin sporangial wall (peridium) breaks releasing sporangiospores



Diagrammatic representation of sporangiospore development and release. Source: www.unex.es/botanica/LHB/anima/mucor2.htm

The Zygomycota (cont.)

- Asexual stage (cont.)
  - Sporangiospores germinate to repeat the asexual life cycle



Generalized life cycle of a zygomycetous fungus. Source: Deacon, 2006

The Zygomycota (cont.)

- The zygospore represents the teleomorphic phase (sexual; perfect form) of this phylum

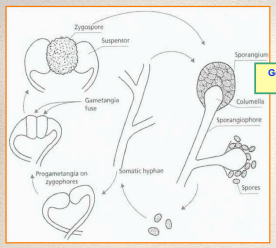
Mating of *Phycomyces* in culture (left image) forming a line of darkly-pigmented zygospores at the point of contact. The zygospores are highly ornate (left image). Source: Kendrick, 2003

The Zygomycota (cont.)

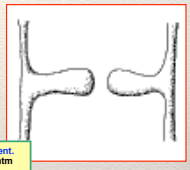
- The zygospore represents the teleomorphic phase (sexual; perfect form) of this phylum
  - Results from the fusion of gametangia of heterothallic (two different mating types; designated "+" and "-") or homothallic (self fertile) strains
  - Acts as a thick-walled resting spore

The Zygomycota (cont.)

- Mating process
  - Hyphae make physical contact and exchange chemical signals to establish that each is of a different mating type
  - Hyphal tips (isogamous zygophores - not distinguished from one another) grow, loop back towards one another, swell (becoming progametangia at this point) then fuse (anastomose)
  - Nuclei mix/fused and immediate region walled off from rest of hyphae (gametangium or zygosporangium)



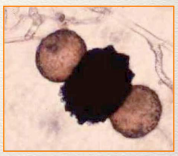
Generalized life cycle of a zygomycetous fungus. Source: Deacon, 2006



Diagrammatic representation of zygospore development. Source: www.unex.es/botanica/LHB/anima/mucor3.htm

The Zygomycota (cont.)

- Zygosporangium becomes thick walled to form the zygospore
- Hyphae to the sides become empty appendages (suspensor cells)
- Zygospore often forms ornate appendages
- Zygospore is constitutively dormant for a time, but then germinates to produce a sporangium containing haploid sporangiospores



Zygospore and suspensor cells of *Rhizopus*. Source: Deacon, 2006

The Zygomycota (cont.)

- Phylum Zygomycota - two Classes
  - Class Zygomycetes - six orders
    - Order Mucorales
      - Typical globose mitosporangium containing hundreds of non-motile asexual spores
      - Contains saprobes and the common 'black bread molds' - *Mucor*, *Rhizopus*, *Absidia*
      - Contains the corpophilous (dung-fungus) *Pilobolus*, which can 'shoot' its single spored sporangium almost 6 feet in the direction of light

The Zygomycota (cont.)

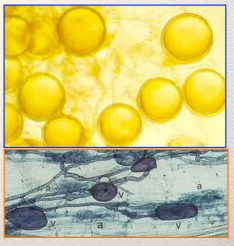
- Class Zygomycetes (cont.)
  - Order Entomophthorales - insect pathogens
  - Order Kickxellales - atypical zygomycete having regularly septate hyphae
  - Order Zoopagales - mycoparasites
- Class Trichomycetes - four Orders
  - Live nearly exclusively in the guts of arthropods
  - Does not produce sporangiospores, but instead trichospores
  - Unusual zygospore structure

The Glomeromycota

- These fungi were originally placed within the Phlyum Zygomycota
  - ***Do not*** produce zygospores
  - Live as obligate, mutualisitic symbionts in >90% of all higher plants - known at arbusular mycorrhizas (AM; endomycorrrhiza)
- Will not grow axenically

The Glomeromycota (cont.)

- Produce large, thick-walled spores in soils that germinate in the presence of a plant root



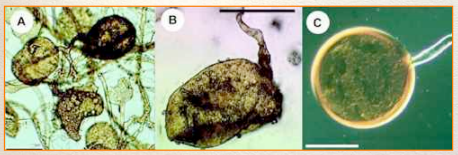
Spores of the endomycorrhizal fungus *Glomus* (top image) and an intracellular endomycorrhizal fungus that has developed vesicles (V) and arbuscules (A) (bottom image). Sources: Kendrick, 2003 and Deacon, 2006

The Glomeromycota (cont.)

Develop non-septate hyphae that invade the root, then form a branch, tree-like arbuscules within the root

- Help plants thrive in nutrient poor soils, especially phosphorous

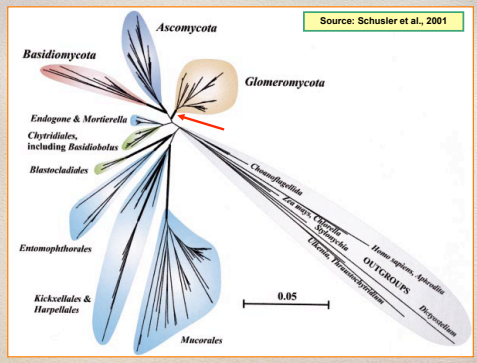
The Glomeromycota (cont.)



Fossil hyphae and spores (A and B) compared with a spore (C) of a present-day *Glomus* species (an arbuscular mycorrhizal fungus). Sources: Deacon, 2006

The Glomeromycota (cont.)

- Phylogenetics of the Glomeromycota
  - Based upon rRNA sequences, this phylum is monophyletic



The Glomeromycota (cont.)

- Phlyogenetics of the Glomeromycota
  - Based upon rRNA sequences, this phlyum is monophyletic
  - Morphologically distinct from other fungi
  - Probably had same ancestor as the phyla Ascomycota and Basidiomycota

The Ascomycota

- This phylum contains 75% of all fungi described to date
- Most diverse phylum being significant:
  - Decomposers
  - Agricultural pests (e.g., Dutch elm disease, powdery mildews of crops)
  - Pathogens of humans and animals

The Ascomycota (cont.)

- Asexual spores (mitospores)
  - Variety of types
  - Usually not used for taxonomic purposes
  - Generally referred to as conidia
  - Tend to be haploid and dormant

Mitospores (conidia) of *Penicillium*. Source: Kendrick, 2003

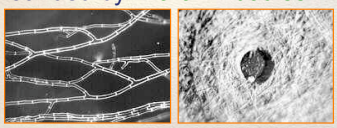
The Ascomycota (cont.)

- Key feature is the ascus (pl., asci) - sexual reproductive cell containing meiotic products termed ascospores

Asci and ascospores of *Tuber* (left image) and *Sordaria* (right image). Note the thin sac layers (blue arrows) and the ring-like structure (red arrow) in the inoperculate ascus. Source: Kendrick, 2003

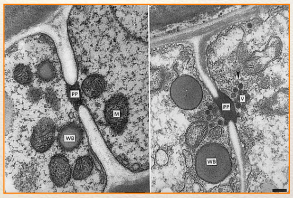
The Ascomycota (cont.)

- Another significant structural feature - a simple septum with a central pore surrounded by Woronin bodies



Septate hyphae (left image) and the central pore of a simple septum (right image). Source: Kendrick, 2003

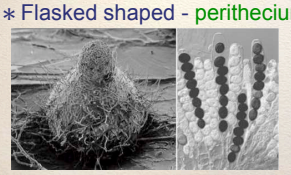
The Ascomycota (cont.)



These two images show Woronin bodies (WB) and vesicles (V) adjacent to the central pore of a simple septum. Source: www.deemy.de/Descriptors/CharacterDefinition.cfm?CID=366

The Ascomycota (cont.)

- The fruiting body of these fungi, termed an ascocarp, takes on diverse forms
  - Flasked shaped - perithecium



Perithecium (left image) and asci with ascospores (right image) of *Sordaria*. Source: Deacon, 2006

The Ascomycota (cont.)

- Cup-shaped - apothecium

Diagram of an apothecium showing asci/ascospores (left image) and ascomata (apothecia) of *Ascobolus* (right image). Source: Kendrick, 2003

The Ascomycota (cont.)

- Closed structure - cleistothecium

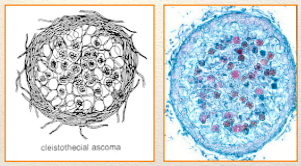


Diagram (left image) and a photomicrograph (right image) of a cleistothecium showing asci/ascospores. Source: Kendrick, 2003

The Ascomycota (cont.)

- Embedded structure - pseudothecium
- Some ascospores are borne singly or not enclosed in a fruiting structure

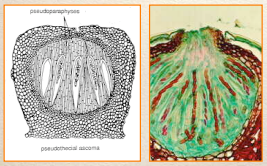


Diagram (left image) and a photomicrograph (right image) of a pseudothecium showing asci/ascospores. Source: Kendrick, 2003

The Ascomycota (cont.)

- Asci also vary in structure:
  - Unitunicate-operculate - single wall with lid/opening (operculum); found only in apothecial ascomata (fruiting body tissue)

Unitunicate (single wall) and operculate (lid) asci. Source: Kendrick, 2003

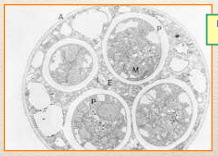
The Ascomycota (cont.)

- Unituicate-inoperculate - operculum replaced with an elastic ring; found in perithecial and some apothecial

Electron micrograph of an unitunicate (single wall) and inoperculate ascus depicting the apical elastic ring (arrow). Source: Kendrick, 2003

The Ascomycota (cont.)

- Protunicate - no active spore shooting mechanism; ascus dissolves to release spores; characteristically produced by fungi that form cleistothecia



Electron micrograph of a protunicate ascus. Source: Kendrick, 2003

The Ascomycota (cont.)

- Bitunicate - double-walled ascus in which outer wall breaks down, inner wall swells through water uptake, then expels spores

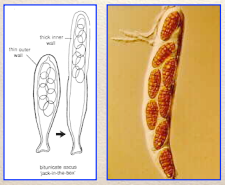


Diagram (left image) and a photomicrograph (right image) of a bitunicate ascus with ascospores. Source: Kendrick, 2003

The Ascomycota (cont.)

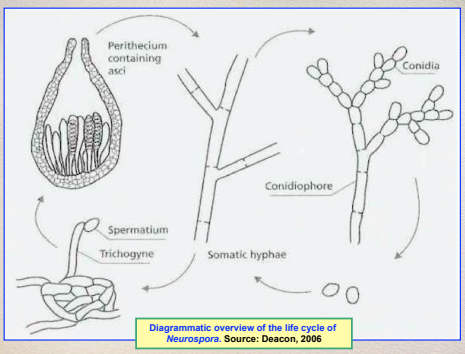
- Ascomycetes differ from zygomycetes in both their basic anamorphic and teleomorphic characteristics:
  - Anamorph - mitospores (conidia) of ascomyetes are typically derived from modified bits of hyphae, whereas zygospores result from the cleavage of a multinucleated cytoplasm within a sporangium

The Ascomycota (cont.)

- Teleomorph - in zygomycetes, the anamorph and teleomorph often occur together and share the same nomenclature; in ascomycetes, anamorphs can be completely separated from the teleopmorph and are often given different binomials
- For the Ascomycota, anamorph + teleomorph = holomorph

The Ascomycota (cont.)

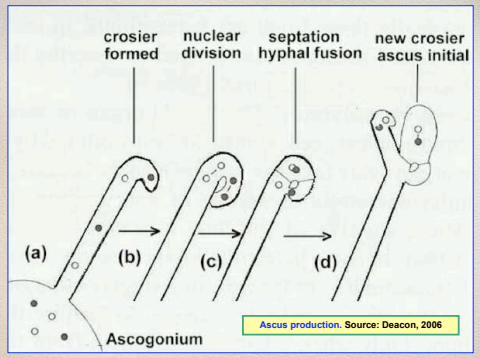
- Life cycle of most ascomycetes typified by *Neurospora*
  - Conidia/ascospores give rise to hyphae
  - Hyphae may continue to grow and produce conidia
  - Sexual reproduction begins with the differentiation of female hyphae into a trichogyne



Diagrammatic overview of the life cycle of *Neurospora*. Source: Deacon, 2006

The Ascomycota (cont.)

- Trichogyne is fertilized by a conidium or by an antheridium (male reproductive structure)
- Plasmogamy occurs without karyogamy, i.e., cytoplasmic fusion without nuclear fusion, producing heterokaryotic hyphae (presence of two different nuclei in the same cytoplasm)
- The heterokaryotic hyphae undergo crozier formation



Ascus production. Source: Deacon, 2006

The Ascomycota (cont.)

- Nuclear division continues followed by septation of the crozier to produce an ascus initial cell that contains one nucleus of each mating type, i.e., a dikaryotic state

The Ascomycota (cont.)

- Karyogamy occurs to form a diploid nucleus that then undergoes meiosis
- Haploid nuclei are then walled off to form ascospores - typically there are 4-8 meiotic products

Ascus production. Source: Kendrick, 2003

The Basidiomycota

The mushroom *Russula emetica*. Source: Kendrick, 2003

- Very important for their ecological and agricultural impact
- Majority are terrestrial, although some can be found in marine or freshwater environments

The Basidiomycota (cont.)

- Oldest confirmed basidiomycete fossil is about 290 millions years old
- Some are molds, some are yeasts, and some are dimorphic

Mushroom cap in amber. Source: www.uky.edu/AS/Geology/webdogs/amber/plants/mushroom-b.jpg

The Basidiomycota (cont.)

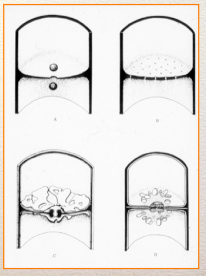
- Features similar to those of the Ascomycota
  - Haploid somatic hyphae
  - Septate hyphae
  - Potential for hyphal anastomosis
  - Production of complex fruiting structures
  - Presence of a dikaryotic life cycle phase
  - Production of a conidial anamorph

The Basidiomycota (cont.)

- Key differences
  - Cell wall
    - Ascomycetes - two layered
    - Basidiomycetes - multilayered
  - Septa
    - Ascomycetes
      - Hyphal forms - simple with central pore surrounded by Woronin bodies
      - Yeast forms - simple with micropores

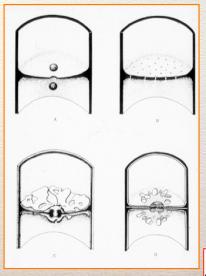
The Basidiomycota (cont.)

- Septa
  - Ascomycetes
    - Hyphal forms - simple with central pore surrounded by Woronin bodies
    - Yeast forms - simple with micropores

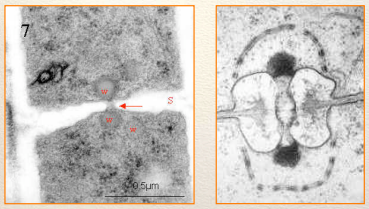


The Basidiomycota (cont.)

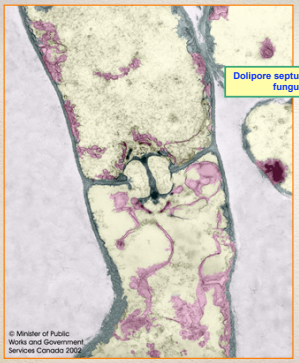
- Basidiomycetes
  - Dolipore type septum surrounded by a parenthosome
  - Central pore blocked by a pulleywheel occlusion
  - Dolipore-like, but parenthosome is absent



The Basidiomycota (cont.)



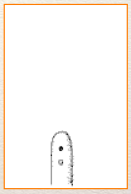
Ascomyceteous septum (left image) showing Woronin bodies (W) and a basidiomycetous dolipore-type septum (right image) depicting the parenthosome.
Sources: forages.oregonstate.edu/is/tfis/enmain.cfm?PageID=69 and Kendrick, 2003



Dolipore septum in the hypha of the basidiomycetous fungus *Coprinus psychromorbidus*.

The Basidiomycota (cont.)

- Dikaryophase
  - Ascomycetes
    - Restricted to ascogenous tissue
    - Nuclear fusion and subsequent meiosis involve the formation of a crozier



Diagrammatic representation of ascosporogenesis. Source: www.unex.es/botanica/LHB/an/asca2.gif

The Basidiomycota (cont.)

- Basidiomycetes
  - Heterokaryotic nuclei (2 per cell)
  - Not restricted to a tissue phase and may continue indefinitely
  - Perpetuated by the formation of a clamp connection at each septum of a dikaryotic hypha

The Basidiomycota (cont.)

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  - Heterokaryotic nuclei (2 per cell)
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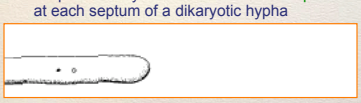
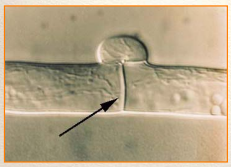


Diagrammatic representation of clamp cell formation in a basidiomyceteous fungus. Source: www.unex.es/botanica/LHB/an/fibula0.gif

The Basidiomycota (cont.)



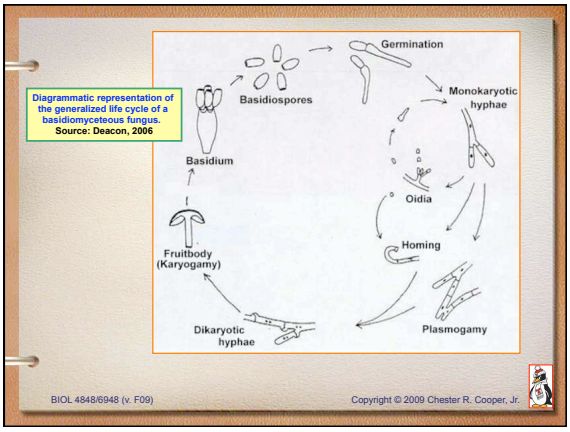
Clamp connection (left image) and the its dolipore-type septum (right image). Sources: www.apsnet.org/education/IllustratedGlossary/PhotosS-V/septum.jpg and Kendrick, 2003

The Basidiomycota (cont.)

- Meiospore production - meiosis occurs within a specialized cell termed a basidium (pl., basidia), but the spores are borne ***exogenously*** on tapering outgrowths termed sterigmata (sing., sterigma)

The Basidiomycota (cont.)

- Very complex life cycles that vary among the different classes/species
- Generalized life cycle:
  - Haploid basidiospores germinate to form hyphae with a single nucleus per cell (monokaryotic phase)
  - Monokaryons can produce oidia (= conidia)



Diagrammatic representation of the generalized life cycle of a basidiomyceteous fungus. Source: Deacon, 2006

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The Basidiomycota (cont.)

- Monokaryons of different mating types fuse *or* an odium attracts monokaryon of compatible mating type, then fuses
- Fusion (plasmogamy) results in dikaryotic hyphae (two nuclei per cell; heterokaryotic)
- Fruiting body forms containing dikaryotic basidia
- Nuclear (karyogamy) fusion occurs followed by meiosis

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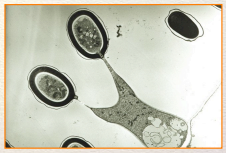
The Basidiomycota (cont.)

- Sterigmata form on the surface of the basidium
- Haploid nuclei migrate into the sterigmata as the basidiospore develops



Transmission electron micrograph of a basidium with the accompanying sterigma and basidiospores. Source: www.bsu.edu/classes/ruch/msa/mims/1-39.jpg

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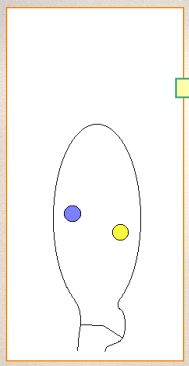

Basidiosporogenesis. Source: Kendrick, 2003

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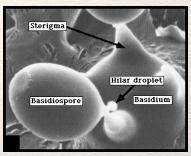
The Basidiomycota (cont.)

- Mature basidiospore in many fungi released through a ballistic-like method involving a hylar (or hilar) drop (see Chapter 1 in Money's book for historical and descriptive details about this mechanism)



Scanning electron micrograph of a basidium with the accompanying sterigma, basidiospore, and hilar droplet. Source: from McLaughlin et al. (1985) as depicted at tolweb.org/tree?group=Basidiomycota

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The Basidiomycota (cont.)

- Mature basidiospore in many fungi released through a ballistic-like method involving a hylar (or hilar) drop (see Chapter 1 in Money's book for historical and descriptive details about this mechanism)

Diagrammatic representation of basidiospore release involving a hilar drop. Source: www.unex.es/botanica/LHB/an/basid0.gif

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The Basidiomycota (cont.)

- Phylogenetics
  - rDNA analysis has separated the Phylum Basidiomycota into three separate sub-groups (clades)
    - Hymenomycetes - typical mushroom, toadstools, and "jelly fungi"
    - Urediniomycetes - "rusts"
    - Ustilaginomycetes - "smuts"
  - Phylogenetic relationships between and within the sub-groups remains unclear

The Basidiomycota (cont.)

- Taxonomy
  - Urediniomycetes
    - Agriculturally significant "rusts"
    - Example *Puccinia graminis* - causes black stem of wheat
  - Ustilaginomycetes
    - Agriculturally significant "smuts"
    - Example *Ustilago maydis* - corn smut fungus

The Basidiomycota (cont.)

- Selected differences between 'rusts' and 'smuts' (adapted from Table 5.1 in Kendrick):

Urediniomycetes	Ustilaginomycetes
Terminal teliospores	Intercalary teliospores
No clamp connections	Clamp connections present
Requires 2 hosts	Does not require 2 hosts
Infections are localized	Infections are systemic
Obligate biotroph	Facultative biotroph

The Basidiomycota (cont.)

- Hymenomycetes - four clades
  - Homobasidiomycetes - mushrooms, toadstools, bracket fungi, puffballs, earthstars
  - Jelly fungi
    - Tremellomycetidae
    - Dacrymycetales
    - Auriculariales

The Mitosporic Fungi

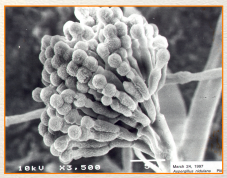
- Many ascomycetous fungi produce asexual (mitotic) spores (anamorphic phase), but their teleomorph phase (sexual reproduction) is absent
- Taxonomically, such fungi are placed in an artificial category variously termed Deuteromycota (or Deuteromycotina) or Fungi Imperfecti

The Mitosporic Fungi (cont.)

- Due to the absence of a teleomorph, these fungi are often given a provisional name termed a "form" genus/species
- If the teleomorph is discovered, the fungus renamed

The Mitosporic Fungi (cont.)

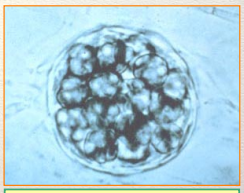
- Example of teleomorph/anamorph dichotomy of names:
  - Anamorph - *Aspergillus nidulans* - forms mitosporically-derived conidia, therefore classified within the form-phylum Deuteromycota



Scanning electron micrograph of conidia and phialides of *Aspergillus nidulans*. Source: www.gettysburg.edu/~rcavalie/em/sem_pics.html

The Mitosporic Fungi (cont.)

- Teleomorph - *Emerciella nidulans* - forms a cleistothecium containing ascospores, therefore classified within the Phylum Ascomycota

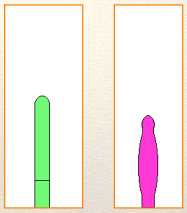


Cleistothecium of *Aspergillus*. Source: www.angelfire.com/wizard/kimbrough/Textbook/CommonGroupsZygoAsco_blue.htm

The Mitosporic Fungi (cont.)

- Conidia are produced in a variety of ways, but never by cytoplasmic cleavage as in the Zygomycota
- Two main types of conidium development are the basis for the production for all types of conidia
  - Thallic - fragmentation process
  - Blastic - swelling process

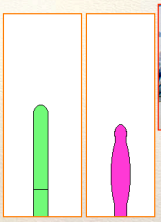
Thallic vs. Blastic

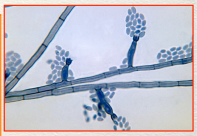


Thallic vs. blastic conidiogenesis. Source: Kendrick, 2003

Thallic vs. Blastic

Geotrichum candidum. Source: www.doctorfungus.com





Phialophora verrucosa. Source: pathmicro.med.sc.edu/mycology/mycology-5.htm

Thallic vs. blastic conidiogenesis. Source: Kendrick, 2003

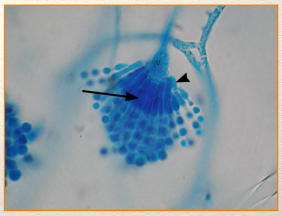
The Mitosporic Fungi (cont.)

- Most conidia are blastic in origin and are borne in various ways:
  - Budding

ASM Digital Image Collection. Meaden

The Mitosporic Fungi (cont.)

* Extrusion of flask shaped cells termed phialides



Conidiophore of *Aspergillus* of phialide (long arrow) and metulae (arrow head). Source: abmed.ucsf.edu/Education/fung_morph/fungal_site/subpages/aspergillusvesiclemetulasp.html

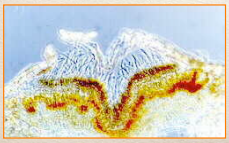
The Mitosporic Fungi (cont.)

* Aggregation of condiophores in stalks termed synnema or coremium

Fungal synnema Source: bios.sakura.ne.jp/gf/2003/synnema.html

The Mitosporic Fungi (cont.)

* On a pad-like surface (acervulus)
* Within a flask-shaped structure (pycnidium)



Fungal acervulus (left) and pycnidium (above) Source: Kendrick, 2003

The Mitosporic Fungi (cont.)

- Taxonomic divisions of the Fungi Imperfecti - truly an artificial classification scheme based solely on conidial structures
  * Hyphomycetes - conidia borne on conidiophores
  * Coelomycetes - conidia borne on an acervulus or within a pycnidium
  * Agonomycetes - "Mycelia Sterilia" - no conidia; sometimes sclerotia