LECTURE PRESENTATIONS
For CAMPBELL BIOLOGY, NINTH EDITION
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Chapter 30

Plant Diversity II: The Evolution of Seed Plants

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Overview: Transforming the World

- Seeds changed the course of plant evolution, enabling their bearers to become the dominant producers in most **terrestrial** ecosystems
- Seed plants originated about 360 million years ago
- A **seed** consists of an **embryo** and **nutrients** surrounded by a protective coat
- **Domestication** of seed plants had begun by 8,000 years ago and allowed for permanent settlements

Figure 30.1

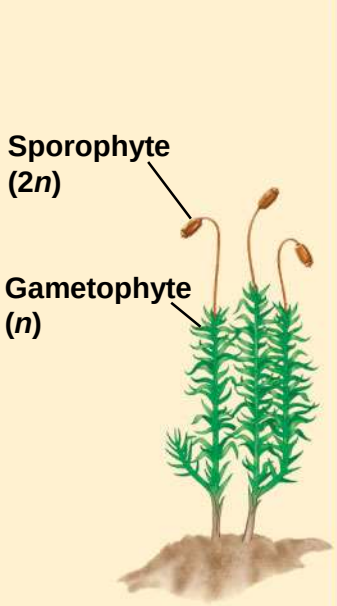
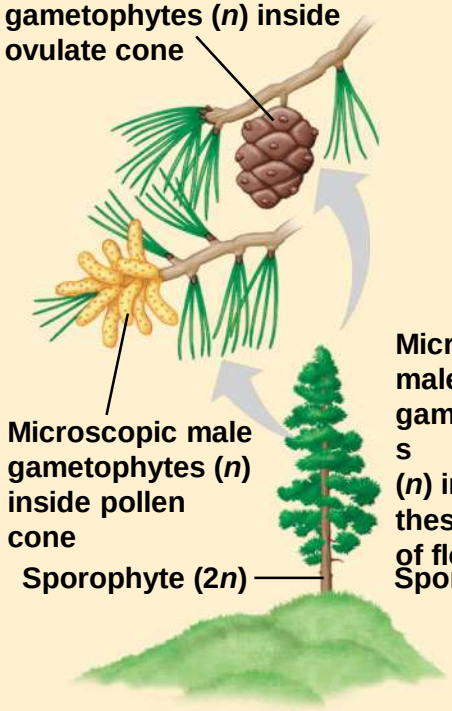
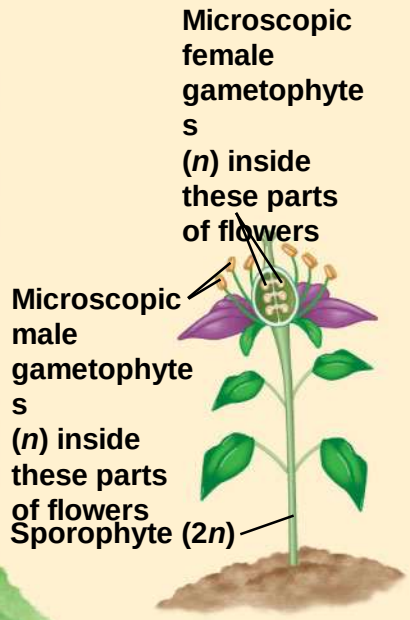
Concept 30.1: Seeds and pollen grains are key adaptations for life on land

- In addition to seeds, the following are common to all seed plants
  - **Reduced gametophytes**
  - **Heterospory**
  - **Ovules**
  - **Pollen**

Advantages of Reduced Gametophytes

- The **gametophytes of seed plants develop within the walls of spores that are retained within tissues of the parent sporophyte**

Figure 30.2

	PLANT GROUP		
	Mosses and other nonvascular plants	Ferns and other seedless vascular plants	Seed plants (gymnosperms and angiosperms)
Gametophyte	Dominant	Reduced, independent (photosynthetic and free-living)	Reduced (usually microscopic), dependent on surrounding sporophyte tissue for nutrition
Sporophyte	Reduced, dependent on gametophyte for nutrition	Dominant	Dominant
Example			Gymnosperm  Angiosperm 

Heterospory: The Rule Among Seed Plants

- The ancestors of seed plants were likely **homosporous**, while **seed plants are heterosporous**
- **Megasporangia** produce megaspores that give rise to **female gametophytes**
- **Microsporangia** produce microspores that give rise to **male gametophytes**

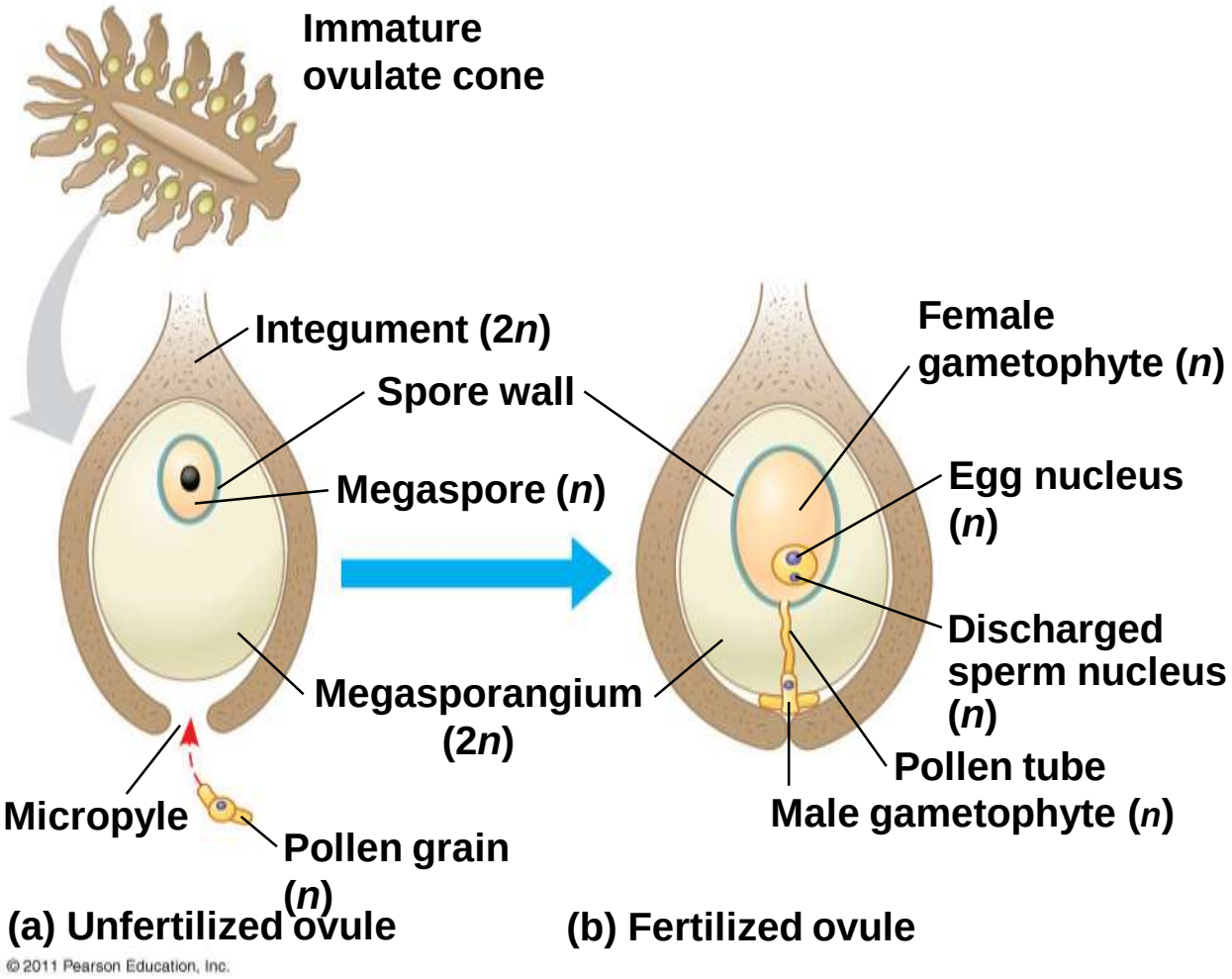
Ovules and Production of Eggs

- An **ovule** consists of a megasporangium, megaspore, and one or more protective **integuments**
- Angiosperm megaspores usually have **two integuments**

Pollen and Production of Sperm

- Microspores develop into **pollen grains**, which contain the male gametophytes
- **Pollination** is the transfer of pollen to the part of a seed plant containing the ovules
- Pollen **eliminates the need for a film of water** and can be dispersed great distances by air or animals
- If a pollen grain germinates, it gives rise to a pollen tube that discharges sperm into the female gametophyte within the ovule

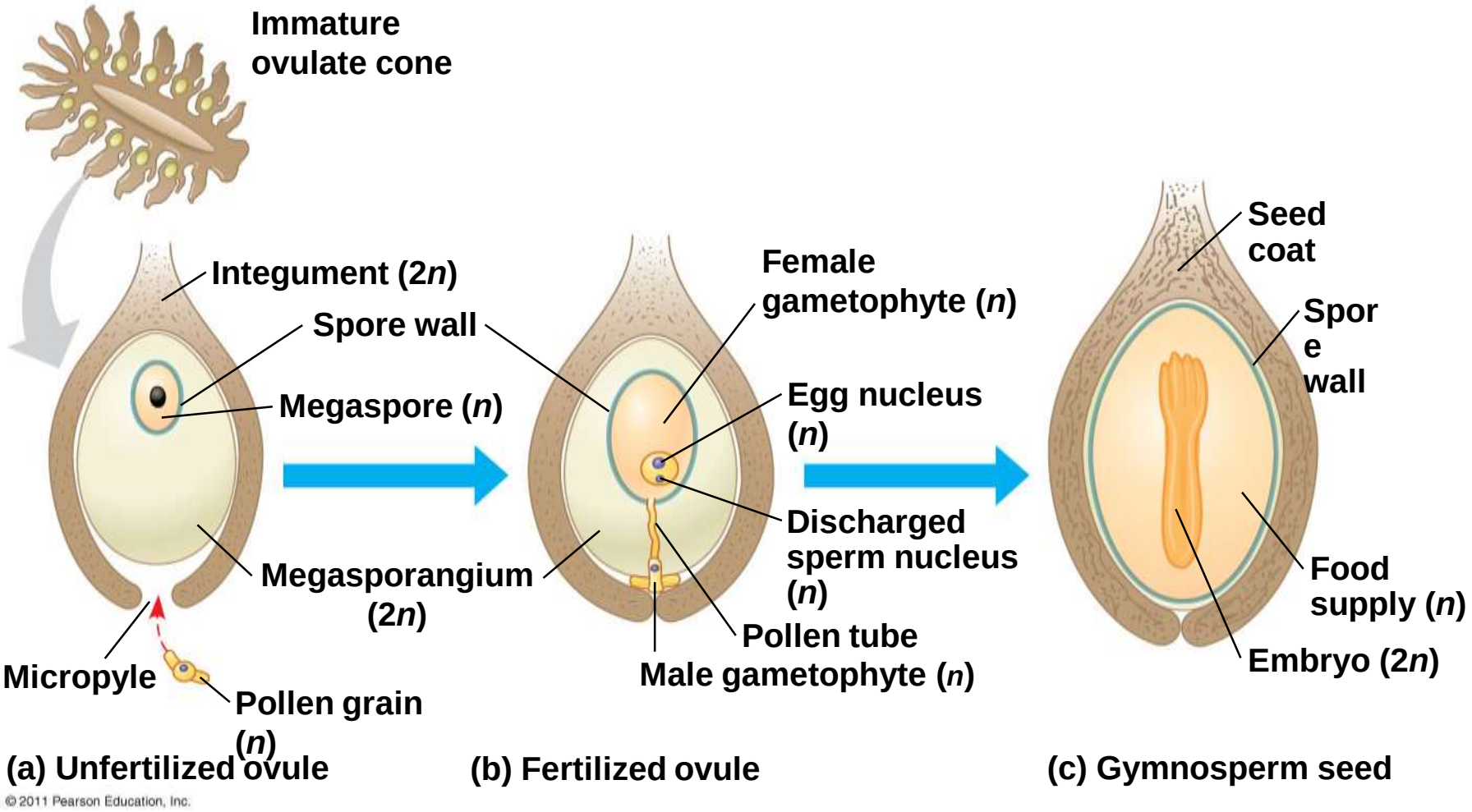
Figure 30.3-2



The Evolutionary Advantage of Seeds

- **A seed develops from the whole ovule**
- A seed is a **sporophyte embryo**, along with its food supply, packaged in a protective coat

Figure 30.3-3

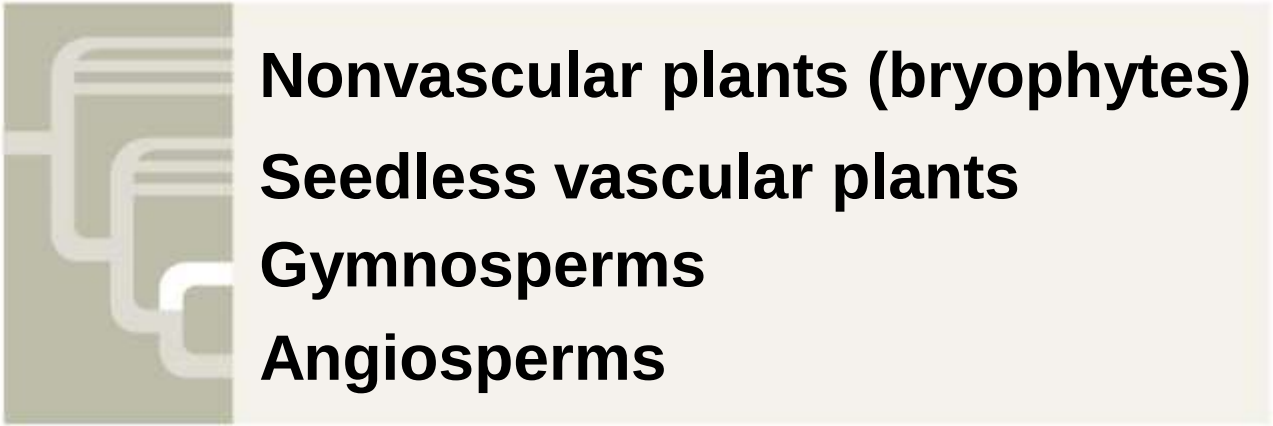


- Seeds provide some evolutionary advantages over spores
  - They may **remain dormant for days to years**, until conditions are favorable for germination
  - Seeds have a supply of stored food
  - They may be **transported long distances** by wind or animals

Concept 30.2: Gymnosperms bear "naked" seeds, typically on cones

- Gymnosperms means "naked seeds"
- The seeds are exposed on **sporophylls** that form cones
- Angiosperm seeds are found in **fruits, which are mature ovaries**

Figure 30.UN01



- Living seed plants can be divided into **two clades**:
  - gymnosperms and
  - angiosperms
- Gymnosperms appear early in the fossil record about 305 million years ago

- Gymnosperms **were better suited** than nonvascular plants to drier conditions

- Angiosperms now dominate more terrestrial ecosystems

- Today, cone-bearing gymnosperms called **conifers** dominate in the northern latitudes

- The gymnosperm consist of four phyla
  - Cycadophyta (cycads)
  - Gingkophyta (one living species: *Ginkgo biloba*)
  - Gnetophyta (three genera: *Gnetum, Ephedra, Welwitschia*)
  - **Coniferophyta** (conifers, such as pine, fir, and redwood)

Figure 30.5a

Cycas revoluta

Phylum Ginkgophyta

- This phylum consists of a single living species, ***Ginkgo biloba***
- It has a high tolerance to air pollution and is a popular ornamental tree

Figure 30.5b

Ginkgo biloba **leaves and fleshy seeds**

Ginkgo biloba **pollen-producing tree**

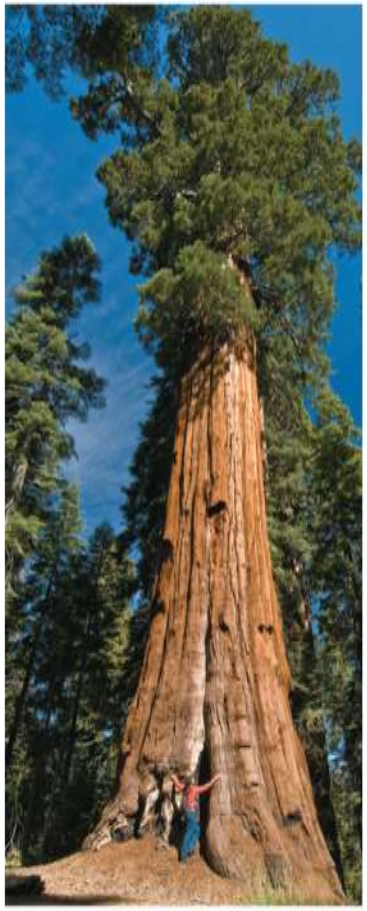
Phylum Coniferophyta

- This phylum is by far **the largest of the gymnosperm phyla**

- Most conifers are evergreens and can carry out photosynthesis year round

Figure 30.5e

Douglas fir



Sequoia

Common juniper

European larch

Wollemi pine

Bristlecone pine

The Life Cycle of a Pine: *A Closer Look*

- Three key features of the gymnosperm life cycle are
  - **Dominance of the sporophyte generation**
  - **Development of seeds from fertilized ovules**
  - **The transfer of sperm to ovules by pollen**
- The life cycle of a pine provides an example

Figure 30.6-1

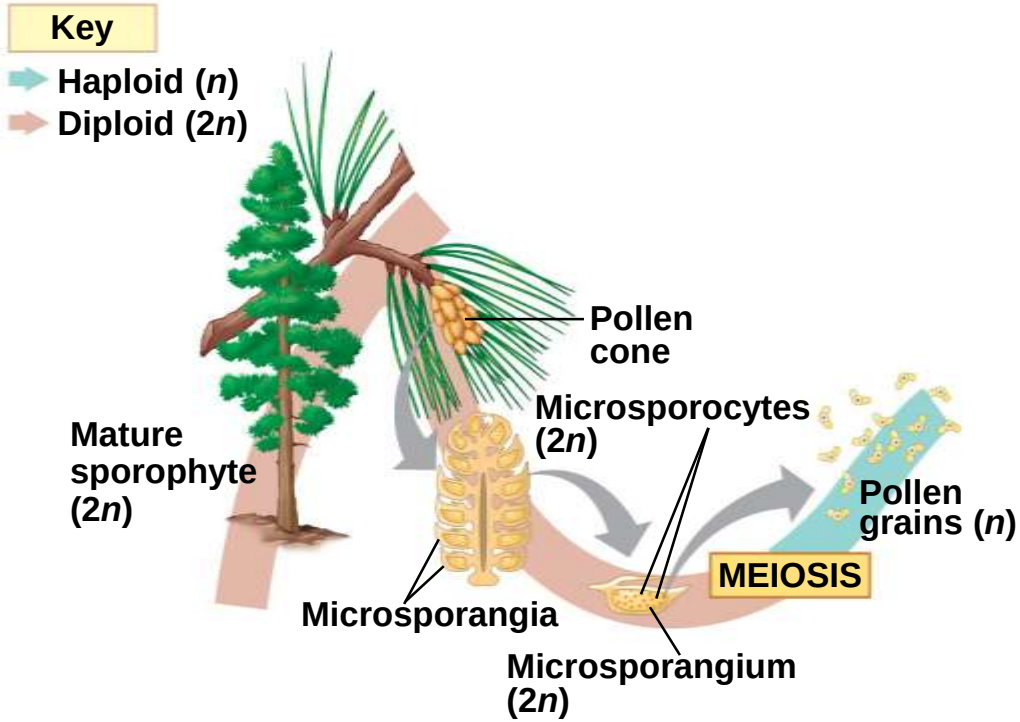


Figure 30.6-2

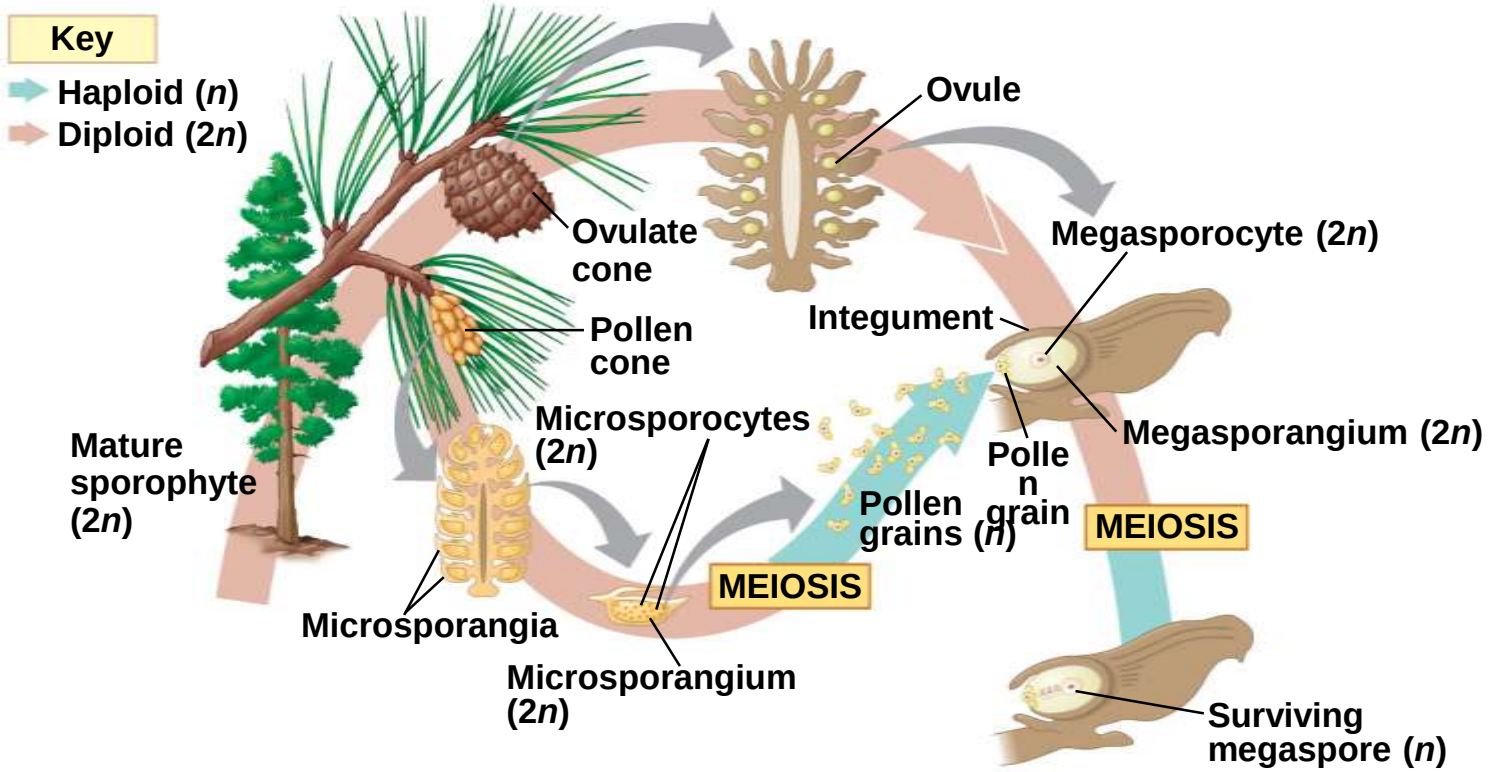


Figure 30.6-3

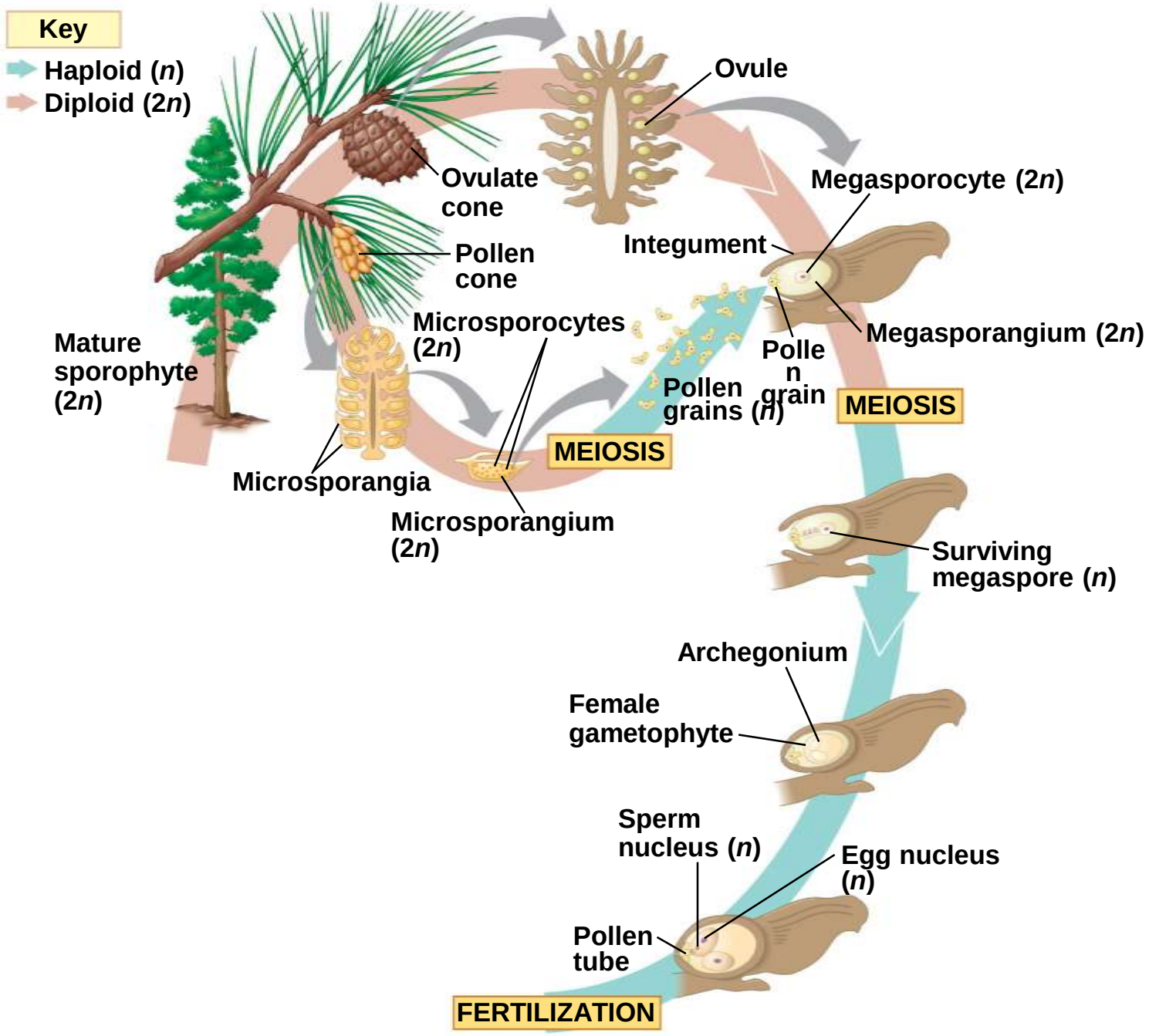
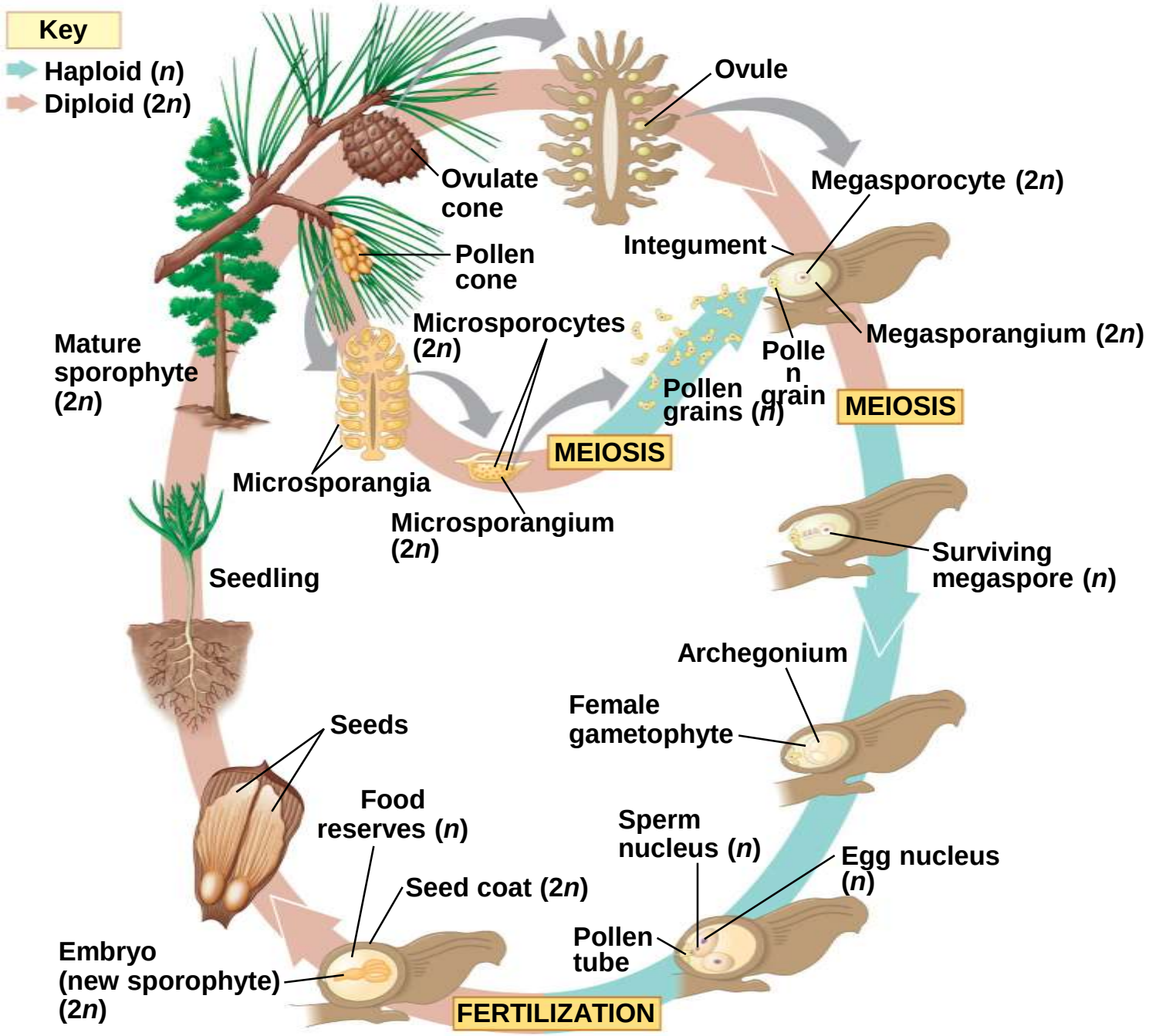


Figure 30.6-4



Concept 30.3: The reproductive adaptations of angiosperms include flowers and fruits

- Angiosperms are seed plants with reproductive structures called flowers and fruits

- They are the most widespread and diverse of all plants

Characteristics of Angiosperms

- All angiosperms are classified in a single phylum, Anthophyta, from the Greek *anthos* for flower

- Angiosperms have two key adaptations
  - Flowers
  - Fruits

Flowers

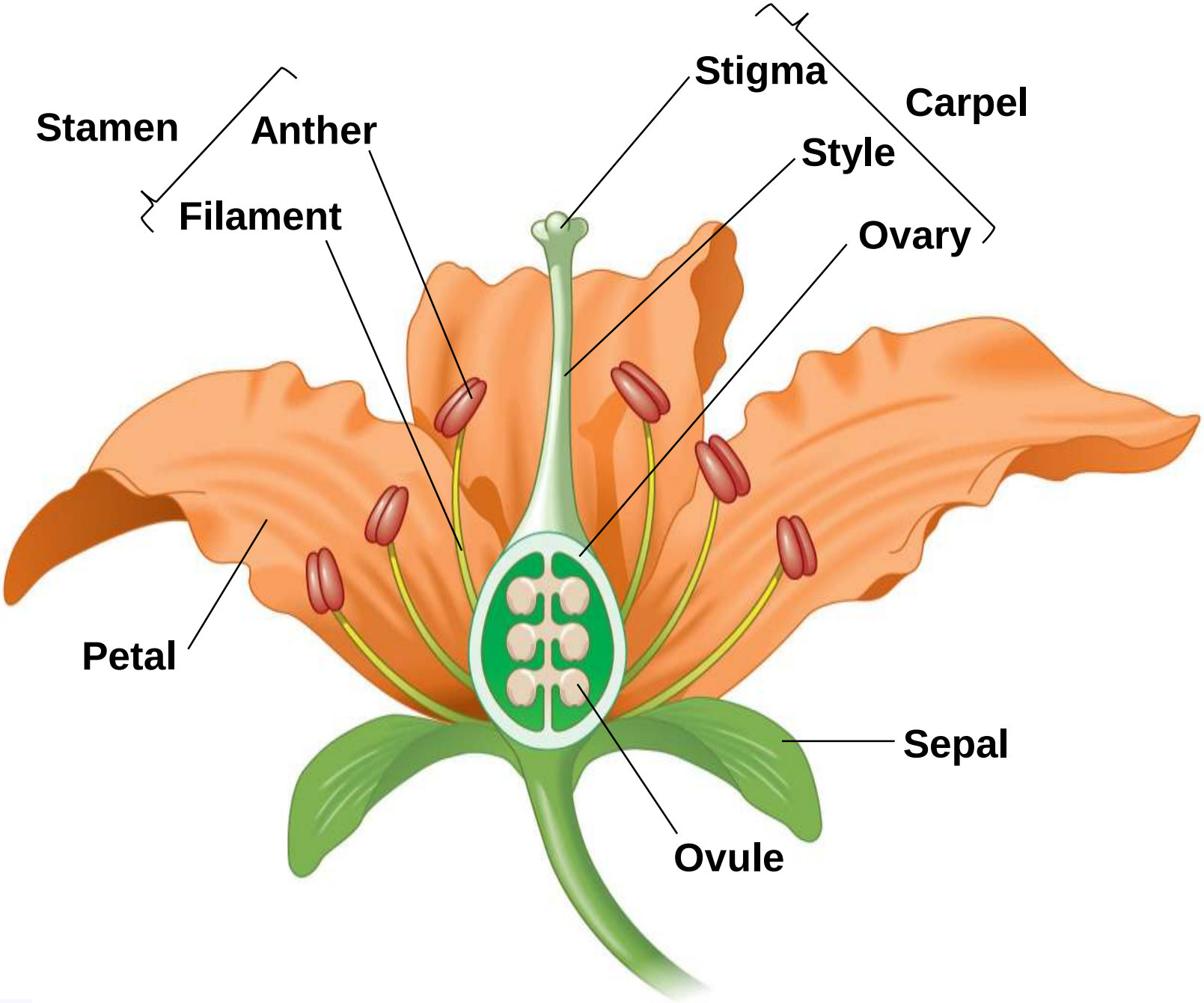
- The **flower** is an angiosperm structure specialized for sexual reproduction

- Many species are pollinated by insects or animals, while some species are wind-pollinated

- A flower is a specialized shoot with up to four types of modified leaves
  - **Sepals**, which enclose the flower
  - **Petals**, which are brightly colored and attract pollinators
  - **Stamens**, which produce pollen
  - **Carpels**, which produce ovules

- A stamen consists of a stalk called a **filament**, with a sac called an **anther** where the pollen is produced
- A carpel consists of an **ovary** at the base and a **style** leading up to a **stigma**, where pollen is received

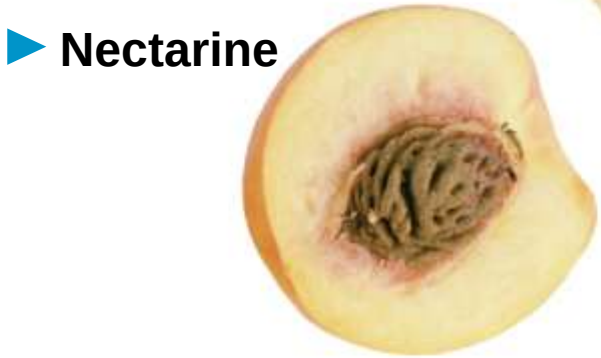
Figure 30.7



Fruits

- A **fruit** typically consists of a mature ovary but can also include other flower parts
- Fruits protect seeds and aid in their dispersal
- Mature fruits can be either fleshy or dry

Figure 30.8



- Various fruit adaptations help **disperse** seeds

- Seeds can be carried by wind, water, or animals to new locations

The Angiosperm Life Cycle

- The flower of the sporophyte is composed of both male and female structures
- Male gametophytes are contained within pollen grains produced by the microsporangia of anthers
- The female gametophyte, or **embryo sac**, develops within an ovule contained within an ovary at the base of a stigma
- Most flowers have mechanisms to ensure **cross-pollination** between flowers from different plants of the same species

- A pollen grain that has landed on a stigma germinates and the pollen tube of the male gametophyte grows down to the ovary
- The ovule is entered by a pore called the **micropyle**
- **Double fertilization** occurs when the pollen tube discharges two sperm into the female gametophyte within an ovule

- One sperm fertilizes the egg, while the other combines with two nuclei in the central cell of the female gametophyte and initiates development of food-storing **endosperm**
- The triploid endosperm nourishes the developing embryo
- Within a seed, the embryo consists of a root and two seed leaves called **cotyledons**

Figure 30.10-1

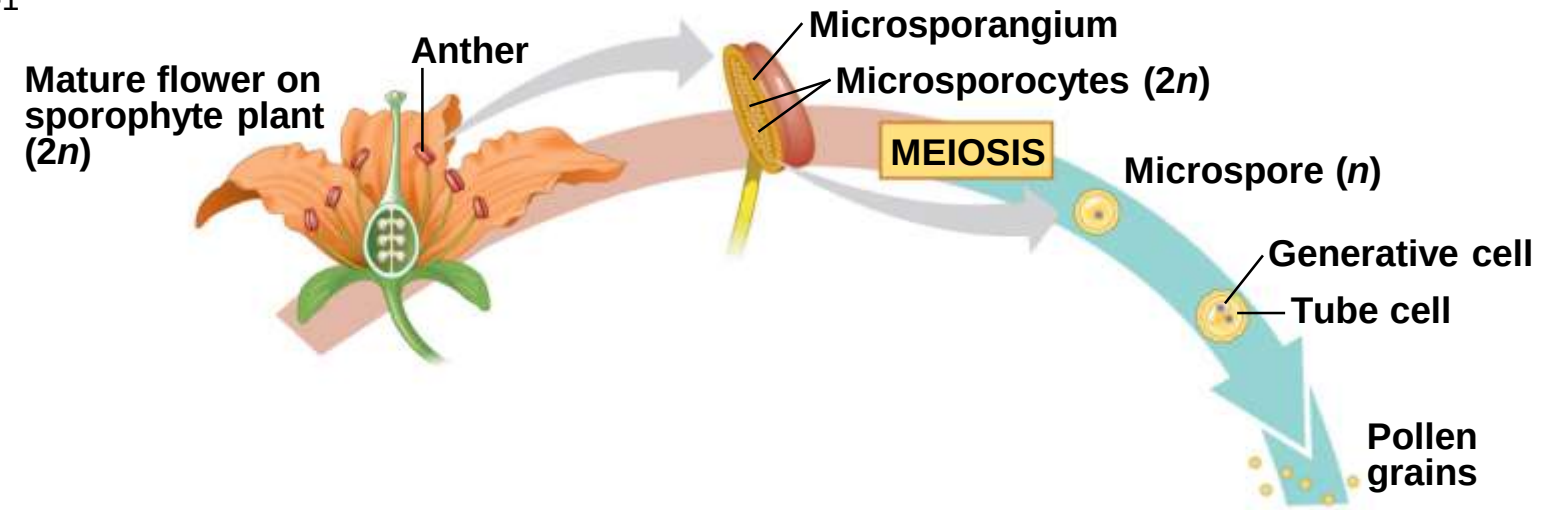


Figure 30.10-2

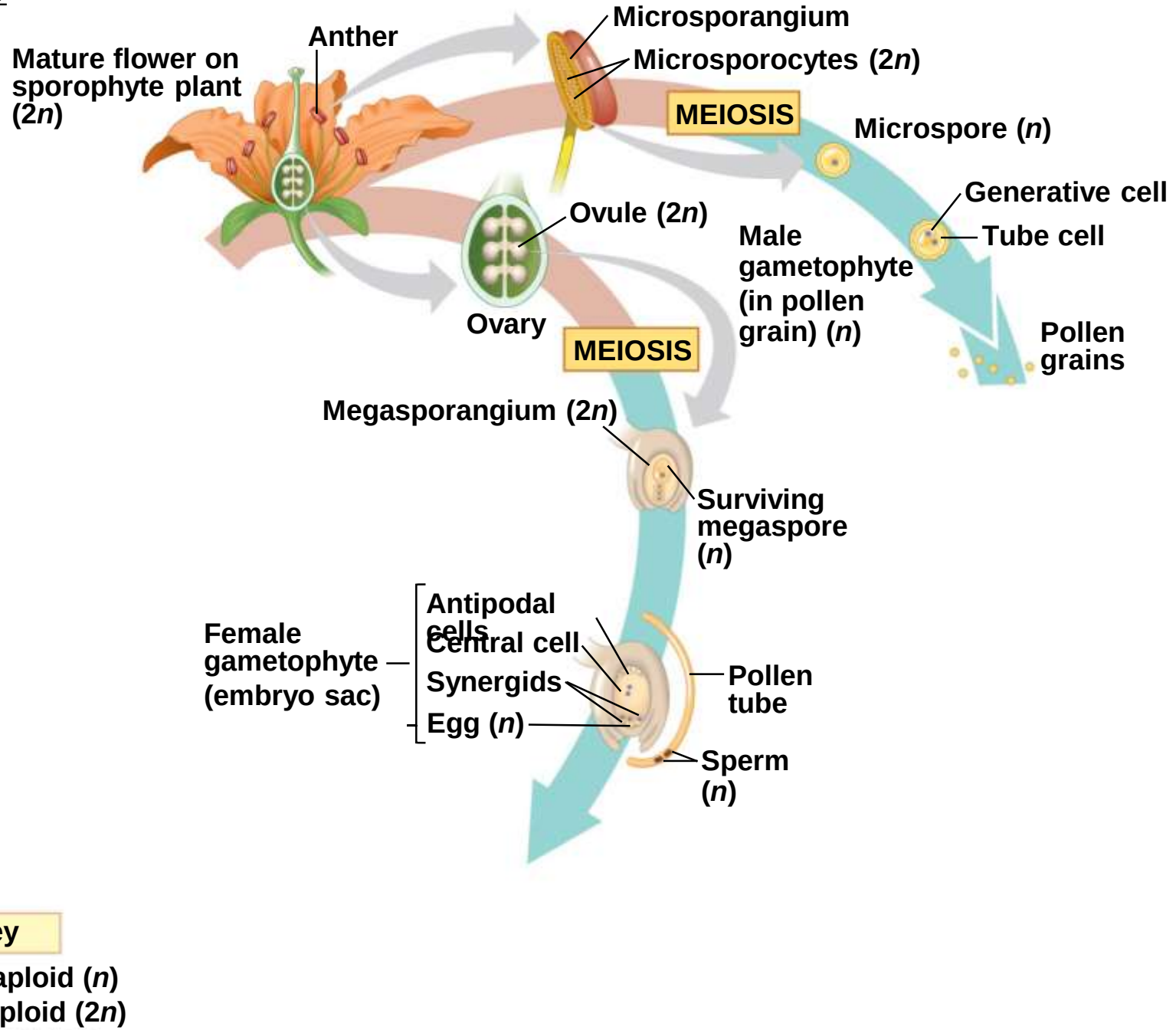


Figure 30.10-3

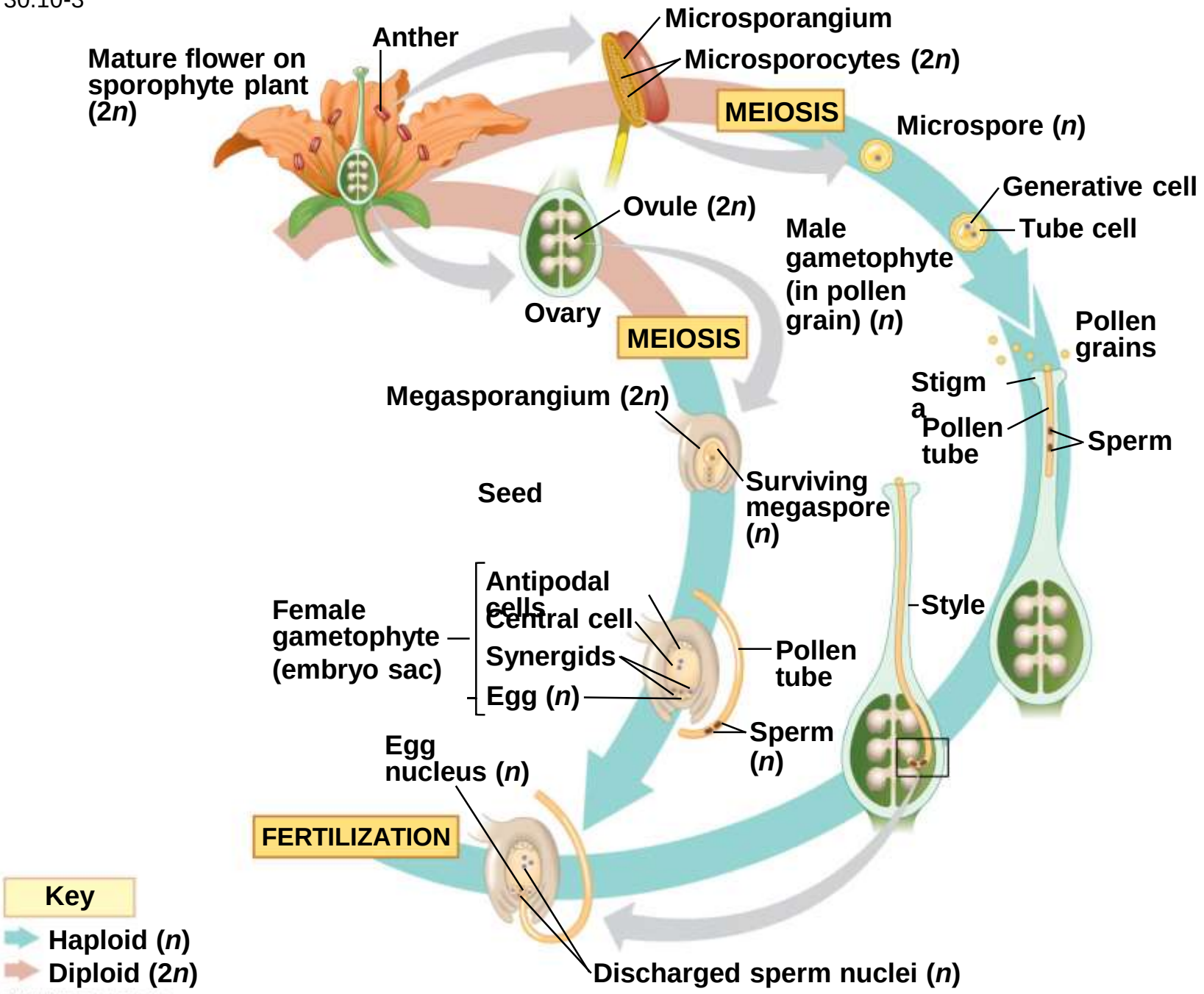
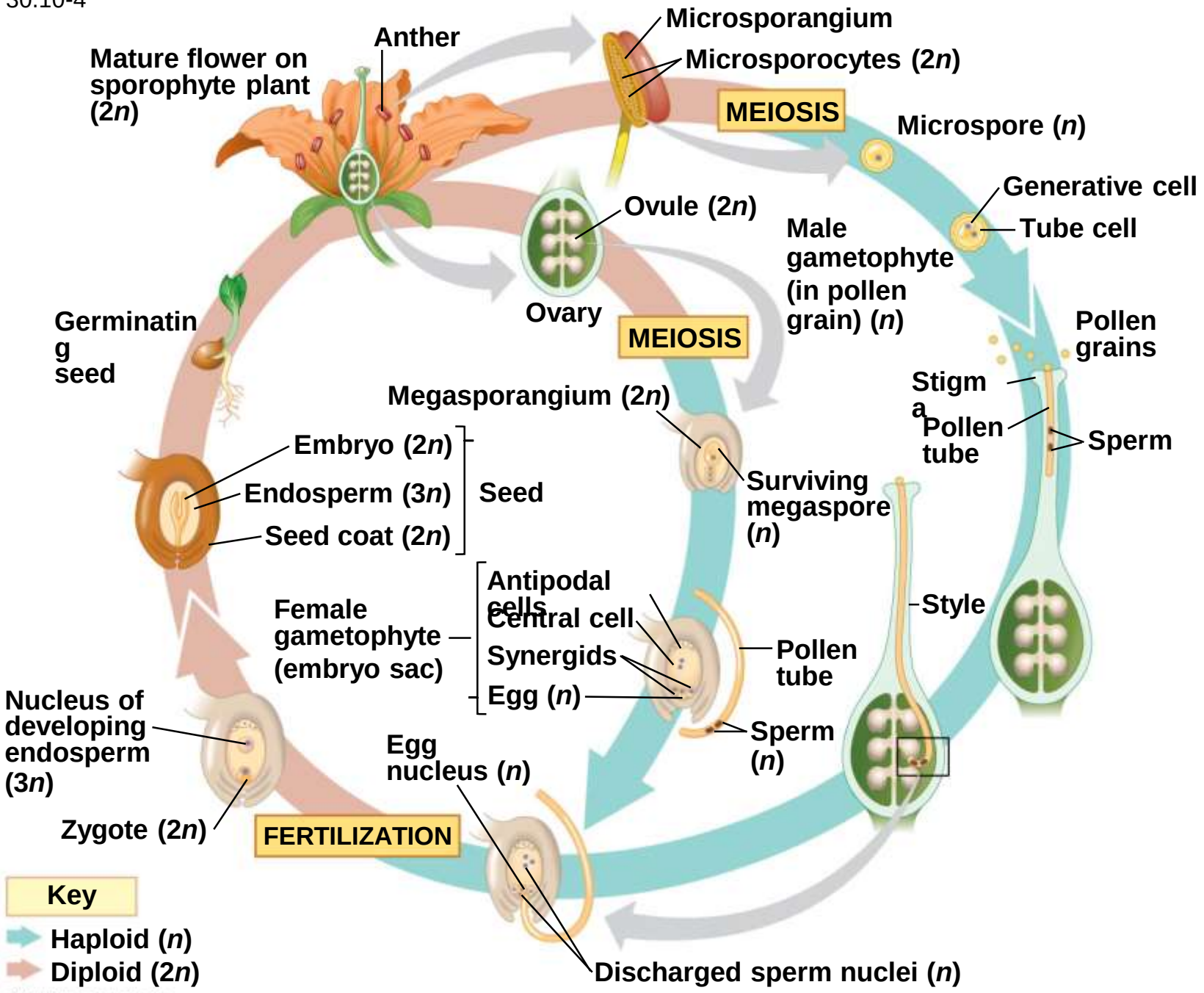


Figure 30.10-4



Angiosperm Evolution

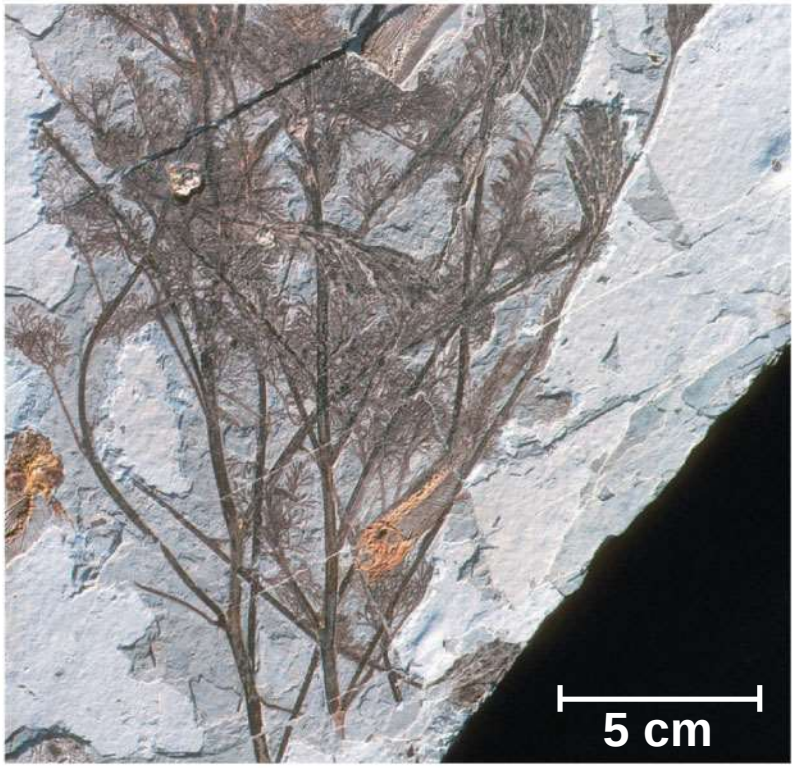
- Darwin called the origin of angiosperms an "**abominable** mystery"
- Angiosperms originated at least 140 million years ago
- Scientists are studying fossils, refining phylogenies, and investigating developmental patterns to resolve the mystery

Fossil Angiosperms

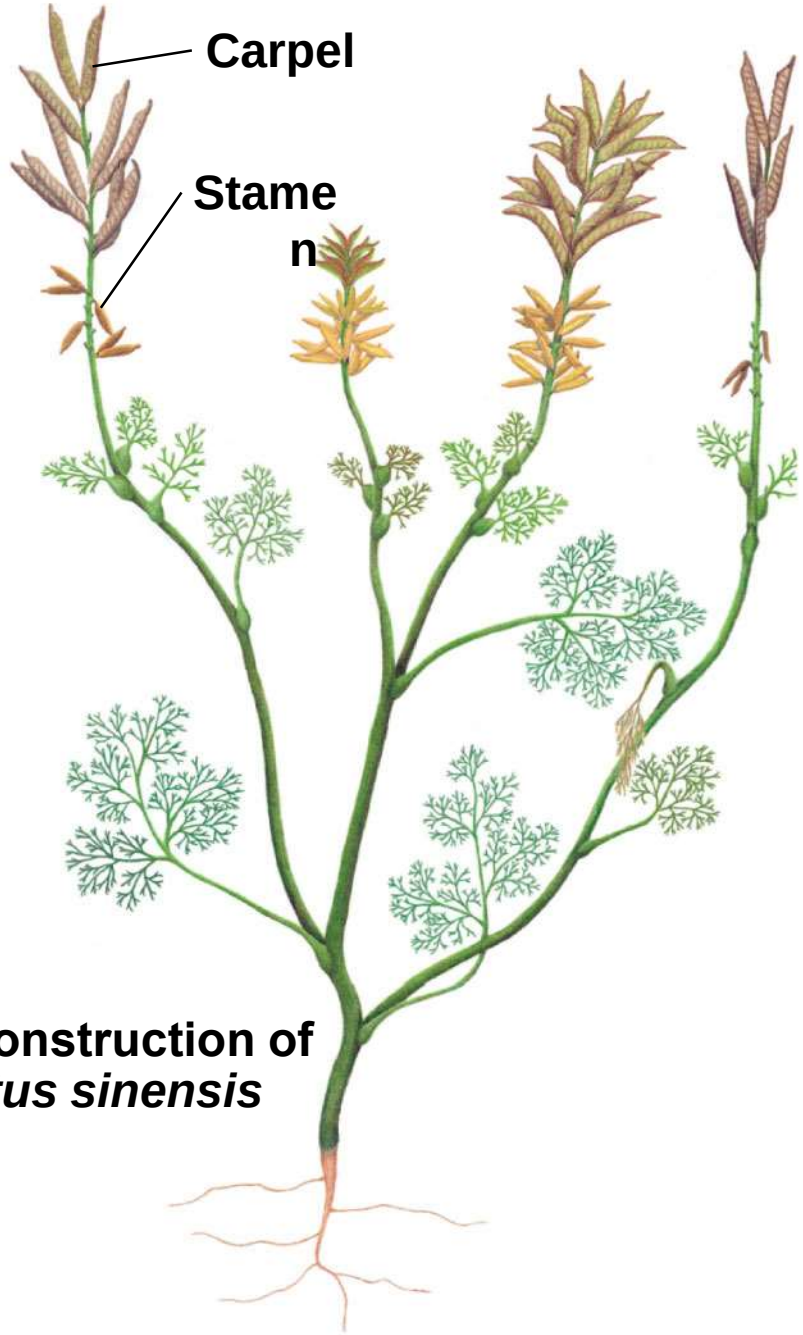
- Chinese fossils of 125-million-year-old angiosperms share some traits with living angiosperms but lack others

- *Archaefructus sinensis,* for example, has anthers and seeds but lacks petals and sepals

Figure 30.11



(a) *Archaefructus sinensis*, a 125-million-year-old fossil



(b) Artist's reconstruction of *Archaefructus sinensis*

Angiosperm Diversity

- Angiosperms comprise more than 250,000 living species

- Previously, angiosperms were divided into two main groups
  - **Monocots** (one cotyledon)
  - **Dicots** (two dicots)

- DNA studies suggest that monocots form a clade, but dicots are polyphyletic

Monocots

- More than one-quarter of angiosperm species are monocots

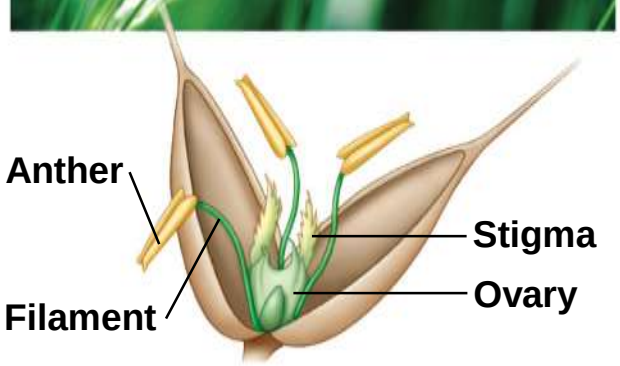
Figure 30.13c

Monocots

Orchid

Lily

Pygmy date palm



Barley, a grass

Eudicots

- More than two-thirds of angiosperm species are eudicots

Figure 30.13d

Eudicots

California poppy

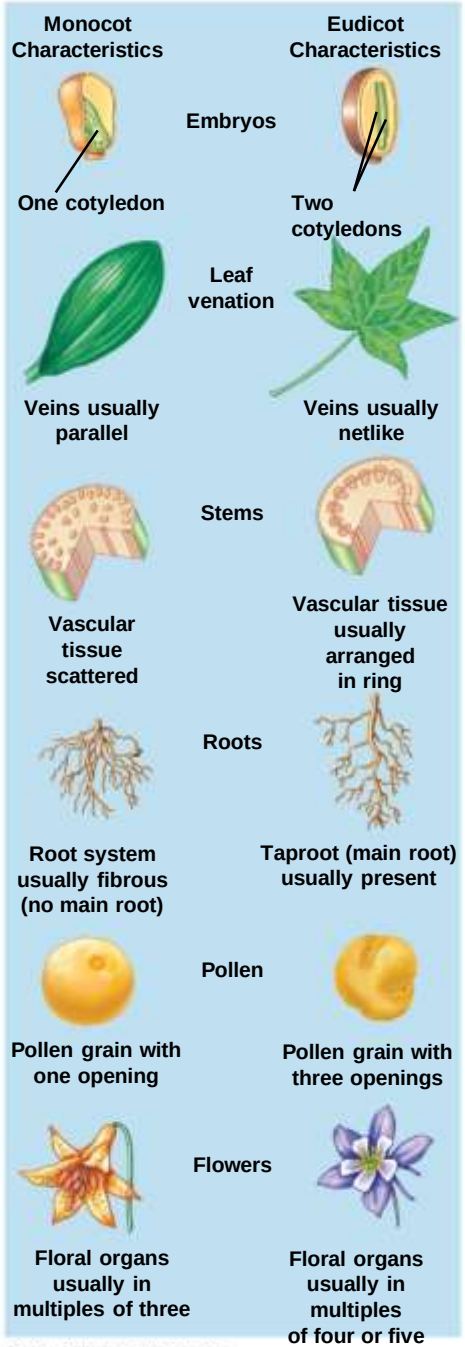
Dog rose

Pyrenean oak

Snow pea

Zucchini

Figure 30.13e



Concept 30.4: Human welfare depends greatly on seed plants

- No group of plants is more important to human survival than seed plants
- Plants are key sources of food, fuel, wood products, and medicine
- Our reliance on seed plants makes preservation of plant diversity critical

Products from Seed Plants

- Most of our food comes from angiosperms
- Six crops (**wheat, rice, maize, potatoes, cassava, and sweet potatoes**) yield 80% of the calories consumed by humans
- Modern crops are products of relatively recent genetic change resulting from artificial selection
- Many seed plants provide wood
- **Secondary compounds of seed plants are used in medicines**

Table 30.1 Examples of Plant-Derived Medicines

Compound	Source	Use
Atropine	Belladonna plant	Eye pupil dilator
Digitalin	Foxglove	Heart medication
Menthol	Eucalyptus tree	Throat soother
Quinine	Cinchona tree	Malaria preventive
Taxol	Pacific yew	Ovarian cancer drug
Tubocurarine	Curare tree	Muscle relaxant
Vinblastine	Periwinkle	Leukemia drug

Threats to Plant Diversity

- **Destruction of habitat** is causing extinction of many plant species
- In the tropics 55,000 km^2 are cleared each year
- At this rate, the remaining tropical forests will be eliminated in 200 years
- **Loss of plant habitat is often accompanied by loss of the animal species that plants support**

- At the current rate of habitat loss, 50% of Earth's species will become extinct within the next 100–200 years

- The tropical rain forests may contain **undiscovered medicinal compounds**