Diversity of Fungi

(Freeman Ch31)

24 February 2009
ECOL 182R UofA
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Thanks to Joanna Masel
Upcoming Syllabus (middle third)

24 Feb KB – Fungi Chapter 31
26 Feb KB – Prokaryotes, Protists, Photoautotrophy, Endosymbioses
   Chapters 28, 29

3 Mar KB – Plant Diversity Chapter 30
5 Mar KB – Plant Form and Function Chapters 36, 37

10 Mar KB – Plant Function Chapters 38, 40, and 39 (pp. 857-866,
   873-882, 887-888)
12 Mar WS – Population Growth and Regulation Chapter 52

17&19 Mar Spring Recess

24 Mar KB – Plant Community Ecology, Disturbance, Succession
   Chapters 30, 53
26 Mar KB – Galapagos Case Study Wikelski 2000 and
   www.darwinfoundation.org/en/galapagos/marine
   www.darwinfoundation.org/en/galapagos/land

31 Mar Part 2. Discussion and Review.
02 Apr EXAM 2
Kevin Bonine
182 Office Hours

10-noon Tuesdays
BSE 113

-also M 1-2 and W 11-noon-
-206 and 437 students have priority-
Tree of Life

Common ancestor of all organisms

BACTERIA

ARCHAEA

EUKARYA

Time

Ancient

Fungi

Bacteria

Archaea

Protists

Plantae

Animalia

Protists
Opisthokonts
(Fungi and Animals are closely related)

Absorptive nutrition, chitin in cell walls

Common ancestor

Flagellum, if present, is single and posterior

Common ancestor of all organisms

EUKARYA

BACTERIA
Bacteria

ARCHAEA
Archaea

Protists

Plantae

Fungi

Animalia

Protists

Opisthokonts

Fungi
Animals
Choanoflagellate protists
- Microsporidia
- Chytridiomycota and Zygomycota
- Glomeromycota
- Basidiomycota
- Ascomycota

- Make chytrid-like motile gametes and spores
- Make zygote with tough outer coat
- Make pedestal-like basidium
- Make sac-like ascus
Chitin
(tough but flexible nitrogen-containing polysaccharide)

- Production of **chitin** is a shared derived trait for
  - choanoflagellates

- Evidence that fungi are closer to  than
How fungi live

• All use absorptive nutrition, secreting digestive enzymes and absorbing the breakdown products

• Most are saprobes (on organic matter)
  - Earth’s main decomposers (with bacteria)
  - principal decomposers of cellulose & lignin
  - nutrient (re)cyclers

• Some are parasites

• A few are mutualists
Cell structure of *multicellular* fungi

Vegetative body = *mycelium* (plural *mycelia*)

Composed of threadlike (singular *hypha*)
Incomplete division into cells

Cell-like compartments separated by septa (singular septum)

Free movement of organelles, sometimes even nuclei, and other materials

coenocytic hypha

septate hypha
Fungus structure

• **Hyphae** may
  - disperse to look for nutrients
  - clump together to exploit a food source

• Most **Unicellular** fungi are called

![Image of fungal structure]
Fungal hyphae attack a leaf

Hyphae give a large surface:volume ratio, which helps with absorptive nutrition
Symbiotic fungi are symbiotic associations of a fungus with a unicellular photosynthetic eukaryote – cyanobacterium – or both. Lichens are important pioneer species.
Symbiotic fungi

- **Mycorrhizae** are mutualistic associations of fungi and plant roots.

  - The fungus obtains organic compounds, while the plant is provided with water and soil nutrients.
  - Some plants can’t grow without them.

Lots of surface area!
Symbiotic fungi

Mycorrhizae =

associations of fungi and plant roots
Fungi increase **surface area** for nutrient and water absorption by plant

(a) Ectomycorrhizal fungi (EMF) form sheaths around roots and penetrate between root cells.

(b) Arbuscular mycorrhizal fungi (AMF) contact the plasma membranes of root cells.

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Fungi are very important cyclers of nutrients. Especially Carbon, Nitrogen, Phosphorus.
Predatory fungus!

Fungus capturing a nematode worm

*LIFE 8e, Figure 30.6*
Fungal reproduction can be complex

OR

• Life cycles distinguish 4/5 phyla

• When sex has not been observed, provisionally classified as imperfect fungi (aka deuteromycetes): ~ 25,000 species
Alternation of Generations

Haploid (N)
(~gametes)
Fertilization
Diploid (2N)
Meiosis
Haploid (N)
Etc.

Sexual Reproduction Depicted Here (Meiosis & Fertilization)
Alternation of Generations

Both the haploid and the diploid have multicellular forms.

Compare to Haplontic and Diplontic.
Haplontic life cycle

- **Haploidy** is dominant, multicellular structure
  - Often *diploid* only very briefly as a *zygote*
  - *Meiosis* produces *haploid* nuclei again
  - Haploid spores divide *mitotically* to form haploid hyphae
Dikaryotic Lifestage

- Unique to fungi
- Two haploid (n) cells fuse, but not their nuclei
  \[ n + n \] dikaryote
- Plasmogamy (cell fusion)
  followed later by Karyogomy to produce

Diploid (2n) Zygote
Alternation of generations

Chytrids
(no dikaryote)

Zygomycetes

Ascomycetes

Basidiomycetes

Haplontic

Dikaryotic stage

Haplontic

Dikaryotic stage

Basidiocarp
Chytrid Fungi

A chytrid fungus (*Batrachochytrium dendrobatidis; Bd*) has been implicated in the worldwide decline of numerous species. Frogs infected with this fungus suffer chytridiomycosis, a disease affects amphibian skin and is often fatal. Chytrid zoospores can survive in damp conditions and may be transported between frog populations in muddy clothing and footwear.

- water balance
- respiration
- immune system
GLOBAL SPREAD OF CHYTRID FUNGUS, 2007

Chytrid fungus detected:
-Associated with mortalities
-Not associated with mortalities

African Clawed Frog?
Yeast are fungi

- All five fungal phyla have unicellular species
- Those of all phyla except chytrids are called yeasts
- The yeast *Saccharomyces cerevisiae* makes $CO_2$ and ethanol during fermentation
- Used for bread and beer
Asexual reproduction via spores

Production of haploid spores within **sporangia**

Production of naked spores at the tips of hyphae (not within sporangia) called **conidia**
Fungal spores are everywhere

- Every breath we take is full of fungal spores (~10,000/m³ of air)

- Most humans only succumb to fungal pathogens when immunocompromised

sporotrichosis  ring worm  some pneumonias
Plants are not so lucky

Parasitic fungus *Ustilago maydis* (corn smut)

*Fungus* (aka mold, mildew, etc.) causes lots of crop damage

- Dutch Elm disease
- Chestnut blight
Neither was this ant

Spores of this fungus don’t germinate until ingested by an ant
Fungal asexual reproduction

• Cell division by unicellular fungi
  — equal division (fission)
  — production of a daughter cell (budding)

• Simple breakage of the mycelium
Fungal Sexual reproduction

- Some fungi have more than 2 mating types
- Mating types don’t look different
- Mating can only occur between different mating types, preventing self-fertilization
- Sexual reproduction when hyphae (or motile cells in chytrids) of different mating types meet and fuse
Basidiomycete life cycle

Basidiospores are the characteristic sexual reproductive structure of the basidiomycetes. Basidiospores form outside the basidium.

Basidiocarp (fructification structure)
- Pileus
- Gills lined with basidia

Nuclei develop on the gills and nuclei fuse to form a single, dikaryotic nucleus.

Nuclear fusion and meiosis take place in the developing basidium.

Mushrooms

The basidiocarp is topped by a cap, or pileus, which has gills on its underside.
Basidiomycete life cycle

(d) Basidiomycota have reproductive structures with many spore-producing basidia.

Mushrooms
Important points about sex and reproduction

• Sex = ________________

• Reproduction ________________

• Genetic recombination = any gene exchange: not just sex, also nonreproductive processes such as conjugation

• Dikaryotic individuals include 2 fused individuals, but not fused nuclei

• “Spores” can be sexual or asexual, reproductive or not: normally a small, tough cell with potential to become new organism. Often capable of latency. Can be plant, bacterial, protist or fungal.
Five Fungi Phyla

1+ bya
Common ancestor

Chytridiomycota
Zygomycota
Glomeromycota
Ascomycota
Basidiomycota

Crown fungi
Chytrids

~Aquatic
Only fungi group with flagella

Includes *Batrachochytrium dendrobatidis* (Bd) causing amphibian die-offs
Glomerocytes

Important mycorrhizae associations with plants
Ascomycetes

Includes brewer’s and baker’s yeast.
Lots of plant parasites.
Molds and Mildew.
Penicillin.
Stinky cheese production.
Basidiomycetes

Named after basidiocarp, which we know as a mushroom.