BIOL 1202

General Biology II Lecture

note: book is overkill
too much detail on
biol 1202 (i think i meant to
type fungi)

CHAPTER 31

Fungi

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CH 31 Learning Objectives

1. Describe the structure of the fungal body.
2. Compare and contrast sexual and asexual reproduction in fungi.
3. Explain how fungi may have evolved from a single-celled protist.
4. Identify and characterize major phylogenetic groups of fungi.
5. Give examples of how fungi interact with other organisms.

I would suggest completing the crossword puzzle to help you understand the terminology and correlate how the terms relate to topics covered in this chapter.

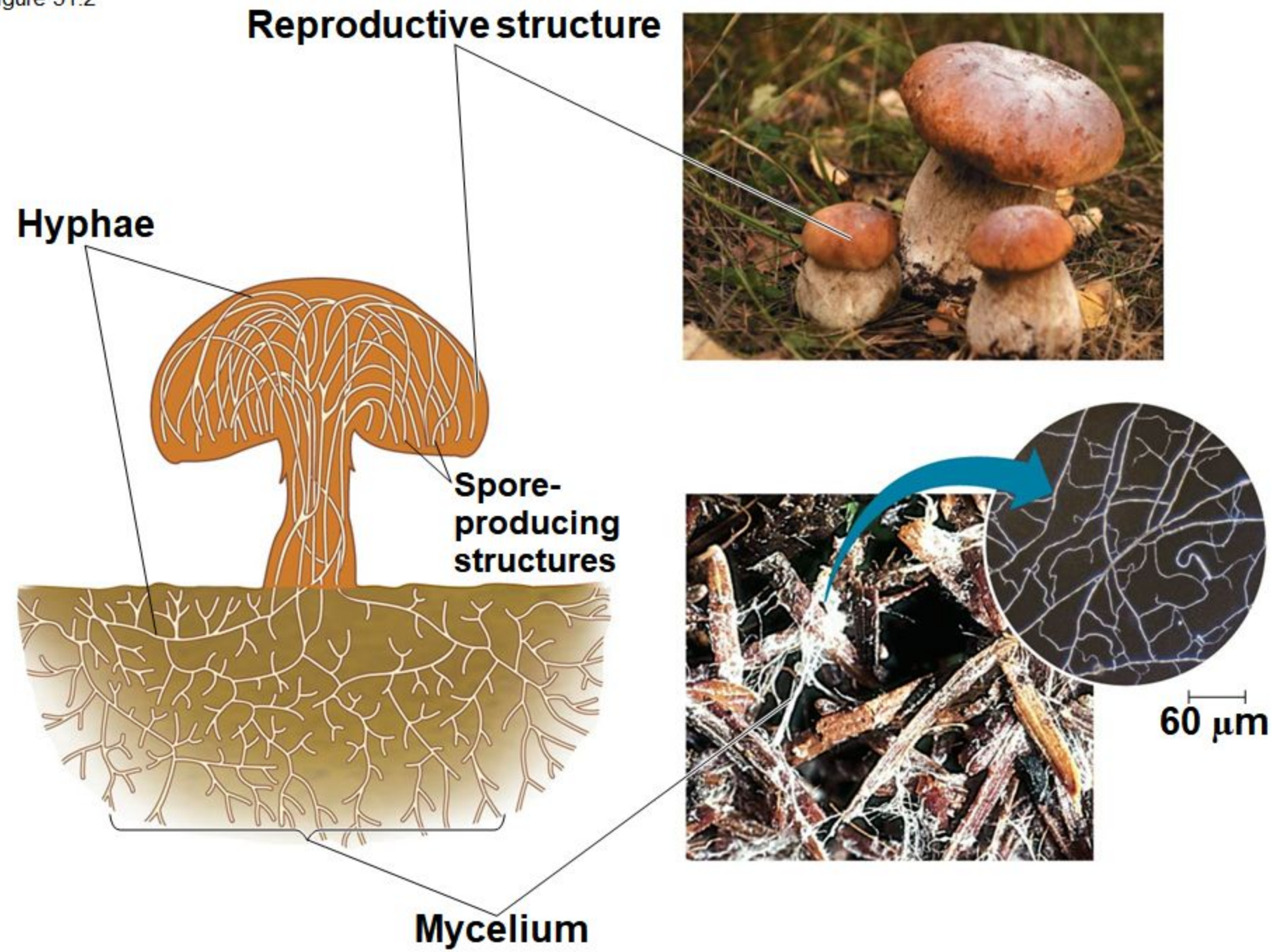
Concept 31.1: Fungi are heterotrophs that feed by absorption

- Despite their diversity, fungi share key traits, such as the way in which they drive nutrition
- Fungi use enzymes to break down a large variety of complex molecules into smaller organic compounds
- The versatility of these enzymes contributes to fungi's ecological success
  - **Decomposers**: break down and absorb nutrients from nonliving organic material
  - **Parasitic**: absorb nutrients from living hosts
  - **Mutualistic**: absorb nutrients from hosts and reciprocate with actions that benefit the host

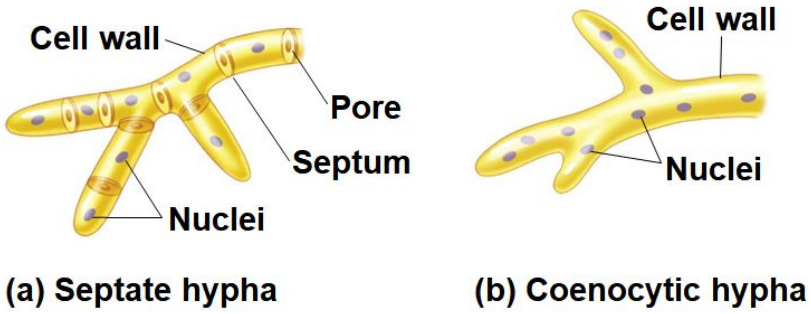
Body Structure

- The most common body structures are multicellular filaments and single cells (**yeast**)
- Some species grow as either filaments or yeasts; others grow as both
- The morphology of multicellular fungi enhances their ability to absorb nutrients
- The body of fungi form networks of branched **hyphae** adapted for absorption
- Hyphae have tubular cell walls strengthened with **chitin** (pronounced kite-in)

Figure 31.2

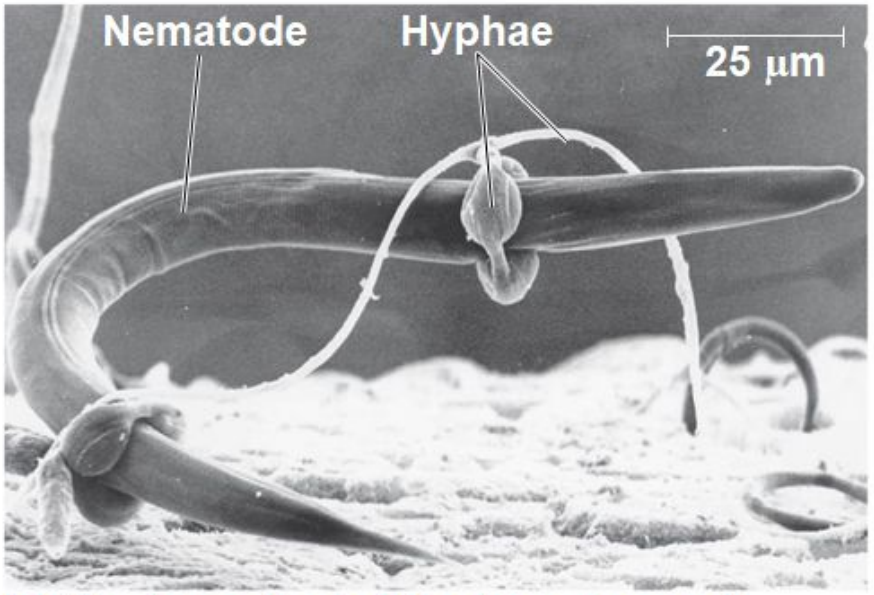

Reproductive structure
Hyphae
Spore-producing structures
60 µm
Mycelium

- Most fungi have hyphae divided into cells by **septa**, with pores allowing cell-to-cell movement of organelles
- **Coenocytic fungi** lack septa and have a continuous cytoplasmic mass with hundreds or thousands of nuclei
- Fungal hyphae form an interwoven mass called a **mycelium**
- The structure of a mycelium maximizes surface-to-volume ratio, making feeding very efficient

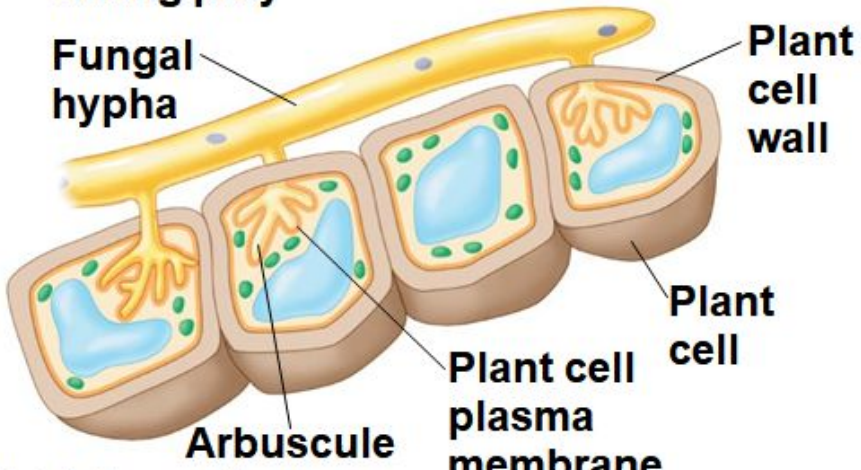


Specialized Hyphae in Mycorrhizal Fungi

- Some fungi have specialized hyphae for <u>feeding on live animals</u>
- Others have specialized hyphae called haustoria that allow them <u>to extract nutrients from plants</u>
- Mutualistic fungi have branching hyphae such as **arbuscules** that they <u>use to exchange nutrients with plant hosts</u>



(a) Hyphae adapted for trapping and killing prey

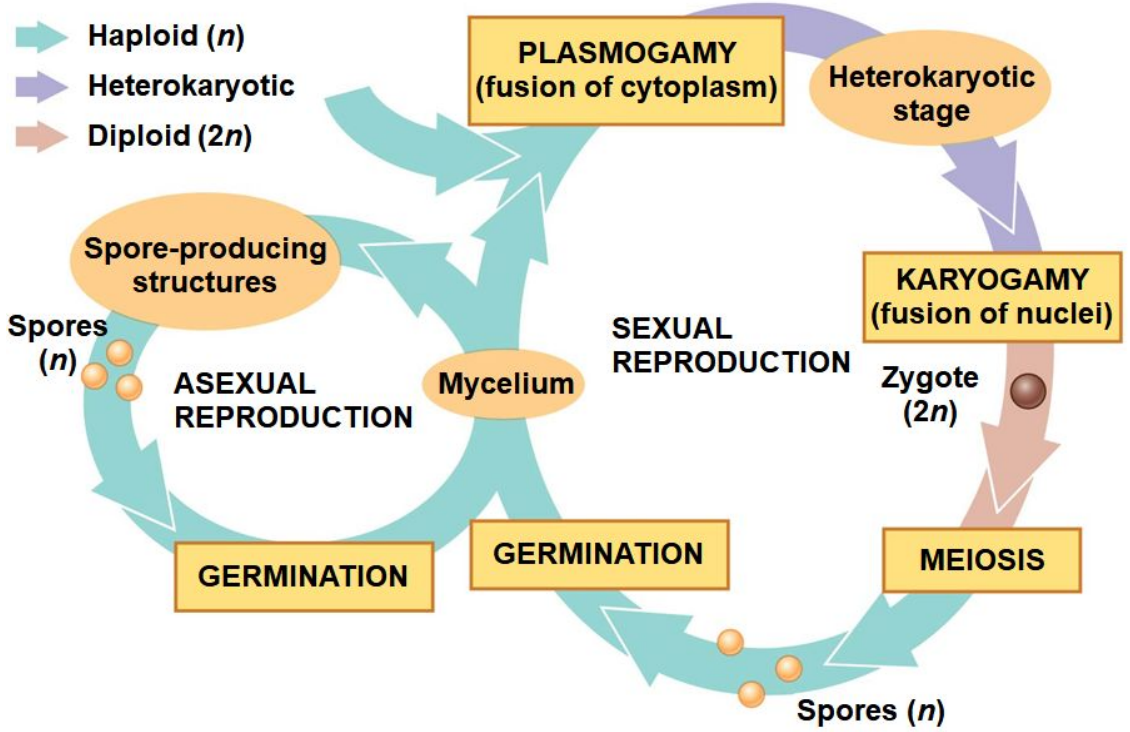


(b) Arbuscules

- **Ectomycorrhizal fungi** form sheaths of hyphae over a root and typically grow into the extracellular spaces of the root cortex
- **Arbuscular mycorrhizal fungi** extend arbuscules through the root cell wall and into tubes formed by invagination of the plasma membrane
- **Mycorrhizae** are mutually beneficial relationships between fungi and plant roots
- Mycorrhizal fungi deliver phosphate ions and minerals to plants
- Most vascular plants have mycorrhizae
- Mycorrhizal fungi colonize soils by the dispersal of haploid cells called **spores**

Concept 31.2: Fungi produce spores through sexual or asexual life cycles

- Fungi propagate themselves by producing vast numbers of spores, either sexually or asexually
- Spores can be carried long distances by wind/water; germinate when landing in fertile, moist areas



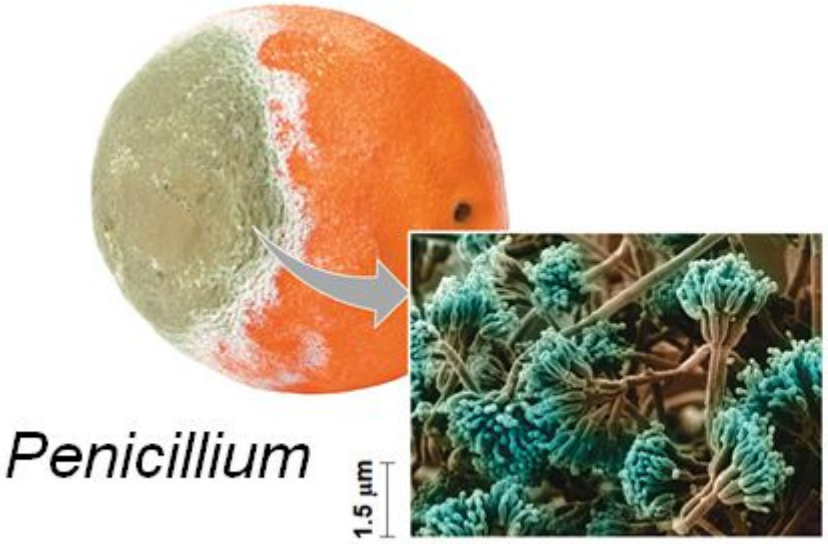
Sexual Reproduction

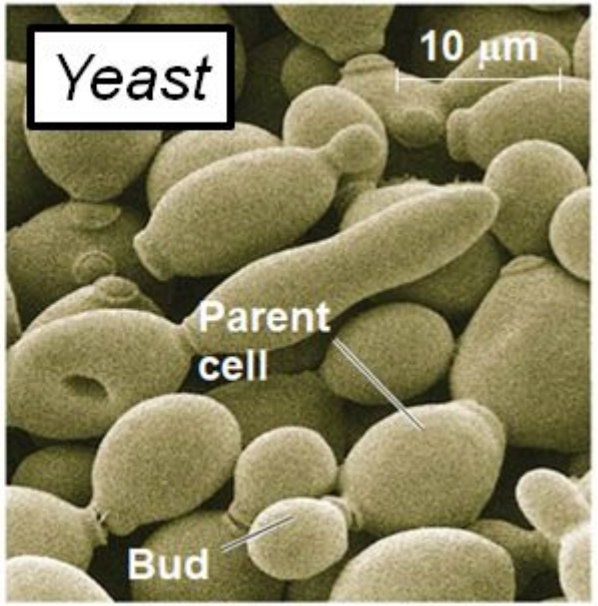
- Fungal nuclei are normally haploid
- Hyphae fuse from different mating types
- Fungi use sexual signaling molecules called **pheromones** to communicate their mating type
- **Plasmogamy** is the union of cytoplasm from two parent mycelia
- Hours, days, or centuries may pass before **karyogamy** (nuclear fusion) producing diploid cells
- The diploid phase is short-lived and undergoes meiosis, producing haploid spores
- The paired processes of karyogamy and meiosis produce genetic variation

Asexual Reproduction

- In addition to sexual reproduction, many fungi can reproduce asexually
- **Molds** produce haploid spores by mitosis and form visible mycelia
- Other fungi that can reproduce asexually are yeasts, which are single cells
- Instead of producing spores, yeasts reproduce asexually by simple cell division and the pinching of "bud cells" from a parent cell
- Some fungi can grow as filamentous mycelia*

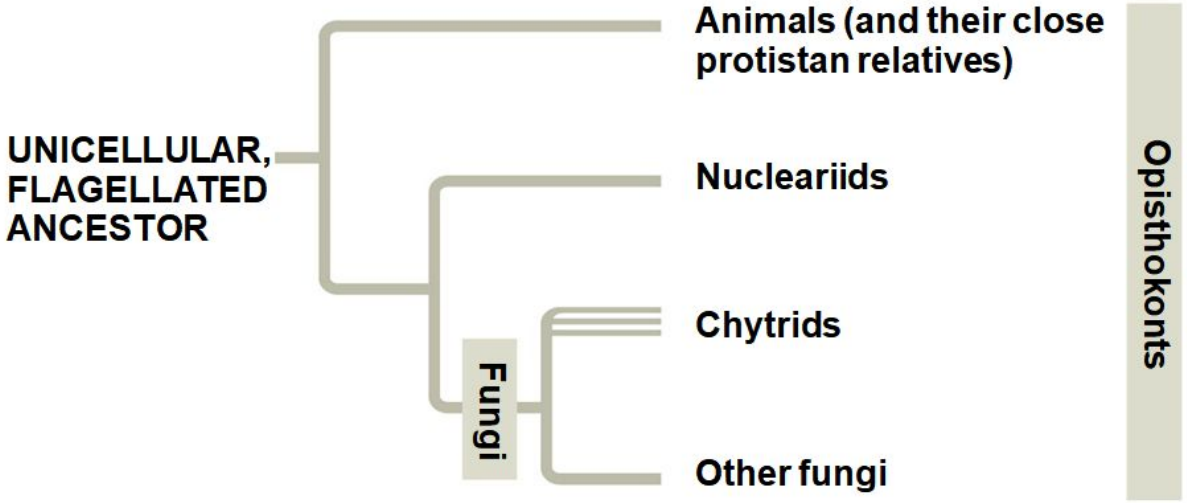
- Many molds and yeasts have no know sexual stage
- Mycologists have traditionally called these **deuteromycetes**
- These fungi are reclassified once their sexual stage is discovered
- Mycologists can now also use genomic techniques to classify fungi





Concept 31.3: The ancestor of fungi was an aquatic, single-celled, flagellated protist

- Fungi and animals are more closely related to each other than they are to plants or other eukaryotes
- Fungi, animals, and their protistan relatives form the **opisthokonts** clade
- Opisthokonts evolved from a unicellular flagellated ancestor



- DNA evidence suggests that
  - Fungi are most closely related to unicellular protists called **nucleariids**
  - Animals are most closely related to unicellular protists called choanoflagellates
- This suggests that multicellularity arose separately in animals and fungi
- The oldest undisputed fossils of fungi are about 460 million years old
- Fungi were among the earliest colonizers of land
- Fossil evidence indicates fungi formed mutualistic relationships with early land plants

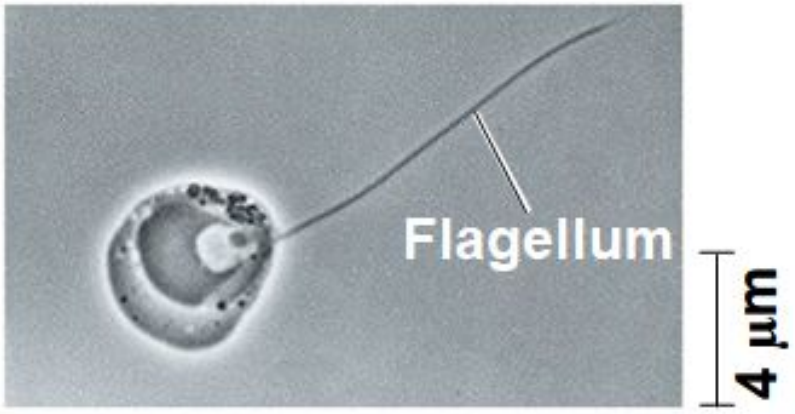
Concept 31.4: Fungi have radiated into a diverse set of lineages

- Molecular analyses have helped clarify evolutionary relationships among fungal groups, although areas of uncertainty remain
- Recent metagenomic studies estimate fungal diversity at around 1.5 million species
- Five phyla/divisions of fungi are recognized

1. Chytrids (1000 species)
2. Zygomycetes (1000 species)
3. Glomeromycetes (160 species)
4. Ascomycetes (65,000 species)
5. Basidiomycetes (35,000 species)

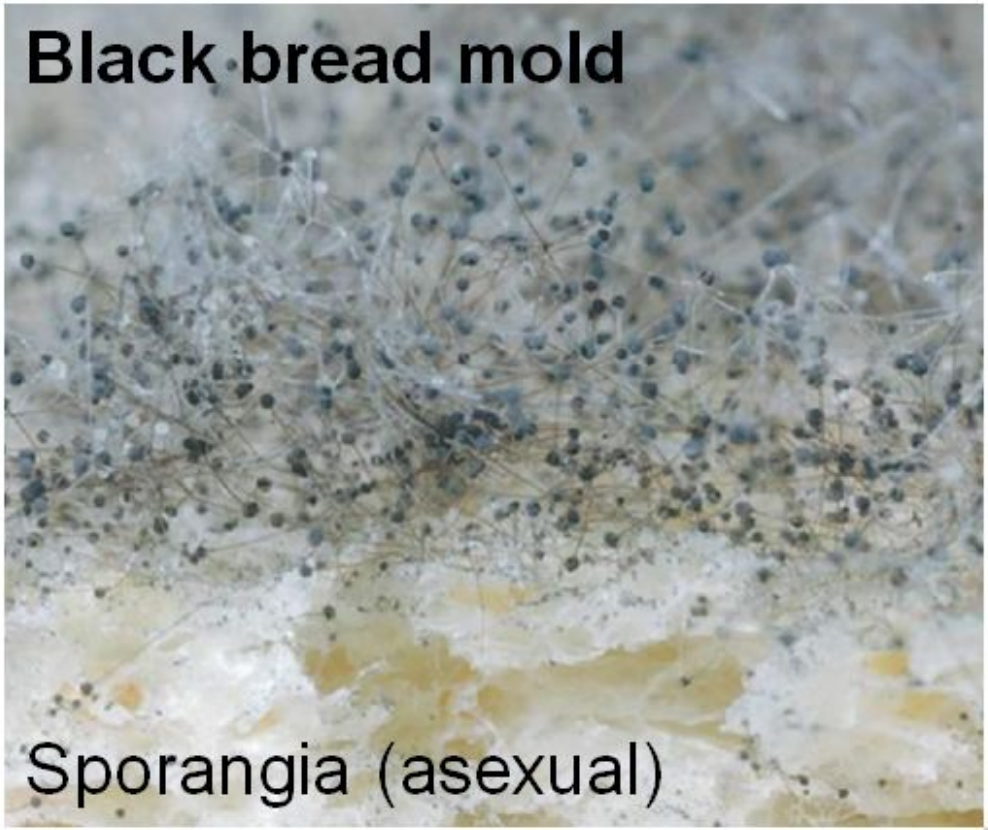
1. Chytrids

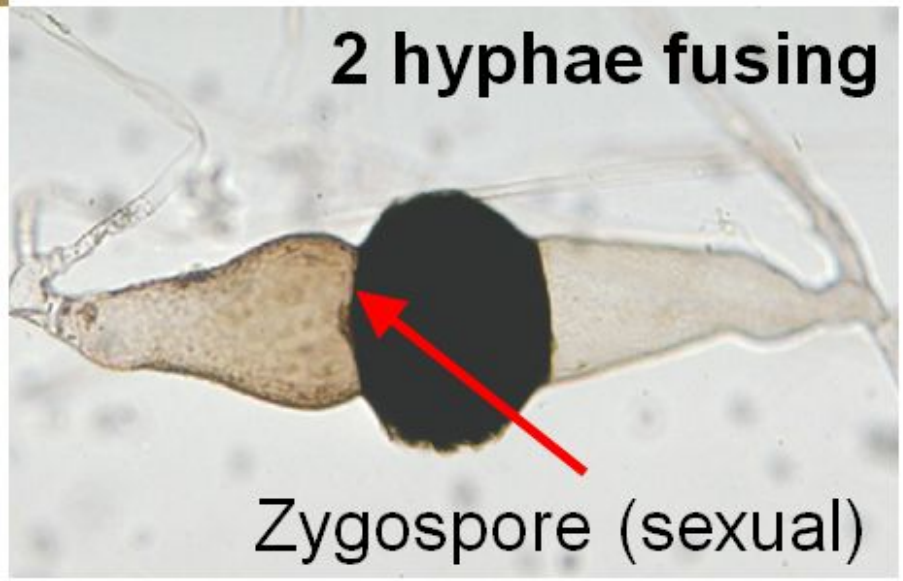
- **Chytrids** (phylum Chytridiomycota) are found in terrestrial, freshwater, and marine habitats including hydrothermal vents
- They can be decomposers, parasites, or mutualists
- Molecular evidence supports the hypothesis that chytrids diverged early in fungal evolution
- Chytrids are unique among fungi in having flagellated spores, called **zoospores**



2. Zygomycetes

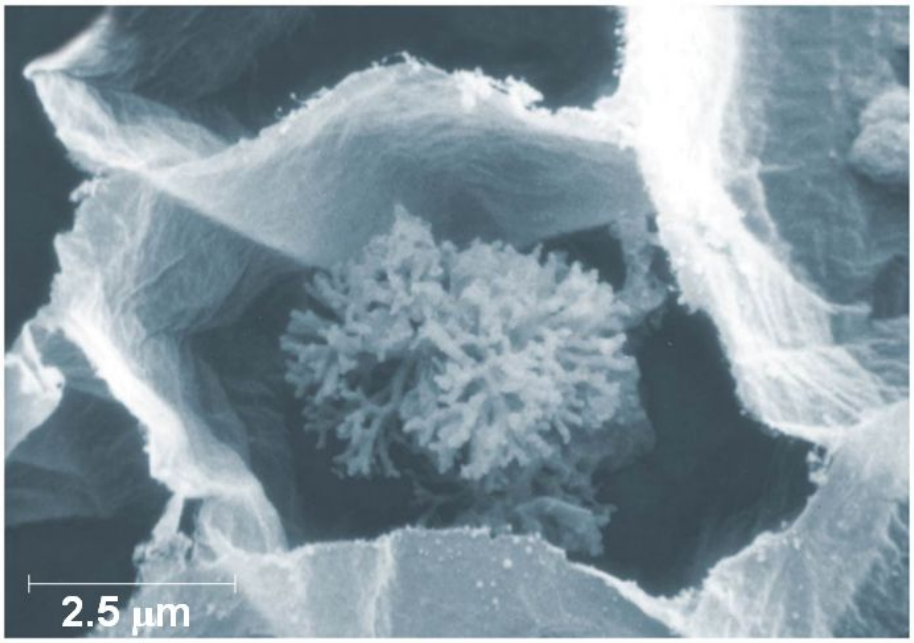
- The **zygomycetes** (phylum Zygomycota) include fast-growing molds, parasites, and commensal symbionts
- The life cycle of black bread mold (*Rhizopus stolonifer*) is fairly typical of the phylum
- Its hyphae are coenocytic
- Asexual sporangia produce haploid spores
- The zygomycetes are named for their sexually produced **zygosporangia**
- Zygosporangia are the site of karyogamy and then meiosis
- Zygosporangia, which are resistant to freezing and drying, can survive unfavorable conditions


Black bread mold
Sporangia (asexual)


2 hyphae fusing
Zygospore (sexual)

3. Glomeromycetes

- The **glomeromycetes** (phylum Glomeromycota) were once considered zygomycetes
- Molecular analyses indicate that glomeromycetes form a separate clade
- Nearly all species of glomeromycetes form arbuscular mycorrhizae



4. Ascomycetes

- **Ascomycetes** (phylum Ascomycota) live in marine, freshwater, and terrestrial habitats
- Ascomycetes produce sexual spores in saclike **asci** contained in fruiting bodies called **ascocarps**
- Called “sac fungi”; vary in size and complexity from unicellular yeasts to elaborate cup fungi and morels
- Ascomycetes include plant pathogens, decomposers, and symbionts
- More than 25% form symbiotic associations with green algae or cyanobacteria called lichens
- Ascomycetes typically reproduce asexually by enormous number of asexual spores called **conidia**

Ascomycete (“cup fungi”) examples

the missing slide o._.o

- Ascomycetes include plant pathogens, decomposers, and symbionts
- More than 25% of all ascomycete species form symbiotic associations with green algae or cyanobacteria called lichens
- Ascomycetes reproduce asexually by enormous numbers of asexual spores called **conidia**
- Conidia are produced at the tips of specialized hyphae called conidiophores
- Conidia may also participate in sexual reproduction by fusing with the hyphae of a mycelium from a different mating type

5. Basidiomycetes

- **Basidiomycetes** (phylum Basidiomycota) include mushrooms, puffballs, and shelf fungi
- Some basidiomycetes form mycorrhizae, and others are plant parasites
- The phylum is defined by a clublike structure called a **basidium**, a transient diploid stage in the life cycle
- Basidiomycetes are commonly called club fungi
- Many basidiomycetes are decomposers of wood

Figure 31.17

Puffballs

Shelf fungi

Maiden veil fungus

- The life cycle of a basidiomycete usually includes a long-lived dikaryotic mycelium
- The mycelium can reproduce sexually by producing fruiting bodies called **basidiocarps**
- EX: Edible white button mushrooms
- The numerous basidia in a basidiocarp are sources of sexual spores called basidiospores
- Can produce mushrooms within a few hours
- Some species produce rings of mushrooms called "fairy rings" that appear literally overnight

Concept 31.5: Fungi play key roles in nutrient cycling, ecological interactions, and human welfare

- Fungi interact with other organisms as decomposers, mutalists, and pathogens
- Fungi are efficient decomposers of organic material including cellulose and lignin
- They perform essential recycling of chemical elements between the living and nonliving world
- Without these critical decomposers, life as we know it would cease

Fungi as Mutualists

- Fungi form mutualistic relationships with plants, algae, cyanobacteria, and animals
- Mutualistic fungi absorb nutrients from the host organism and reciprocate actions that benefit the host
- Mycorrhizae are enormously important in natural ecosystems and agriculture
- Plants harbor harmless symbiotic **endophytes**, fungi that live inside leaves or other plant parts
- Some endophytes make toxins to help defend the host plant; others help the plant tolerate heat, drought, or heavy metals
- Most endophytes are ascomycetes

Fungus-Animal Mutualisms

- Some fungi share their digestive services with animals
- These fungi help break down plant material in the guts of cows and other grazing mammals
- Many species of ants use the digestive power of fungi by raising them in “farms”

Lichens

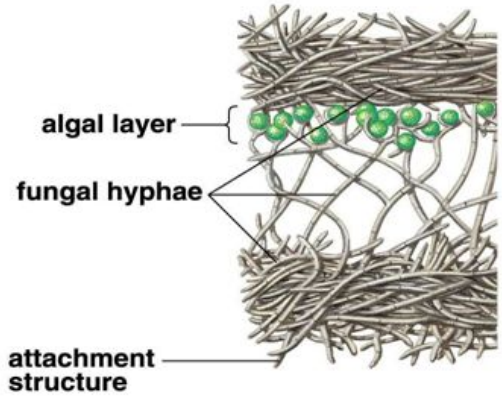
- A **lichen** is a symbiotic association between a photosynthetic microorganism and a fungus
- The photosynthetic component is green algae or cyanobacteria
- The fungal component is most often an ascomycete
- Millions of photosynthetic cells are held in a mass of fungal hyphae
- Algae or cyanobacteria occupy an inner layer below the lichen surface
- The symbioses are so complete that lichens are given scientific names
- Are important pioneers on new rock and soil surfaces

Figure 31.22

A fruticose (shrublike) lichen

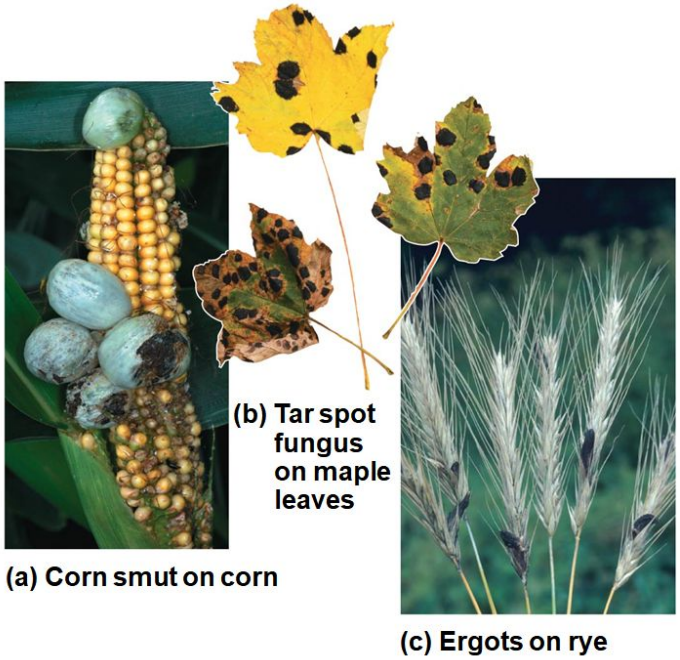
A foliose (leaflike) lichen

Crustose (encrusting) lichens



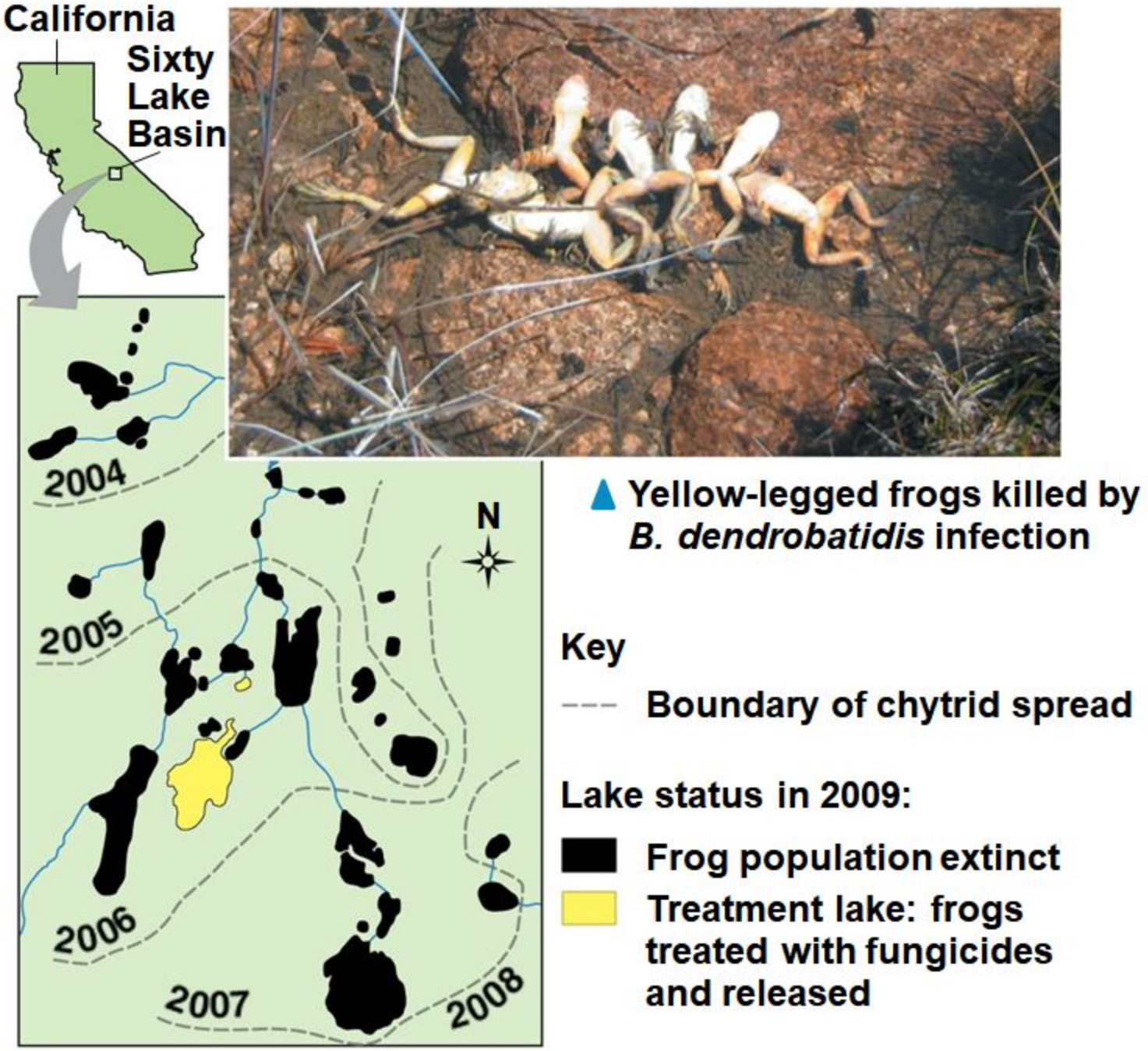
Fungi as Parasites

- About 30% of known fungal species are parasites or pathogens, mostly on or in plants
- Each year, 10% to 50% of the world's fruit harvest is lost due to fungi
- Some fungi that attack food crops are toxic to humans



- Ergot on rye is caused by an ascomycete and produces toxins
- More than 40,000 people died from an epidemic of ergotism during the Middle Ages
- Ergotism is characterized by gangrene, nervous spasms, burning sensations, hallucinations, and temporary insanity (Salem Witch Trials of 1692)
- Ergots contain lysergic acid, the compound in LSD
- Animals are much less susceptible to parasitic fungi than are plants
- The chytrid *Batrachochytrium dendrobatidis* has been implicated in the decline or extinction of about 200 species of amphibians worldwide

Figure 31.25


California
Sixty
Lake
Basin
2004
2005
2006
2007
2008
N
Yellow-legged frogs killed by
B. dendrobatidis infection
Key
Boundary of chytrid spread
Lake status in 2009:
Frog population extinct
Treatment lake: frogs
treated with fungicides
and released

- The general term for a fungal infection in animals is **mycosis**
- EX: Ringworm and athlete's foot are human mycoses

- Systemic mycoses spread through the body
  - EX: Coccidioidomycosis produces tuberculosis-like symptoms
- Some mycoses are opportunistic
  - EX: *Candida albicans*, which causes yeast infections

Practical Uses of Fungi

- Humans eat many fungi and use others to make cheeses, alcoholic beverages, and bread
- Some fungi are used to produce antibiotics for the treatment of bacterial infections
  - EX: the ascomycete *Penicillium*

- Genetic research on fungi is leading to applications in biotechnology
  - EX: Scientists are using *Saccharomyces* to study homologs of the genes involved in Parkinson's and Huntington's diseases
  - EX: Insulin-like growth factor can be produced in the fungus *Saccharomyces cerevisiae*
  - EX: *Gliocladium roseum*, a fungus that produces hydrocarbons similar to diesel fuel, could be used to produce biofuels