Kingdom: Fungi (Eumycota)

- *Sphongos* (Greek:): "spongy"
  - ☛ *Fungus* (Latin): "mushroom"
- *Mycos* (Greek): "mushroom"

- **Mycology**: the study of fungi
  - Eukaryotic
  - Multicellular (most) with limited differentiation
  - Chitinous cell walls
  - ~100,000 named species
    - ~ a third with unclear taxonomy
  - Heterotrophic with external digestion
  - Haploid life history

Kingdom: Fungi (Eumycota)

Fungal **mycelium** (body) is comprised of many **hyphae** (tubular filaments)

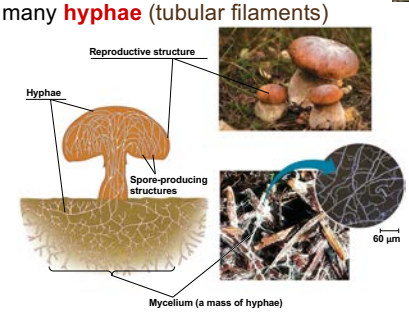
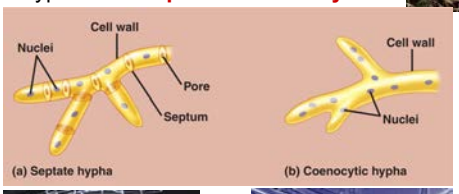


Fig. 31.2

Kingdom: Fungi

Hyphae are **septate** or **coenocytic**

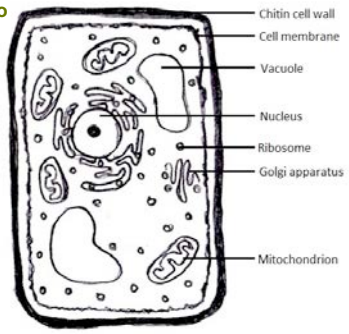


Fungal Cell

Structurally similar to plant cell

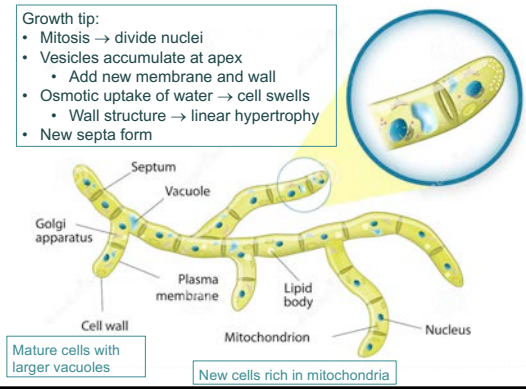
- Large central vacuole
- Cell wall
  - But primarily of chitin rather than cellulose
- [No plastids]

But biochemically & genetically more similar to animal cell

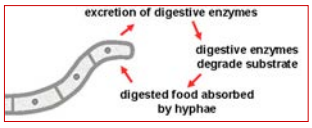


Hypha structure & growth

Growth tip:
- Mitosis → divide nuclei
- Vesicles accumulate at apex
  - Add new membrane and wall
- Osmotic uptake of water → cell swells
  - Wall structure → linear hypertrophy
- New septa form



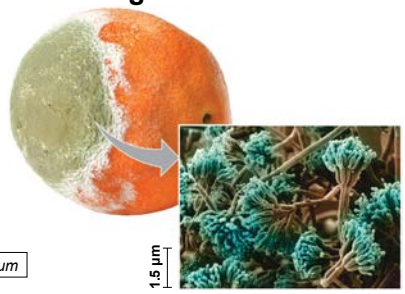
Kingdom: Fungi



Heterotrophic

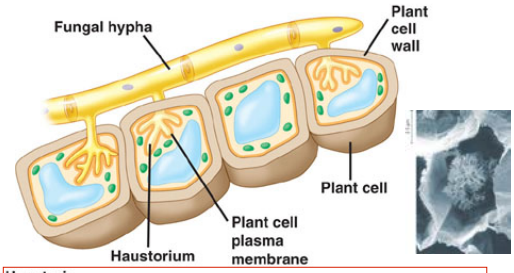
- Secrete exoenzymes for external digestion
- Absorb nutrients from environment
  - Usually store fuel as glycogen (like animals) rather than starch (like plants)
- Most are **saprobic**
  - Major decomposers
- Many are **parasitic**
- Many are **mutualistic symbionts**
- Some are **predatory**!

Saprobic Fungi



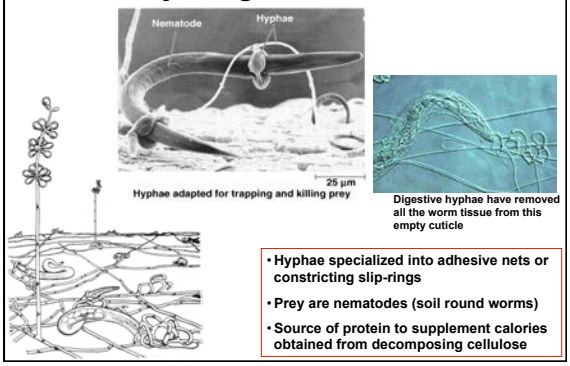
- Hyphae penetrate soil or decaying tissues
- Erect sporangia to disperse spores

Symbiotic Fungi



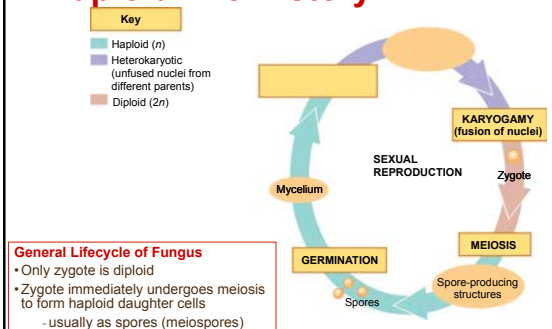
(b) Haustoria
- Present in many symbiotic (incl. parasitic) species
- Specialized branches off of hyphae
- Note: penetrate cell wall, but not plasma membrane

Predatory Fungi



- Hyphae specialized into adhesive nets or constricting slip-rings
- Prey are nematodes (soil round worms)
- Source of protein to supplement calories obtained from decomposing cellulose

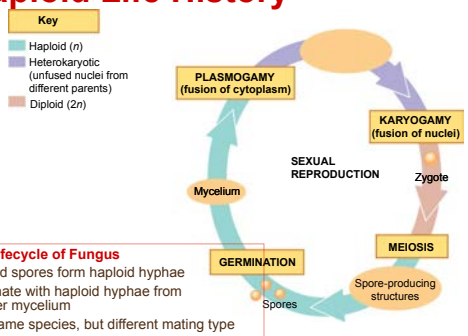
Haploid Life History



General Lifecycle of Fungus
- Only zygote is diploid
- Zygote immediately undergoes meiosis to form haploid daughter cells
  - usually as spores (meiospores)

Fig. 31.5

Haploid Life History

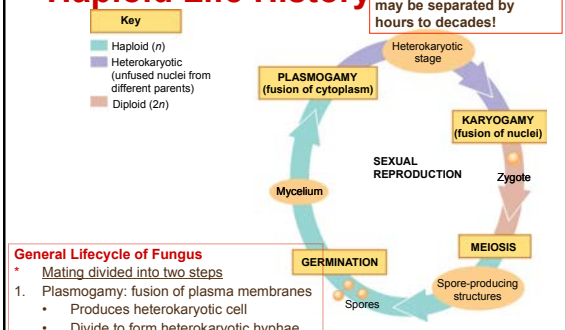


General Lifecycle of Fungus
- Haploid spores form haploid hyphae
- May mate with haploid hyphae from another mycelium
  - Same species, but different mating type
    - Prevent mating with its own hyphae
  - Attracted by pheromones

Fig. 31.5

Haploid Life History

Plasmogamy & karyogamy may be separated by hours to decades!

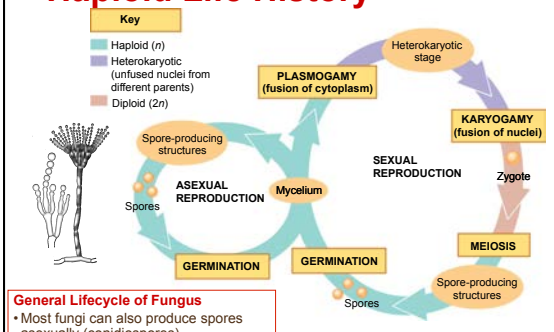


General Lifecycle of Fungus
* Mating divided into two steps

1. Plasmogamy: fusion of plasma membranes
   - Produces heterokaryotic cell
   - Divide to form heterokaryotic hyphae
2. Karyogamy: fusion of dikaryotic nuclei
   - Produce diploid zygote

Fig. 31.5

Haploid Life History



General Lifecycle of Fungus
- Most fungi can also produce spores asexually (conidiospores)
- (Many *only* produce spores asexually)

Fig. 31.5

Fungal Phyla (Divisions)

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

Zygomycota

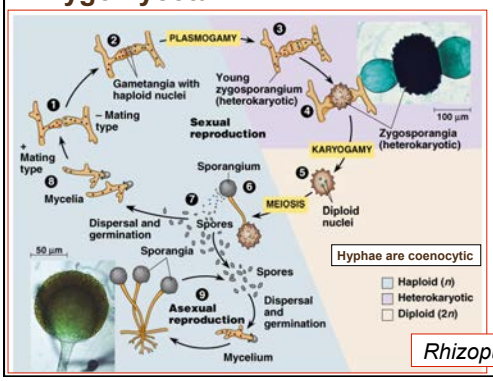
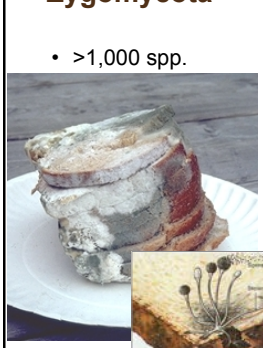


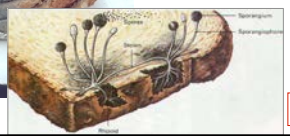
Fig. 31.12

Rhizopus sp.

Zygomycota

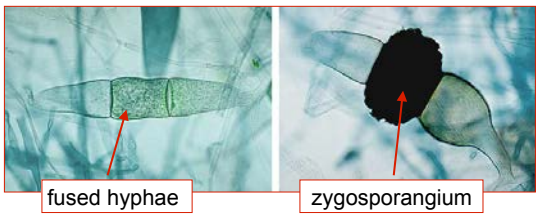
- >1,000 spp.



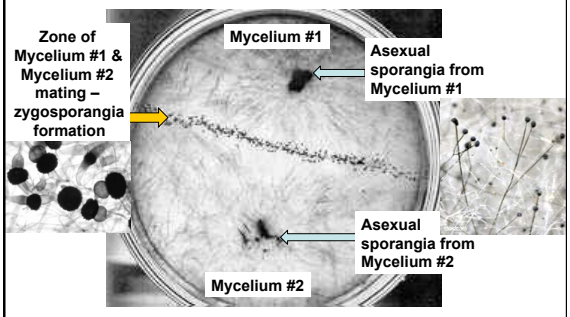


Rhizopus sp.

Zygomycota



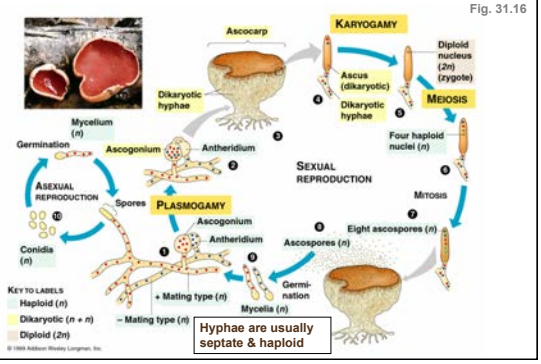
Rhizopus sp.



Rhizopus sp.

Ascomycota (sac fungi)

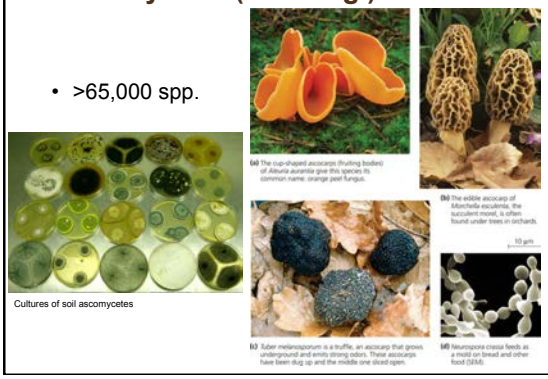
Fig. 31.16



Hyphae are usually septate & haploid

Ascomycota (sac fungi)

- >65,000 spp.

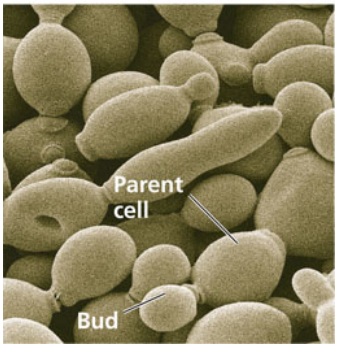


Cultures of soil ascomycetes

Ascomycota (sac fungi)

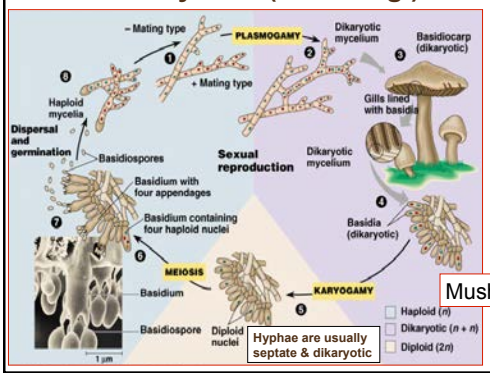
10 µm

Yeasts —
- Single-celled ascomycetes



Basidiomycota (club fungi)

Fig. 31.18



Mushroom

Hyphae are usually septate & dikaryotic

Basidiomycota (club fungi)

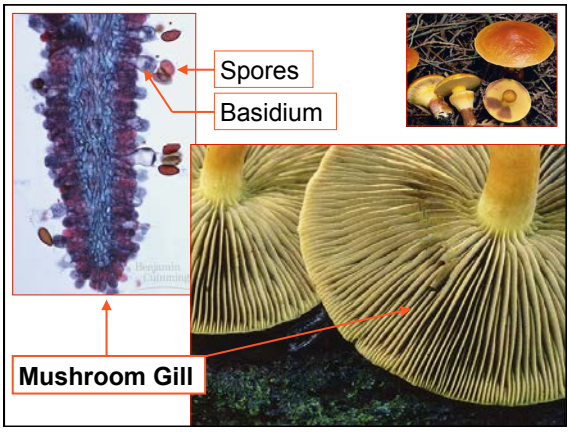
~30,000 spp.

Basidiomycota (club fungi)

Mushroom

Fruiting Bodies

Shelf Fungus



"Fairy Rings"



Transient fruiting bodies (basiocarps) where the periphery of one mycelium encounters & mates with surrounding mycelia.

Ecological Importance

Decomposers

Able to decompose usually nondigestible polymers,
e.g., cellulose, lignin, waxes, chitin, keratin, etc.

Ecological Importance

Cause of disease: in animals (mycosis)


Athlete's foot


Yellow-legged frogs killed by chytrid infection

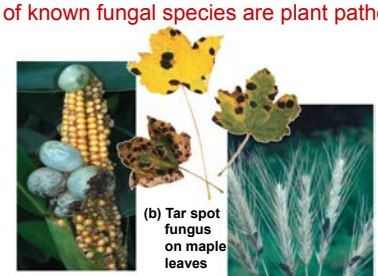

Dermatophytosis ("ringworm")


Entamapathogenic fungus

Ecological Importance

Cause of disease: in plants

~30% of known fungal species are plant pathogens


(a) Corn smut on corn

(b) Tar spot fungus on maple leaves

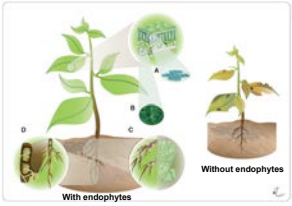
(c) Ergots on rye

Ecological Importance

Mutualistic Endophytic (within plants) Fungi

Found within the cell walls of **nearly all plants**, esp. in leaves.

- **Resistance to osmotic or temp stress**
- **Produce toxins against consumers, esp. insects**
- **Provide pathogen resistance**

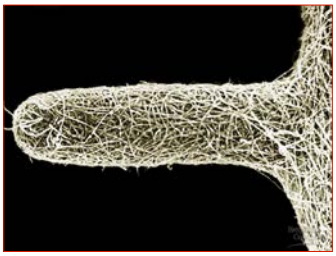


Soil Temp.	Endophyte (*Curvularia*) + or –	Plant Mass (g)	# New Shoots
30°C	E– E+	16.2 22.8	32 60
35°C	E– E+	21.7 28.4	43 60
40°C	E– E+	8.8 22.2	10 37
45°C	E– E+	0 15.1	0 24

R. S. Redman et al., Thermotolerance generated by plant/fungal symbiosis, *Science* 298: 1581 (2002).

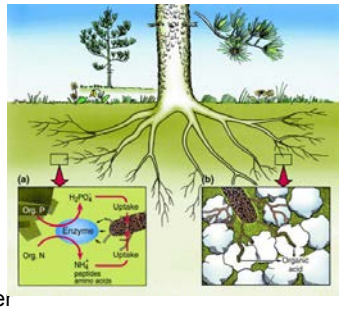
Ecological Importance

Symbiotic relationships: **mycorrhizae**



Mycorrhizae

- Decompose organic matter in soil
  - –Free up inorganic nitrogen & phosphorus compounds
- Produce organic acids
  - –Dissolve minerals from soil particles
- Increase surface area to absorb water & inorganic nutrients

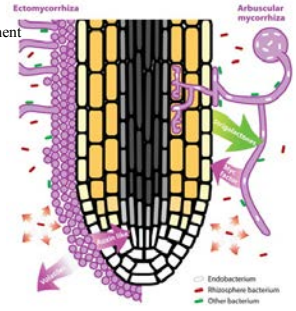


Mycorrhizae

Ectomycorrhiza & Endomycorrhiza

Rhizosphere: special root environment

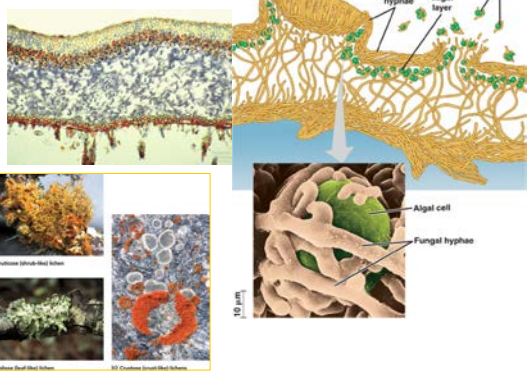
- Roots secrete substances -
  - stimulate germination of mycorrizzal spores & attract growing mycorrizzal hyphae
- Mycorrizza secrete substances -
  - stimulate growth of root tips
- Mycorrizza secrete volatile organics -
  - stimulate growth of beneficial soil bacteria



Ecological Importance

Symbiotic relationships: **lichens**

Symbiotic relationships: **lichens**



Human Uses

Food

Human Uses

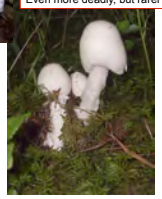
Food

Warning:
Edible & poisonous varieties are difficult to distinguish!

Esp. genus *Amanita*

Death cap, ***Amanita phalloides***
>50% of mushroom poisonings

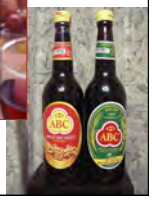
Destroying angel,
A. bisporiga
Even more deadly, but rarer



Fly agaric, ***A. muscaria***
Insecticidal & hallucinogenic

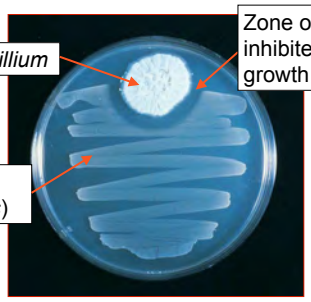
Human Uses

Food Processing



Human Uses – Myco-Pharmaceuticals

Antibiotics



Penicillium

Zone of inhibited growth

Bacteria (*Staphylococcus*)

Human Uses – Myco-Pharmaceuticals

Psycho-active mushrooms

- psilocybin / psilocin (serotonin analogs)
- adrenalin-like rush
- visual/auditory hallucinations

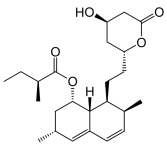
- *Psilocybe zapotecorum.* Jalisco, Mexico

- Mesoamerican mushroom stones

Human Uses – Myco-Pharmaceuticals

Statins

- Lower blood cholesterol



- Lovastatin from *Aspergillus terreus* and *Pleurotus ostreatus* (oyster mushroom)

Human Uses

Bioremediation (Mycoremediation)

Clean up contaminated environments

- Decompose organic toxins
  - petroleum, pesticides, plastics, etc.
- Accumulate inorganic toxins
  - heavy metals, incl. radioactive wastes

Oyster mushrooms used to clean up 2007 fuel oil spill in San Francisco Bay