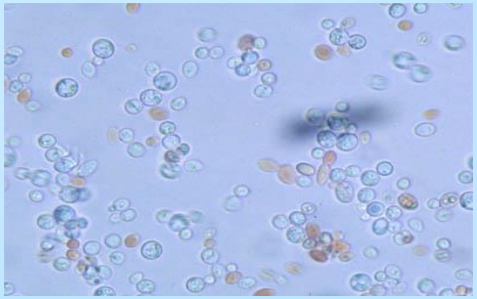
Kingdom Fungi

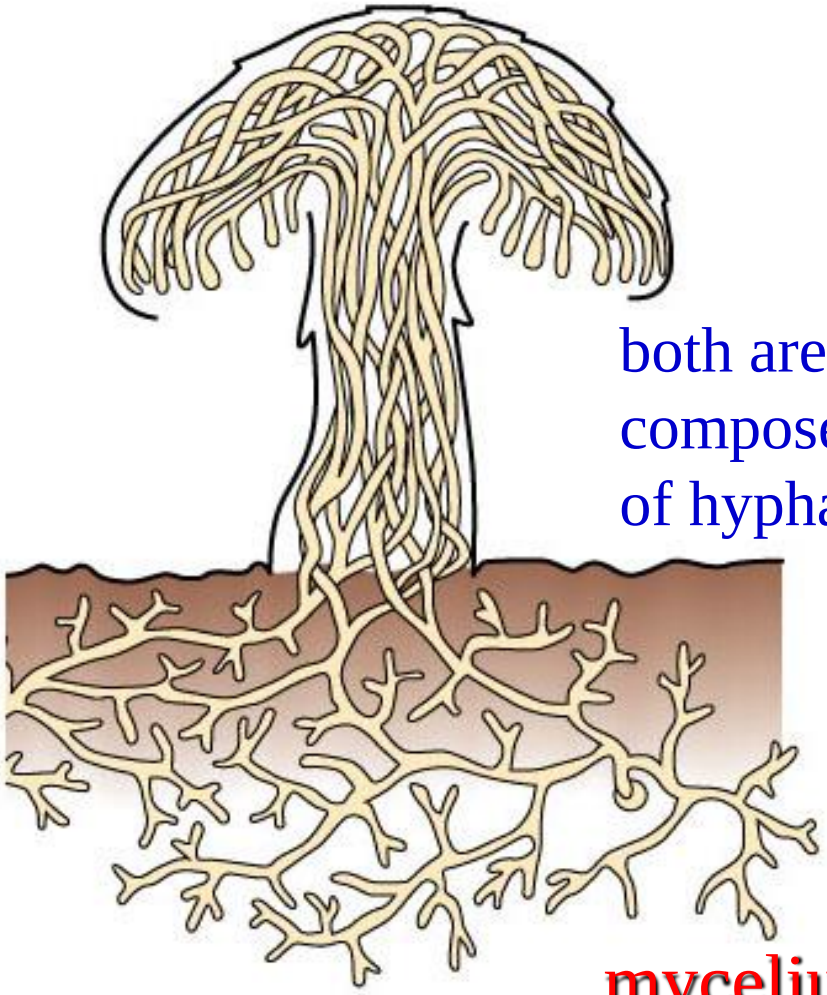
- The characteristics of fungi
- The evolution of the fungi
- Fungal classification
- Fungal life cycles

The Characteristics of Fungi

- Body form
  - * unicellular
  - * filamentous (tube-like strands called hypha (singular) or hyphae (plural)
  - * mycelium = aggregate of hyphae
  - * sclerotium = hardened mass of mycelium that generally serves as an overwintering stage.
  - * multicellular, such as mycelial cords, rhizomorphs, and fruit bodies (mushrooms)



fruiting bodies



both are composed of hyphae

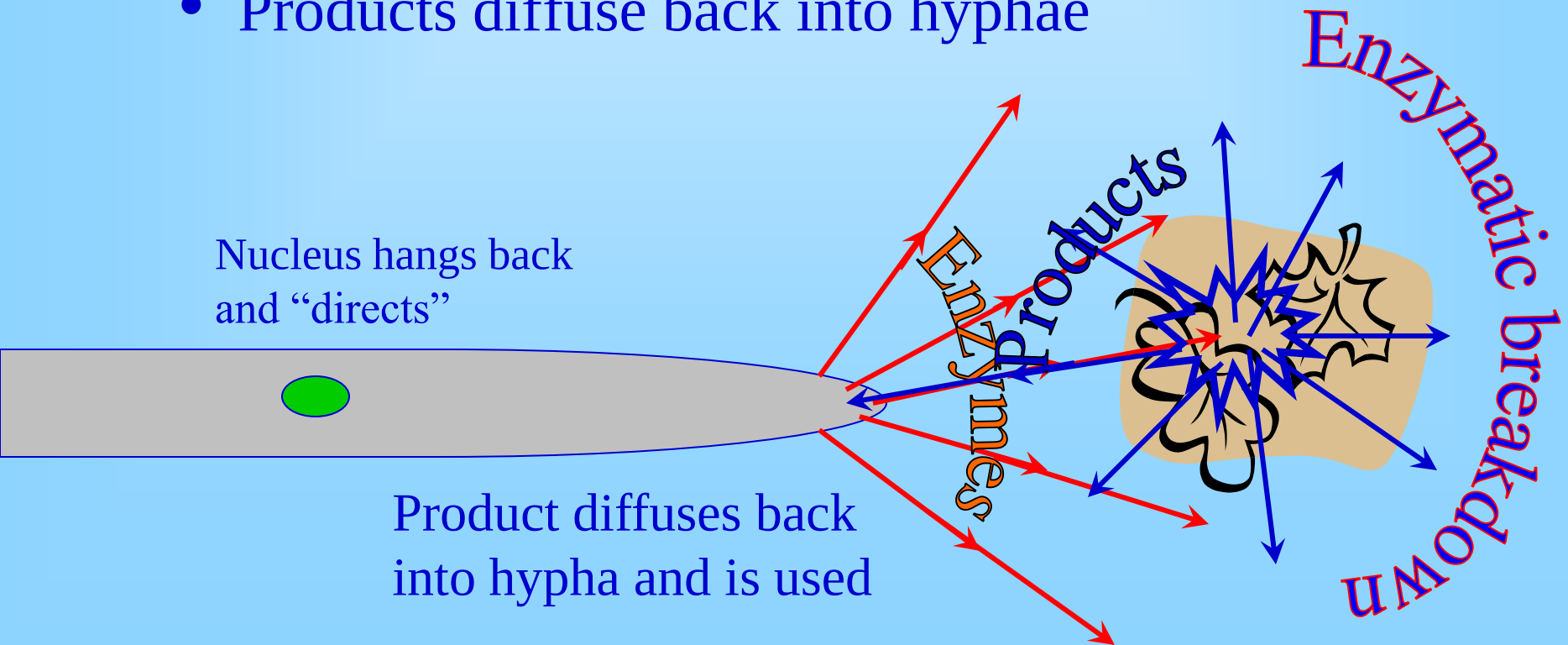
mycelium

The Characteristics of Fungi

- Heterotrophy - 'other food'
  * Saprophytes or saprobes - feed on dead tissues or organic waste (decomposers)
  * Symbionts - mutually beneficial relationship between a fungus and another organism
  * Parasites - feeding on living tissue of a host.
    - Parasites that cause disease are called pathogens.

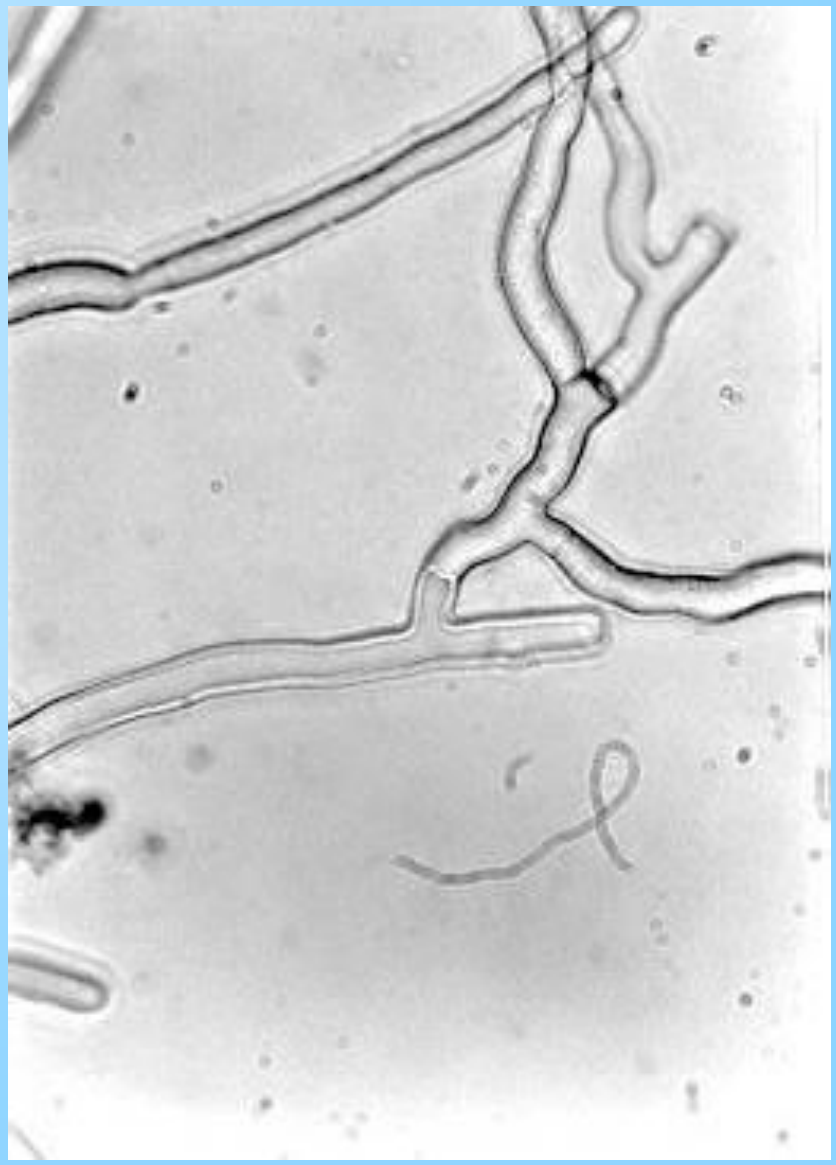
Heterotrophic by Absorption

- Fungi get carbon from organic sources
- Hyphal tips release enzymes
- Enzymatic breakdown of substrate
- Products diffuse back into hyphae



Hyphae

- Tubular
- Hard wall of chitin
- Crosswalls may form compartments (± cells)
- Multinucleate
- Grow at tips



Fungi as Saprobes and Decomposers

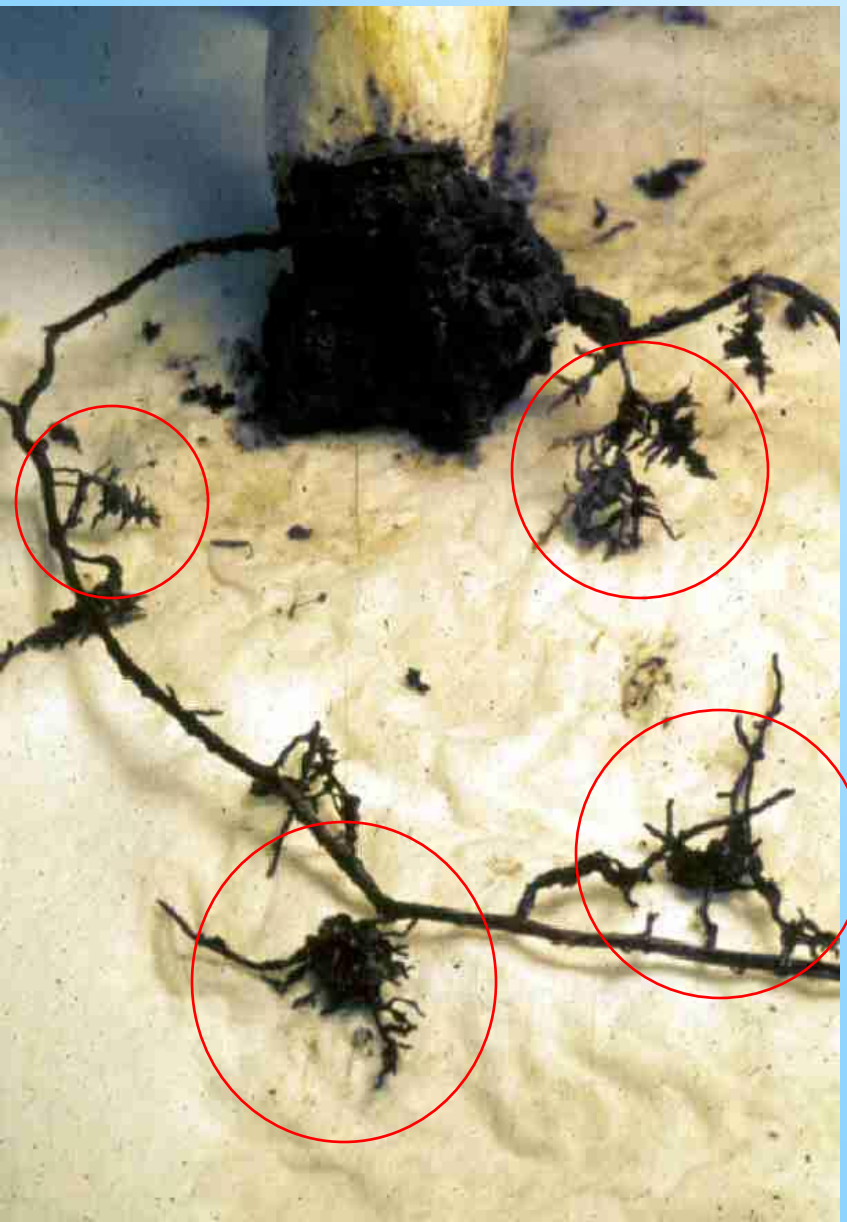
Fungi as Symbionts (Mutualism)

Mycorrhizae

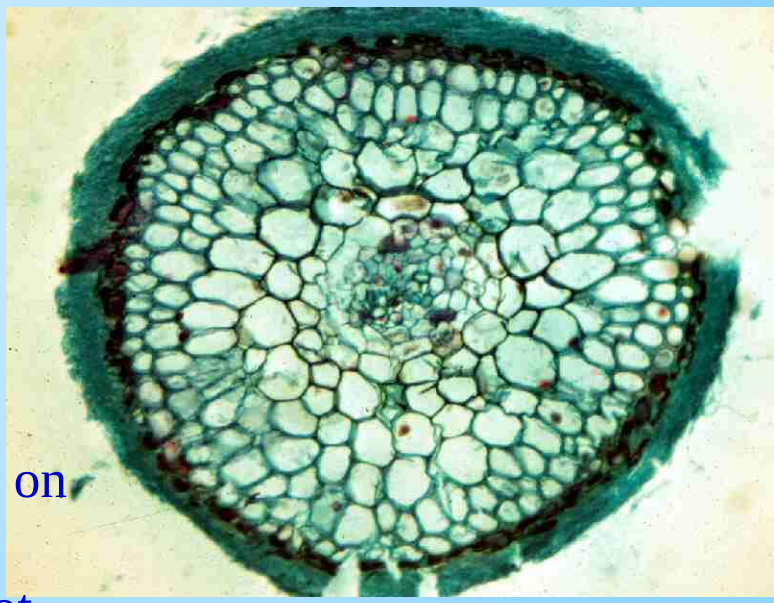
- “Fungus roots”
- Mutualism between:
  * Fungus (nutrient & water uptake for plant)
  * Plant (carbohydrate for fungus)
- Several kinds
  * Zygomycota – hyphae invade root cells
  * Ascomycota & Basidiomycota – hyphae invade root but don’t penetrate cells

- **Extremely** important ecological role of fungi

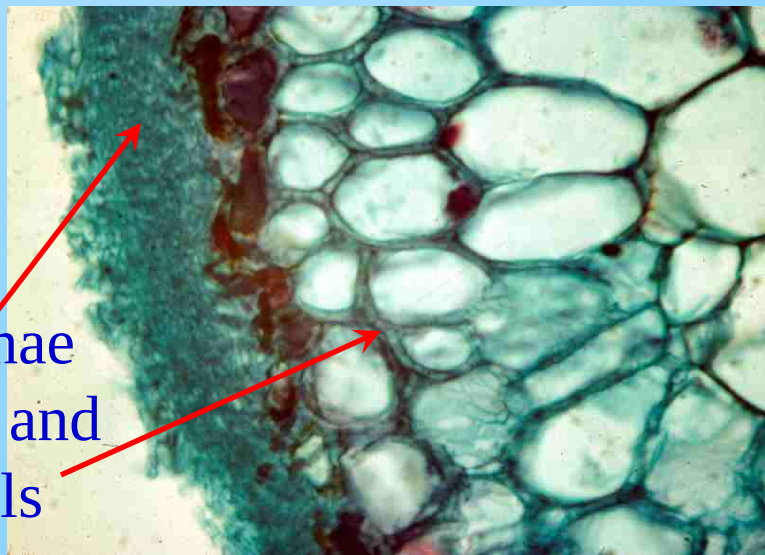
“Ecto”mycorrhizae



Russula mushroom mycorrhizas on Western Hemlock root



Mycorrhiza cross sections



Fungal hyphae around root and between cells

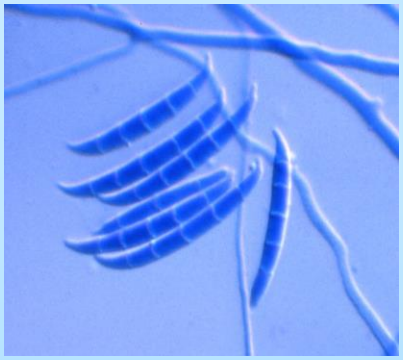
Lichens

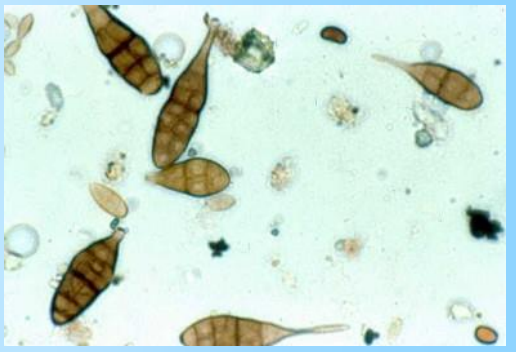
- "Mutualism" between
  - Fungus – structure
  - Alga or cyanobacterium – provides food
- Three main types of lichens:
  - **Crustose lichens** form flat crusty plates.
  - **Foliose lichens** are leafy in appearance, although lobed or branched structures are not true leaves.
  - **Fruticose lichens** are even more finely branched and may hang down like beards from branches or grow up from the ground like tiny shrubs.

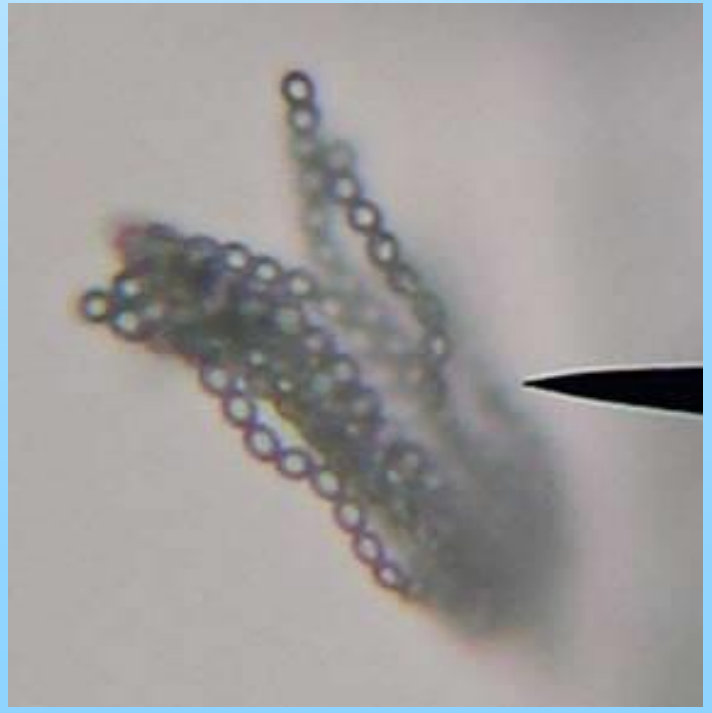
Fungi as Parasites & Pathogens

Fungi are Spore

- Spores - asexual (product of mitosis) or sexual (product of meiosis) in origin.
- Purpose of Spores
  * Allows the fungus to move to new food source.
  * Resistant stage - allows fungus to survive periods of adversity.
  * Means of introducing new genetic combinations into a population



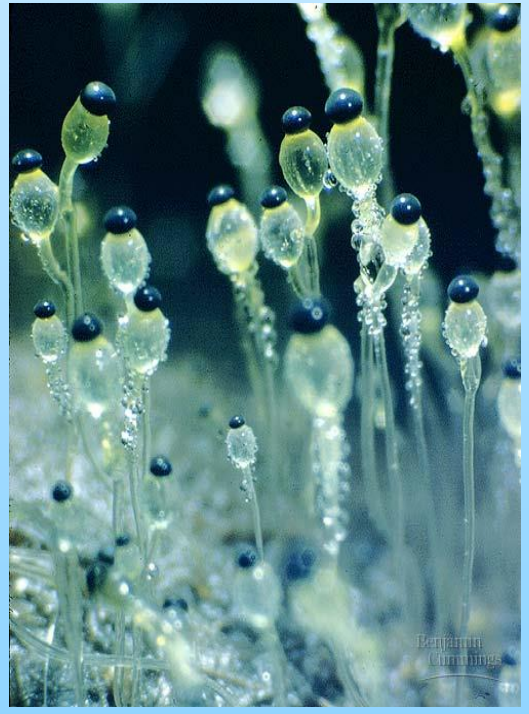




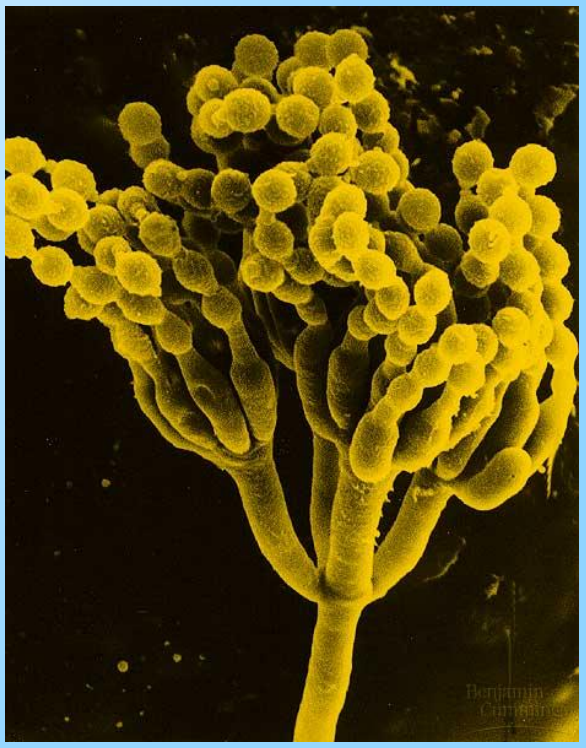
Reproduce by spores

- Spores are reproductive cells
  - * Sexual (meiotic in origin)
  - * Asexual (mitotic in origin)
- Formed:
  - * Directly on hyphae
  - * Inside sporangia
  - * Fruiting bodies

Amanita fruiting body

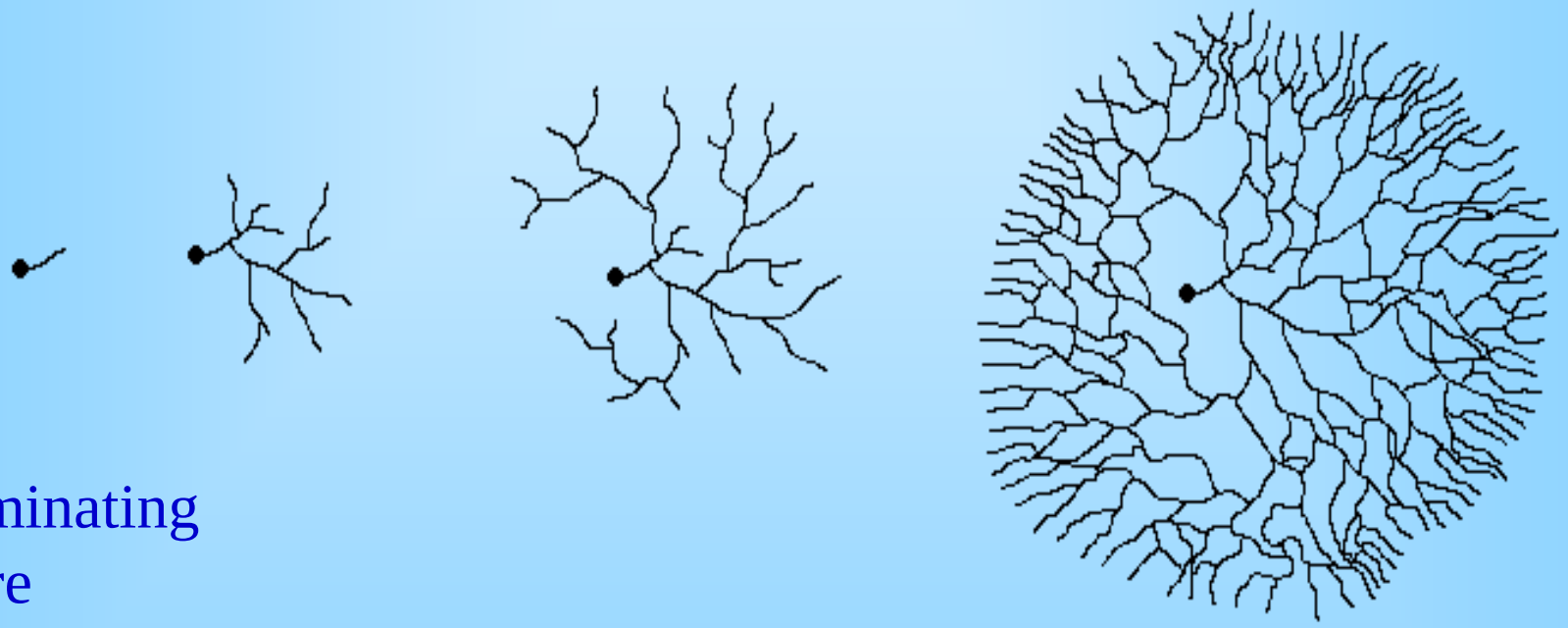


Pilobolus sporangia



Penicillium hyphae with conidia

Hyphal growth from spore



germinating spore

mycelium

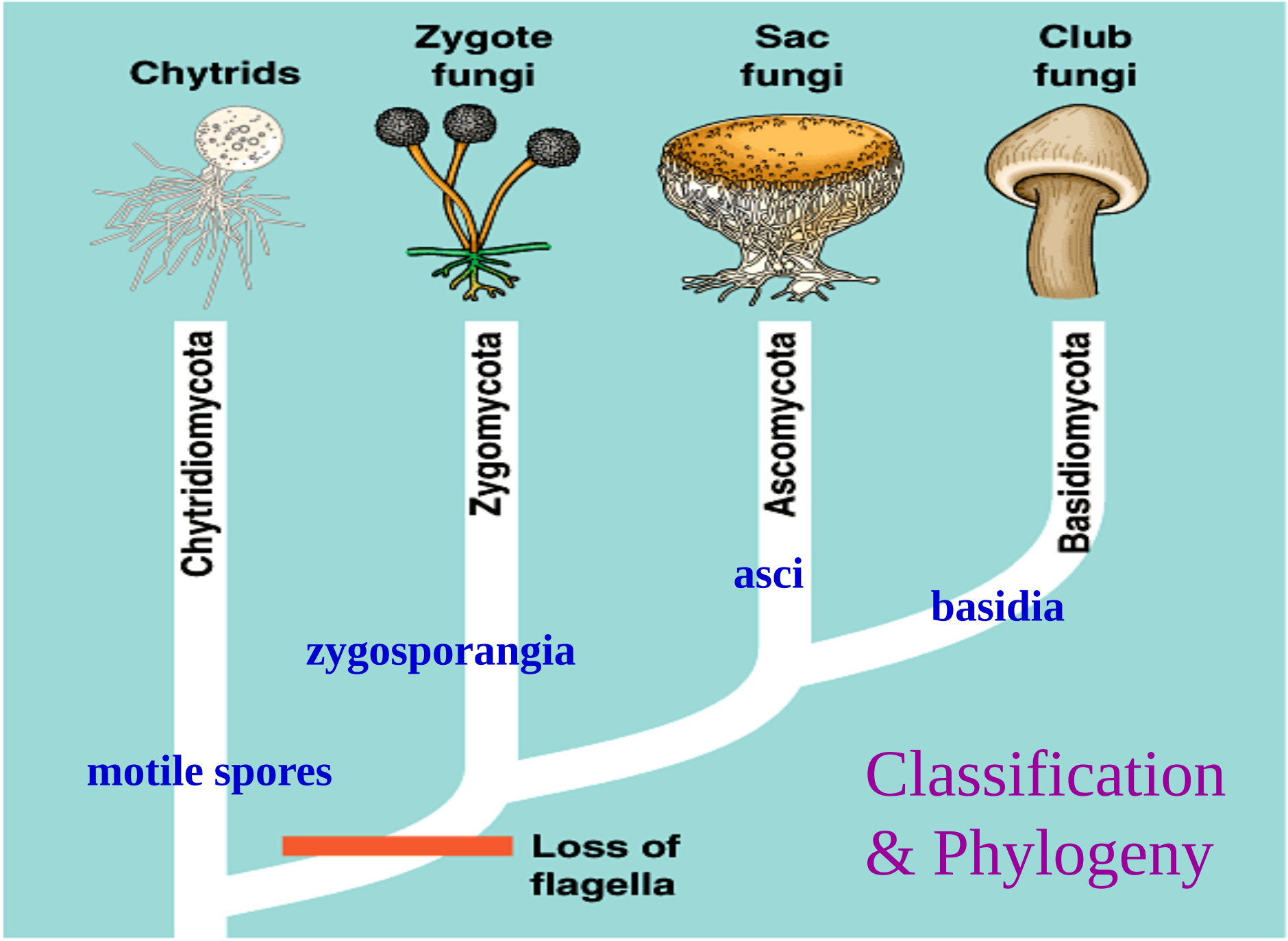
- Mycelia have a huge surface area

The Characteristics of Fungi

- Fungus is often hidden from view. It grows through its food source (substratum), excretes extracellular digestive enzymes, and absorbs dissolved food.
- Indeterminate clonal growth.
- Vegetative phase of fungus is generally sedentary.

The Characteristics of Fungi

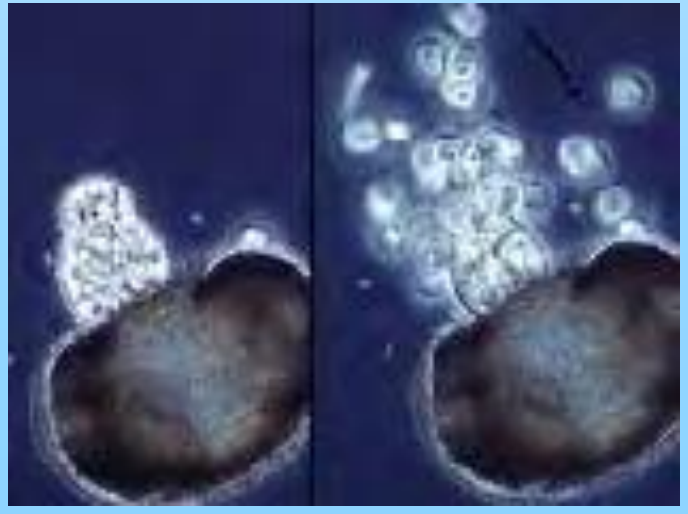
- Cell wall present, composed of cellulose and/or chitin.
- Food storage - generally in the form of lipids and glycogen.
- Eukaryotes - true nucleus and other organelles present.
- All fungi require water and oxygen (no obligate anaerobes).
- Fungi grow in almost every habitat imaginable, as long as there is some type of organic matter present and the environment is not too extreme.
- Diverse group, number of described species is somewhere between 69,000 to 100,000 (estimated 1.5 million species total).

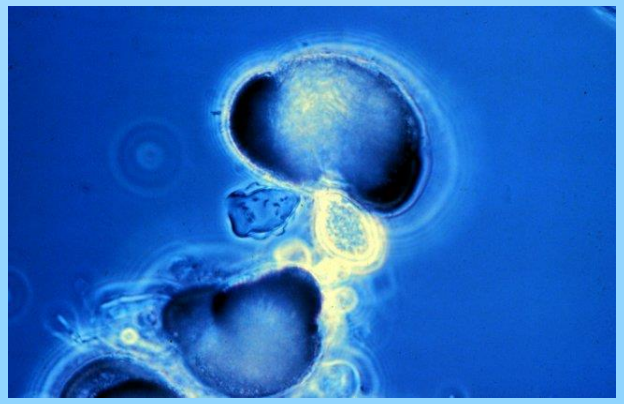


Chytridiomycota – "chytrids"

- Simple fungi
- Produce motile spores - zoospores
- Mostly saprobes and parasites in aquatic habitats
- Could just as well be Protists

Chytridium growing on spores





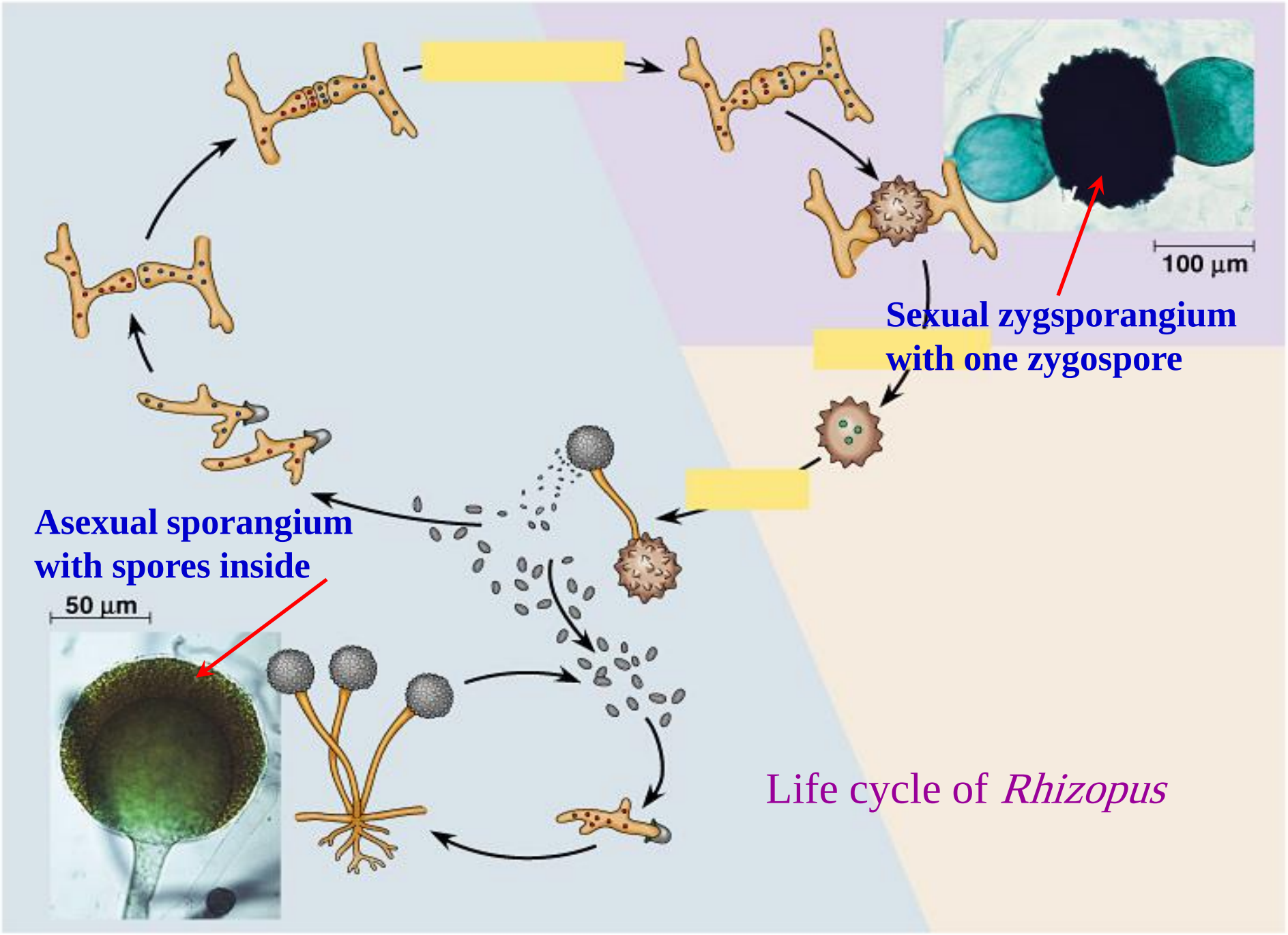
Chytriomyces growing on pine pollen

Zygomycota – “zygote fungi”

Rhizopus on strawberries

- Sexual Reproduction - zygosporangia
- Asexual reprod. – common (sporangia – bags of asexual spores)
- Hyphae have no cross walls
- Grow rapidly
- Decomposers, pathogens, and some form mycorrhizal associations with plants

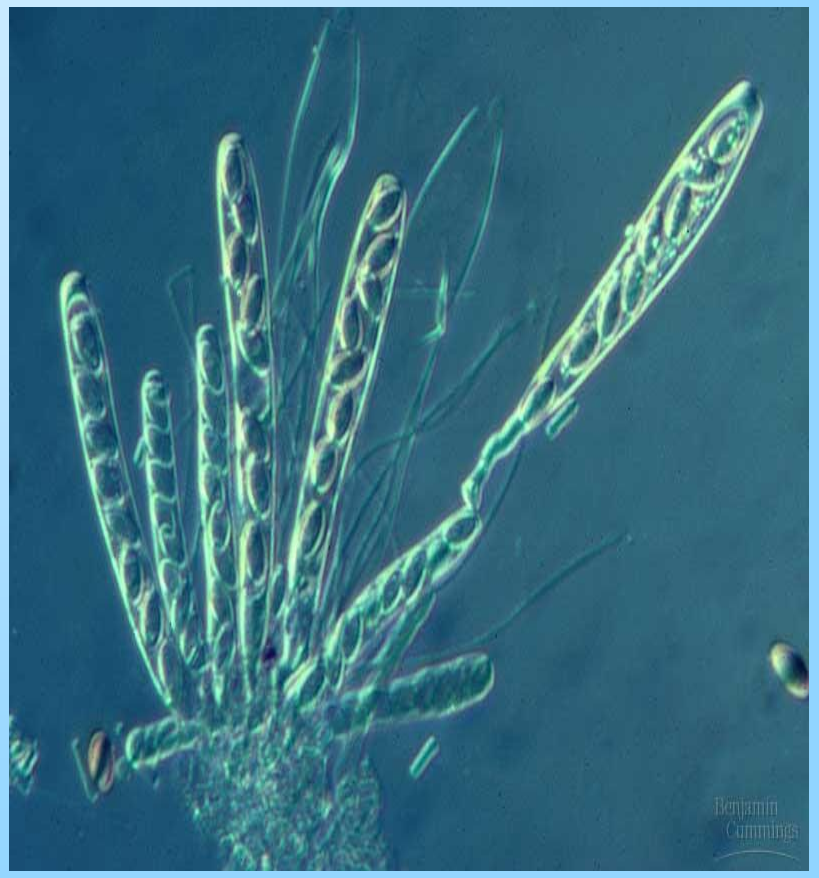
Rhinocerebral zygomycosis



Life cycle of *Rhizopus*

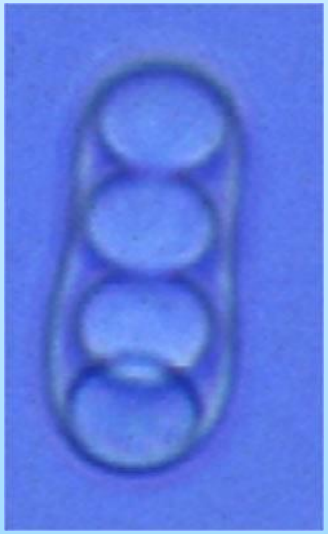
Ascomycota – “sac fungi”

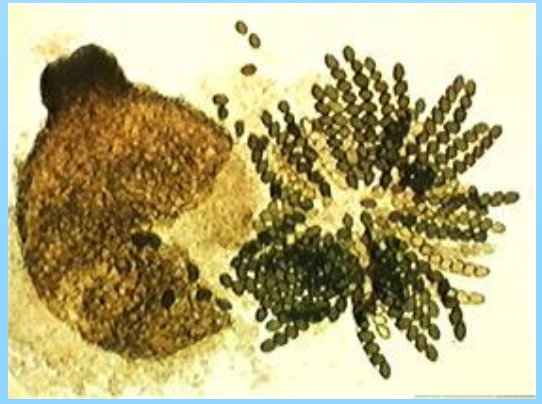
- Sexual Reproduction – asci (sing. = ascus)
- Asex. Reprod. – common
- Cup fungi, morels, truffles
- Important plant parasites & saprobes
- Yeast - *Saccharomyces*
- Decomposers, pathogens, and found in most lichens

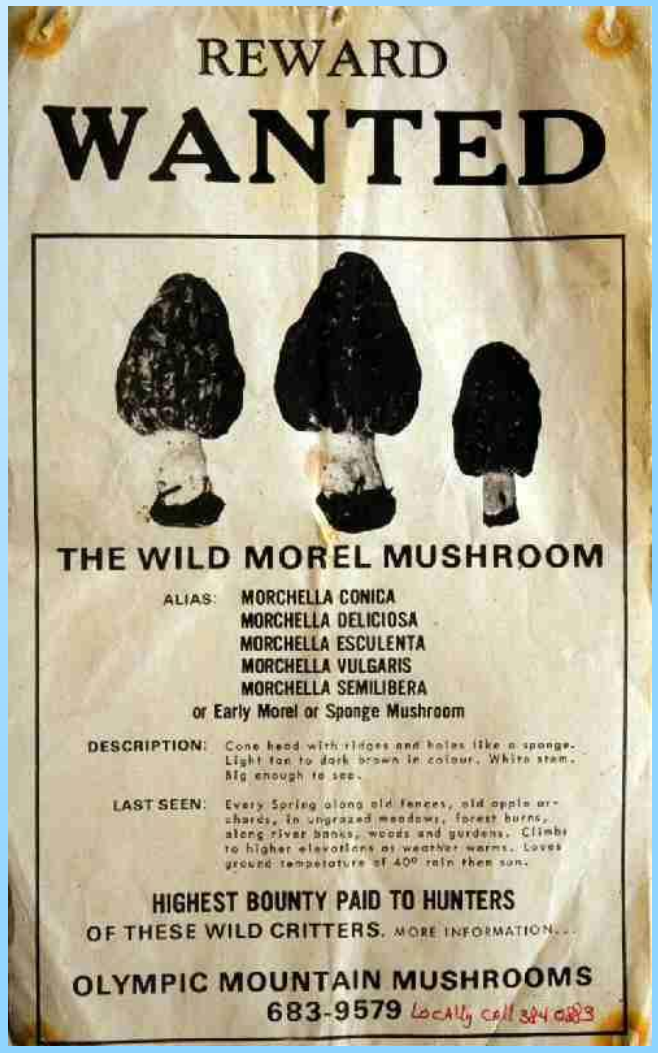


A cluster of asci with spores inside

Sac fungi diversity

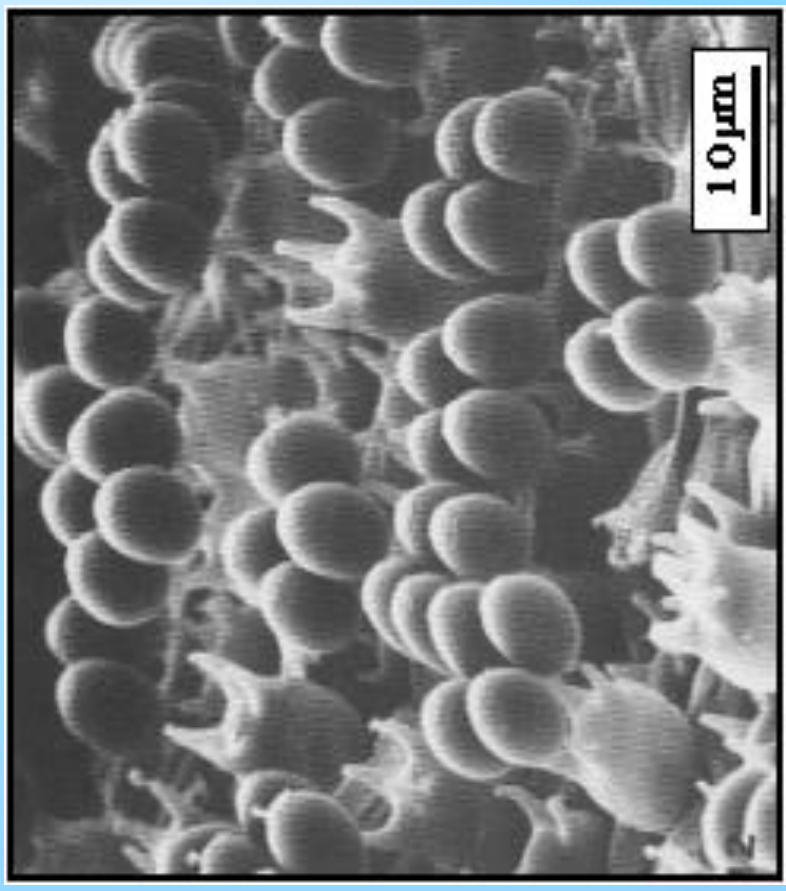






Basidiomycota – “club fungi”

- Sexual Reproduction – basidia
- Asexual reprod – not so common
- Long-lived **dikaryotic** mycelia
- Rusts & smuts –plant parasites
- Mushrooms, polypores, puffballs, boletes, bird’s nest fungi
- Enzymes decompose wood, leaves, and other organic materials
- Decomposers, pathogens, and some form mycorrhizal associations with plants



SEM of basidia and spores

Mushroom Life Cycle

haploid mycelium

Hyphal fusion of haploid mycelia

mycelium and fruiting body are dikaryotic

N

2N

N+N

Meiosis

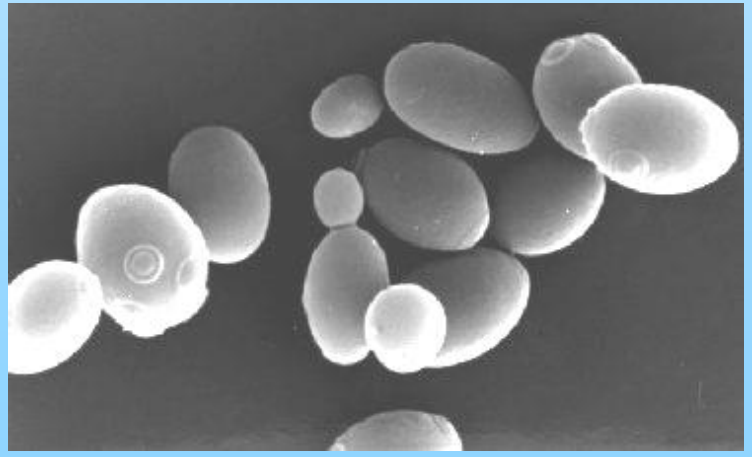
Nuclear fusion in basidium

young basidia - the only diploid cells

Bioluminescence in *Mycena*

Yeasts

- Single celled fungi
- Adapted to liquids
  - * Plant saps
  - * Water films
  - * Moist animal tissues



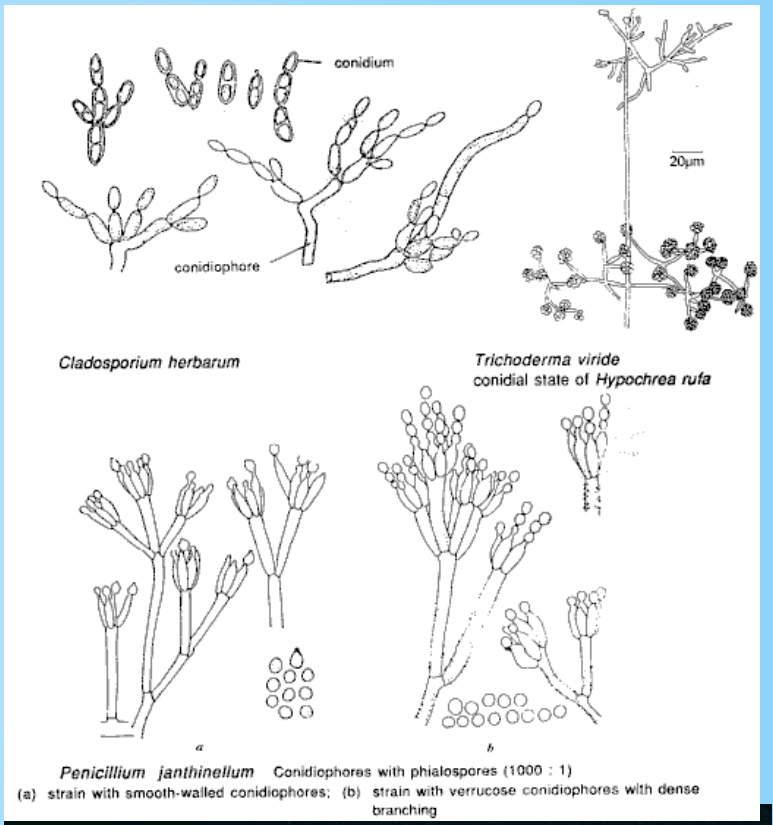
Saccharomyces

Candida

Molds

- Rapidly growth
- Asexual spores
- Many human importances
  * Food spoilage
  * Food products
  * Antibiotics, etc.

Noble Rot - *Botrytis*



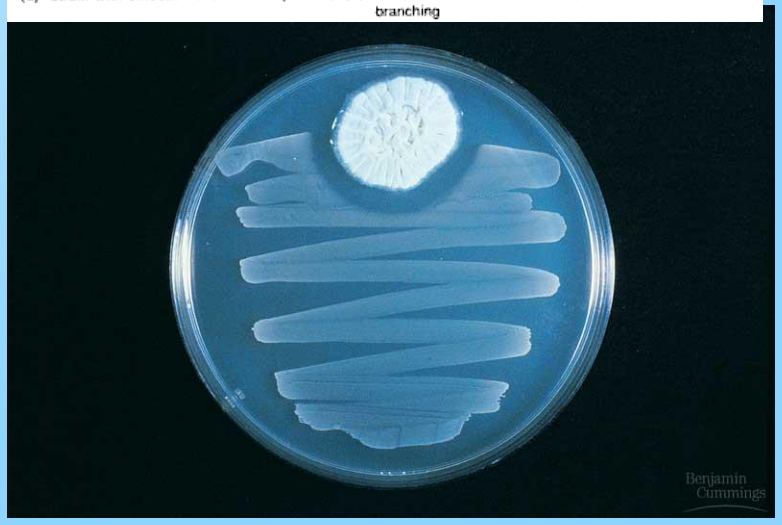


Fig 31.21 Antibiotic activity

HUMAN-FUNGUS INTERACTIONS

- **Beneficial Effects of Fungi**
  * Decomposition - nutrient and carbon recycling.
  * Biosynthetic factories. Can be used to produce drugs, antibiotics, alcohol, acids, food (e.g., fermented products, mushrooms).
  * Model organisms for biochemical and genetic studies.
- **Harmful Effects of Fungi**
  * Destruction of food, lumber, paper, and cloth.
  * Animal and human diseases, including allergies.
  * Toxins produced by poisonous mushrooms and within food (e.g., grain, cheese).
  * Plant diseases.