

General Biology 1

BIO1201 RM 1021

Syllabus & Textbook:

<https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/>

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Grade Breakdown:

Lecture (60%)

Exams (4): 22.5% Each

Pop Quizzes (?): 10% Average

Lab (40%) – Lab Instructor

<u>Letter Grade</u>	<u>Numerical Ranges</u>
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

KINGDOM FUNGI



Outline

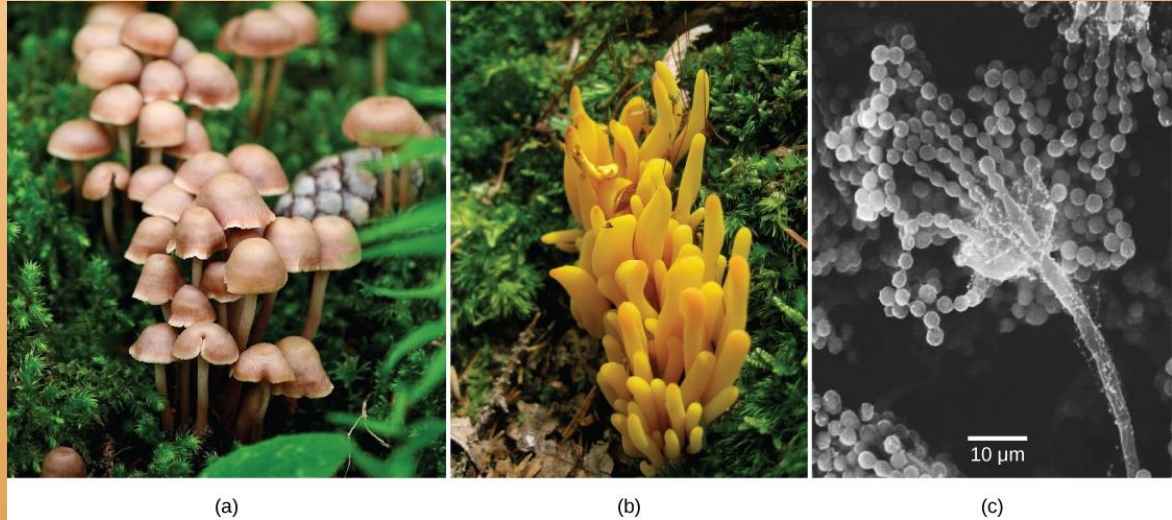
- **Evolution and Characteristics of Fungi**
- **Classification of Fungi**
 - ✧ Chytrids, the Aquatic Fungi
 - ✧ Zygomycota, the Black Bread Mold & Others
 - ✧ Ascomycota, Truffles, Yeast & Others
 - ✧ Basidiomycota, The Mushrooms, Puffballs, ...
 - ✧ Glomeromycota, the Symbiotic Fungi
- **Ecology & Symbiotic Relationships of Fungi**
 - ✧ Lichen: Green Algae/Cyanobacteria & Fungi
 - ✧ Mycorrhizae: Plants & Fungi
 - ✧ Parasitic fungi



**Aren't these plants, and edible mushrooms just vegetables?
Why does it settle on my bread or causes athlete's foot? Is it
the same fungus?**

Characteristics of the Fungi

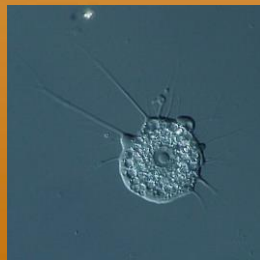
- ◆ Kingdom Fungi contains 80,000 spp
- ◆ Mostly multicellular eukaryotes that share a common mode of nutrition



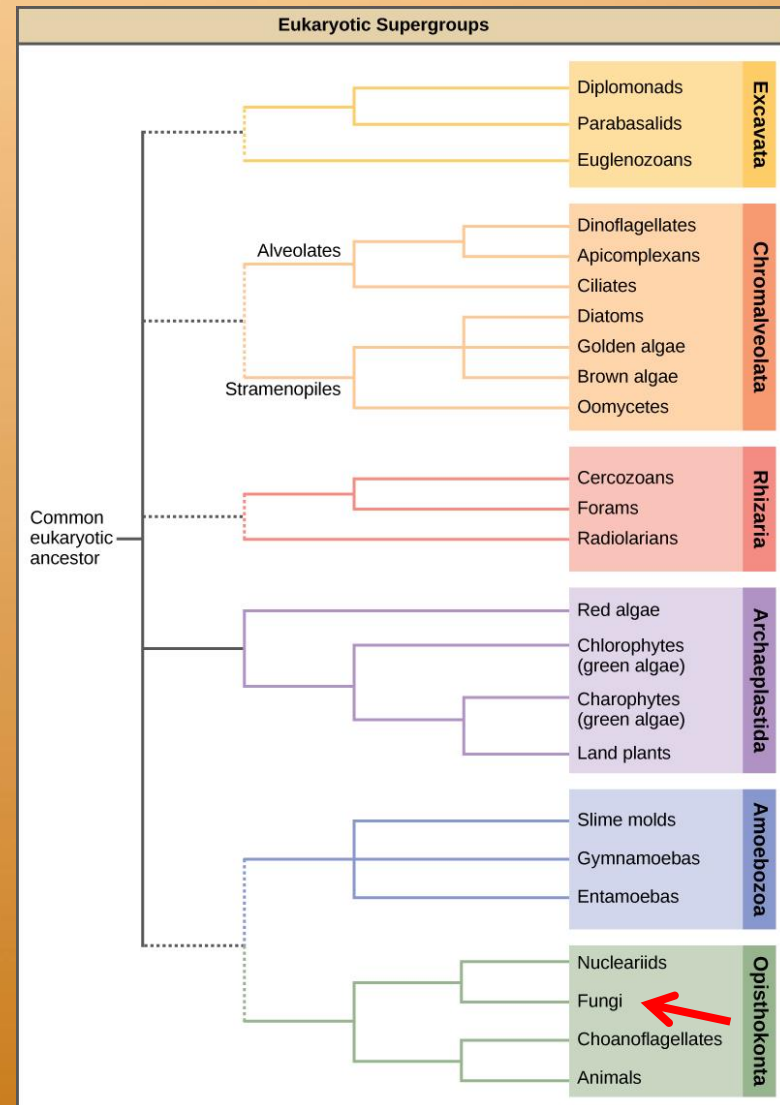
- Heterotrophic
 - Cells release digestive enzymes and then **absorb** resultant nutrient molecules
- ◆ Most are **saprobies (prey on dead organisms)**, some are parasitic
 - ◆ Several in mutualistic relationships with plants or other organisms
 - ◆ Biggest organism on Earth is a fungus!

Evolution of Fungi

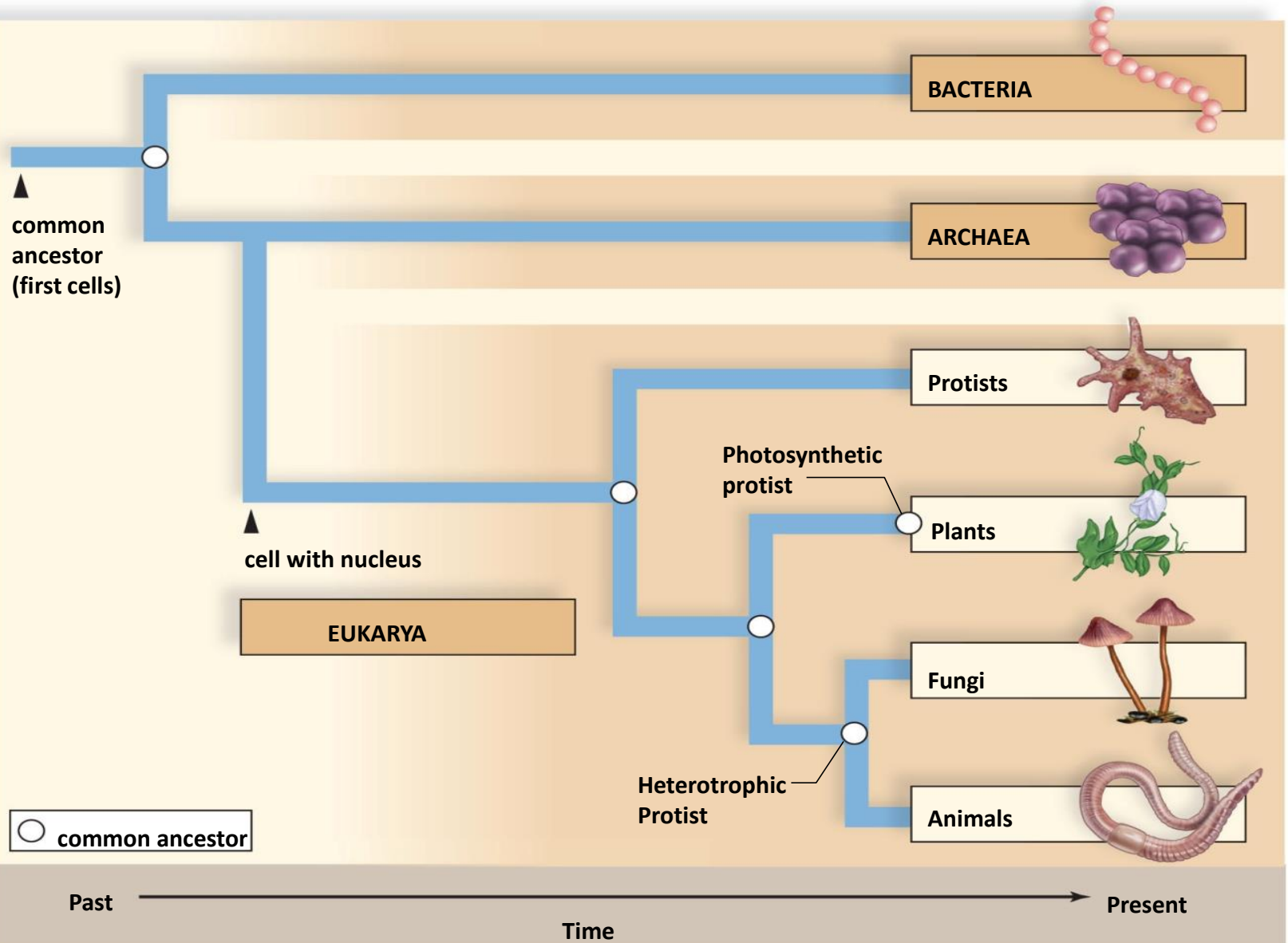
- ◆ Plants, animals, and fungi trace their ancestry to protists
- ◆ Molecular data tells that animals and fungi shared a common ancestor after plants evolved.
 - **Animals and fungi are more closely related** to each other than either is to plants.
 - Flagellated unicellular protist, was most likely the common ancestor



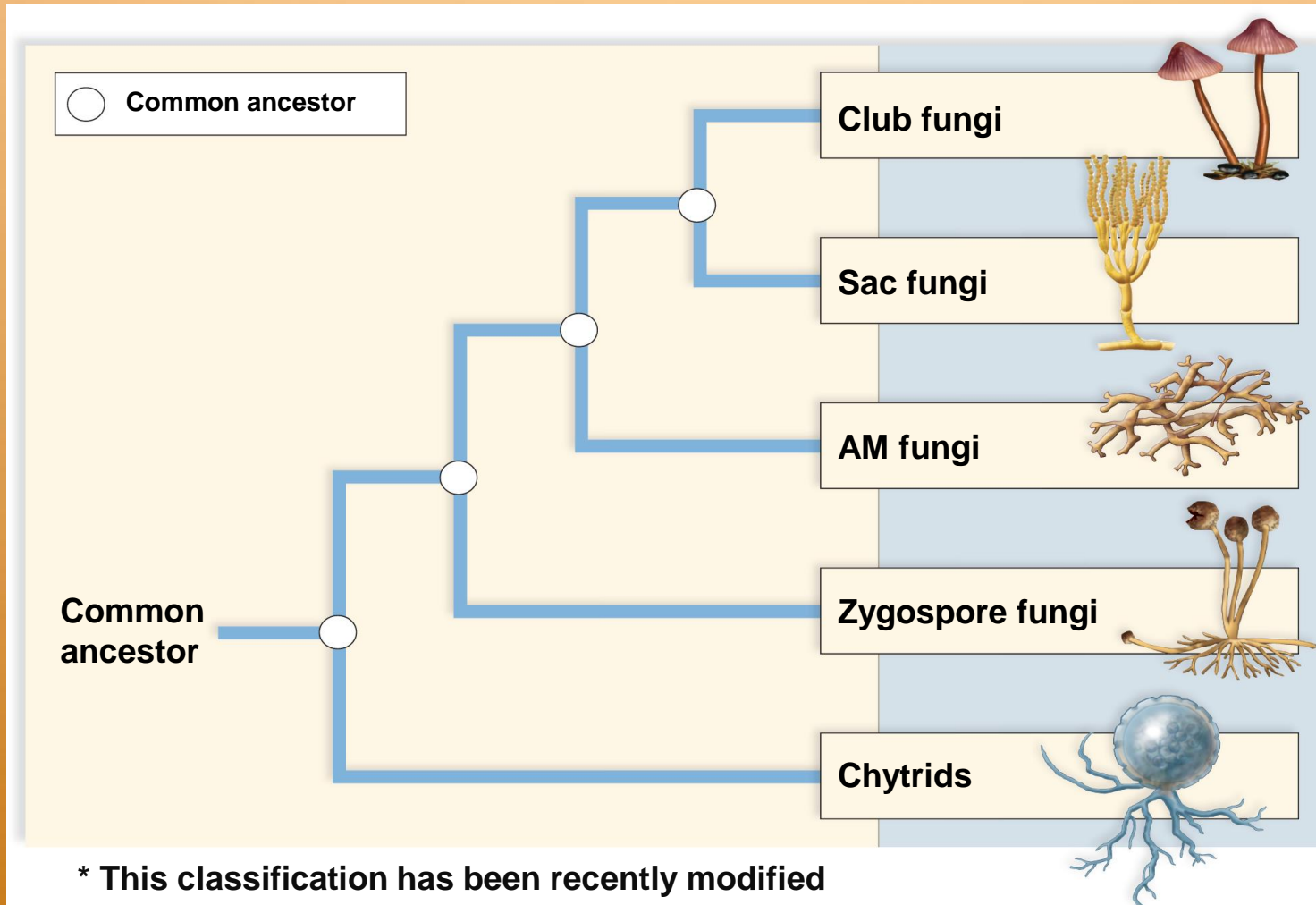
Nuclearia sp.



Evolutionary Tree of Life



Evolutionary Relationships Among the Fungi



Fungal groups chytrids (Aquatic), zygosporangia, AM (Arbuscular mycorrhizas) fungi (Glomeromycota), sac fungi (Ascomycota), and club fungi (Basidiomycota): Differentiated according to their life cycle and **the type of structure they use to produce spores**

Evolution of Fungi

- ◆ Description of fungal structure applies best to the zygosporangium fungi, sac fungi, and the club fungi.
- ◆ The AM (**arbuscular mycorrhizal**) fungi exist only as **mycorrhizae** in association with plant roots
- ◆ Fungal anatomy doesn't lend itself to becoming fossilized,
 - ◆ Probably evolved a lot earlier than the earliest known fungal fossil dated 450 mya.
 - ◆ Mycorrhizae are evident in plant fossils

WHY DO YOUR PLANTS NEED MYCORRHIZAE FUNGI?

Mycorrhizae Fungi are beneficial, and form a symbiotic relationship with plant roots.

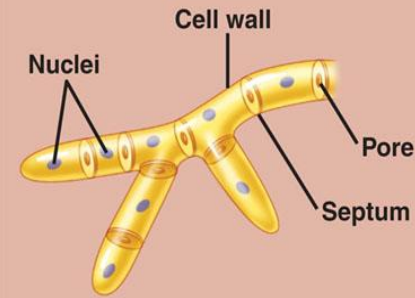
The fungi receives sugar from the root. In exchange, it absorbs and sends soil nutrients and water back to the plant. When those nutrients and water are depleted, the fungi simply reaches further into the soil for more.



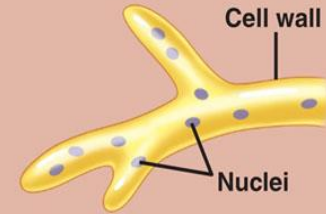
MYCORRHIZAL FUNGI INCREASE THE ROOT SYSTEM'S SURFACE AREA 100 TO 1,000 TIMES!

Structure of Fungi

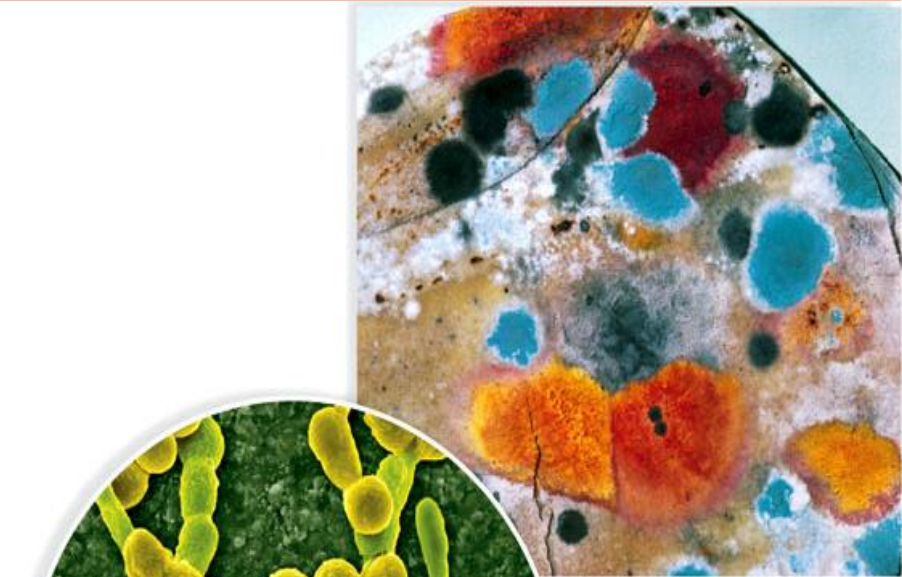
- ◆ Body (**thallus**) of most fungi is multicellular mycelium (yeasts are unicellular)
 - ◆ Consists of a vast network of thread-like **hyphae**
 - ◆ **Septate** (separated) fungi have hyphae with cross walls
 - ◆ **Nonseptate** fungi are multinucleated
 - ◆ Hyphae grow from tip
 - ◆ Gives the mycelium a large surface area per unit volume
- ◆ Cell walls of **chitin**, like insect exoskeleton
- ◆ Excess food stored as **glycogen** as in animals



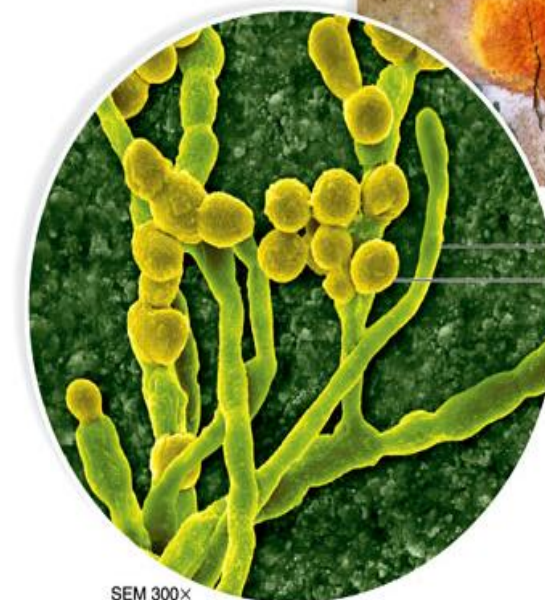
(a) Septate hypha



(b) Coenocytic hypha

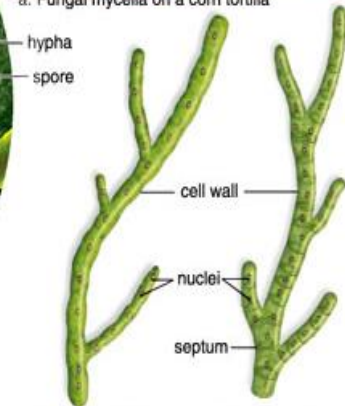


a. Fungal mycelia on a corn tortilla



SEM 300X

b. Specialized fungal hyphae that bear spores

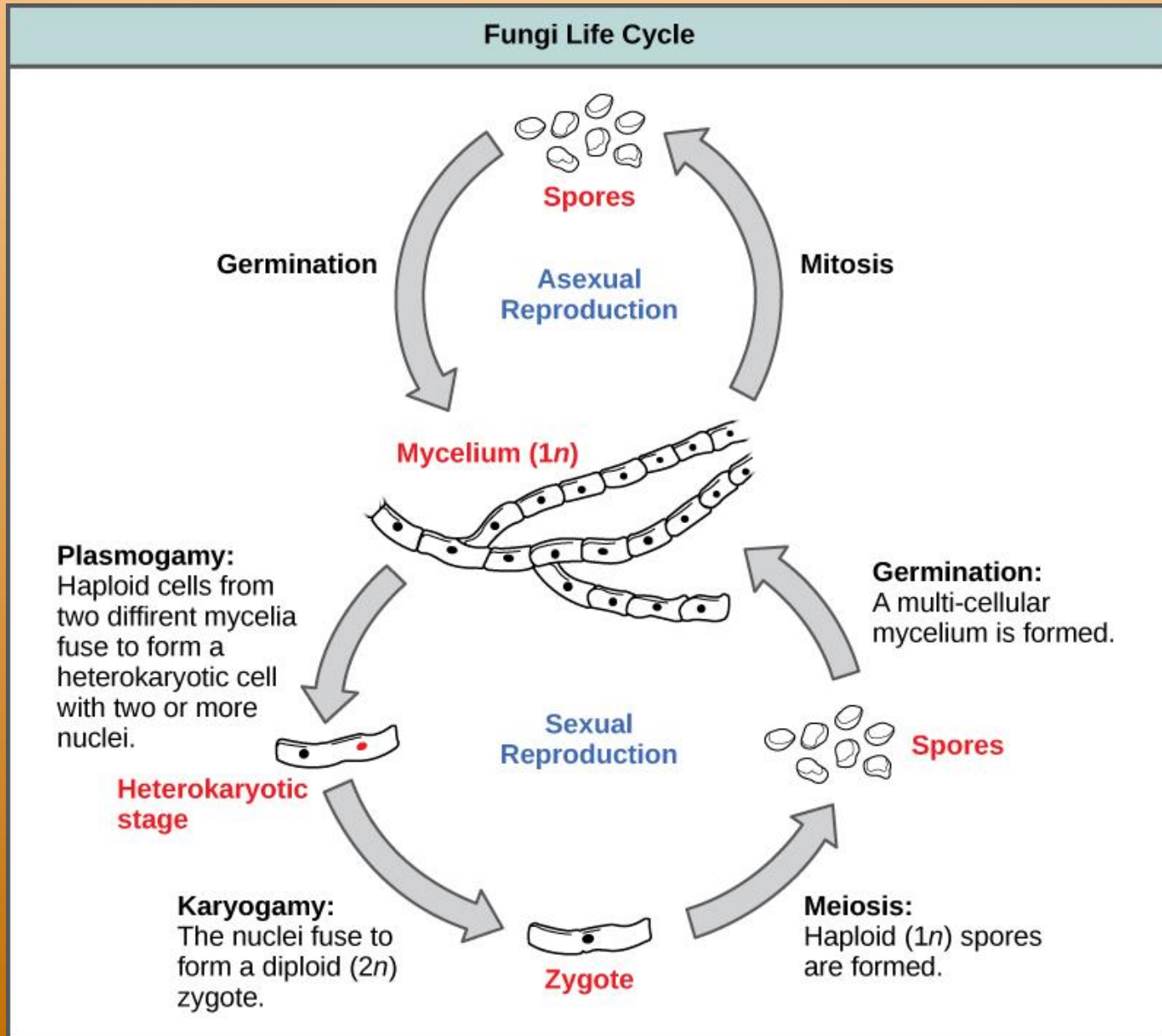


c. nonseptate hypha septate hypha

Reproduction of Fungi

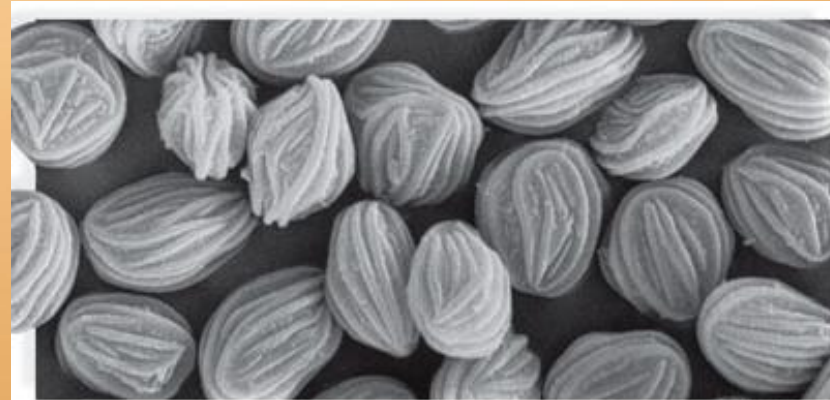
- ◆ Both sexual (in most) and asexual reproduction
- ◆ Sexual reproduction involves three stages:
 - ◆ **Haploid Hyphae**
 - ◆ **Dikaryotic (aka heterokaryotic) Stage**
 - ◆ **Diploid Zygote**

Generalized life cycle of Fungi



Reproduction of Fungi

- ◆ During **sexual reproduction**, hyphae from two different mating types fuse
 1. Hyphae that contain paired haploid nuclei are said to be dikaryotic
 2. Nuclear fusion produces diploid nucleus, which produces haploid windblown spores by meiosis
 3. Spores germinate directly into haploid hyphae without embryological development
- ◆ **Asexual reproduction** usually involves the production of windblown spores
- ◆ Unicellular **yeasts** reproduce by **budding**



a.

20 μ m



b.

Ahh this is 'Fun...gi'

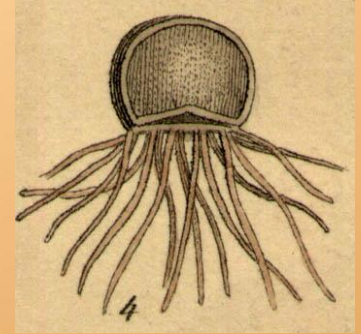
1. Which characteristics best define fungi?
2. Describe the body/structure of a fungus
3. How do fungi reproduce?
4. Discuss the evolution of fungi
5. How are fungi classified?



chytrids (Aquatic), zygosporangium fungi, AM (Arbuscular mycorrhizas) fungi (Glomeromycota), sac fungi (Ascomycota), and club fungi (Basidiomycota)

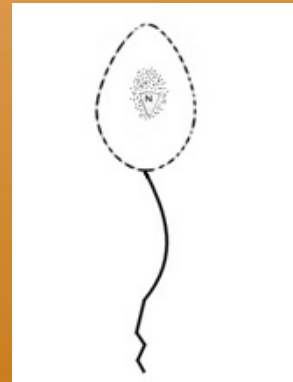
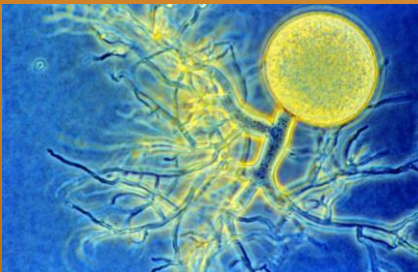
6. The study of fungi islogy
Mycology

Chytridiomycota



◆ Phylum Chytridiomycota (aquatic fungi)

- ◆ Members of this phylum are considered to be the most primitive fungi and probably appeared about 500 million years ago
- ◆ Chytrids are found everywhere. They synthesize and release digestive enzymes that break down molecules in the protective covers (such as cellulose, keratin and chitin) of other organisms
- ◆ Some are part of the digestive flora of ruminants
- ◆ **Microscopic**, they produce motile spores called **zoospores**
- ◆ Placed in the Protista Kingdom for a long time



Zygomycota

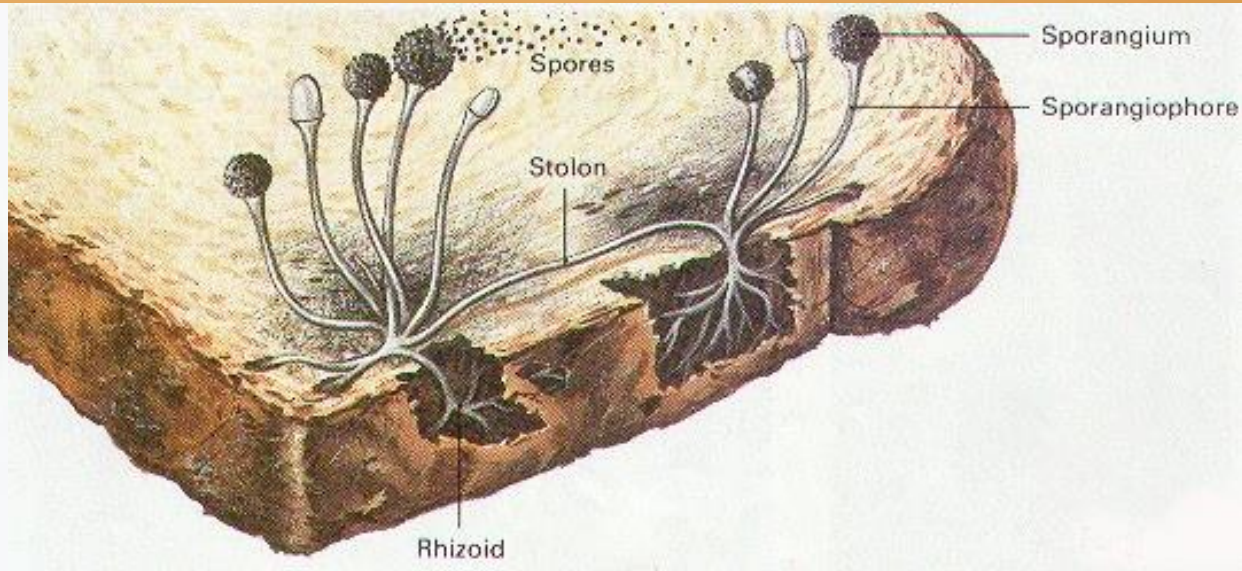


<http://www.businessinsider.com/pilobolus-fungus-shoots-super-fast-spores-2015-2>

- ◆ Zygospore Fungi

- ◆ Phylum Zygomycota

- ◆ Mainly saprotrophs decomposing animal and plant remains
- ◆ Black bread mold - *Rhizopus stolonifer*

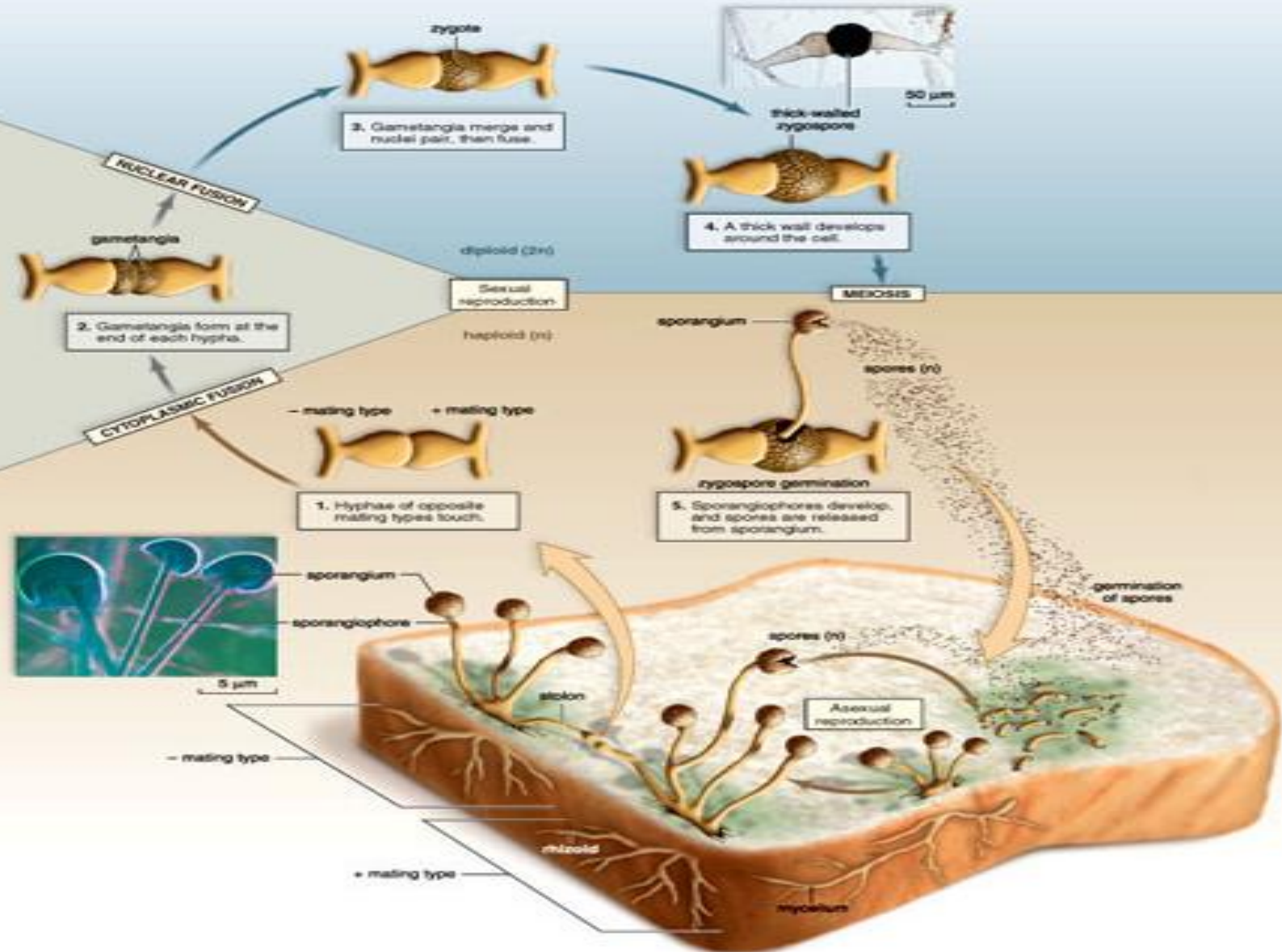


Fruit decomposition: <http://youtu.be/zhQLfEAs31g>

McDonald's: <http://www.youtube.com/watch?v=8uHxRwQqWFO&noredirect=1>

Zygomycota

- ♦ Black bread mold - *Rhizopus stolonifer*



Aggressive Fungus Strikes Joplin Tornado Victims

Found HERE Posted: Jun 9, 2011 12:01 PM by

Associated Press

Updated: Jun 9, 2011 12:54 PM



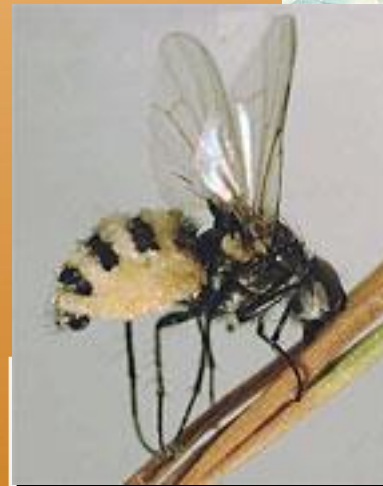
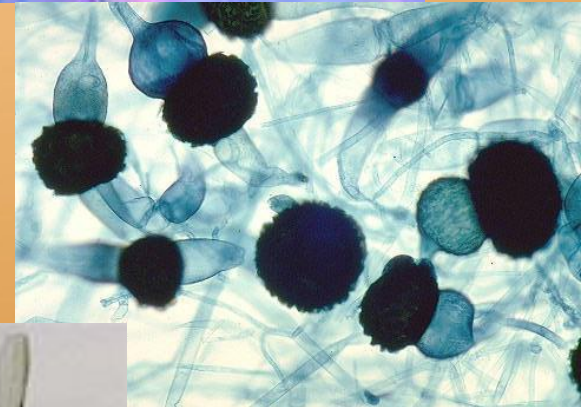
JOPLIN (AP) – An aggressive fungus is striking Joplin tornado victims, contributing to a handful of deaths.

Doctors told the Springfield News-Leader that at least nine survivors may have contracted blood-vessel invading **zygomycosis** infections.

Overall numbers weren't available. The Springfield Greene County Health Department declined to release them, citing patient privacy concerns.

Kendra Williams, of the health department, says the common fungus likely came from soil or vegetative materials imbedded in the skin by the tornado.

After the tornado, Freeman Health System in Joplin treated more than 1,700 patients. An infectious disease specialist there, Dr. Uwe Schmidt, says some wounds that were stitched up in that rush of patients had to be reopened because they weren't adequately cleaned and had debris in them.



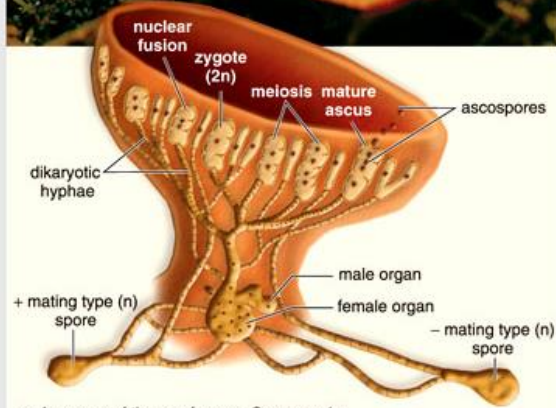
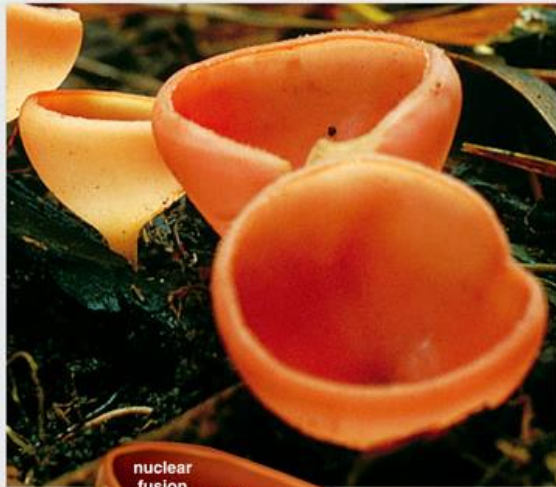
Root maggot fly (*Delia*) killed by the 'insect-destroyer' *Entomophthora* (*Entomophthorales*). The fungus has burst through the segments and the abdominal wall. Copyright © [George Barron](#)

Sac Fungi

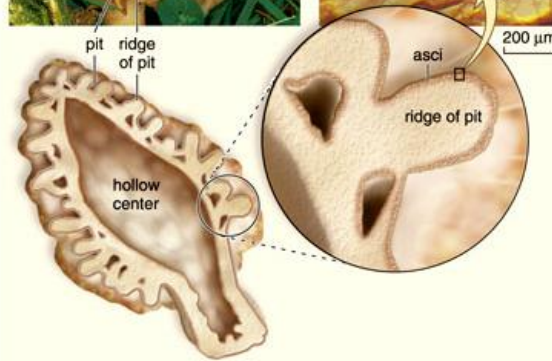
- ◆ Phylum **Ascomycota** - about 60,000 species of sac fungi
- ◆ Most are saprotrophs can digest cellulose, lignin, or collagen
- ◆ Most are composed of septate hyphae
- ◆ *Neurospora*, experimental organism for the one-gene-one-enzyme studies
- ◆ Morels and truffles, famous gourmet delicacies revered throughout the world
- ◆ Many plant *diseases*: Powdery mildews; leaf curl fungi; ergot of rye; chestnut blight and Dutch elm disease
- ◆ *Aspergillus* and *Candida* cause serious human infections: **mycosis**



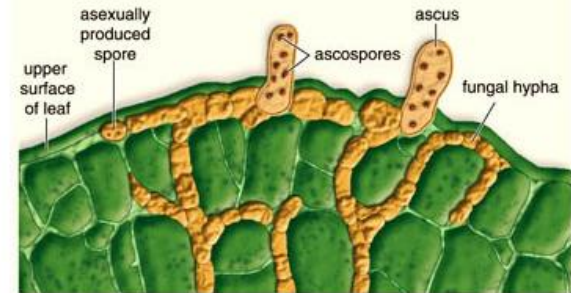
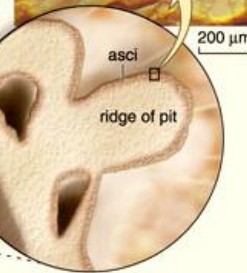
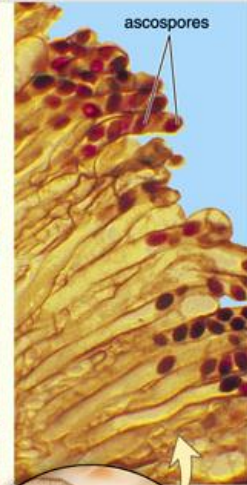
Sexual Reproduction in Sac Fungi



a. Ascocarp of the cup fungus, *Sarcoscypha*



b. Ascocarp of the morel, *Morchella*

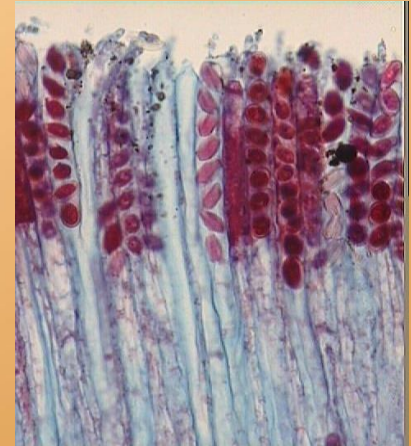


c. Peach leaf curl, *Taphrina*

Sac Fungi: Reproduction

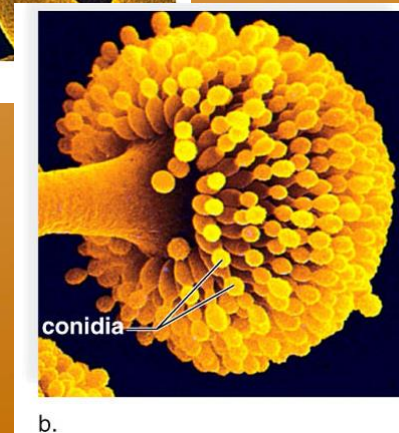
♦ Sexual reproduction

- ♦ **Ascus:** fingerlike sac that develops during **sexual reproduction**
- ♦ Haploid hyphae fuse to make diploid nucleus
- ♦ Mitosis and then meiosis produces 8 **ascospores**



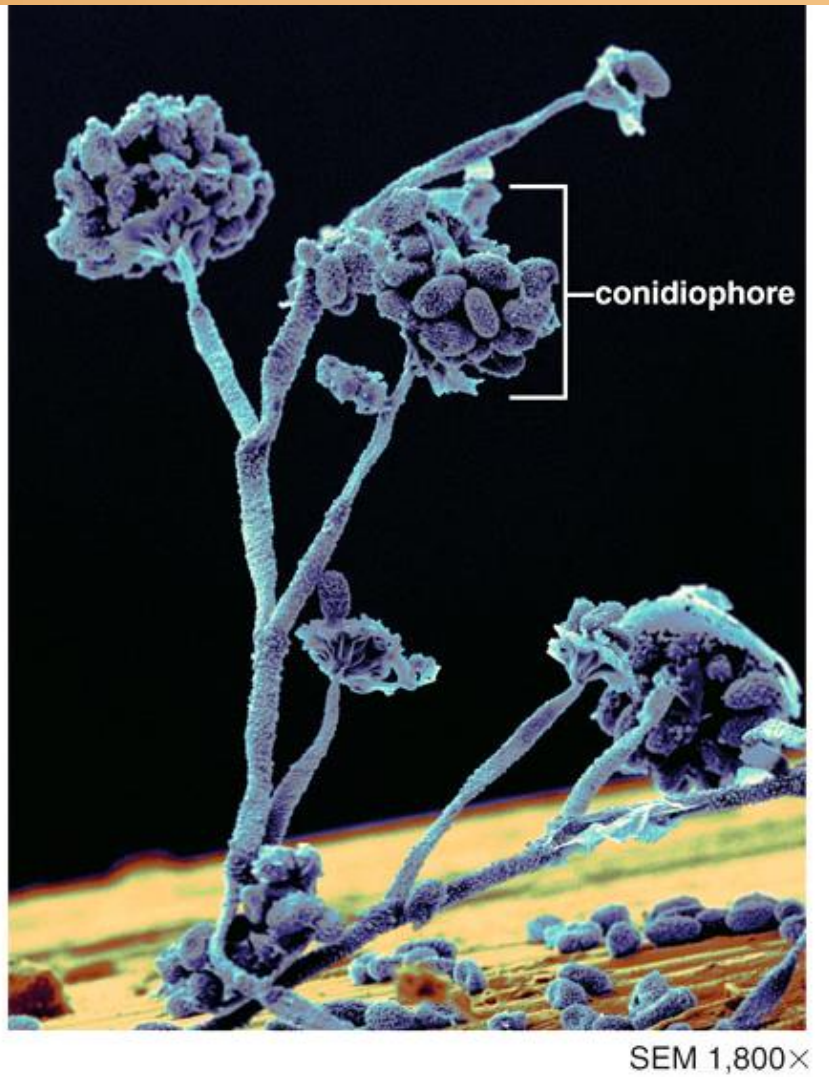
♦ Asexual reproduction is the norm

- ♦ Yeasts usually reproduce by **budding**
 - ♦ A small bulge forms on side of cell
 - ♦ Receives a nucleus and gets pinched off and becomes full size
- ♦ Other ascomycota produce spores called **conidia or conidiospores**



Pathogenic/Parasitic Sac Fungi

Black Mold



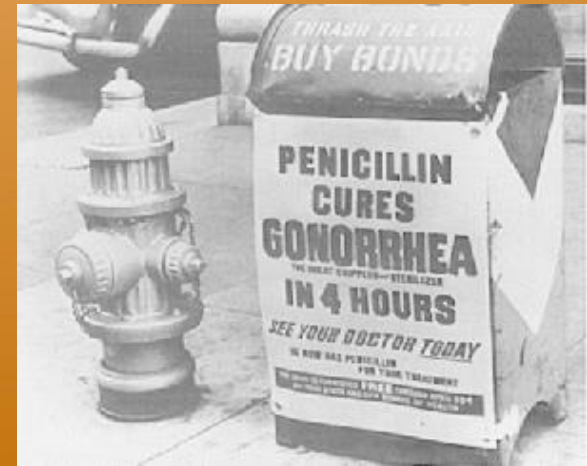
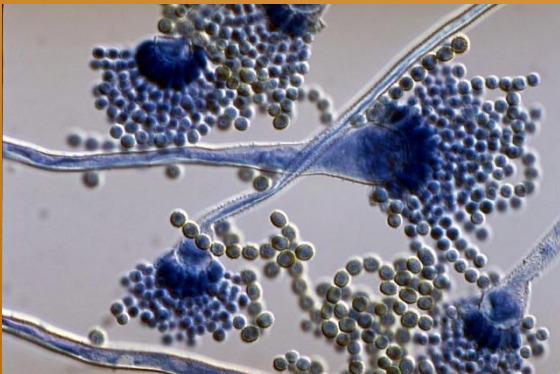
Tineas

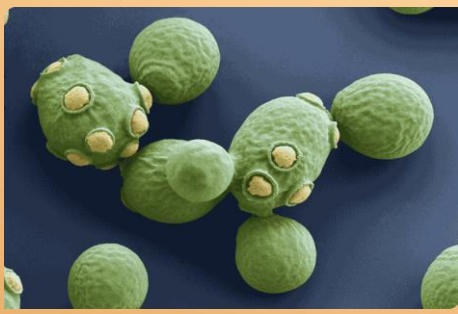


Sac Fungi: Molds



- ◆ Can be helpful to humans.
- ◆ Aspergillus is a group of green molds used to produce soy sauce by fermentation of soybeans.
- ◆ Aspergillus is used to produce citric and gallic acids,
- ◆ A species of Penicillium (blue molds now classified as Talaromyces) is the source of the familiar **antibiotic** called penicillin





Sac Fungi: Yeasts



Yeasts can be both beneficial and harmful to humans.

- ◆ *Saccharomyces cerevisiae*, are added to relatively sterile grape juice to make **wine**.
- ◆ Also, this yeast is added to prepared grains to make **beer**.
- ◆ When some yeasts ferment, they produce ethanol and carbon dioxide
- ◆ It is in genetic engineering experiments



- ◆ *Candida albicans* is a yeast that causes **fungal infections**.
- ◆ A vaginal infection results in inflammation, itching, and discharge
- ◆ Oral thrush is a *Candida* infection of the mouth, common in newborns and AIDS patients.

Sac Fungi / Ascomycta



OPEN ACCESS Freely available online

PLOS ONE

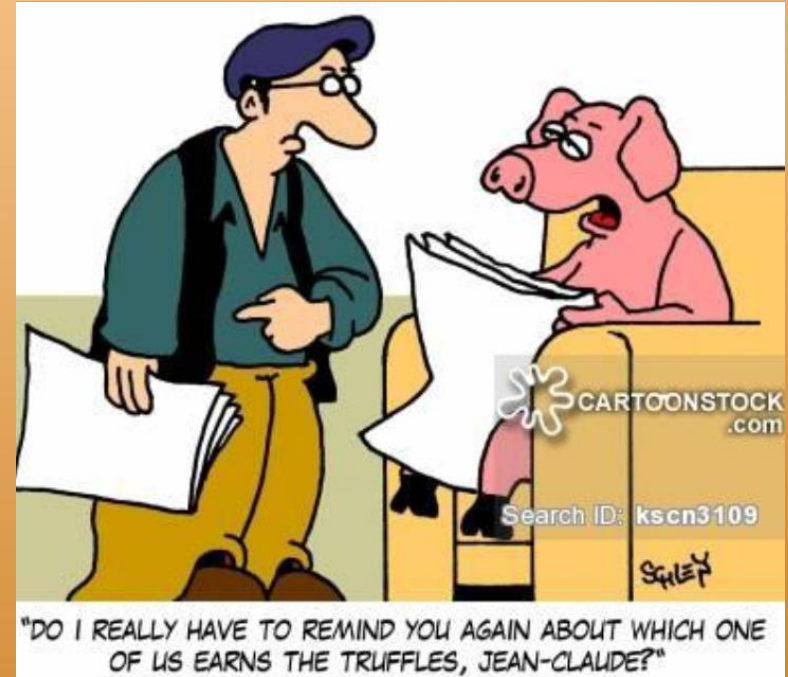
Long-Term Disease Dynamics for a Specialized Parasite of Ant Societies: A Field Study

Raquel G. Loreto^{1,2*}, Simon L. Elliot², Mayara L. R. Freitas², Thairine M. Pereira², David P. Hughes^{1,3*}

¹ Center for Infectious Disease Dynamics, Department of Entomology, Pennsylvania State University, University Park, Pennsylvania, United States of America, ² Department of Entomology, Federal University of Viçosa, Viçosa, Minas Gerais, Brazil, ³ Department of Biology, Pennsylvania State University, University Park, Pennsylvania, United States of America

Abstract

Many studies have investigated how social insects behave when a parasite is introduced into their colonies. These studies have been conducted in the laboratory, and we still have a limited understanding of the dynamics of ant-parasite interactions under natural conditions. Here we consider a specialized parasite of ant societies (*Ophiocordyceps camponoti-rufipedis* infecting *Camponotus rufipes*) within a rainforest. We first established that the parasite is unable to develop to transmission stage when introduced within the host nest. Secondly, we surveyed all colonies in the studied area and recorded 100% prevalence at the colony level (all colonies were infected). Finally, we conducted a long-term detailed census of parasite pressure, by mapping the position of infected dead ants and foraging trails (future hosts) in the immediate vicinity of the colonies over 20 months. We report new dead infected ants for all the months we conducted the census – at an average of 14.5 cadavers/month/colony. Based on the low infection rate, the absence of colony collapse or complete recovery of the colonies, we suggest that this parasite represents a chronic infection in the ant societies. We also proposed a “terminal host model of transmission” that links the age-related polyethism to the persistence of a parasitic infection.



The Club Fungi

- ◆ Phylum **Basidiomycota** – 22,000 spp
- ◆ Familiar toadstools, mushrooms, bracket fungi, puffballs, stinkhorns – some deadly poisonous
- ◆ Also **plant diseases** such as the smuts and rusts
- ◆ Mycelium composed of septate hyphae



a. Fairy ring



b. Shelf fungus



c. Pore mushroom, *Boletus*

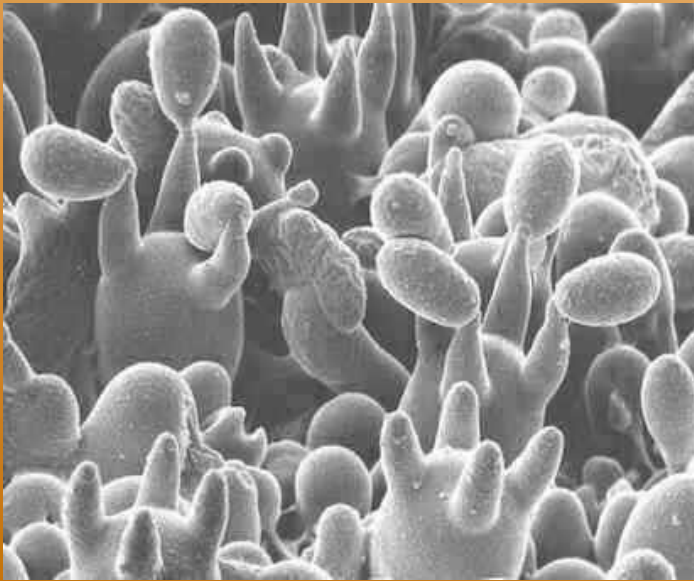


d. Puffball, *Calvatiga gigantea*

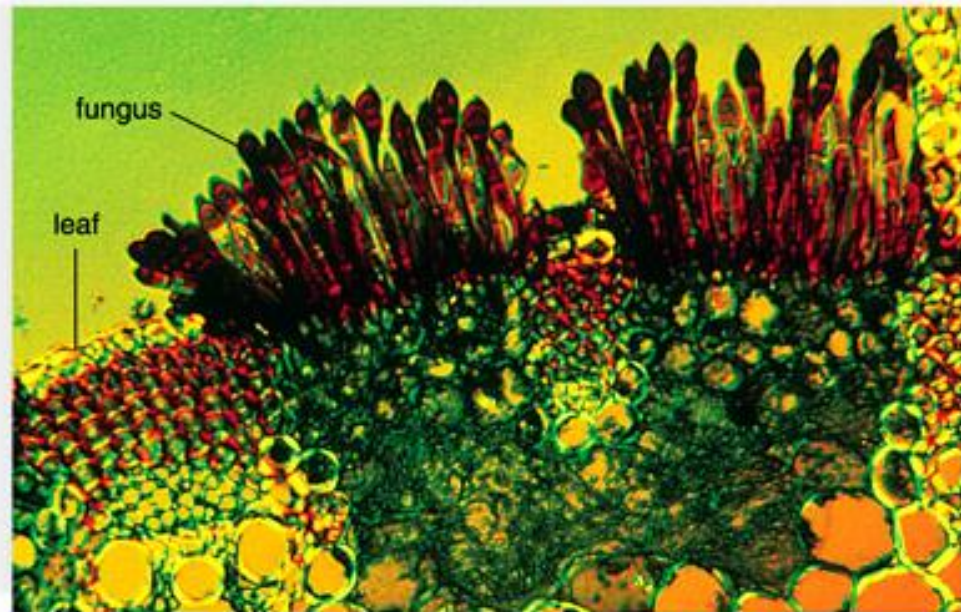
Smuts & Rusts

club fungi that parasitize cereal crops

Great economic importance because of annual crop losses



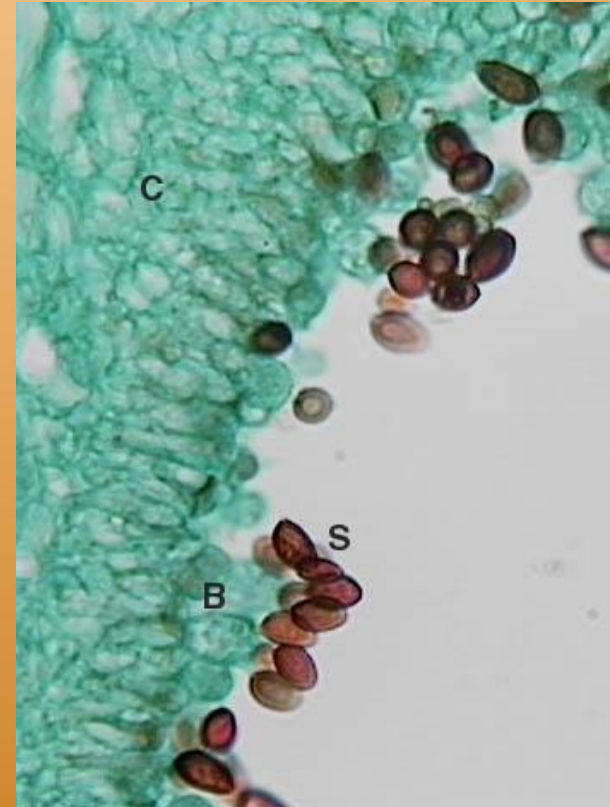
a. Corn smut, *Ustilago*



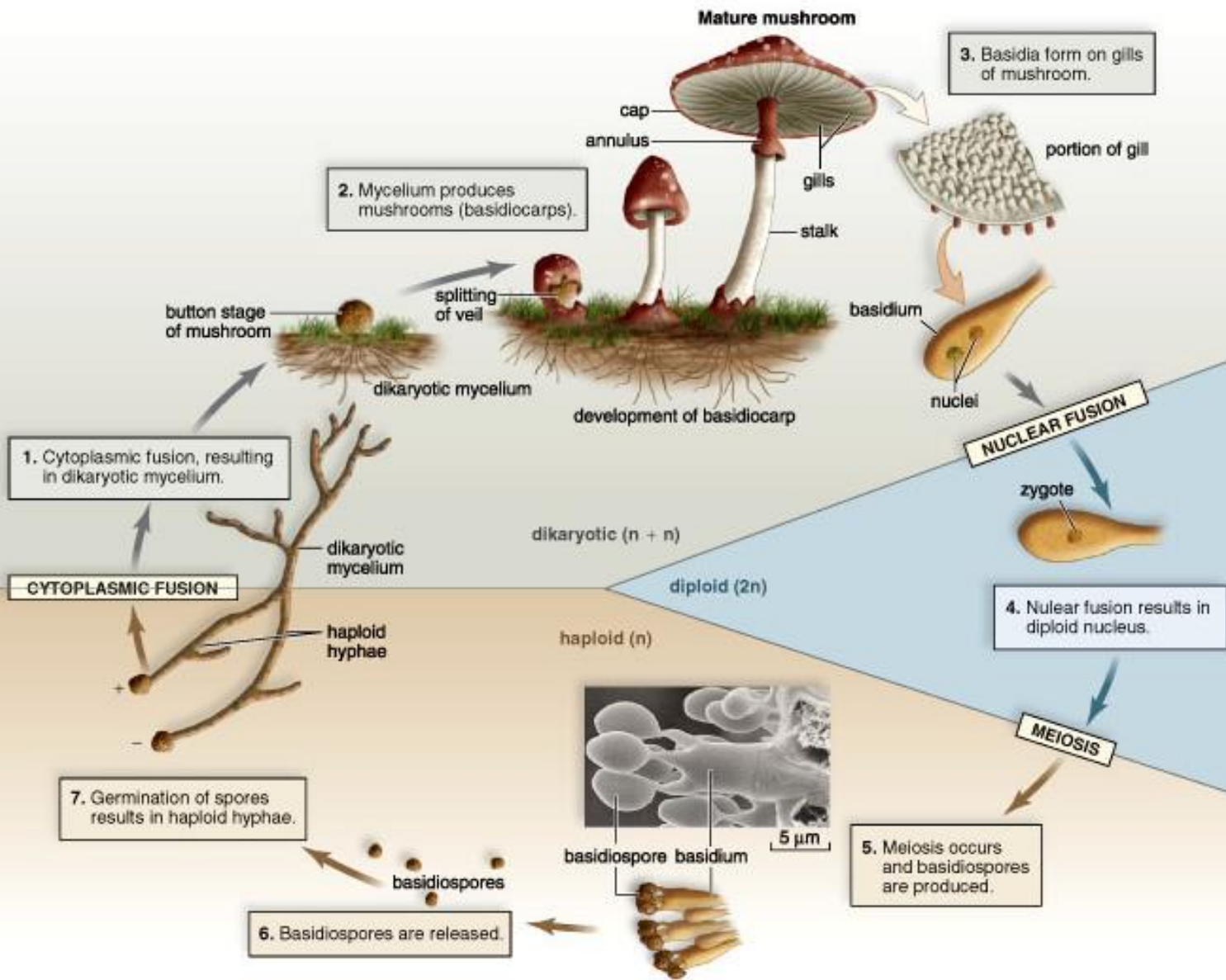
b. Wheat rust, *Puccinia*

The Club Fungi: Reproduction

- ◆ Usually reproduce sexually
- ◆ Haploid hyphae fuse, forming a dikaryotic ($n + n$) mycelium
- ◆ Dikaryotic mycelium forms **fruiting bodies** called basidiocarps (mushrooms)
- ◆ Contain club-shaped structures called **basidia**
- ◆ Nuclear fusion followed by meiosis produces basidiospores (up to 40,000,000 per hour)

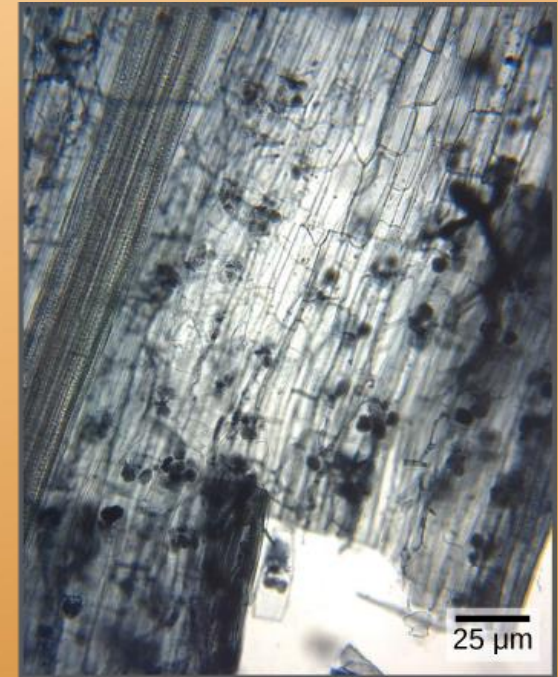


Club Fungi



Glomeromycota

- ◆ The arbuscular mycorrhizal (AM) fungi (glomeromycota) are a relatively small group - 160 spp
 - ◆ Arbuscules are branching invaginations that fungus makes when it invades plant roots
 - ◆ Endomycorrhizae are a mutualistic association
- ◆ They were classified as zygosporangium fungi. Now classified as a separate group based on molecular data.

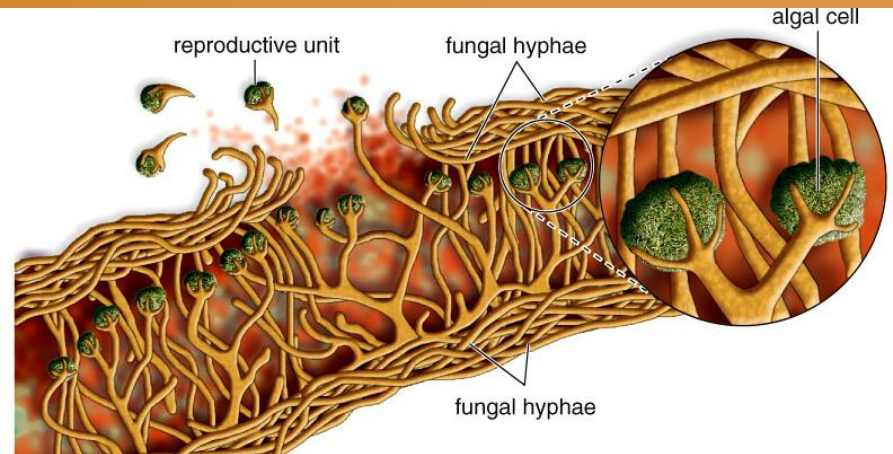


Check Point!

1. How are Chytrids different from other phyla of fungi?
2. Explain the term zygosporangium fungi. How do they reproduce asexually? Sexually?
3. Why do we say 'sac' fungi? How do they reproduce asexually? Sexually?
4. Describe the structure of yeasts, How do they reproduce. List useful/harmful ones
5. Explain the term club fungi. Can you draw and explain a diagram of the life cycle of a typical mushroom?
6. What's the economic importance of smuts and rusts?

Symbiotic Relationships: Lichens

- ◆ Lichens are Symbiotic association between a fungus and a cyanobacterium or green algae
- ◆ Specialized fungal hyphae penetrate photosynthetic symbiont
- ◆ Transfer nutrients directly to the fungus



a. Crustose lichen, *Xanthoria*



b. Fruticose lichen, *Cladonia*



c. Foliose lichen, *Xanthoparmelia*

Symbiotic Relationships: Mycorrhizae



- ◆ Mutualistic relationships between soil fungi and the roots of most familiar plants
 - ◆ Give plant greater absorptive surface
 - ◆ Help plants acquire mineral nutrients
 - ◆ Can be ecto- or endomycorrhizae
- ◆ Fungal symbiont is an asco-, zygo or Basidiomycota, or an AM fungus if endomycorrhizae
- ◆ Earliest fossil plants have mycorrhizae associated with them

Almost done ...

1. Describe the structure of a lichen, and name the three different types. What is the nature of this fungal association?
2. Describe the association known as mycorrhizae and explain how each partner benefits.

