CH 17: The evolution of plant and fungal diversity

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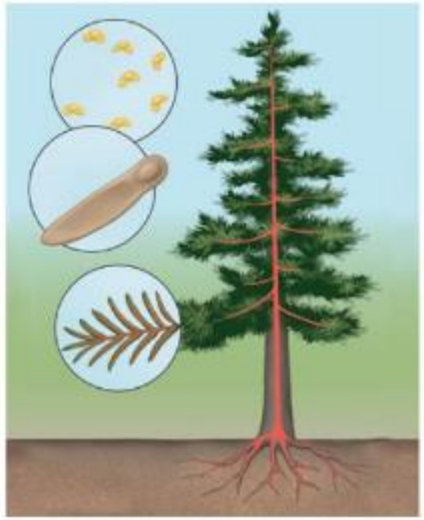
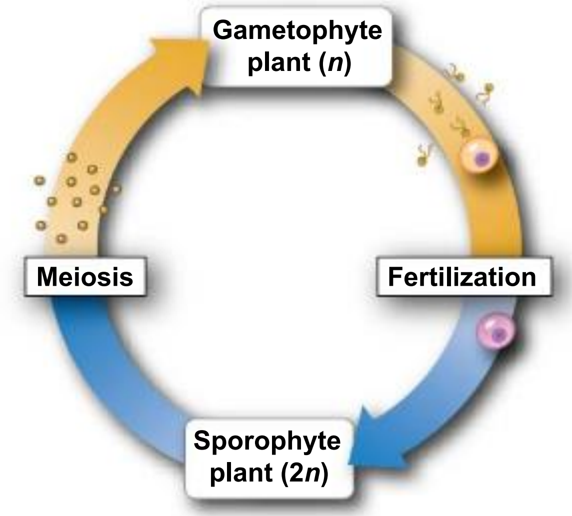
Figure 17.0-2

Chapter 17: Big Ideas



Plant Evolution and Diversity



Alternation of Generations and Plant Life Cycles

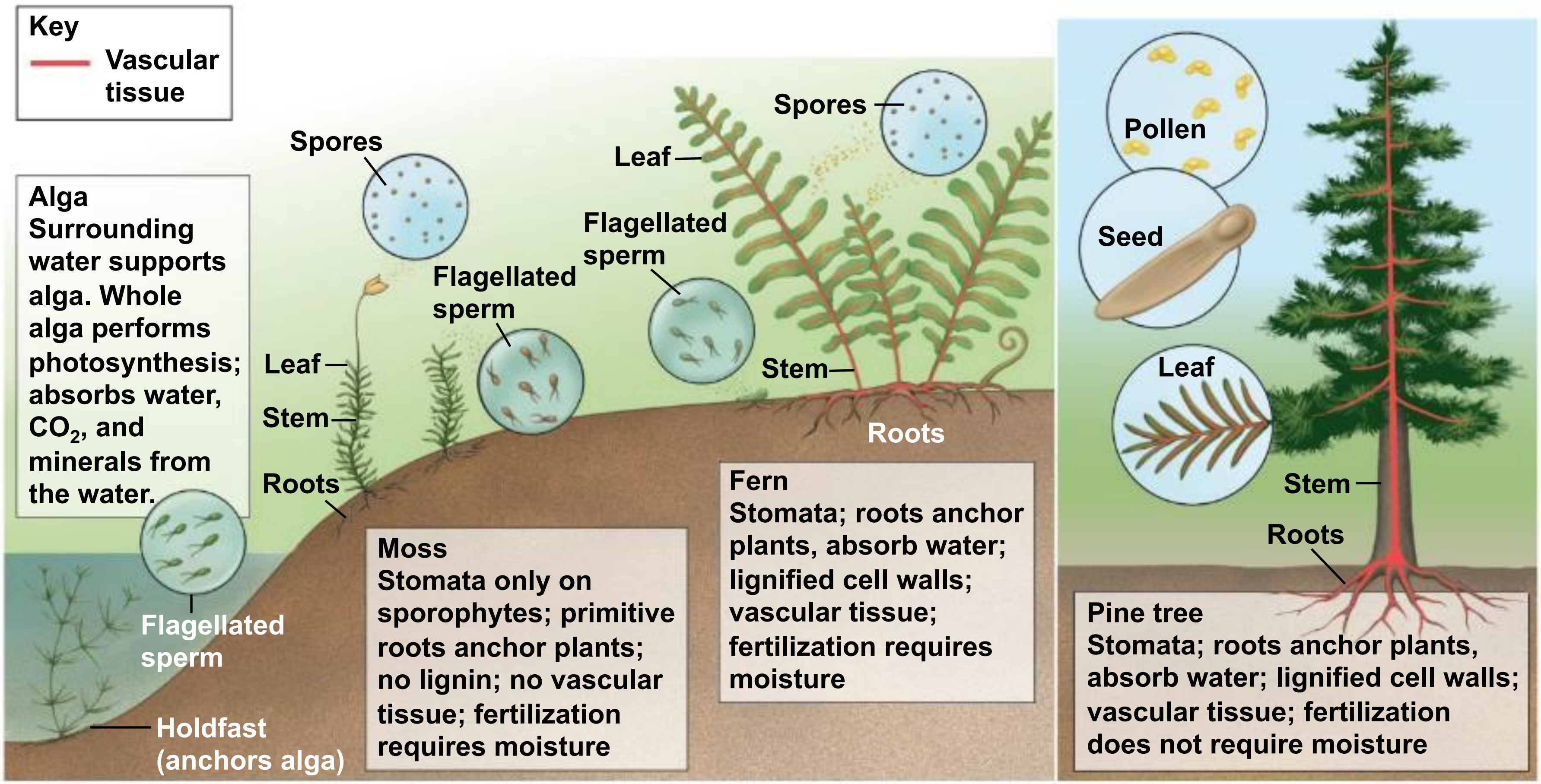
Diversity of Fungi

PLANT EVOLUTION AND DIVERSITY

17.1 Plants have adaptations for life on land

- Land provides new opportunity for plants
- But life on land had disadvantages, too. On land, plants must
  - maintain moisture inside their cells, to keep from drying out,
  - support their body in a nonbuoyant medium,
  - reproduce and disperse offspring without water,
  - anchor their bodies in soil, and
  - obtain resources from soil and air.

Figure 17.1c-0



17.1 Plants have adaptations for life on land

- Land plants maintain moisture in their cells using
  - a waxy cuticle and
  - cells that regulate the opening and closing of stomata.
- Land plants obtain
  - water and minerals from roots in the soil,
  - CO_2 from the air, and
  - sunlight through leaves.
- Growth-producing regions of cell division, called **apical meristems**, are found near the tips of stems and roots.

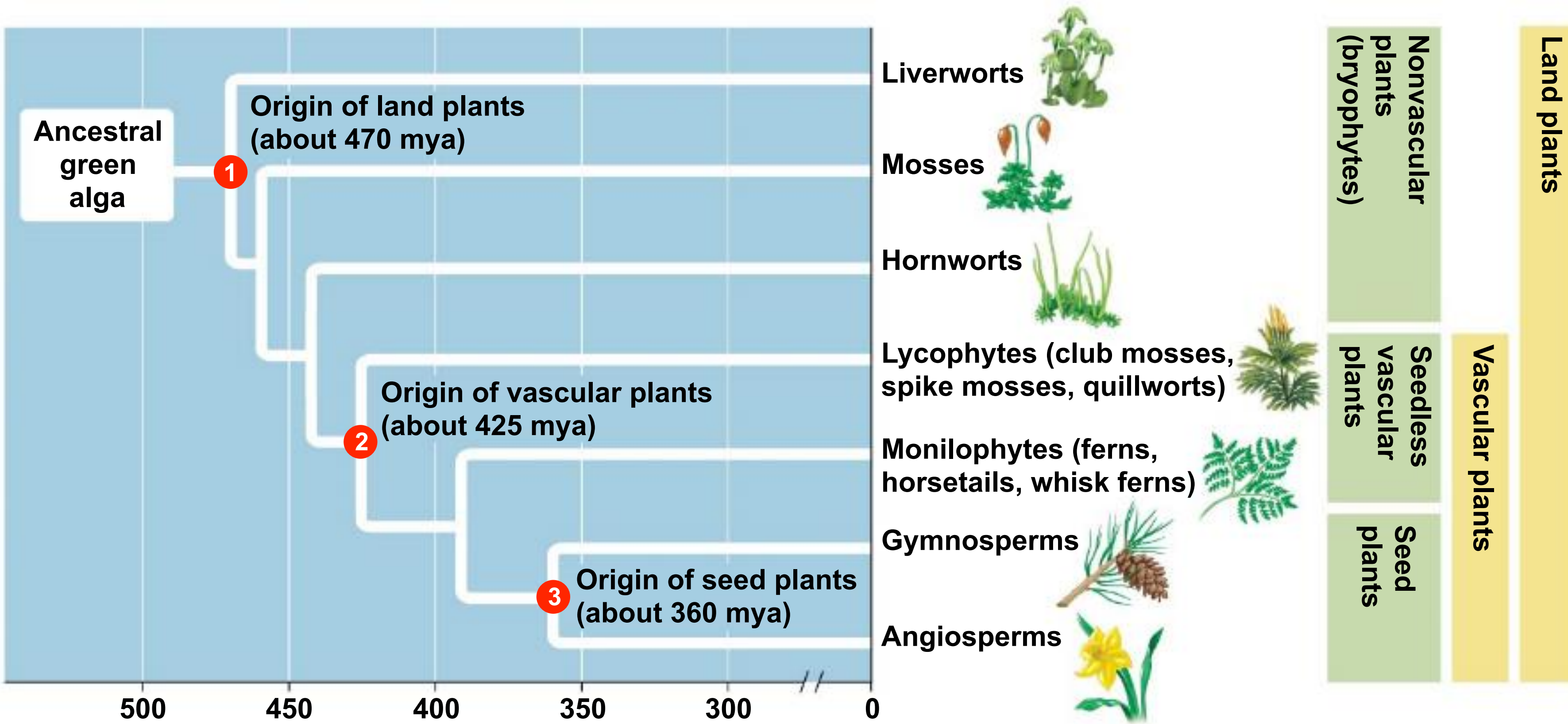
17.1 Plants have adaptations for life on land

- In many land plants, water and minerals move up from roots to stems and leaves using **vascular tissue**.
  - **Xylem**
    - consists of dead cells and
    - conveys water and minerals.
  - **Phloem**
    - consists of living cells and
    - conveys sugars.

17.1 Plants have adaptations for life on land

- The cell walls of some plant tissues, including xylem, are thickened and reinforced by a chemical called **lignin (木質素)**.
- The absence of lignified cell walls in mosses and other plants that lack vascular tissue limits their height.

Figure 17.2a-0



17.2 Plant diversity reflects the evolutionary history of the plant kingdom

- Early diversification of plants gave rise to seedless, nonvascular plants called **bryophytes**, including
  - mosses,
  - liverworts, and
  - hornworts.
- They lack
  - true roots,
  - leaves, and
  - lignified cell walls.

17.2 Plant diversity reflects the evolutionary history of the plant kingdom

- About 425 million years ago, **vascular plants** evolved with lignin-hardened vascular tissues.
- The **seedless vascular plants** include
  - lycophytes (including club mosses) and
  - monilophytes (ferns and their relatives).

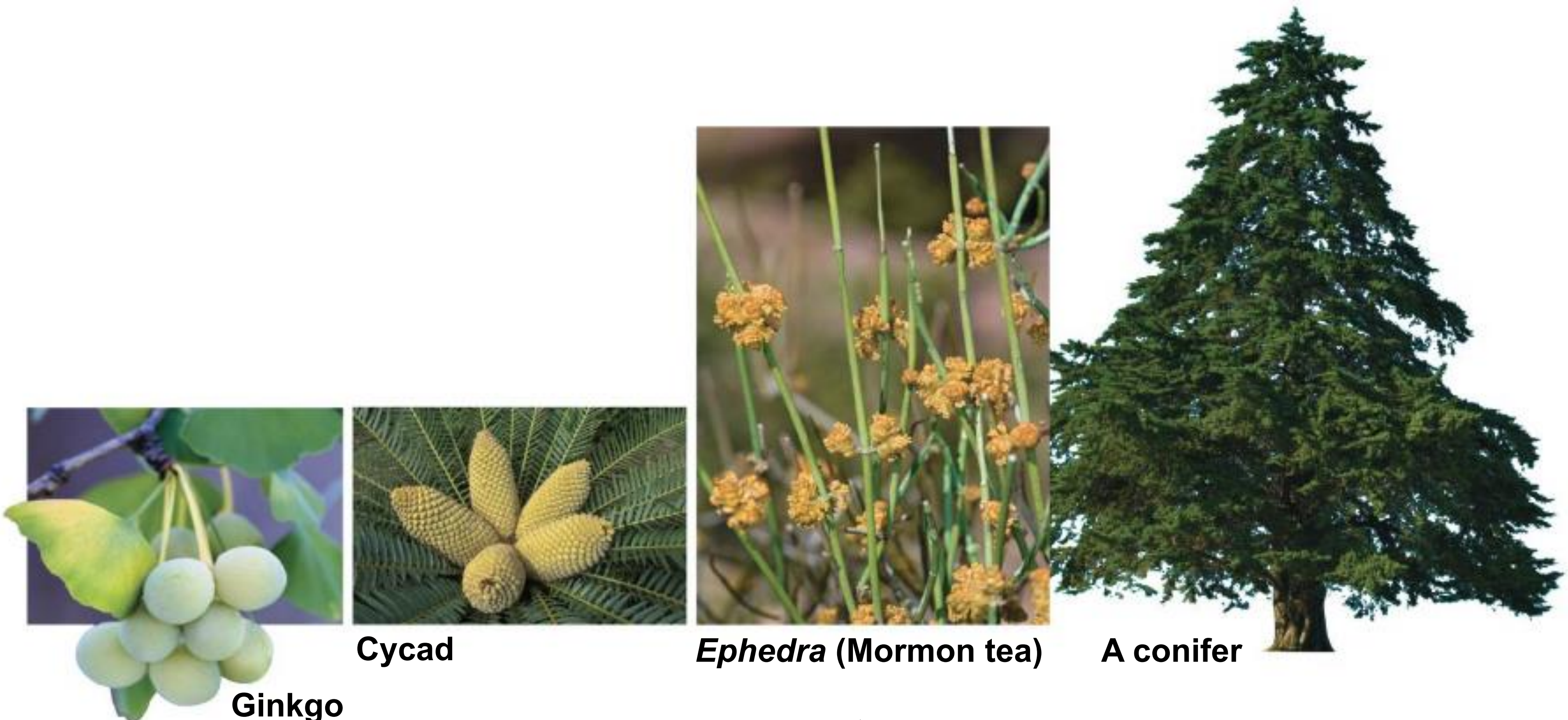
Club moss (a lycophyte)

Fern (a monilophyte)

17.2 Plant diversity reflects the evolutionary history of the plant kingdom

- Vascular plants with seeds include
  - **gymnosperms** (including ginkgo, cycad, and conifer species) and
  - **angiosperms** (such as flowering trees and grasses).

Figure 17.2d-0



麻黃
和木麻黃不一樣

17.2 Plant diversity reflects the evolutionary history of the plant kingdom

- **Angiosperms**
  - evolved at least 140 million years ago,
  - are flowering plants, and
  - include flowering trees and grasses.

Figure 17.2e-0

A jacaranda tree

Green foxtail, a grass

Alternation of Generations and Plant Life Cycles

17.3 VISUALIZING THE CONCEPT: Haploid and diploid generations alternate in plant life cycles

- Plants have an **alternation of generations** in which the haploid and diploid stages are distinct, multicellular bodies.
  - The haploid generation of a plant produces gametes and is called the **gametophyte**.
  - The diploid generation produces spores and is called the **sporophyte**.

Figure 17.3-1-5

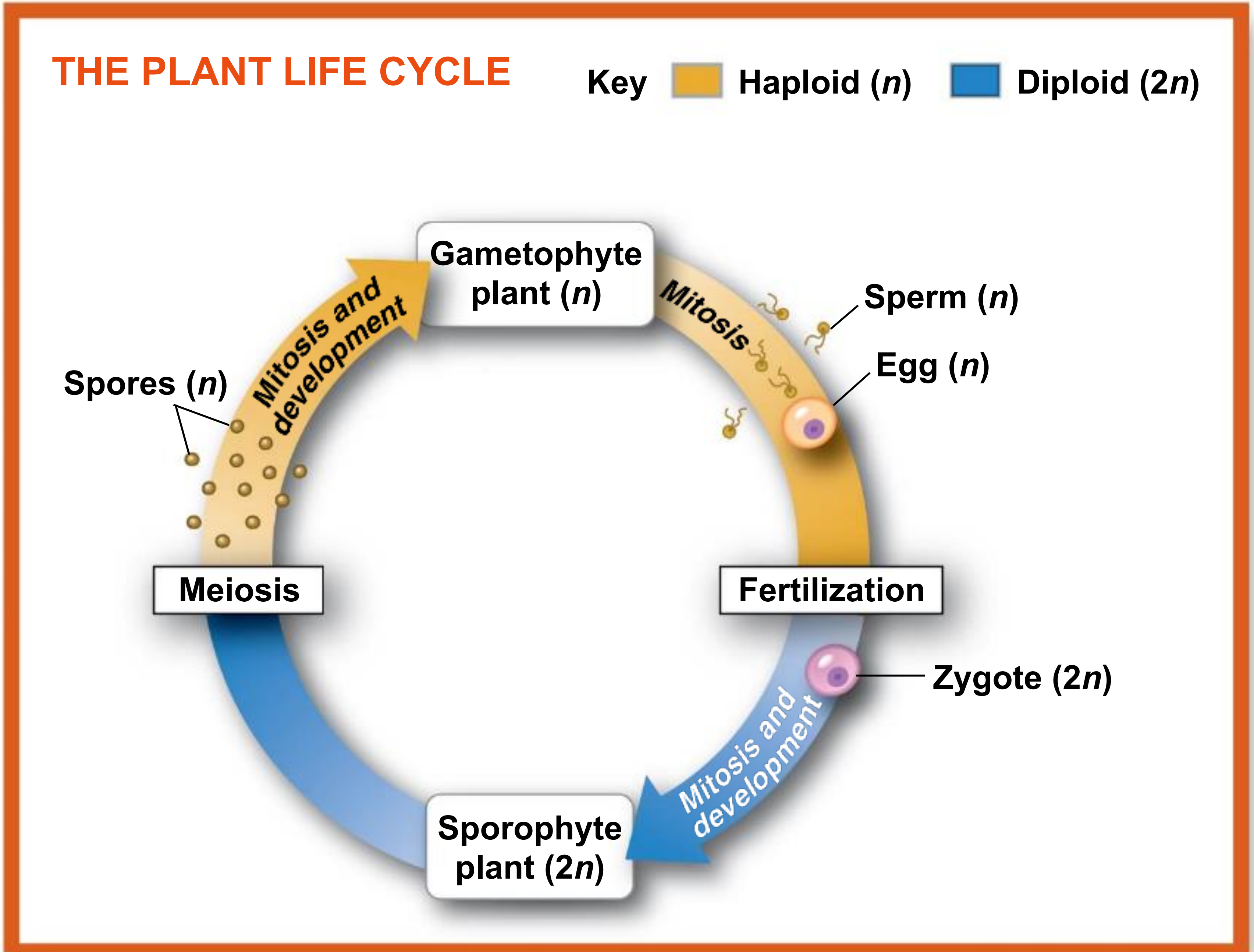


Figure 17.3-2-5

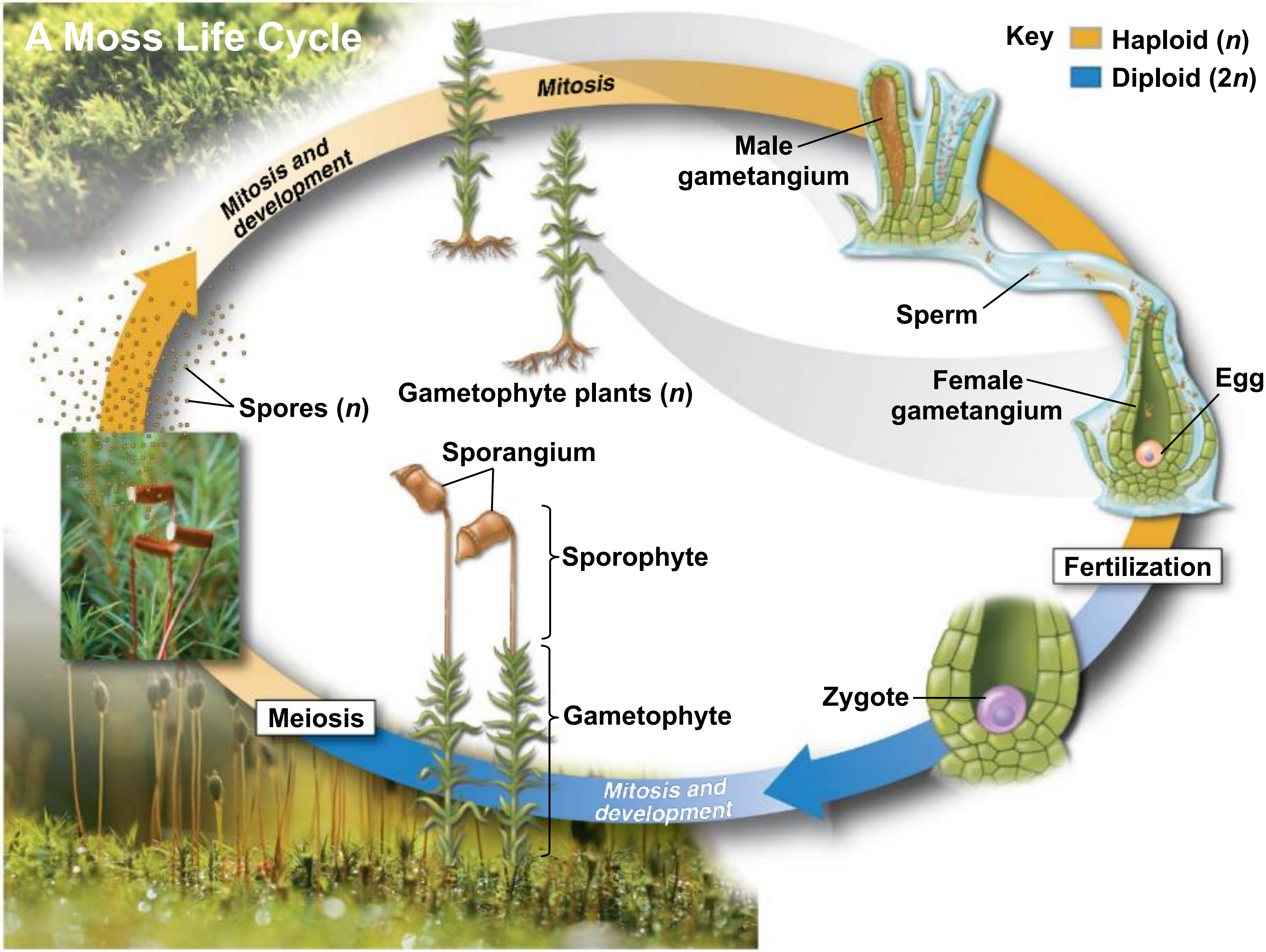


Figure 17.3-6-5

A Fern Life Cycle

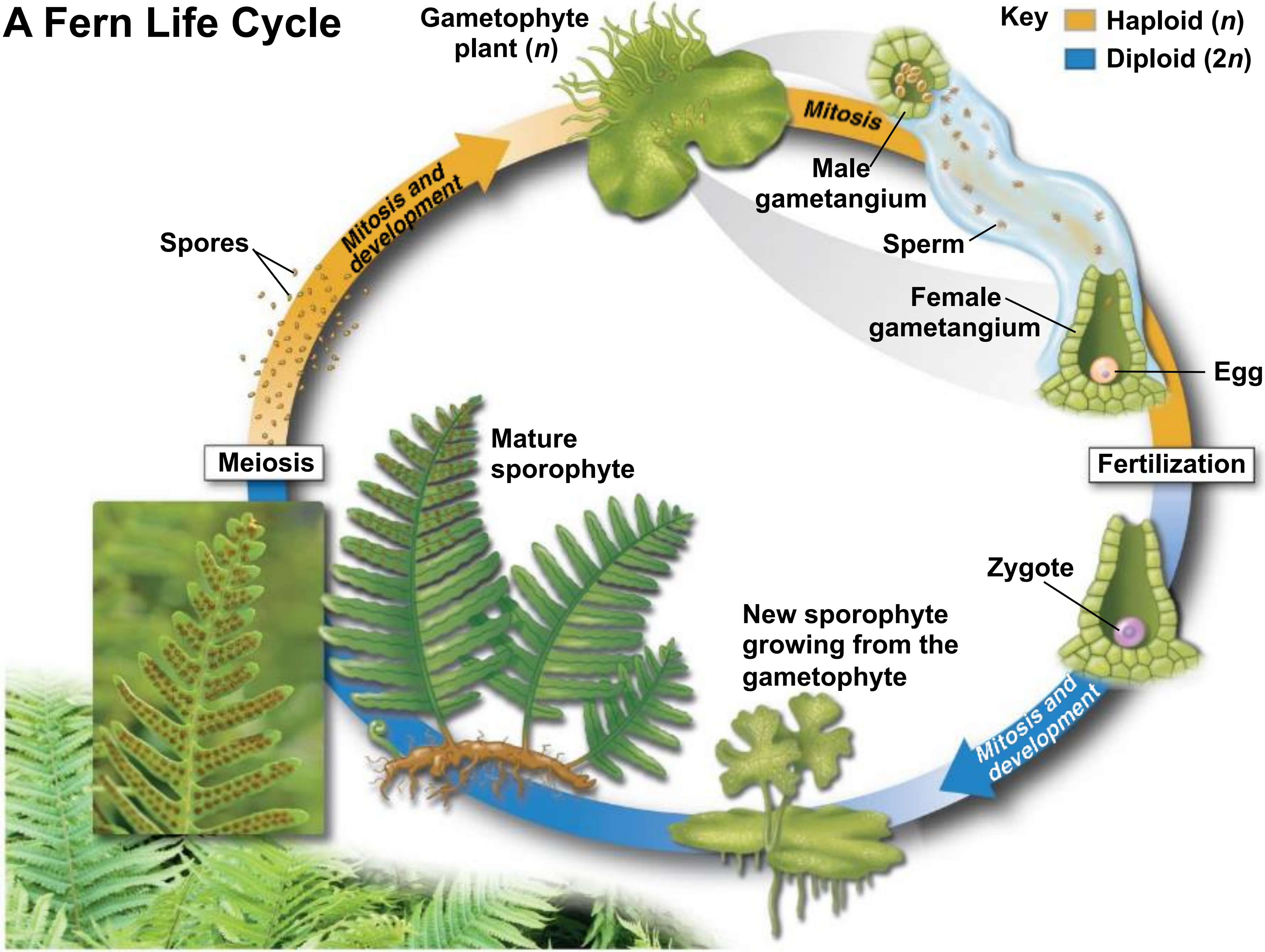
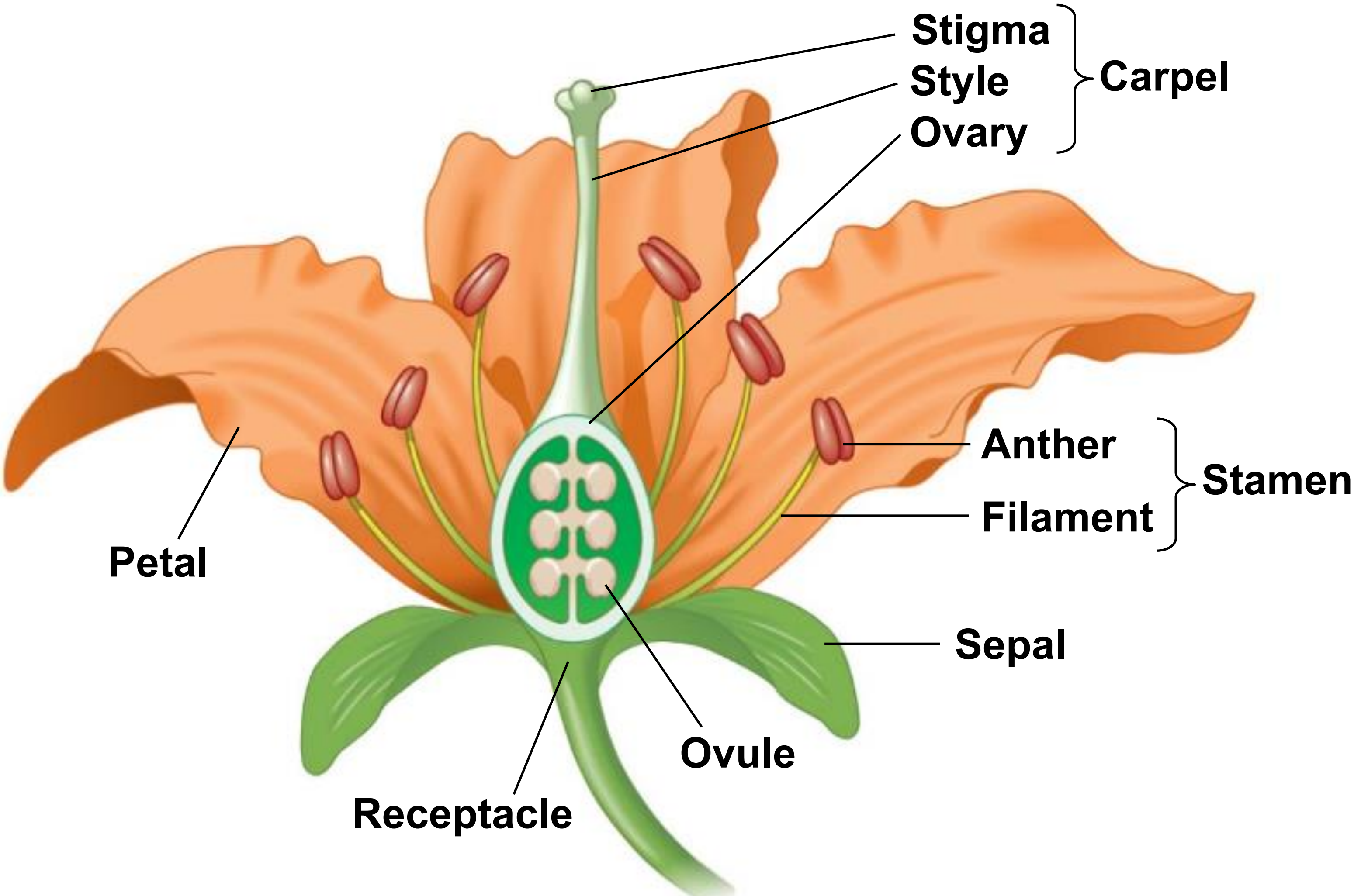


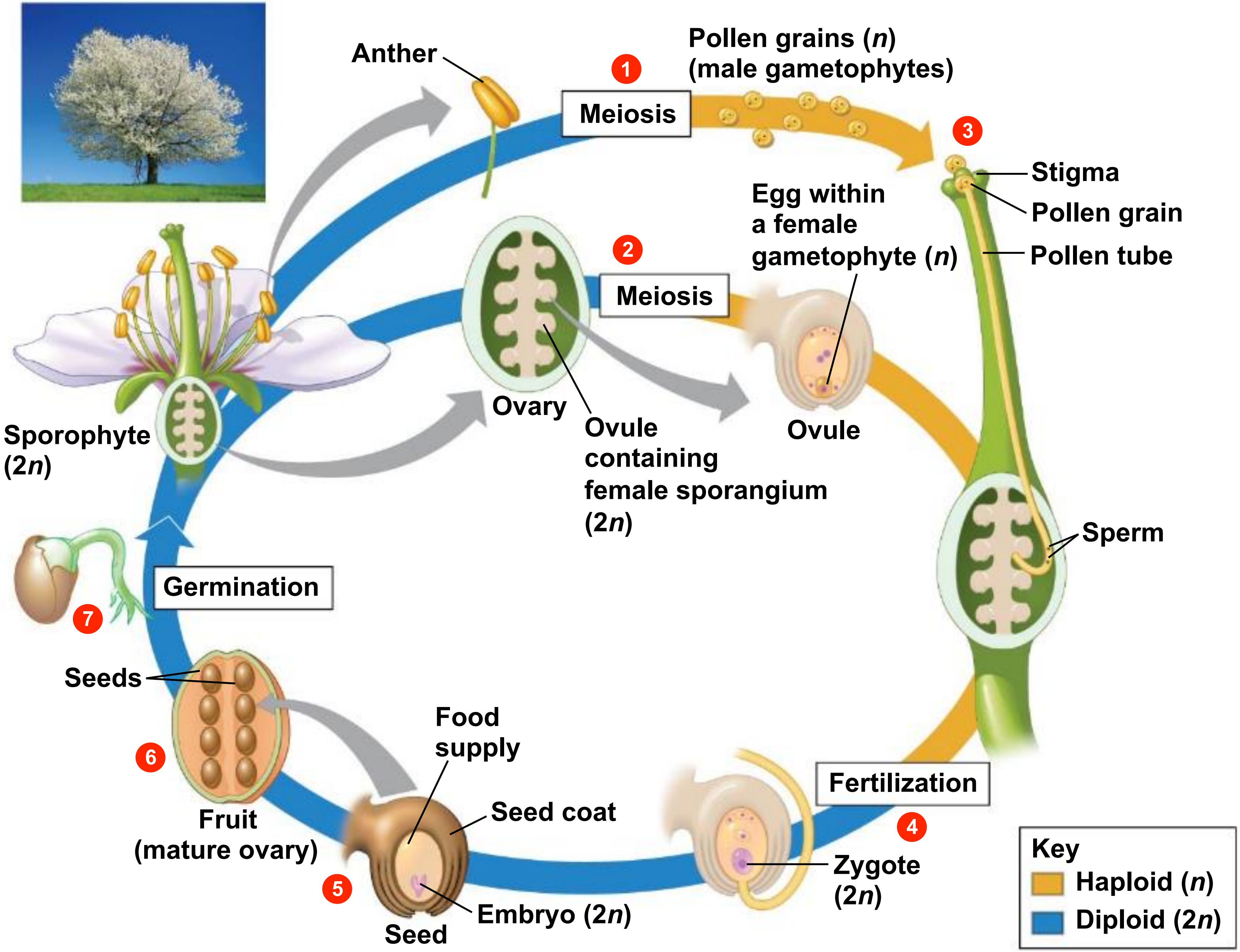
Figure 17.6b


Stigma
Style
Ovary
Carpel
Anther
Filament
Stamen
Petal
Sepal
Ovule
Receptacle

17.5 Pollen and seeds are key adaptations for life on land

- In the male reproductive structures of seed plants, haploid spores develop into pollen grains, which are male gametophytes enclosed within a tough wall.
- If a pollen grain lands on a compatible female structure, an event known as **pollination**, it undergoes mitosis to produce a sperm.
- Haploid spores in female reproductive structures develop into **ovules**, which contain the egg-producing female gametophytes.

Figure 17.7-5



Anther
Pollen grains (n)
(male gametophytes)
1
Meiosis
3
Stigma
Pollen grain
Pollen tube
Egg within
a female
gametophyte (n)
2
Meiosis
Ovary
Ovule
containing
female sporangium
(2n)
Ovule
Sporophyte
(2n)
Sperm
Germination
7
Seeds
6
Fruit
(mature ovary)
Food
supply
Seed coat
5
Seed
Embryo (2n)
Fertilization
4
Zygote
(2n)
Key
Haploid (n)
Diploid (2n)

Figure 17.6a-0

Foxglove (a cluster of flowers)

Coral bean

Passionflower

Figure 17.8

Figure 17.10c

https://www.youtube.com/watch?v=YZGs_s4JkEs

https://www.youtube.com/watch?v=_uHJGdTgtXE

Diversity of Fungi

17.12 Fungi absorb food after digesting it outside their bodies

- **Fungi**
  - are heterotrophic eukaryotes,
  - secrete powerful enzymes to digest their food externally, and
  - acquire their nutrients by **absorption**.

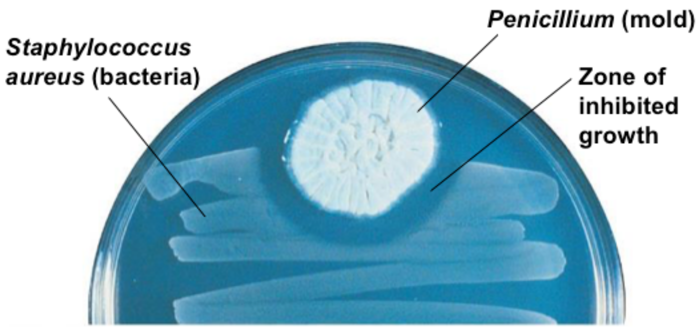
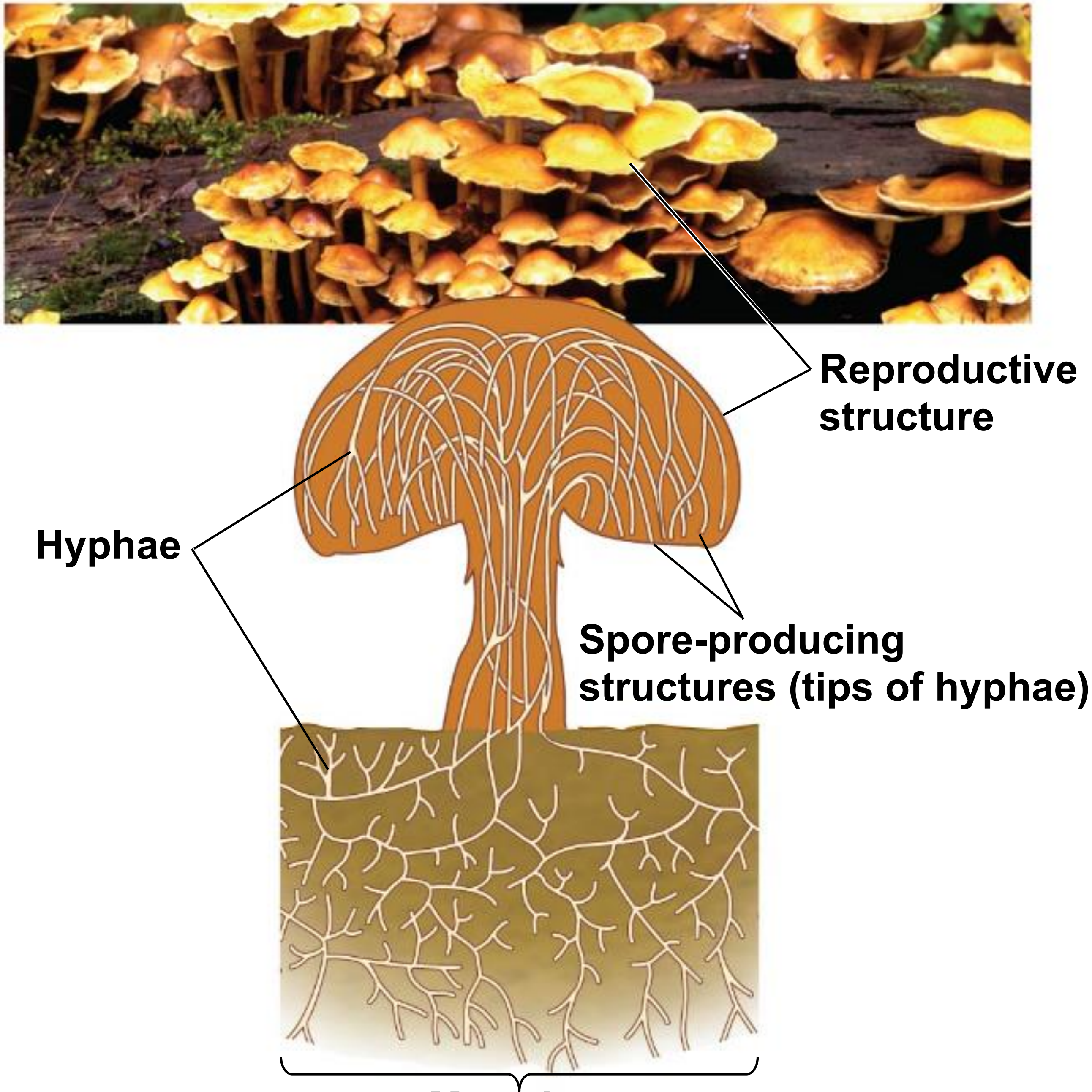


Figure 17.12b-0



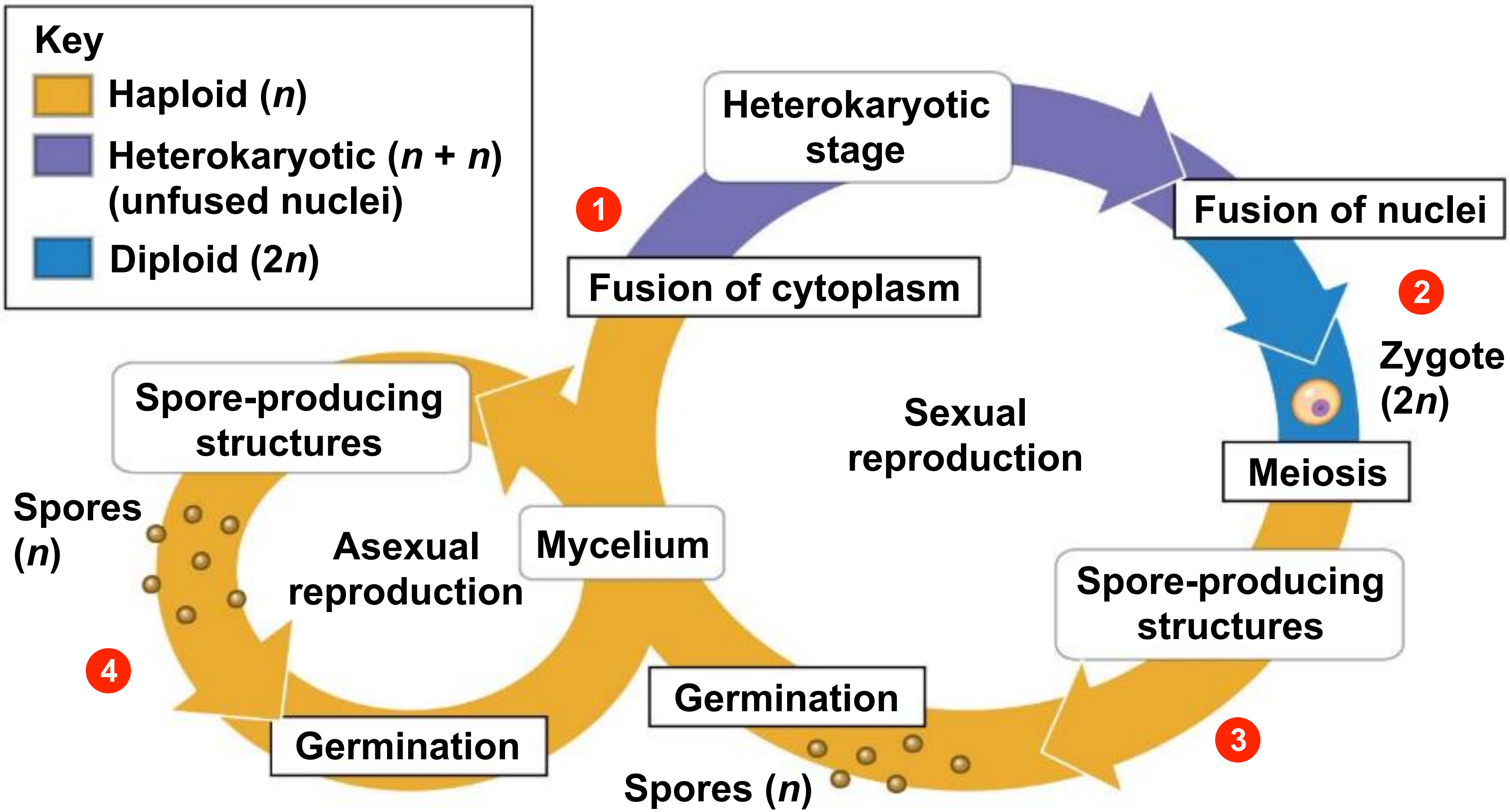
17.12 Fungi absorb food after digesting it outside their bodies

- Fungal hyphae are surrounded by a cell wall made of **chitin** instead of cellulose.
- Some fungi are **parasites**, obtaining their nutrients at the expense of living plants or animals.

17.12 Fungi absorb food after digesting it outside their bodies

- **Mycorrhizae**
  - represent a symbiotic relationship between fungi and plant roots and
  - absorb phosphorus and other essential materials from the soil and make them available to the plant.
- Sugars produced by the plant through photosynthesis nourish the fungus, making the relationship mutually beneficial.

Figure 17.13

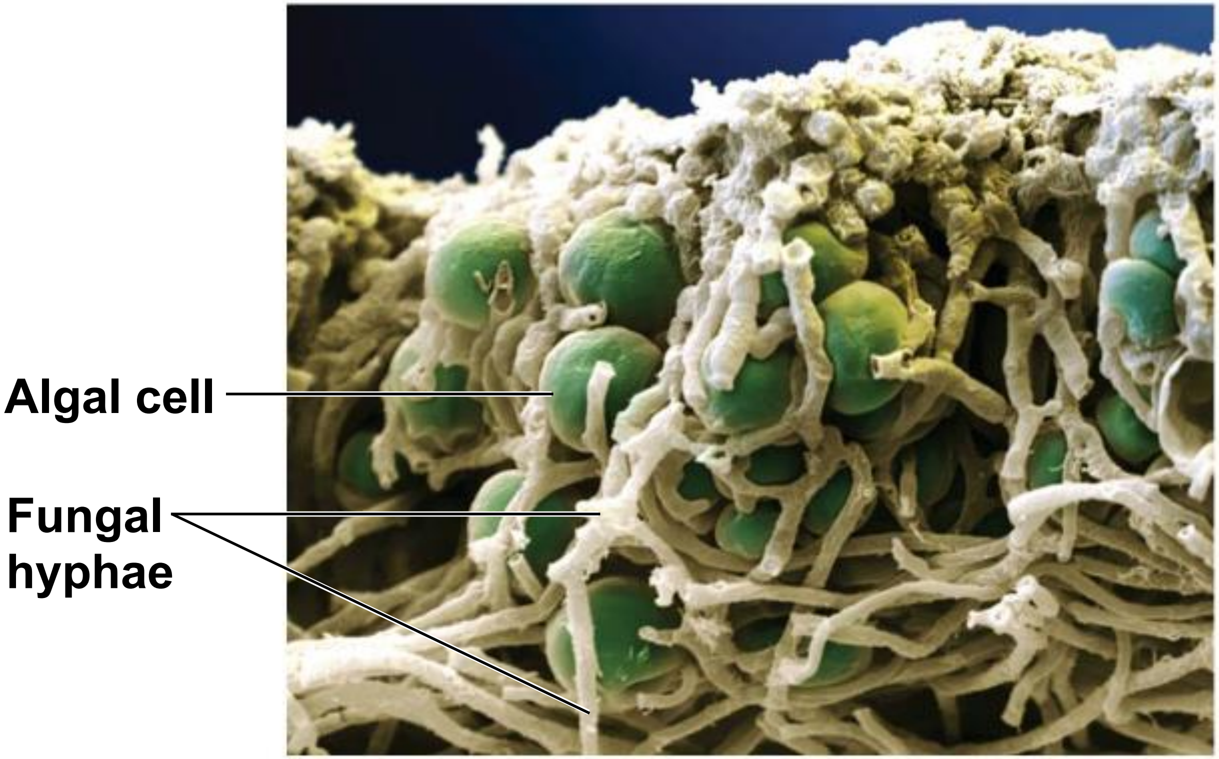


Key
Haploid (*n*)
Heterokaryotic (*n* + *n*)
(unfused nuclei)
Diploid (2*n*)
Heterokaryotic stage
Fusion of nuclei
1
Fusion of cytoplasm
2
Zygote (2*n*)
Sexual reproduction
Meiosis
Spore-producing structures
Spores (*n*)
Asexual reproduction
Mycelium
Spore-producing structures
4
Germination
Germination
3
Spores (*n*)

17.17 Lichens are symbiotic associations of fungi and photosynthetic organisms

- **Lichens** consist of symbiotic associations of algae or cyanobacteria within a mass of fungal hyphae.
  - 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.

Figure 17.17b



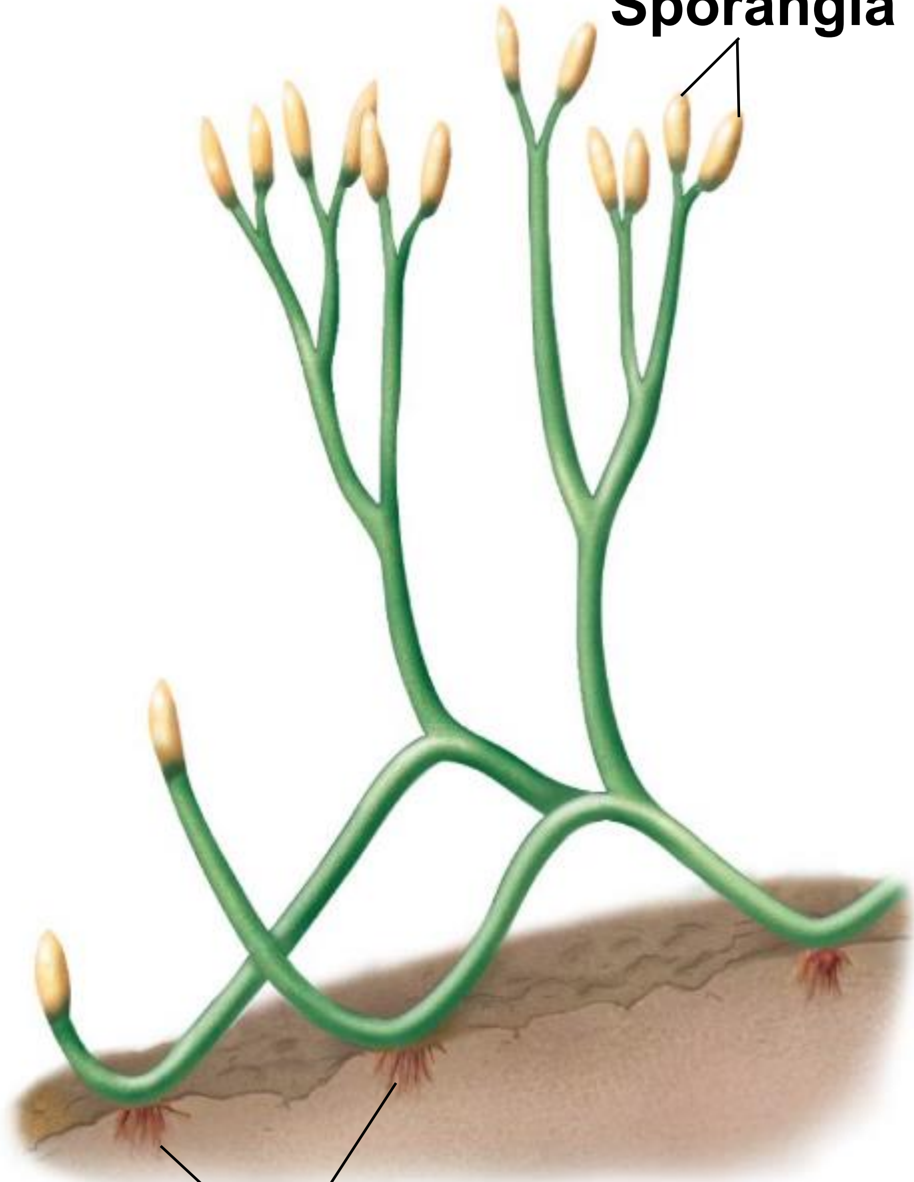
17.18 SCIENTIFIC THINKING: Mycorrhizae may have helped plants colonize land

- Scientists have proposed that symbioses with fungi were crucial to the colonization of land by plants.
- To test this hypothesis, researchers have pursued three lines of evidence, including
  1. present-day mycorrhizal relationships,
  2. fossils of early land plants, and
  3. molecular genetics.

17.18 SCIENTIFIC THINKING: Mycorrhizae may have helped plants colonize land

- About 80% of all plant species establish symbioses with mycorrhizal fungi
- The presence of mycorrhizal associations in almost all major lineages of present-day plants suggests an ancient origin for plant-fungus symbioses.

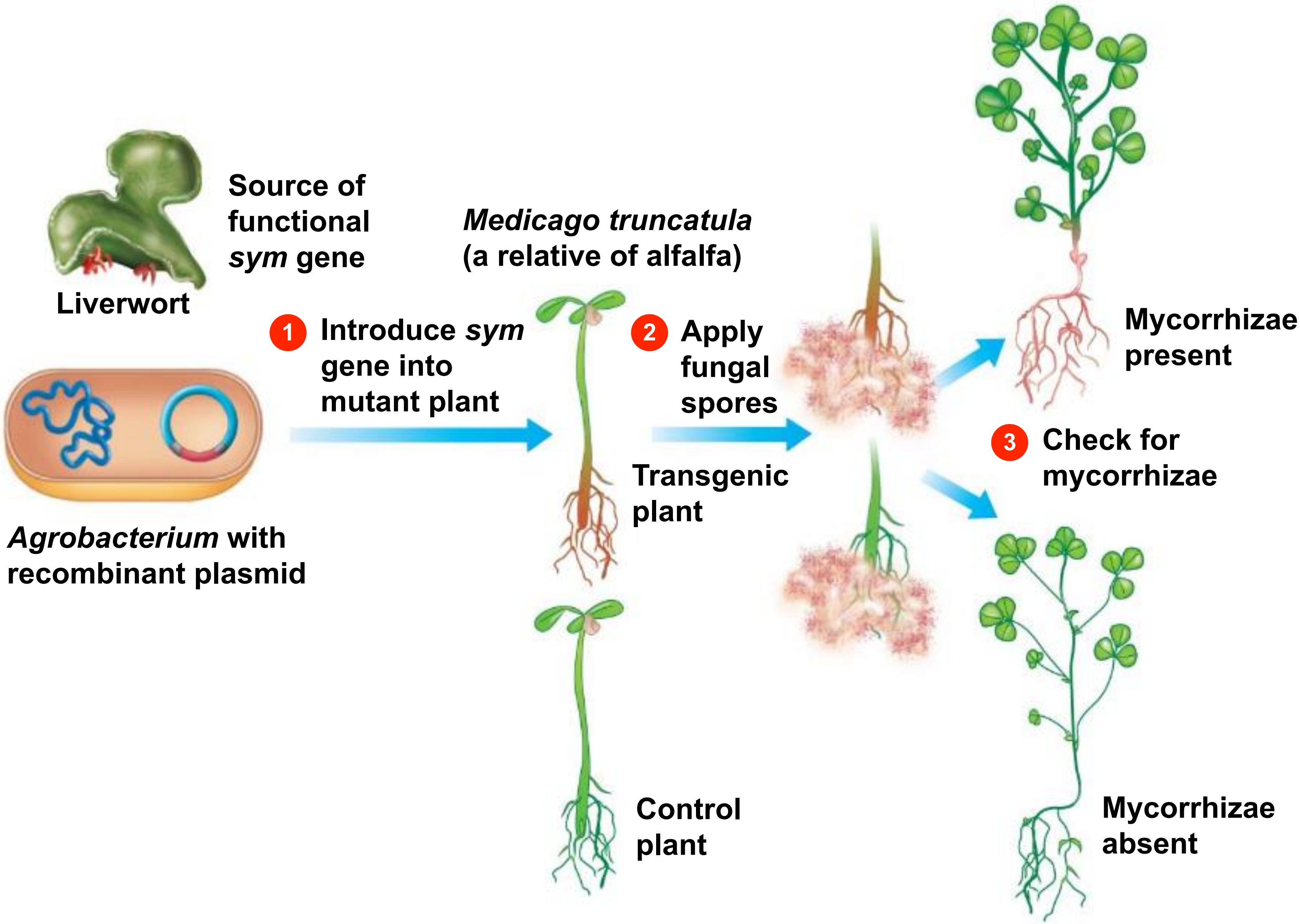
Figure 17.18a



17.18 SCIENTIFIC THINKING: Mycorrhizae may have helped plants colonize land

- Recent studies using molecular genetics have introduced another line of evidence.
- Scientists have studied three of the genes, called *sym* (for symbiosis) genes, that encode the plant's side of the molecular "handshake" with mycorrhizae.
- In a paper published in 2010, researchers reported that *sym* genes are found in all major lineages of land plants.

Figure 17.18b-4



17.19 CONNECTION: Parasitic fungi harm plants and animals

- Of the 100,000 known species of fungi, about 30% are either parasites or pathogens in or on plants.
- About 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.

What else is fun about fungi?

- https://www.youtube.com/watch?v=vWIkphqHV7A

- https://www.youtube.com/watch?v=r4TeOa4IiDs
- https://www.theatlantic.com/science/archive/2017/11/how-the-zombie-fungus-takes-over-ants-bodies-to-control-their-minds/545864/

- https://www.youtube.com/watch?v=iV4WHFU2Id8

Why sex?

- There are many disadvantages for sexual reproduction
  - Uncertainty to find mates
  - Energy to find and compete for mates
  - Mating may harm females, etc

- Why don’t organisms just perform asexual & vegetative reproduction?

- https://en.wikipedia.org/wiki/Evolution_of_sexual_reproduction