

Kingdom Fungi

Reading: Chap. 31



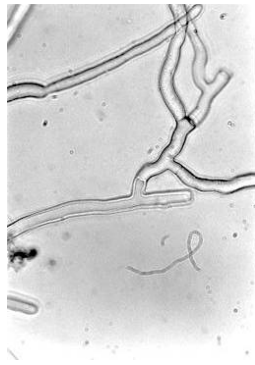
- I. Characteristics of fungi
 - A. Morphology – what do they look like?
 - B. Lifestyle – how do they live?
 - C. Basic life cycle – how do they reproduce?
 - D. Ecology - who cares about fungi?
- II. Evolution of Fungi
 - A. Phylogeny
 - B-E. Overview of phyla
- III. Fungal mutualisms
 - A. Lichens
 - B. Mycorrhizae

I. The Characteristics of Fungi

- Fungi are NOT plants
- Hyphae = tubular units of construction
- Heterotrophic by absorption
- Reproduce by spores
- Ecologically pivotal roles

A. Morphology 1. Hyphae & Mycelia

- Tubular
- Cell wall of chitin
- Multinucleate
- Grow at tips



Hyphal septa

Hyphae are broken into compartments by septa.

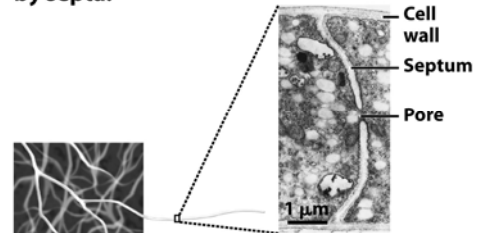
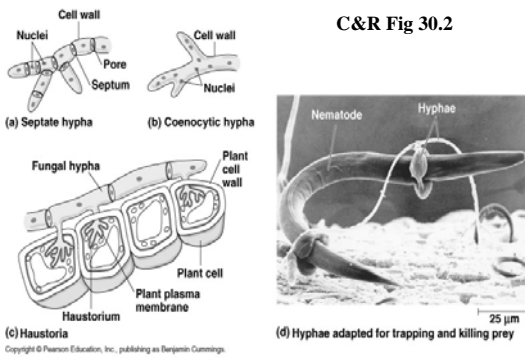
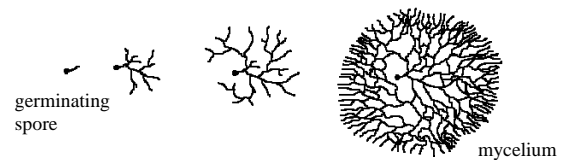


Figure 30.4b. Biological Science, 2/e
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Modifications of hyphae



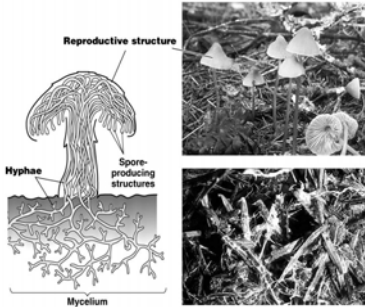
Hyphal growth from spore



- Hyphae grow from their tips
- Mycelium = extensive, feeding web of hyphae
- Mycelia are the ecologically active bodies of fungi
- Mycelia have a huge surface area
- “The humongous fungus”



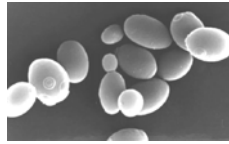
"Fruiting bodies" are also composed of hyphae



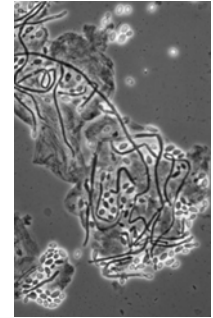
C&R, Fig. 31.1

2. Yeasts

- Single celled fungi
- Adapted to liquids
 - * Plant saps
 - * Water films
 - * Moist animal tissues



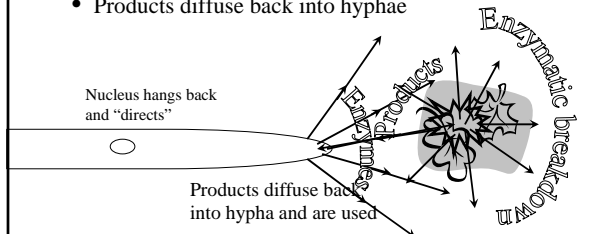
Saccharomyces cerevisiae



Candida albicans

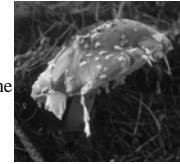
B. Fungal Lifestyle: Heterotrophic by Absorption

- Fungi get carbon from organic sources
- Hyphal tips release enzymes
- Enzymatic breakdown of substrate
- Products diffuse back into hyphae



The Absorptive Lifestyle

- Saprobies
 - * Decomposers
 - * Mostly of plants, some animals
- Parasites
 - * Harm host
 - * Mostly on plants, some animals
- Mutualists
 - * Lichens
 - * Mycorrhizas
 - * Endophytes (see book)



Decomposer



Parasite/pathogen



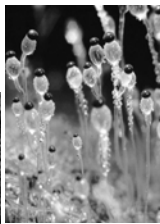
Mutualist

C. Basic fungal life cycle

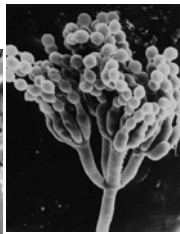
- Spores are reproductive cells
 - * Sexual
 - * Asexual
- Formed:
 - * Directly on hyphae
 - * Inside sporangia
 - * Fruiting bodies



Amanita fruiting body

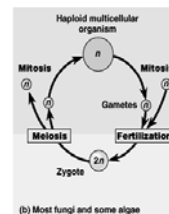


Pilobolus sporangia



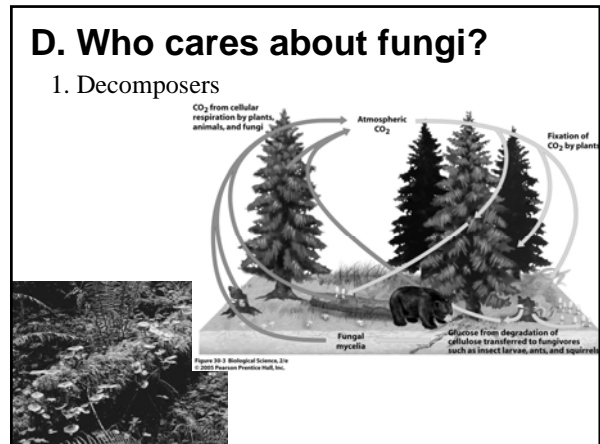
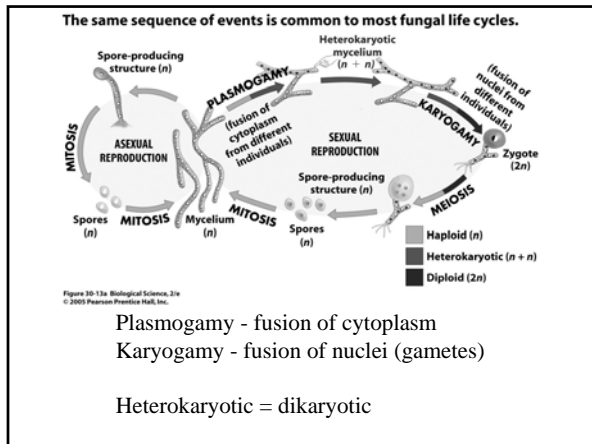
Penicillium conidia

C. Basic fungal life cycle



1. Zygotic - haploid phase is dominant

C&R, fig. 13.5b

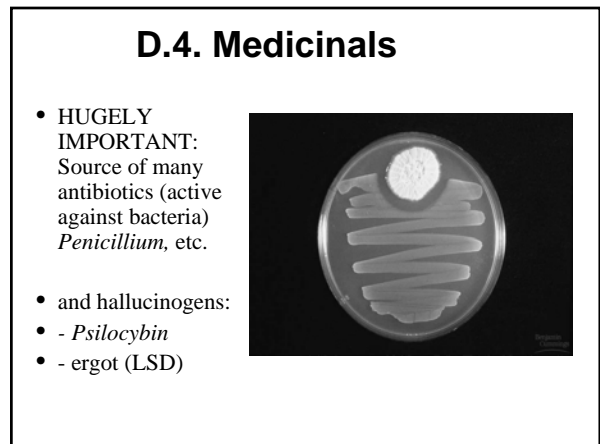
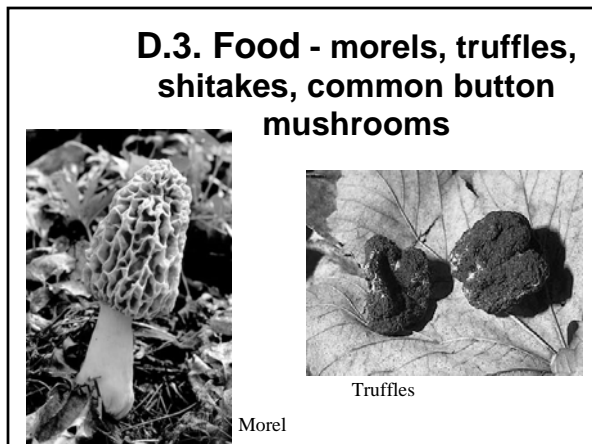
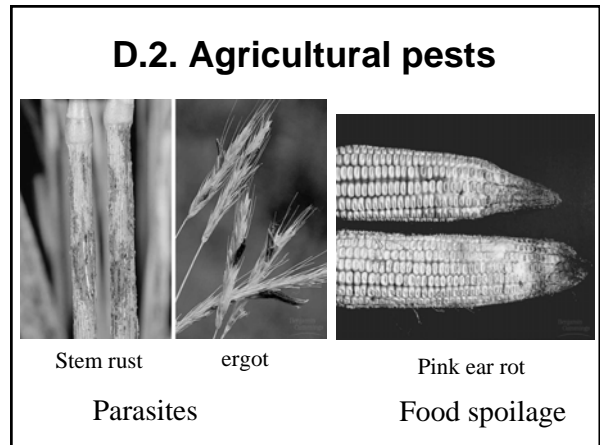


Also eat:

- wood in houses, boats, fences;
- food;
- other materials - cloth, paint, leather, waxes, jet fuel, petroleum, paper, wire insulation, photographic film, to name a few.

What do all of these materials have in common?

They are all C-based.



D.5. Yeast for brewing and baking: *Saccharomyces cerevisiae*



II. Fungal Evolution

A. Overview

1. Common eukaryotic ancestor with animals

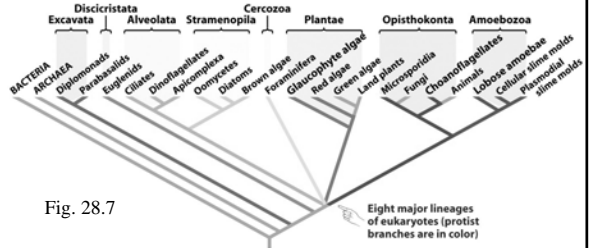


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2. Four phyla of fungi?

According to traditional thinking, there are four phyla of fungi.

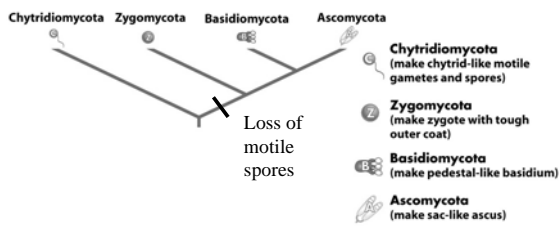


Figure 30-8a Biological Science, 2/e
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DNA sequence data have revealed that Glomeromycota, Basidiomycota, and Ascomycota are monophyletic.

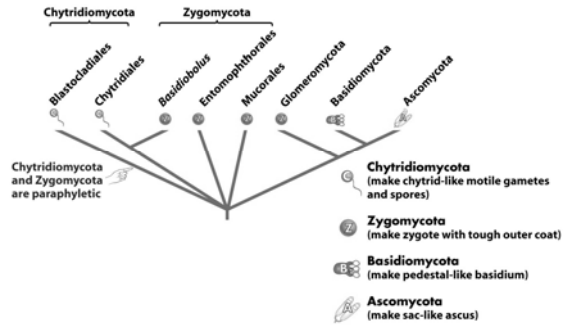


Figure 30-8b Biological Science, 2/e
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B. Chytridiomycota – “chytrids”

- Simple fungi
- Produce motile spores and gametes
- Mostly saprobes and parasites in aquatic habitats

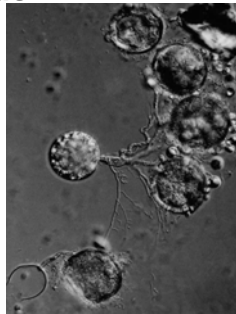


Fig 31.5 *Chytridium* growing on spores

Chytrids are a primary factor resulting in amphibian declines.

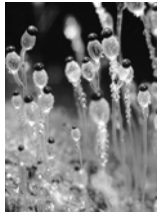


Figure 30-30 Biological Science, 2/e
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C. Zygomycota

1. Examples:

- *Rhizopus* (C&R, fig. 31.6)



Pilobolus, with asexual sporangia
C&R, 31.8

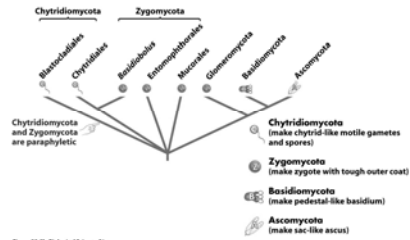
Pilobolus Dance Group



<http://www.youtube.com/watch?v=TrKJAoimB1Y>
<http://www.youtube.com/watch?v=9CRNnde0WUc&NR=1>

C. Zygomycota

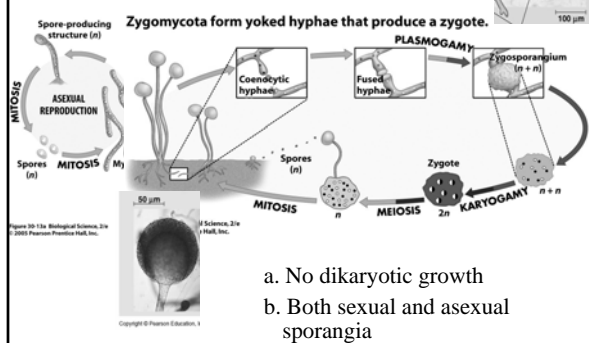
DNA sequence data have revealed that Glomeromycota, Basidiomycota, and Ascomycota are monophyletic.



No longer considered one phylum - polyphyletic
Formerly, many endomycorrhizae, too (e.g., *Glomus*)
Now in their own group (*Glomeromycota*)

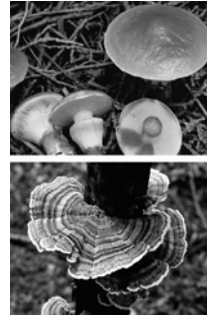
C. Zygomycota

2. Life cycle

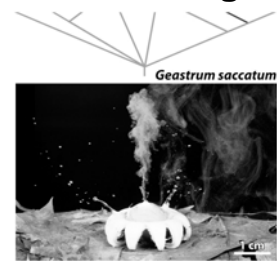


D. Basidiomycota - "club fungi"

Mushrooms (e.g., *Hygrophorus*)



Shelf or bracket fungus



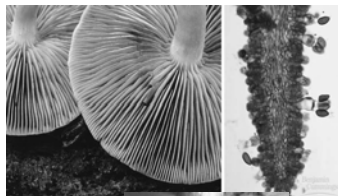
1. structure

a. Fruiting body: basidiocarp

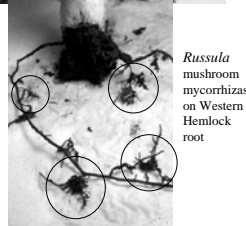
C&R, 31.11

1. structure

- b. Fertile layer on gills with basidia ("clubs")
- c. Four spores per basidium



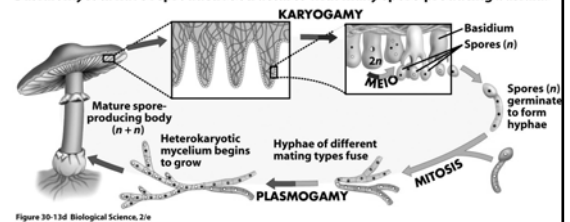
d. Many Basidiomycetes are ectomycorrhizal.



2. Life cycle

- a. Dikaryotic growth
- b. Fruiting body: basidiocarp
- c. Fertile layer on gills with basidia ("clubs")
- d. Four spores per basidium
- e. Asexual reproduction is rare

Basidiomycota have reproductive structures with many spore-producing basidia.



E. Ascomycota “sac fungi” or “cup fungi”



Scarlet cup

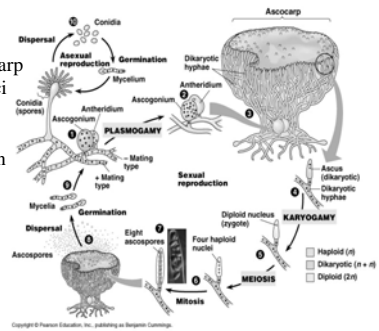
Morels

Truffles

Many “lichen fungi” too!

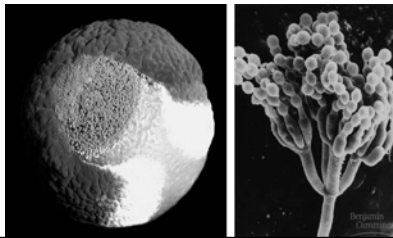
E. Ascomycota - Life cycle

1. Dikaryotic growth
2. Fruiting body: ascocarp
3. Fertile layer with asci
4. Eight ascospores per ascus (sac)
5. Asexual reproduction via conidia



F. Deuteromycetes - “fungi imperfecti”

- 1. Not a true phylum (not a natural group): polyphyletic
- 2. Fungi with no known sexual reproduction (“molds”)
- 3. Asexual reproduction by conidia



III. Fungal mutualisms

- Questions:
- 1. Definitions of mutualism vs. symbiosis, mutualism vs. parasitism vs. commensalism
- 2. What fungal and photosynthetic partners are involved?
- 3. What is the “currency” of the mutualism? How do the partners benefit?
- 4. What is the structure and/or morphology of the organismal interaction?
- 5. What is the ecological importance?

III. Fungal mutualisms

Definitions:

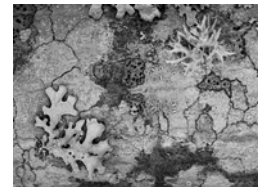
Symbiosis - 2 organisms living together in intimate physical contact

Mutualism - both organisms benefit from the relationship

Parasitism - one benefits, one loses

Commensalism - one benefits, other not affected

A. Lichens



1. Partners

a. Fungal partner

- gives protection
- mostly Ascomycetes (~25,000 spp.)
- only found in lichens (not free-living)
- provide protection, receive photosynthate (fixed C)

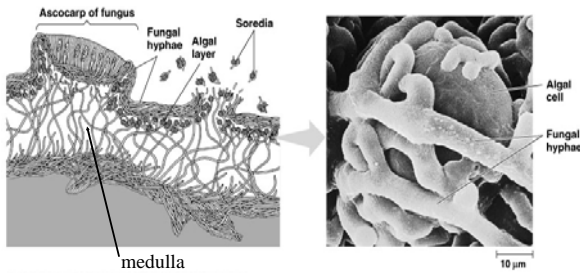
b. Photosynthetic partner

- gives fixed carbon (sugars)
- green alga or cyanobacterium
- can be free-living
- provide photosynthate (fixed C), receive protection

A. Lichens

2. Anatomy

- a. most of lichen body is fungal hyphae
- b. photosynthetic partner in a distinct layer
- c. sexual reproduction of fungal partner only
- d. asexual reproduction: soredia, fragmentation



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A. Lichens

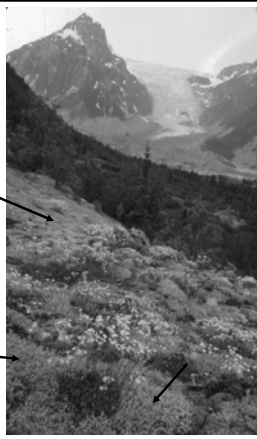
3. Morphology



A. Lichens

4. Importance

- a. rock weathering, soil formation in primary succession
 - acid secretion
 - trapping particulates
 - nitrogen fixation (cyanobacteria)



A. Lichens

4. Importance

- b. winter food for caribou and reindeer in Arctic



A. Lichens

4. Importance

- c. Indicators: susceptible to pollutants

B. Mycorrhizae

- “mycor” = fungus, “rhizae” = root

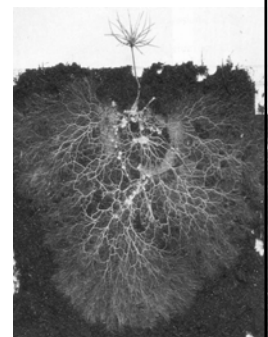
1. Partners

a. Fungus

- gets fixed carbon (sugars)
- Primarily Basidiomycetes and Glomeromycetes (which were formerly part of Zygomycetes)

b. Plant

- gets nutrients (mostly N and P) and water
- about 80% of all plant species are mycorrhizal!!



Raven et al. 1999

2. Structure: two types of fungal/plant contact

a. external (ectomycorrhizae)

- fungal sheath around root
- Basidiomycetes and about 5000 plant species (mostly woody)
- many Basidio's: fairly plant species specific

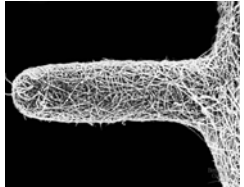
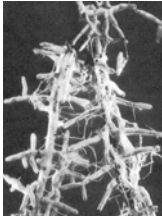


Fig. 31.18



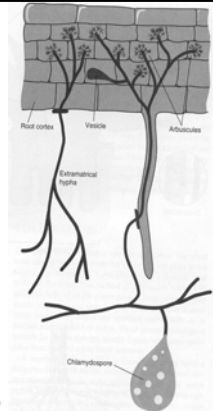
Raven et al. 1999



Smith 1999

b. internal (endomycorrhizae)
(a.k.a. arbuscular mycorrhizae)

- hyphae penetrate root cells
- Glomeromycetes (formerly Zygomycetes)
- 80% of all plants (many herbaceous)
- relatively few fungal species: not plant species specific

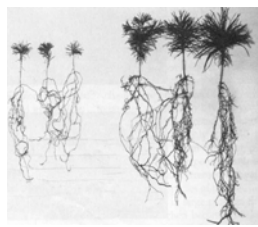


Smith 1999

Figure 27.4 Endomycorrhizae grow within the plant rootlet, and fungal hyphae enter the cells.

B. Mycorrhizae

3. Benefits - is it worth it?



No mycorrhizae With mycorrhizae



Fig. 31.19

The End