Seed Plants

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ECOL 182R UofA
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The Evolution of Seed Plants

Late in the Devonian, some plants developed **growth**: thickened woody stems of xylem.

First species with secondary growth were the *progymnosperms*: seedless vascular plants, now extinct.

Wood: proliferated xylem, gives support and allows plants to grow above their competitors for sunlight.

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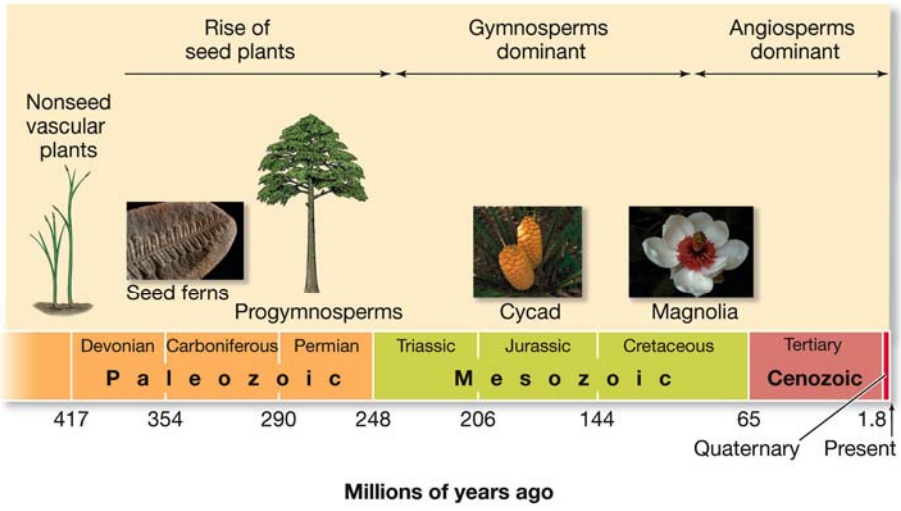
Figure 29.1 Highlights in the History of Seed Plants



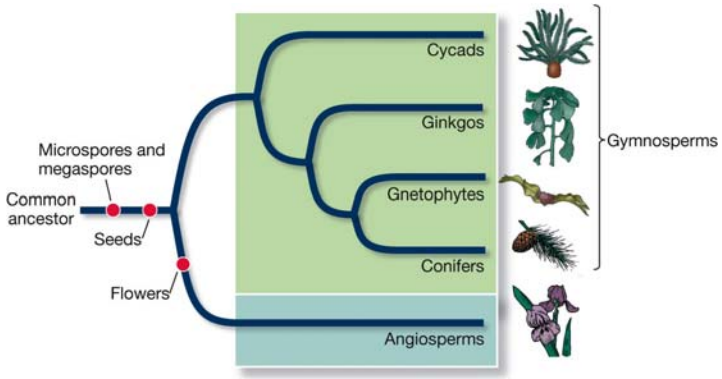
LIFE 8e, Figure 29.1

Seed Plants Took Over

Surviving seed plants fall into two groups:

and cycads

: flowering plants



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Evolution of Plants

Horsetails and ferns (Pteridophytes) replaced by

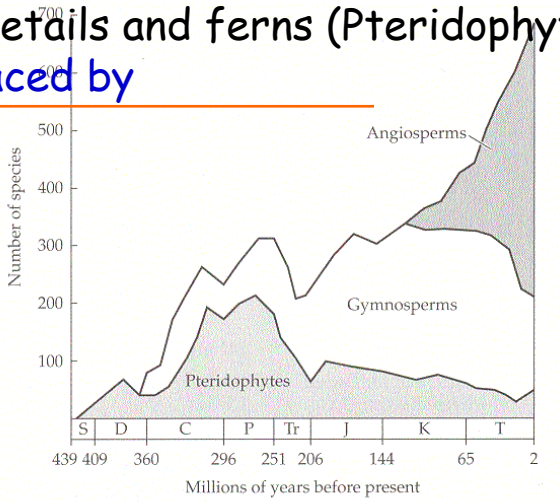

Figure 2.6 Terrestrial plant species richness. Ferns, gymnosperms, and angiosperms have, in turn, dominated the world's flora. (Modified from Signor 1990.)

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Living fossils: Gingko

(a) Triassic (~200mya)

(b)

Cycas revoluta

UA Campus

Gingko biloba

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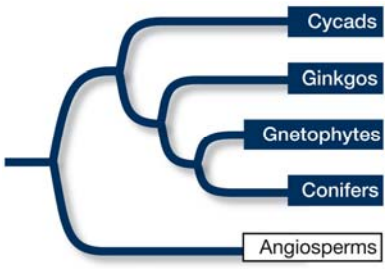
Gymnosperms

Extant gymnosperms are probably a clade.

Gymnosperm: "_____"—the ovules and seeds are not protected by ovary or fruit tissue.



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Gymnosperms

Four major groups of living gymnosperms:

- **Cycads**: *Cycadophyta*—140 species
- **Ginkgos**: *Ginkgophyta*—one living species, *Ginkgo biloba*
- **Gnetophytes**: *Gnetophyta*—90 species in 3 genera
- **Conifers**: *Coniferophyta*—600 species, the cone bearers

- Cycads and Ginkgos still have _____

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(A) *Encephalartos villosus* cycad

(B) *Ginkgo biloba*

(C) *Welwitschia mirabilis* gnetophyte

(D) *Sequoiadendron giganteum*

Gymnosperms

Gymnosperm Evolution

Most living gymnosperms have only tracheids for water conduction and support.

Angiosperms have vessel elements and fibers alongside of tracheids.

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Evolution of Seed Plants

Gametophyte generation is reduced even further than it is in ferns.

Haploid gametophyte develops partly or entirely while attached to the sporophyte.

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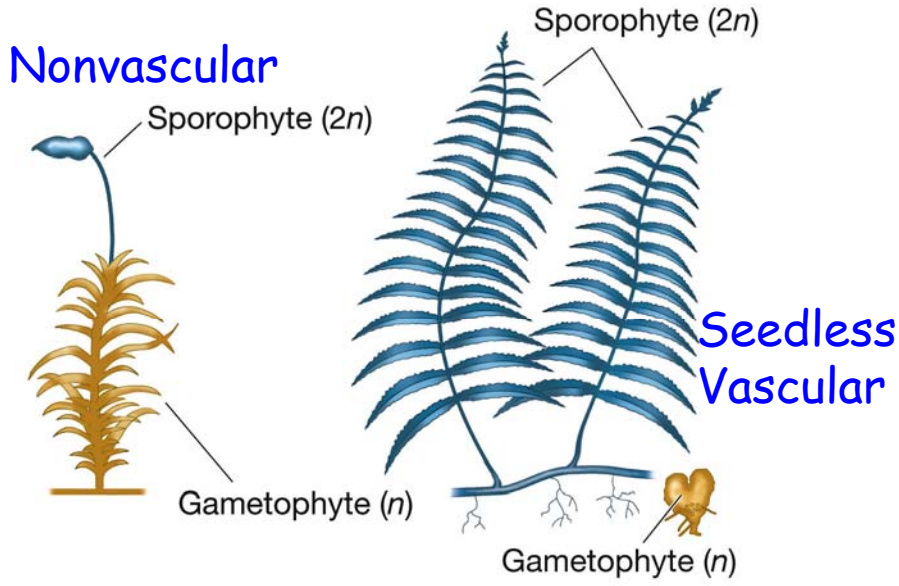
Figure 29.3 The Relationship between Sporophyte and Gametophyte Has Evolved (Part 1)



LIFE 8e, Figure 29.3 (Part 1)

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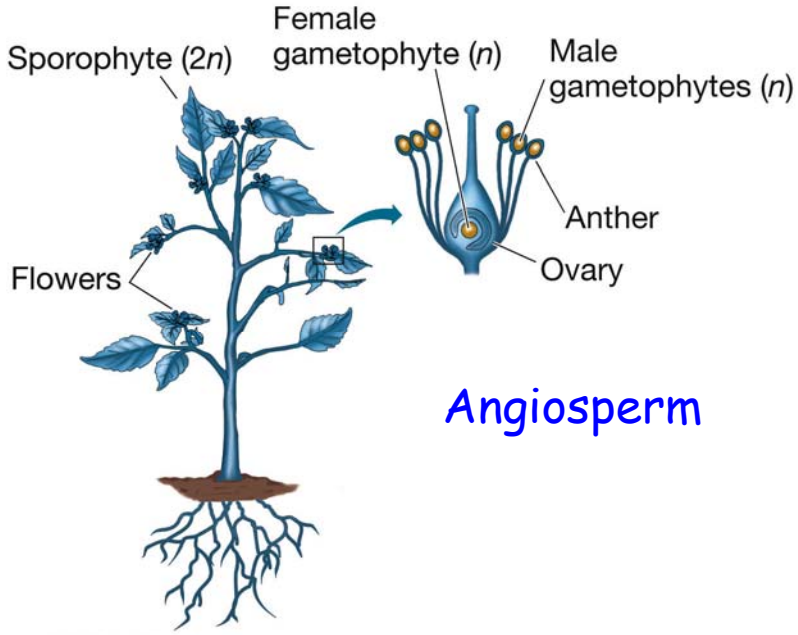
Figure 29.3 The Relationship between Sporophyte and Gametophyte Has Evolved (Part 2)



LIFE 8e, Figure 29.3 (Part 2)

Evolution of Seed Plants

Seed plants are heterosporous: produce two types of spores.

Only one meiotic product survives and develops into the megagametophyte by mitotic divisions. Megagametophyte (haploid) produces an egg by mitosis.

Megagametophyte houses the next sporophyte generation when egg is fertilized.

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Evolution of Seed Plants

Megasporangium is surrounded by integument made of sporophytic structures.

Megasporangium and the integument together form the (which develops into a).

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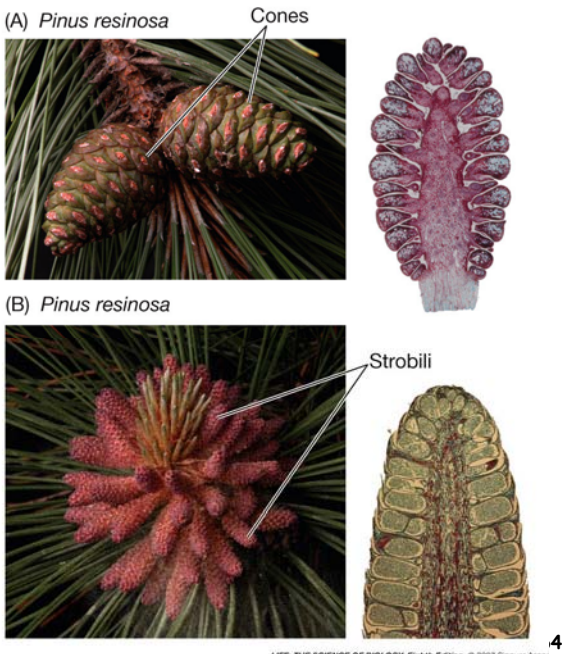
Gymnosperm Example:

Megasporangium (cone)

Microsporangium (strobili)



LIFE 8e, Figure 29.7

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Evolution of Seed Plants

In the microsporangium, microspores produce the male gametophyte, or **pollen** grain with *sporopollenin* in walls, the most resistant biological compound known.

Reproduction becomes _____ of _____ in some Gymnosperms!

How do you think this affected the evolution and diversification of seed plants?

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Conifers (Pine Cones…)

A **cone** is a modified stem, bearing a tight cluster of scales (reduced *branches*), specialized for reproduction. Megaspores are produced here.

Strobilus: cone-like structure; scales are modified *leaves*. Microspores are produced here.

Recall that evolution by natural selection typically involves modification of existing structures.

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Pine Life Cycle

- Wind carries pollen grains from strobilus to cone.
- Two sperm travel through pollen tube; one degenerates after fertilization.

Note that pollinization does NOT equal fertilization.

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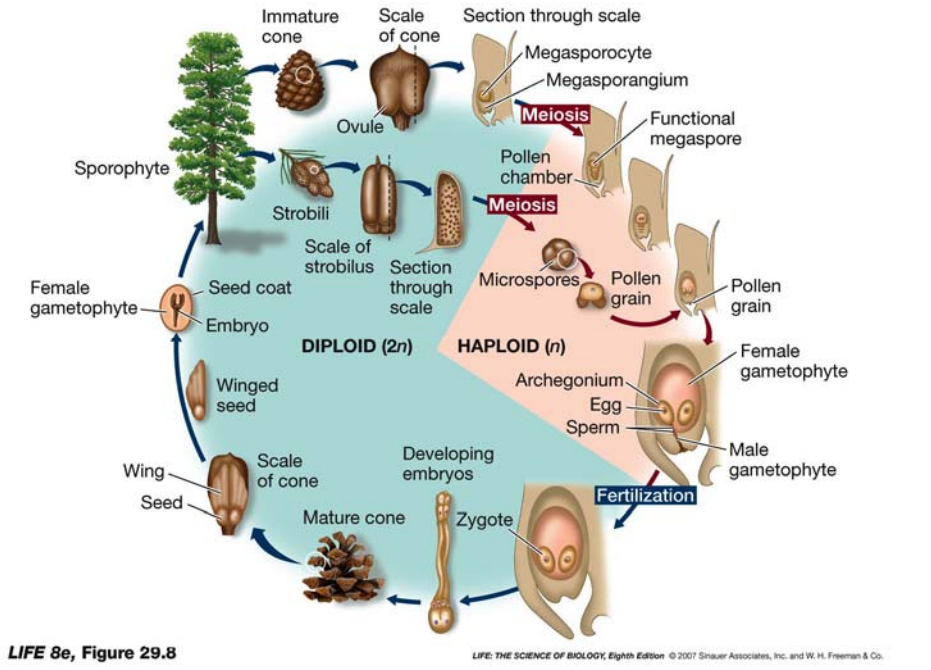
Figure 29.8 The Life Cycle of a Pine Tree



Evolution of Seed Plants

After fertilization, diploid zygote divides to produce an embryonic sporophyte.

Growth is then suspended, the embryo enters a dormant stage, with the end product being a multicellular seed.

How might suspension of growth be a fitness advantage?

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Evolution of Seed Plants

Seeds have tissues from three generations:

1. *Seed coat* develops from the sporophyte parent (integument).

2. Female gametophytic tissue from the next generation contains a nutrient supply for developing embryo.

3. Embryo is the new sporophyte generation.

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Evolution of Seed Plants

Seeds are well-protected resting stages.

May remain *viable* for many years, germinating when conditions are favorable.

Seed coat protects from drying out as well as predators.

Many seeds have adaptations for dispersal.

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Evolution of Seed Plants

Seeds and Secondary Growth are the main reasons for the success of seed plants—currently the dominant life forms in terrestrial environments.

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Origin of Land Plants

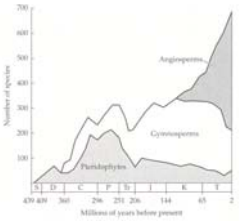
TABLE 28.1

Classification of Land Plants

GROUP	COMMON NAME	CHARACTERISTICS
NONVASCULAR PLANTS		
Hepatophyta	Liverworts	No filamentous stage; gametophyte flat
Anthocerophyta	Hornworts	Embedded archegonia; sporophyte grows basally (from the ground)
Bryophyta	Mosses	Filamentous stage; sporophyte grows apically (from the tip)
VASCULAR PLANTS		
Lycophyta	Club mosses and allies	Microphylls in spirals; sporangia in leaf axils
Pteridophyta	Horsetails, whisk ferns, ferns	Differentiation between main stem and side branches (overtopping growth)
SEED PLANTS		
Gymnosperms		
Cycadophyta	Cycads	Compound leaves; swimming sperm; seeds on modified leaves
Ginkgophyta	Ginkgo	Deciduous; fan-shaped leaves; swimming sperm
Gnetophyta	Gnetophytes	Vessels in vascular tissue; opposite, simple leaves
Coniferophyta	Conifers	Seeds in cones; needle-like or scale-like leaves
Angiosperms	Flowering plants	Endosperm; carpels; gametophytes much reduced; seeds within fruit

Note: No extinct groups are included in this classification.

Angiosperms



Oldest angiosperm fossils are Cretaceous, 140 million years old.

Radiation was explosive; angiosperms became dominant in only 60 million years.

Over 250,000 species exist today.

Female gametophyte even more reduced— usually only seven cells.

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Angiosperm Synapomorphies

- Xylem with vessel elements and fibers
- Phloem with companion cells

- Triploid endosperm
- Ovules and seeds

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Double Fertilization & Endosperm

Microgametophyte has two male gametes. Nucleus of one combines with egg.

The other nucleus combines with two haploid nuclei of female gametophyte to form a *triploid nucleus*—becomes the **endosperm**.

Endosperm nourishes developing sporophyte.

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Carpels

Angiosperm: "enclosed seed"—the ovules and seeds are enclosed in a modified leaf called a **carpel**.

Carpels provide protection, and may interact with pollen to prevent self-pollination.

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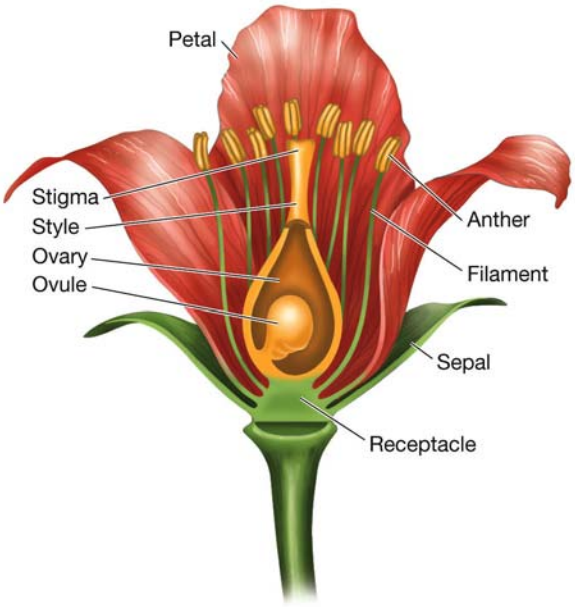
Flowers

Stamens bear microsporangia: consist of **filament** and **anther**.

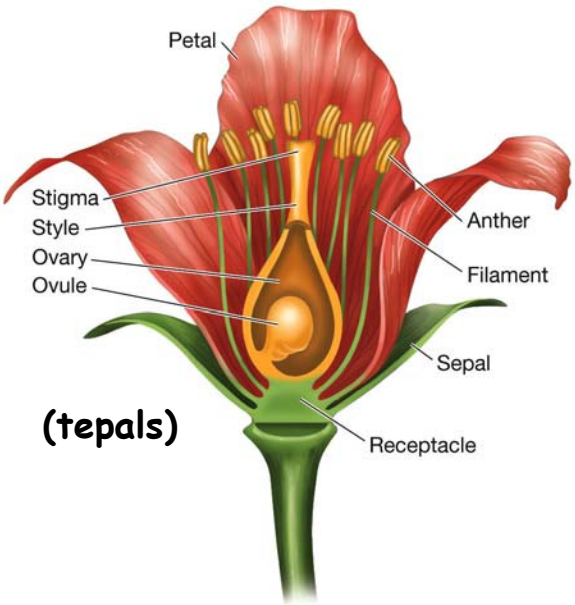
Carpels bear megasporangia. One or more carpels form the **pistil—stigma**, **style**, and **ovary**.



Flowers

Petals (corolla) and **sepals (calyx)** are modified leaves. Often play a role in attracting pollinators.

The calyx often protects the flower bud before it opens.



(tepals)

Flowers

Perfect flowers: have *both* mega- and microsporangia.

Imperfect flowers: either mega or microsporangia.

Monoecious: "one-housed"; male and female flowers occur on the same plant.

Dioecious: "two-housed"; male and female flowers on different plants.

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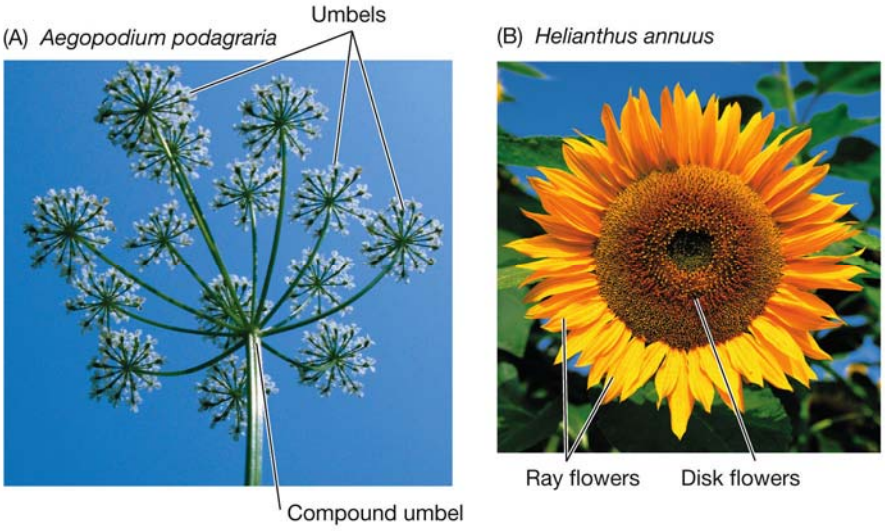
Inflorescence: grouping of flowers.
Different families have characteristic types.

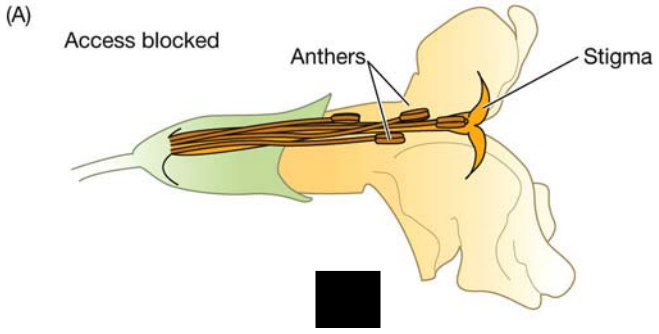


(C) *Pennisetum setaceum*

***LIFE 8e*, Figure 29.10 (Part 2)**

Flowers

Long styles in pistils and long filaments in stamens: length increases likelihood of pollination—either making them more accessible to insects, or to catch the wind.



Flowers

Most angiosperms are animal-pollinated—by insects, birds, and bats.

Many flowers entice pollinators with nectar and pollen.

Plants and their pollinators have coevolved; some relationships are very specific.

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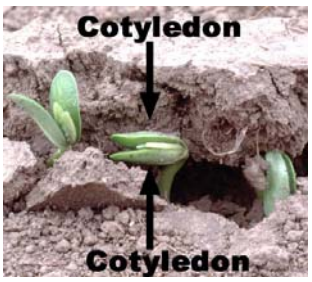
www.bio.miami.edu/muchhala/home.html

Angiosperm Lifecycle



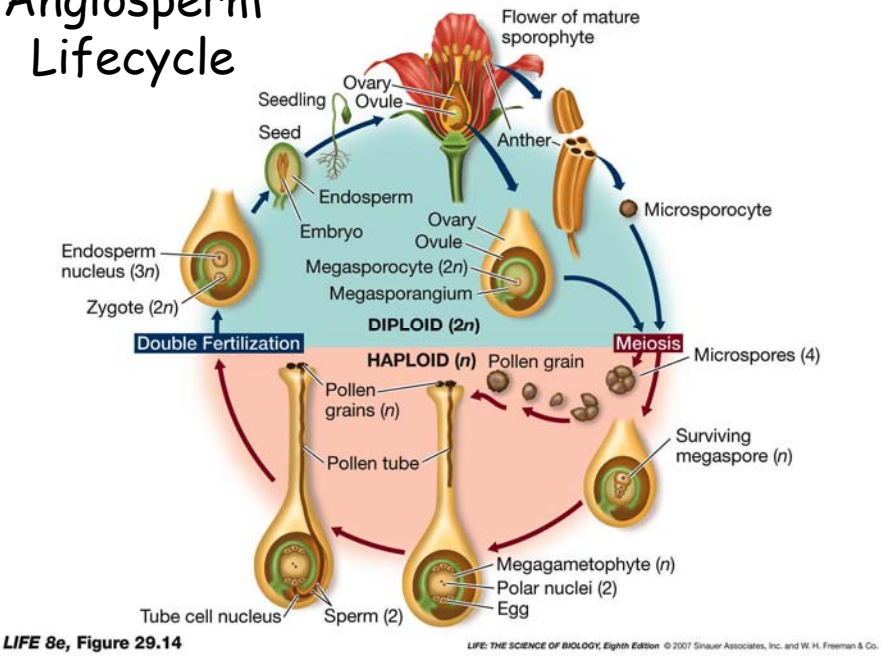
Zygote develops into an embryo: consists of an embryonic axis (will become stem and root), and 1 or 2 **cotyledons**—seed leaves.

Cotyledons absorb and digest the endosperm, some become photosynthetic.

Ovary and seeds develop into fruits.

Fruit protects seed and aids in dispersal, (e.g., can become attached to or eaten by animals). 86

Angiosperm Lifecycle



LIFE 8e, Figure 29.14

Fruits

Simple fruits develop from one carpel.

Aggregate fruits develop from several carpels.

Multiple fruits form from a cluster of flowers.

Accessory fruits develop from parts other than carpels.

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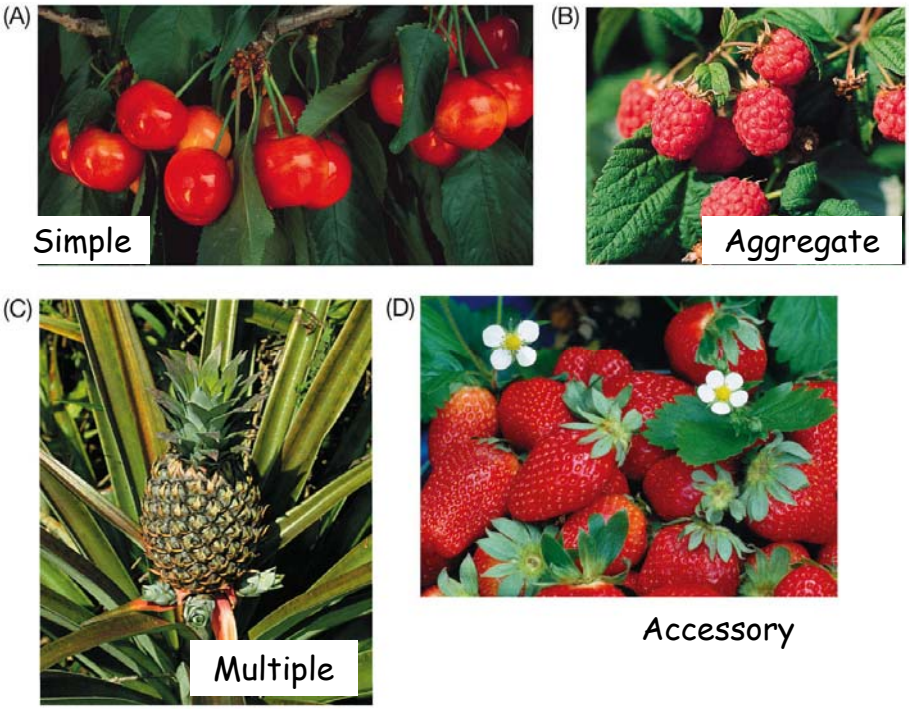
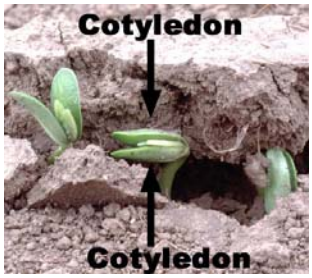


Angiosperm Diversification

Most angiosperms are in two clades:



- Other clades include star anise and relatives, water lilies, and magnoliids.

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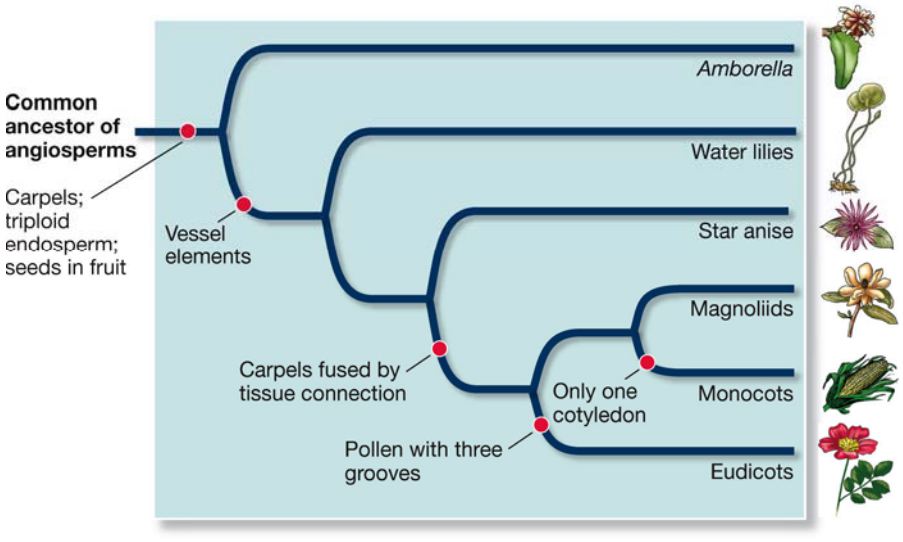
Angiosperm Diversification



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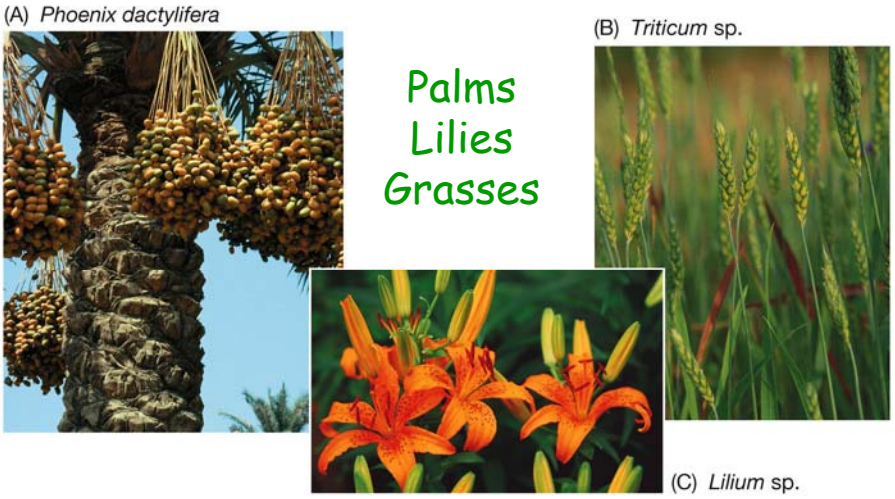
Monocots



Palms
Lilies
Grasses

LIFE 8e, Figure 29.18

Eudicots

LIFE 8e, Figure 29.19

Plants Support Our World

Plants contribute to **ecosystem services**: processes by which the environment maintains resources that benefit humans.

Plants are **primary producers**: photosynthesis traps energy and carbon, making them available to consumers.

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Plants Support Us

Seed plants are our primary food source.

Twelve are most important: rice, coconut, wheat, corn, potato, sweet potato, cassava, sugarcane, sugar beet, soybean, common bean, banana.

Half of the world's population gets most of its food energy from rice.

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Plants Support Us

Many medicines come from seed plants.

Medicines are found by screening large numbers of plants, or screening large numbers of chemical compounds.

Ethnobotanists also discover medicinal plants by studying people and their uses of plants all over the world.

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TABLE 29.1

Some Medicinal Plants and Their Products

PRODUCT	PLANT SOURCE	MEDICAL APPLICATION
Atropine	Belladonna	Dilating pupils for eye examination
Bromelain	Pineapple stem	Controlling tissue inflammation
Digitalin	Foxglove	Strengthening heart muscle contraction
Ephedrine	*Ephedra*	Easing nasal congestion
Menthol	Japanese mint	Relief of coughing
Morphine	Opium poppy	Relief of pain
Quinine	Cinchona bark	Treatment of malaria
Taxol	Pacific yew	Treatment of ovarian and breast cancers
Tubocurarine	Curare plant	As muscle relaxant in surgery
Vincristine	Periwinkle	Treatment of leukemia and lymphoma

***LIFE 8e*, Table 29.1**