Fungi

MIC 1001: General Microbiology
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Fungi

- Eukaryotes
- The fungi comprise a diverse group of organisms that are heterotrophic and typically saprozoic, parasitic or symbiotic
- In addition to the well-known macroscopic fungi (such as mushrooms and molds), many unicellular yeasts and spores of macroscopic fungi are microscopic. For this reason, fungi are included within the field of microbiology.

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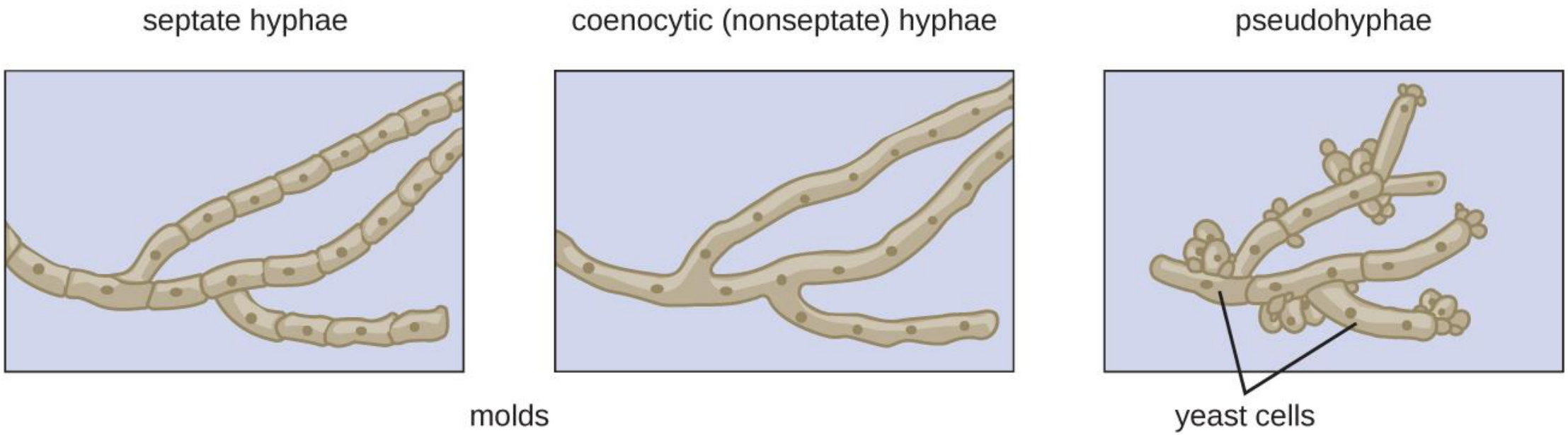
- Fungi are important to humans in a variety of ways. Both microscopic and macroscopic fungi have medical relevance, with some pathogenic species that can cause **mycoses** (illnesses caused by fungi). Some pathogenic fungi are opportunistic, meaning that they mainly cause infections when the host's immune defenses are compromised and do not normally cause illness in healthy individuals. Fungi are important in other ways. They act as decomposers in the environment, and they are critical for the production of certain foods such as cheeses. Fungi are also major sources of antibiotics, such as penicillin from the fungus *Penicillium*.

Fungal Structure



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Characteristics of Fungi

- Fungi have well-defined characteristics that set them apart from other organisms. Most multicellular fungal bodies, commonly called molds, are made up of filaments called **hyphae**. Hyphae can form a tangled network called a **mycelium** and form the **thallus** (body) of fleshy fungi. Hyphae that have walls between the cells are called **septate hyphae**; hyphae that lack walls and cell membranes between the cells are called nonseptate or **coenocytic hyphae**).
- In contrast to molds, yeasts are unicellular fungi. The **budding yeasts** reproduce asexually by budding off a smaller daughter cell; the resulting cells may sometimes stick together as a short chain or **pseudohypha**
- Some fungi are dimorphic, having more than one appearance during their life cycle. These **dimorphic fungi** may be able to appear as yeasts or molds, which can be important for infectivity.

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Fungi- characteristics

- There are notable unique features in fungal cell walls and membranes. Fungal cell walls contain **chitin**, as opposed to the cellulose found in the cell walls of plants and many protists. Additionally, whereas animals have cholesterol in their cell membranes, fungal cell membranes have different sterols called ergosterols. Ergosterols are often exploited as targets for antifungal drugs.

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Reproduction

- Fungal life cycles are unique and complex. Fungi reproduce sexually either through cross- or self-fertilization. Haploid fungi form hyphae that have gametes at the tips. Two different mating types (represented as “+ type” and “– type”) are involved. The cytoplasms of the + and – type gametes fuse (in an event called plasmogamy), producing a cell with two distinct nuclei (a **dikaryotic** cell). Later, the nuclei fuse (in an event called karyogamy) to create a diploid zygote. The zygote undergoes meiosis to form **spores** that germinate to start the haploid stage, which eventually creates more haploid mycelia (Figure 5.27). Depending on the taxonomic group, these sexually produced spores are known as zygospores (in Zygomycota), ascospores (in Ascomycota), or basidiospores (in Basidiomycota) (Figure 5.28).

Asexual reproduction

- Fungi may also exhibit asexual reproduction by mitosis, mitosis with budding, fragmentation of hyphae, and formation of asexual spores by mitosis.
- These spores are specialized cells that, depending on the organism, may have unique characteristics for survival, reproduction, and dispersal.
- Fungi exhibit several types of asexual spores and these can be important in classification.

Sexual Reproduction

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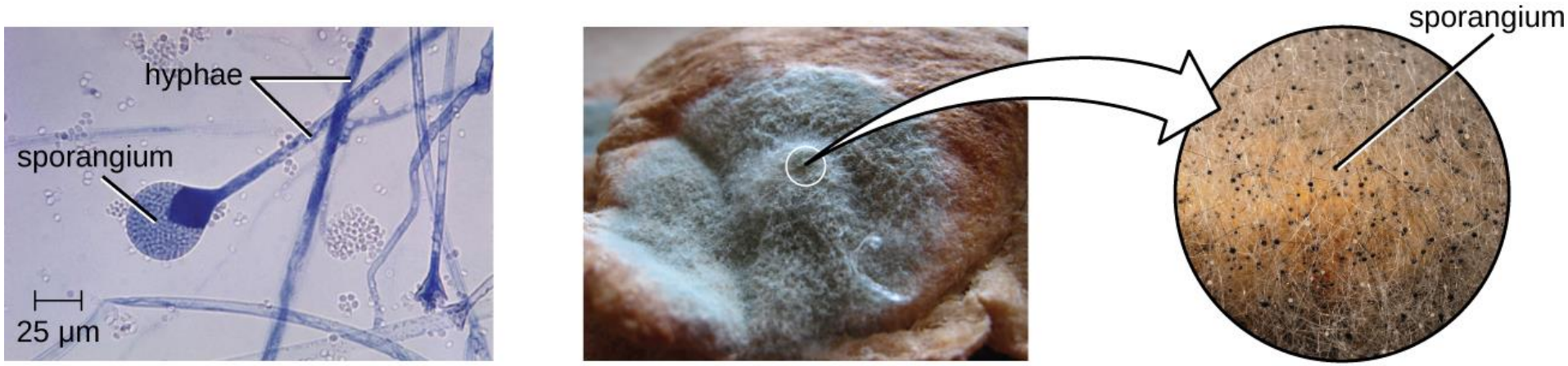
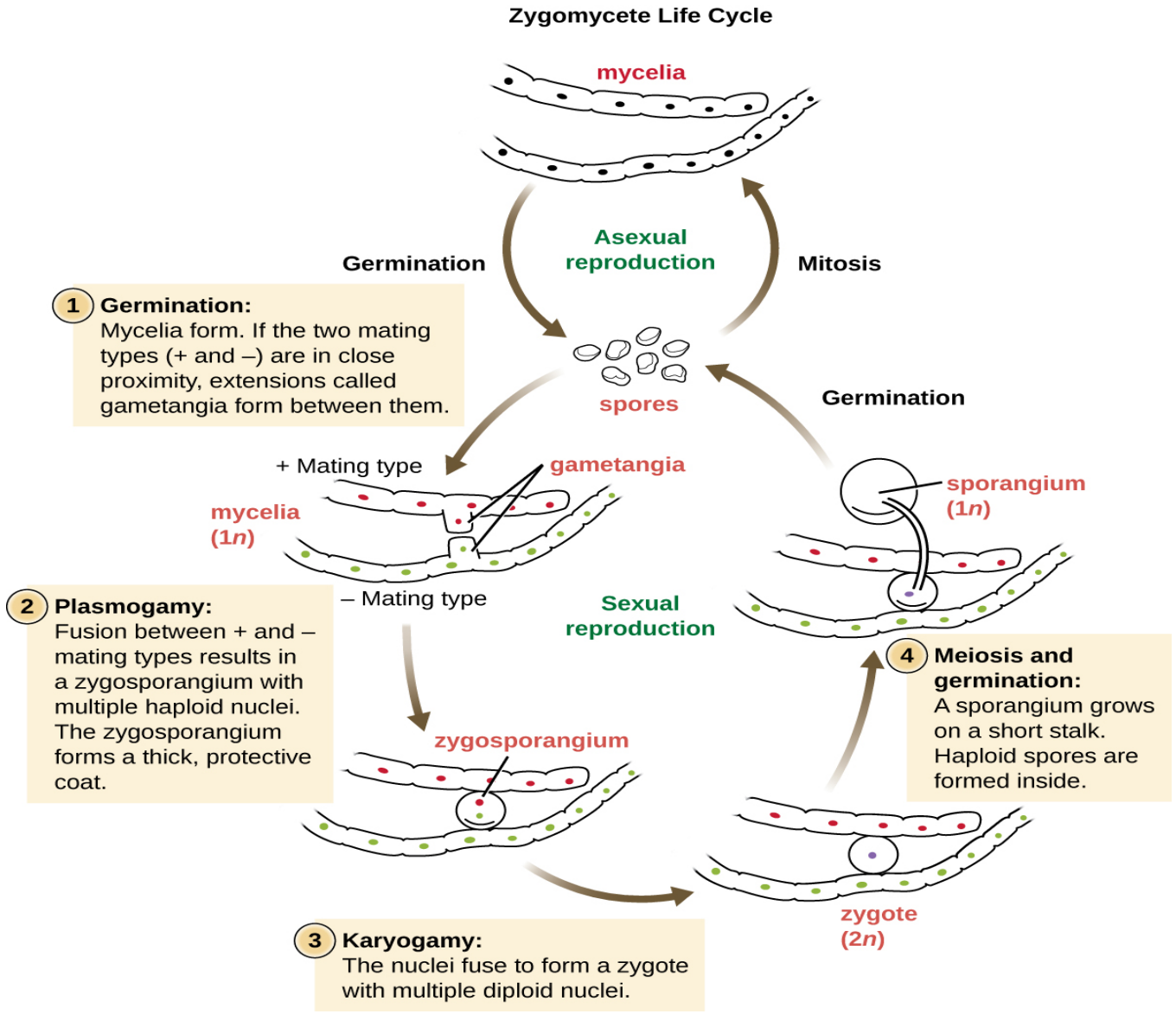


Figure. These images show asexually produced spores. (a) This brightfield micrograph shows the release of spores from a sporangium at the end of a hypha called a sporangiophore. The organism is a Mucor sp. fungus, a mold often found indoors. (b) Sporangia grow at the ends of stalks, which appear as the white fuzz seen on this bread mold, Rhizopus stolonifer. The tips of bread mold are the dark, spore-containing sporangia. (credit a: modification of work by Centers for Disease Control and Prevention; credit b right: modification of work by “Andrew”/Flickr)

Zygomycetes



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Zygomycota

- The Zygomycota (zygomycetes) are mainly saprophytes with coenocytic hyphae and haploid nuclei. They use sporangiospores for asexual reproduction. The group name comes from the zygospores that they use for sexual reproduction (Figure 5.27), which have hard walls formed from the fusion of reproductive cells from two individuals. Zygomycetes are important for food science and as crop pathogens. One example is Rhizopus stolonifer (Figure 5.28), an important bread mold that also causes rice seedling blight. Mucor is a genus of fungi that can potentially cause necrotizing infections in humans, although most species are intolerant of temperatures found in mammalian bodies

Ascomycota

- The Ascomycota include fungi that are used as food (edible mushrooms, morels, and truffles), others that are common causes of food spoilage (bread molds and plant pathogens), and still others that are human pathogens. Ascomycota may have septate hyphae and cup-shaped fruiting bodies called ascocarps. Some genera of Ascomycota use sexually produced ascospores as well as asexual spores called conidia, but sexual phases have not been discovered or described for others. Some produce an ascus containing ascospores within an ascocarp (Figure 5.29).

- Examples of the Ascomycota include several bread molds and minor pathogens, as well as species capable of causing more serious mycoses. Species in the genus Aspergillus are important causes of allergy and infection, and are useful in research and in the production of certain fermented alcoholic beverages such as Japanese sake. The fungus Aspergillus flavus, a contaminant of nuts and stored grains, produces an aflatoxin that is both a toxin and the most potent known natural carcinogen. Neurospora crassa is of particular use in genetics research because the spores produced by meiosis are kept inside the ascus in a row that reflects the cell divisions that produced them, giving a direct view of segregation and assortment of genes (Figure 5.30). Penicillium produces the antibiotic penicillin (Figure 5.29).

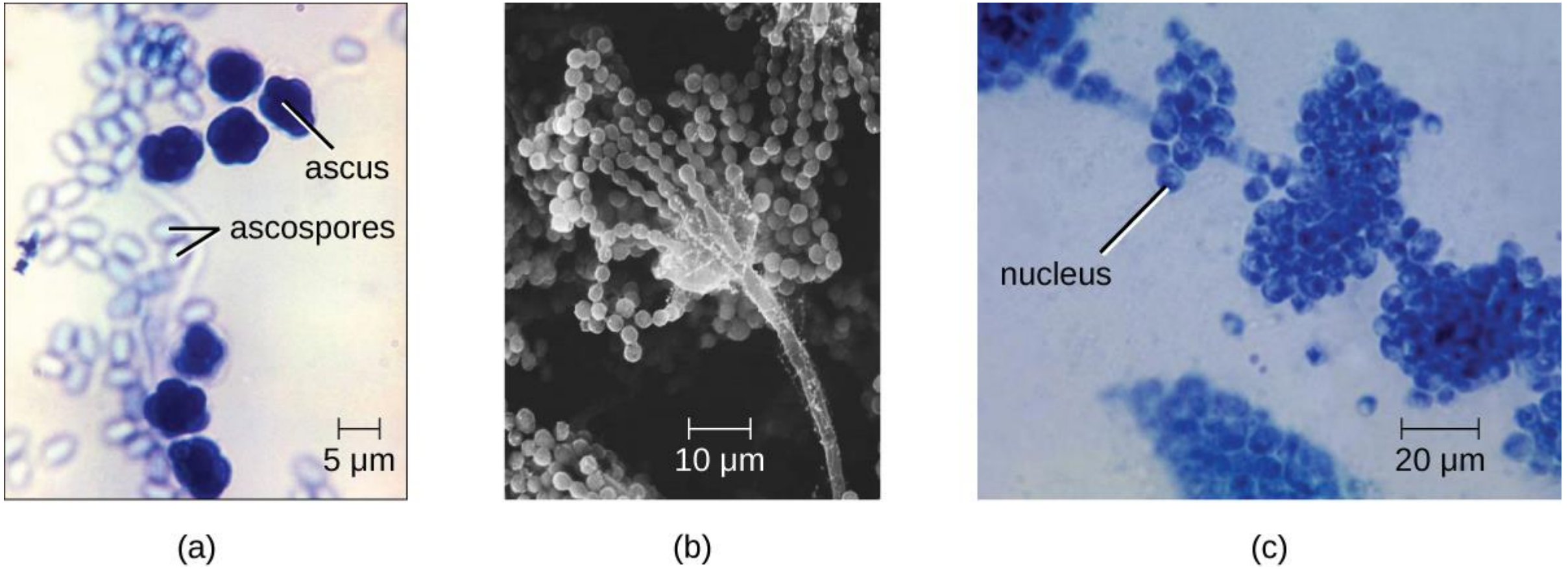
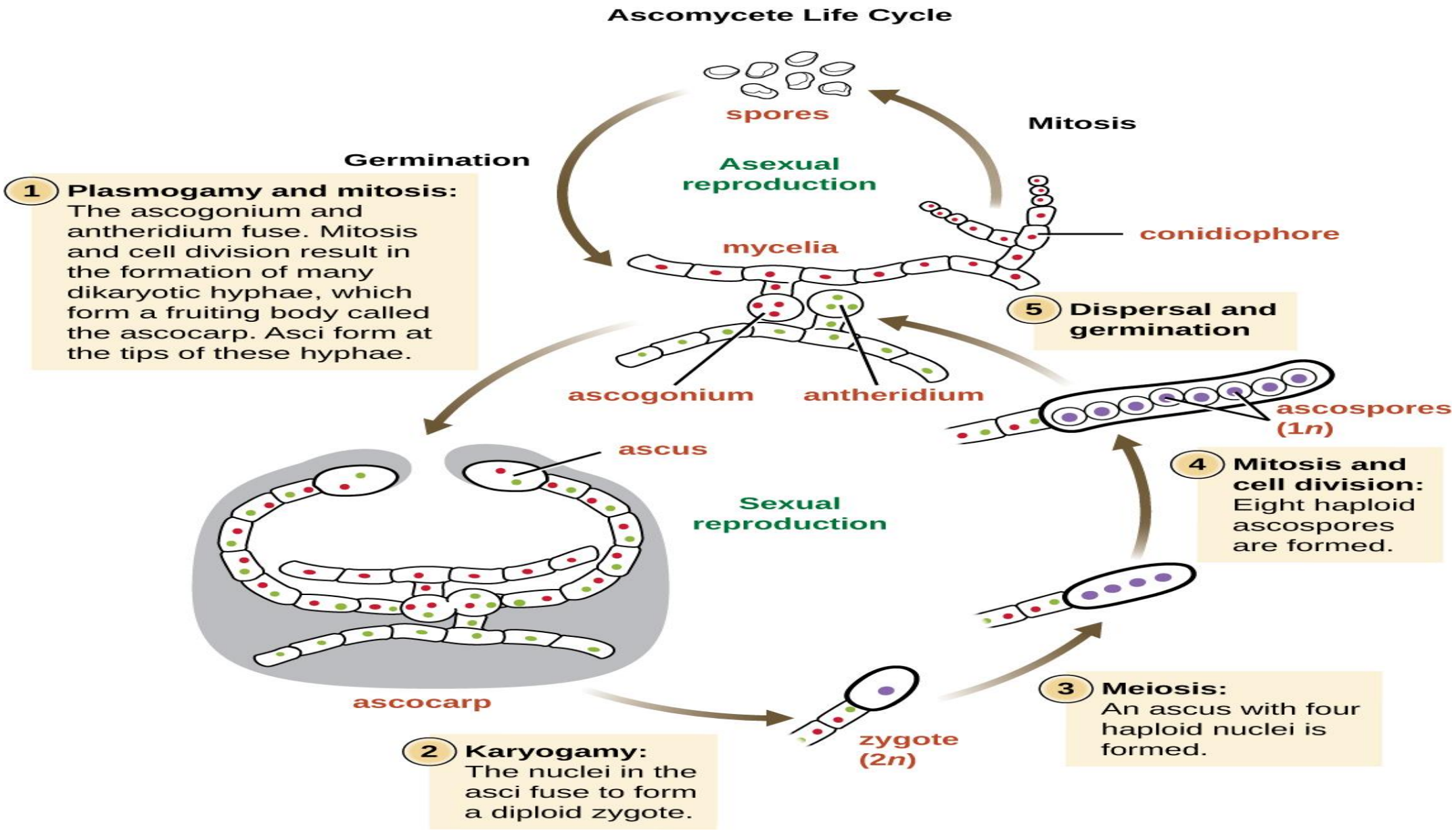


Figure 5.29 (a) This brightfield micrograph shows ascospores being released from asci in the fungus Talaromyces flavus var. flavus. (b) This electron micrograph shows the conidia (spores) borne on the conidiophore of Aspergillus, a type of toxic fungus found mostly in soil and plants. (c) This brightfield micrograph shows the yeast Candida albicans, the causative agent of candidiasis and thrush. (credit a, b, c: modification of work by Centers for Disease Control and Prevention)



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Basidiomycota

- The Basidiomycota (basidiomycetes) are fungi that have **basidia** (club-shaped structures) that produce **basidiospores** (spores produced through budding) within fruiting bodies called **basidiocarps**. They are important as decomposers and as food.
- This group includes rusts, stinkhorns, puffballs, and mushrooms. Several species are of particular importance. *Cryptococcus neoformans*, a fungus commonly found as a yeast in the environment, can cause serious lung infections when inhaled by individuals with weakened immune systems. The edible meadow mushroom, *Agricus campestris*, is a basidiomycete, as is the poisonous mushroom *Amanita phalloides*, known as the death cap. The deadly toxins produced by *A. phalloides* have been used to study transcription.

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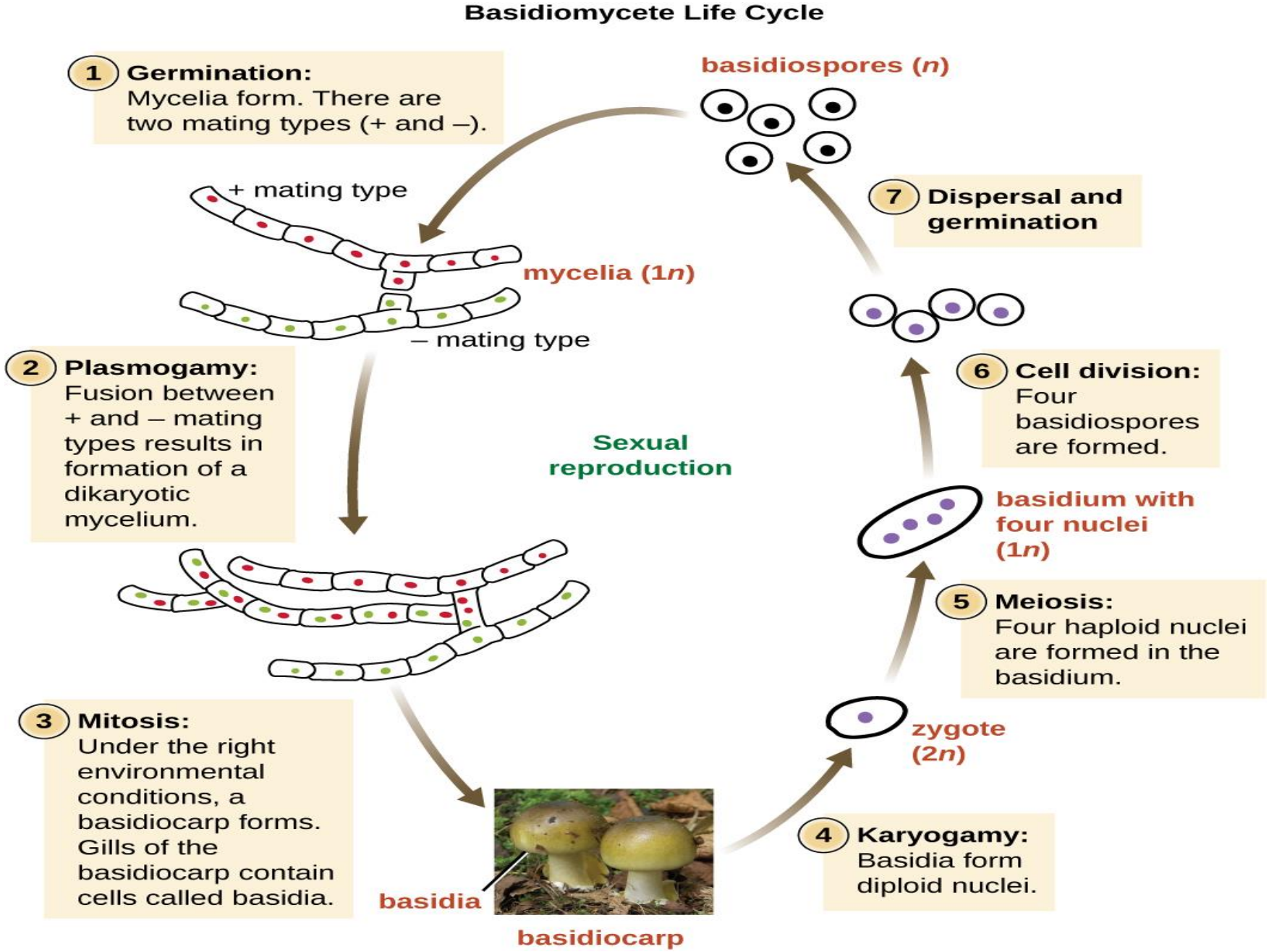

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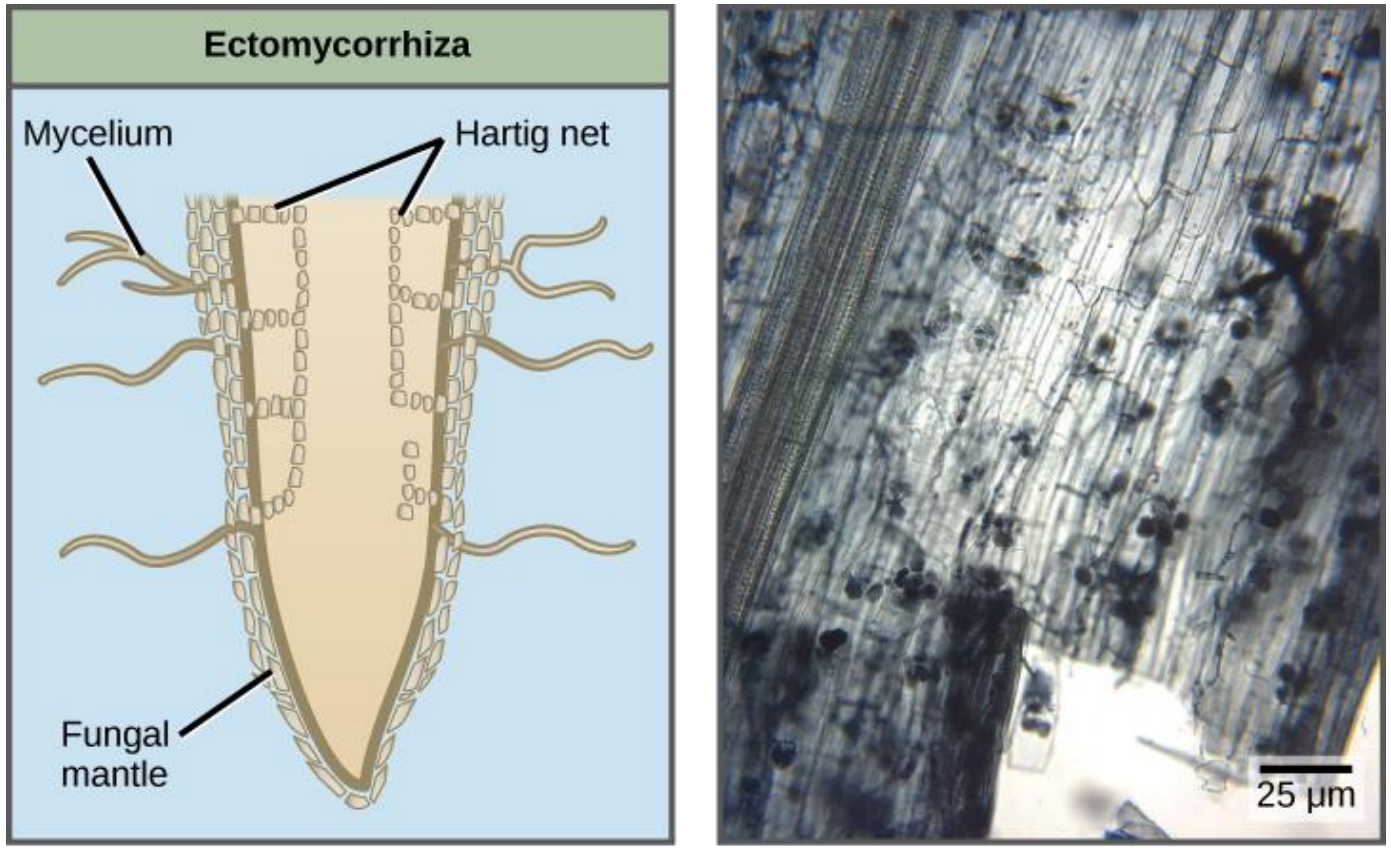
Fungus/Plant Mutualism

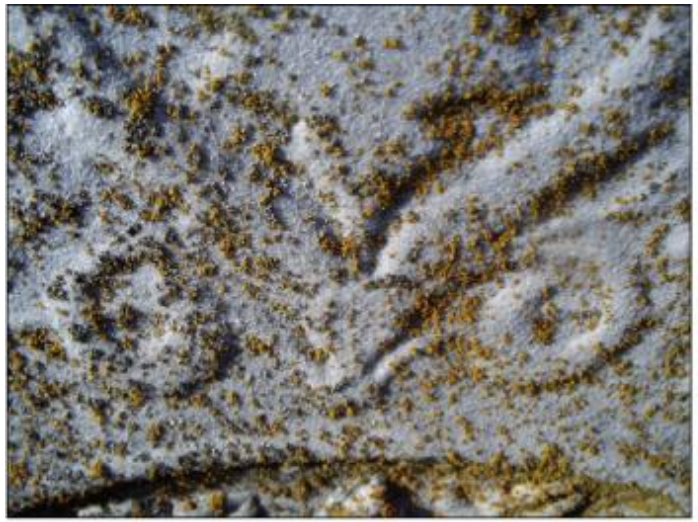
- One of the most remarkable associations between fungi and plants is the establishment of mycorrhizae.
- Mycorrhiza, which comes from the Greek words myco meaning fungus and rhizo meaning root, refers to the association between vascular plant roots and their symbiotic fungi. Somewhere between 80 and 90 percent of all plant species have mycorrhizal partners. In a mycorrhizal association, the fungal mycelia use their extensive network of hyphae and large surface area in contact with the soil to channel water and minerals from the soil into the plant. In exchange, the plant supplies the products of photosynthesis to fuel the metabolism of the fungus.

- There are a number of types of mycorrhizae. Ectomycorrhizae ("outside" mycorrhiza) depend on fungi enveloping the roots in a sheath (called a mantle) and a Hartig net of hyphae that extends into the roots between cells (Figure). The fungal partner can belong to the Ascomycota, Basidiomycota or Zygomycota. In a second type, the Glomeromycete fungi form vesicular–arbuscular interactions with arbuscular mycorrhiza (sometimes called endomycorrhizae). In these mycorrhiza, the fungi form arbuscules that penetrate root cells and are the site of the metabolic exchanges between the fungus and the host plant (Figure and Figure). The arbuscules (from the Latin for little trees) have a shrub-like appearance. Orchids rely on a third type of mycorrhiza. Orchids are epiphytes that form small seeds without much storage to sustain germination and growth. Their seeds will not germinate without a mycorrhizal partner (usually a Basidiomycete). After nutrients in the seed are depleted, fungal symbionts support the growth of the orchid by providing necessary carbohydrates and minerals. Some orchids continue to be mycorrhizal throughout their lifecycle.



(a) Ectomycorrhiza and (b) arbuscular mycorrhiza have different mechanisms for interacting with the roots of plants. (credit b: MS Turmel, University of Manitoba, Plant Science Department)

Lichens



(a)

(b)

(c)

Lichens have many forms. They may be (a) crust-like, (b) hair-like, or (c) leaf-like. (credit a: modification of work by Jo Naylor; credit b: modification of work by "djpmapleferryman"/Flickr; credit c: modification of work by Cory Zanker)

Reference

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