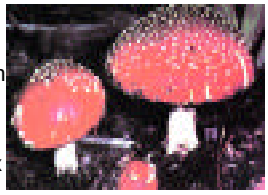
Fungi: recyclers, killers and plant partners

Chapter 30

Fungi

yeasts, molds, mushrooms

- ✓ Eukaryotic
- ✓ Uni- or multicellular
- ✓ Heterotophic
- ✓ Nutrition by absorption
- ✓ Chitin cell walls
- ✓ Asexual and sexual reproduction; complex life cycle

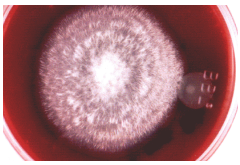


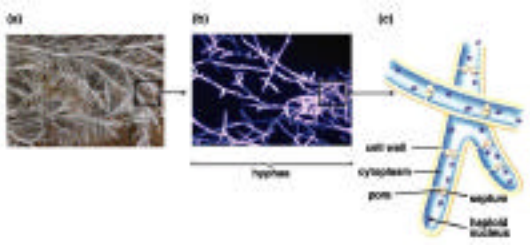
Four Fungal phylum

PHYLUM	COMMON NAME	FEATURES	EXAMPLES
Chytridiomycota	Chytrids	Aquatic; gametes have flagella	chytrids
Zygomycota	Zygomycetes	No regularly occurring septa; usually no fleshy fruiting body	Rhizopus
Ascomycota	Ascomycetes	Asci; perforated septa	Neurospora, baker's yeast
Basidiomycota	Basidiomycetes	Basidium; perforated septa	Puccinia, mushrooms

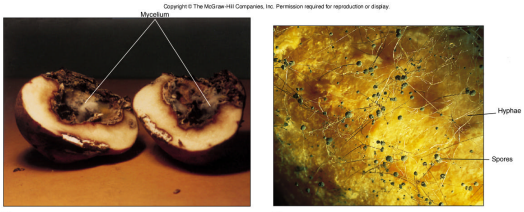
- ✓ Fungi imperfecti or Deuteromycota
  - ➨No identify able sexual life cycle

- ✓ Thallus -body of the fungus
- ✓ Mycelium - makes up the thallus
- ✓ Hyphae - thread like elements that make up mycelium



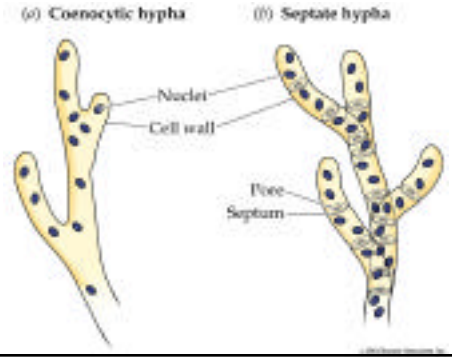


Potato and bread

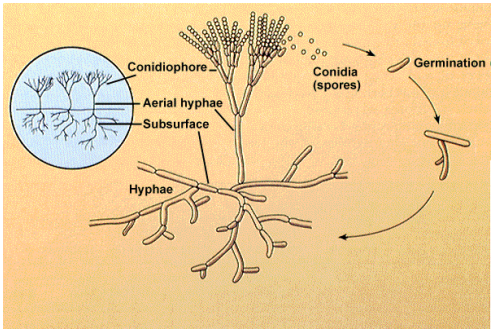


Rhizopus stolonifer

Two types of fungal hyphae



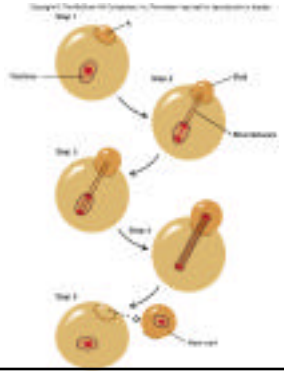
Fungal Hyphae (rhizoids)



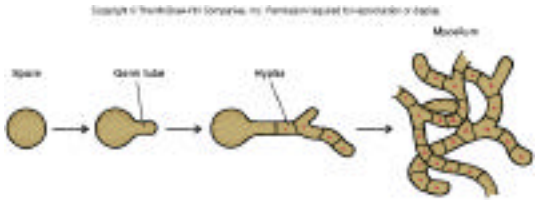
Morphology

- ✓Unicellular or yeast
  - ✒All four phyla
- ✓Sexual and asexual reproduction - spores
  - ✒Spores - dormant for years to days
  - ✒Germination into hyphae - branched hyphae is mycelium
  - ✒Coenocytic (non septate) or non-coenocytic (septate)
- ✓Asexual reproduction - hyphal or mycelial fragments

Yeast cell budding

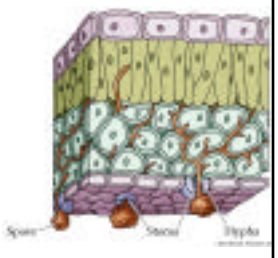


Formation of hyphae & mycelium



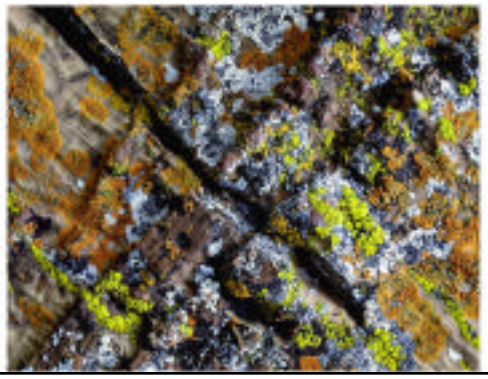
Fungi

- ✓Saprobes
  - ✒Feed on dead organic matter
- ✓Haustorium
  - ✒Hyphae penetration into plant
  - ✒Usually through stomates

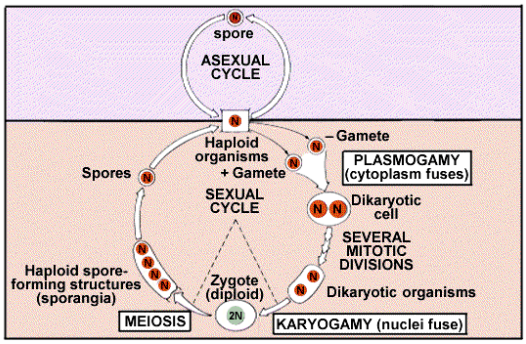


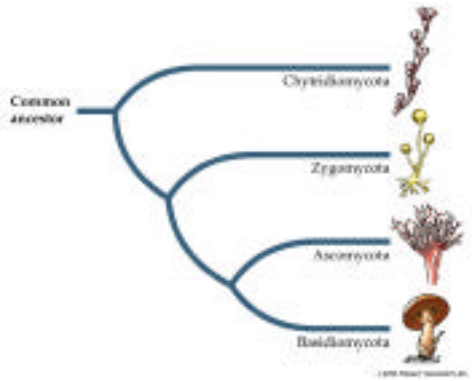
Arthrobotrys (roundworm strangler)

Lichens (fungus with cyanobacteria and/or algae)



Fungi reproduce both asexually and sexually





Chytridiomycota

- ✓Chydridiomycota
  - ✒Zygotic, sporic (gametic) and asexual reproduction
  - ✒Motile gamates and zoospores
  - ✒Centrioles present
  - ✒Aquatic

Chytrid filaments

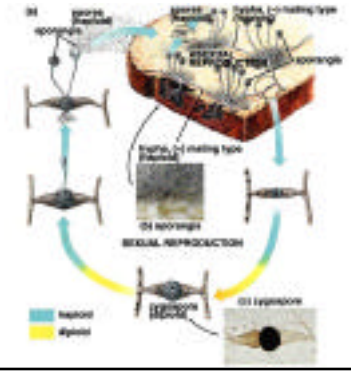
True fungi -

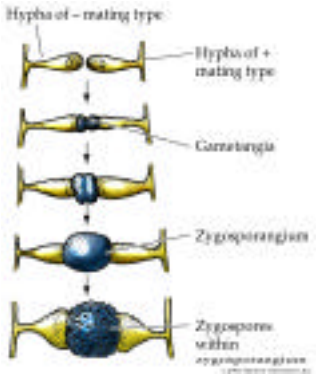
- Haploid, dikaryotic, unicellular to filamentous hyphae
- Zygotic meiosis
- Spindle pole apparatus is distinct
- Asexual reproduction
  - Sporangia - zygomycetes
  - Spores (Conidia) - ascomycetes and basidiomycetes
- Food by absorption
- Mostly terrestrial

Zygomycota

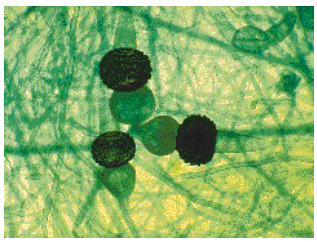
- Bread molds, mold on fruits and vegetables Zygosporangium, conjugation fungi
  - Class Zygomycetes
    - Sporangia - conidia
    - *Rhizopus* (Tempeh), *Mucor* (tofu)
    - Pilobolus (dung mold)
  - Class Trichomycetes
    - Short hyphae
    - No mycelium
    - Symbiotic - insect gut
    - Need a host

Zygomycota life cycle

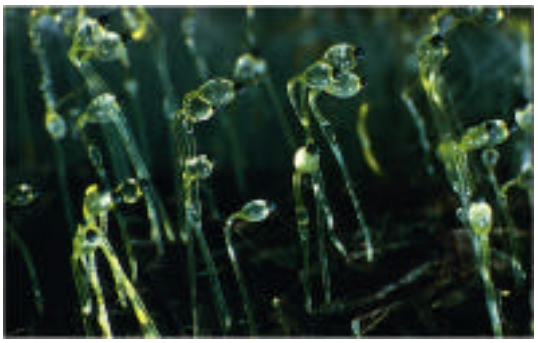




Conjugation to form Zygospores in *Rhizopus*



Pilobolus (an explosive zygomycete)

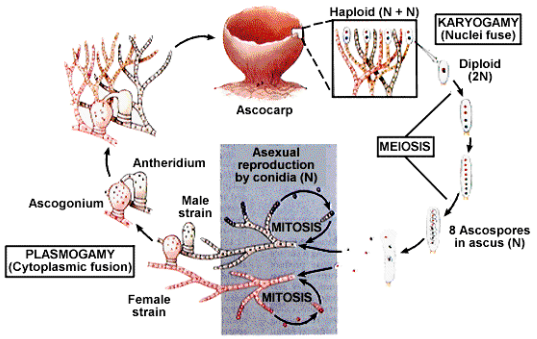


Fungi disperse their spores effectively

Ascomycota

- Sac fungi (sac-like structure called ascus - ascospores)
- Class Hemiascomycotina
  - Without ascocarps
    - Order Saccharomycetales
      - Yeast, *Saccharomyces cerevisiae*, Bakers yeast
      - Single cells make four naked ascospores
      - *Schizosaccharomyces* - fission yeasts
- Class Euascomycotina
  - With ascocarps
    - *Neurospora* (pink molds), chestnut blight, Dutch elm disease, cup fungi, morels, truffles
    - Some *Penicillium* and *Aspergillus* species

Ascomycota reproduction



Morels

Ascommycetes

Peziza (pigs ears)

Morel (Ascomycota)

Truffles

Ascoma

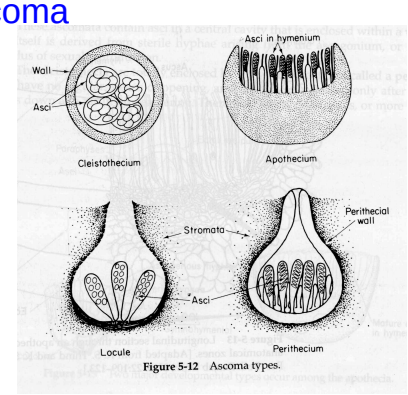


Figure 5-12 Ascoma types.

Apothecium

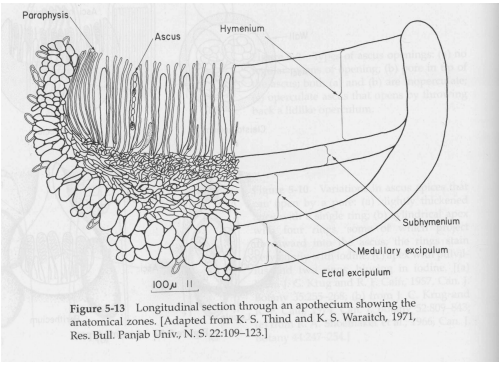


Figure 5-13 Longitudinal section through an apothecium showing the anatomical zones. [Adapted from K. S. Thind and K. S. Waraitch, 1971, Res. Bull. Panjab Univ., N. S. 22:109–123.]

Acsogonium and antheridium development

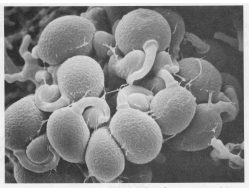
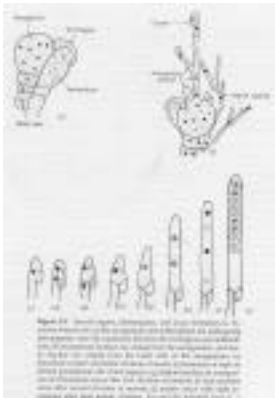


Figure 5-4 Scanning electron micrograph of the gametangia of *Pyronema domesticum*. The ascogonia are the balloonlike structures, and each is producing a tubular trichogyne that is in contact with a club-shaped antheridium. × 1000. [Courtesy K. L. O'Donnell.]

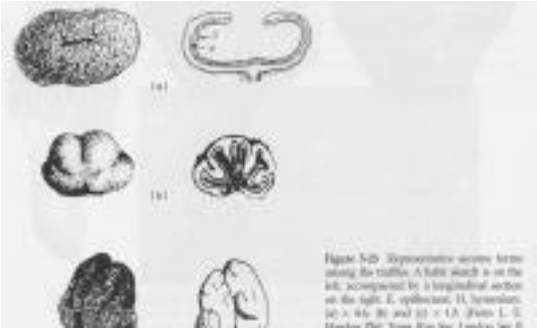


Cup fungus

Figure 5-21 Apothecia of *Sarcoscypha coccinea*, the scarlet elf cup, a member of the Pezizales. These apothecia are conspicuously colored, with an orange-red hymenium and a white exterior. About natural size. [Courtesy Plant Pathology Department, Cornell University.]

Order Pezizales

Truffles



Powdery mildews

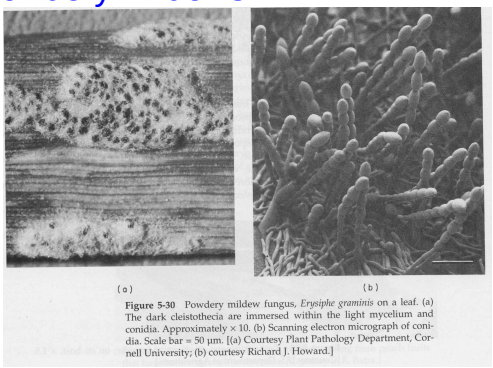
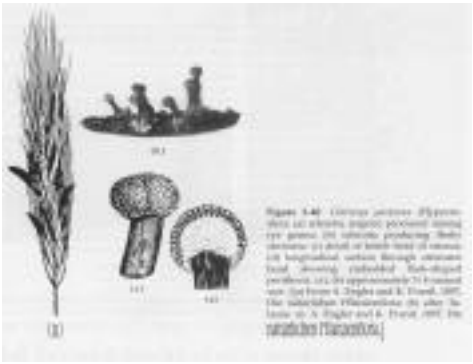
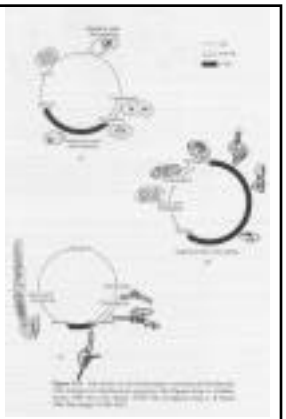


Figure 5-30 Powdery mildew fungus, *Erysiphe graminis* on a leaf. (a) The dark cleistothecia are immersed within the light mycelium and conidia. Approximately ×10. (b) Scanning electron micrograph of conidia. Scale bar = 50 μm. [(a) Courtesy Plant Pathology Department, Cornell University; (b) courtesy Richard J. Howard.]

Claviceps purpurea

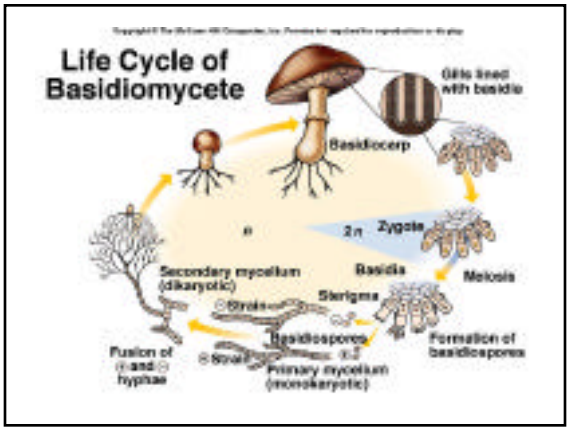


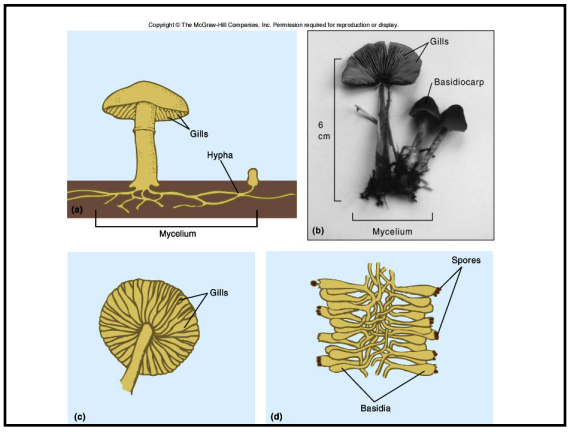
Saccharomyces cerevisiae

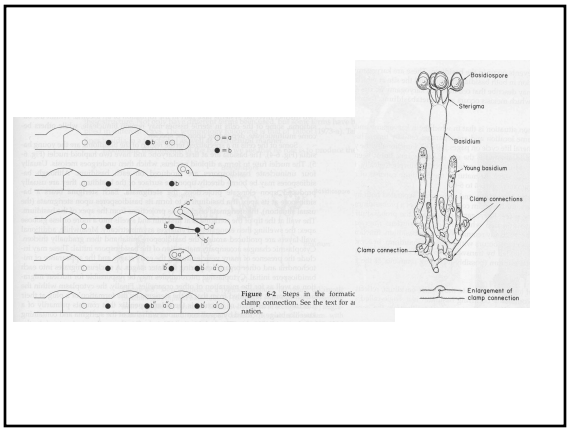


Basidiomycota

- ✓ Club fungi (clubbed shaped sexual structures called basidia-basidiospores)
- ✓ Mushrooms such as *Amanita*, Rust; *Cryptococcus neoformans*







Deuteromycota

- ✓Fungi imperfecti - most human pathogens
- ✓*Coccidioides immitis*, *Aspergillus*, *Penicillium*, *Candida albicans*

Candida albicans budding

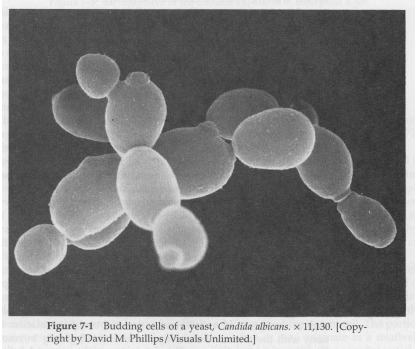
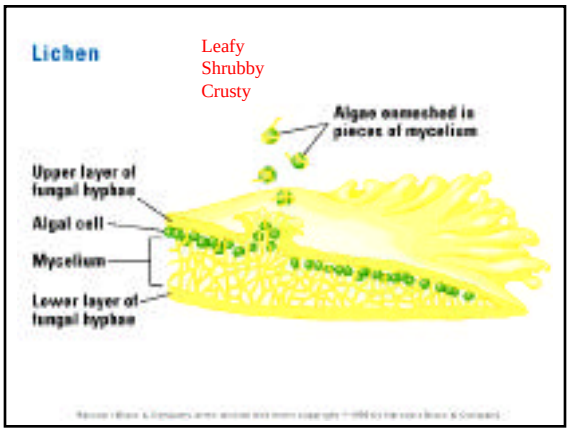
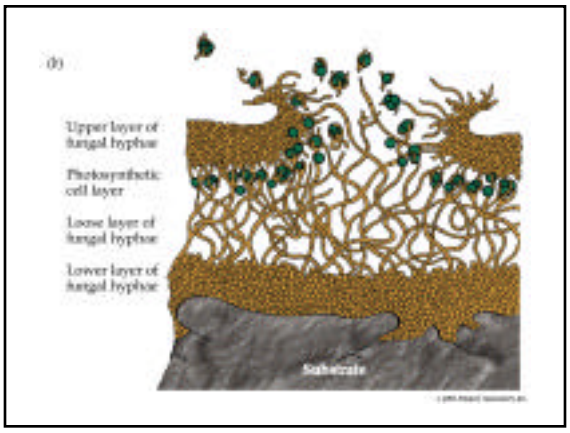
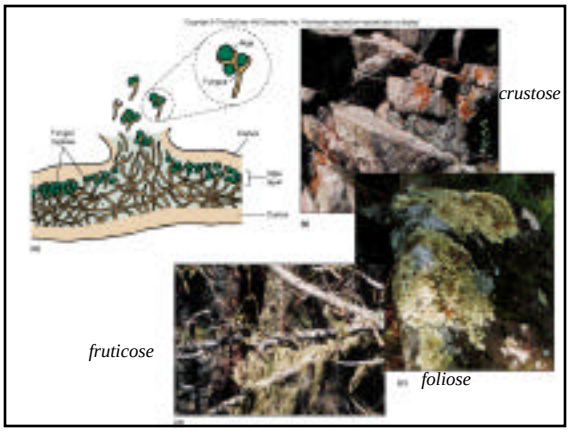


Figure 7-1 Budding cells of a yeast, *Candida albicans*. × 11,130. [Copyright by David M. Phillips/Visuals Unlimited.]

Aspergillus

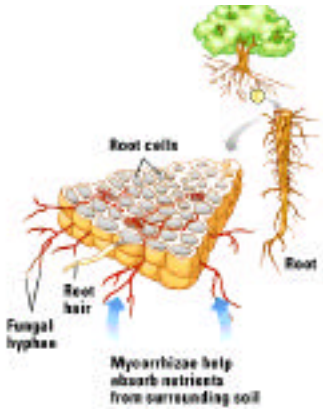




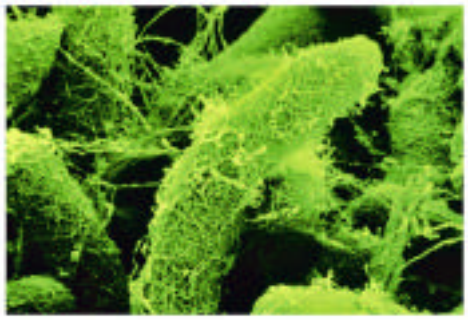


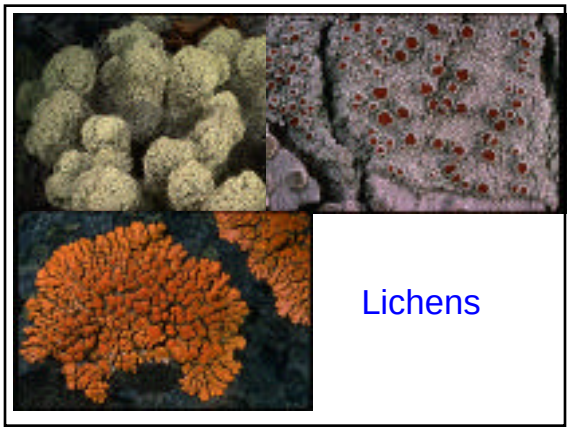
Mycorrhizae grow inside or along of the roots of trees and other plants

Endo and ecto



Ectomycorrhizae on an aspen root





Lichens

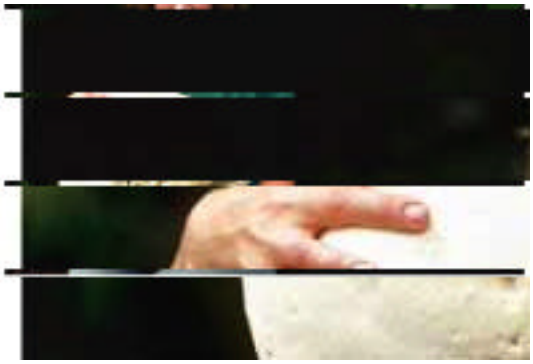
Mushrooms

Mushrooms

Puffball

Scarlet cup fungus (Ascomycota)

Giant puffball (*Lycopedon giganteum*)

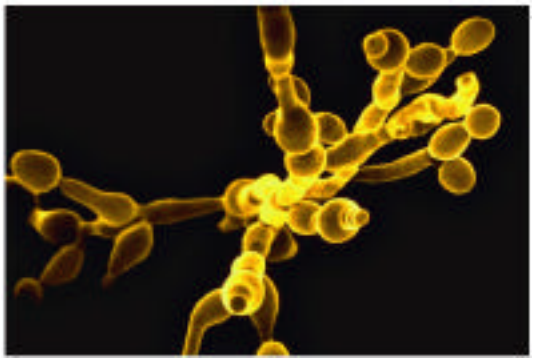


Shelf fungus

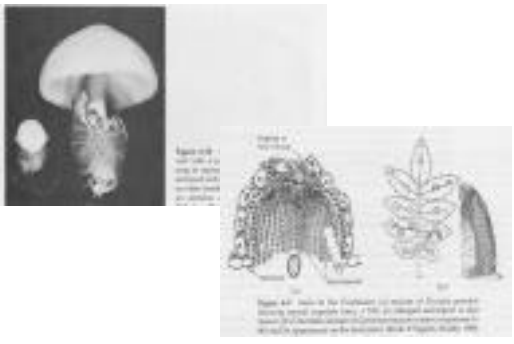
Fairy ring

Corn smut (aka *huitlacoche*)

Candida albicans



Basidiomycota



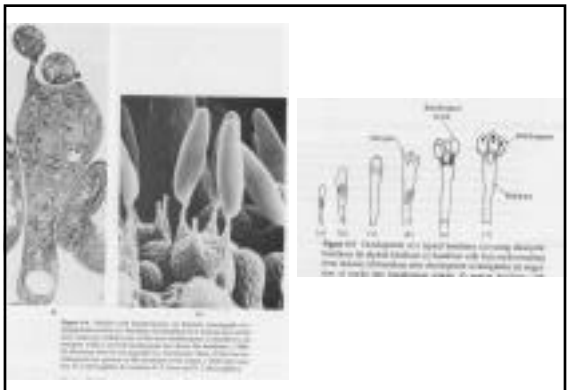


Figure 6-55 Bird's nest fungus, *Cyathus striatus*. [Courtesy O. K. Miller.]

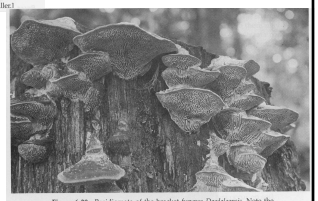


Figure 6-30 Basidiomata of the bracket fungus *Daedalopsis*. Note the irregularly shaped pores. Basidiomata range from 3 to 15 centimeters at their widest point. [From E. J. Moore and V. N. Rockcastle, Fungi, Cornell Science Leaflet.]

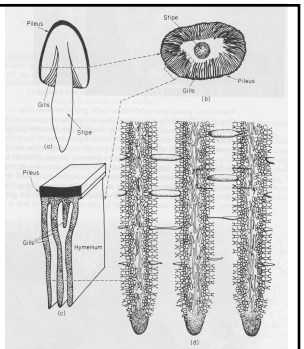


Figure 6-32 (a) Longitudinal section through *Coprinus*, a member of the Agaricales with gills; (b) cross-section through pileus; (c) three-dimensional view of a section of the gills; the hymenium covers the sheet-like surface; (d) section through the gills; note the cystidia that extend between the gills. [(a), (c), and (d) Adapted from A. H. R. Buller, 1924, Researches on fungi, Vol. 3, Longmans, Green & Co. Ltd., London.]

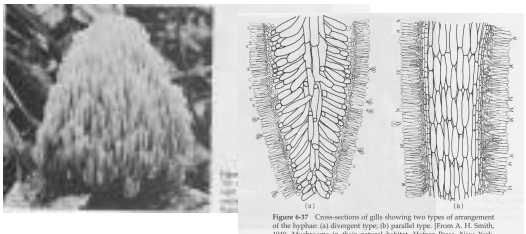


Figure 6-37 Cross-sections of gills showing two types of arrangement of the hyphae: (a) divergent type; (b) parallel type. [From A. H. Smith, 1949, Mushrooms in their natural habitat, Hafner Press, New York. Copyright GAF Corporation.]

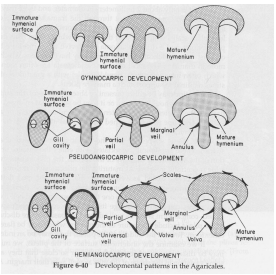


Figure 6-40 Developmental patterns in the Agaricales.

Figure 6-41 Basidiomata of the inky cap mushroom, *Coprinus*: (a) unopened basidiomata with conical pileus; (b) autolysis of the pileus results in the dripping of a black fluid containing basidiospores. [From E. J. Moore and V. N. Rockcastle, Fungi, Cornell Science Leaflet.]

Figure 6-19 Basidiomata of *Tremella fibuliformis*, a jelly fungus. The larger basidiomta is about 4 centimeters in diameter. [Courtesy J. S. Furtado.]

Pycnia

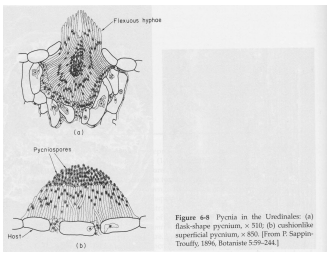
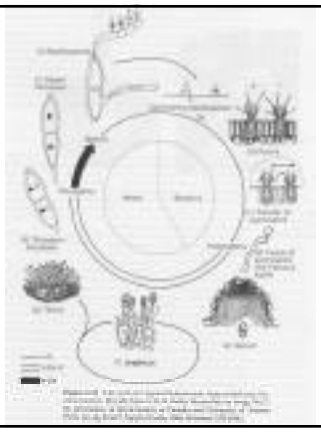


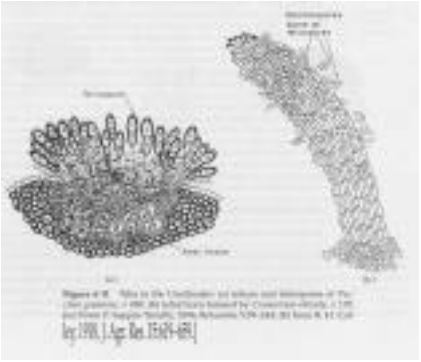
Figure 6-8 Pycnia in the Uredinales: (a) flask-shape pycnium, × 510; (b) cushionlike superficial pycnium, × 850. [From P. Sappin-Trouffy, 1896, Botaniste 5:99-244.]

Rust life cycle



Puffballs

Teliospores



Tubes in bracket fungi

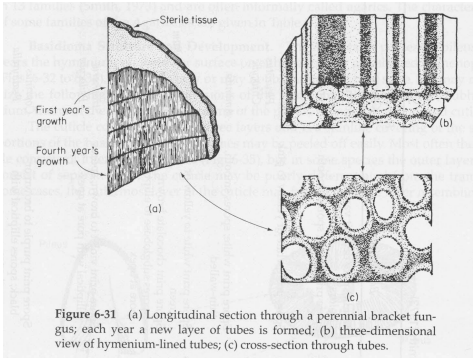


Figure 6-31 (a) Longitudinal section through a perennial bracket fungus; each year a new layer of tubes is formed; (b) three-dimensional view of hymenium-lined tubes; (c) cross-section through tubes.

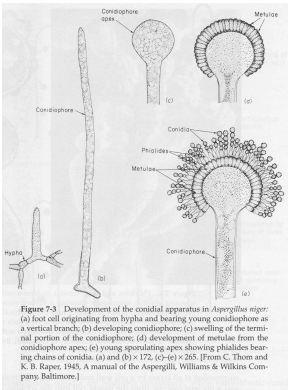
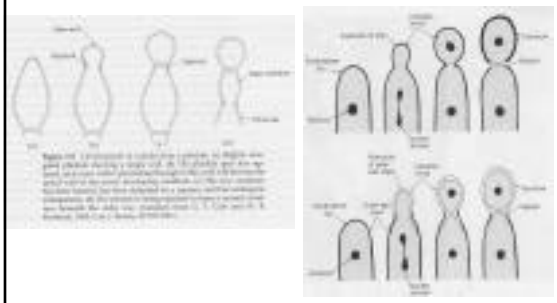
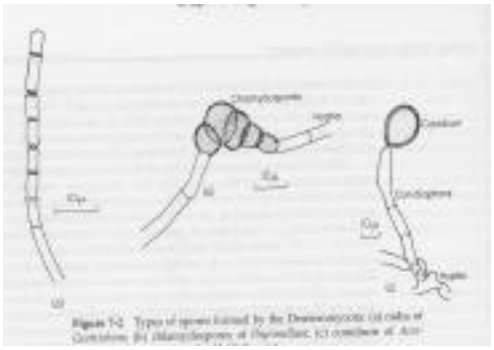


Figure 7-3 Development of the conidial apparatus in *Aspergillus niger*: (a) foot cell originating from hypha and bearing young conidiophore as a vertical branch; (b) developing conidiophore; (c) swelling of the terminal portion of the conidiophore; (d) development of metulae from the conidiophore apex; (e) young sporulating apex showing phialides bearing chains of conidia. (a) and (b) × 172, (c)–(e) × 265. [From C. Thom and K. B. Raper, 1945, A manual of the Aspergilli, Williams & Wilkins Company, Baltimore.]

Conidia development



Chlamydospores



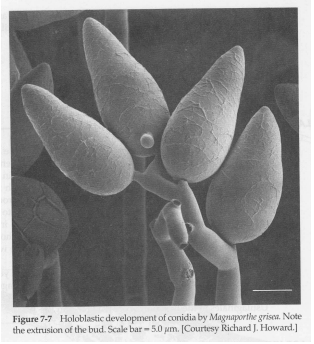
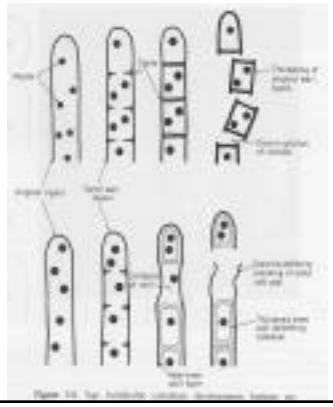


Figure 7-7 Holoblastic development of conidia by *Magnaporthe grisea*. Note the extrusion of the bud. Scale bar = 5.0 μm. [Courtesy Richard J. Howard.]



Pycnidia