SLE 132 – Form and Function
Diversity of Plants

Vascular Plants with Seeds

- **Seeds changed the course of plant evolution**, enabling their bearers to become the dominant producers in most terrestrial ecosystems
- A seed consists of an embryo and nutrients surrounded by a protective coat
- So what is so great about a seed? Or what are the advantages of producing a seed?

The evolutionary advantage of seeds

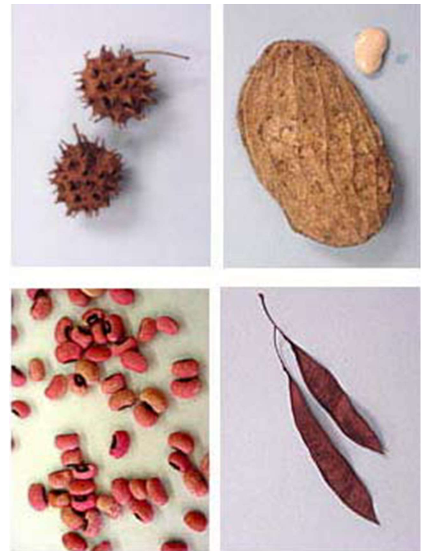
A seed develops from the whole ovule

- A seed is a sporophyte embryo, along with its food supply, packaged in a protective coat

Seeds provide **some evolutionary advantages** over spores:

– They may remain dormant for days to years, until conditions are favourable for germination

– They may be transported long distances by wind or animals



Seed Plants

In addition to seeds, the following are common to all seed plants:

- **Reduced gametophyte** stages
- **Heterospory** (production of spores of two different sexes and sizes)
- **Ovules**
- **Pollen** (eliminated the requirement for liquid environment for fertilisation)

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

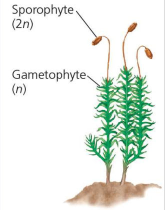
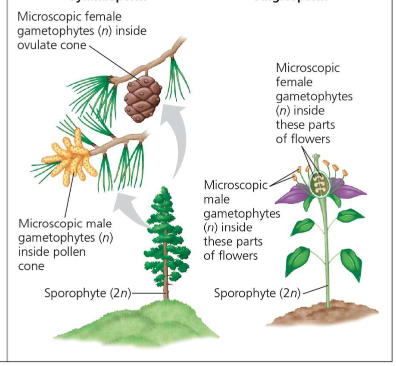
Reduced gametophyte stage

- Ferns and other seedless vascular plants have sporophyte dominated life cycles
- Seed plants also have **highly reduced gametophyte stage**
- Gametophytes of seedless vascular plants are visible to the eye whereas gametophytes of seed plants are **mostly microscopic**

Advantages of reduced gametophyte stage

Tiny gametophytes develop within the wall of spores and are retained within moist reproductive tissue of parent sporophyte

- **Protects the delicate female gametophyte** from UV and other environmental stresses
- Enables the dependant gametophyte to **obtain nutrients** from the sporophyte

	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			

▲ **Figure 30.2 Gametophyte–sporophyte relationships in different plant groups.**

MAKE CONNECTIONS *In seed plants, how does retaining the gametophyte within the sporophyte probably affect embryo fitness? (See Concepts 17.5, 23.1, and 23.4 to review mutagens, mutations, and fitness.)*

Heterospory

- Nearly all seedless plants are homosporous, all seed plants are **heterosporous** (produce two types of spores)
  - **Megasporangia** produces megaspores that give rise to <u>female gametophytes</u>
  - **Microsporangia** procures microspores that give rise to <u>male gametophytes</u>

Pollen

- Microspores **develop into pollen grains** which contain the male gametophytes enclosed within a pollen wall
- The pollen wall is tough, contains the polymer **sporopollenin** which protects the pollen grain
- **Pollination:** the transfer of pollen to the ovules, pollen can be transferred by wind, water or animals

Gymnosperms

Living seed plants can be divided into two groups: **gymnosperms** and **angiosperms**

- Gymnosperms appear early in the fossil record and dominated the Mesozoic terrestrial ecosystems
- Gymnosperms were **better suited** than nonvascular plants to drier conditions
- Today, cone-bearing gymnosperms called **conifers** dominate in the northern latitudes

Gymnosperms

The gymnosperms have "naked" seeds not enclosed by ovaries and 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 30.8**

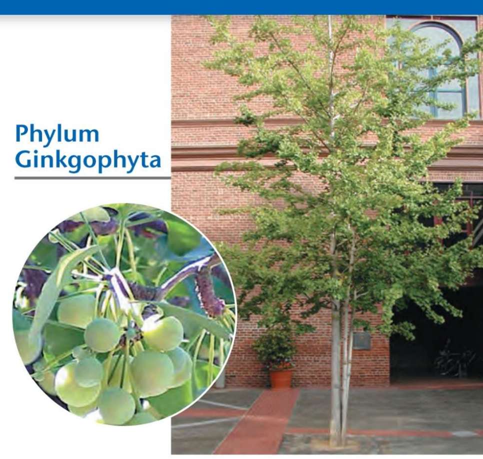
Exploring Gymnosperm Diversity

Phylum Cycadophyta

The 300 species of living cycads have large cones and palmlike leaves (true palm species are angiosperms). Unlike most seed plants, cycads have flagellated sperm, indicating their descent from seedless vascular plants that had motile sperm. Cycads thrived during the Mesozoic era, known as the age of cycads as well as the age of dinosaurs. Today, cycads are the most endangered of all plant groups: 75% of their species are threatened by habitat destruction and other human actions.

Cycas revoluta

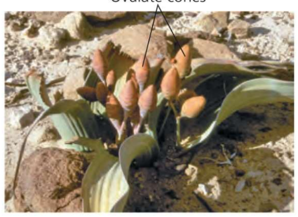
Phylum Ginkgophyta



Ginkgo biloba is the only surviving species of this phylum; like cycads, ginkos have flagellated sperm. Also known as the maidenhair tree, Ginkgo biloba has deciduous fanlike leaves that turn gold in autumn. It is a popular ornamental tree in cities because it tolerates air pollution well. Landscapers often plant only pollen-producing trees because the fleshy seeds smell rancid as they decay.

Phylum Gnetophyta

Phylum Gnetophyta includes plants in three genera: Gnetum, Ephedra, and Welwitschia. Some species are tropical, whereas others live in deserts. Although very different in appearance, the genera are grouped together based on molecular data.



▶ ***Welwitschia.*** This genus consists of one species, *Welwitschia mirabilis*, a plant that can live for thousands of years and is found only in the deserts of southwestern Africa. Its straplike leaves are among the largest leaves known.

◀ ***Gnetum.*** This genus includes about 35 species of tropical trees, shrubs, and vines, mainly native to Africa and Asia. Their leaves look similar to those of flowering plants, and their seeds look somewhat like fruits.

Phylum Coniferophyta

Phylum Coniferophyta, the largest gymnosperm phyla, consists of about 600 species (from the Latin *conus*, cone, and *ferre*, to carry), including many large trees. Below and over the page are examples of four families of conifers inhabiting Australia and New Zealand: Podocarpaceae; Araucariaceae; Cupressaceae and Taxodiaceae. Also included is an example of the tallest tree on Earth—the giant sequoia that inhabits high mountain areas in the eastern United States. Most conifers are evergreens; they retain their leaves throughout the year.

◀ **Queensland and New Zealand kauri.** *Agathis robusta* occurs in two localities: southern Queensland centred around Maryborough and Fraser Island, and the Atherton Tablelands west of Cairns. *Agathis australis* grows above the 38th parallel on New Zealand's North Island. For both species, remnant populations exist where the human-wrought menaces like frequent fires and logging were slow to penetrate. Mature trees of both species can reach between 650 and 1,000 years of age. Queensland Kauri reach heights of up to 35 m, while their New Zealand counter-parts can reach heights of up to 50 m.

Phylum Coniferophyta

- This phylum is by far the **largest** of the gymnosperm phyla
- Most conifers are **evergreens** and can carry out photosynthesis year round
- Slow growing, live very long lives, use nutrients sparingly and are **very well adapted** to heat and cold extremes
- Terrestrial conifer forests of the northern hemisphere are massive **carbon sinks**

Pine Tree Life Cycle

Three key features of the gymnosperm life cycle are:

- Dominance of the **sporophyte generation**
- **Development of seeds** from fertilised ovules
- The transfer of sperm to ovules by **pollen**

The life cycle of a pine provides an example

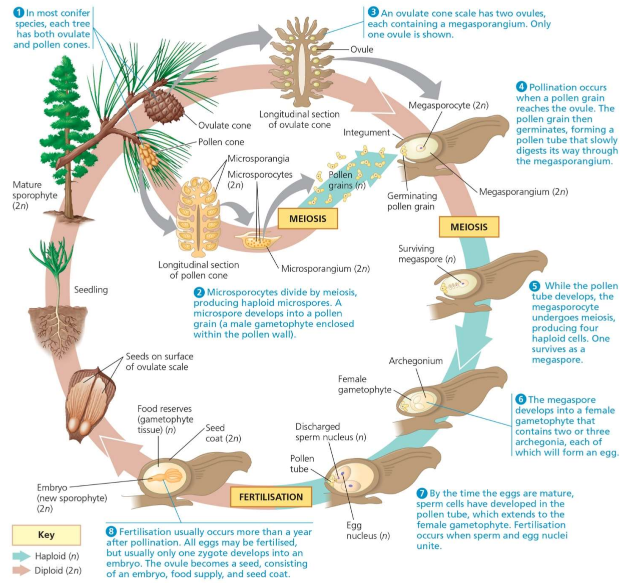
The life cycle of a pine: a closer look

Small cones produce **microspores** (pollen grains)

Each pollen grain contains a male gametophyte (n)

The familiar larger cones contain ovules, which produce **megaspores** that develop into female gametophytes (n)

It takes **nearly 3 years** from cone production to mature seed



▲ **Figure 30.5** **The life cycle of a pine.**

MAKE CONNECTIONS *What type of cell division occurs as a megaspore develops into a female gametophyte? (See Figure 13.10.)*

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Angiosperms – Flowering plants

- Angiosperms are seed plants with reproductive structures
  - **flowers and fruits**
- They are the most widespread and diverse of all plants
- The flower is specialized for sexual reproduction
- Reproductive cycle is characterized by the 3 F's:
  - **flowers, fruits and double fertilization**
- Many species are pollinated by insects or animals, while some species are wind-pollinated

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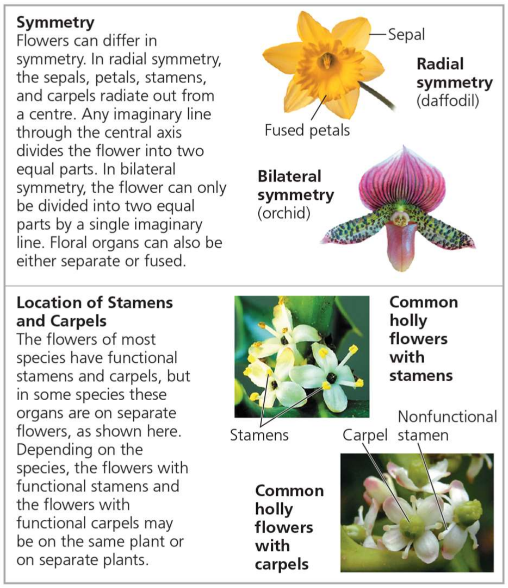
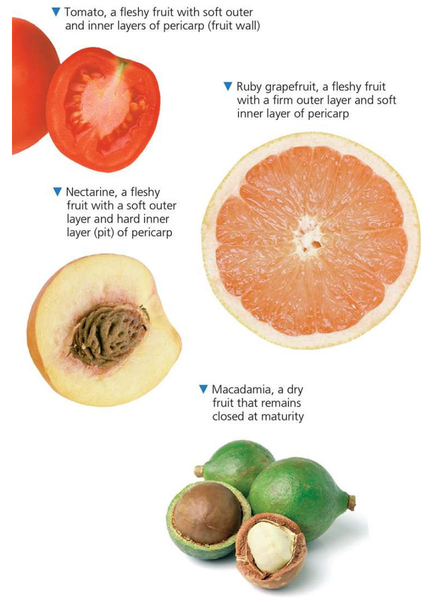


▲ **Figure 30.10** Some variations in flower structure.



▲ **Figure 30.11** Some variations in fruit structure.

Angiosperms – flowering plants

The two main groups of angiosperms are:

- **Monocots** (one cotyledon or "seed leaf")
- **Eudicots** (two cotyledons or "seed leaves")

The majority of angiosperm diversity in Australia remains restricted to a few families and species rich genera

- Two genera dominate in over 75% of Australia:
- *Eucalyptus* and *Acacia*
- This dominance occurs mainly in response to rainfall

Monocots

About one-quarter of angiosperm species are monocots—about 70,000 species. Some of the largest groups are the orchids, grasses, and palms. Grasses include some of the most important crops, such as corn, rice, and wheat.

◀ Orchid (*Lemboglossum rossii*)

Pygmy date palm (*Phoenix roebelenii*) ▶

▲ Barley (*Hordeum vulgare*), a grass

Eudicots

More than two-thirds of angiosperm species are eudicots—roughly 170,000 species. The largest group is the legume family, which includes such crops as peas and beans. Also important economically is the rose family, which includes many plants with ornamental flowers as well as some species with edible fruits, such as strawberry plants and apple and pear trees. Most of the familiar flowering trees are eudicots, such as eucalypts, acacia, figs, grasses, and southern beech.

◀ Snow pea (*Pisum sativum*), a legume

Apple (*Malus domestica*) ▶

Make a table with the headings of the four groups of land plants in order of evolution and fill in for each group.

Plant group				
Dominant generation				
Vascular tissue (present/absent)				
Seeds (present/absent)				
Method of fertilisation (how does the sperm get to the egg?)				
Example organisms				

Quick Question

1) Which of the following correctly illustrates the sequence of the origin of modern groups of plants?

A) gymnosperms, ferns, bryophytes, angiosperms

B) bryophytes, ferns, gymnosperms, angiosperms

C) bryophytes, ferns, angiosperms, gymnosperms

D) ferns, gymnosperms, angiosperms, bryophytes

Quick Question

2) _________ were the first plants that did not require water for transferring sperm to eggs.

A) Bryophytes

B) Gymnosperms

C) Ferns

D) Angiosperms

Quick Question

3) Gymnosperms and angiosperms share multiple similarities. Which of the following is NOT a shared feature of angiosperms and gymnosperms?

A) Both produce flowers.

B) Both have pollen grains that are male gametophytes.

C) Both have a dominant sporophyte generation.

D) Both have seeds.