

A Survey of Fungi

1. Pre-Lab Reading

Chapter 24 “Fungi” Biology2e, OpenStax College

2. Purpose and Objectives

The purpose of this lab is to examine the distinguishing characteristics of fungi and review their classification.

After completing this investigation, you should be able to:

1. Describe the distinguishing characteristics of fungi.
2. Understand the criteria used to classify fungi into different phyla.
3. Be familiar with examples of fungi in each fungal phylum.
4. Know how fungi reproduce.
5. Understand the ecological importance of fungi.

You will work independently in this exercise. Various types of fungi and prepared slides of fungi are available for you to examine.

3. Safety Guidelines

1. Do not open fungal plates.
2. Carry microscopes and stereoscopes with two hands.
3. Before examining any specimens using the compound microscopes, make sure that the lowest power objective is in place.
4. Use scalpels and razors with extreme care. Always cut away from you.
5. Clean and replace all equipment.
6. Wash your hands before leaving the lab.

4. Background Information

Fungi are eukaryotic heterotrophic absorptive organisms that reproduce primarily by means of spores. Fungi may be unicellular or multicellular. **Mold** is a general term for multicellular filamentous fungi. The unicellular form is referred to as a **yeast**. Most fungi are multicellular and are composed of tubular filaments called **hyphae** that form an interwoven, cotton-like mass called a **mycelium**. In most species of fungi, the hyphae are divided by cross-walls (**septa**) that create separate cells. These fungi are described as being **septate**. Hyphae that lack septa are termed **coenocytic** and are multinucleate. In fungi, cell walls are usually made of **chitin**, the same polysaccharide found in the exoskeleton of insects and crustaceans.

Fungi exhibit **absorptive nutrition**, meaning they obtain their nutrients by the extracellular digestion and absorption of organic materials found in their **substrates**. Hydrolytic **exoenzymes** are secreted onto the substrate and the products are absorbed into the mycelium. The filamentous form of the molds provides a large surface area for absorption. Like animals, most fungi store food in the form of **glycogen**. **Saprophytic** fungi obtain nutrients from dead organic matter while **parasitic** fungi feed on the tissues of living organisms. Some fungi live in a **mutualistic** relationship with either plants or algae. One **symbiotic** association of plants and fungi is known as **mycorrhizae**. In mycorrhizae the fungus associates with plant roots and greatly increases the absorptive surface, helping the plant extract minerals from the soil in exchange for organic nutrients synthesized by the plants. It is estimated that about 90% of vascular plants have mycorrhizae associations. **Lichens** are formed by the symbiotic association of a fungus and a photosynthetic alga. **Endophytic** fungi live in the intercellular spaces within plants. Found throughout the plant kingdom, some of these may be parasitic while others are believed to help protect the plant from herbivores by producing chemicals that are either toxic or distasteful.

Both sexual and asexual reproduction occurs in most groups of fungi and involves the formation of microscopic haploid **spores**. Spores are cells that can give rise to new

individual organisms without fusion with another cell. The primary mode of reproduction in most fungi is asexual unless environmental conditions change, in which case fungi may reproduce sexually. Sexual reproduction results in the production of genetically more diverse spores than does asexual reproduction.

Classification of fungi is based on structure as well as patterns of reproduction, especially sexual reproduction. Fungi are grouped in one of at least five phyla: **Chytridiomycota** (chytrids), **Zygomycota** (zygote fungi), **Glomeromycota** (arbuscular mycorrhizal fungi) **Ascomycota** (cup or sac fungi), and **Basidiomycota** (club fungi).

In this activity, you will examine fungi belonging to the phyla Zygomycota, Ascomycota and Basidiomycota. In addition, you will examine different types of lichen.

5. Phylum Zygomycota

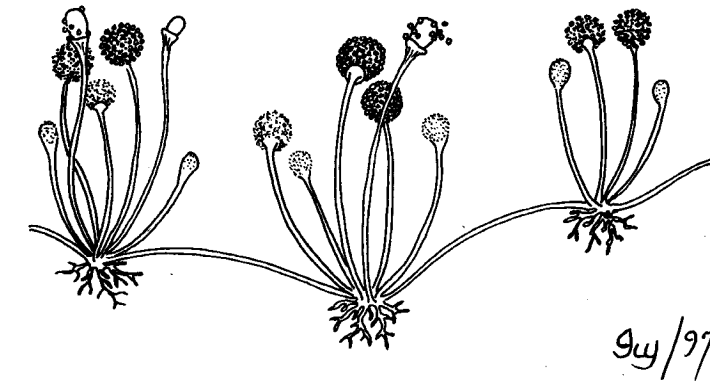
Zygomycotes are relatively simple fungi. Approximately 1,050 species have been identified and recent analyses indicate that this phylum is not monophyletic. Updated classification schemes differ but *Rhizopus*, the genus examined here, is generally now considered part of a new phylum called Mucoromycota. The original zygomycete group derives its name from the formation of a microscopic structure during sexual reproduction called a **zygosporangium**. A well-known member of this group is the common black bread mold *Rhizopus stolonifer*.

Procedure

1. Review the life cycle of *Rhizopus stolonifer* in the text.
2. Examine a Petri dish containing a culture of *Rhizopus stolonifer*, taking care to keep the dish closed. Describe the appearance of the mold(s).
3. Using a stereomicroscope, further examine the black bread mold, *Rhizopus stolonifer*. The most obvious structures are the spherical **sporangia** where haploid spores are

formed. The sporangia are supported by erect hyphae called **sporangiophores**. Anchoring the fungus to the medium are root-like extensions called **rhizoids**. Hyphae that run horizontally and connect adjacent sporangiophores are called **stolons**.

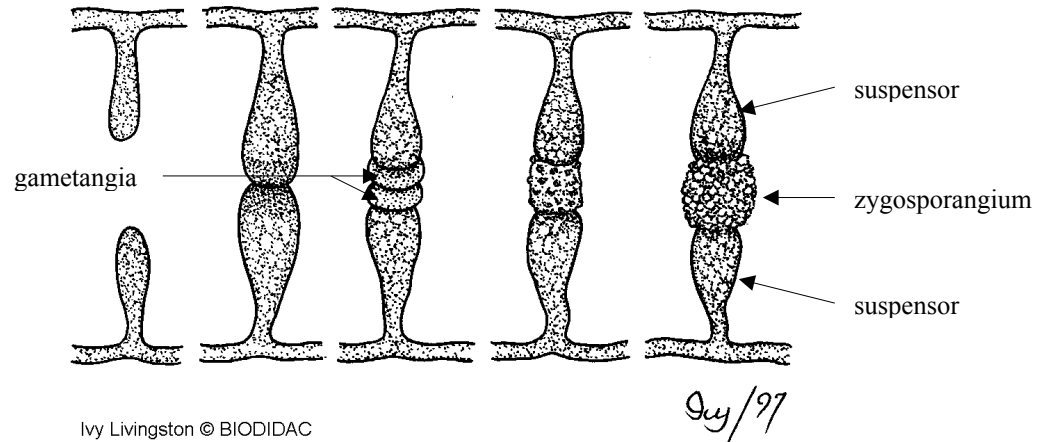
Figure 1: *Rhizopus* colonies.



Ivy Livingstone ©BIODIDAC

4. Examine the prepared slides. Draw and label **stolon**, **rhizoids** **sporangium** and **sporangiophore** (Remember to provide the total magnification used!).
5. Determine and record whether the hyphae are **septate** or **coenocytic**.
6. Identify a **zygosporangium** among the colony (Figure 2). Gametangia are structures formed during sexual reproduction between opposite mating strains of *Rhizopus* and appear as swollen knobs. Sometime after the gametangia fuse, the haploid nuclei they contained fuse forming diploid zygote nuclei. This area then develops into a zygosporangium, the structure from which the group's name is derived. This structure can develop a tough coat that helps it survive under adverse conditions. The two cells on either side of a zygosporangium are called **suspensors**. During germination of the zygosporangium, the diploid nuclei undergo meiosis to produce haploid spores. **Draw and label a zygosporangium and its suspensors.**

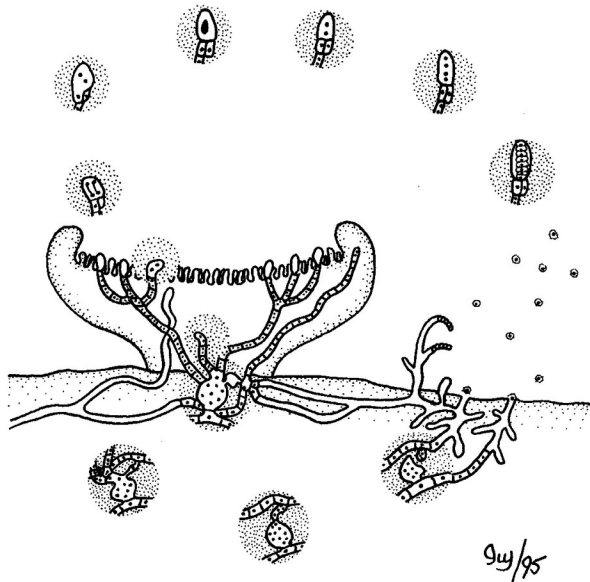
Figure 2: Zygosporangium formation.



6. Phylum Ascomycota

There are more than 60,000 species of Ascomycetes, including fungi such as yeasts, mildews, truffles, morels and *Penicillium*. Ascomycetes are characterized by the formation of sexual spores, or **ascospores**, in a sac-like structure called an **ascus** from which the group derives its name. In many cases these structures line the rim of a fruiting body called an ascocarp which is often cup-shaped and macroscopic. Asexual reproduction in most ascomycetes results in the formation of spores called **conidia** that form at the tip of specialized hyphae called **conidiophores**. Yeasts, being unicellular, do not form conidia. While yeasts can reproduce sexually, asexual reproduction is more common and occurs by a process called **budding** where mitosis in a parent yeast cell creates a smaller cell, or **bud** that separates eventually from the parent cell.

Figure 3: Sexual Reproduction in Ascomycetes.



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Procedure

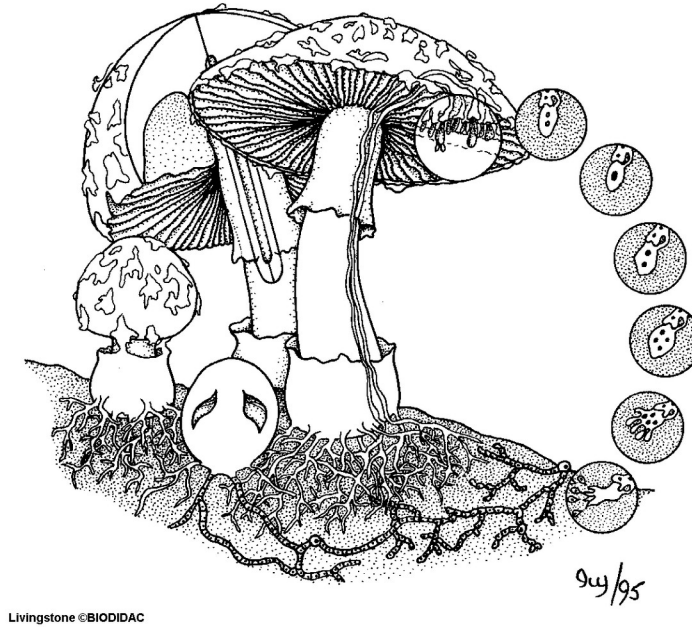
1. Review the life cycle of ascomycetes in the text.
2. Obtain a prepared slide of *Peziza*. The asci containing **ascospores** line the cup. Draw and label an **ascus** and **ascospores** in your lab book. How many ascospores would be found in an unbroken ascus? (Hint: Consult the diagram in your text.)
3. Record whether the hyphae below the asci are septate or coenocytic.

7. Phylum Basidiomycota

Basidiomycetes are probably the most familiar fungi and this group includes species commonly referred to as mushrooms. To date, approximately 30,000 species have been identified. Other members of this group include puff balls and bracket or shelf fungi in addition to plant pathogens such as rusts and smuts. Sexual reproduction results in the formation of a fruiting body called a **basidiocarp** which consists of a **cap** lined

with **gills** and a **stalk** (stem). Microscopic club-shaped cells (**basidia**) are found lining the gills and give rise to sexual spores called **basidiospores**.

Figure 4: Sexual Reproduction in Basidiomycetes.



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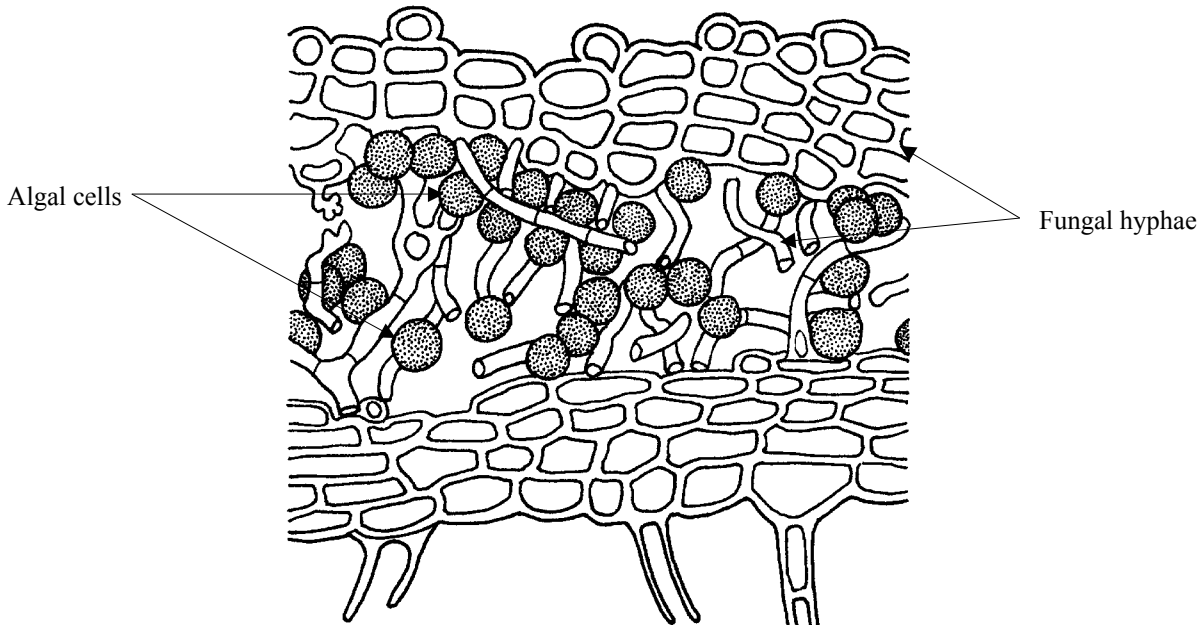
Procedure

1. Review the lifecycle of basidiomycetes in the text.
2. Examine the basidiocarp of *Agaricus*, a common mushroom found in grocery stores. Draw and label the **cap**, **gills**, **stalk** and **annulus** (a ring formed on the stem when the cap opens).
3. With a forceps or dissecting needles, carefully remove a very thin section of the stalk. Tease it apart and make a wet-mount slide for examination under the microscope (lower light works best). Determine and record whether the hyphae are septate or coenocytic.
4. Obtain a prepared slide of *Coprinus*. Using 400X magnification, locate and draw and label **hyphae**, **basidium** and **basidiospores**.

8. Lichen

Lichen are considered by most scientists to be the result of a mutualistic relationship between a fungus, most often an ascomycete, and a photosynthetic alga or cyanobacterium. Lichen grow very slowly, and are found in a variety of habitats. Some lichens can grow under harsh conditions and are “pioneers” on rock surfaces, beginning the process of converting bare rock to soil. They are, however, very sensitive **bioindicators** of air pollution, especially sulfur and nitrogen. Three kinds of lichen are recognized based on their gross appearance: **crustose** (crust-like; may be buried in tree bark or between crystals in rocks), **foliose** (flat and leaf-like), **fruticose** (shrub-like).

Figure 5: Lichen in Cross Section. Algal cells are represented as spheres and fungal hyphae form a network of filaments.



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Procedure

1. Examine the lichen samples in the specimen jars provided and note the distinctive body type of each sample. Be able to identify these by their appearance.

2. Examine a slide of lichen and identify, draw and label the **fungal hyphae** and the **algal cells** (stained red).

9. Summary and Conclusion

1. List a characteristic that distinguishes fungi from each of the following groups of organisms (one characteristic for each group): plants, animals and protozoa.
2. Were the organisms that you observed molds or yeasts? What is an advantage of the mold's filamentous form?
3. Describe at least two ecological roles fungi play in nature (your text will be helpful here).
4. Give two examples of economically important fungi and describe their importance.
5. Describe three follow-up investigations that would increase your knowledge and understanding of fungi.

NOTES: