

General Biology

Course No: BNG2003
Credits: 3.00

13.3. Fungi

Prof. Dr. Klaus Heese

• Overview: Mighty Mushrooms

- Fungi are diverse and widespread;
- They are essential for the well-being of most terrestrial ecosystems because **they break down organic material and recycle vital nutrients ----> decomposers !**
- Fungi are heterotrophs that feed by absorption
- Despite their diversity Fungi share some key traits

Nutrition and Fungal Lifestyles

- **Fungi are heterotrophs but do not ingest their food**

Fungi secrete into their surroundings exoenzymes that break down complex molecules and then absorb the remaining smaller compounds

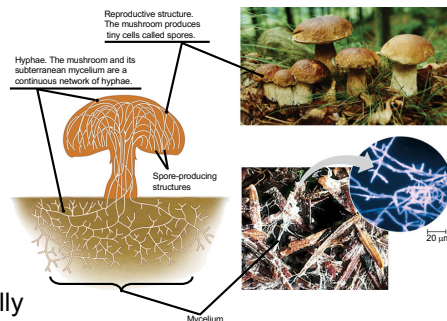


- **Fungi exhibit diverse lifestyles**
 - Decomposers
 - Parasites
 - Mutualistic symbionts

• **Body Structure:**

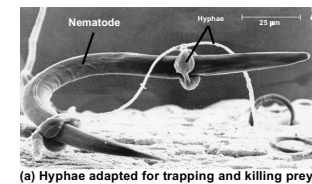
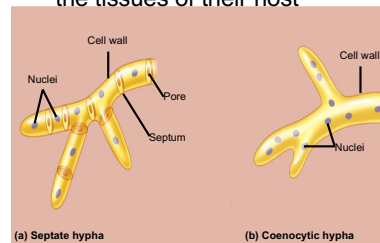
- The morphology of multicellular fungi enhances their ability to absorb nutrients from their surroundings

- Mycorrhizae are mutually beneficial relationships between fungi and plant roots

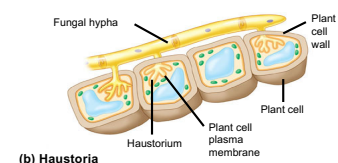


- **Fungi consist of Mycelia, networks of branched hyphae adapted for absorption**
- Most fungi have cell walls made of chitin
- Some fungi have hyphae divided into cells by septa, with pores allowing cell-to-cell movement of materials

- Coenocytic fungi lack septa
- Some unique fungi have specialized hyphae that allow them to penetrate the tissues of their host

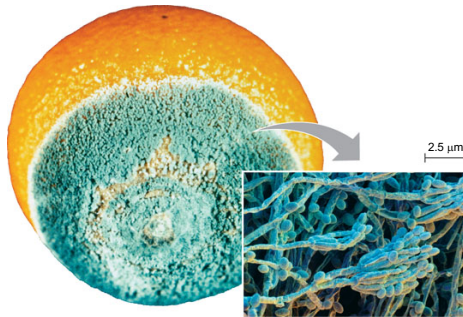


(a) Hyphae adapted for trapping and killing prey



(b) Haustoria

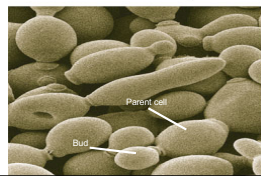
- Many fungi that can reproduce asexually grow as mold, sometimes on fruit, bread, and other foods



- Many molds and yeasts have no known sexual stage

- Mycologists have traditionally called these deuteromycetes, or imperfect fungi

- Other asexual fungi are yeasts
 - that inhabit moist environments
 - which produce by simple cell division



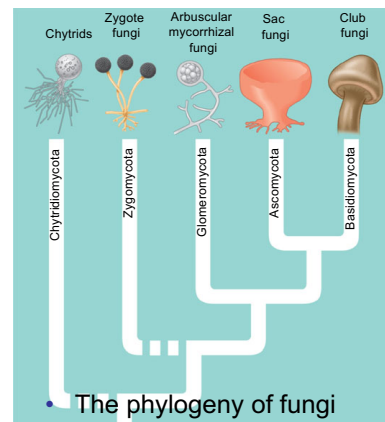
The Origin of Fungi

- Fungi descended from an aquatic, single-celled, flagellated protist
- Systematists now recognize **Fungi and Animalia as sister kingdoms** because fungi and animals are more closely related to each other than they are to plants or other eukaryotes
- Molecular evidence supports the hypothesis that fungi and animals diverged from a common ancestor that was unicellular and bore flagella
- Fungi probably evolved before the colonization of land by multicellular organisms
- The oldest undisputed fossils of fungi are only about 460 million years old



The Move to Land

- Fungi were among the earliest colonizers of land, probably as symbionts with early land plants
- Fungi have radiated into a diverse set of lineages
- The phylogeny of fungi is currently the subject of much research
- Molecular analysis has helped clarify the evolutionary relationships between fungal groups, although there are still areas of uncertainty



- A review of fungal phyla

Table 31.1 Review of Fungal Phyla

Phylum	Distinguishing Feature
Chytridiomycota (chytrids)	Motile spores with flagella
Zygomycota	Resistant zygosporangium as sexual stage
Glomeromycota	Arbuscular mycorrhizae
Ascomycota (sac fungi)	Sexual spores borne internally in sacs called asci
Basidiomycota (club fungi)	Elaborate fruiting body called basidiocarp

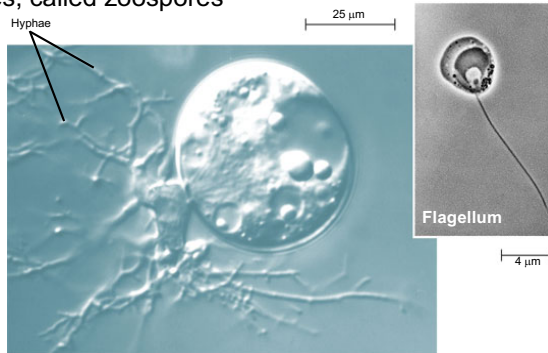
The ascomycetes are a monophyletic group, i.e., all of its members trace back to one common ancestor. This group is of particular relevance to humans as sources for medicinally important compounds, such as antibiotics; and for making bread, alcoholic beverages, and cheese, but also as pathogens of humans and plants.

subkingdom Dikarya

>60 000 species
Some species also asexual

Chytrids

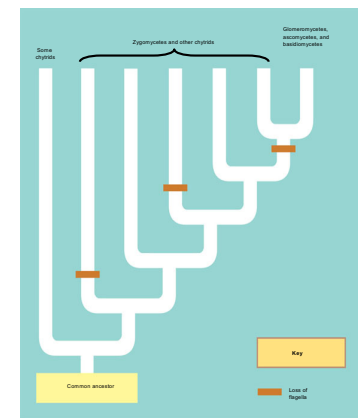
- Fungi classified in the phylum Chytridiomycota, or chytrids are found in freshwater and terrestrial habitats and they can be saprobic or parasitic
- Chytrids are unique among fungi in having flagellated spores, called zoospores



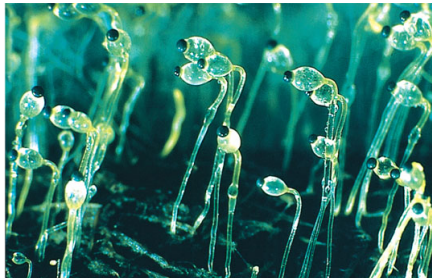
- Until recently, systematists thought that fungi lost flagella only once in their history
- Molecular data indicate that some “chytrids” are actually more closely related to another fungal group, the zygomycetes

Zygomycetes

- Fungi in the phylum Zygomycota, the zygomycetes
 - exhibit a considerable diversity of life histories
 - Include fast-growing molds, parasites, and commensal symbionts
 - are named for their sexually produced zygosporangia



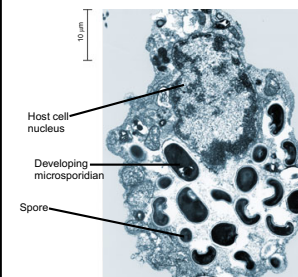
- Some zygomycetes, such as *Pilobolus*, can actually “aim” their sporangia toward conditions associated with good food sources



- Zygosporangia, which are resistant to freezing and drying,
 - are capable of persisting through unfavorable conditions
 - can undergo meiosis when conditions improve

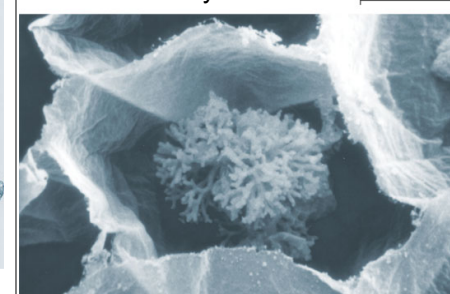
Microsporidia

- Microsporidia are unicellular parasites of animals and protists; they are now classified as zygomycetes



Glomeromycetes

- Fungi assigned to the phylum Glomeromycota were once considered zygomycetes and are now classified in a separate clade
- All glomeromycetes form a distinct type of endomycorrhizae called arbuscular mycorrhizae



Ascomycetes

- Fungi in the phylum Ascomycota are found in a variety of marine, freshwater, and terrestrial habitats; they are defined by the production of sexual spores in saclike asci, which are usually contained in fruiting bodies called ascocarps
- Ascomycetes vary in size and complexity from unicellular yeasts to elaborate cup fungi and morels

Cheese, bread, beer, vine, medicine

sac fungi include morels, truffles, brewer's yeast and baker's yeast, Dead Man's Fingers, and cup fungi. plant-pathogenic ascomycetes, including apple scab, rice blast, the ergot fungi, black knot, and the powdery mildews.

Neurospora crassa, several species of yeasts, and *Aspergillus* species are used in many genetics and cell biology studies. *Penicillium* species on cheeses and those producing antibiotics for treating bacterial infectious diseases are examples of taxa that belong to the Ascomycota.



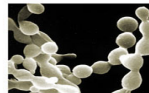
(a) The cup-shaped ascomycetes (fruiting bodies) of *Ascomycota* give this species its common name: orange peel fungus.



(b) The edible ascomycete of *Morchella esculenta*, the succulent morel, is often found under trees in orchards.



(c) *Tuber melanosporum* is a truffle, an ascomycete that grows underground and emits strong odors. These ascomycetes have been dug up and the middle one sliced open.



(d) *Neurospora crassa* feeds as a mold on bread and other food (SEM).

Basidiomycetes

- Fungi in the phylum Basidiomycota include mushrooms and shelf fungi; they are defined by a clublike structure called a basidium, a transient diploid stage in the life cycle



(a) Fly agaric (*Amanita muscaria*), a common species in conifer forests in the northern hemisphere



(b) Maiden veil fungus (*Dictyophora*), a fungus with an odor like rotting meat



(d) Puffballs emitting spores



(c) Shelf fungi, important decomposers of wood

- The life cycle of a basidiomycete usually includes a long-lived dikaryotic mycelium, which can erect its fruiting structure, a mushroom, in just a few hours



- Fungi have a powerful impact on ecosystems and human welfare

Decomposers

- Fungi are well adapted as decomposers of organic material performing essential recycling of chemical elements between the living and nonliving world
- > applications in Bio-Energy Engineering / Bio-Remediation etc

Symbionts

- Fungi form symbiotic relationships with plants (e.g. the orchid *Tian Ma*), algae, and animals

Mycorrhizae

- Mycorrhizae are enormously important in natural ecosystems and agriculture; they increase plant productivity

EXPERIMENT—Researchers grew soybean plants in soil treated with fungicide (poison that kills fungi) to prevent the formation of mycorrhizae in the experimental group. A control group was exposed to fungi that formed mycorrhizae in the soybean plants' roots.

RESULTS—The soybean plant on the left is typical of the experimental group. Its stunted growth is probably due to a phosphorus deficiency. The taller, healthier plant on the right is typical of the control group and has mycorrhizae.



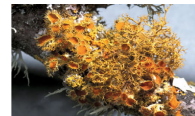
CONCLUSION—These results indicate that the presence of mycorrhizae benefits a soybean plant and support the hypothesis that mycorrhizae enhance the plant's ability to take up phosphate and other needed minerals.

Fungus-Animal Symbiosis

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



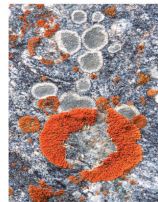
- **Lichens** are a symbiotic association of millions of photosynthetic microorganisms held in a mass of fungal hyphae



(a) A fruticose (shrub-like) lichen

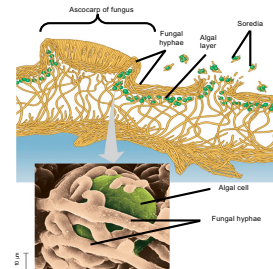


(b) A foliose (leaf-like) lichen



(c) Crustose (crust-like) lichens

- The fungal component of a lichen is most often an ascomycete
- Algae or cyanobacteria occupy an inner layer below the lichen surface



Pathogens

- About 30% of known fungal species are parasites, mostly on or in plants
- Some of the fungi that attack food crops are toxic to humans



(a) Corn smut on corn



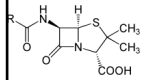
(b) Tar spot fungus on maple leaves



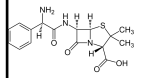
(c) Ergots on rye

Practical Uses of Fungi

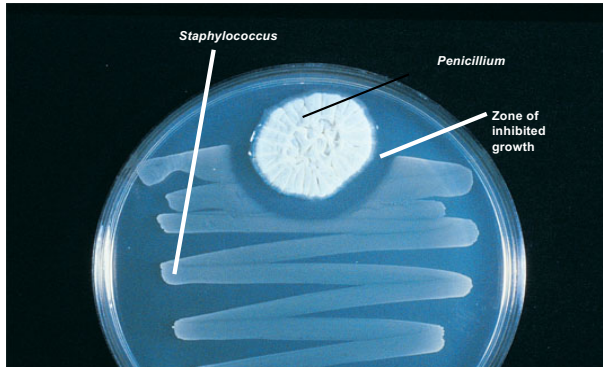
- Humans eat many fungi and use others to make cheeses, alcoholic beverages (beer, wine), and bread
- Antibiotics produced by fungi treat bacterial infections



Penicillin
core structure



Ampicillin



- Genetic research on fungi is leading to applications in biotechnology