

Dr SR SIVAKUMAR
Assistant Professor
Department of Botany
Bharathidasan University
Tiruchirappalli-24

Fungi

Introduction

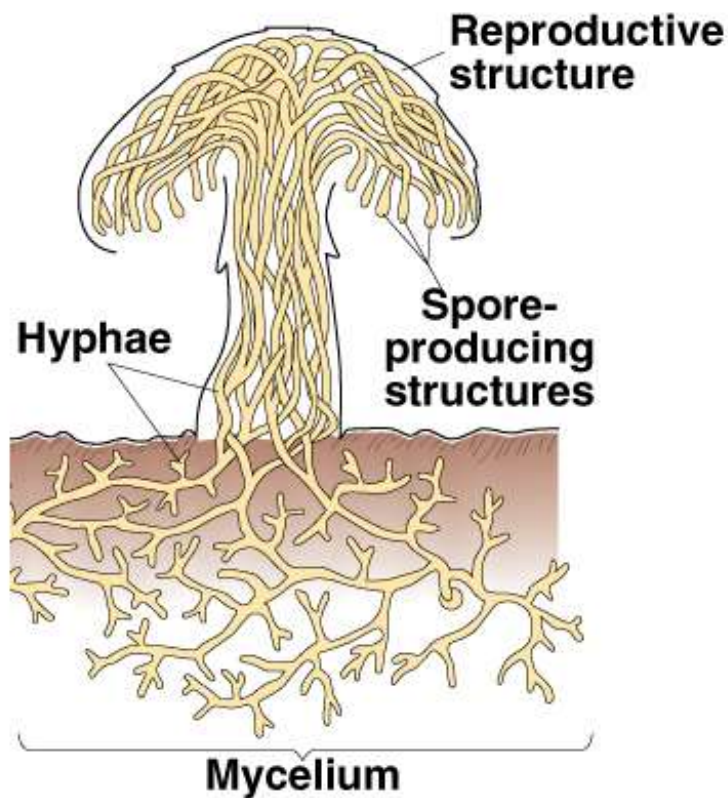


- Fungi are eukaryotes
- Nearly all multicellular (yeasts are unicellular)
- Distinguished from other kingdoms by:
 - Nutrition
 - Structural organisation
 - Growth
 - Reproduction

Absorptive nutrition enables fungi to live as decomposers and symbionts

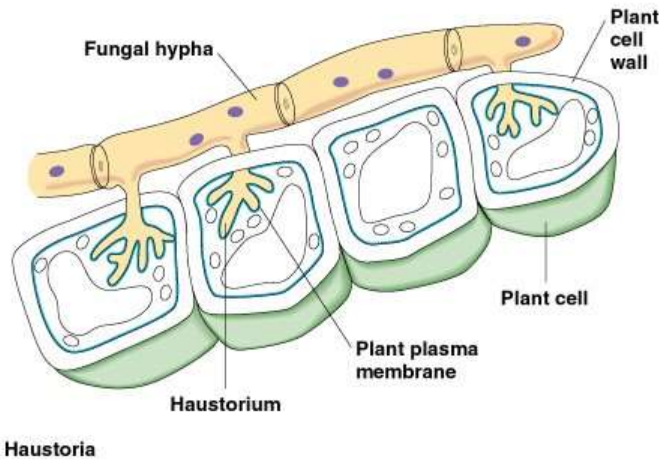
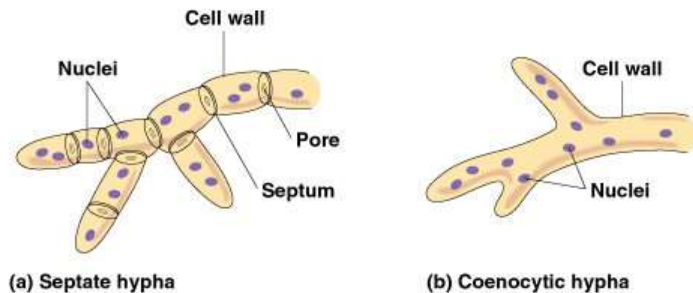
- Fungi are heterotrophs that acquire nutrients by absorption
- Secrete hydrolytic enzymes and acids to decompose complex molecules into simpler ones that can be absorbed
- Specialised into three main types:
 - Saprobes - absorb nutrients from dead organic material
 - Parasitic fungi - absorb nutrients from cells of living hosts; some are pathogenic
 - Mutualistic fungi - absorb nutrients from a host, but reciprocate to benefit the host

Extensive surface area and rapid growth adapt fungi for absorptive nutrition



- Basic structural unit of fungal vegetative body (mycelium) is the hypha
- Except for yeast, hyphae are organised around and within food source:
 - Composed of tubular walls containing chitin
 - Provide enormous surface area: 10cm² of soil may contain 1km of hyphae with 314cm² surface area

Fungal hyphae may be septate or aseptate

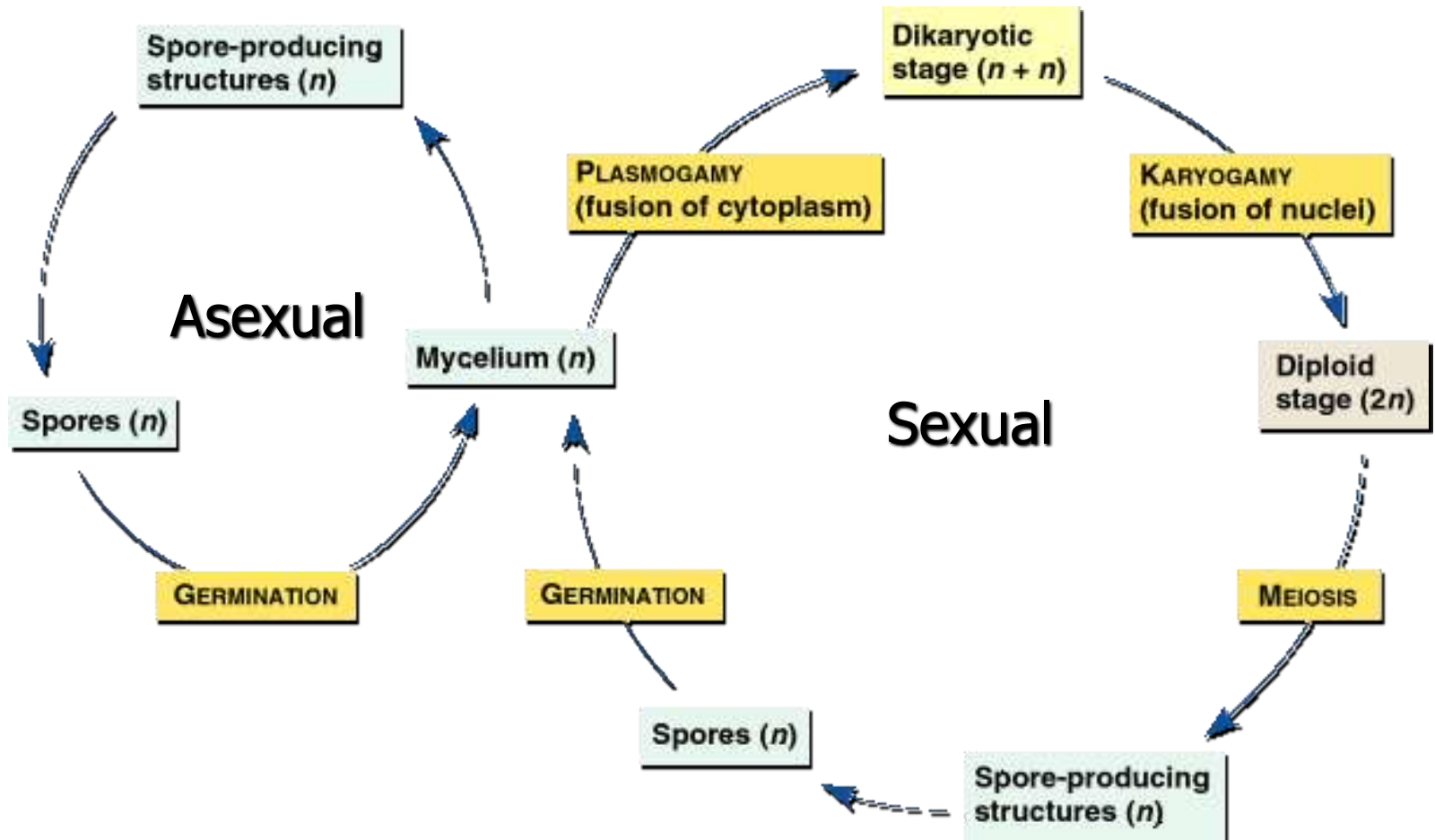


- Hyphae of septate fungi are divided into cells by crosswalls called septa
- Hyphae of aseptate fungi lack cross walls (coenocytic)
- Parasitic fungi have modified hyphae called haustoria, which penetrate the host tissue but remain outside cell membrane

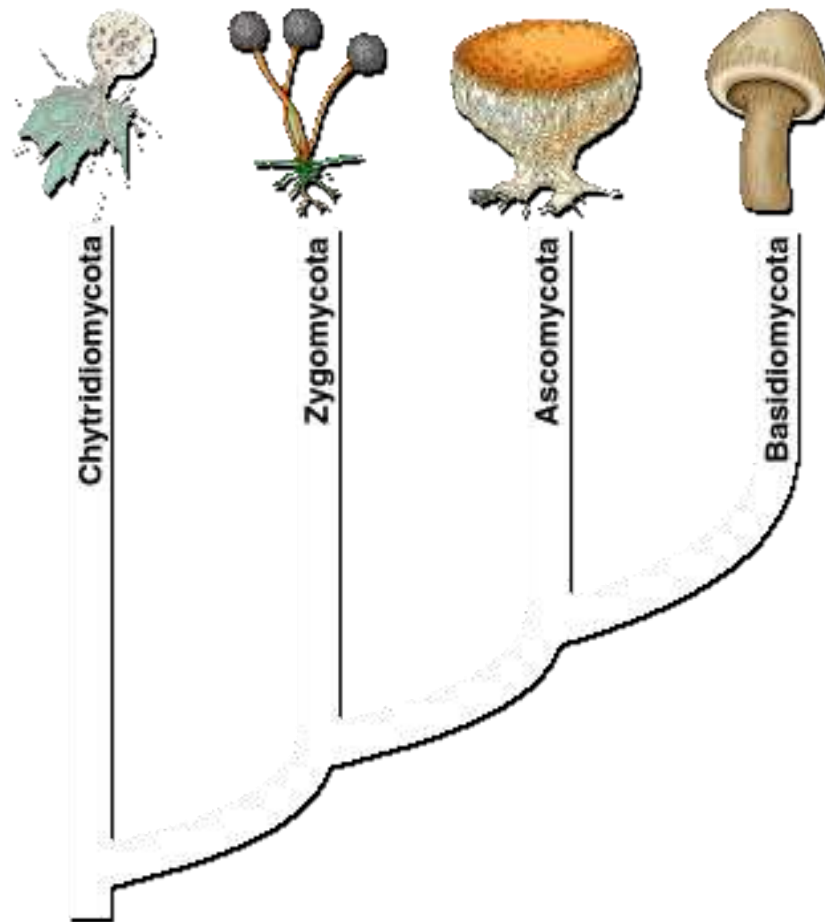
Fungi reproduce by releasing spores that are produced either sexually or asexually

- Usually unicellular, haploid and of various shapes and sizes
- Produced either sexually (by meiosis) or asexually (by mitosis)
 - In favourable conditions, fungi generally clone themselves by producing enormous numbers of spores asexually
 - For many fungi, sexual reproduction only occurs as a contingency - results in greater genetic diversity
- Spores are the agent of dispersal responsible for geographic distribution of fungi:
 - Carried by wind or water
 - Germinate in moist places with appropriate substrata

Generalised life cycle of fungi



Phylogeny of fungi



Division Chytridiomycota: chytrids may provide clues about fungal origins



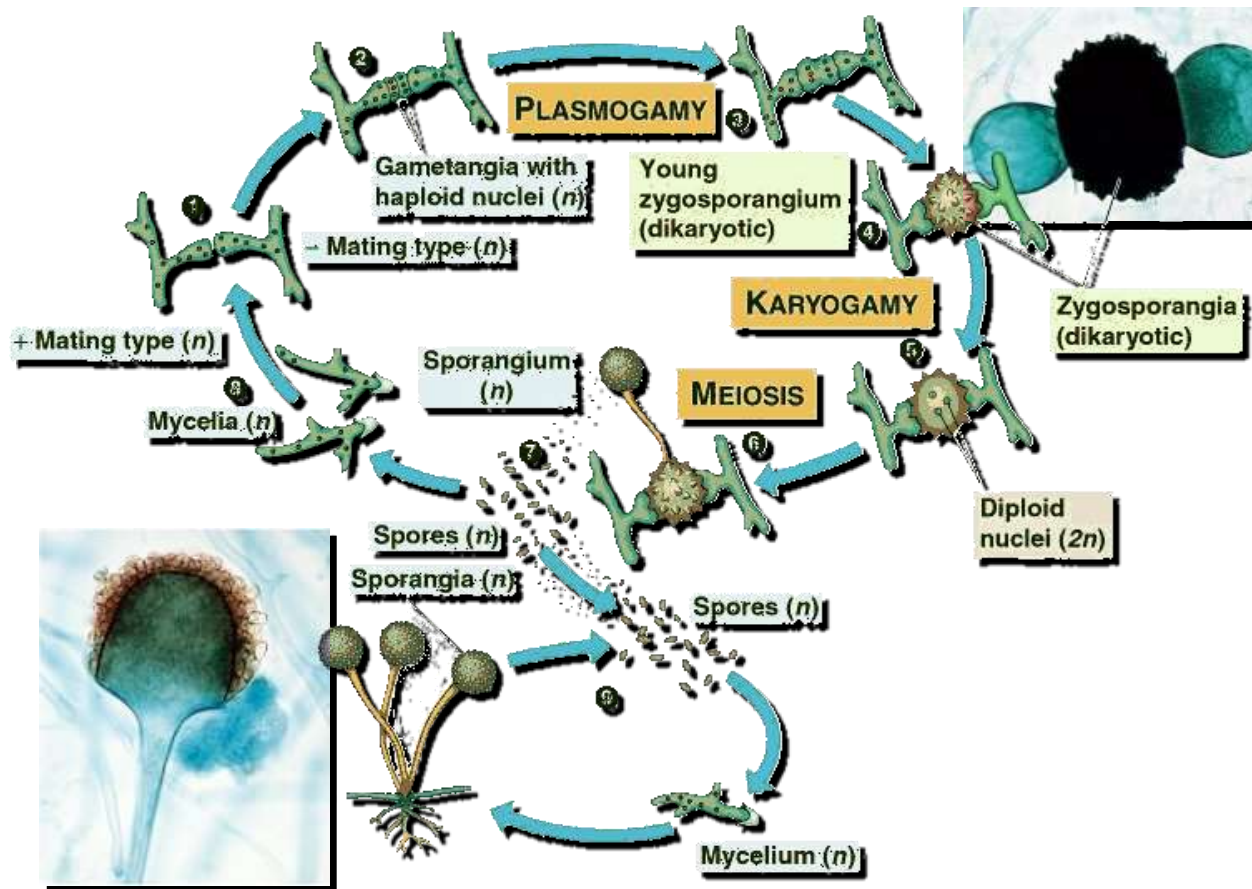
- Originally placed in Kingdom Protista
- Share many characteristics with fungi:
 - Absorptive nutrition
 - Chitin cell walls
 - Hyphae
 - Enzymes / metabolism
- Earliest fungi: evolved from protists and retained flagella

Division Zygomycota: dikaryote structures formed during sexual reproduction



- Characterised by dikaryotic zygosporangia
- Mostly terrestrial - live in soil or decaying material
- Some form mycorrhizae, mutualistic associations with plant roots
- Hyphae are coenocytic - septa only found in reproductive cells

Life cycle of the zygomycete *Rhizopus stolonifer*, a common bread mould



Life cycle of the zygomycete *Rhizopus stolonifer*, a common bread mould

- Under favourable conditions, reproduces asexually:
 - Sporangia develop at tips of hyphae
 - Mitosis produces hundreds of haploid spores
- In unfavourable conditions, sexual reproduction occurs:
 - Mycelia of opposite mating types (+ and -) form gametangia that contain several haploid nuclei walled off by the septum
 - Plasmogamy of gametangia occurs → dikaryotic zygosporangium
 - Under favourable conditions, karyogamy occurs: diploid nuclei immediately undergo meiosis producing haploid spores
 - Zygosporangium germinates sporangium which releases recombined haploid spores

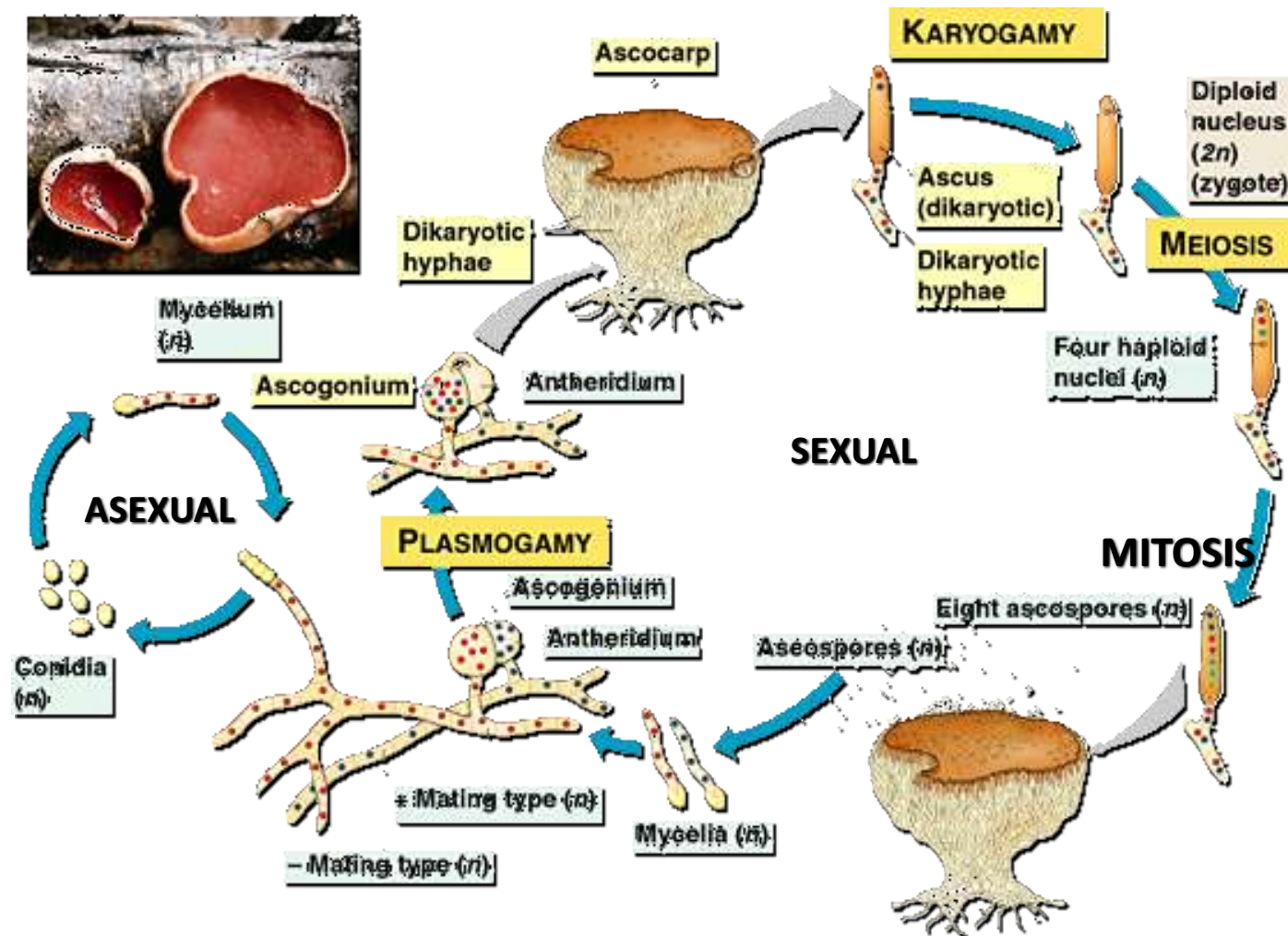
Division Ascomycota: sac fungi

produce sexual spores in saclike asci



- Include unicellular yeasts and complex multicellular cup fungi
- Hyphae are septate
- In asexual reproduction, tips of specialised hyphae form conidia - chains of haploid asexual spores
- In sexual reproduction, haploid mycelia of opposite mating strains fuse

Life cycle of an ascomycete

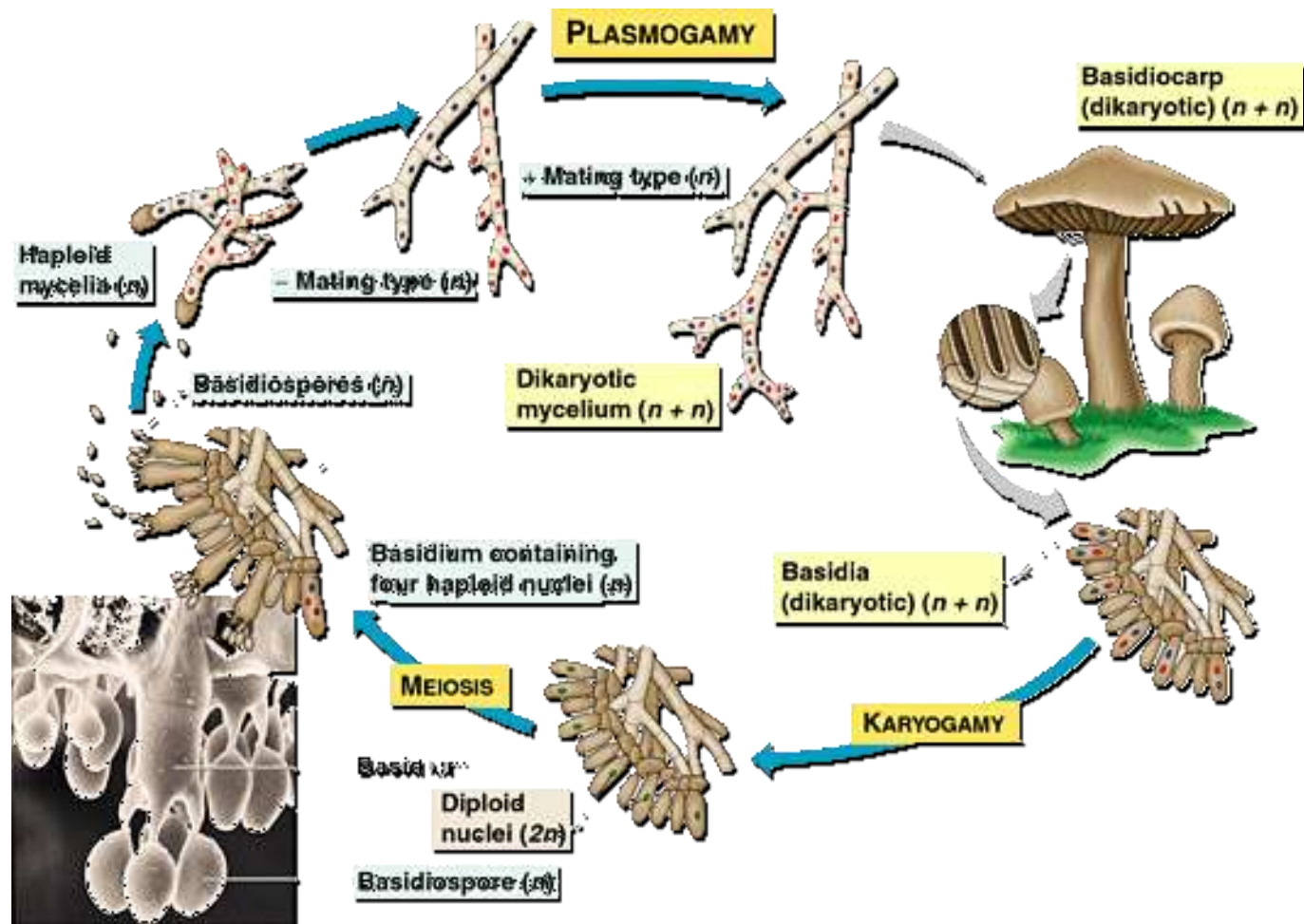


Division Basidiomycota: club fungi



- Named after transient diploid stage: basidium
- Important decomposers of wood / plant material
- Include:
 - Mycorrhiza-forming mutualists
 - Mushroom-forming fungi
 - Plant parasites e.g. rusts and smuts
- Characterised by dikaryotic mycelium that reproduces sexually via basidiocarps

Life cycle of a mushroom-forming basidiomycete

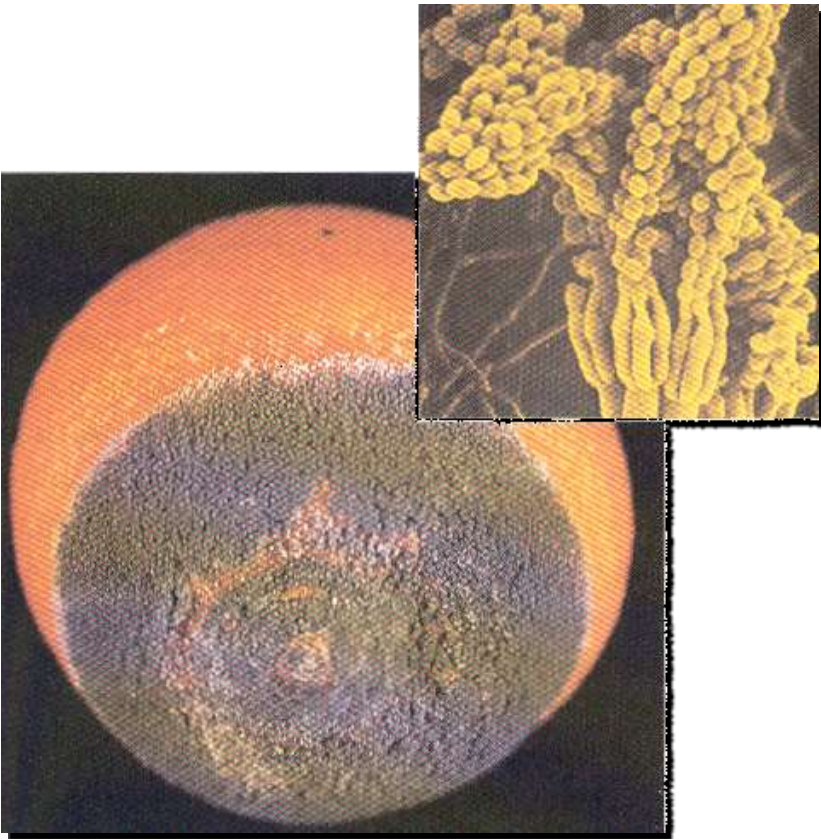


Life cycle of a mushroom-forming basidiomycete

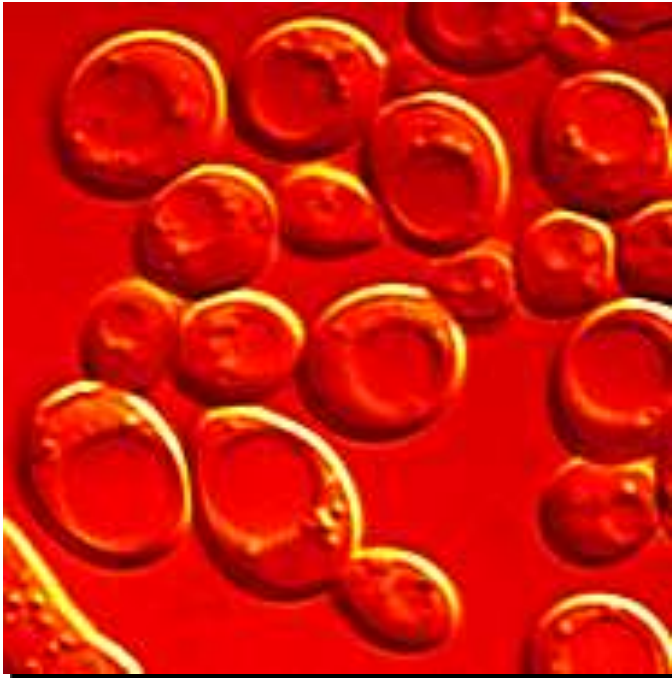
- Haploid basidiospores grow into short-lived haploid mycelia: under certain conditions, plasmogamy occurs
- Resulting dikaryotic mycelium grows forming mycorrhiza or mushrooms (basidiocarps)
- Mushroom cap supports and protects gills: karyogamy in the terminal, dikaryotic cells lining the gills produces diploid basidia
- Resulting basidium immediately undergoes meiosis producing four haploid basidiospores
- Asexual reproduction less common than in ascomycetes

Moulds

- Rapidly growing fungus with no sexual stages
- May develop into a sexual fungus, producing zygosporangia, ascocarps or basidiocarps
- Moulds with no known sexual stage are known as Deuteromycota or imperfect fungi:
 - *Penicillium*
 - Flavour for blue cheeses



Yeasts



- Unicellular: reproduce
 - Asexually by budding
 - Sexually by producing asci or basidia
- *Saccharomyces cerevisiae* is most important domesticated fungus:
 - Baking and brewing
 - Model organism
- Can cause problems:
 - *Rhodotorula*: shower curtains
 - *Candida*: “thrush”

Lichens



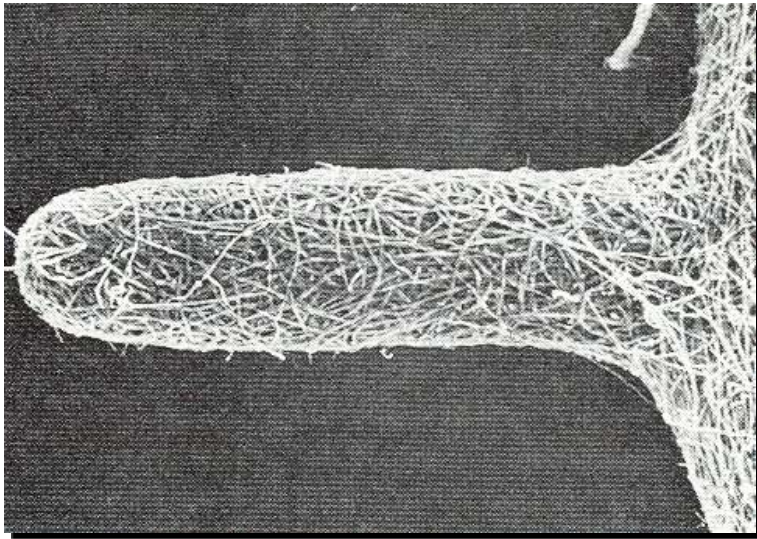
- Symbiosis of algae with fungal hyphae
- The alga:
 - Provides fungus with food
 - May fix nitrogen
- Fungus provides good environment for growth:
 - Hyphal mass absorbs minerals and protects algae
 - Produces compounds that:
 - shield algae from sunlight
 - are toxic - prevents predation

Lichen reproduction



- Occurs as a combined unit or independently
- Fungi reproduce sexually (usually ascocarps)
- Algae reproduce asexually by cell division
- Symbiotic units reproduce asexually by:
 - Fragmentation of parent
 - Formation of soredia: small clusters of hyphae with embedded algae

Mycorrhizae



- Specific, mutualistic association of plant roots and fungi
- Fungi increase absorptive surface of roots and exchange soil minerals
- Found in 95% of vascular plants
- Necessary for optimal plant growth

Ecological impacts of fungi

- Ecosystems depend on fungi as decomposers and symbionts: decompose food, wood and even plastics!
- Some fungi are pathogens e.g. athlete's foot, ringworm etc.:
 - Plants particularly susceptible (e.g. Dutch elm disease)
 - Ergot - affects cereal crops: causes gangrene, hallucinations and "St. Anthony's fire"
- Many animals, including humans, eat fungi:
 - In US, mushroom consumption restricted to *Agaricus*
 - We eat a range of cultivated and wild mushrooms
 - Truffles are underground ascocarps of mycelia that are mycorrhizal on tree roots