LECTURE PRESENTATIONS
For CAMPBELL BIOLOGY, NINTH EDITION
Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

Chapter 29

GiỚI THIỆU NGUỒN GỐC VÀ SỰ ĐA DẠNG CỦA THỰC VẬT

Lectures by
Erin Barley
Kathleen Fitzpatrick

Overview: Màu xanh của trái đất

- For more than the first 3 billion years of Earth's history, the terrestrial surface was lifeless
- Cyanobacteria likely existed on land 1.2 billion years ago
- **Around 500 million years ago, <u>small plants</u>, fungi, and animals emerged on land**

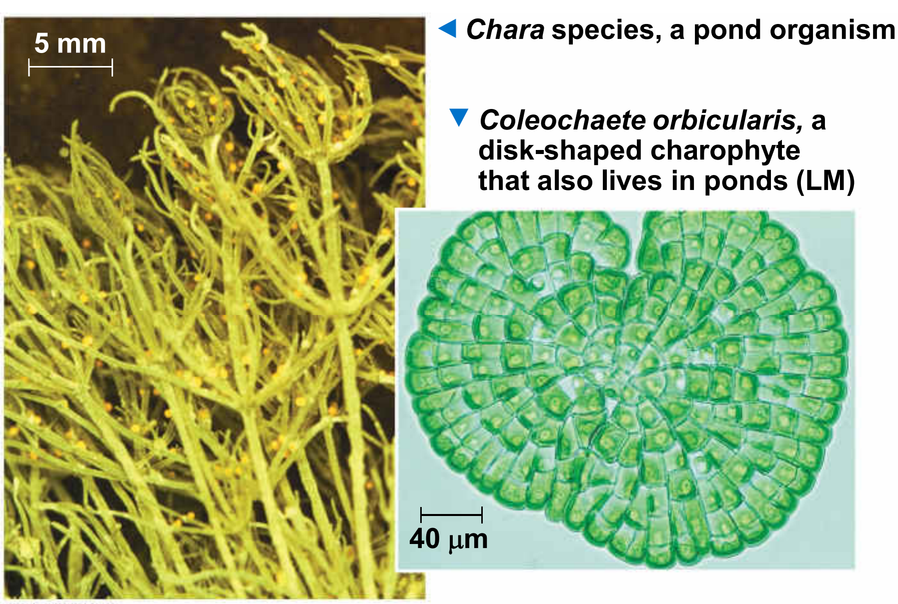
- Since colonizing land, plants have diversified into roughly **290,000 living species**
- Land plants are defined as having terrestrial ancestors, even though some are now aquatic
- Land plants do not include photosynthetic protists (algae)
- Plants supply oxygen and are the ultimate source of most food eaten by land animals

Figure 29.1

Tổ tiên của thực vật trên cạn là Tảo

- Green algae called charophytes are the closest relatives of land plants

Figure 29.3

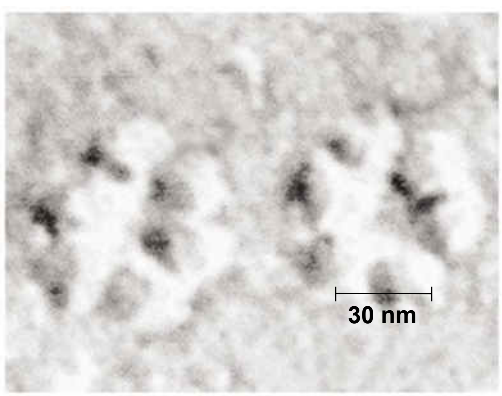


Morphological and Molecular Evidence

- Many characteristics of land plants also appear in a variety of algal clades, mainly algae
- However, land plants share four key traits with only charophytes
  - Rings of cellulose-synthesizing complexes
  - Peroxisome enzymes
  - Structure of flagellated sperm (tinh trùng hình roi)
  - Formation of a **phragmoplast (**vách hạt)
  - Comparisons of both nuclear and chloroplast genes point to charophytes as the closest living relatives of land plants

Figure 29.2

Rings of cellulose-synthesizing proteins.



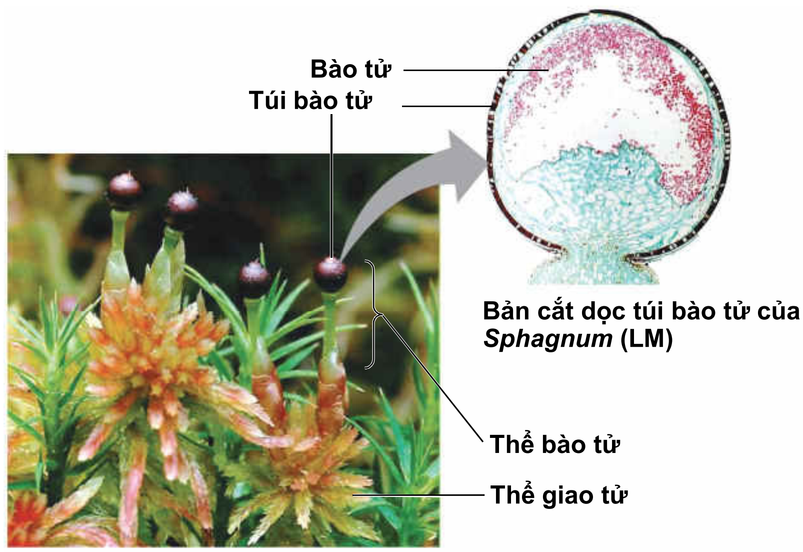
Sự thích nghi bảo đảm cho sự chuyển lên cạn

- In charophytes a layer of a durable polymer called **sporopollenin** prevents exposed zygotes from drying out. Sporopollenin is also found in plant spore walls
- The movement onto land by charophyte ancestors provided unfiltered sun, more plentiful CO_2, nutrient-rich soil, and few herbivores or pathogens
- Land presented challenges: a scarcity of water and lack of structural support

Đặc điểm phát sinh của thực vật

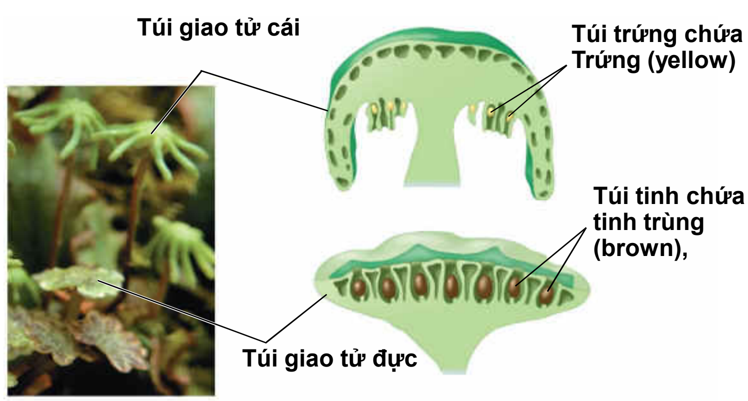
- Four key traits appear in nearly all land plants but are absent in the charophytes
  – Sự xen kẽ thế hệ
  – Bào tử có vách dày trong túi bào tư
  – Túi giao tử đa bào
  – Mô phân sinh ngọn

Figure 29.5c



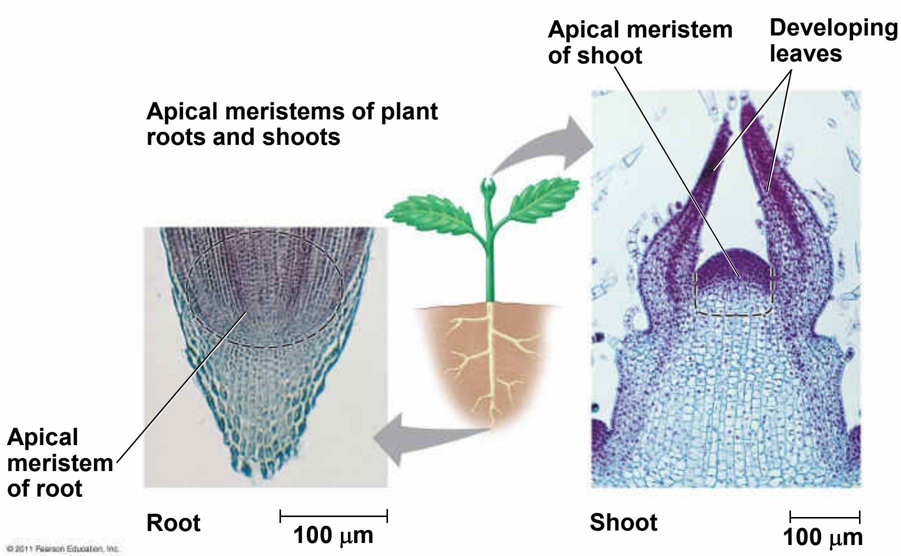
Bào tử có vách dày trong túi bào tử của *Sphagnum* (a moss)

Figure 29.5d



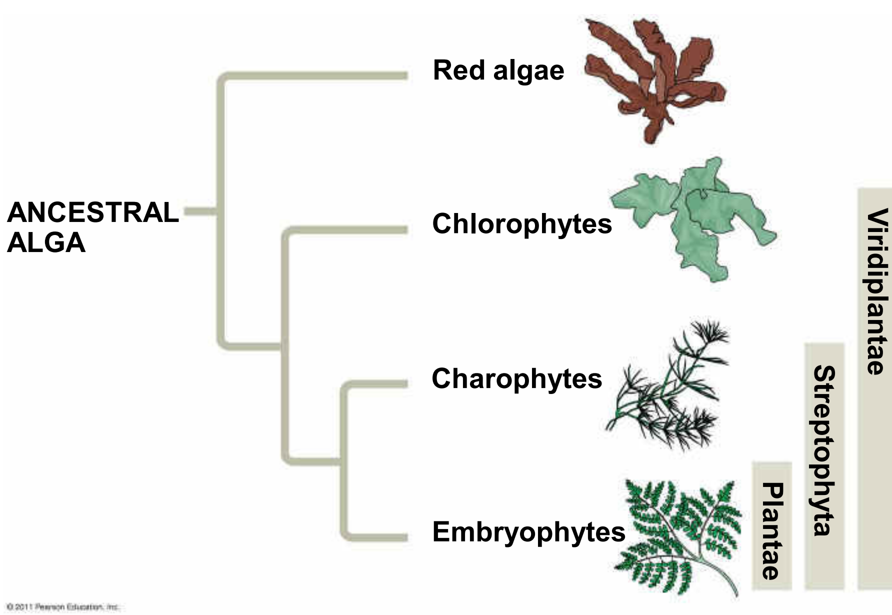
Túi giao tử đa bào của *Marchantia* (a liverwort)

Figure 29.5e



Mô phân sinh ngọn của chồi và rễ

Figure 29.4



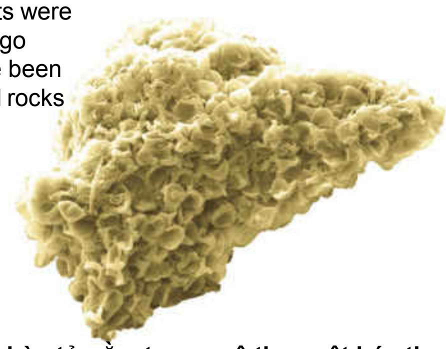
- Additional derived traits include
  - **Cuticle**, a waxy covering of the epidermis
  - Mycorrhizae, symbiotic associations between fungi and land plants that may have helped plants without true roots to obtain nutrients
  - Secondary compounds that deter herbivores and parasites

Figure 29.6

(a) Bào tử thực vật hóa thạch

Fossil evidence indicates that plants were on land at least 475 million years ago Fossilized spores and tissues have been extracted from 475-million-year-old rocks

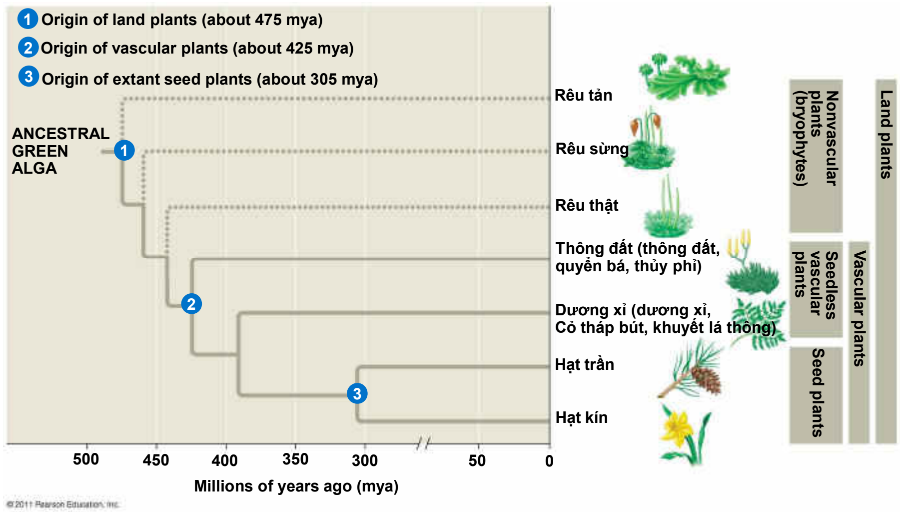
(b)



Các bào tử nằm trong mô thực vật hóa thạch

Figure 29.7

Those ancestral species gave rise to a vast diversity of modern plants



Sự tiến hóa của thực vật có hạt

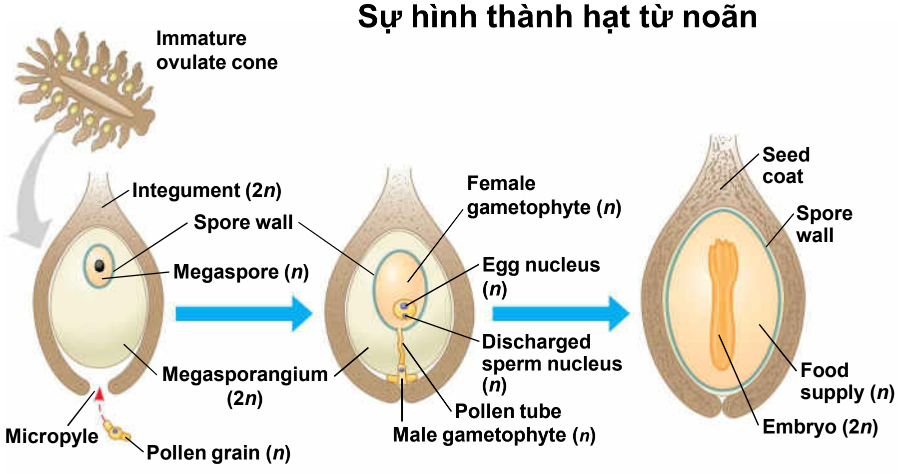
- A seed consists of an embryo and nutrients surrounded by a protective coat

5 đặc điểm tiến hóa của thực vật có hạt

- ***Thể giao tử tiêu giảm***: thể giao tử đực và cái (n) được thể bào tử (2n) nuôi dưỡng và bảo vệ
- ***Bào tử khác loại:*** tiểu bào tử sinh giao tử đực, đại bào tử sinh giao tử cái
- ***Noãn:*** toàn bộ cấu trúc bao gồm túi đại bào tử (2n),đại bào tử (n), và 1 lớp mô của thể bào tử bao bọc
- ***Hạt phấn không cần nước để thụ tinh***
- ***Sự hình thành hạt:*** sức sống tốt hơn bào tử, có thể di chuyển đi xa

Figure 30.3-3

Sự hình thành hạt từ noãn



(a) Unfertilized ovule (b) Fertilized ovule (c) Gymnosperm seed

Figure 30.5a

Cycas revoluta

Ngành Cycadophyta (Tuế)

Figure 30.5b

Ngành Ginkgophyta (Bạch Qủa)

***Ginkgo biloba* leaves and fleshy seeds**

***Ginkgo biloba* pollen-producing tree**

Figure 30.5d

Ngành Gnetophyta (Dây gắm)

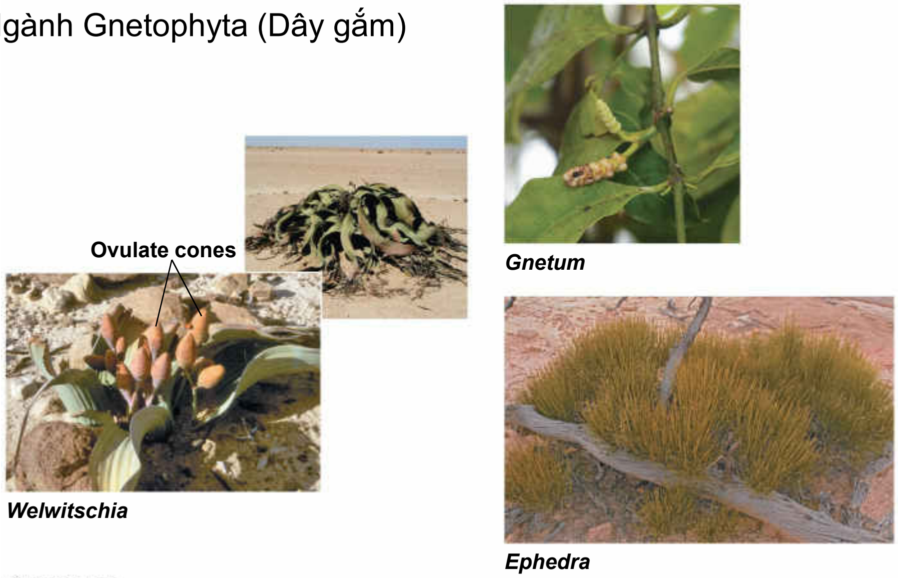
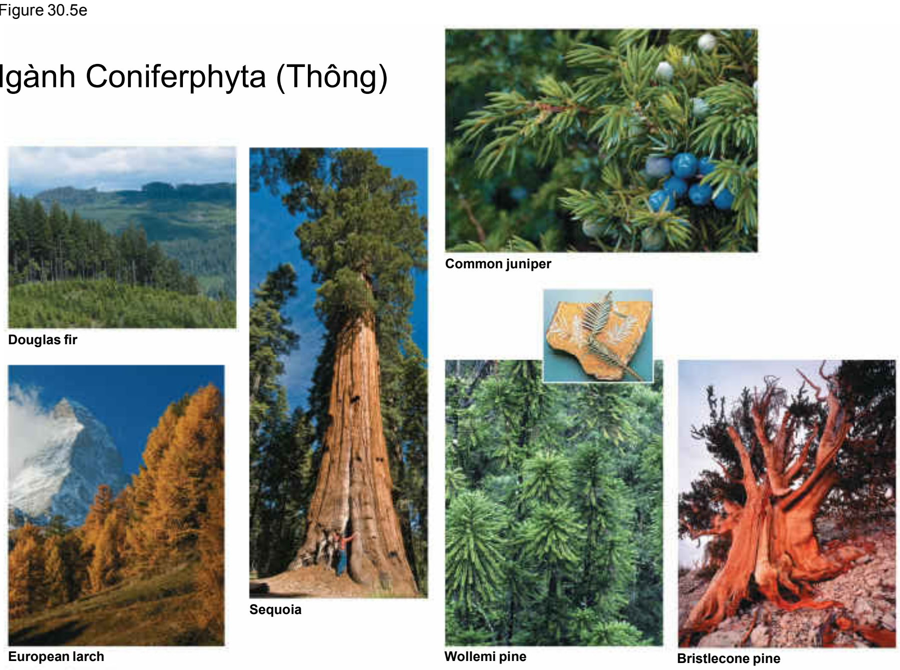


Figure 30.5e

Ngành Coniferphyta (Thông)



Đặc điểm của thực vật hạt kín

- Là thực vật có hạt với cơ quan sinh sản là hoa và quả
- Là loài chiếm số lượng đông nhất

Table 29. 1

Table 29.1 Ten Phyla of Extant Plants

	Common Name	Number of Known Species
Nonvascular Plants (Bryophytes)		
Phylum Hepatophyta	Liverworts	9,000
Phylum Bryophyta	Mosses	15,000
Phylum Anthocerophyta	Hornworts	100
Vascular Plants		
Seedless Vascular Plants		
Phylum Lycophyta	Lycophytes	1,200
Phylum Pterophyta	Pterophytes	12,000
Seed Plants		
Gymnosperms		
Phylum Ginkgophyta	Ginkgo	1
Phylum Cycadophyta	Cycads	130
Phylum Gnetophyta	Gnetophytes	75
Phylum Coniferophyta	Conifers	600
Angiosperms		
Phylum Anthophyta	Flowering plants	250,000

HOA

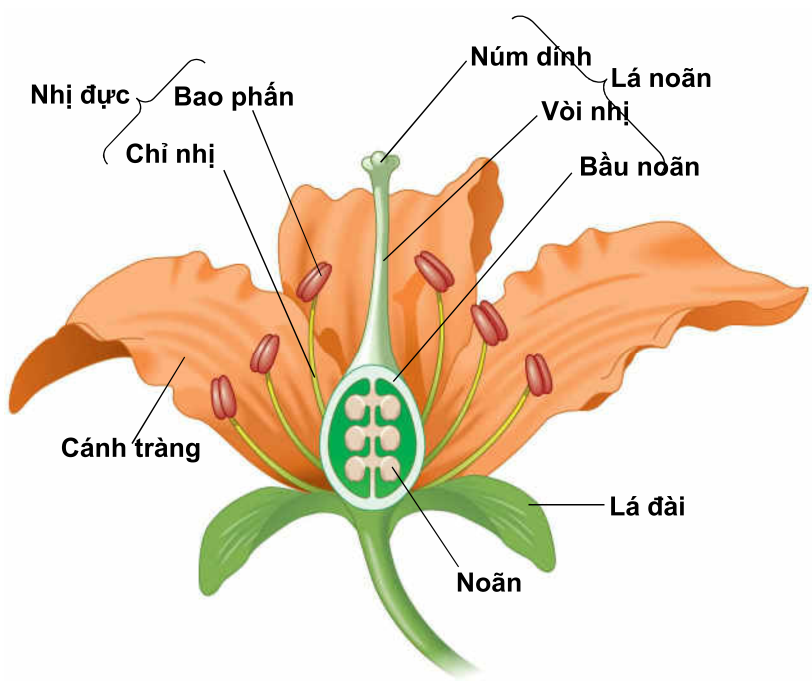
- HOA là 1 cơ quan của thực vật hạt kín chuyên hóa cho sự sinh sản hữu tính
- Ở nhiều loài, hoa được thụ phấn nhờ côn trùng hay những động vật khác, một số ít nhờ gió (loài có quần thể dày như cỏ, lúa, cây gỗ rừng ôn đới)

- HOA còn được xem là 1 chồi chuyên hóa có 4 vòng lá có hình thái thay đổi khác nhau:
  - **Sepals (lá đài)**, bao lấy hoa trước khi hoa nở
  - **Petals (cánh hoa/ cánh tràng)**, có màu sặc sở, giúp thu hút con vật thụ phấn
  - **Stamens (nhị đực)**, sinh hạt phấn chứa thể giao tử đực
  - **Carpels (lá noãn)**, sinh ra trứng hay thể giao tử cái

- 1 nhị đực gồm 1 cuống gọi là "**chỉ** nhị", và 1 túi tận cùng gọi là "**bao phấn**", nơi sinh ra hạt phấn
- 1 lá noãn gồm 1 **bầu noãn** ở đáy của lá noãn, 1 **vòi nhị** nối bầu noãn với **núm** dính thu nhận hạt phấn ở đầu lá noãn

PLAY Video: Flower Blooming (time lapse)

Figure 30.7



QUẢ

- QỦA gồm **1 bầu noãn đã chín** nhưng cũng có thể gồm những phần khác của hoa
- QuẢ bảo vệ hạt và giúp phát tán hạt

PLAY Animation: Fruit Development

Figure 30.8

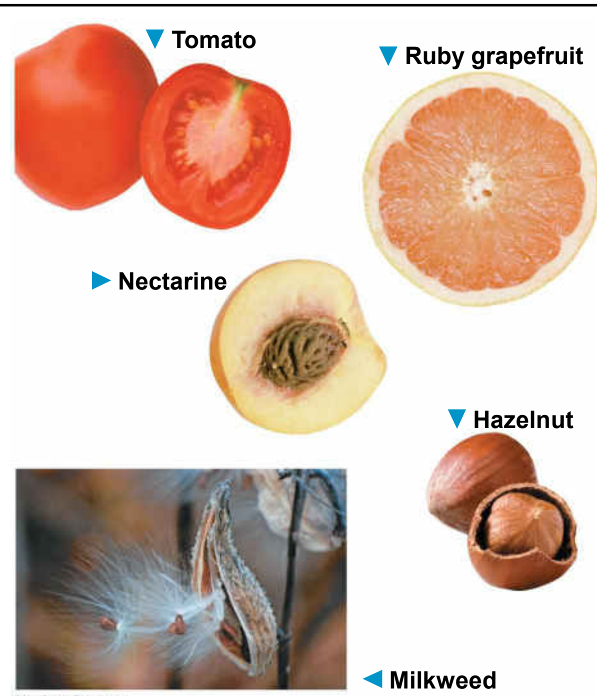


Figure 30.9

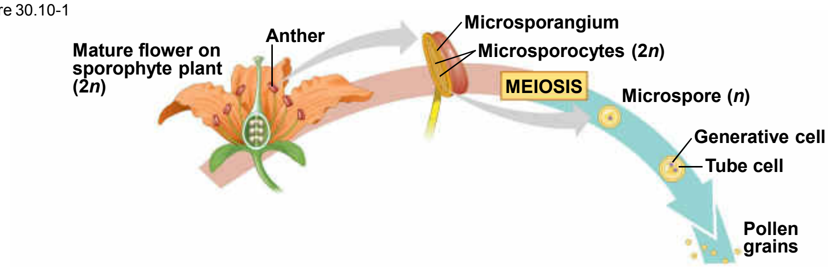
▶ Quả có cánh dễ dàng cho gió mang đi

◀ Hạt bên trong quả ăn được sẽ dc phát tán theo phân động vật

Sự thích nghi của quả làm tăng phát tán hạt

◀ Quả phát tán hạt bằng cách "qua giang" theo đv

Figure 30.10-1



Key
Haploid (*n*)
Diploid (2*n*)

Figure 30.10-2

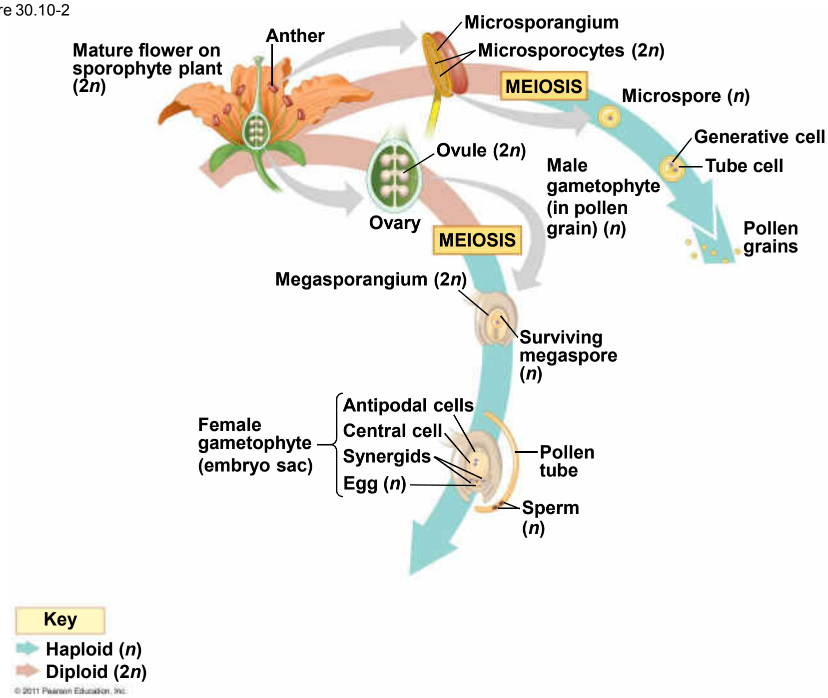


Figure 30.10-3

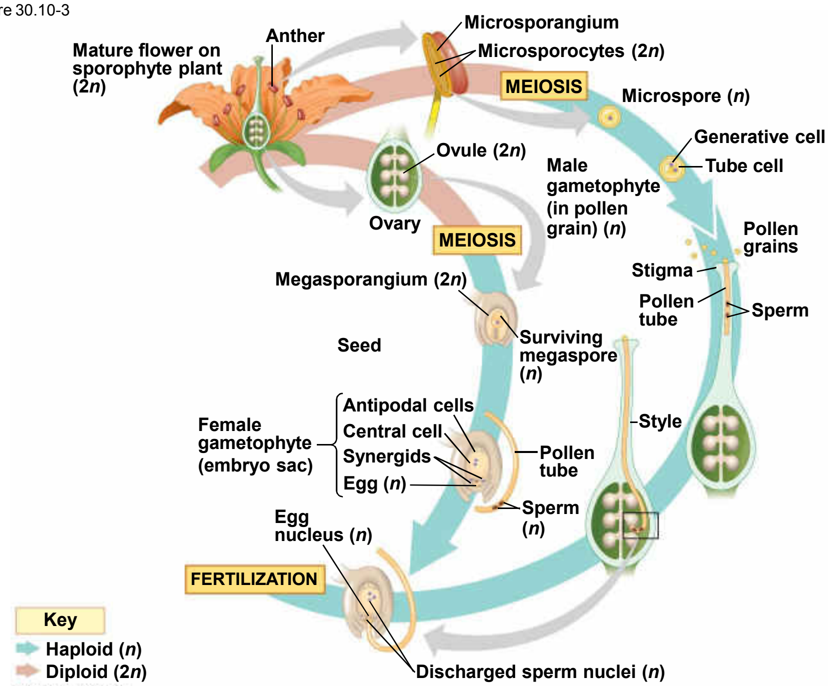
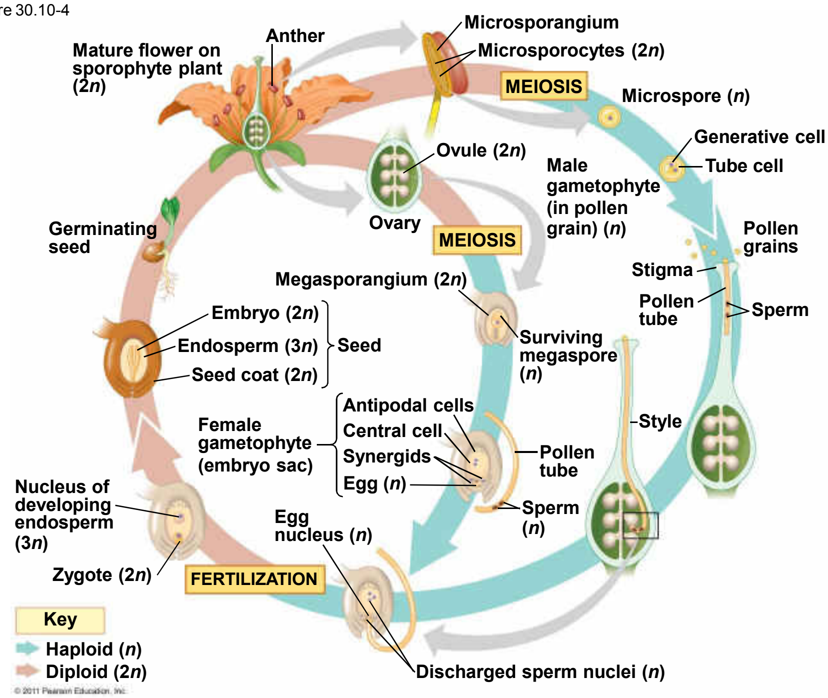


Figure 30.10-4



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

Figure 30.13e

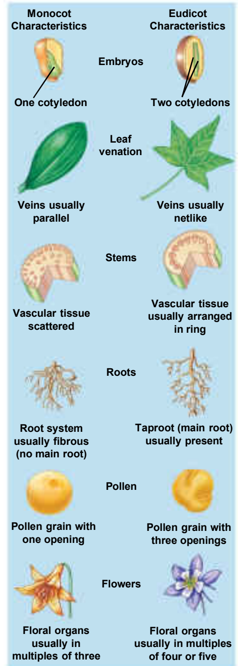


Figure 30.13ea

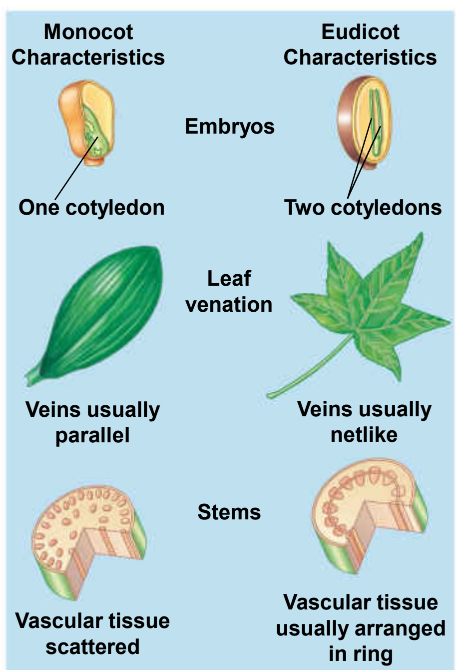
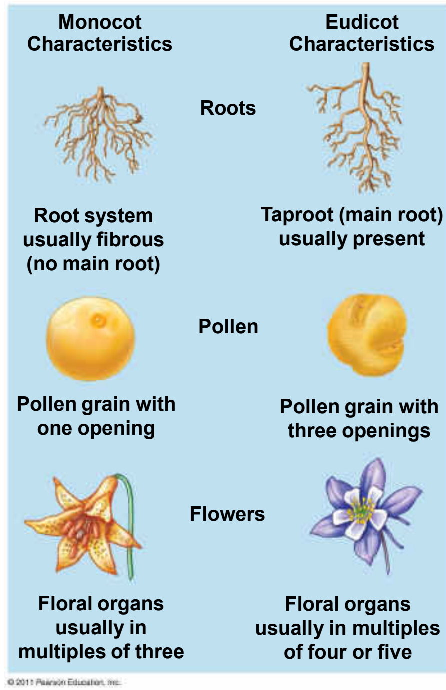


Figure 30.13eb



Evolutionary Links Between Angiosperms and Animals

- Animals influence the evolution of plants and vice versa
  - For example, animal herbivory selects for plant defenses
  - For example, interactions between pollinators and flowering plants select for mutually beneficial adaptations

PLAY Video: Bat Pollinating Agave Plant

PLAY Video: Bee Pollinating

TẦM QUAN TRỌNG CỦA THỰC VẬT TRONG ĐỜI SỐNG CON NGƯỜI

Figure 29.11

Sphagnum-rêu bùn: 1 loại rêu có ý nghĩa kinh tế, sinh thái và khảo cổ học

(a) Rêu bùn phân bố tạo nên lớp lắng đọng kéo dài của từng phần chất hưu cơ phân hủy gọi là than bùn (nguồn chất đốt ở Châu Âu, Châu A, hiện Vẫn còn khai thác)

(b) "Tollund Man," xác ướp vùng đầm lầy Có tuổi từ 405-100 năm trước CN, nhờ Điều kiện acid, thiếu oxy mà rêu bùn Tạo ra

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

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

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Chapter 35

Plant Structure, Growth, and Development

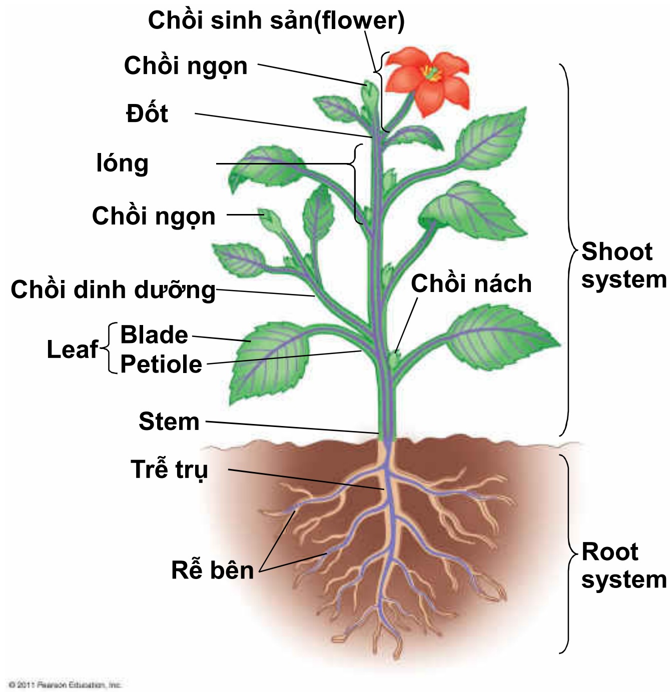
Lectures by
Erin Barley
Kathleen Fitzpatrick

The Three Basic Plant Organs: Roots, Stems, and Leaves

- Basic morphology of vascular plants reflects their evolution as organisms that draw nutrients from below ground and above ground
- Plants take up water and minerals from below ground
- Plants take up CO_2 and light from above ground

- Three basic organs evolved: roots, stems, and leaves
- They are organized into a **root system** and a **shoot system**

Figure 35.2



- Roots rely on sugar produced by photosynthesis in the shoot system, and shoots rely on water and minerals absorbed by the root system

Roots

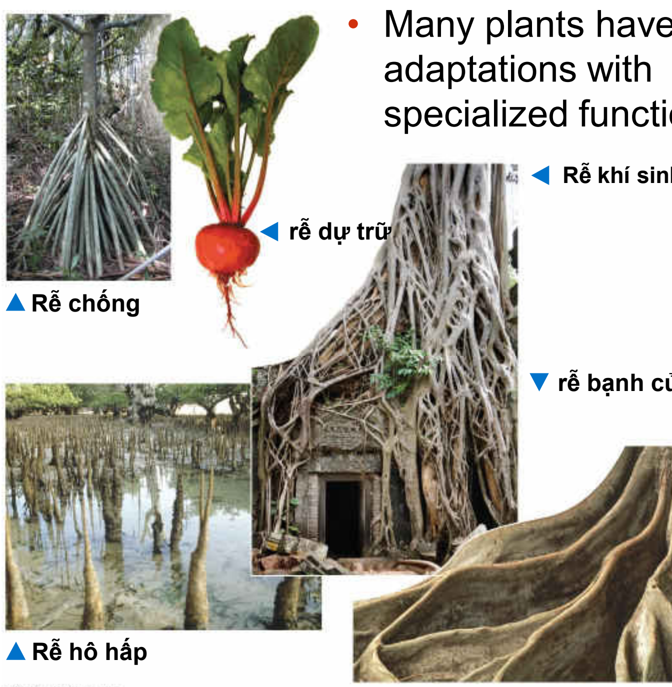
- A **root** is an organ with important functions:
  - – Anchoring the plant
  - – Absorbing minerals and water
  - – Storing carbohydrates

- Most eudicots and gymnosperms have a taproot system, which consists of:
  - A **taproot**, the main vertical root
  - **Lateral roots**, or branch roots, that arise from the taproot
- Most monocots have a fibrous root system, which consists of:
  - Adventitious roots that arise from stems or leaves
  - Lateral roots that arise from the adventitious roots

- In most plants, absorption of water and minerals occurs near the **root hairs**, where vast numbers of tiny root hairs increase the surface area

Figure 35.4

- Many plants have root adaptations with specialized functions



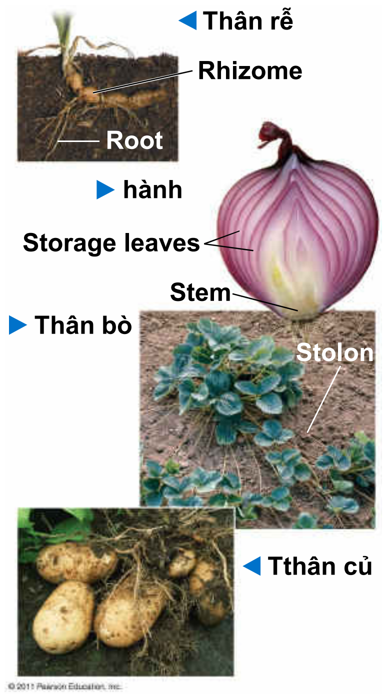
Stems

- A **stem** is an organ consisting of
  - An alternating system of **nodes**, the points at which leaves are attached
  - **Internodes**, the stem segments between nodes

- An **axillary bud** is a structure that has the potential to form a lateral shoot, or branch
- An **apical bud**, or terminal bud, is located near the shoot tip and causes elongation of a young shoot
- **Apical dominance** helps to maintain dormancy in most axillary buds

Figure 35.5

- Many plants have modified stems (e.g., rhizomes, bulbs, stolons, tubers)



Leaves

- The **leaf** is the main photosynthetic organ of most vascular plants
- Leaves generally consist of a flattened **blade** and a stalk called the **petiole**, which joins the leaf to a node of the stem

- Monocots and eudicots differ in the arrangement of **veins**, the vascular tissue of leaves
  - Most monocots have parallel veins
  - Most eudicots have branching veins
- In classifying angiosperms, taxonomists may use leaf morphology as a criterion

Figure 35.6

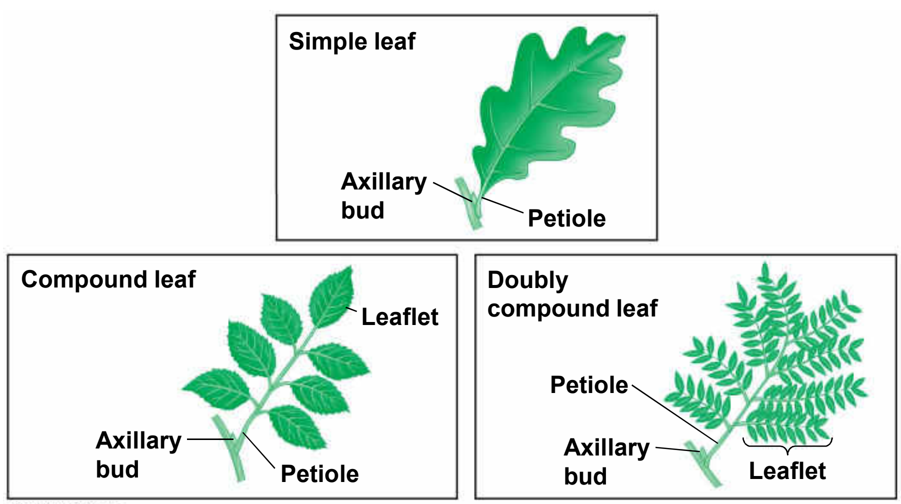


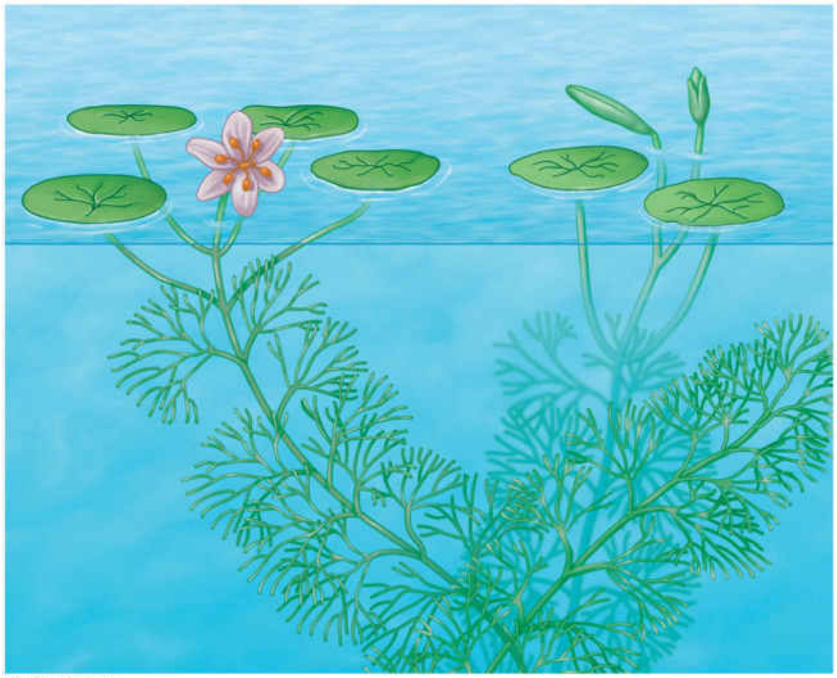
Figure 35.7

- Some plant species have evolved modified leaves that serve various functions

Concept 35.5: Growth, morphogenesis, and cell differentiation produce the plant body

- Cells form specialized tissues, organs, and organisms through the process of **development**
- Developmental plasticity describes the effect of environment on development
  – For example, the aquatic plant fanwort forms different leaves depending on whether or not the apical meristem is submerged

Figure 35.24



- Development consists of growth, morphogenesis, and cell differentiation
- **Growth** is an irreversible increase in size
- **Morphogenesis** is the development of body form and organization
- **Cell differentiation** is the process by which cells with the same genes become different from each other

Growth: Cell Division and Cell Expansion

- By increasing cell number, cell division in meristems increases the potential for growth
- Cell expansion accounts for the actual increase in plant size

Gene Expression and Control of Cell Differentiation

- Cells of a developing organism synthesize different proteins and diverge in structure and function even though they have a common genome
- Cellular differentiation depends on gene expression, but is determined by position
- Positional information is communicated through cell interactions

- Gene activation or inactivation depends on cell-to-cell communication
  - For example, *Arabidopsis* root epidermis forms root hairs or hairless cells depending on the number of cortical cells it is touching

Figure 36.2-1

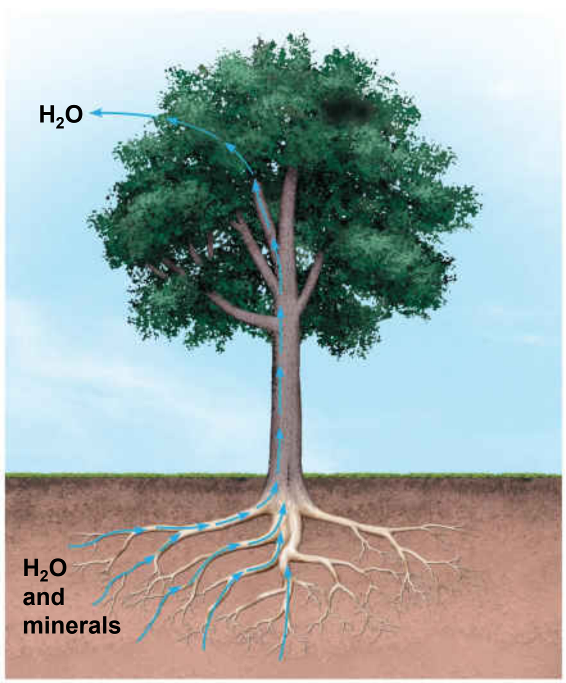


Figure 36.2-2

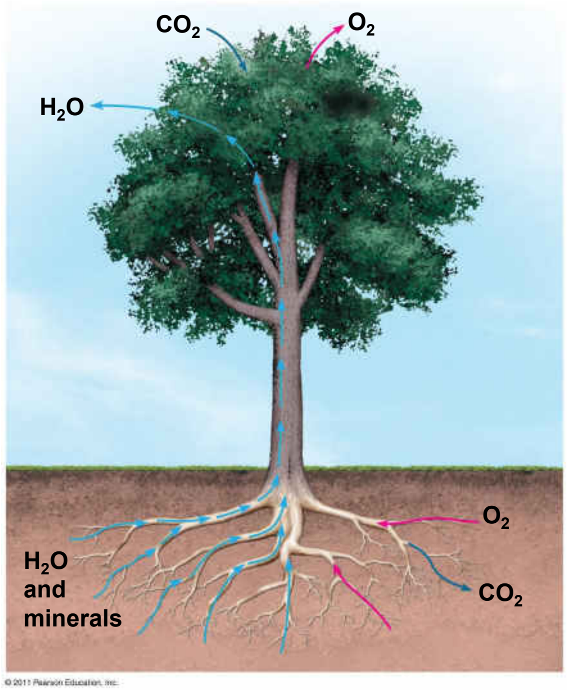
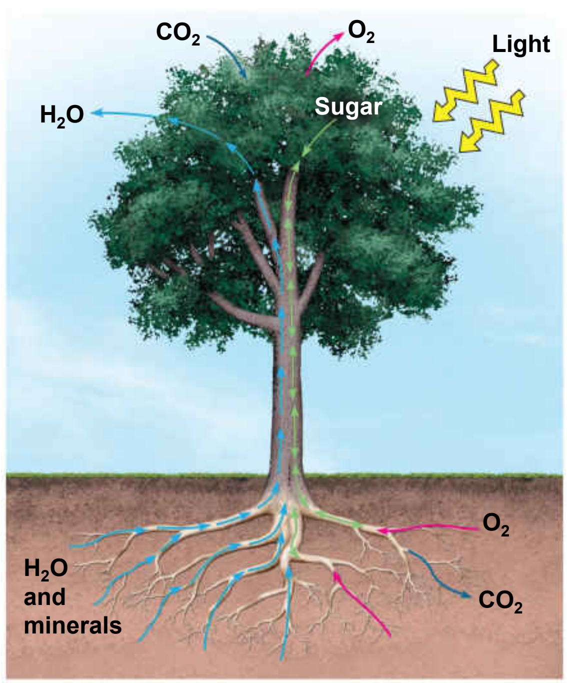


Figure 36.2-3

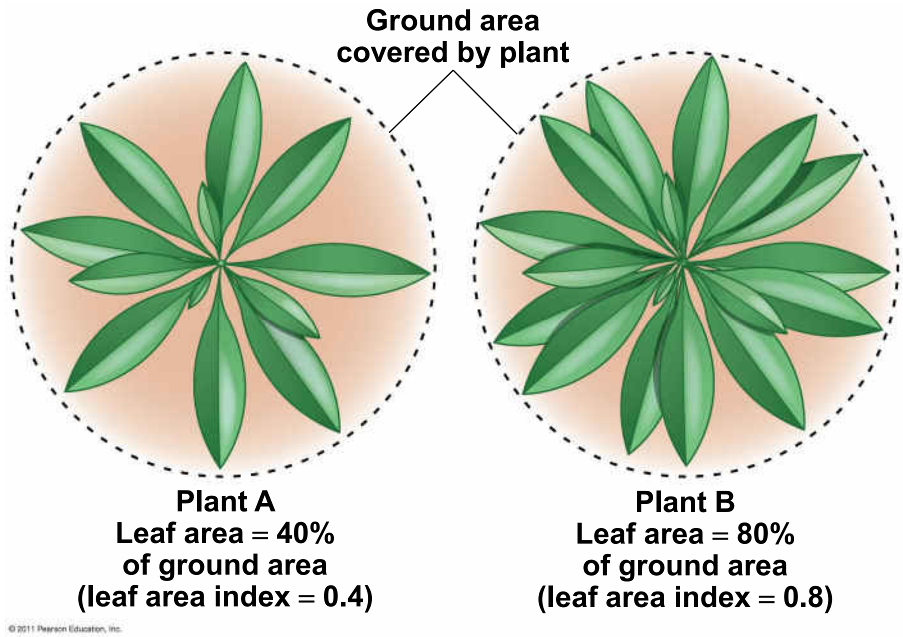


- Adaptations in each species represent compromises between enhancing photosynthesis and minimizing water loss

Shoot Architecture and Light Capture

- Stems serve as conduits for water and nutrients and as supporting structures for leaves
- There is generally a positive correlation between water availability and leaf size

Figure 36.4

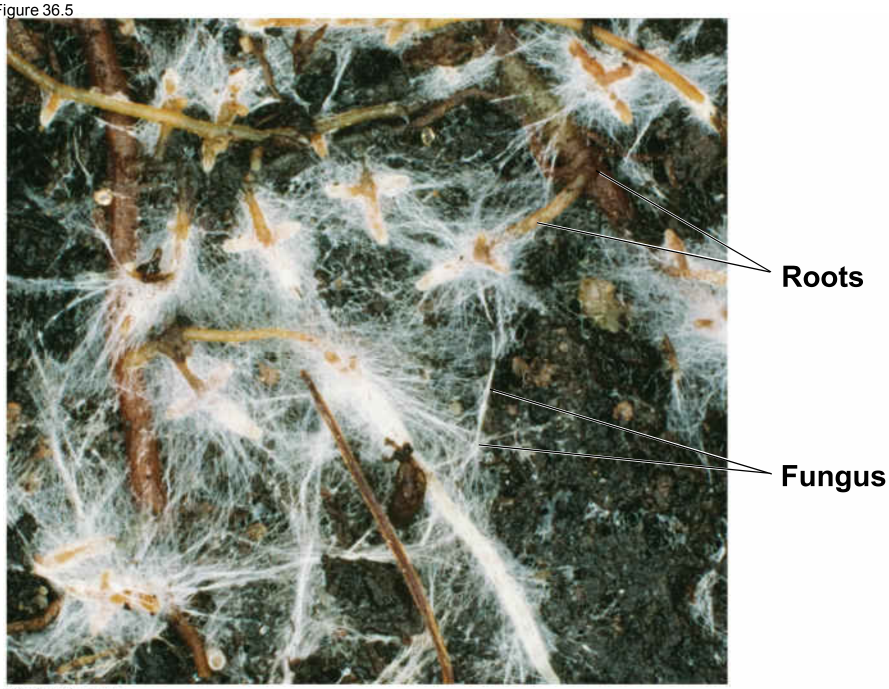


- Leaf orientation affects light absorption
- In low-light conditions, horizontal leaves capture more sunlight
- In sunny conditions, vertical leaves are less damaged by sun and allow light to reach lower leaves

- Shoot height and branching pattern also affect light capture
- There is a trade-off between growing tall and branching

- Roots and the hyphae of soil fungi form mutualistic associations called **mycorrhizae**
- Mutualisms with fungi helped plants colonize land
- Mycorrhizal fungi increase the surface area for absorbing water and minerals, especially phosphate

Figure 36.5

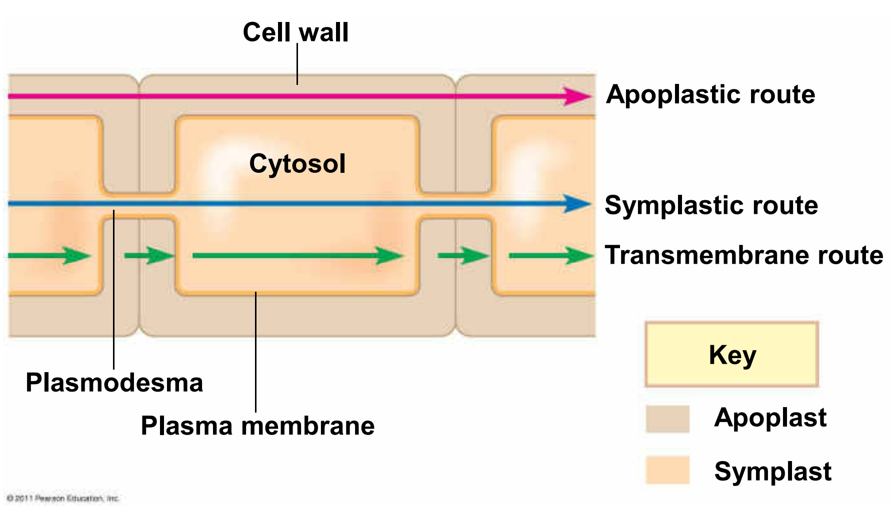


The Apoplast and Symplast: Transport Continuums

- The **apoplast** consists of everything external to the plasma membrane
- It includes cell walls, extracellular spaces, and the interior of vessel elements and tracheids
- The **symplast** consists of the cytosol of the living cells in a plant, as well as the plasmodesmata

- Three transport routes for water and solutes are
  - The apoplastic route, through cell walls and extracellular spaces
  - The symplastic route, through the cytosol
  - The transmembrane route, across cell walls

Figure 36.6



Short-Distance Transport of Solutes Across Plasma Membranes

- Plasma membrane permeability controls short-distance movement of substances
- Both active and passive transport occur in plants
- In plants, membrane potential is established through pumping H^+ by proton pumps
- In animals, membrane potential is established through pumping Na^+ by sodium-potassium pumps

Figure 36.7

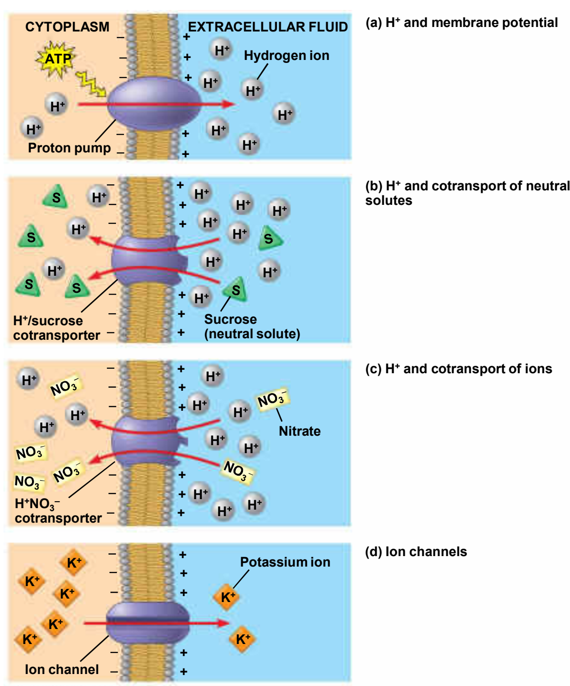
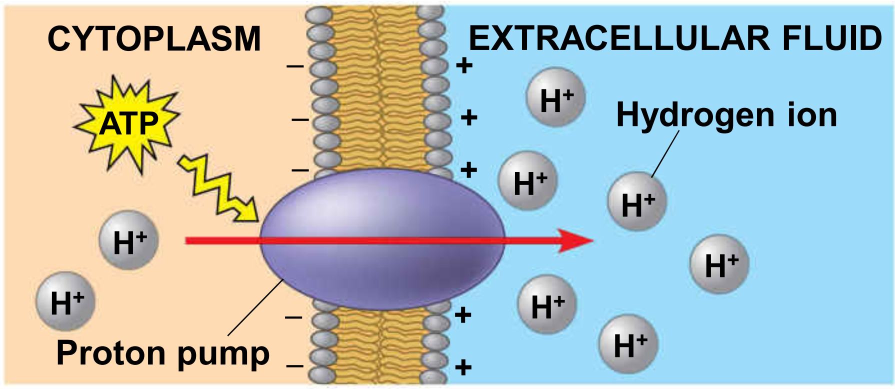


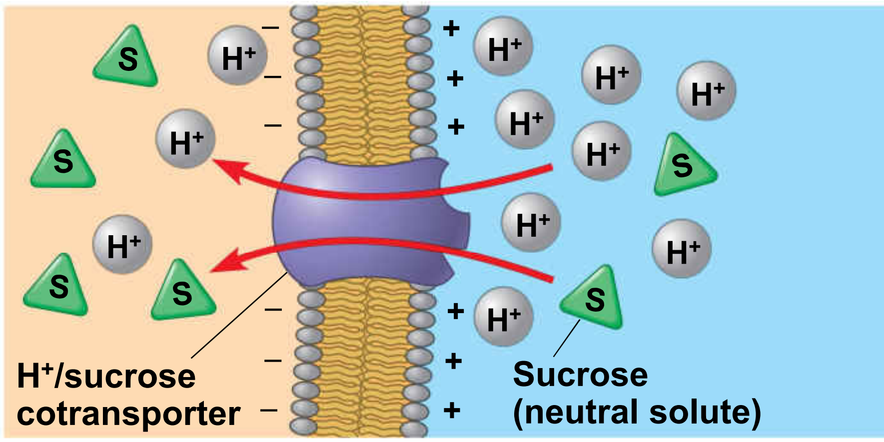
Figure 36.7a



(a) H+ and membrane potential

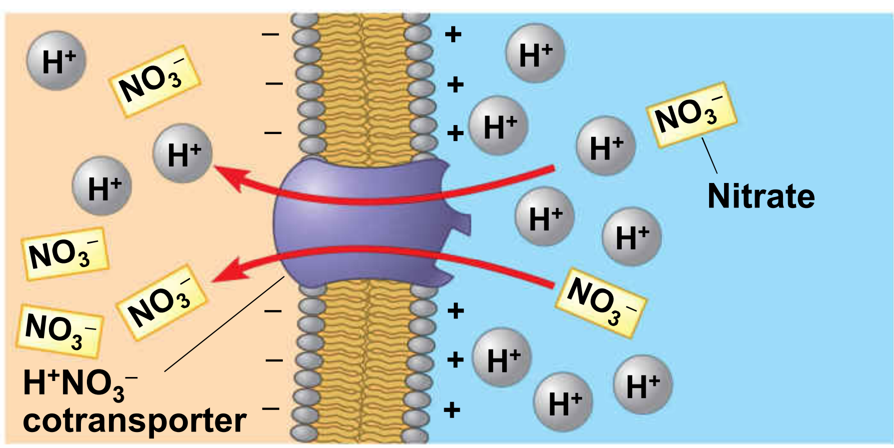
- Plant cells use the energy of H^+ gradients to cotransport other solutes by active transport

Figure 36.7b



(b) H+ and cotransport of neutral solutes

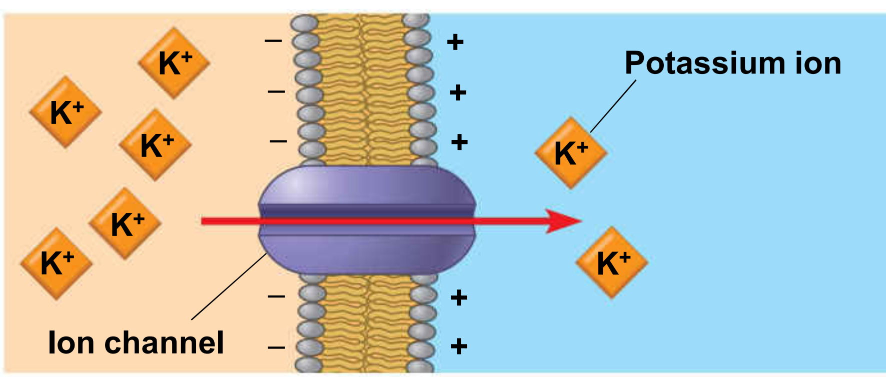
Figure 36.7c



(c) H+ and cotransport of ions

- Plant cell membranes have ion channels that allow only certain ions to pass

Figure 36.7d



(d) Ion channels

Short-Distance Transport of Water Across Plasma Membranes

- To survive, plants must balance water uptake and loss
- **Osmosis** determines the net uptake or water loss by a cell and is affected by solute concentration and pressure

Aquaporins: Facilitating Diffusion of Water

- **Aquaporins** are transport proteins in the cell membrane that allow the passage of water
- These affect the rate of water movement across the membrane

Long-Distance Transport: The Role of Bulk Flow

- Efficient long distance transport of fluid requires **bulk flow**, the movement of a fluid driven by pressure
- Water and solutes move together through tracheids and vessel elements of xylem, and sieve-tube elements of phloem
- Efficient movement is possible because mature tracheids and vessel elements have no cytoplasm, and sieve-tube elements have few organelles in their cytoplasm

Concept 36.4: The rate of transpiration is regulated by stomata

- Leaves generally have broad surface areas and high surface-to-volume ratios
- These characteristics increase photosynthesis and increase water loss through stomata
- Guard cells help balance water conservation with gas exchange for photosynthesis

Figure 36.14

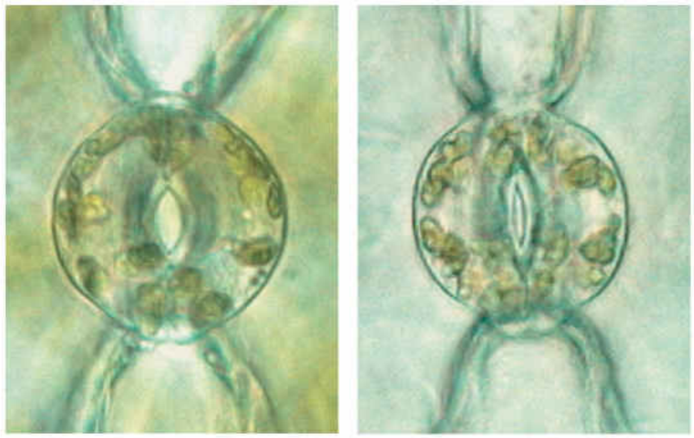


Figure 36.14a

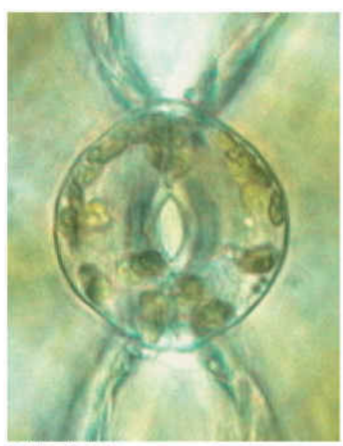


Figure 36.14b

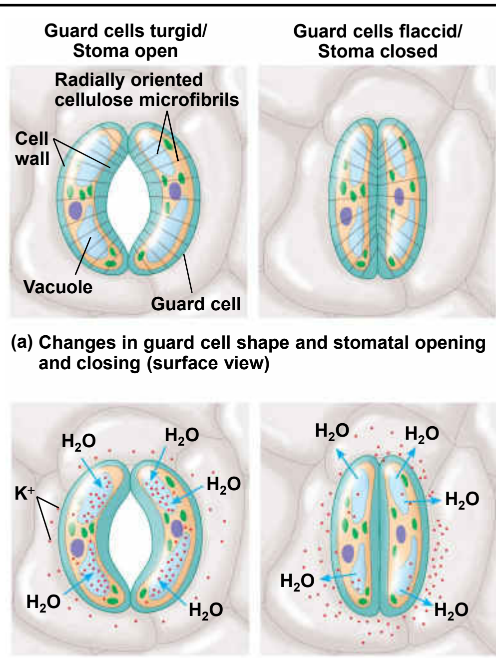
Stomata: Major Pathways for Water Loss

- About 95% of the water a plant loses escapes through stomata
- Each stoma is flanked by a pair of guard cells, which control the diameter of the stoma by changing shape
- Stomatal density is under genetic and environmental control

Mechanisms of Stomatal Opening and Closing

- Changes in turgor pressure open and close stomata
  - When turgid, guard cells bow outward and the pore between them opens
  - When flaccid, guard cells become less bowed and the pore closes

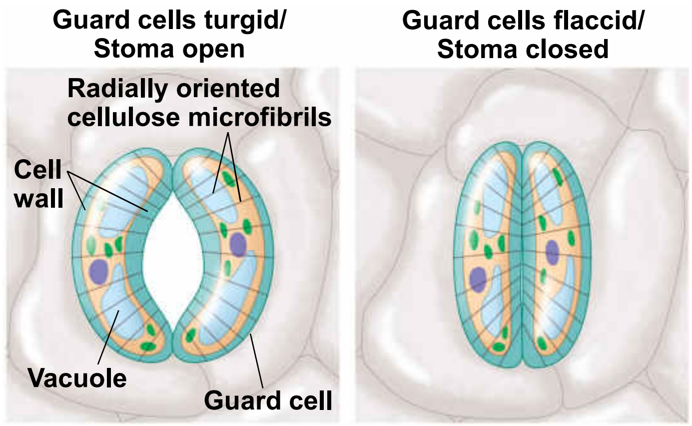
Figure 36.15



(a) Changes in guard cell shape and stomatal opening and closing (surface view)

(b) Role of potassium in stomatal opening and closing

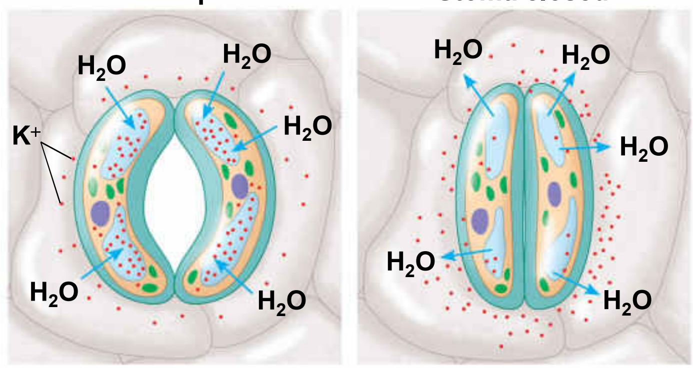
Figure 36.15a



(a) Changes in guard cell shape and stomatal opening and closing (surface view)

- This results primarily from the reversible uptake and loss of potassium ions (K^+) by the guard cells

Figure 36.15b



(b) Role of potassium in stomatal opening and closing

Stimuli for Stomatal Opening and Closing

- Generally, stomata open during the day and close at night to minimize water loss
- Stomatal opening at dawn is triggered by
  - Light
  - CO_2 depletion
  - An internal "clock" in guard cells
- All eukaryotic organisms have internal clocks; **circadian rhythms** are 24-hour cycles

- Drought, high temperature, and wind can cause stomata to close during the daytime
- The hormone **abscisic acid** is produced in response to water deficiency and causes the closure of stomata