# FUNGI

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Fungi are absorptive heterotrophic eukaryotes that digest their food externally and absorb the nutrients

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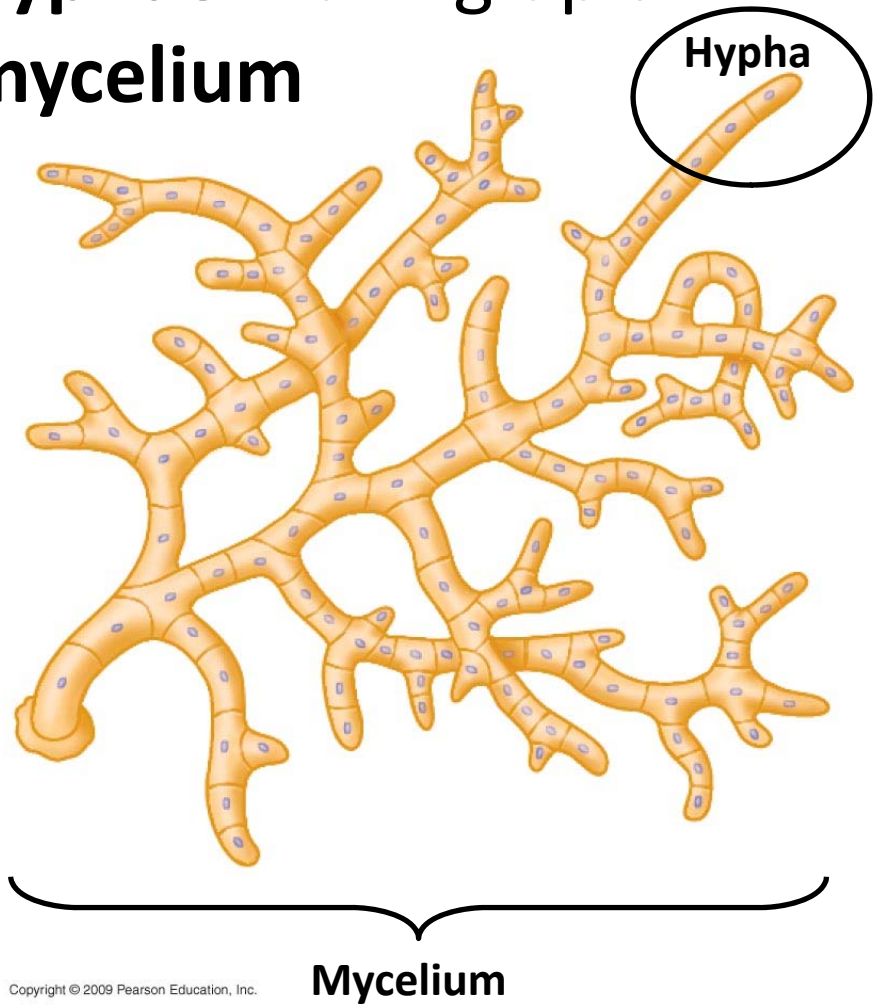
Most fungi consist of a mass of threadlike **hyphae** making up a **mycelium**




Hyphal cells are separated by cross-walls with pores large enough for ribosomes, mitochondria, and nuclei to cross
Some are multinucleate without cross-walls

# FUNGI

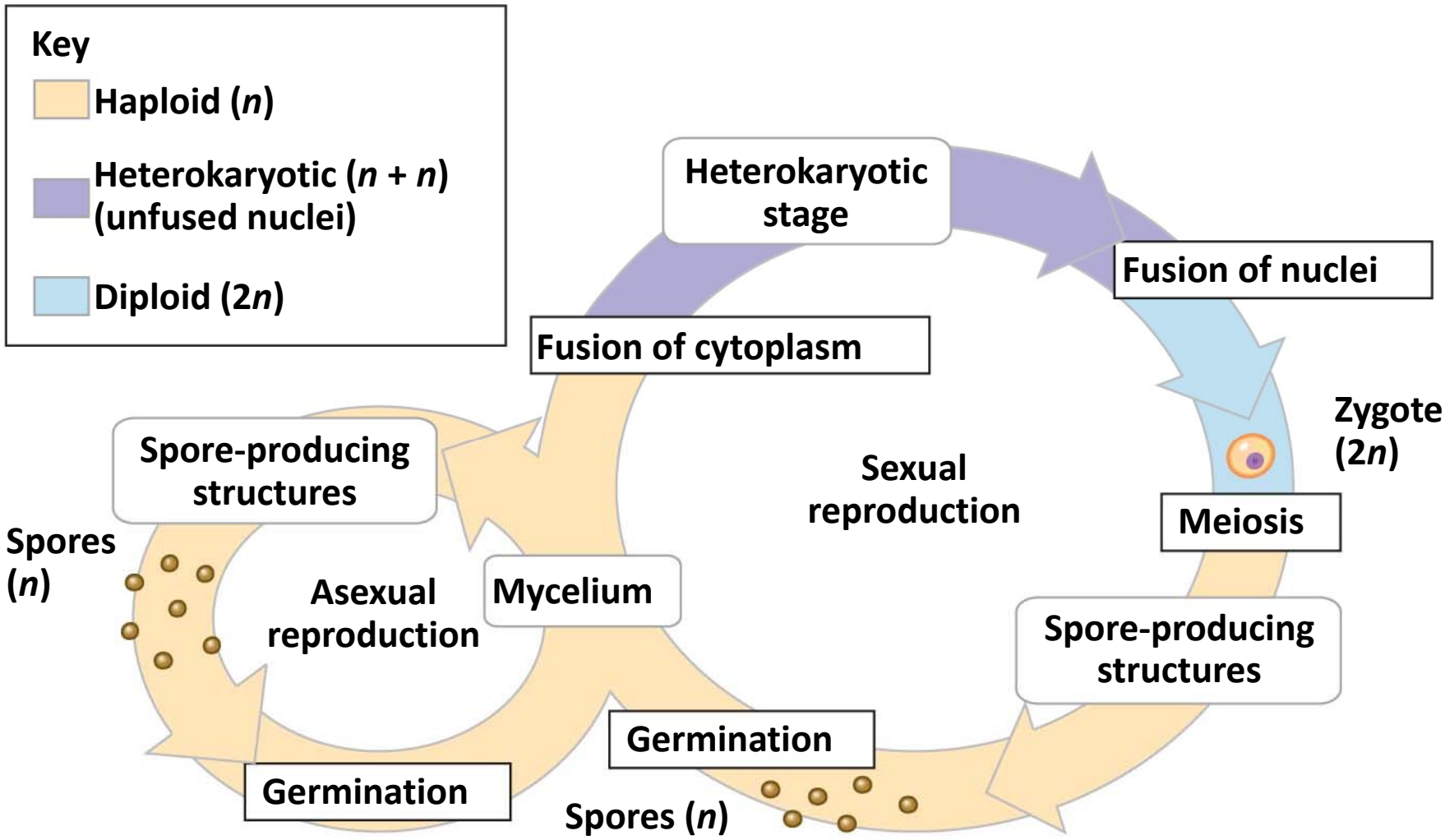


Hyphae have a huge surface area to secrete digestive enzymes and absorb food

- Fungal hyphae are surrounded by a cell wall with chitin

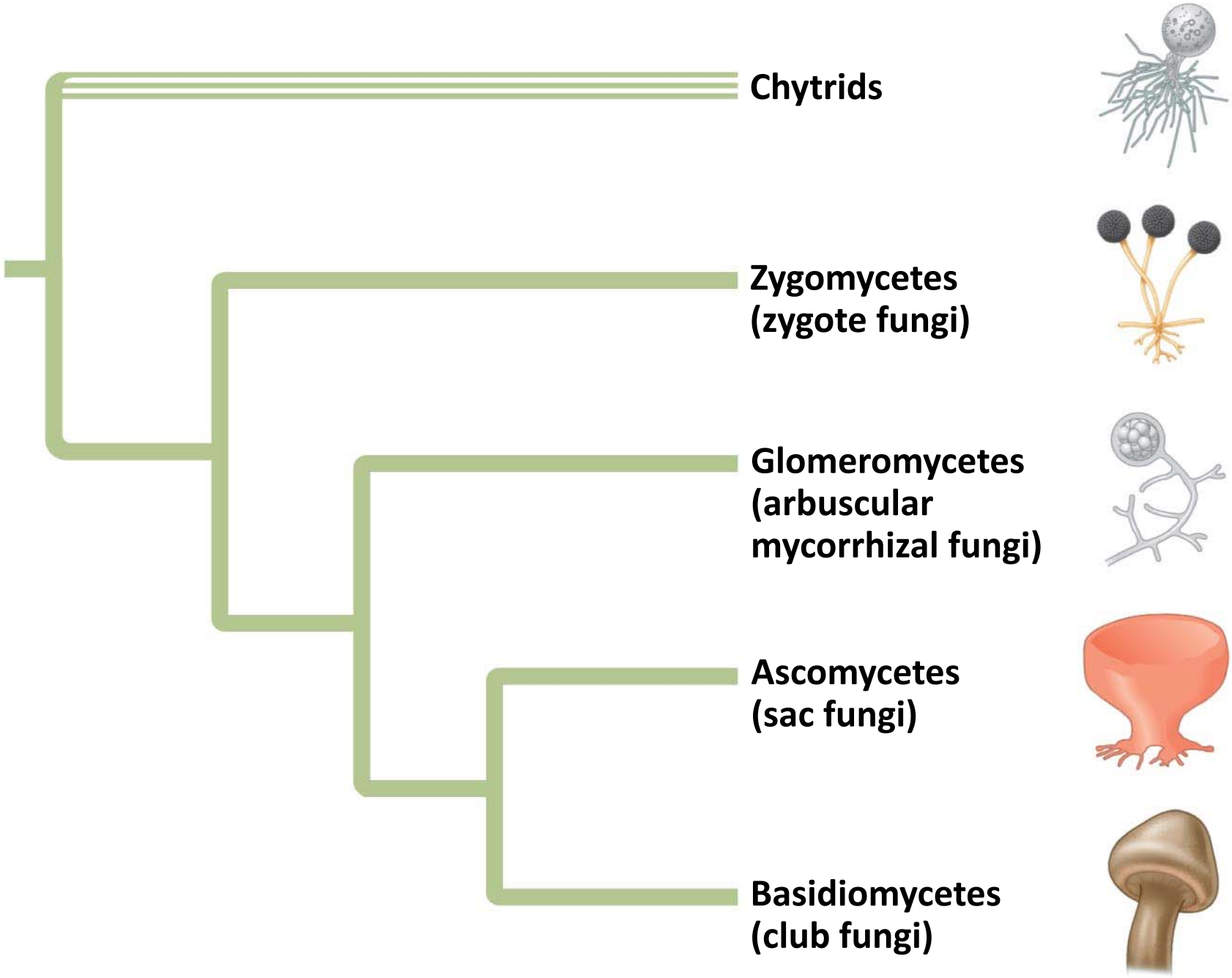
# Fungi produce spores in both asexual and sexual life cycles

- Many fungal species can reproduce both sexually and asexually
- Fungi produce huge numbers of asexual spores, each of which can germinate to form a new fungus
- In many fungi, sexual fusion of haploid hyphae leads to a **heterokaryotic** stage, in which cells contain two genetically distinct haploid nuclei
  - Hours or centuries may pass before parental nuclei fuse to form a short-lived diploid phase
  - Zygotes undergo meiosis inside specialized reproductive structures and disperse haploid



# Fungi are classified into five groups

- Sexual reproductive structures are used to classify fungi
  - Fungi with no known sexual stage are known as **imperfect fungi**
- Fungi likely evolved from an aquatic, flagellated ancestor shared with animals
- **Chytrids**, which have flagellated spores, are the earliest lineage of fungi
- Animals and fungi diverged into separate lineages 1.5 billion years ago

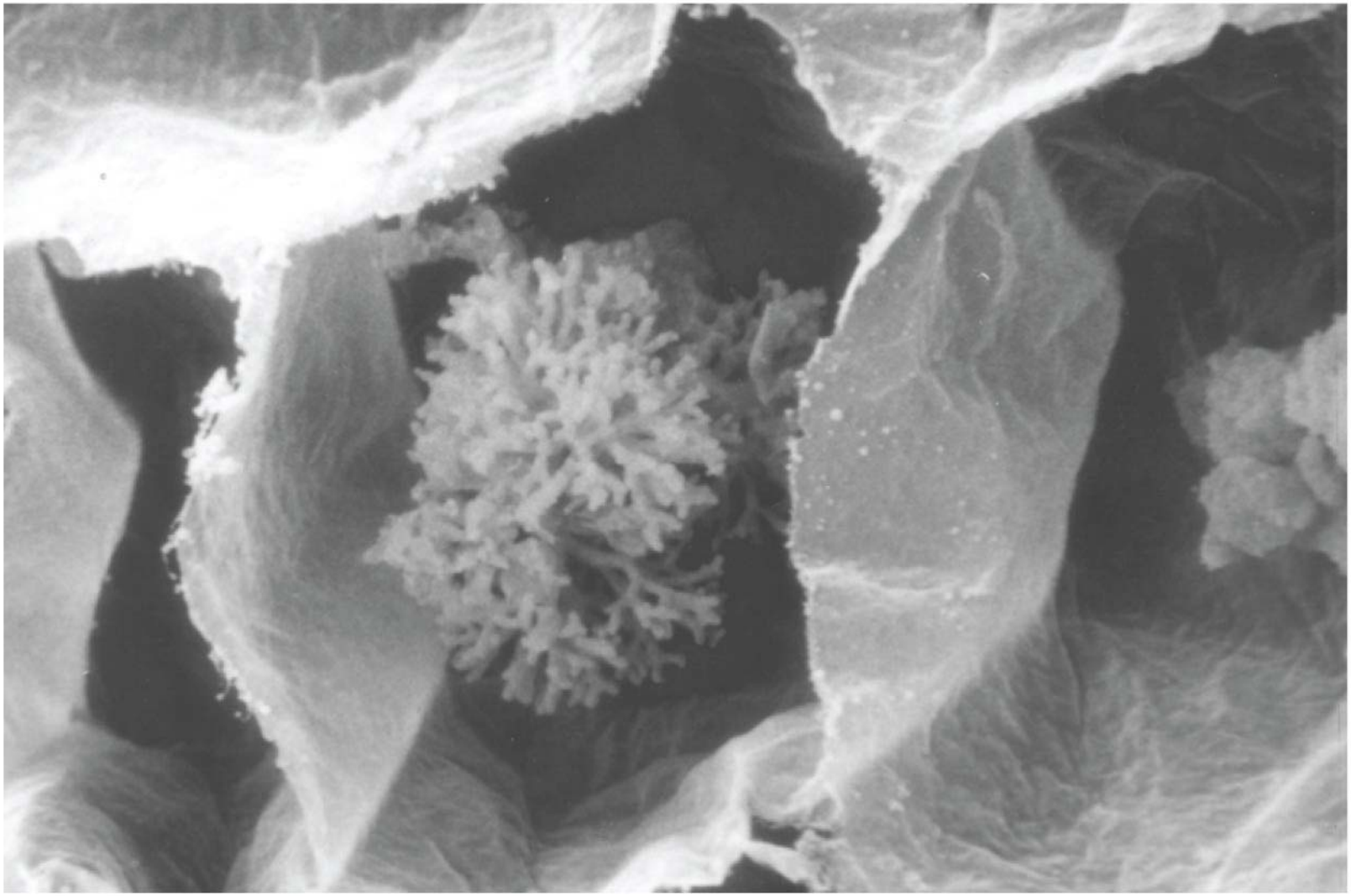


# Fungi are classified into five groups

- **Zygomycetes**
  - Zygote fungi form resistant **zygosporangia** in which haploid spores form by meiosis
    - This group includes black bread mold

# Fungi are classified into five groups

- **Glomeromycetes**
  - These fungi form mycorrhizae, in which invasive hyphae branch into treelike **arbuscules** within plant roots
    - 90% of plants have symbiotic partnerships with glomeromycetes



# Fungi are classified into five groups

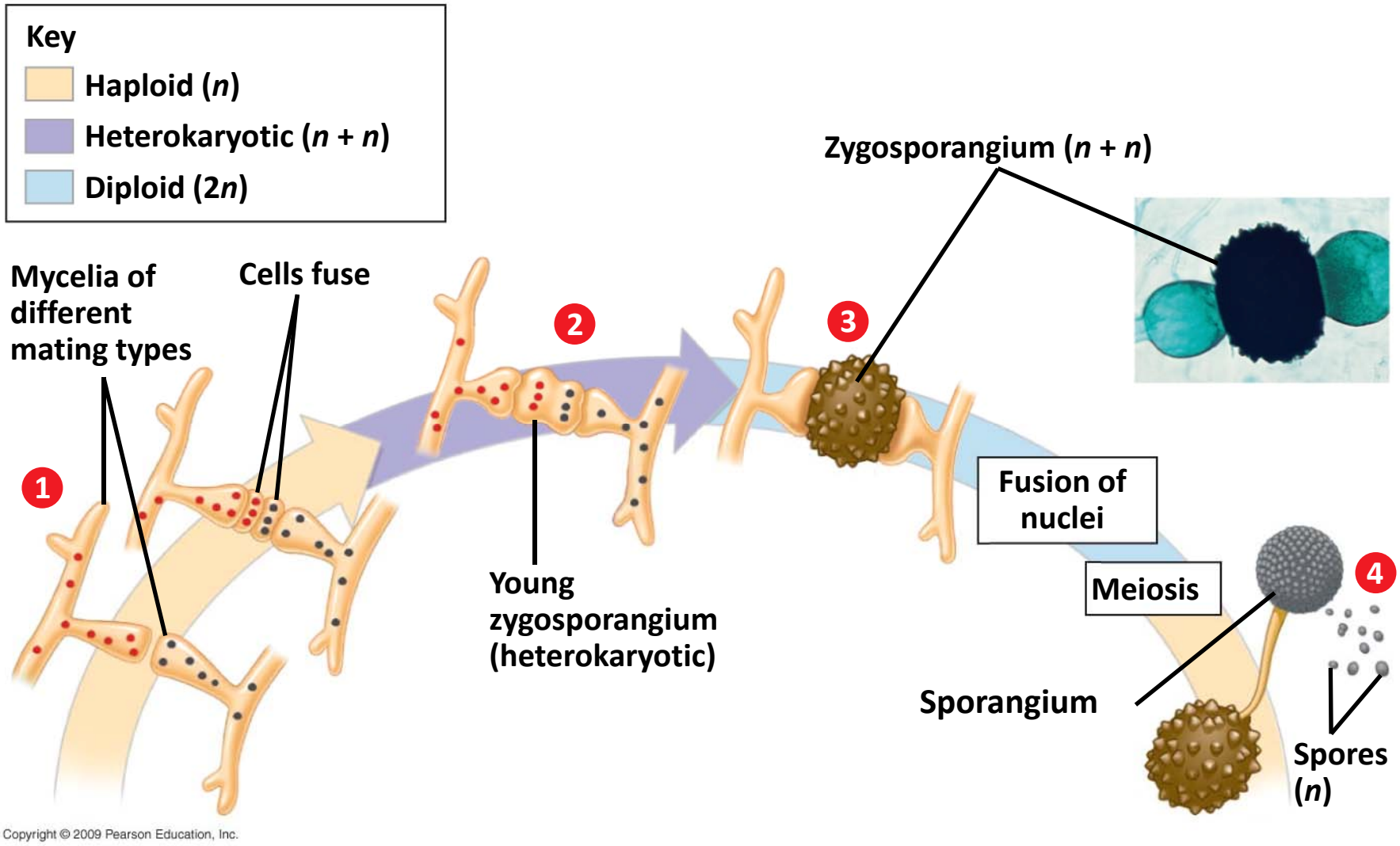
- **Ascomycetes**
  - **Sac fungi** form saclike **asci**, which produce sexual spores
    - They range in size from yeasts to elaborate morels and cup fungi
    - Some form lichens in association with green algae or cyanobacteria

# Fungi are classified into five groups

- **Basidiomycetes**
  - **Club fungi** are the mushrooms, puffballs, and shelf fungi
    - They have club-shaped spore-producing structures called **basidia**
    - These fungi are important forest decomposers

# Fungal groups differ in their life cycles and reproductive structures

- Hyphae reproduce asexually by producing spores in sporangia at the tips of upright hyphae
- When food is depleted, the fungus reproduces sexually
  - Mycelia of different mating types join and produce a **zygosporangium**, which develops into a thick-walled structure that can tolerate dry, harsh conditions
  - Under favorable conditions, the parental nuclei fuse and the diploid nucleus undergoes meiosis to form haploid spores

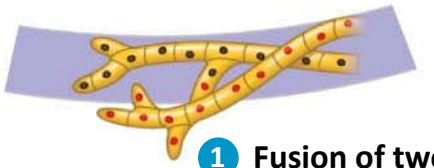


# Fungal groups differ in their life cycles and reproductive structures

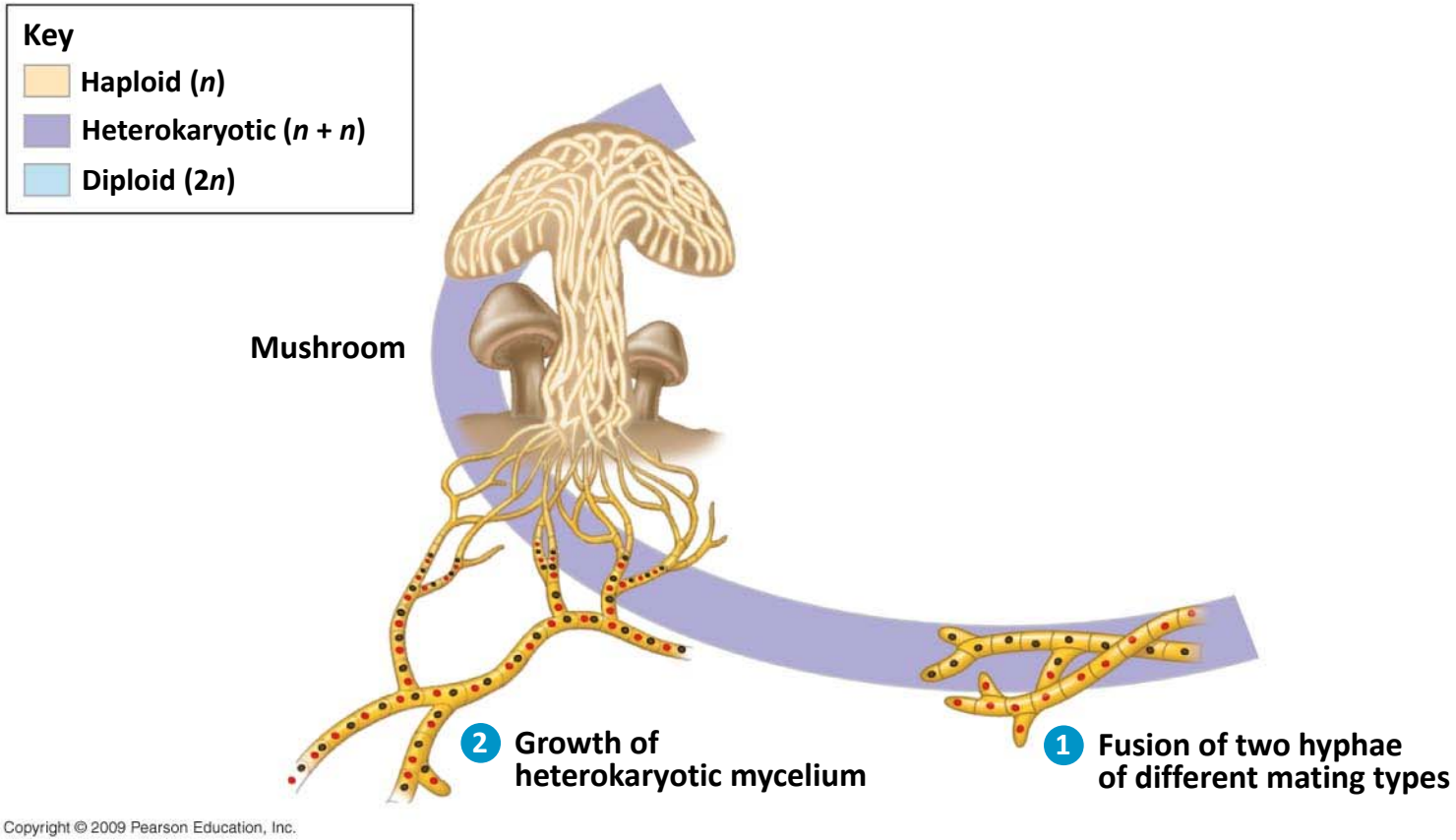
- Hyphae of different mating types fuse to form a heterokaryotic mycelium, which grows to produce a mushroom
  - Haploid nuclei fuse to form diploid nuclei in the club-shaped cells called **basidia** that line the gills of the mushroom
  - Each diploid nucleus undergoes meiosis to form haploid spores

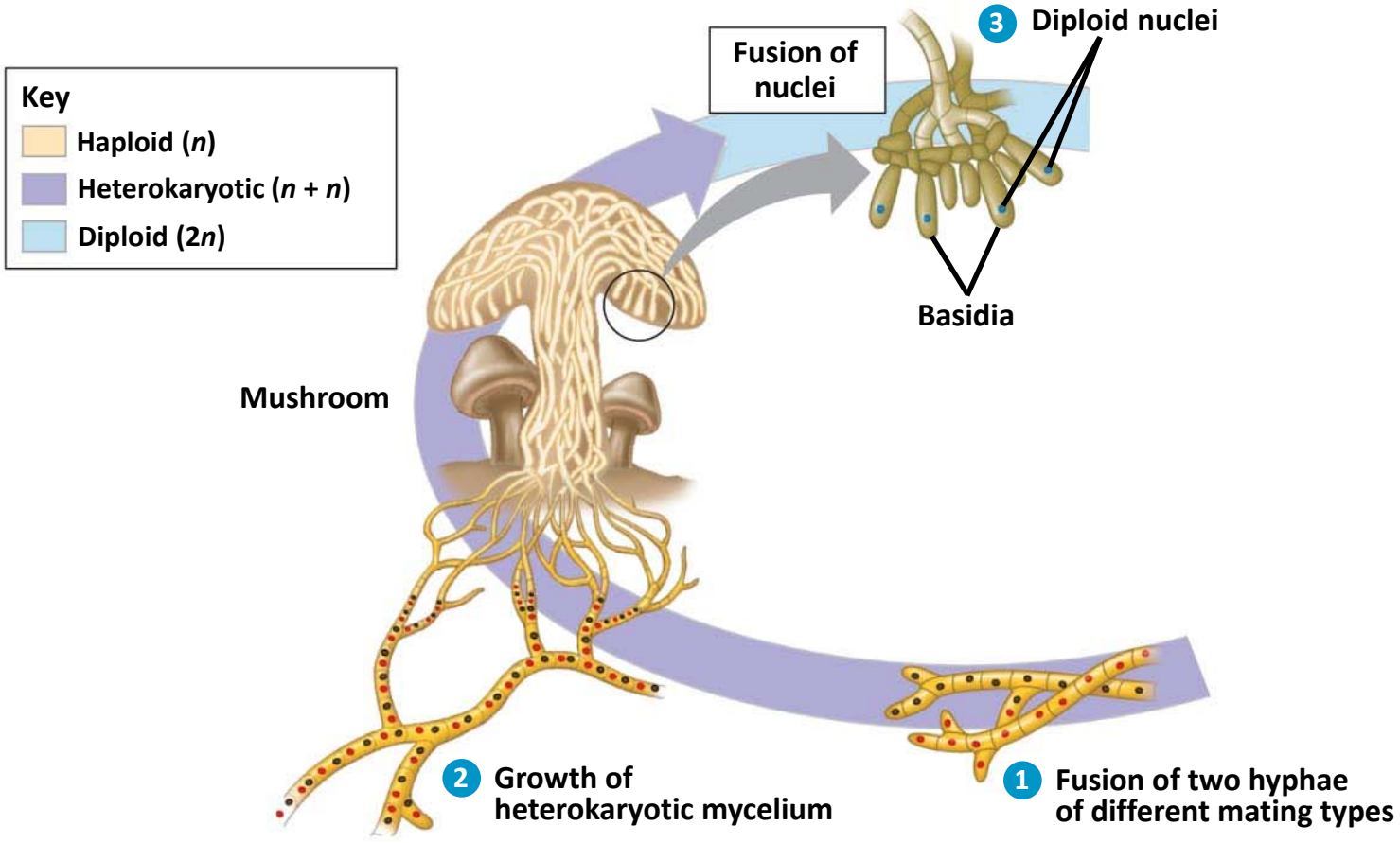
**Key**

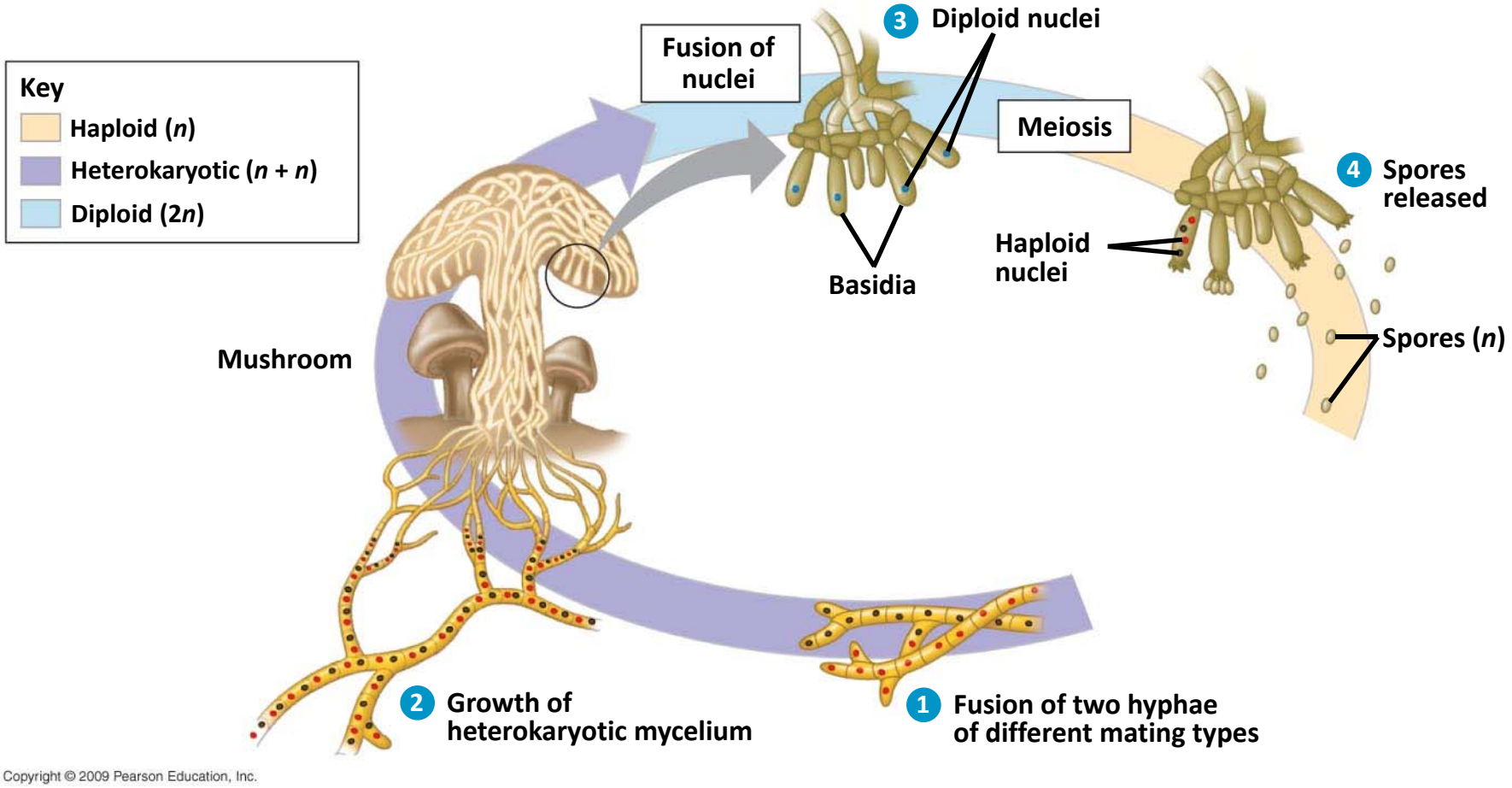
- Haploid (*n*)
- Heterokaryotic (*n* + *n*)
- Diploid (2*n*)

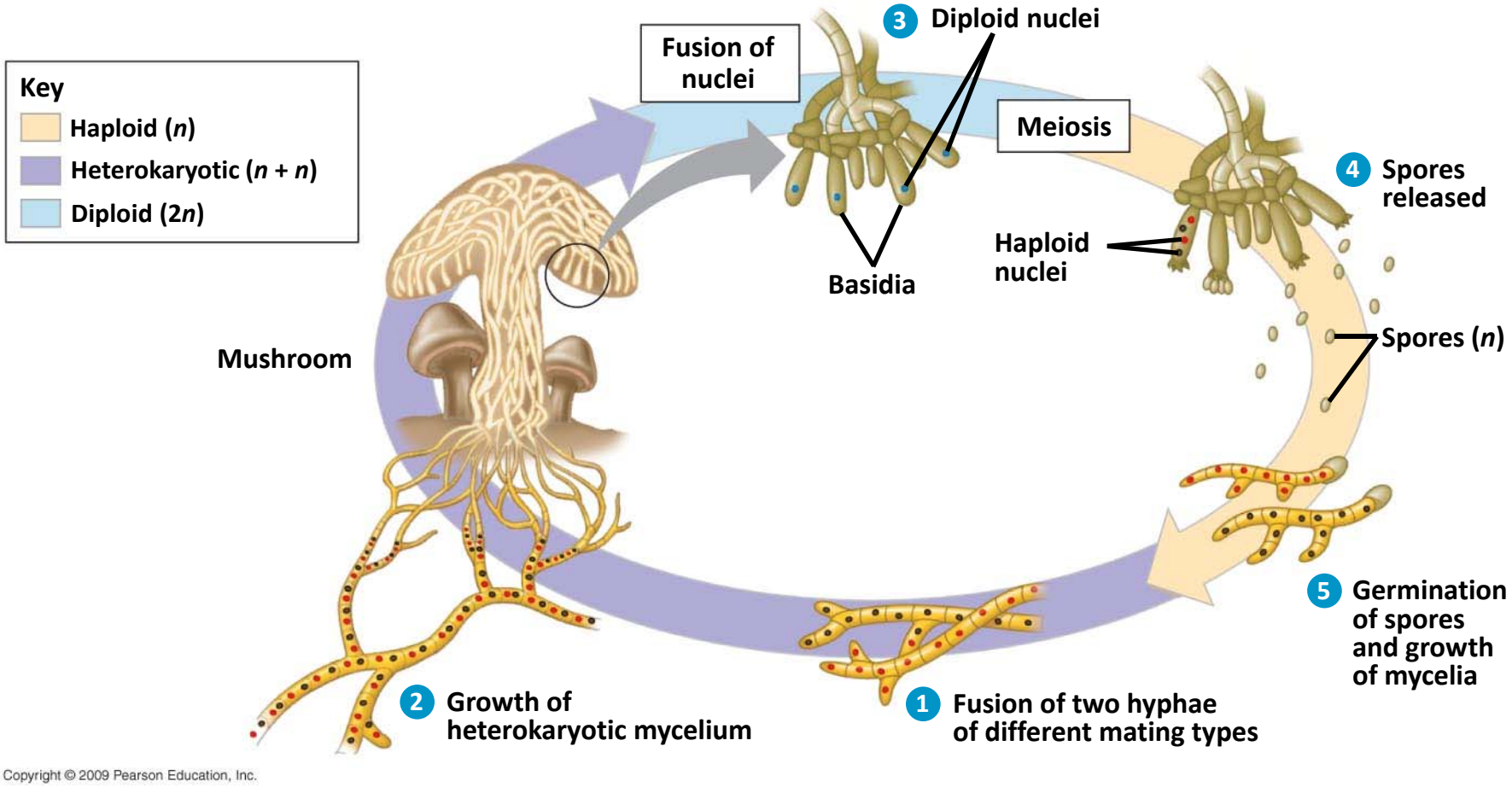


1 Fusion of two hyphae of different mating types









# CONNECTION: Parasitic fungi harm plants and animals

- 80% of plant diseases are caused by fungi
  - Between 10 and 50% of the world's fruit harvest is lost each year to fungal attack
  - A variety of fungi, including smuts and rusts, infect grain crops
- Only 50 species of fungi are parasitic on animals, causing **mycoses**
  - Human infections include athlete's foot (caused by ringworm)
  - Systemic mycoses are rare but serious fungal infections that spread through the body from

# Lichens consist of fungi living in close association with photosynthetic organisms

- Lichens consist of algae or cyanobacteria within a fungal network
  - Many lichen associations are mutualistic
  - The fungus receives food from its photosynthetic partner
  - The fungal mycelium helps the alga absorb and retain water and minerals
- Lichens are important pioneers on new land, where they help to form soil
  - Lichens are sensitive to air pollution, because they obtain minerals from the air

Fungal hyphae

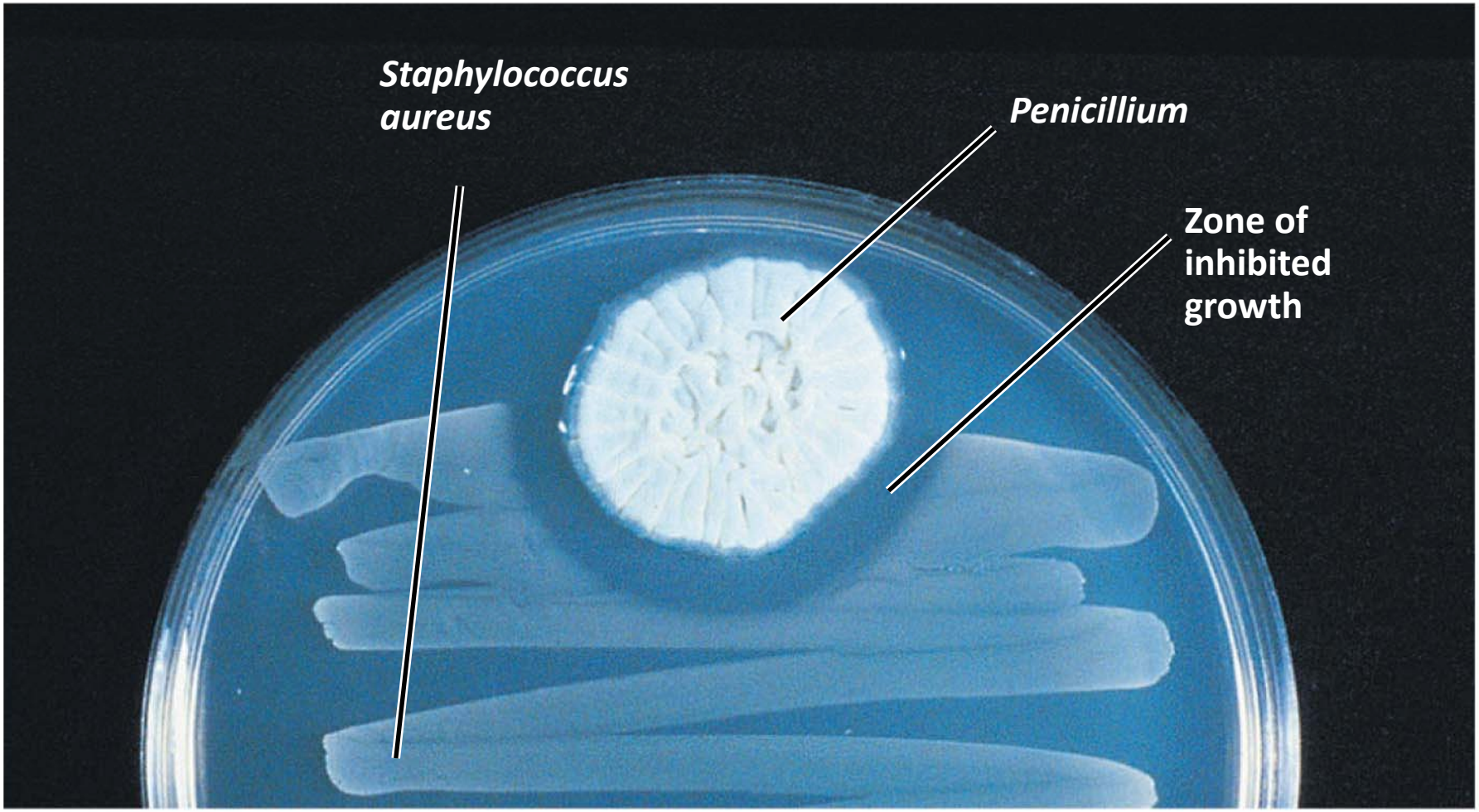
Algal cell

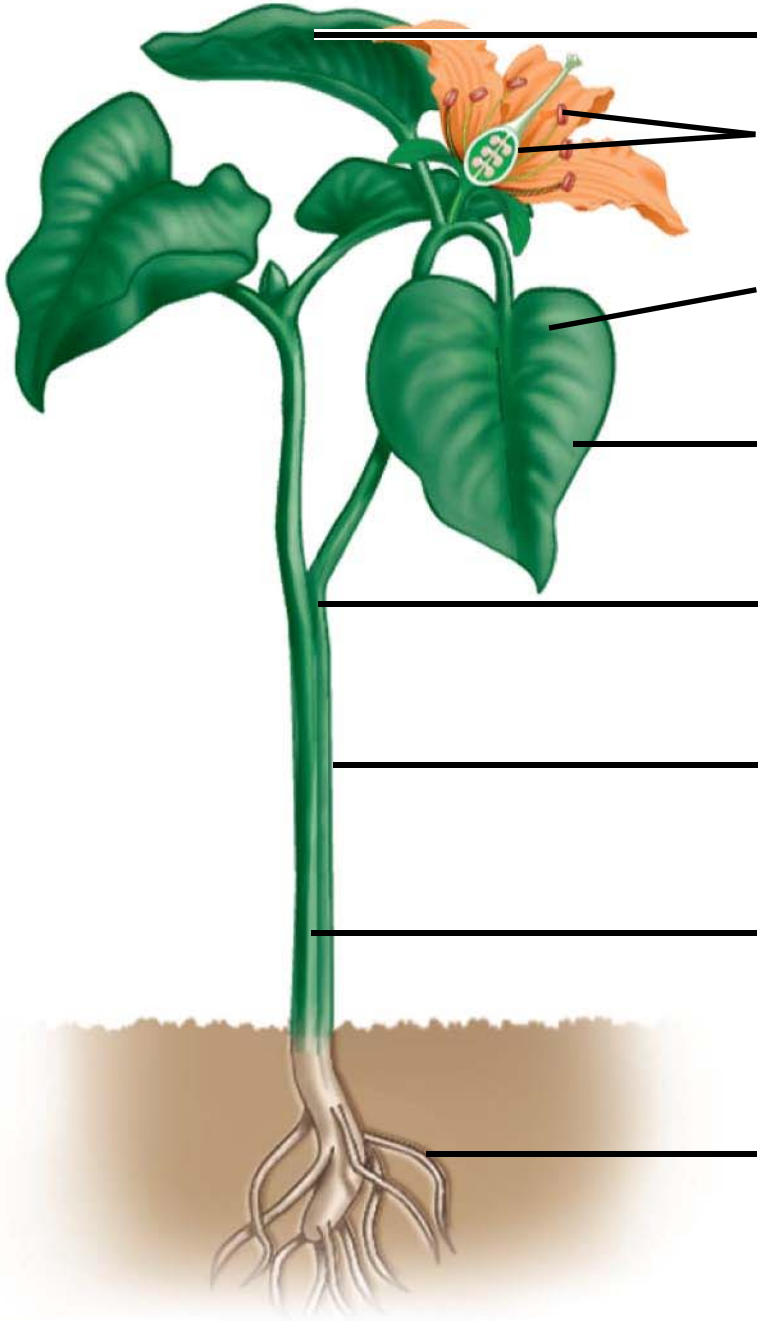
# Some fungi have mutually beneficial relationships with ants

- Several species of ants and termites cultivate fungal gardens
- The insects feed their fungi with leaves, weeding out undesirable fungi
  - The fungi feed on the leaves
  - The ants harvest the swollen hyphal tips
- Farmer insects and fungal “crops” have been evolving together for over 50 million years

# Fungi have enormous ecological benefits and practical uses

- Fungi have many practical uses for humans
  - Some fungi can break down toxic pollutants, including pesticides like DDT and cancer-causing chemicals
  - Fungi may be able to clean up oil spills and chemical messes
  - We eat many fungi, from mushrooms to cheeses modified by fungi
  - Yeasts produce alcohol and cause bread to rise
  - Fungi provide antibiotics that are used to treat bacterial disease
  - Fungi are playing important new roles in





Leaves carry out photosynthesis

Reproductive structures, as in flowers, contain spores and gametes

Cuticle covering leaves and stems reduces water loss

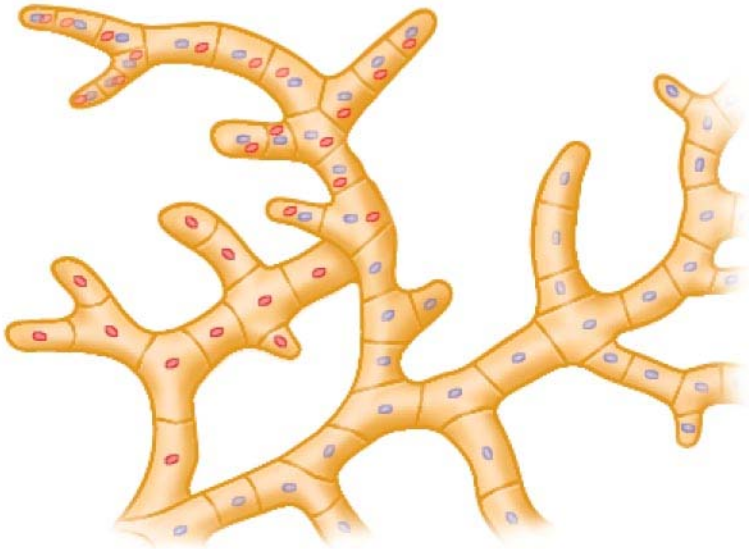
Stomata in leaves allow gas exchange between plant and atmosphere

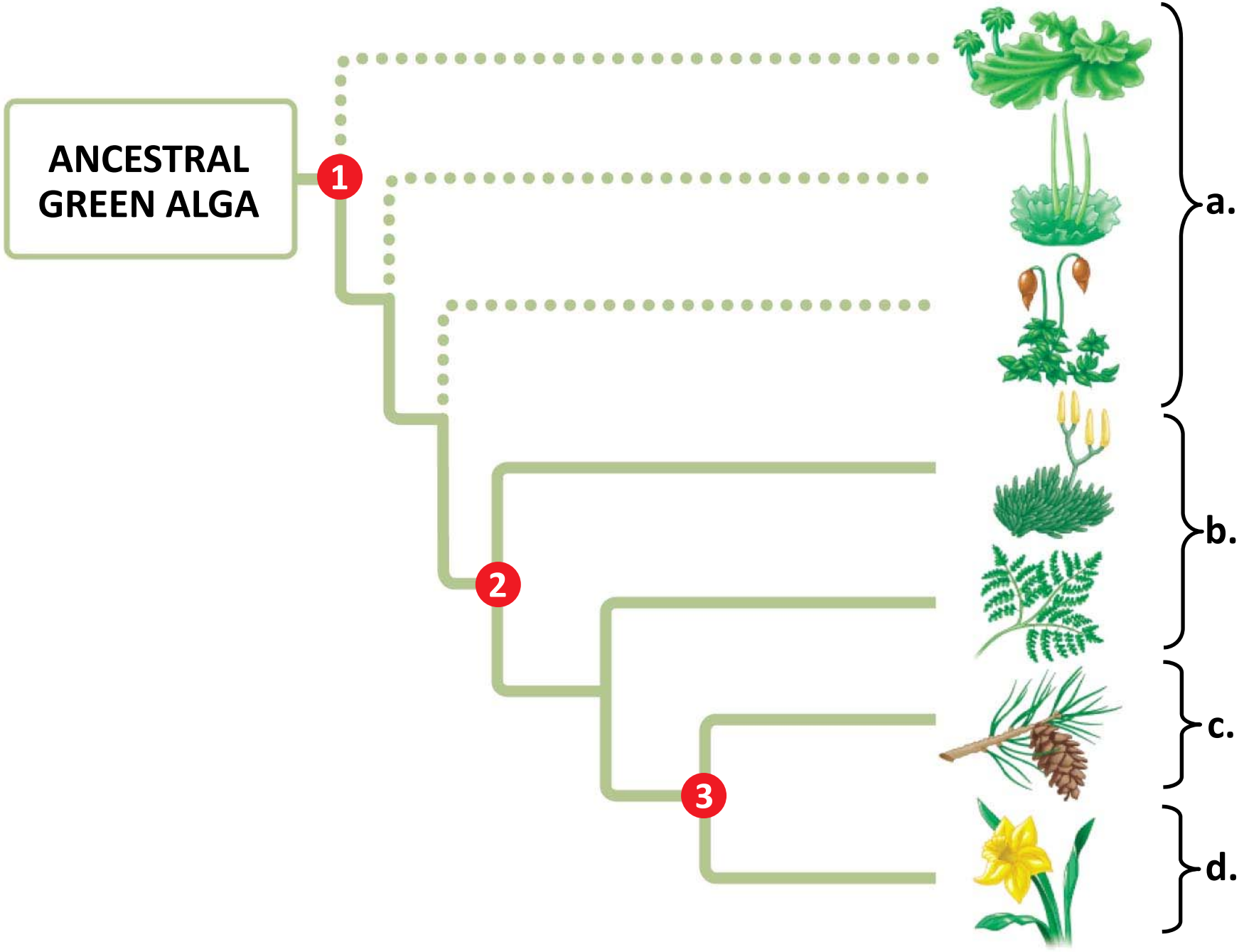
Lignin hardens cell walls of some plant tissues

Stem supports plant; may perform photosynthesis

Vascular tissues in shoots and roots transport water, minerals, and sugars; provide support

Roots anchor plant; mycorrhizae (root-fungus associations) help absorb water and minerals from the soil





**A. Pine tree, a gymnosperm**

**B. Puffball, a club fungus**

# You should now be able to

1. Describe the key plant adaptations for life on land
2. Describe the alternation of generation life cycle; explain why it appears that this cycle has evolved independently in algae and land plants
3. Describe the key events of the moss, fern, and pine life cycles
4. Explain how coal was formed; explain why coal, oil, and natural gas are called fossil fuels

# You should now be able to

5. Describe the parts of a flower and explain their functions
6. Describe the stages of the angiosperm life cycle
7. Describe angiosperm adaptations that promote seed dispersal
8. Explain how flowers are adapted to attract pollinators
9. Compare the life cycles and reproductive structures in the fungal groups

# You should now be able to

10. Describe the structure and characteristics of lichens
11. Describe the positive ecological and practical roles of fungi