Basic Botany

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Plant organs and organ systems

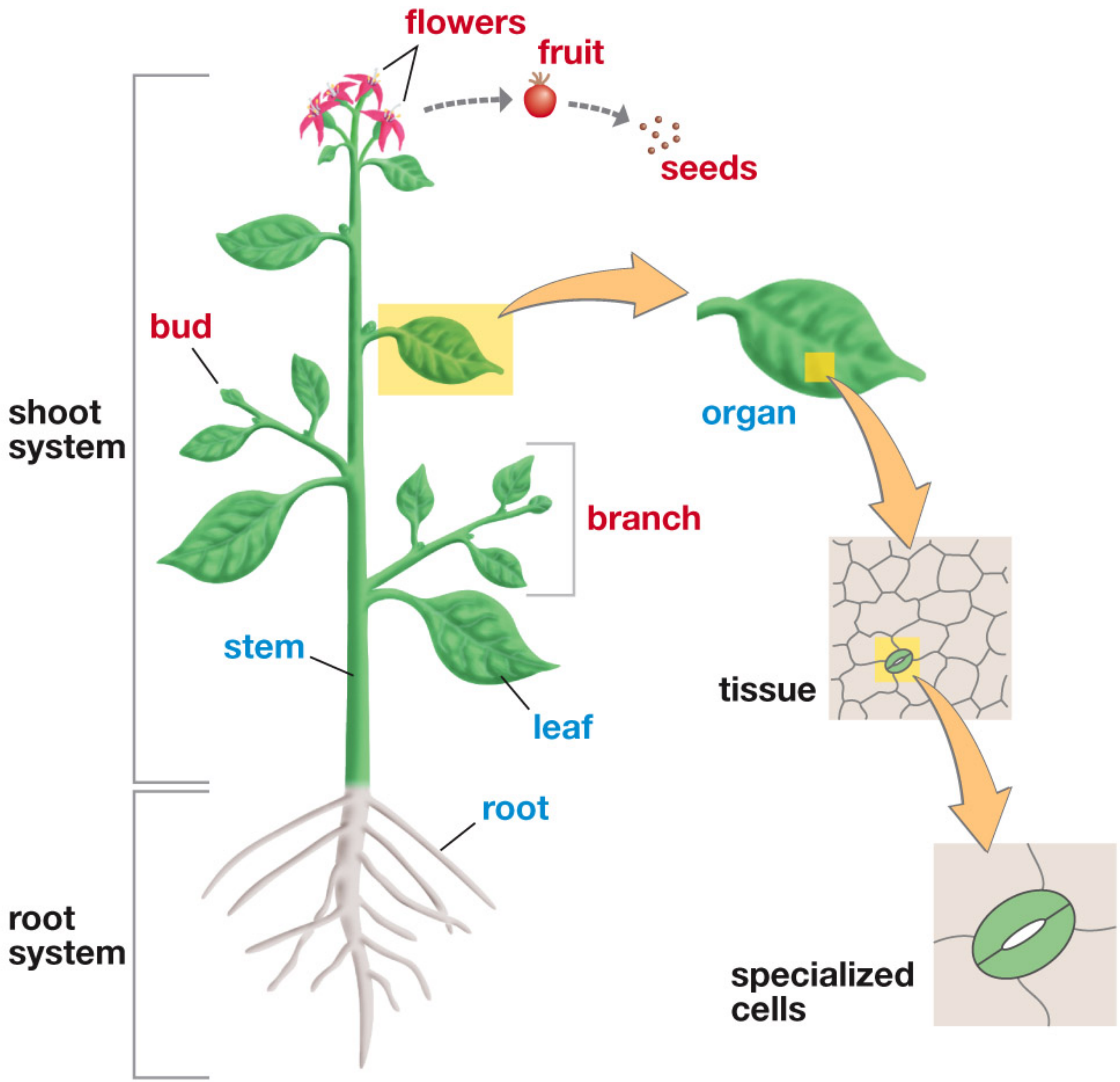


Figure 8.2 Plant Biology, 2/e

Figure 8.5 Plant Biology, 2/e

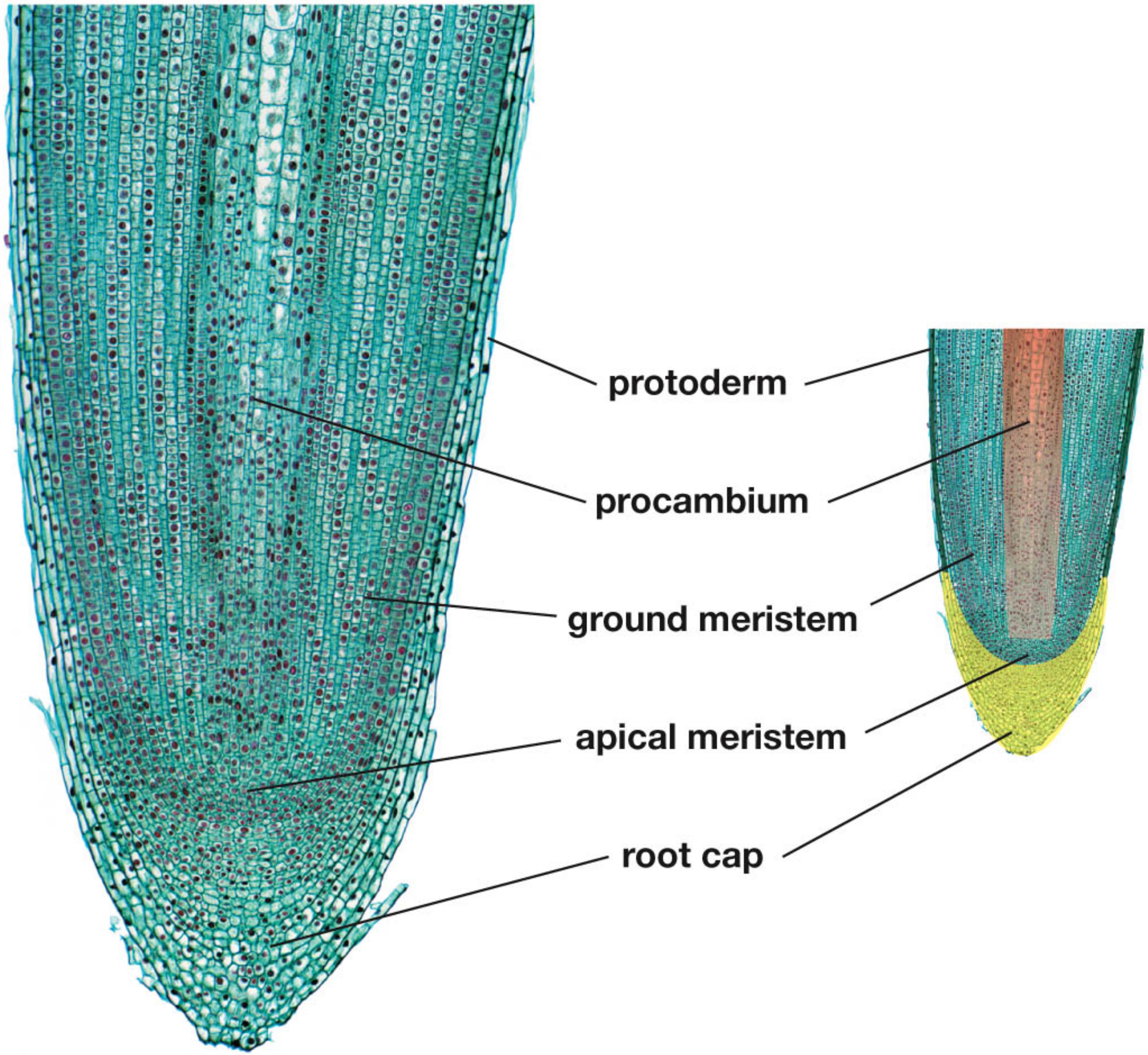


Figure 10.15 Plant Biology, 2/e

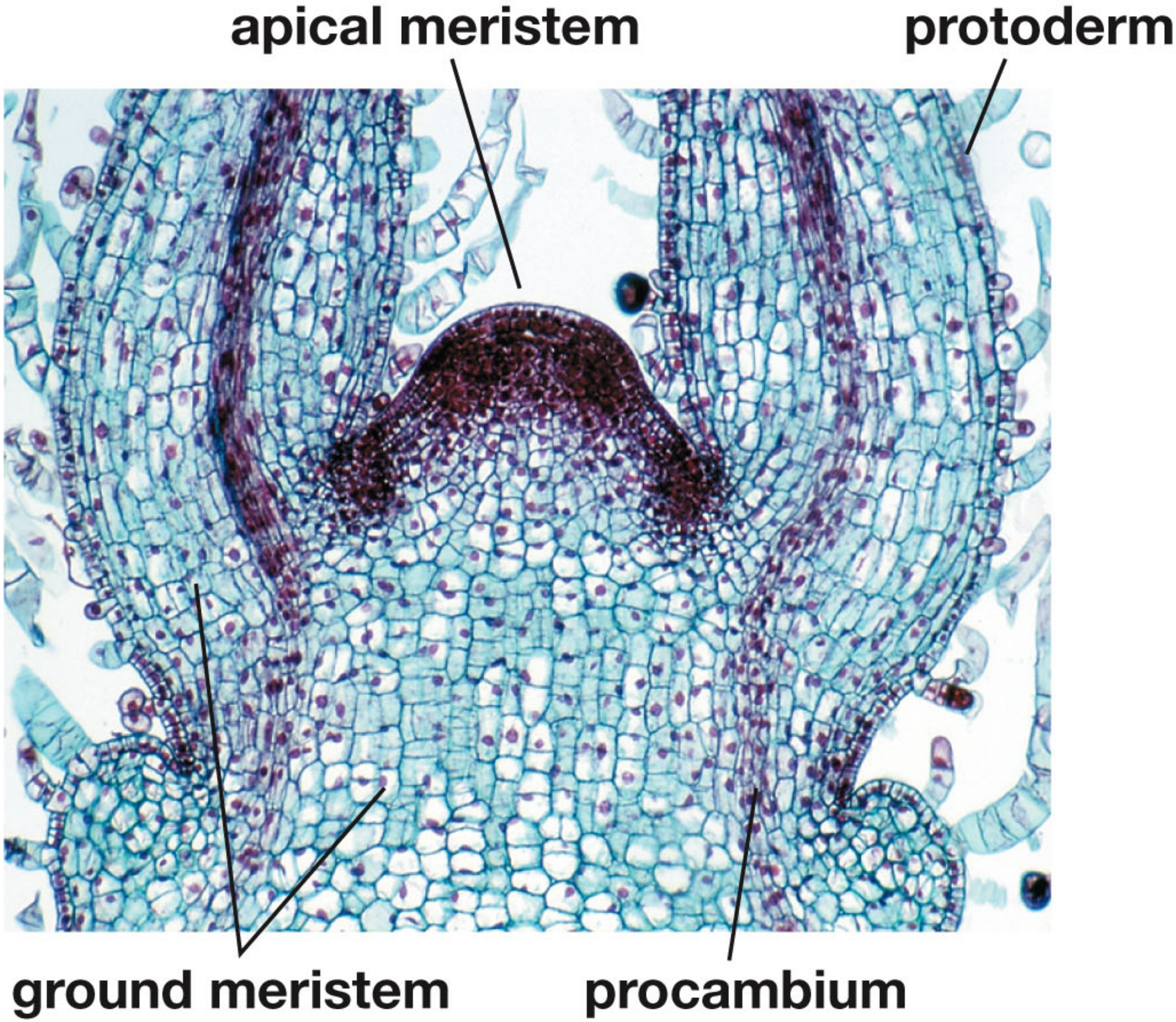
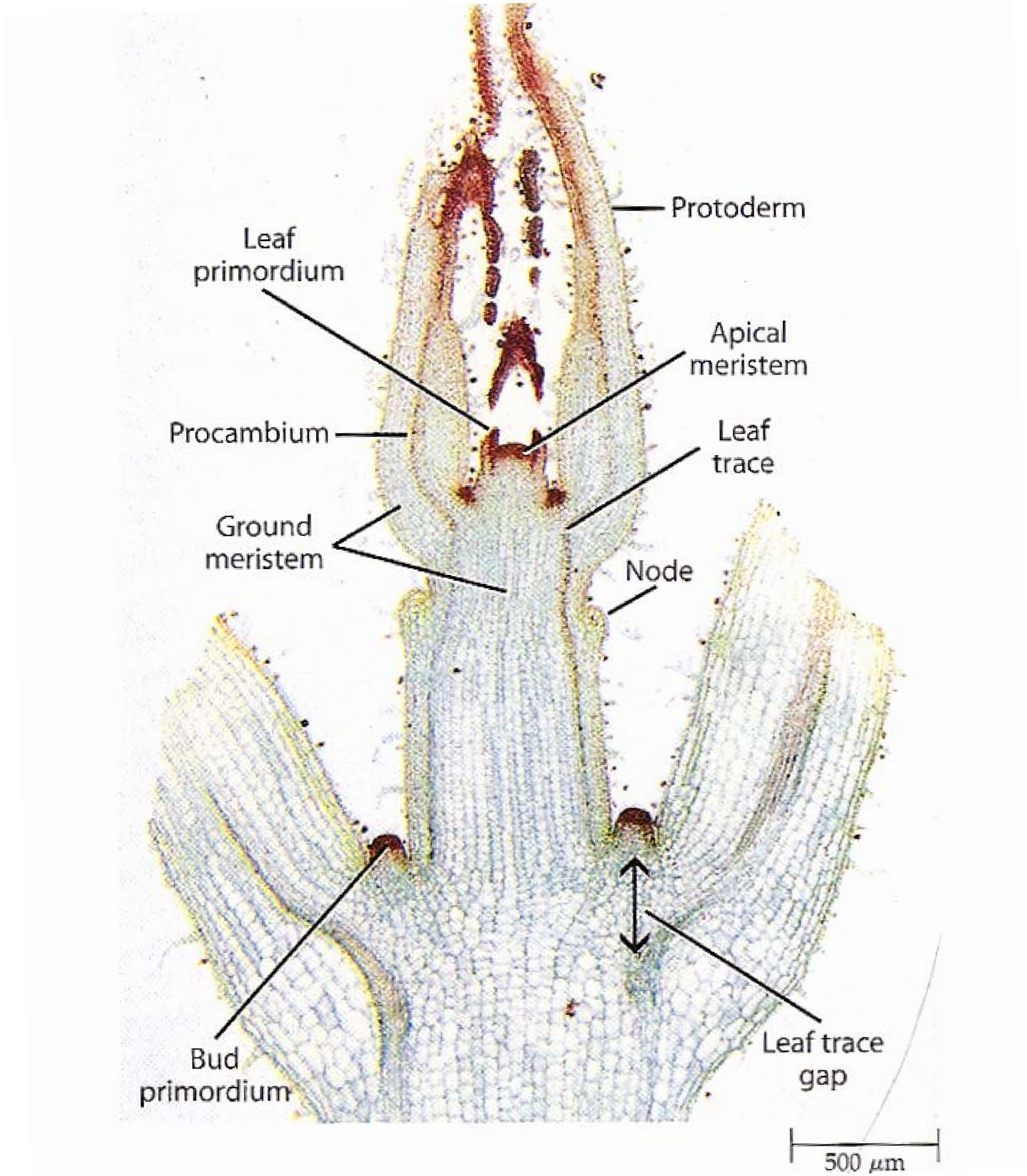


Figure 8.6 Plant Biology, 2/e


Protoderm
Leaf
primordium
Apical
meristem
Procambium
Leaf
trace
Ground
meristem
Node
Bud
primordium
Leaf trace
gap
500 μm

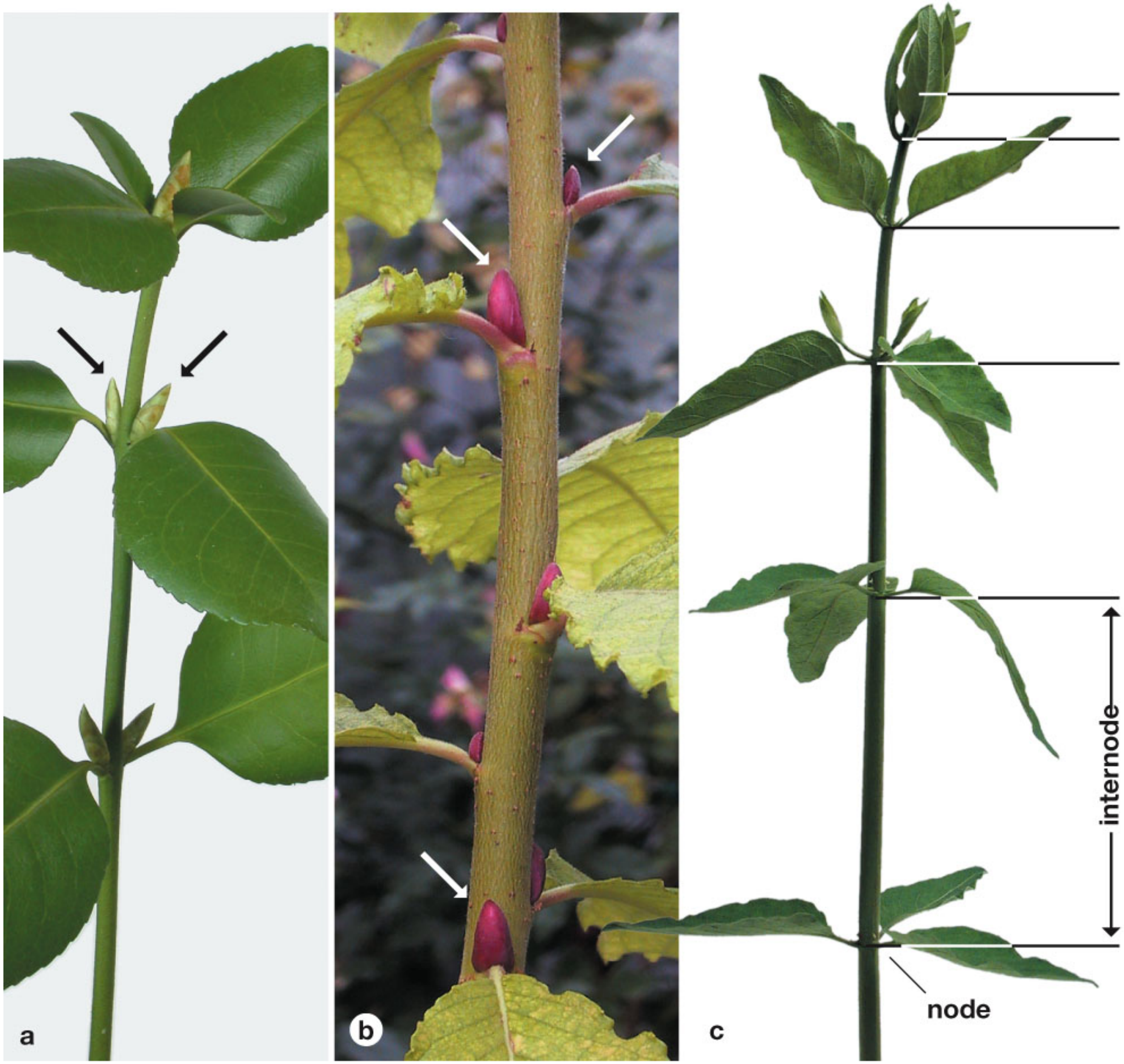
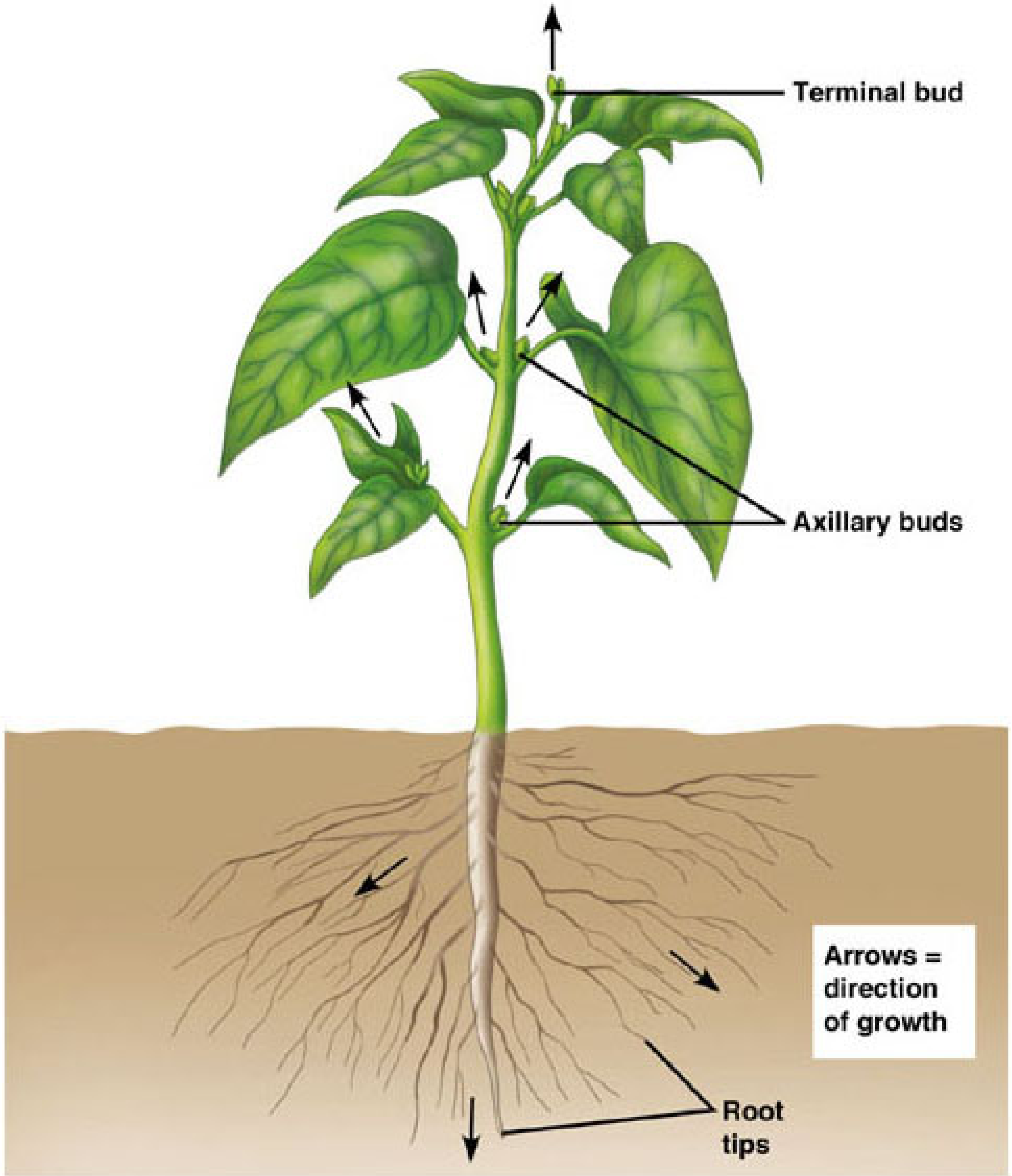


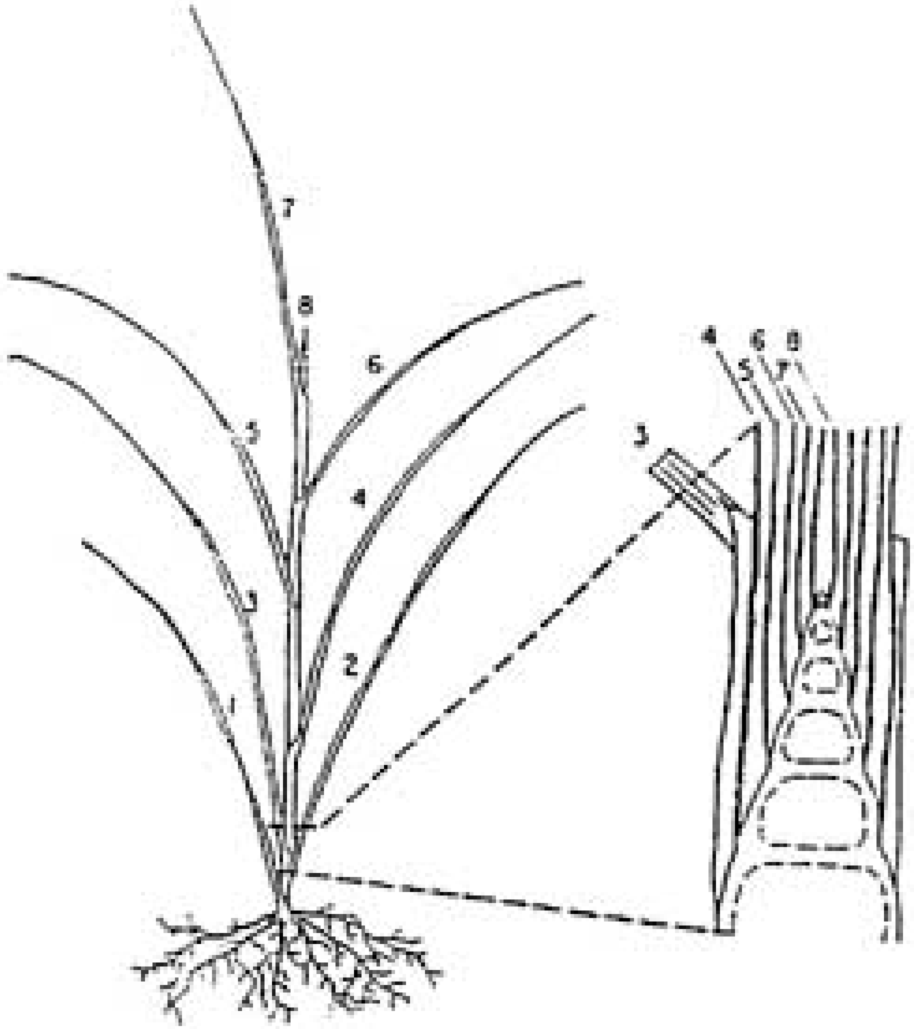
Figure 8.7 Plant Biology, 2/e


Terminal bud
Axillary buds
Arrows = direction of growth
Root tips

Indeterminate, modular growth in a plant

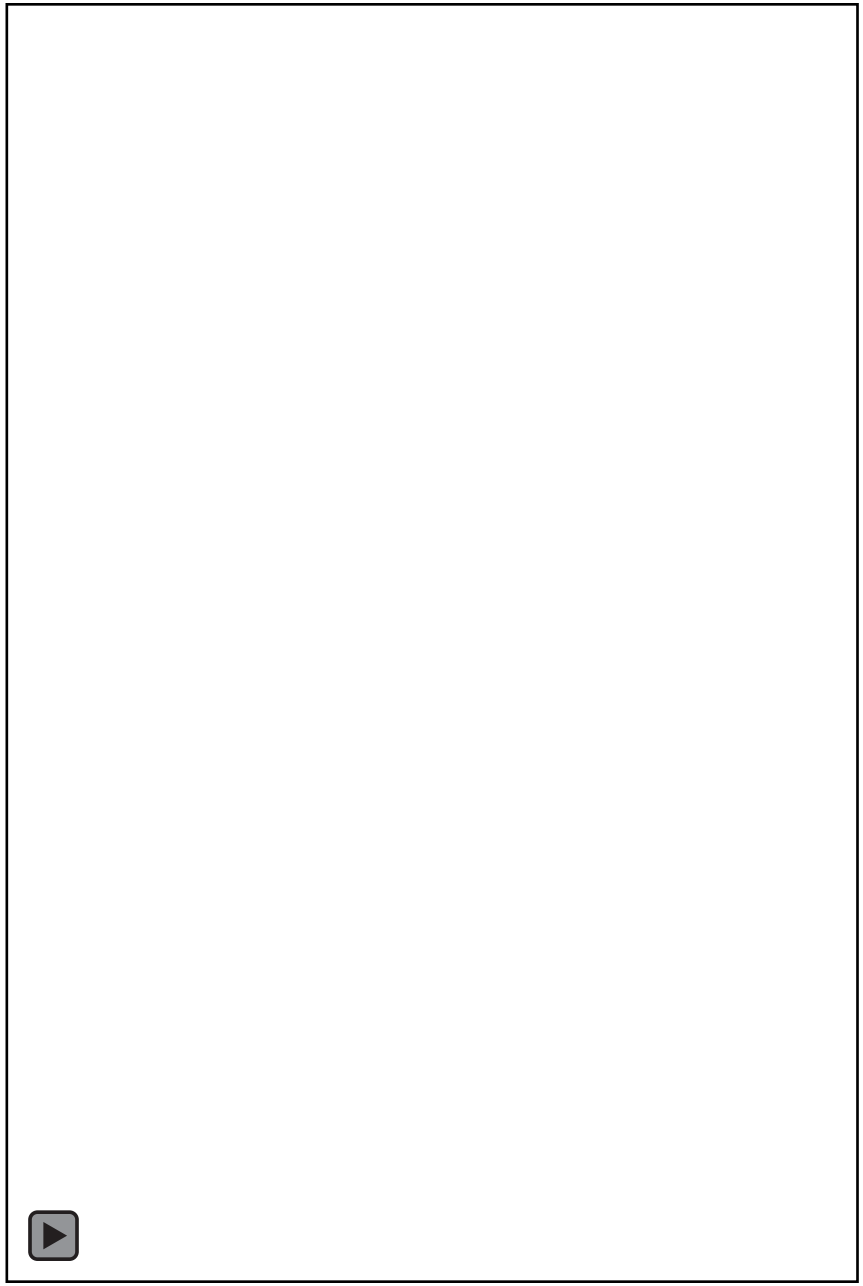
Figure 8.20 Plant Biology, 2/e

Plant cuttings growing roots



Grass meristem

Growth from a basal meristem



All time-lapse video is from Roger Hangarter's lab at Indiana University.

Figure 9.22 Plant Biology, 2/e

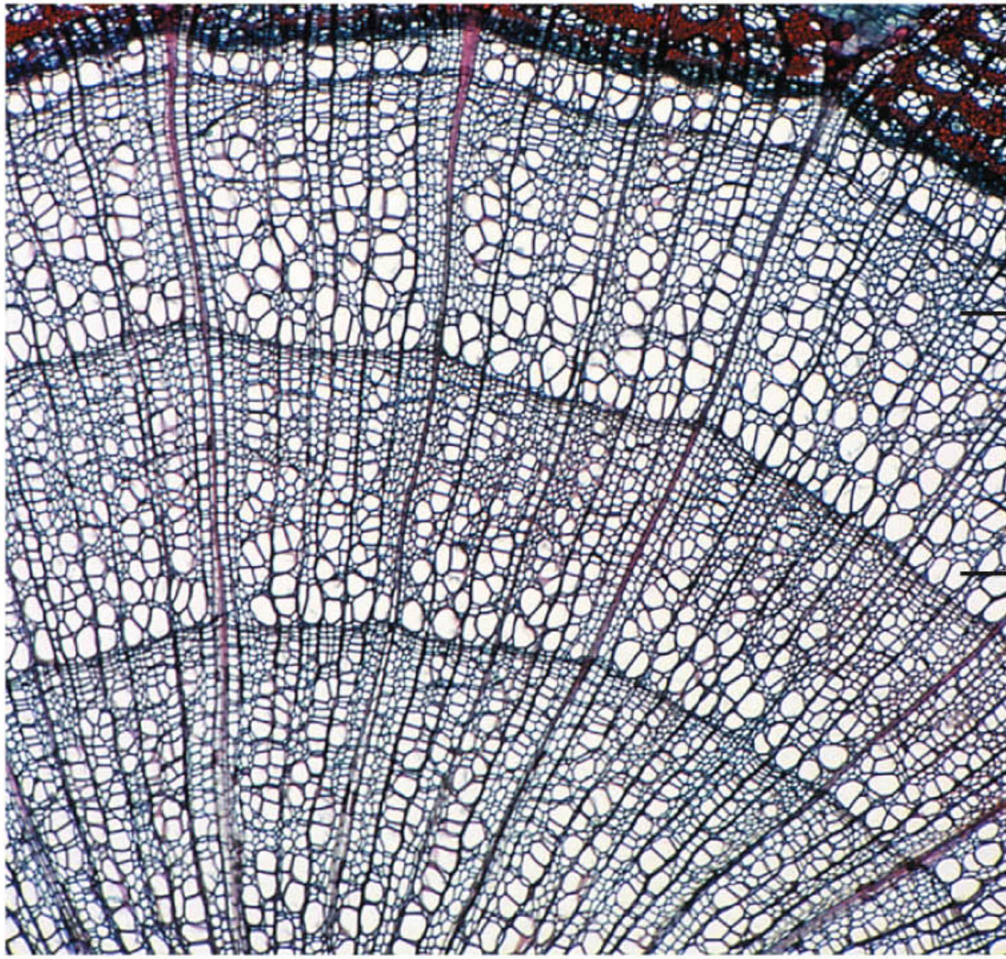


Figure E9.2A Plant Biology, 2/e

What do plants need to live?

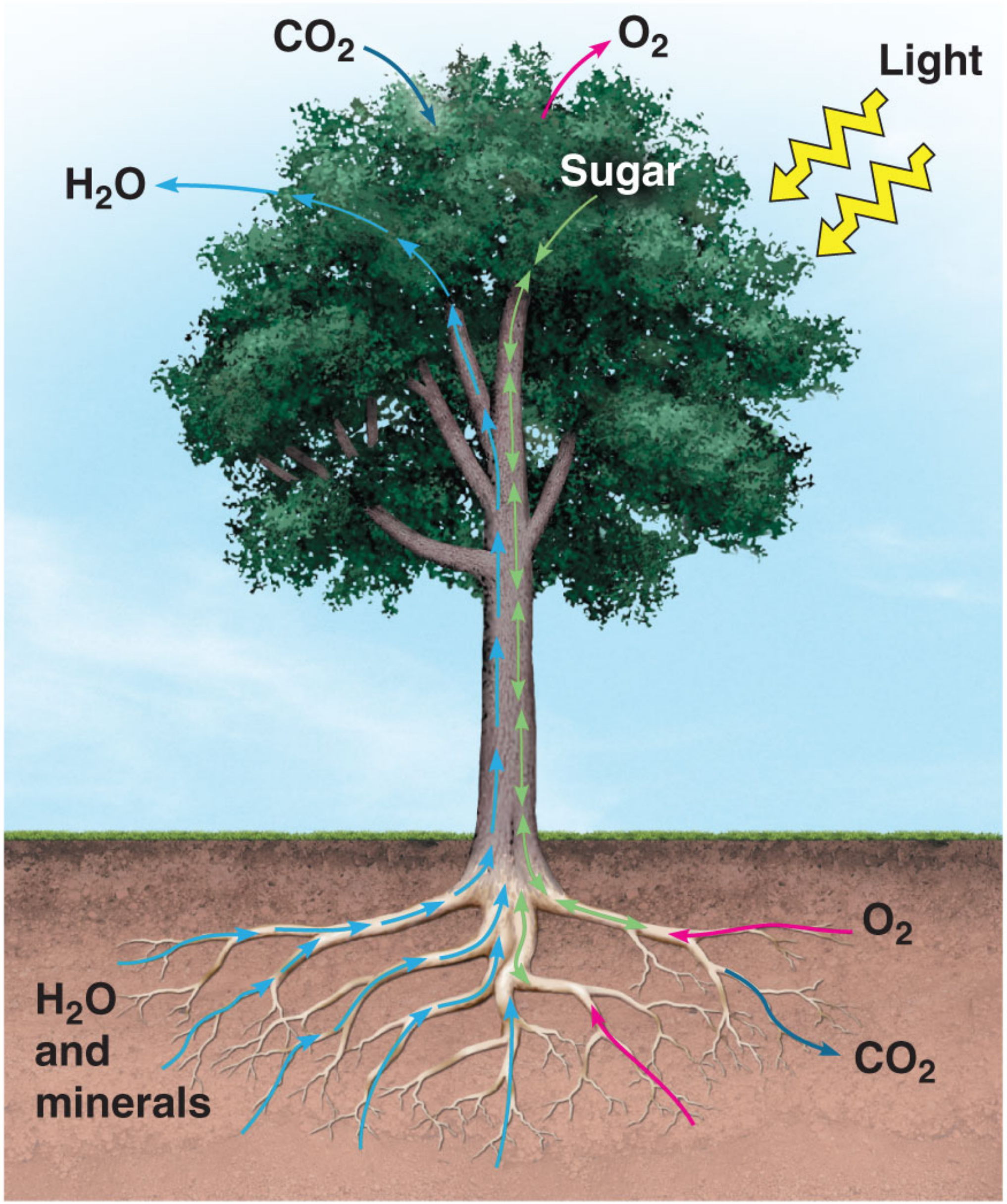
Water

Light

Air

Minerals

Habitat



Taproot system

Figure 10.10 Plant Biology, 2/e

Fibrous root system

Figure 10.11 Plant Biology, 2/e

Adventitious roots developing from a stem

Figure 10.12 Plant Biology, 2/e

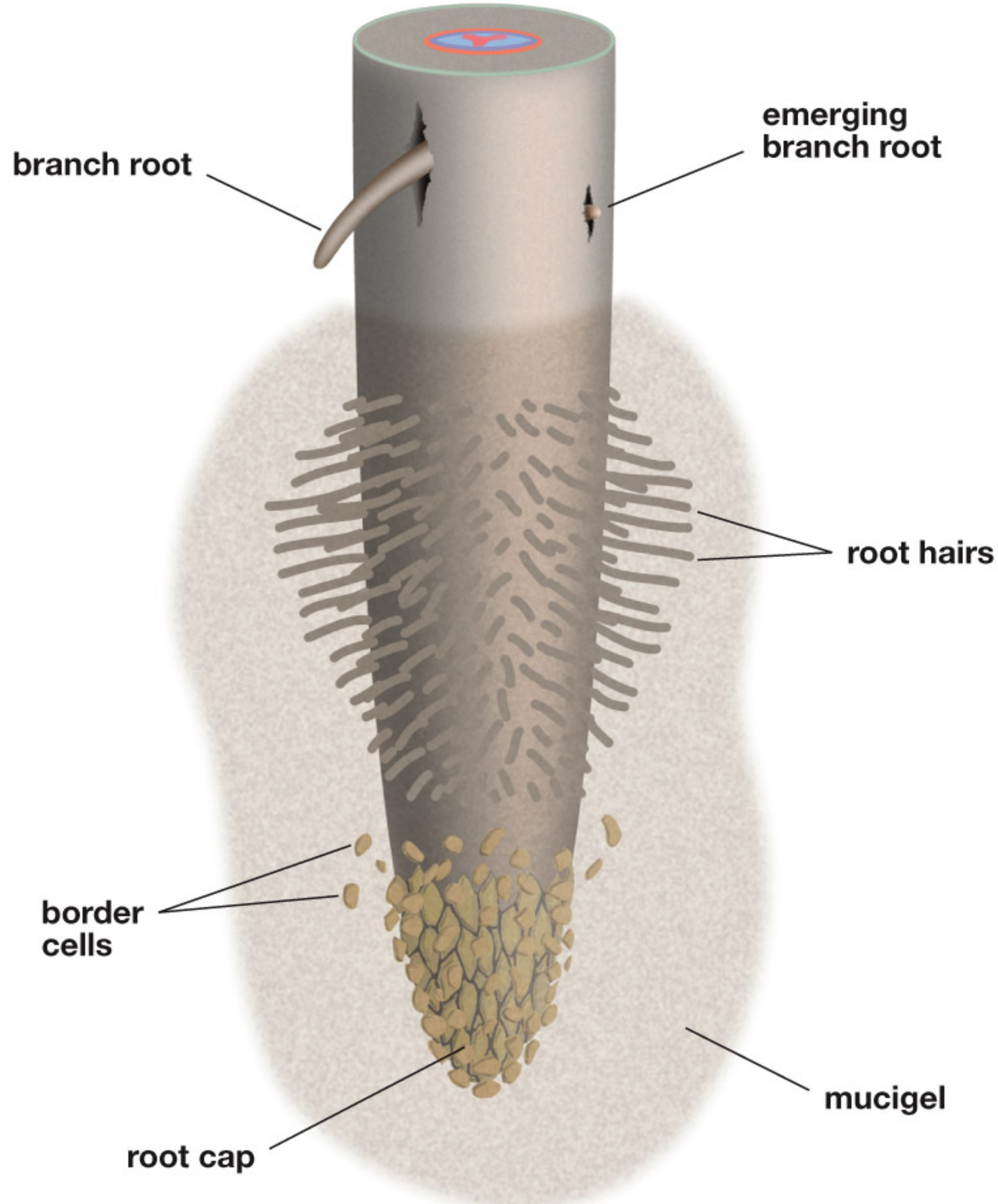
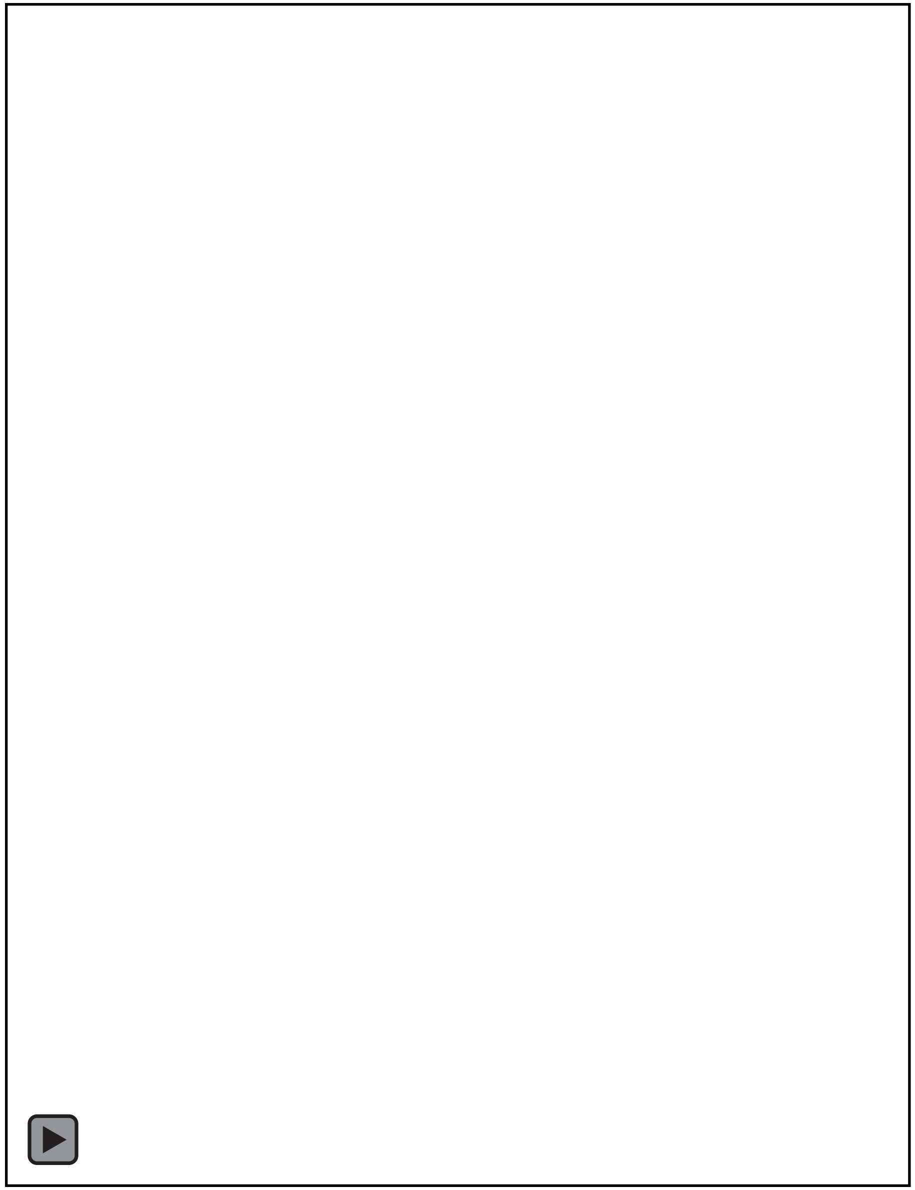
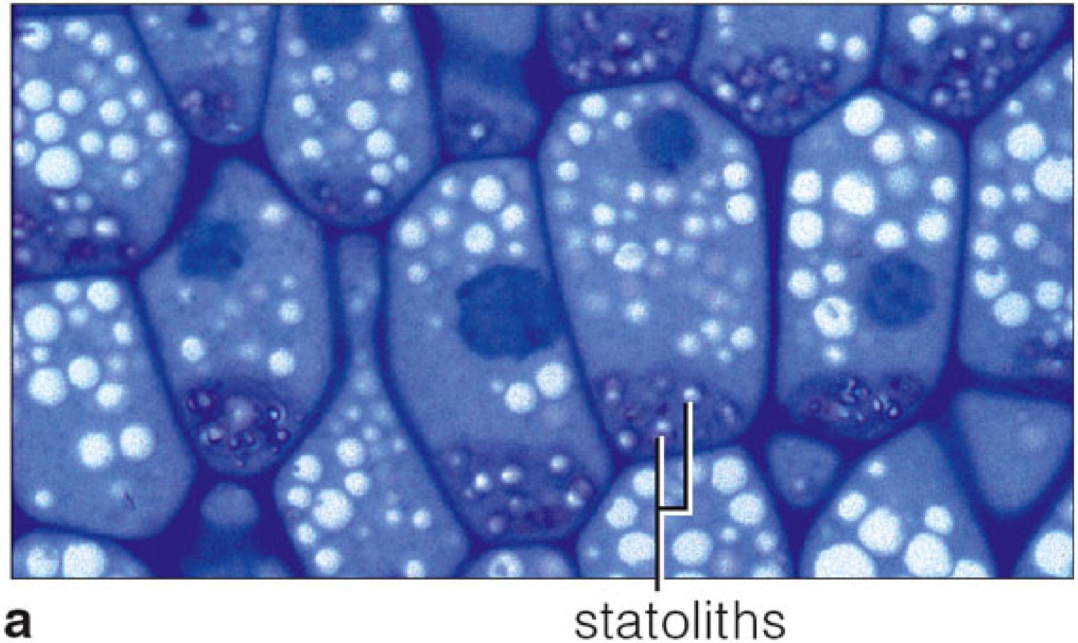


Figure 10.13 Plant Biology, 2/e

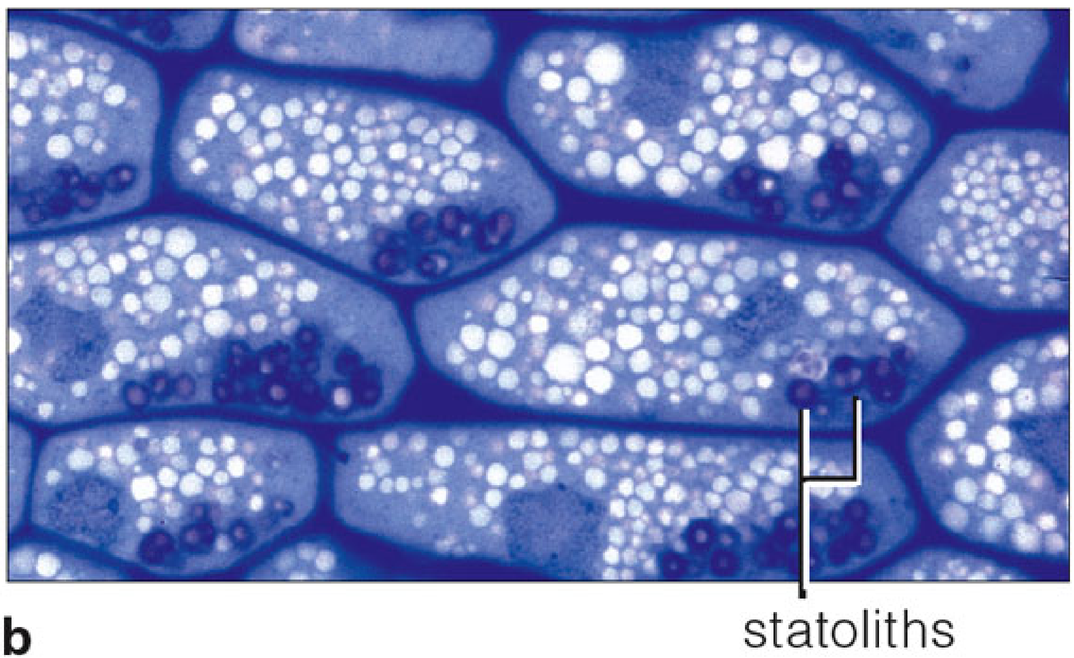
Root hairs on a radish seedling



Roots grow in the direction of gravity.

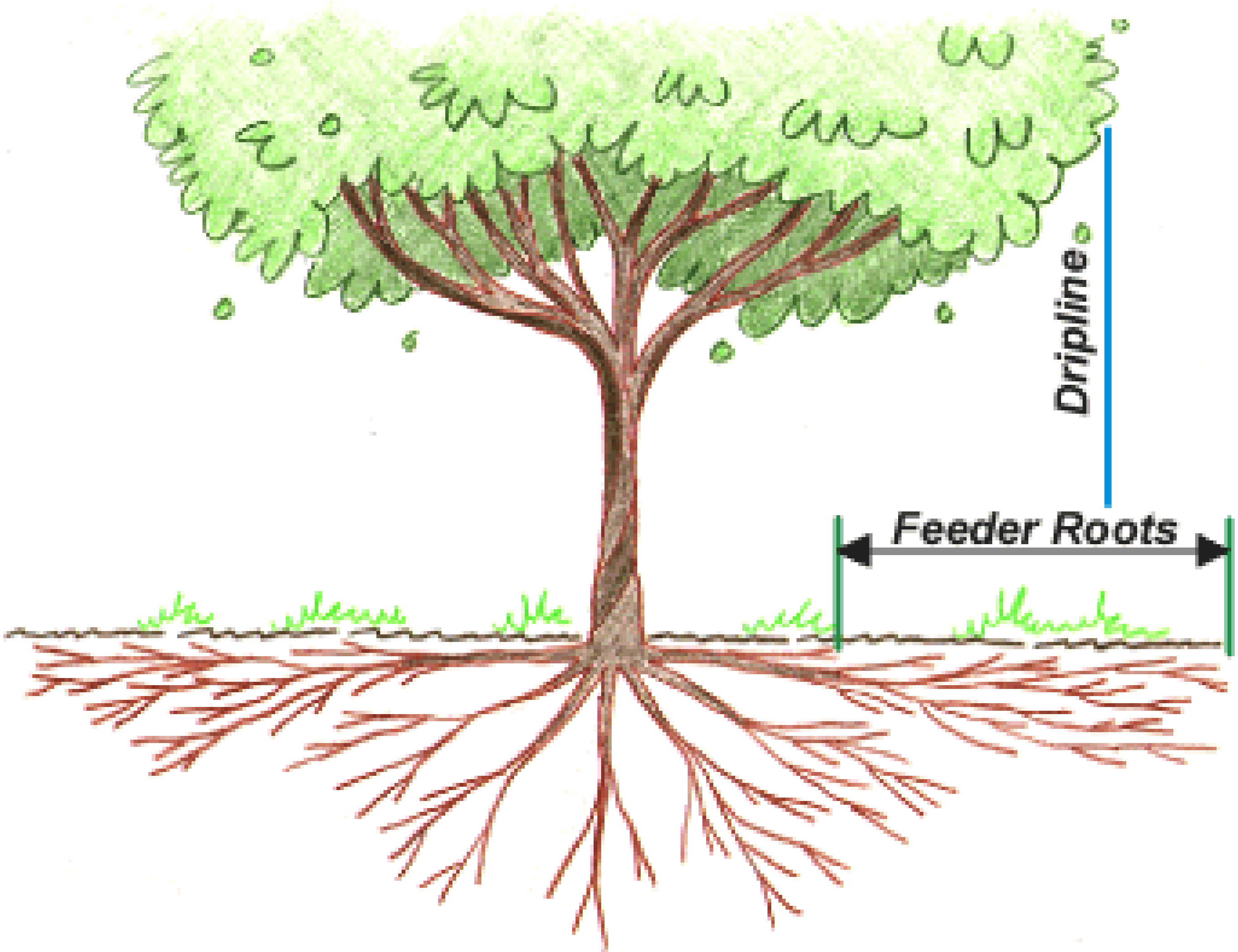


a



b

Plants use gravity to guide the direction of branch growth.


Dripline
Feeder Roots

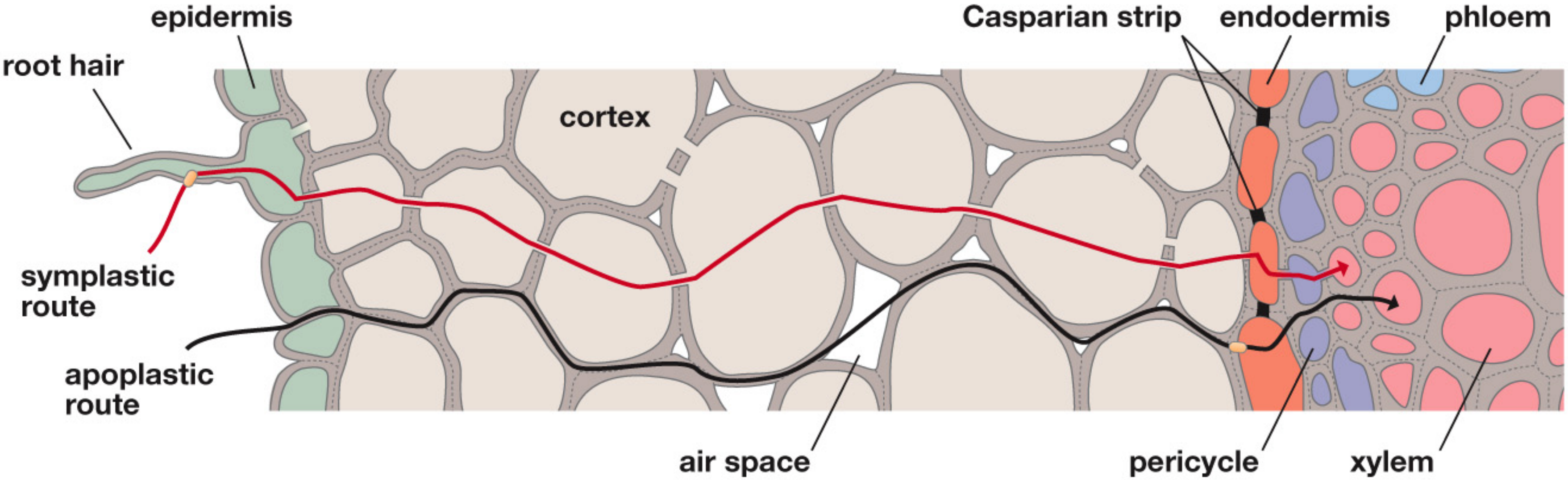


Figure 10.21 Plant Biology, 2/e

Water’s pathway into the vascular tissue of the root

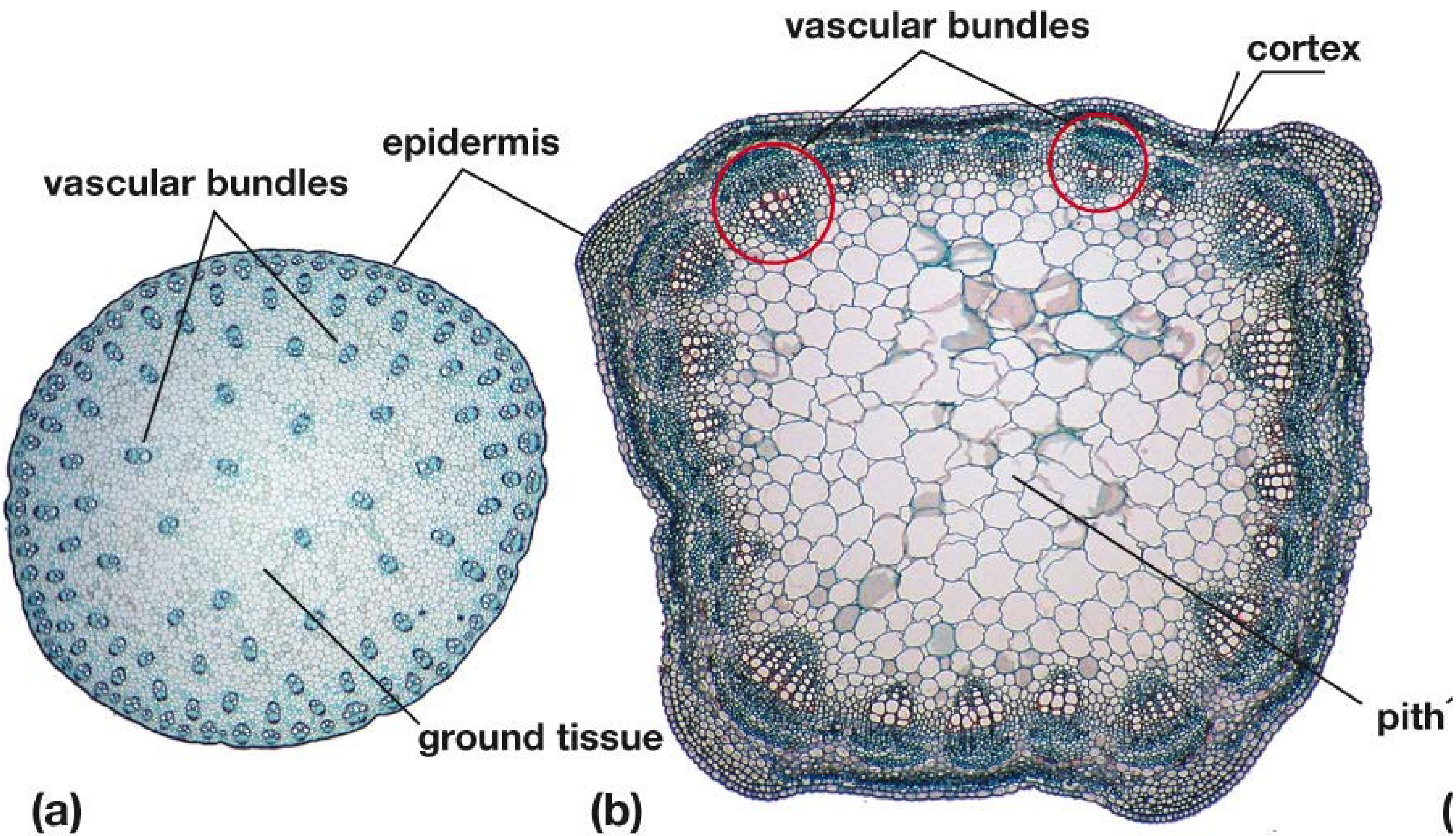


Figure 9.8 Plant Biology, 2/e

The plant's vascular system carries water, minerals, sugars, and other solutes throughout the plant.

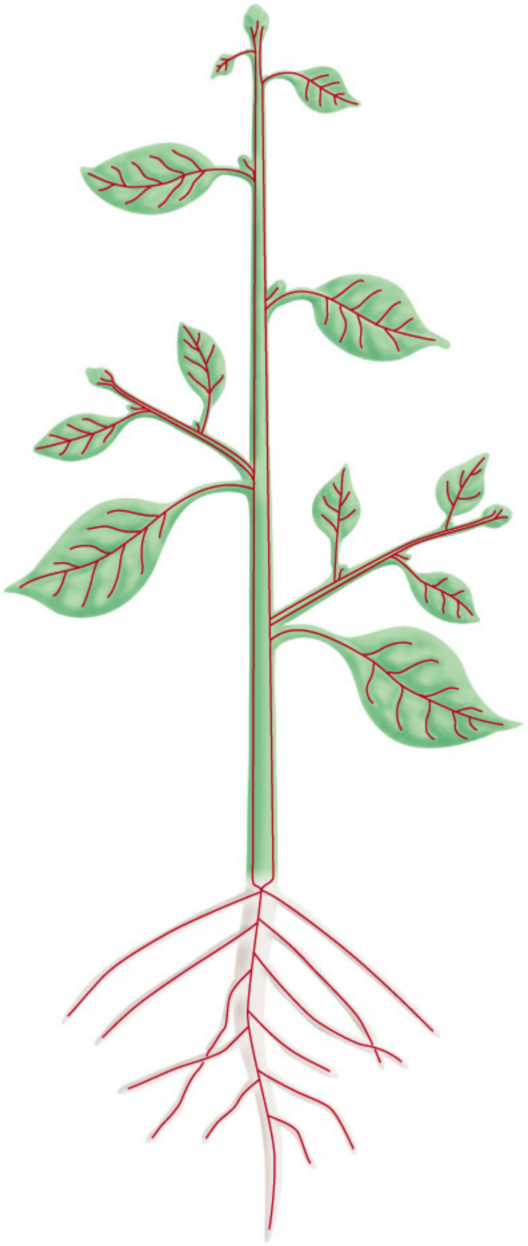


Figure 9.9 Plant Biology, 2/e

Tracheids and vessel elements together in vascular tissue

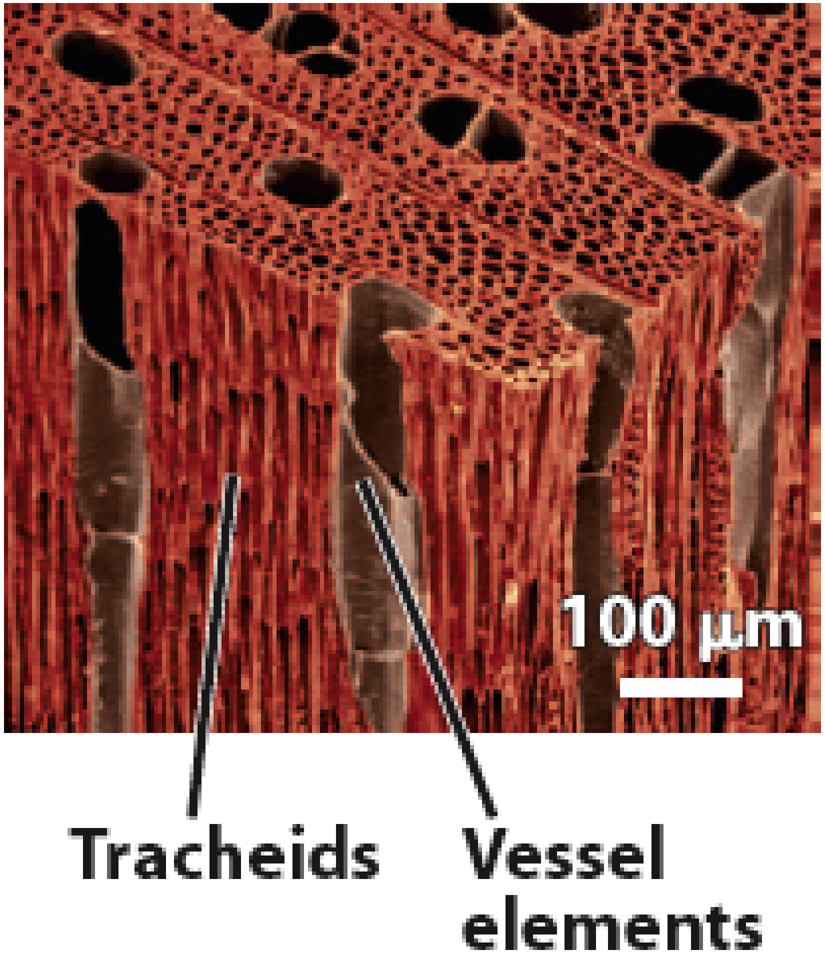
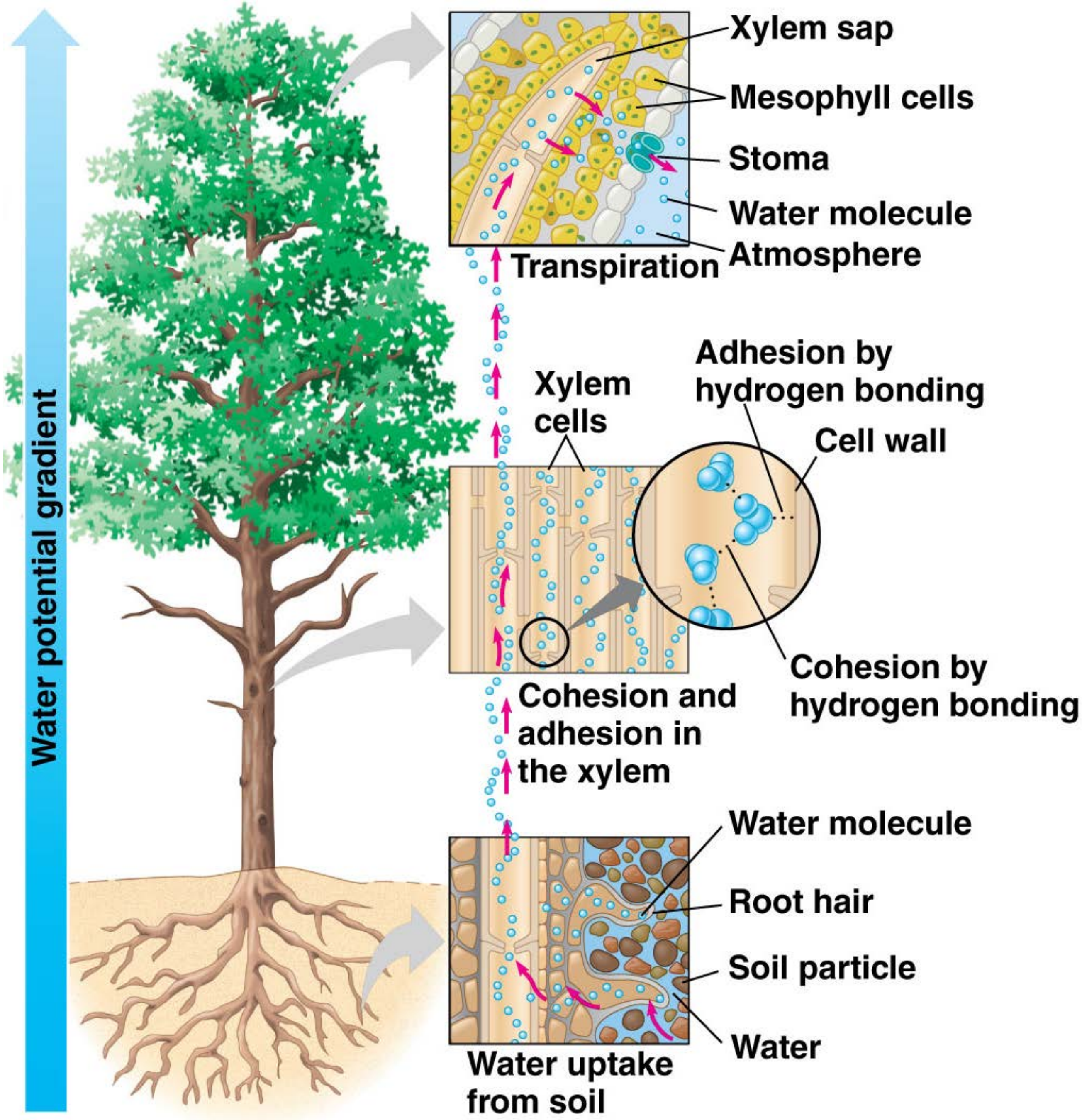


Figure 9.22 Plant Biology, 2/e


Water potential gradient
Xylem sap
Mesophyll cells
Stoma
Water molecule
Atmosphere
Transpiration
Adhesion by hydrogen bonding
Xylem cells
Cell wall
Cohesion by hydrogen bonding
Cohesion and adhesion in the xylem
Water molecule
Root hair
Soil particle
Water
Water uptake from soil

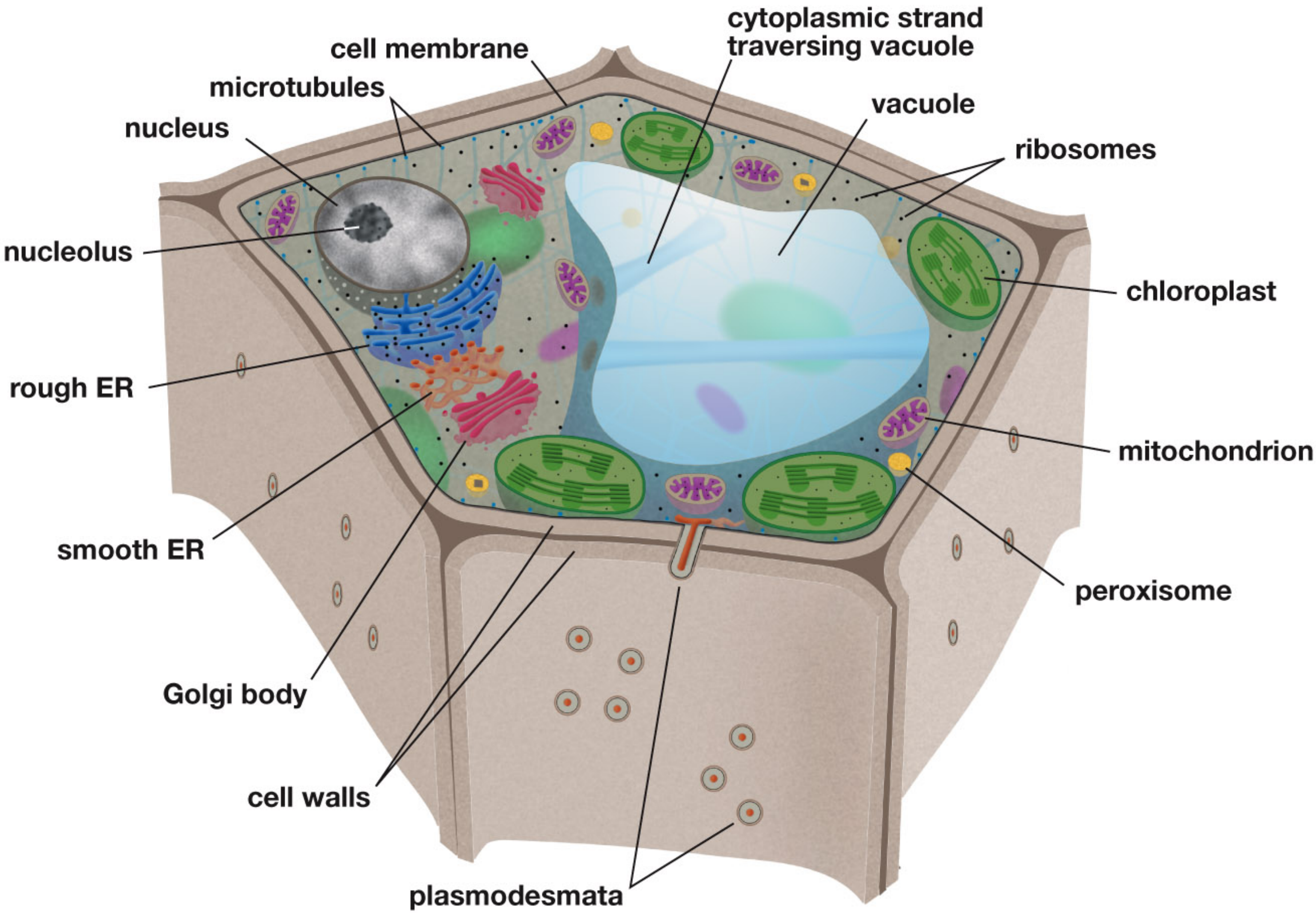
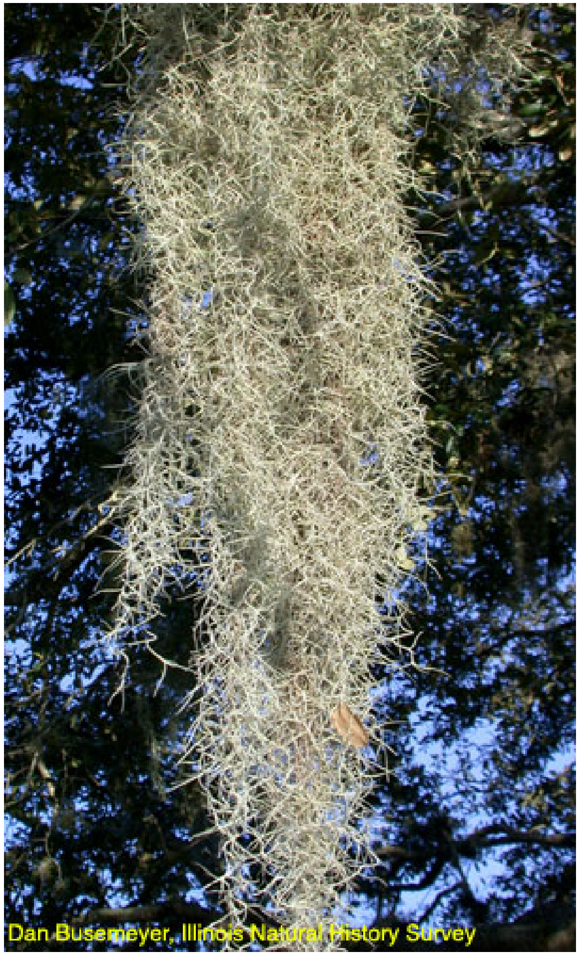


Figure 4.7 Plant Biology, 2/e

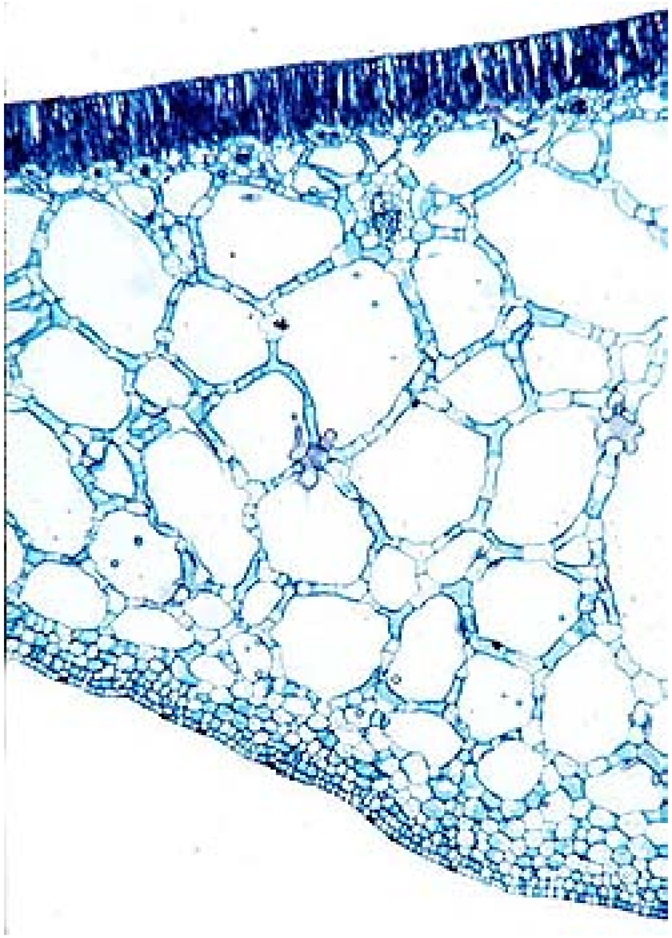


Spanish moss

Cliffbrake fern

Prickly pear cactus

Leaves adapted for water storage



Waterlily leaf in cross-section

Figure 5-CO Plant Biology, 2/e

Circadian rhythms in bean leaves

Plants can keep track of time.

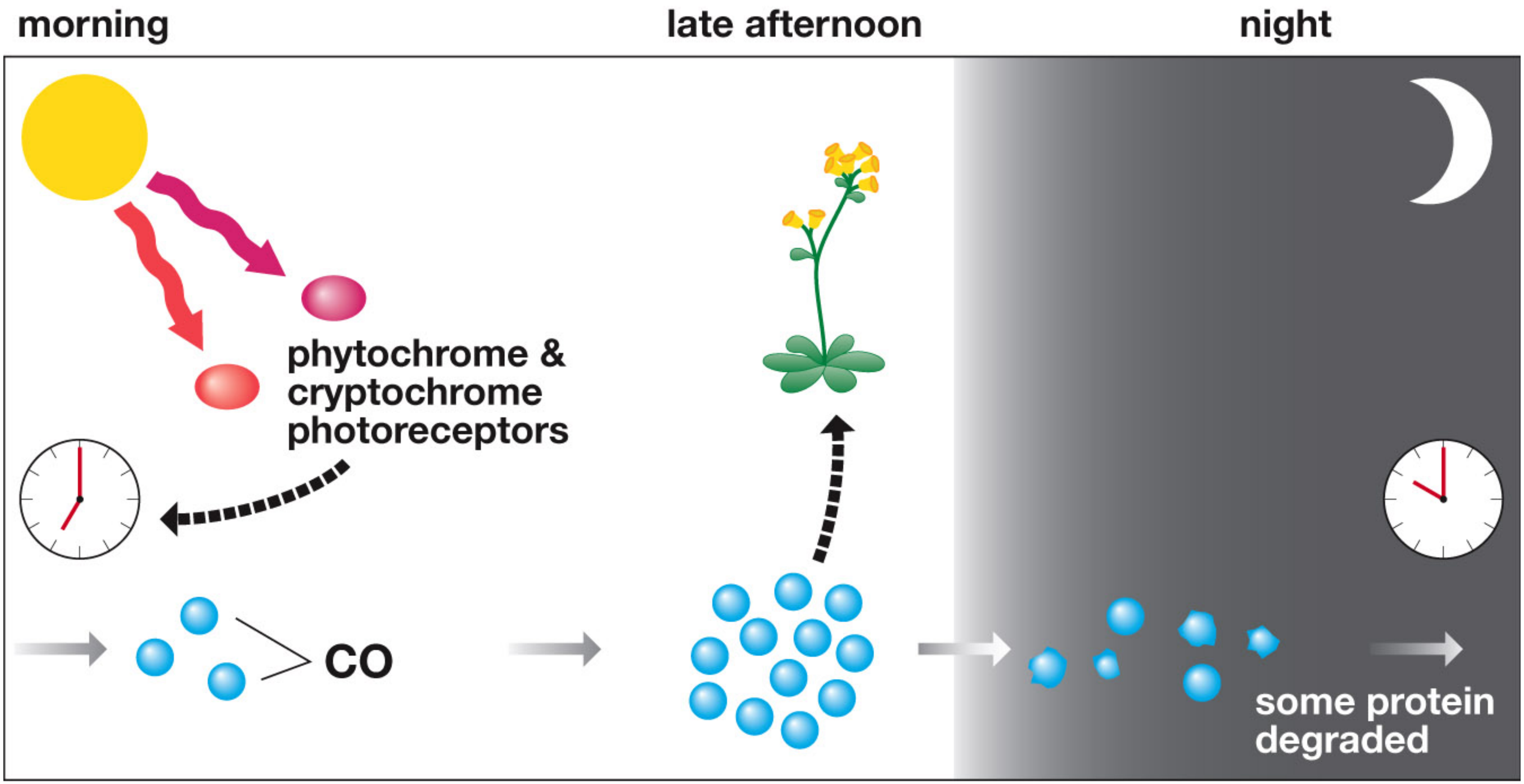


Figure 12.11 Plant Biology, 2/e

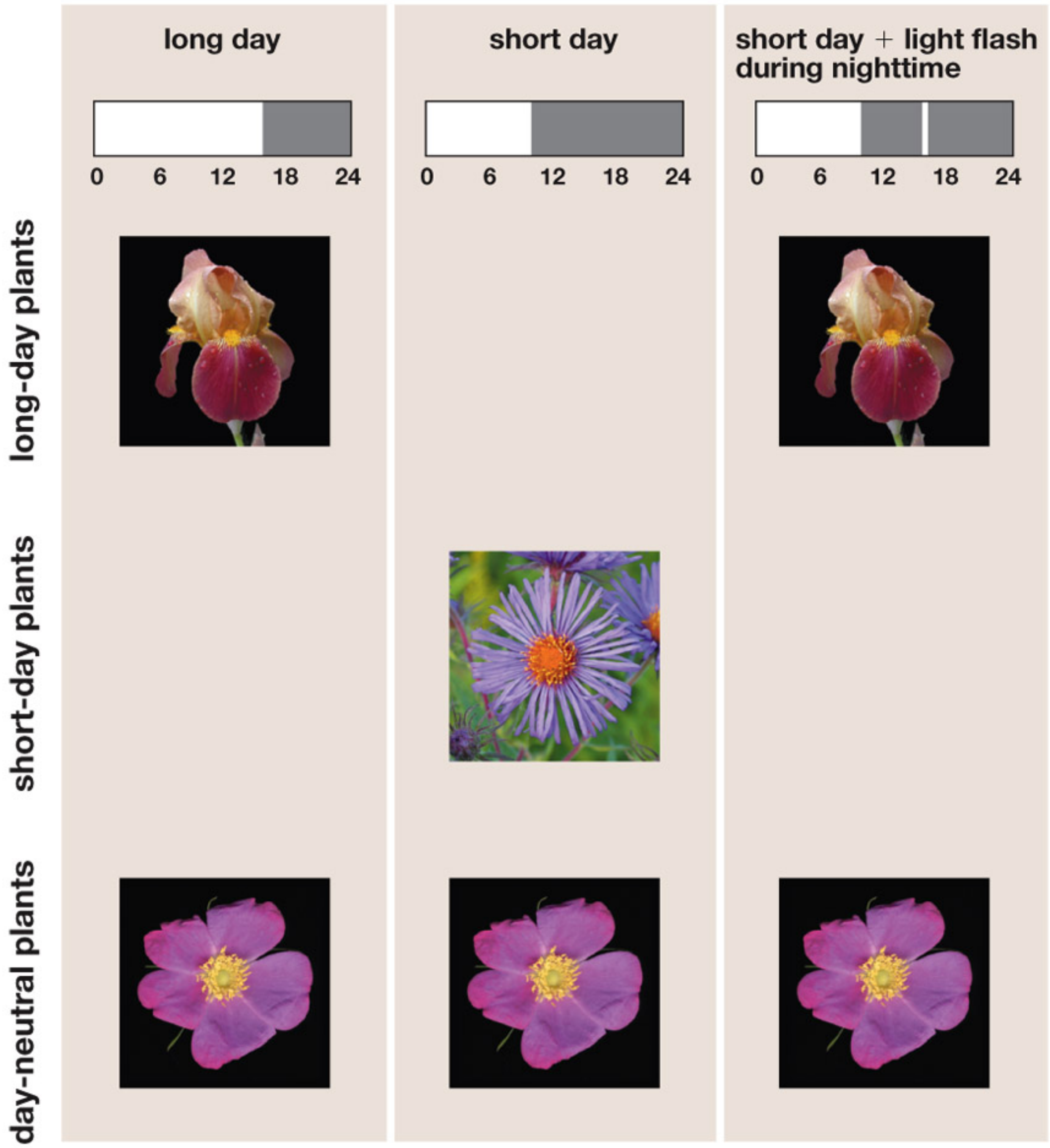


Figure 12.10 Plant Biology, 2/e

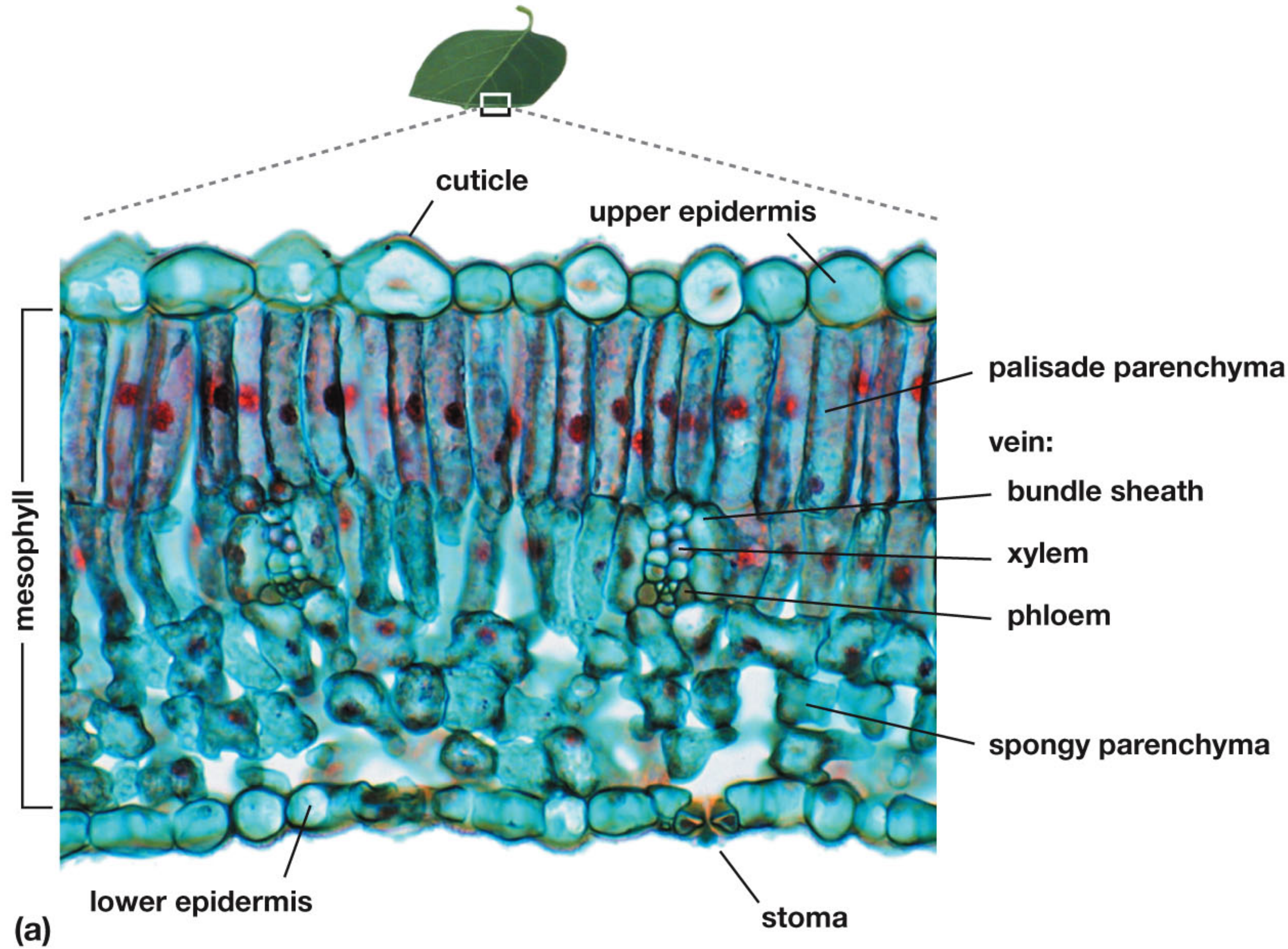
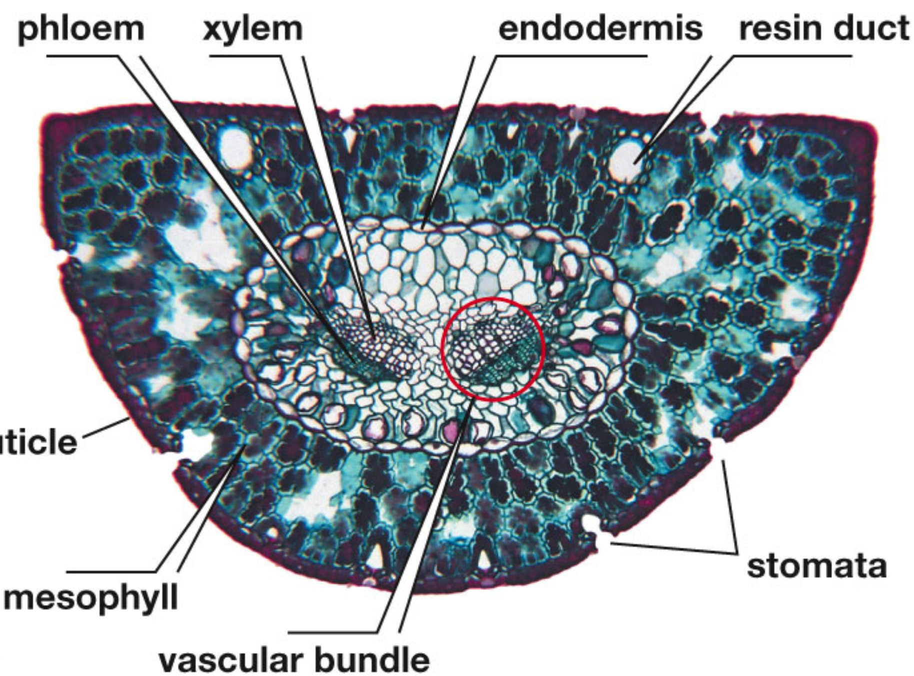


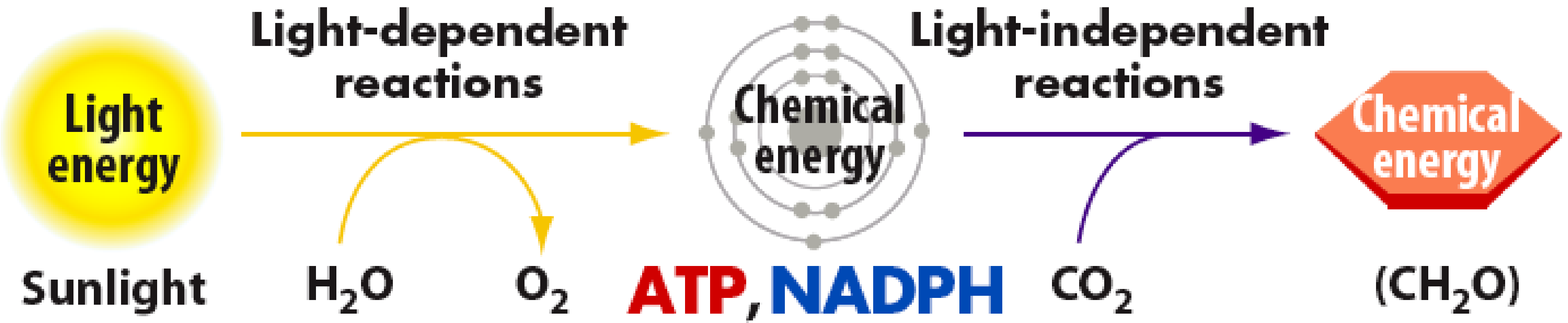
Figure 11.8a Plant Biology, 2/e

(a)



(b)

Figure 22.16 Plant Biology, 2/e

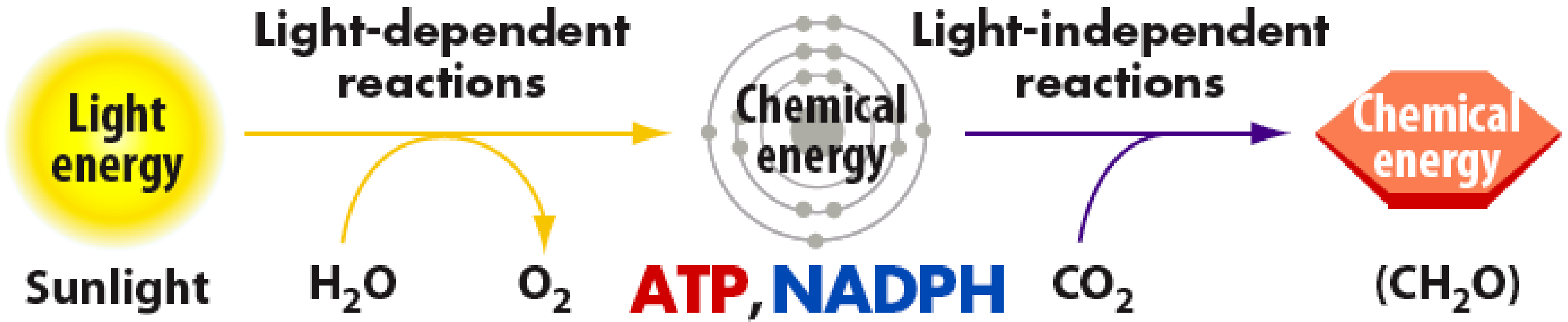

Light-dependent reactions
Light energy
Chemical energy
Light-independent reactions
Chemical energy
Sunlight
H_2O
O_2
ATP, NADPH
CO_2
(CH_2O)

spring beauty

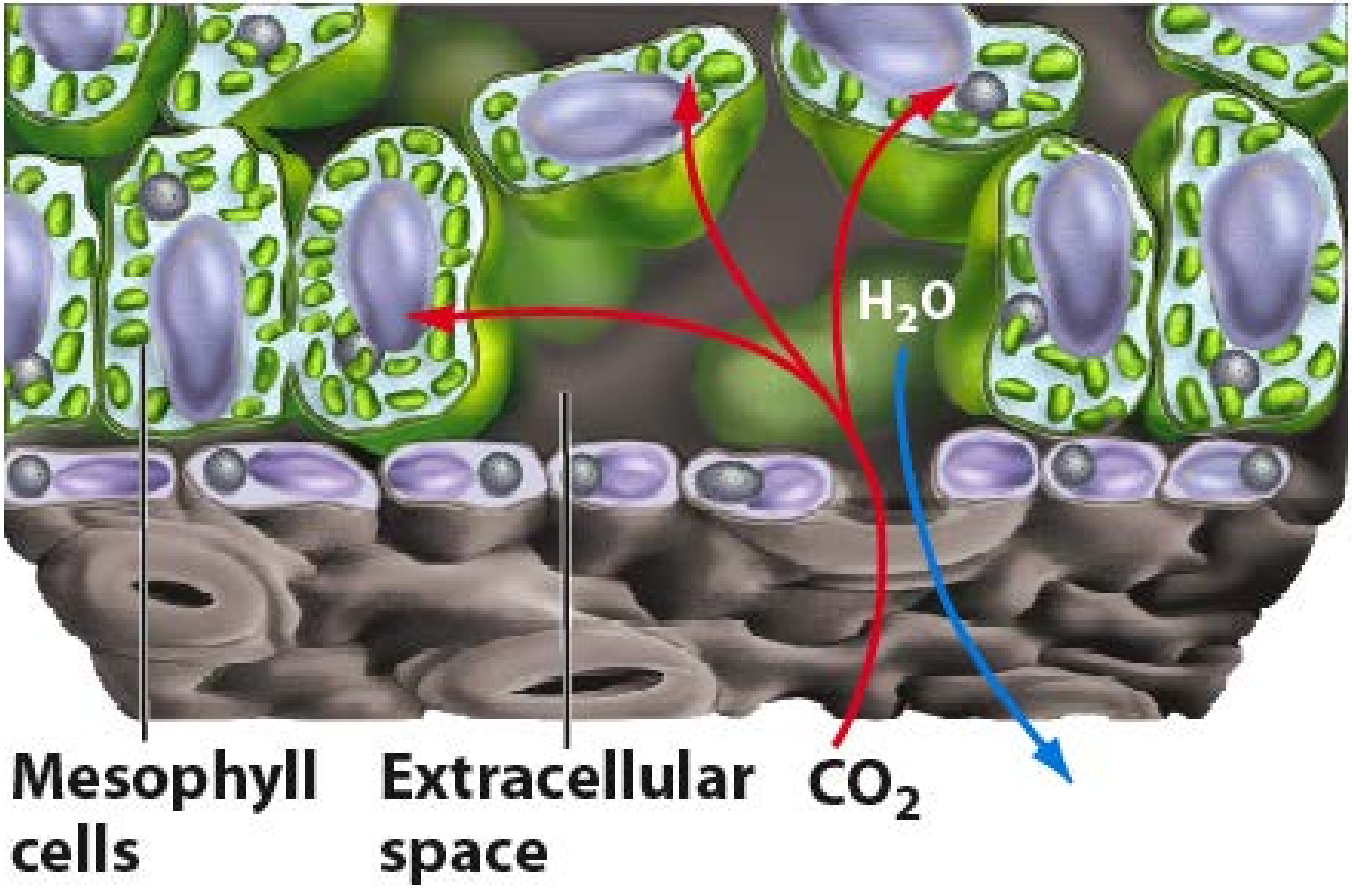
Growth response to light in corn seedlings

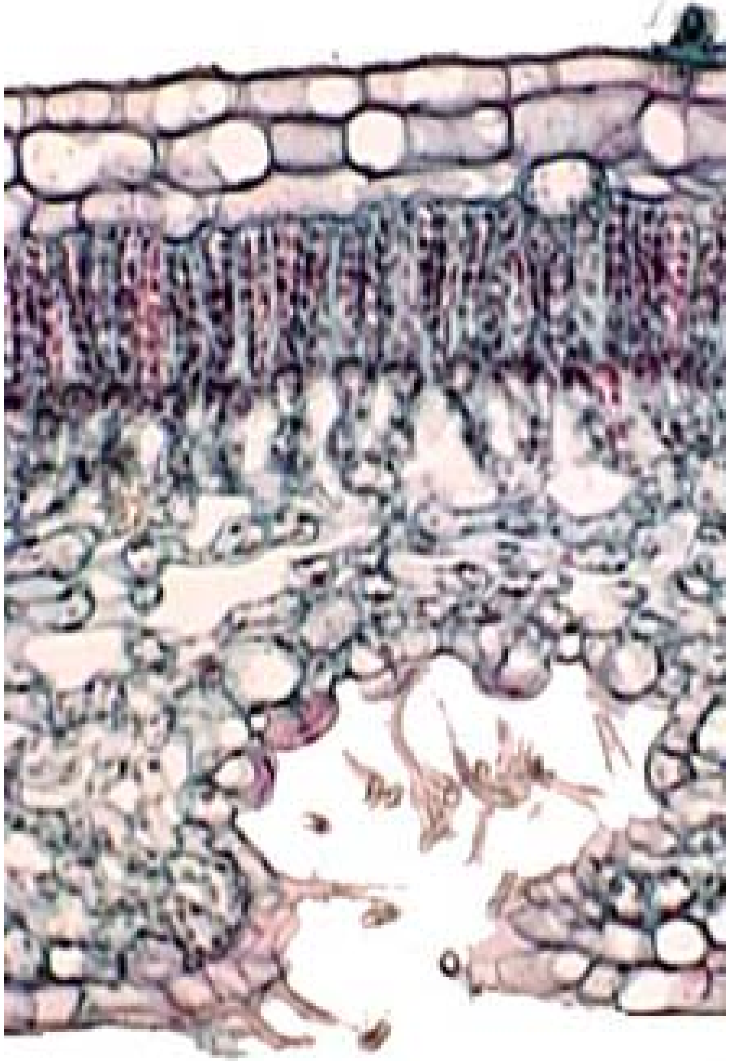
Circadian movements in sunflower

Searching behavior in morning glories


Light energy
Light-dependent reactions
Chemical energy
Light-independent reactions
Chemical energy
Sunlight
H_2O
O_2
ATP, NADPH
CO_2
(CH_2O)

Carbon dioxide diffuses into leaves through stomata.





Oleander leaf

Light absorbed by pigments in photosynthesis

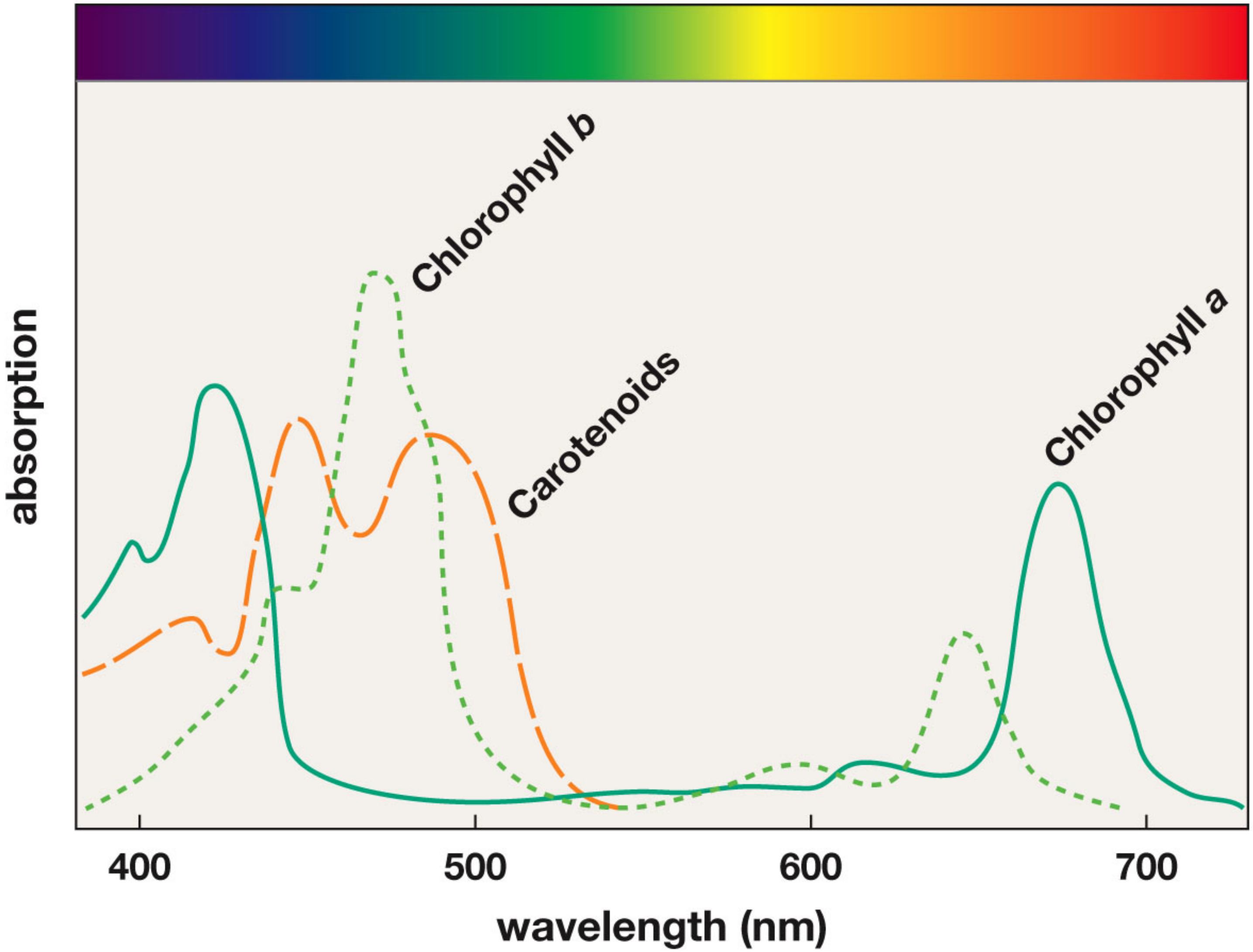
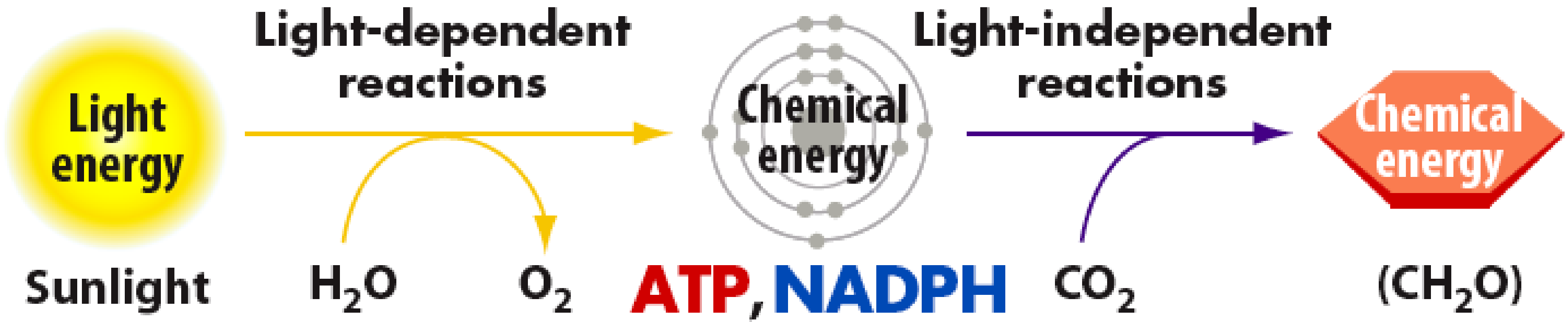
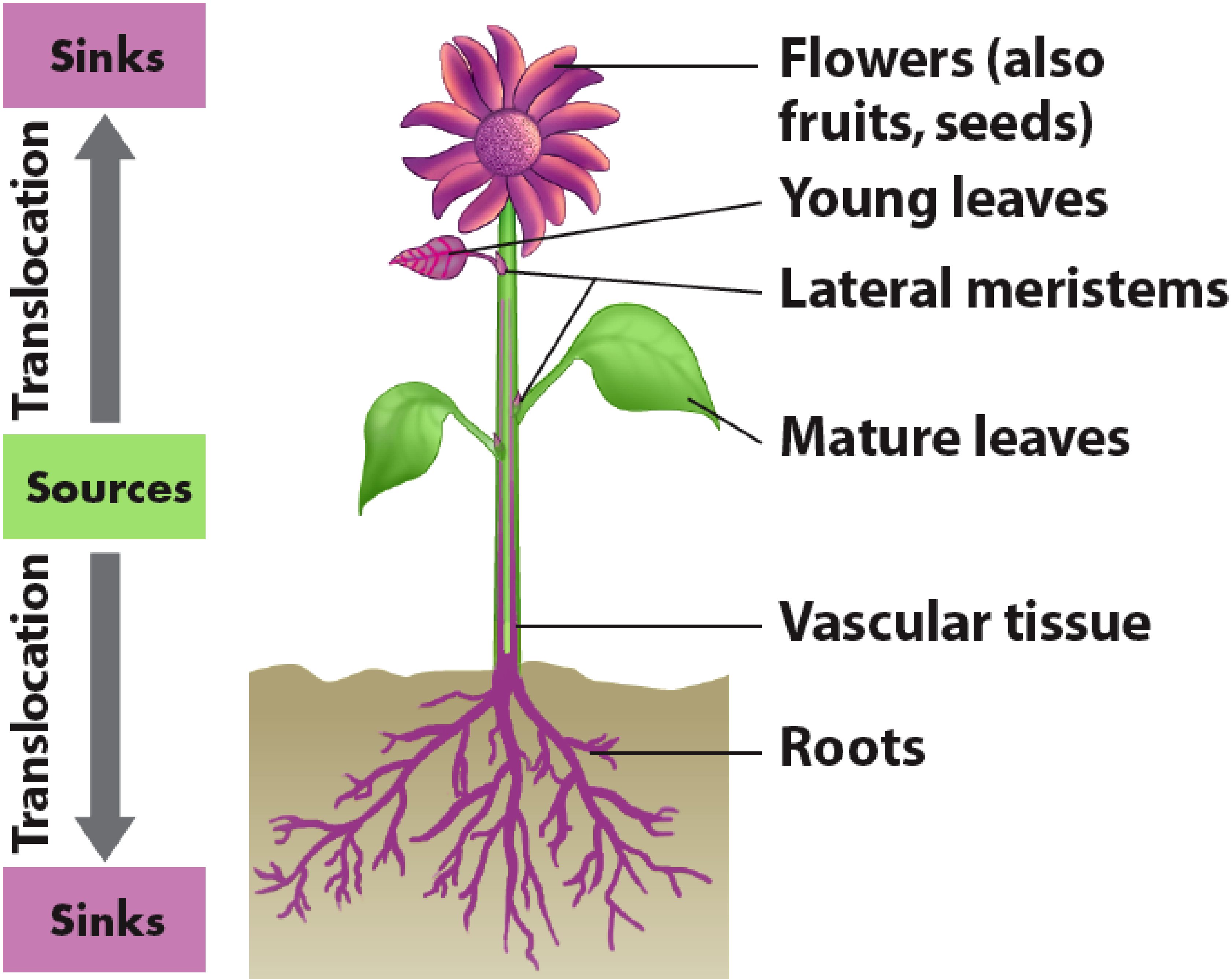


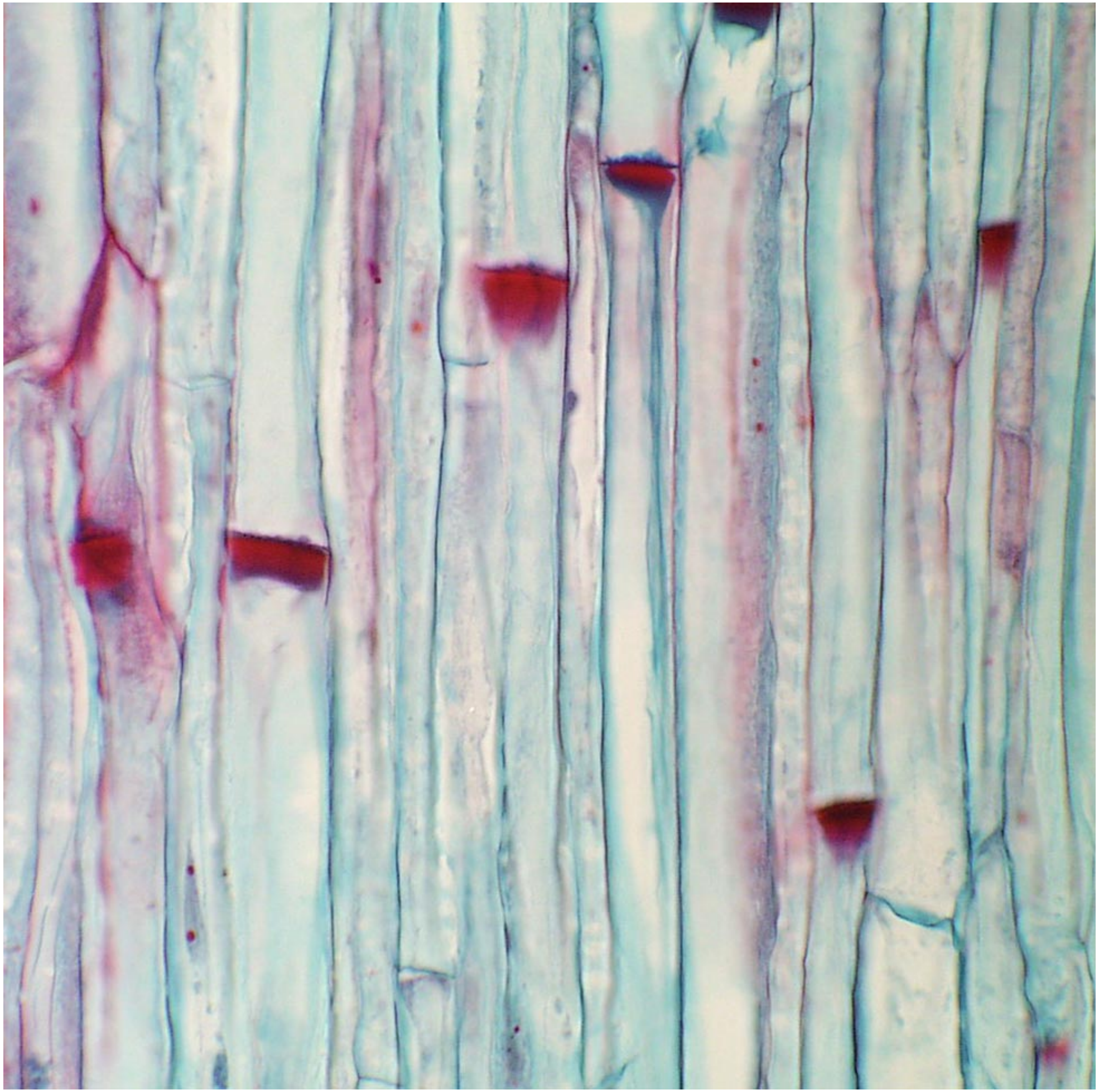
Figure 5.10 Plant Biology, 2/e


Light-dependent reactions
Light-independent reactions
Light energy
Chemical energy
Chemical energy
Sunlight
H_2O
O_2
ATP, NADPH
CO_2
(CH_2O)

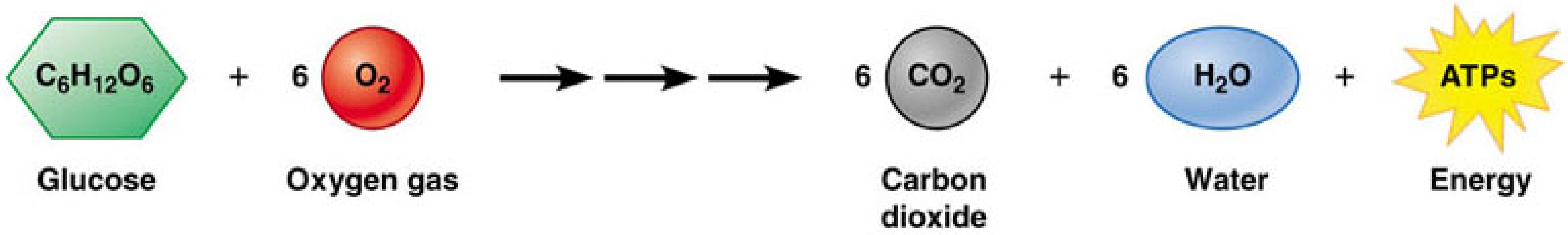


Sinks
Translocation
Sources
Translocation
Sinks
Flowers (also fruits, seeds)
Young leaves
Lateral meristems
Mature leaves
Vascular tissue
Roots

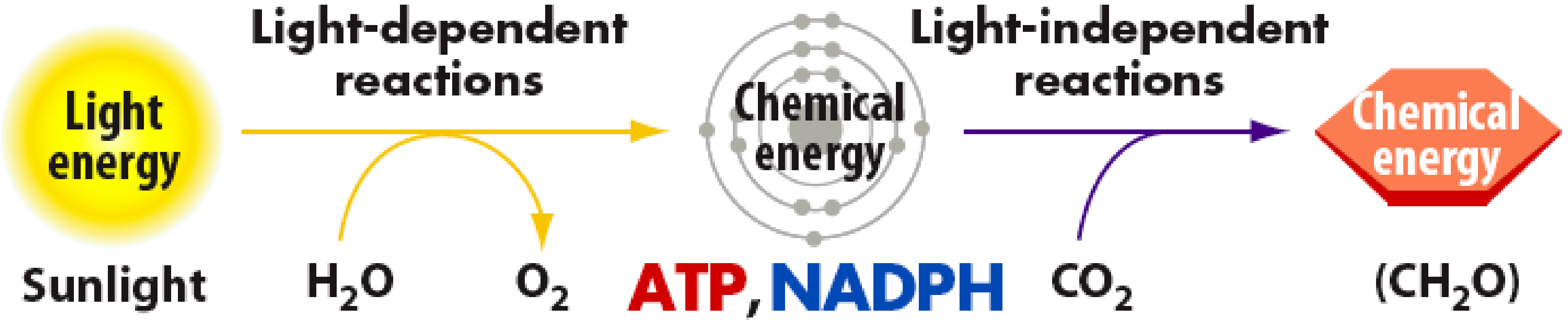
Vertical section of a stem showing phloem, the sugar-conducting tissue.



Respiration



Photosynthesis



Oxygen bubbles on an aquatic plant

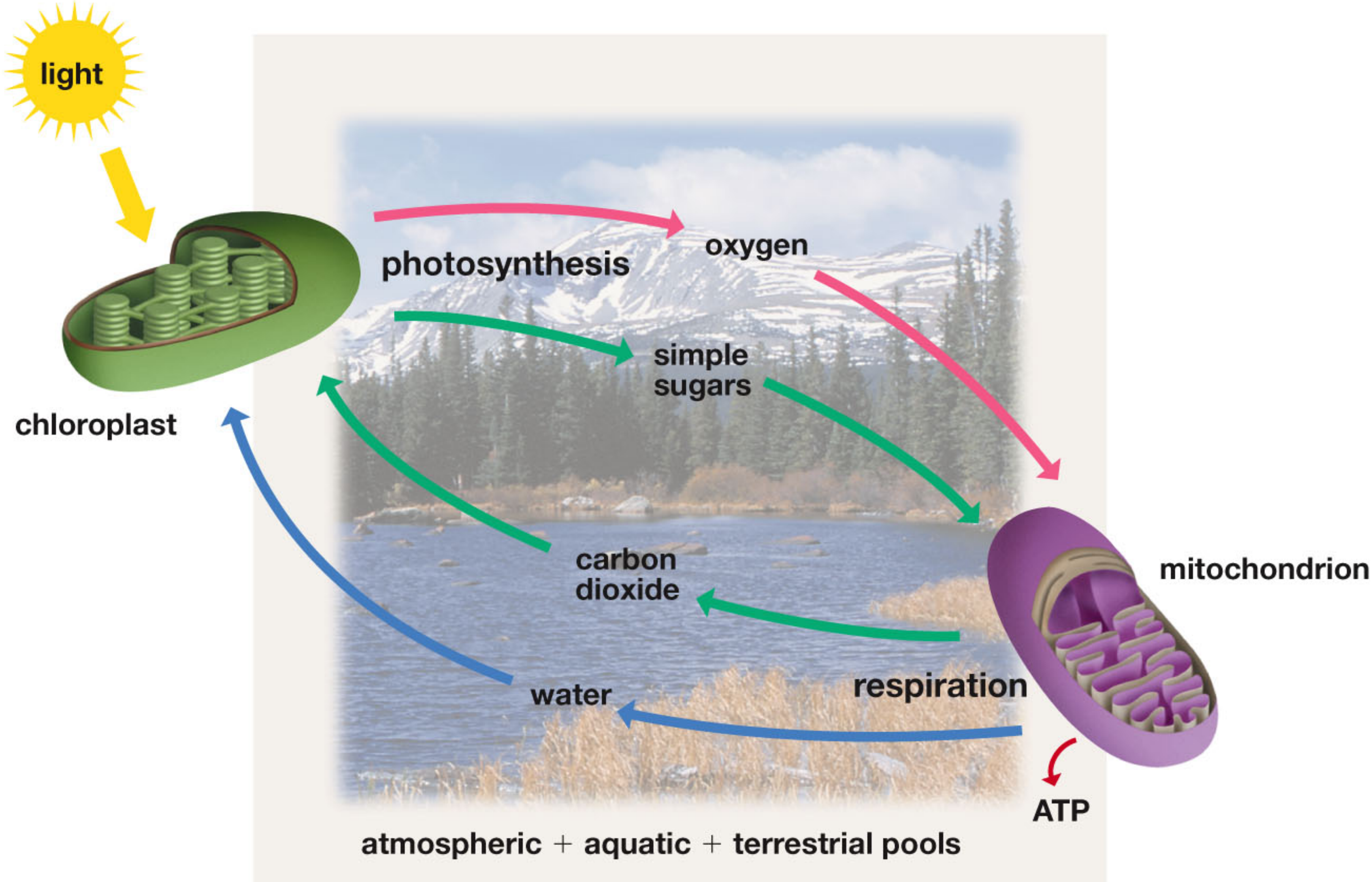
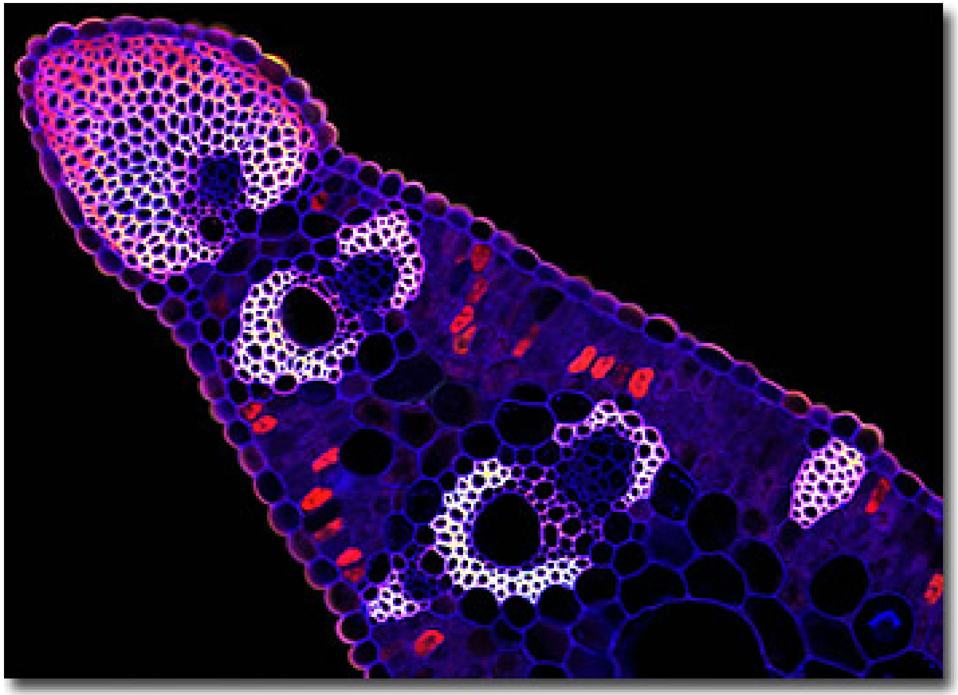


Figure 5.1 Plant Biology, 2/e

Roots need to absorb oxygen.



Cattail leaf

Pneumatophores on bald cypress

Plants absorb minerals through their roots.

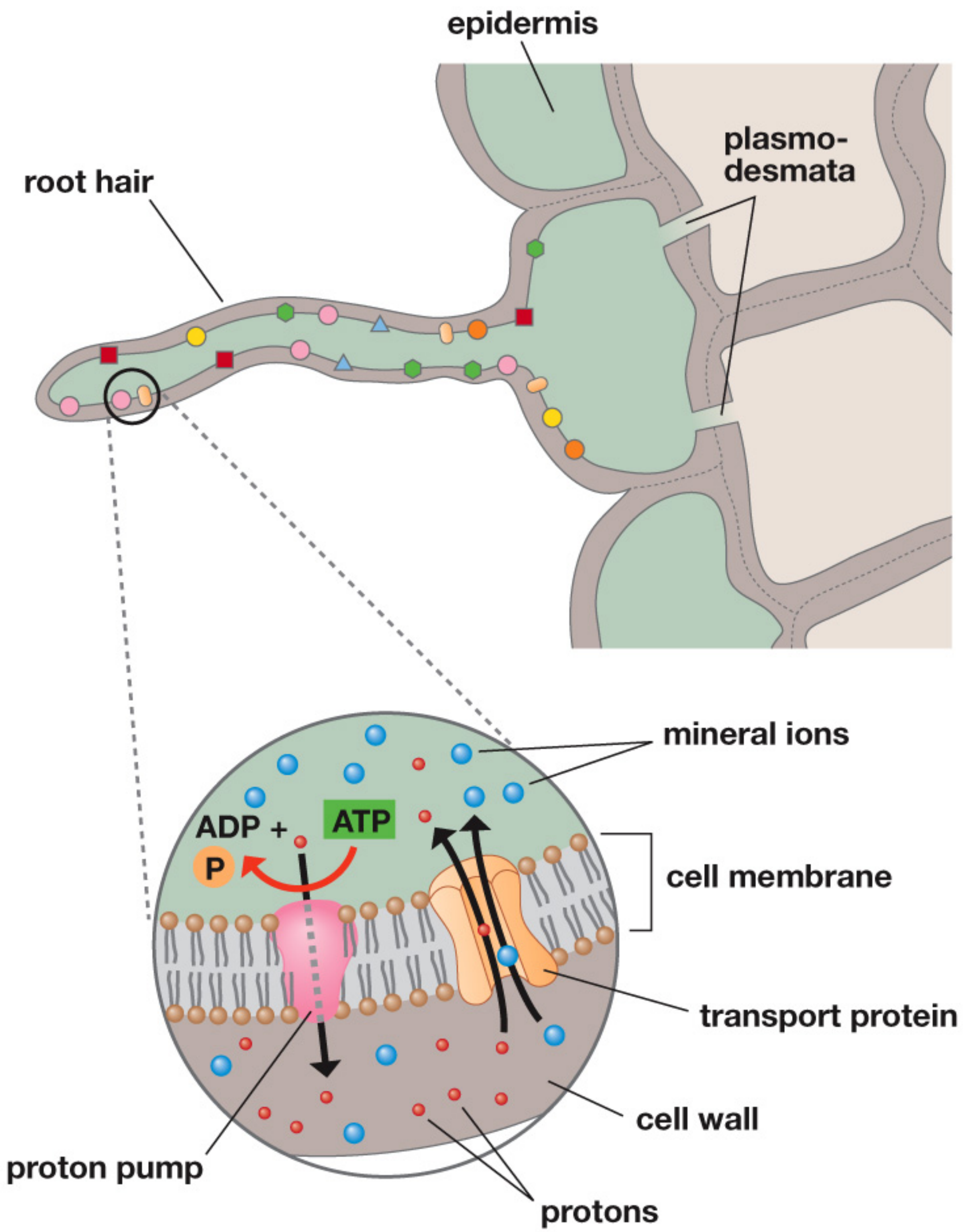
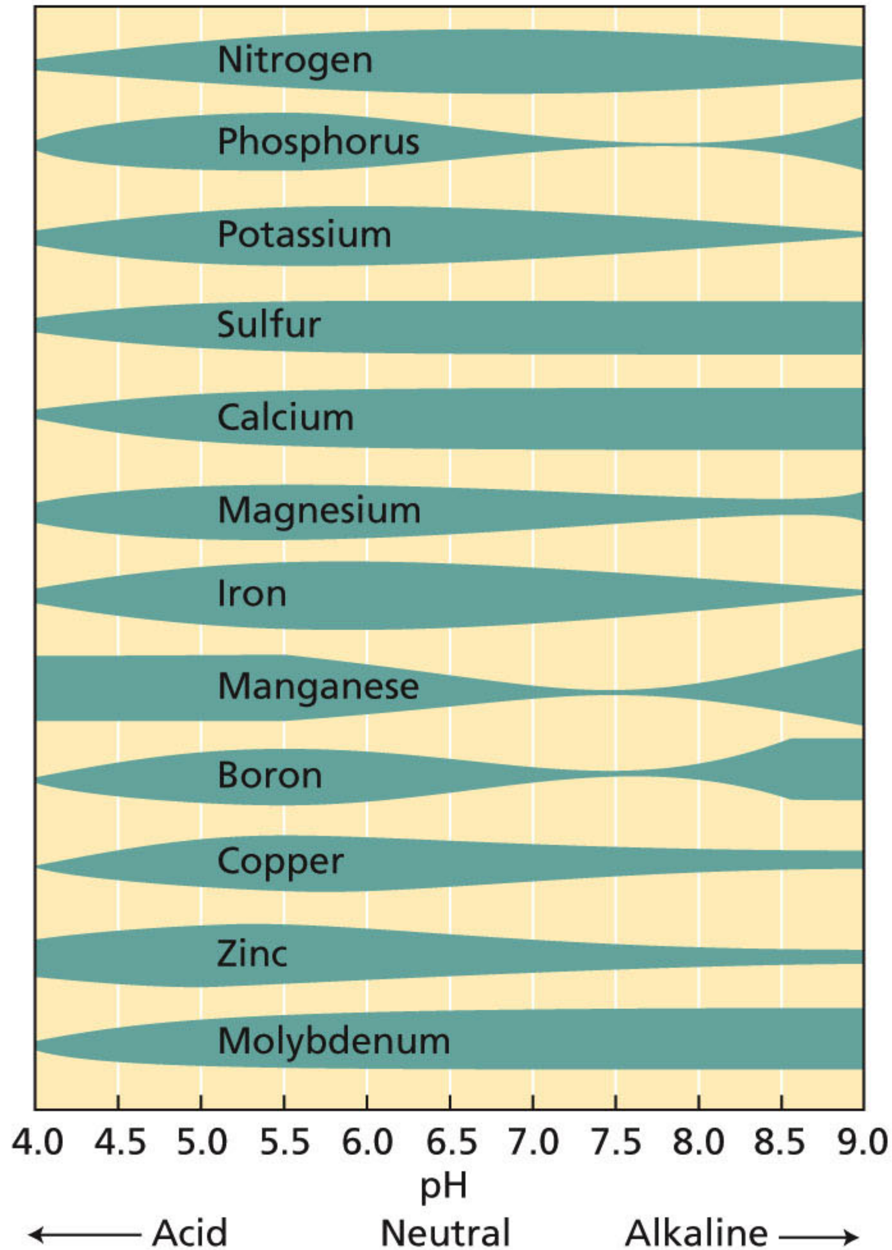


Figure 10.20 Plant Biology, 2/e

Influence of soil pH on the availability of nutrients in organic soils

Ideal pH for most plants is 5.5-7.0



PLANT PHYSIOLOGY, Fourth Edition, Figure 5.4 © 2

TABLE 10.1 Essential Elements for Plants: Sources and Functions

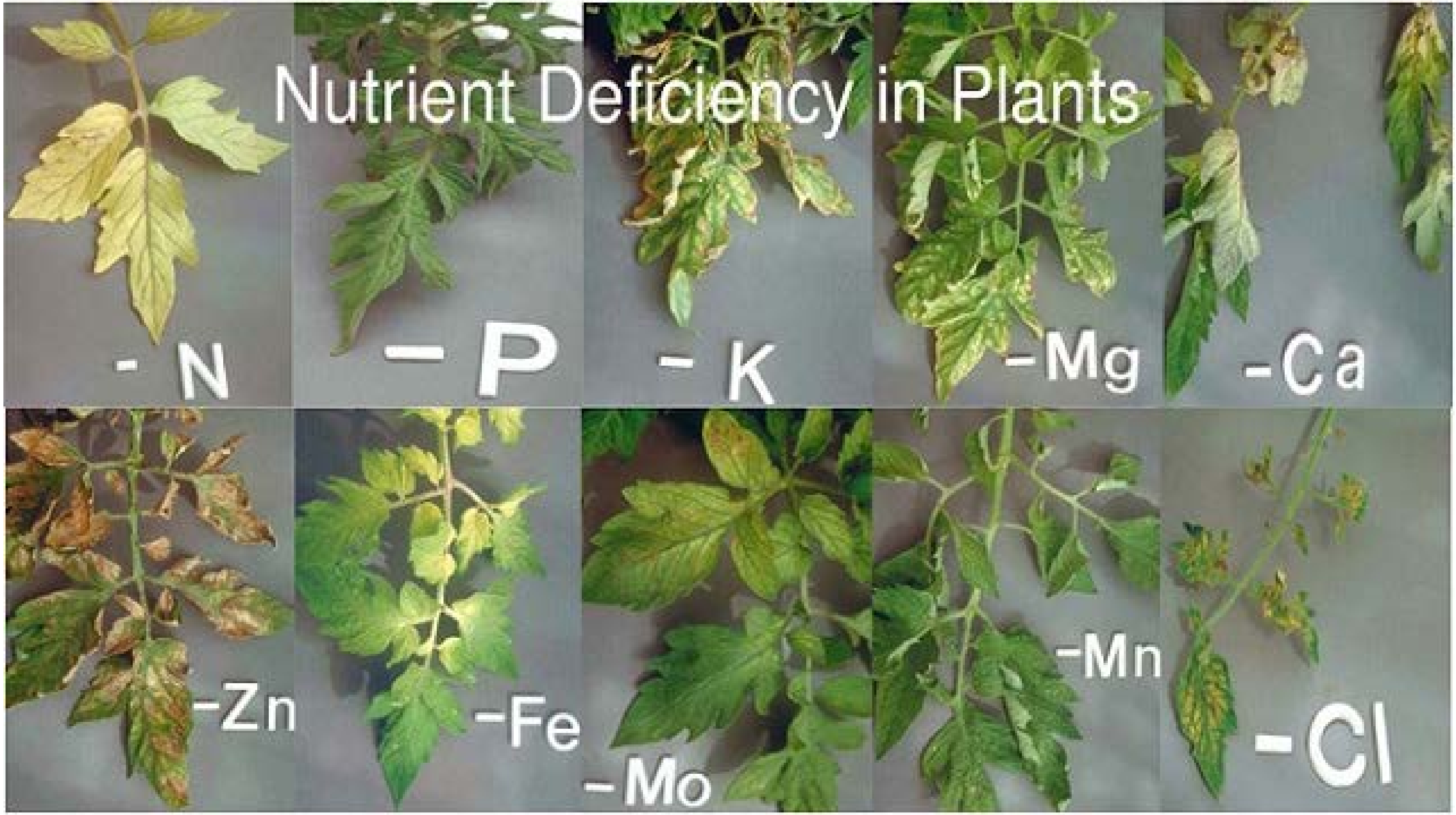
Element (Symbol)	Atomic Number	Percent of Plant Dry Weight	Source	Function(s)
Macronutrients				
Hydrogen (H)	1	6.0	Water	All organic molecules
Carbon (C)	6	45.0	Air as CO_2	All organic molecules
Nitrogen (N)	7	1.5	Soil	Proteins, nucleotides
Oxygen (O)	8	45.0	Water and air	All organic molecules
Magnesium (Mg)	12	0.2	Soil	In chlorophyll
Phosphorus (P)	15	0.2	Soil	Nucleotides, phospholipids
Sulfur (S)	16	0.1	Soil	Proteins, vitamins
Potassium (K)	19	1.0	Soil	Ionic balance in cells
Calcium (Ca)	20	0.5	Soil	Cell-wall component

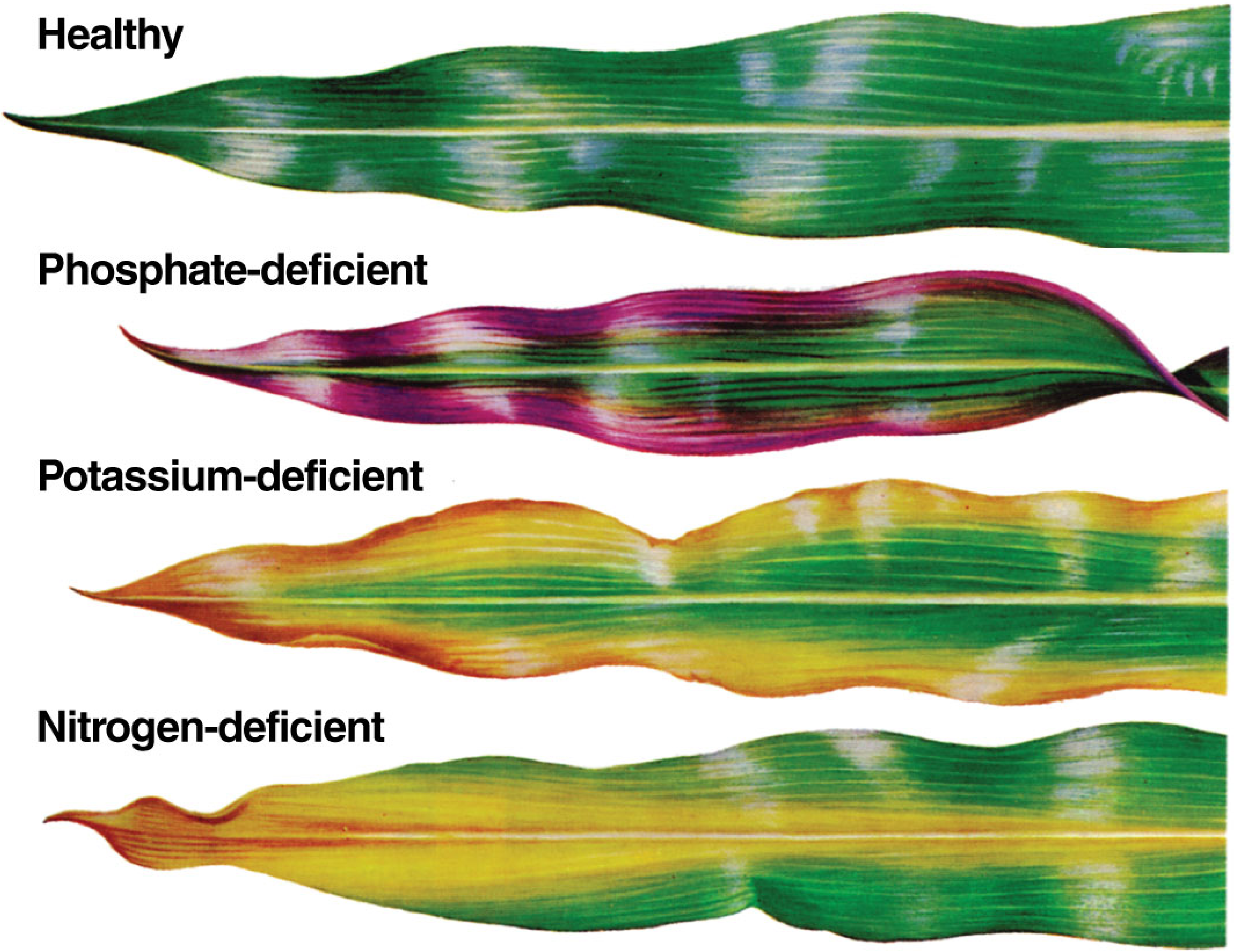
Table 10.1 (top) Plant Biology, 2/e

TABLE 10.1 ***continued***

Micronutrients				
Boron (B)	5	0.002	Soil	Uncertain
Chlorine (Cl)	17	0.01	Soil	Ionic balance in cells
Manganese (Mn)	25	0.005	Soil	Enzyme cofactor
Iron (Fe)	26	0.01	Soil	Enzyme cofactor
Copper (Cu)	29	0.0006	Soil	Enzyme cofactor
Zinc (Zn)	30	0.002	Soil	Enzyme cofactor
Molybdenum (Mo)	42	0.00001	Soil	Enzyme cofactor

Table 10.1 (bottom) Plant Biology, 2/e


Nutrient Deficiency in Plants
- N
- P
- K
-Mg
-Ca
-Zn
-Fe
-Mo
-Mn
-Cl


Healthy
Phosphate-deficient
Potassium-deficient
Nitrogen-deficient

Sulfur deficient corn

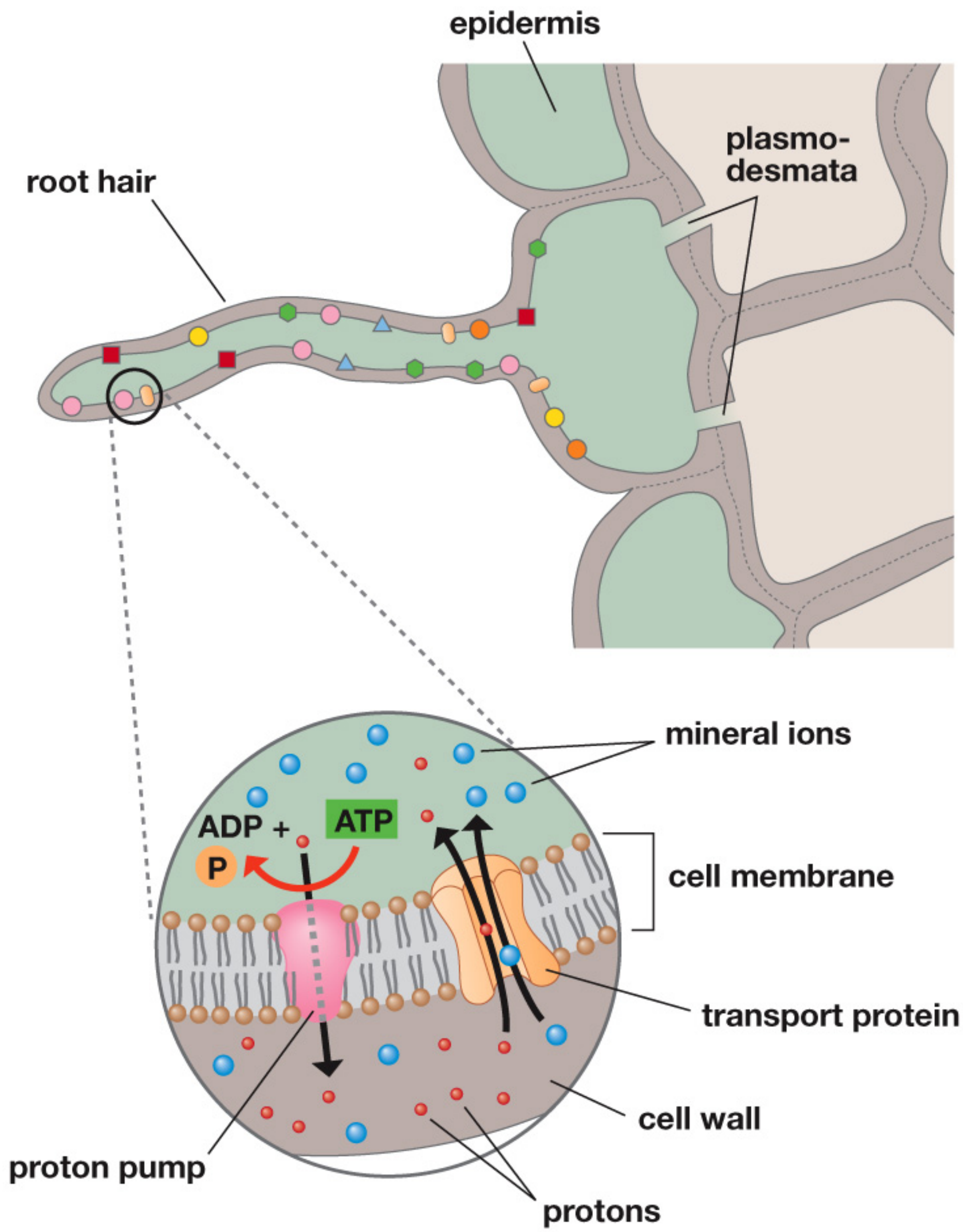


Figure 10.20 Plant Biology, 2/e

Nitrogen-fixing nodules on bean roots

Figure 10.24 Plant Biology, 2/e

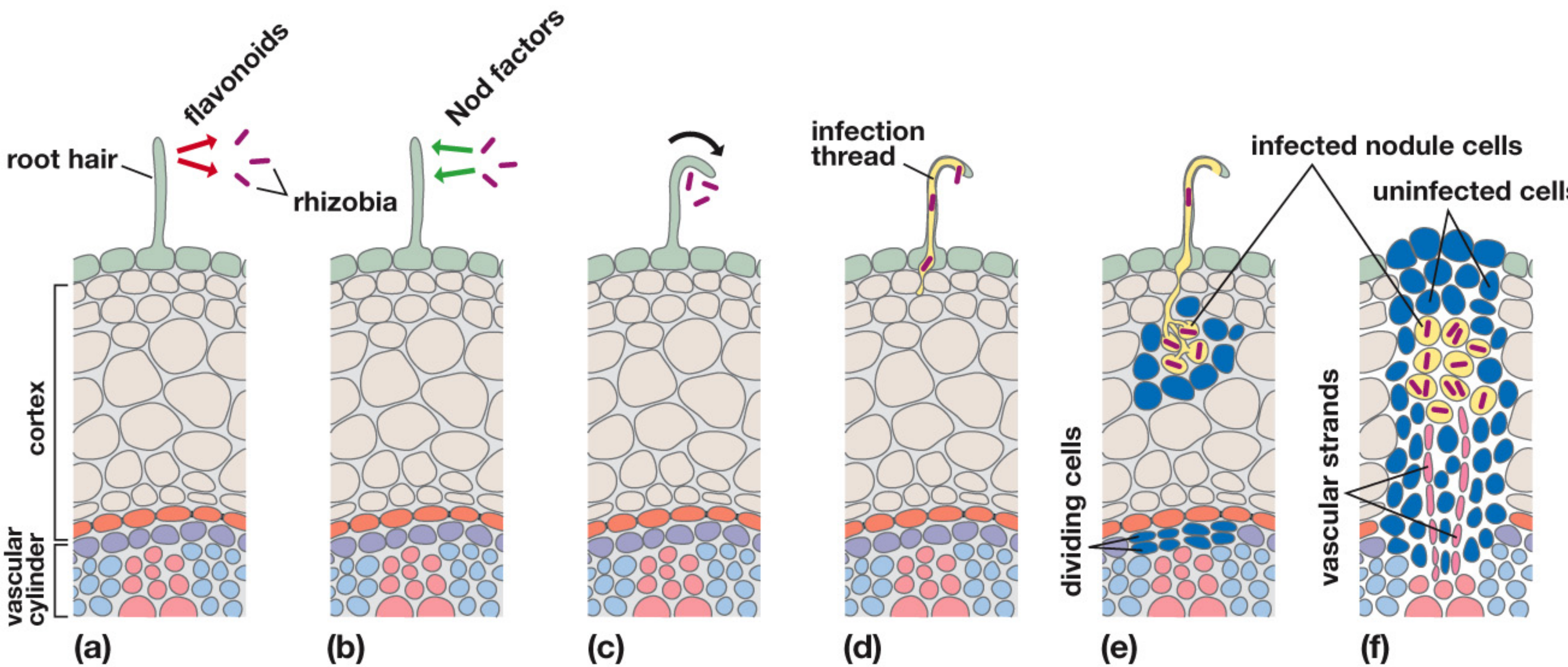
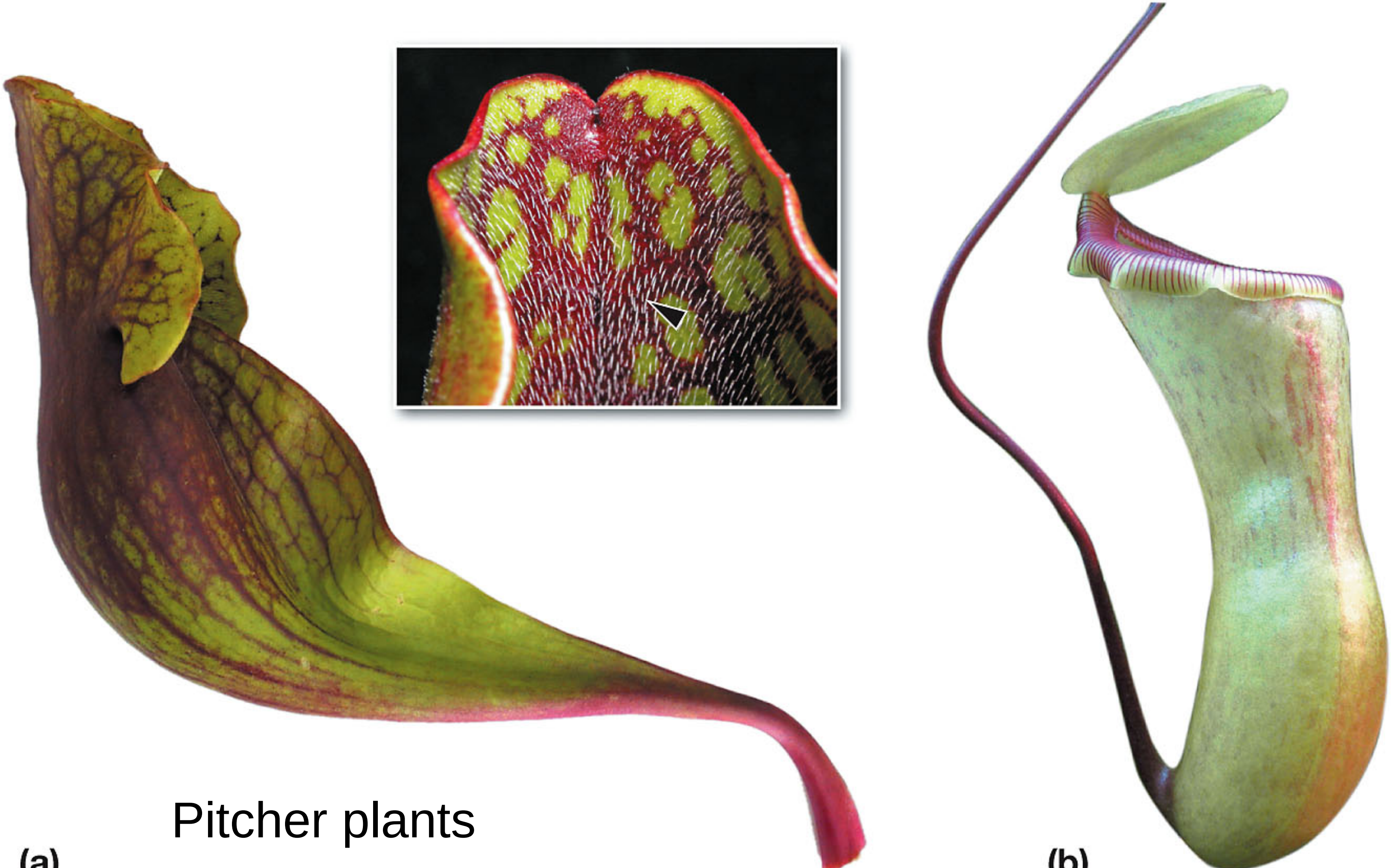


Figure 10.23 Plant Biology, 2/e



Pitcher plants

Figure 11.24 Plant Biology, 2/e

Pitcher plant

mistletoe

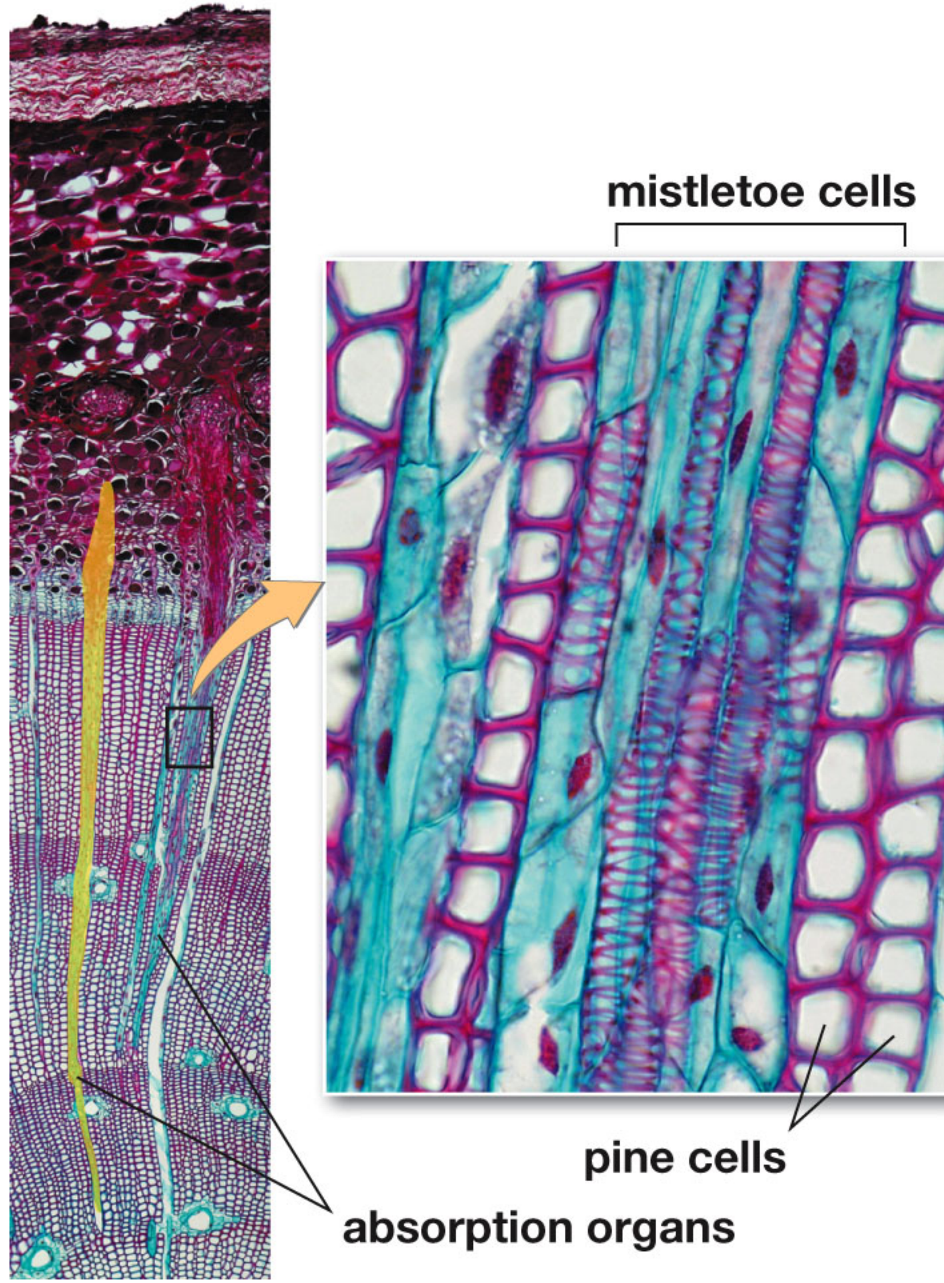


Figure 10.8 Plant Biology, 2/e

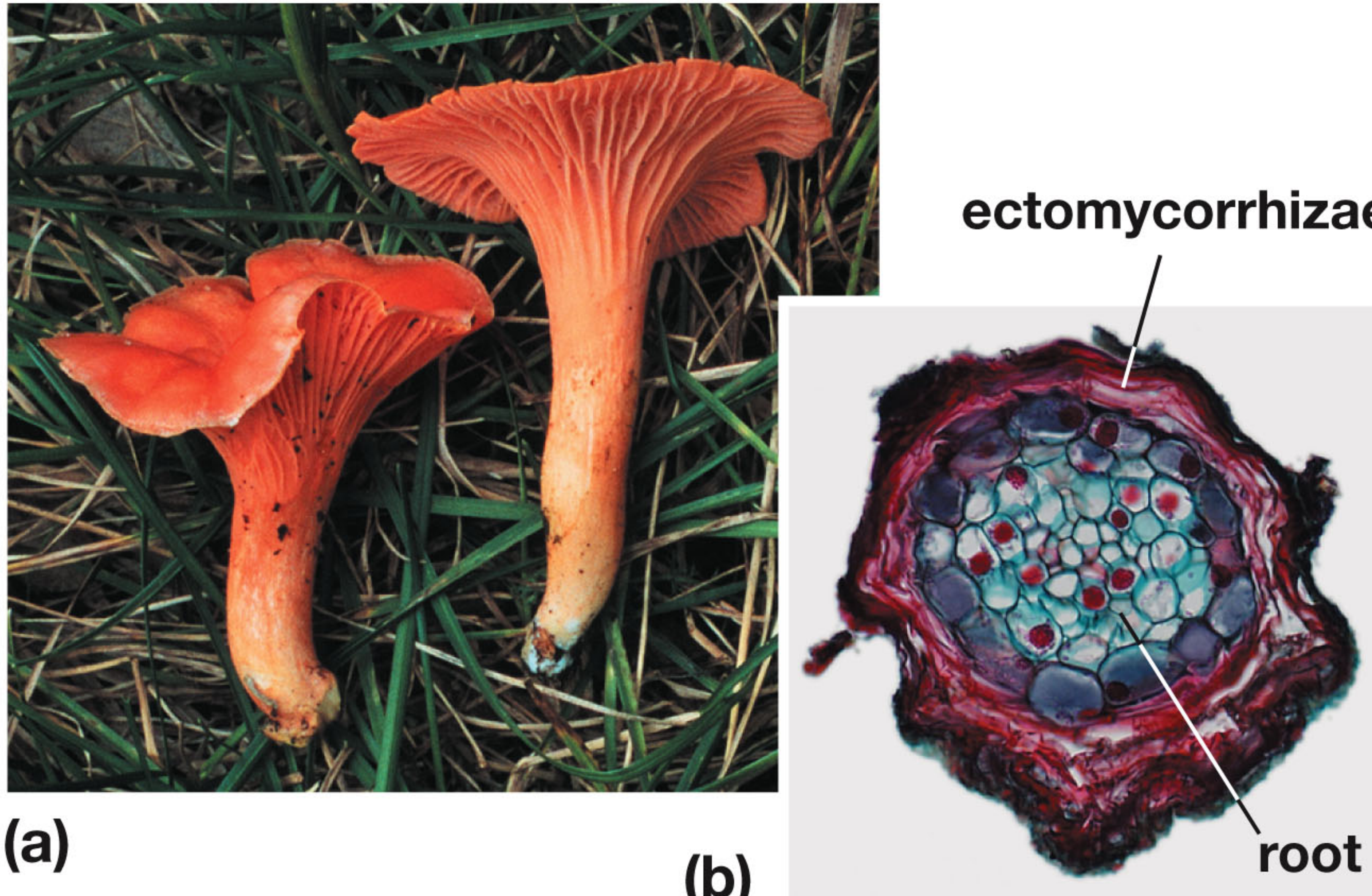


Figure 20.17a,b Plant Biology, 2/e

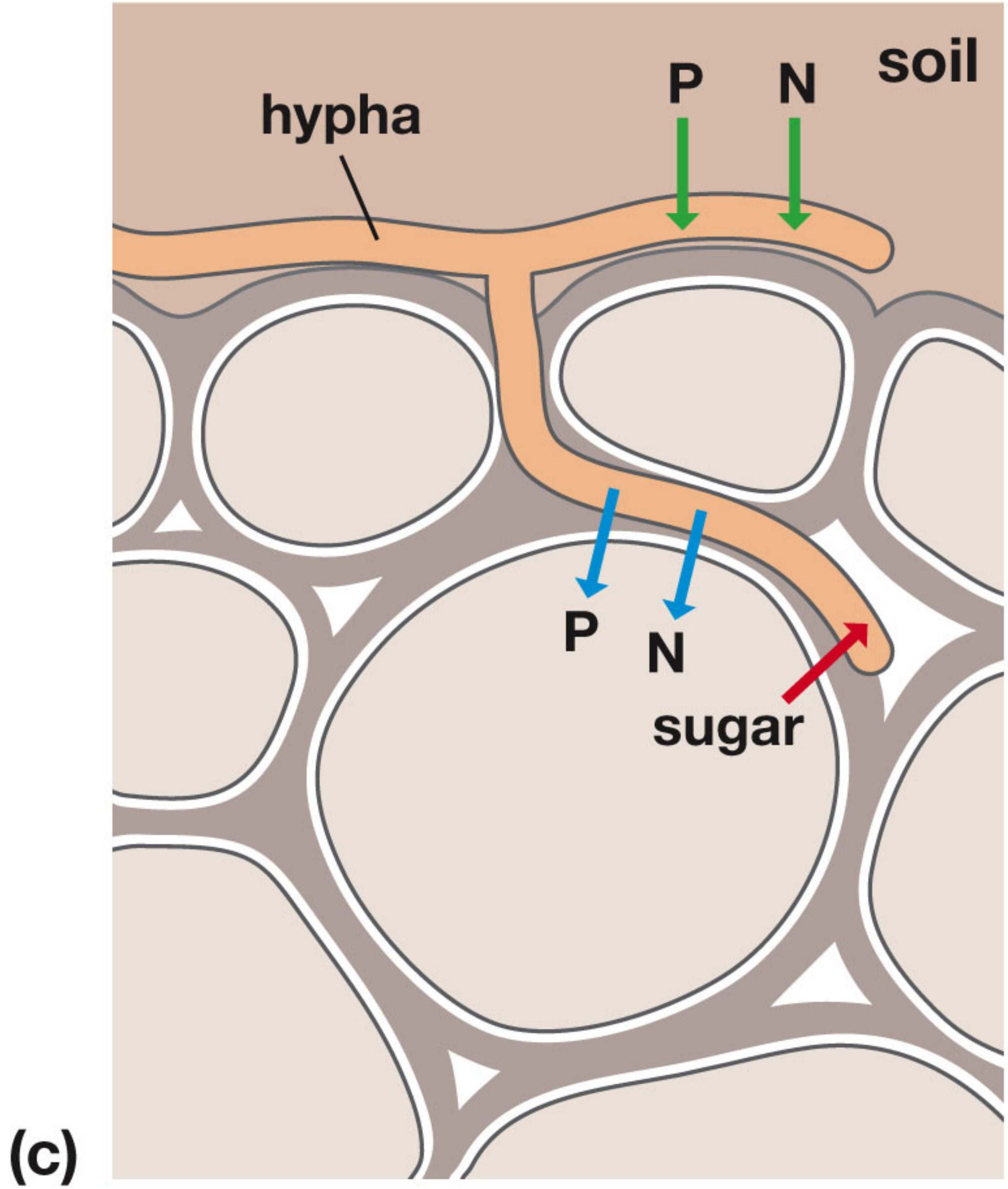


Figure 20.17c Plant Biology, 2/e

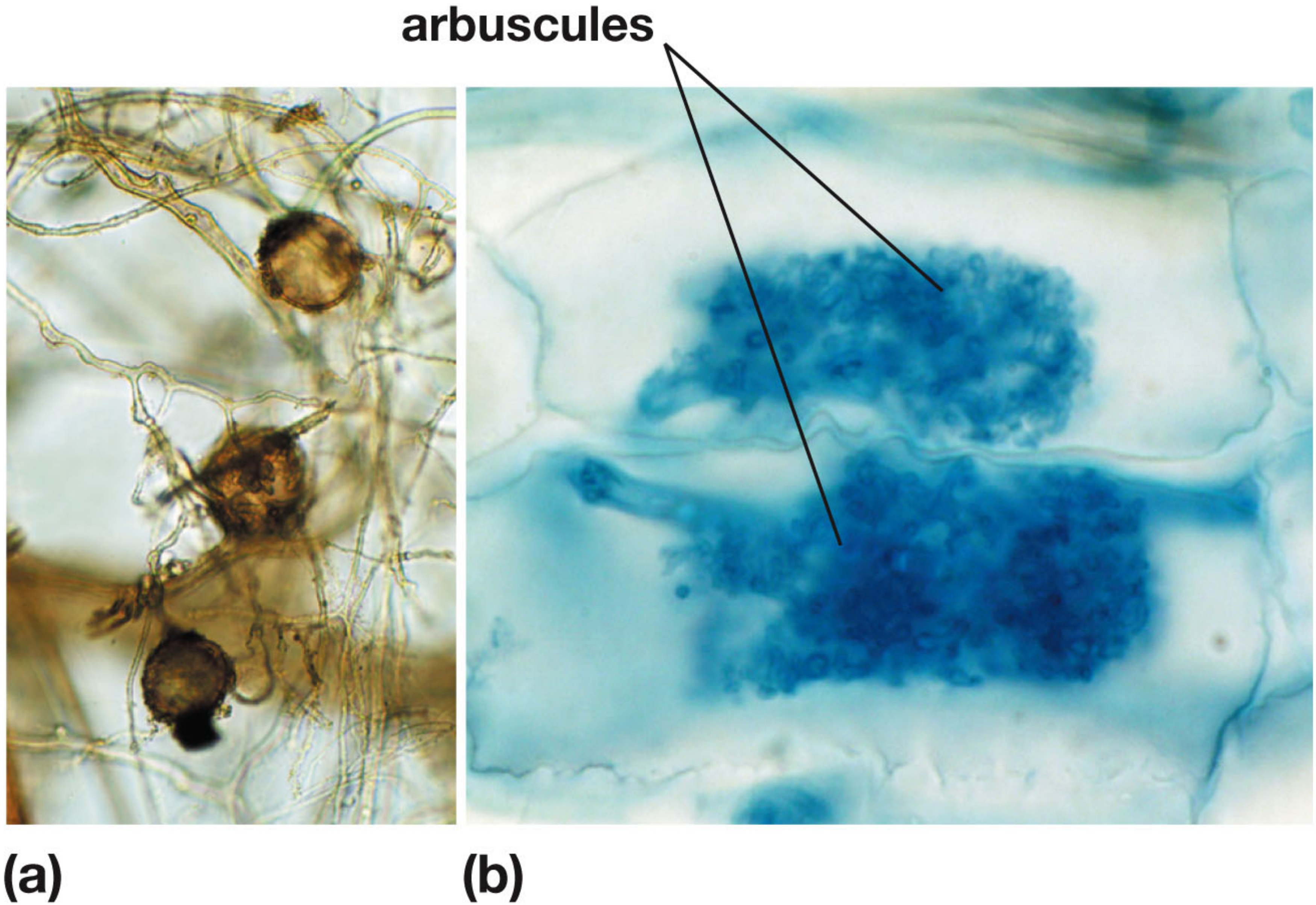


Figure 20.18a,b Plant Biology, 2/e

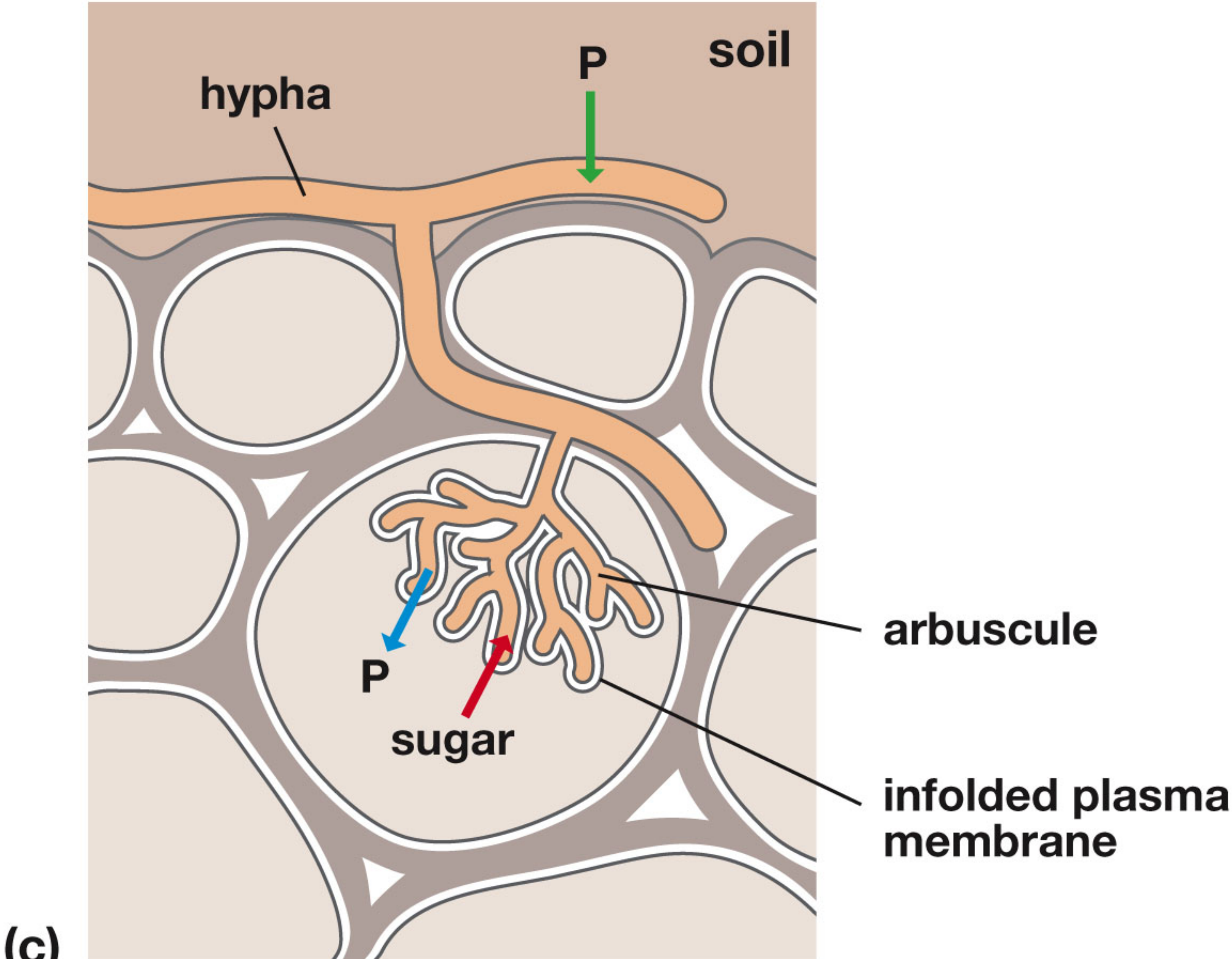
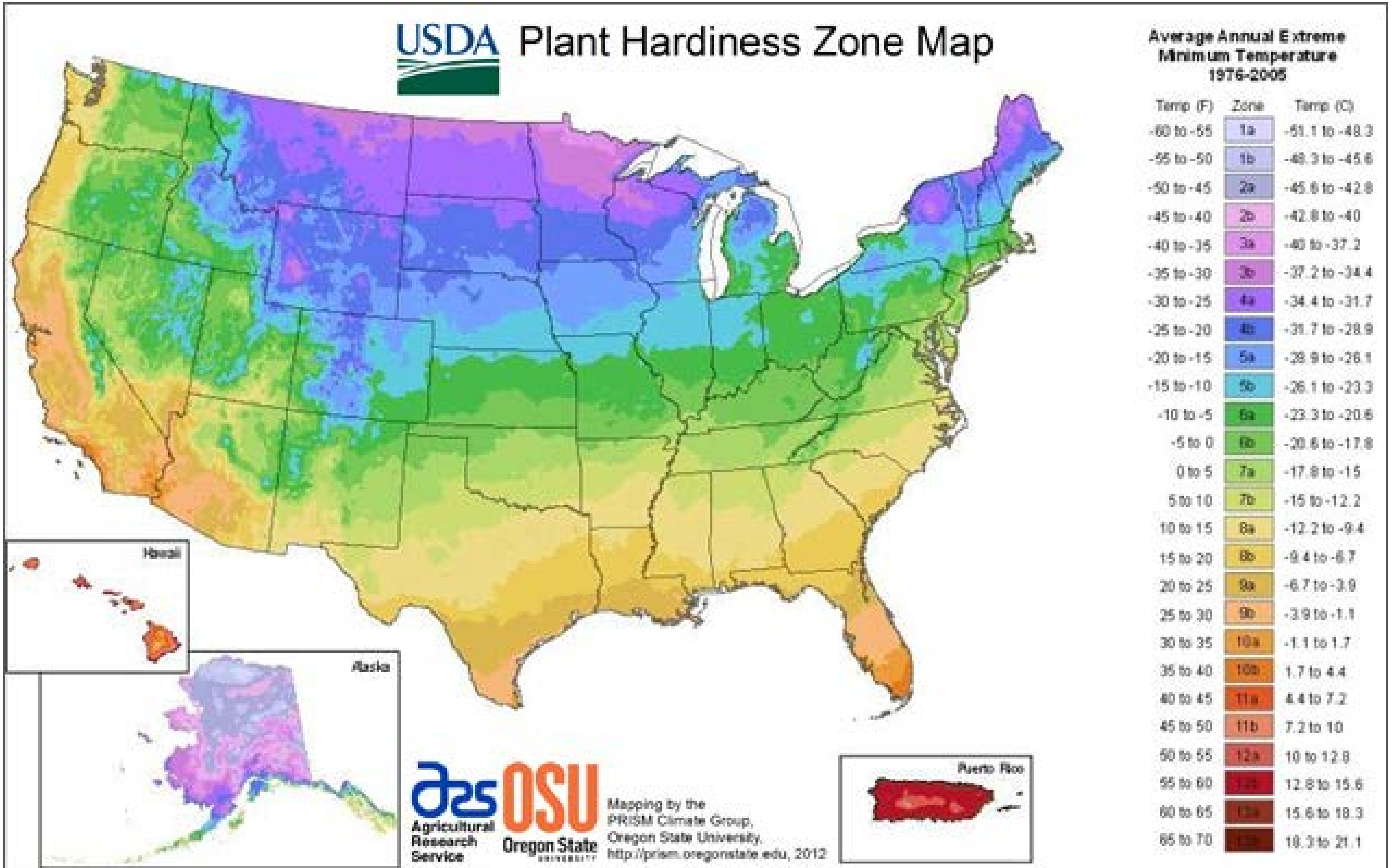


Figure 20.18c Plant Biology, 2/e

TABLE 26.3
Heat-killing temperatures for plants

Plant	Heat-killing temperature (°C)	Time of exposure
Nicotiana rustica (wild tobacco)	49–51	10 min
Cucurbita pepo (squash)	49–51	10 min
Zea mays (corn)	49–51	10 min
Brassica napus (rape)	49–51	10 min
Citrus aurantium (sour orange)	50.5	15–30 min
Opuntia (cactus)	>65	—
Sempervivum arachnoideum (succulent)	57–61	—
Potato leaves	42.5	1 hour
Pine and spruce seedlings	54–55	5 min
Medicago seeds (alfalfa)	120	30 min
Grape (ripe fruit)	63	—
Tomato fruit	45	—
Red pine pollen	70	1 hour
Various mosses		
Hydrated	42–51	—
Dehydrated	85–110	—

Source: After Table 11.2 in Levitt 1980.


USDA
Plant Hardiness Zone Map
Average Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-60 to -55 1a -51.1 to -48.3
-55 to -50 1b -48.3 to -45.6
-50 to -45 2a -45.6 to -42.8
-45 to -40 2b -42.8 to -40
-40 to -35 3a -40 to -37.2
-35 to -30 3b -37.2 to -34.4
-30 to -25 4a -34.4 to -31.7
-25 to -20 4b -31.7 to -28.9
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
5 to 10 7b -15 to -12.2
10 to 15 8a -12.2 to -9.4
15 to 20 8b -9.4 to -6.7
20 to 25 9a -6.7 to -3.9
25 to 30 9b -3.9 to -1.1
30 to 35 10a -1.1 to 1.7
35 to 40 10b 1.7 to 4.4
40 to 45 11a 4.4 to 7.2
45 to 50 11b 7.2 to 10
50 to 55 12a 10 to 12.8
55 to 60 12.8 to 15.6
60 to 65 15.6 to 18.3
65 to 70 18.3 to 21.1
Hawaii
Alaska
Puerto Rico
Agricultural Research Service
OSU
Oregon State UNIVERSITY
Mapping by the PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, 2012

Magnolia grandiflora

What do plants need to live?

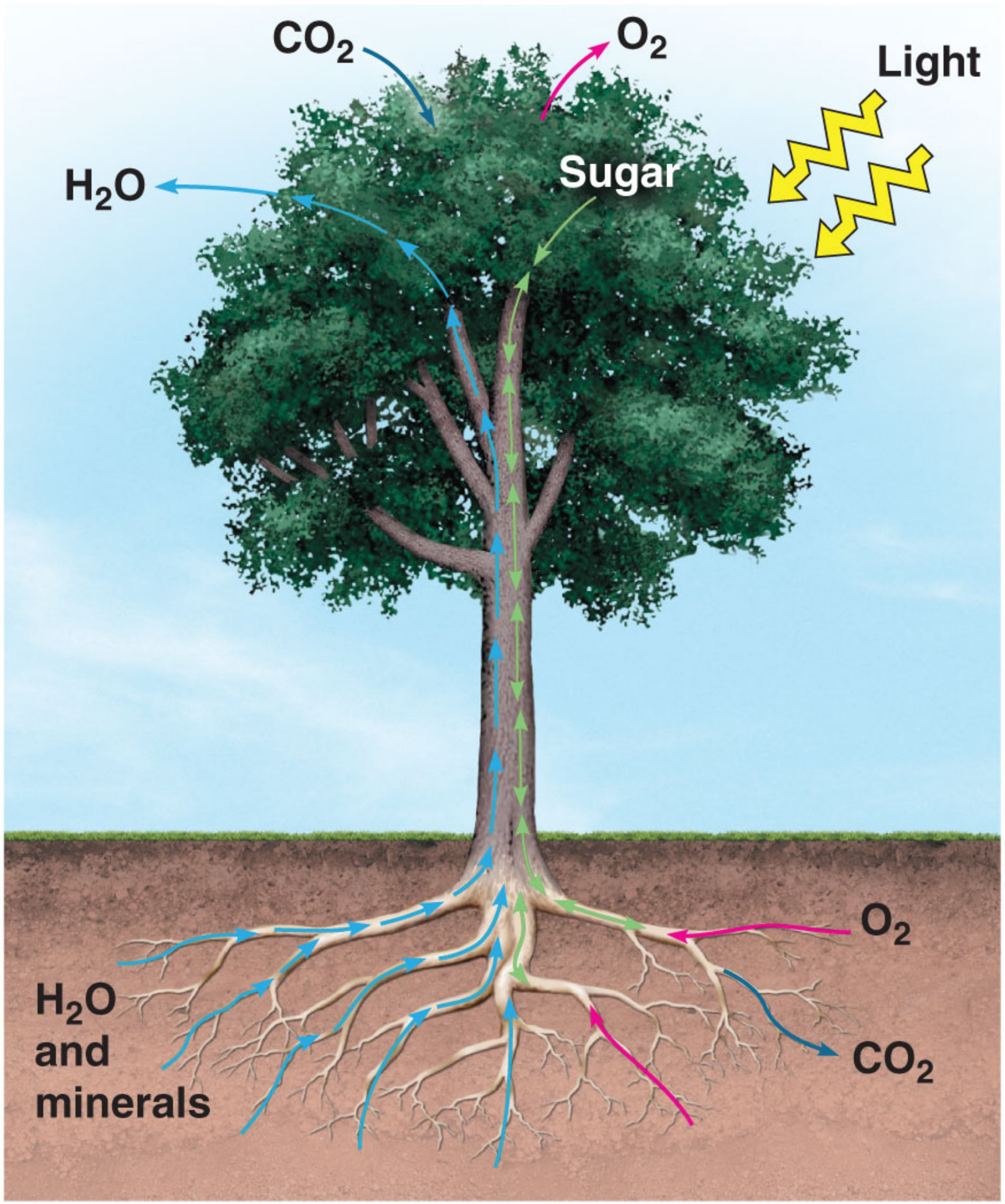
Water

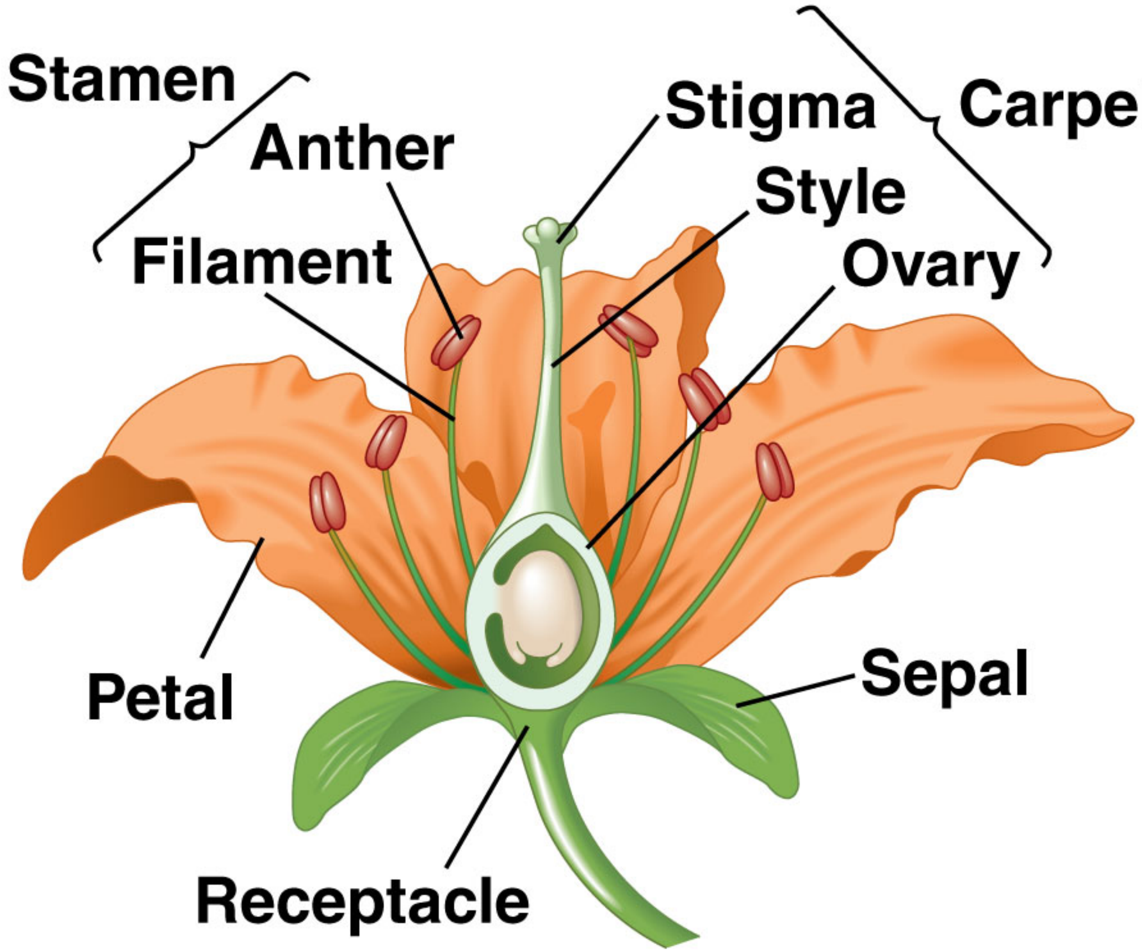
Light

Air

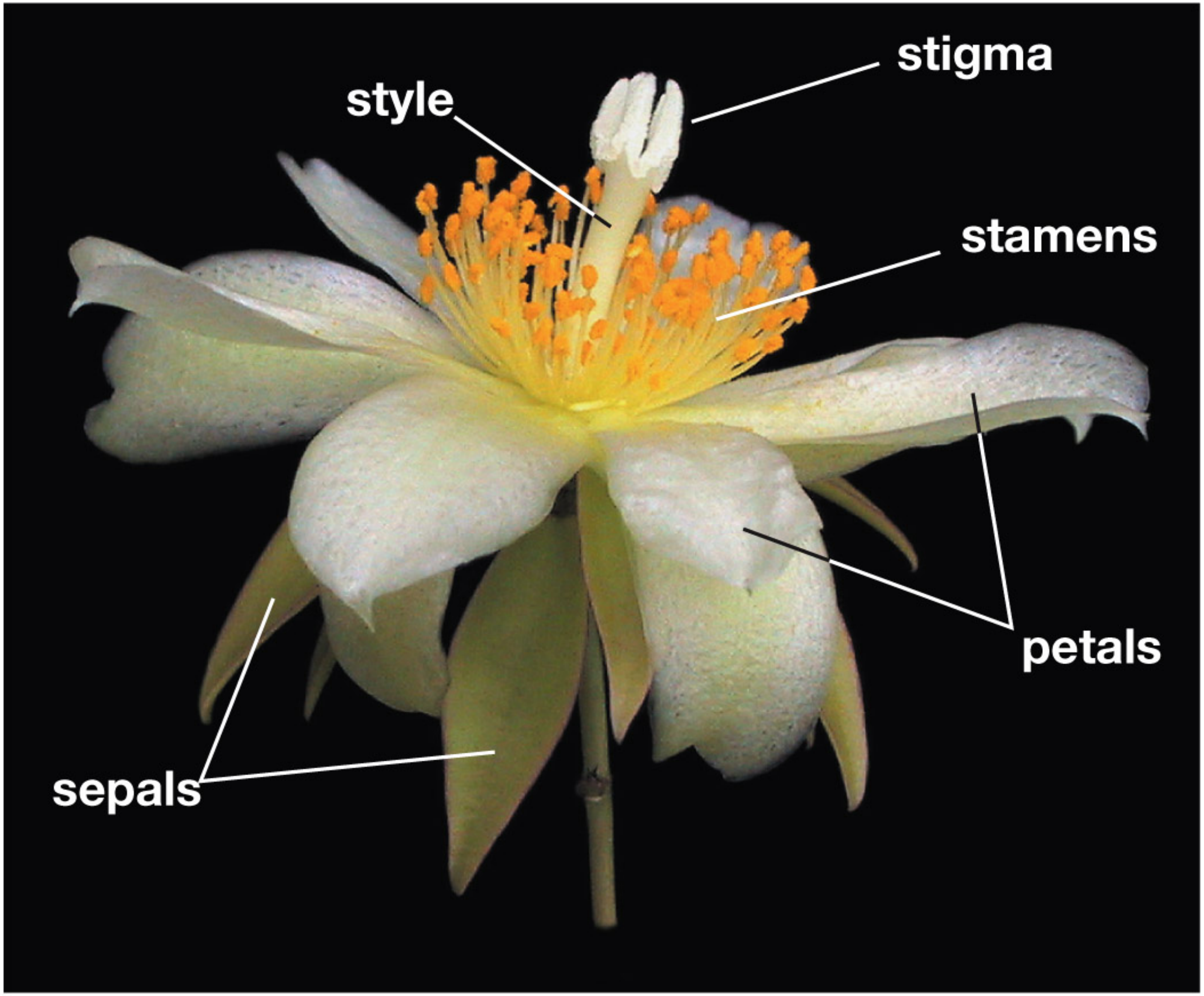
Minerals

Habitat





(a) Structure of an idealized flower



(b)

Figure 23.6b Plant Biology, 2/e

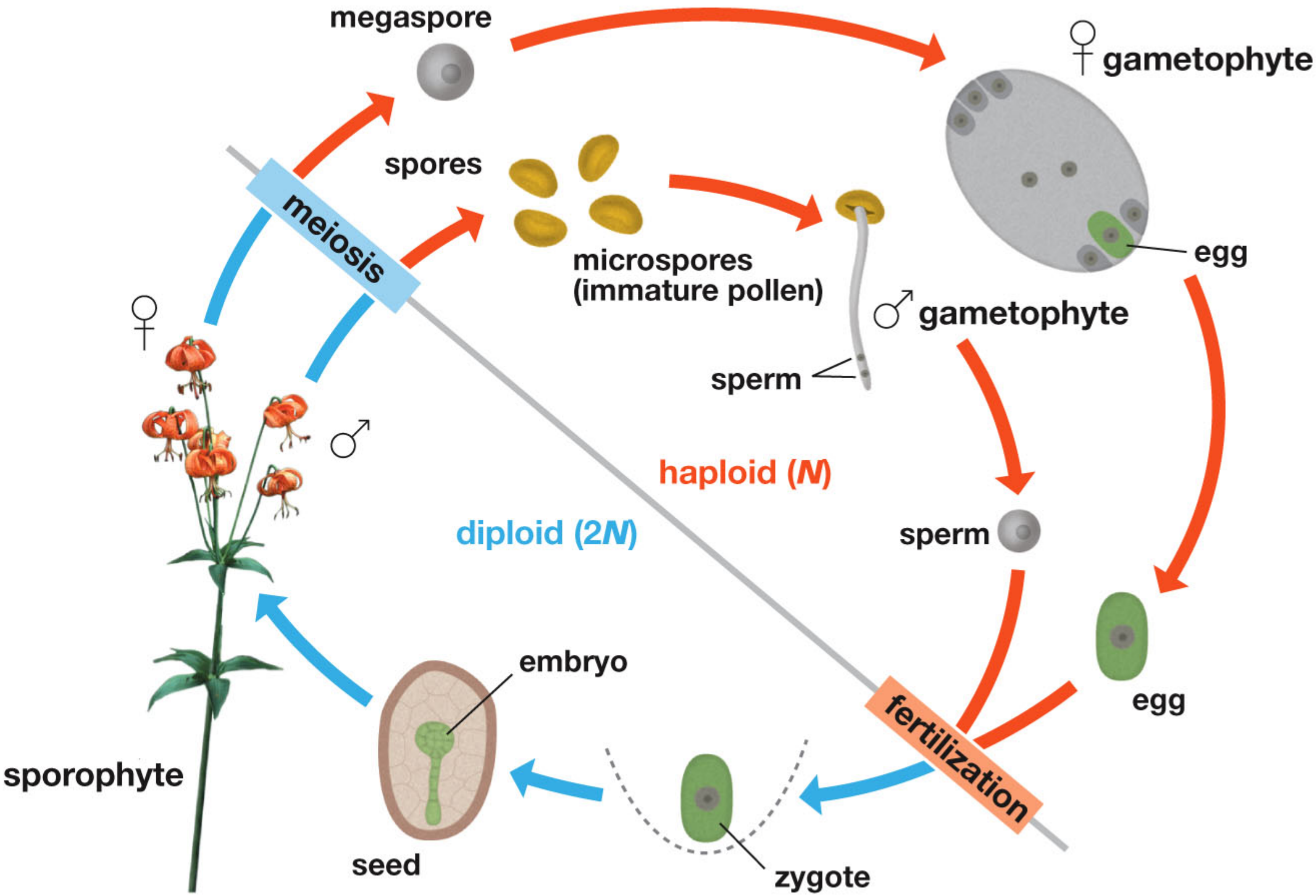


Figure 13.17 Plant Biology, 2/e

Pollination

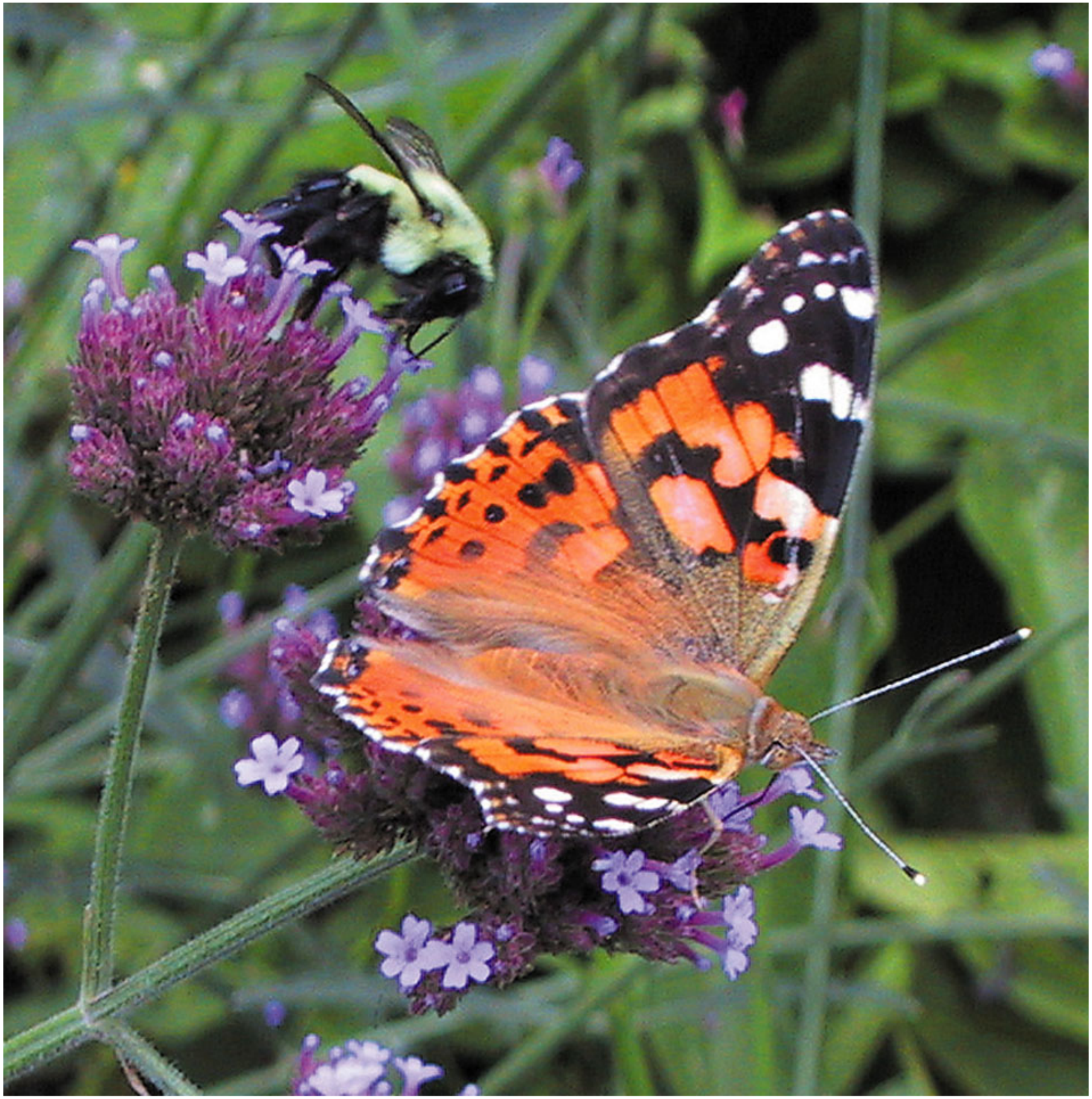


Figure 24.6 Plant Biology, 2/e

Wind-pollinated grass flowers

Figure 24.17 Plant Biology, 2/e

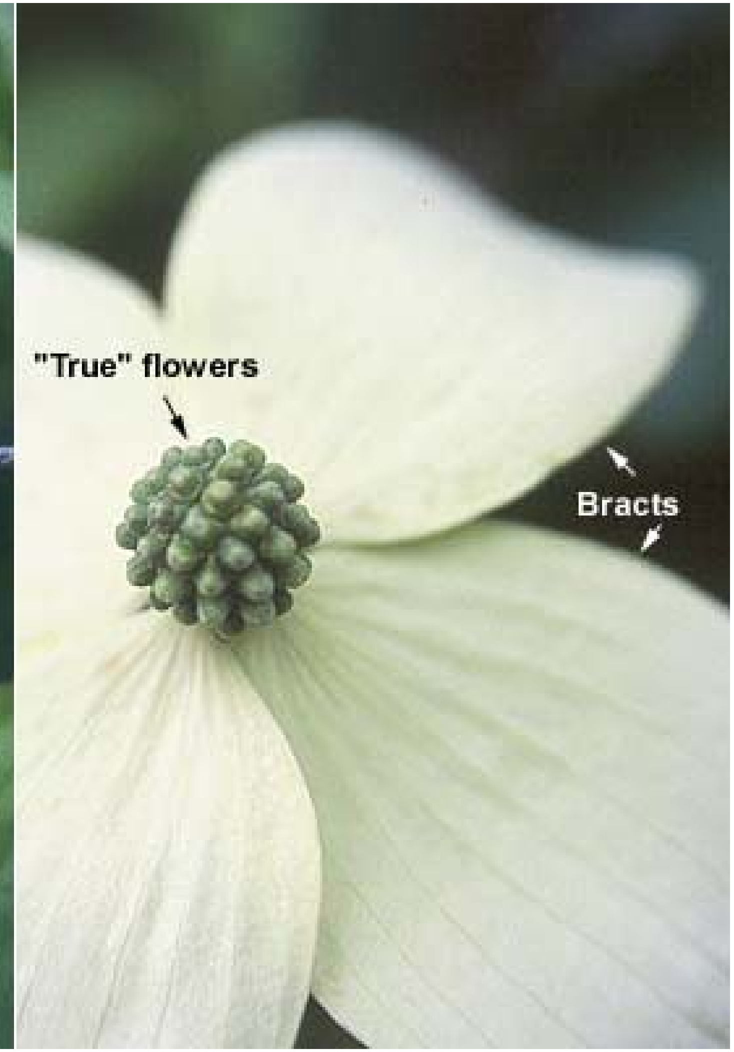
Figure 24.24 Plant Biology, 2/e

Figure 24.21 Plant Biology, 2/e

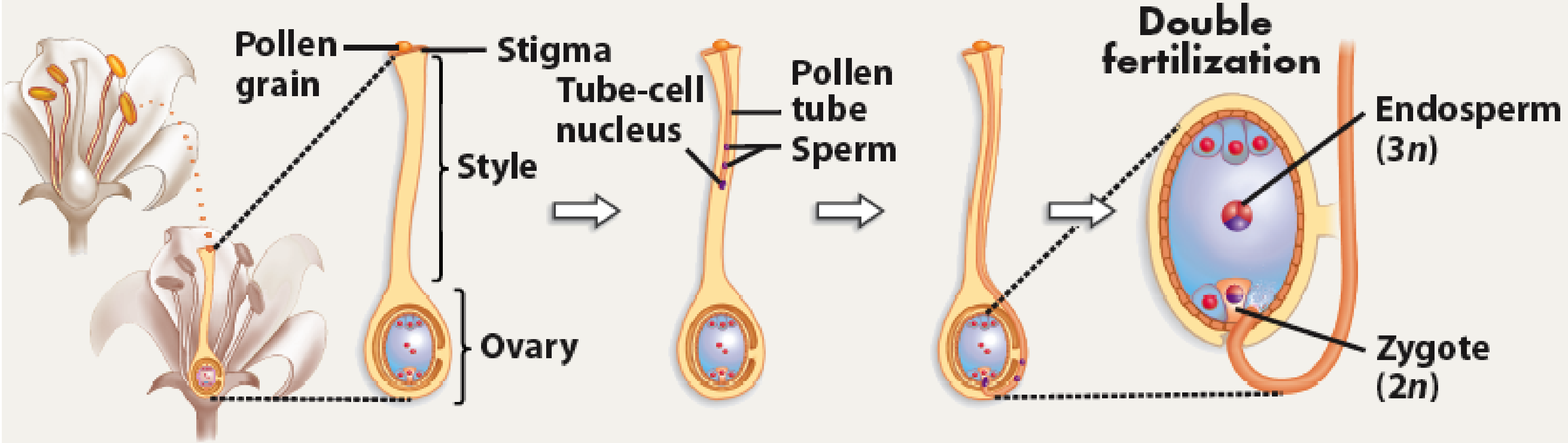
Figure 24.27 Plant Biology, 2/e

Figure 24.28 Plant Biology, 2/e

Bracts



POLLEN TUBE GROWTH AND FERTILIZATION



1. Pollen grain germinates on the stigma. Pollen tube begins growing down the style.

2. The tube-cell nucleus moves into pollen tube, and the generative cell nucleus divides by mitosis to form two sperm in pollen tube.

3. Pollen tube completes growth toward the egg by passing through micropyle and discharging the two sperm into a cell adjacent to egg.

4. One sperm unites with egg to form zygote. The other fuses with the two polar nuclei to form endosperm (nutrient tissue).

The ovary matures into a fruit, and the ovules mature into seeds.

Conifers have seeds in cones.

Flowering plants have seeds in fruits.

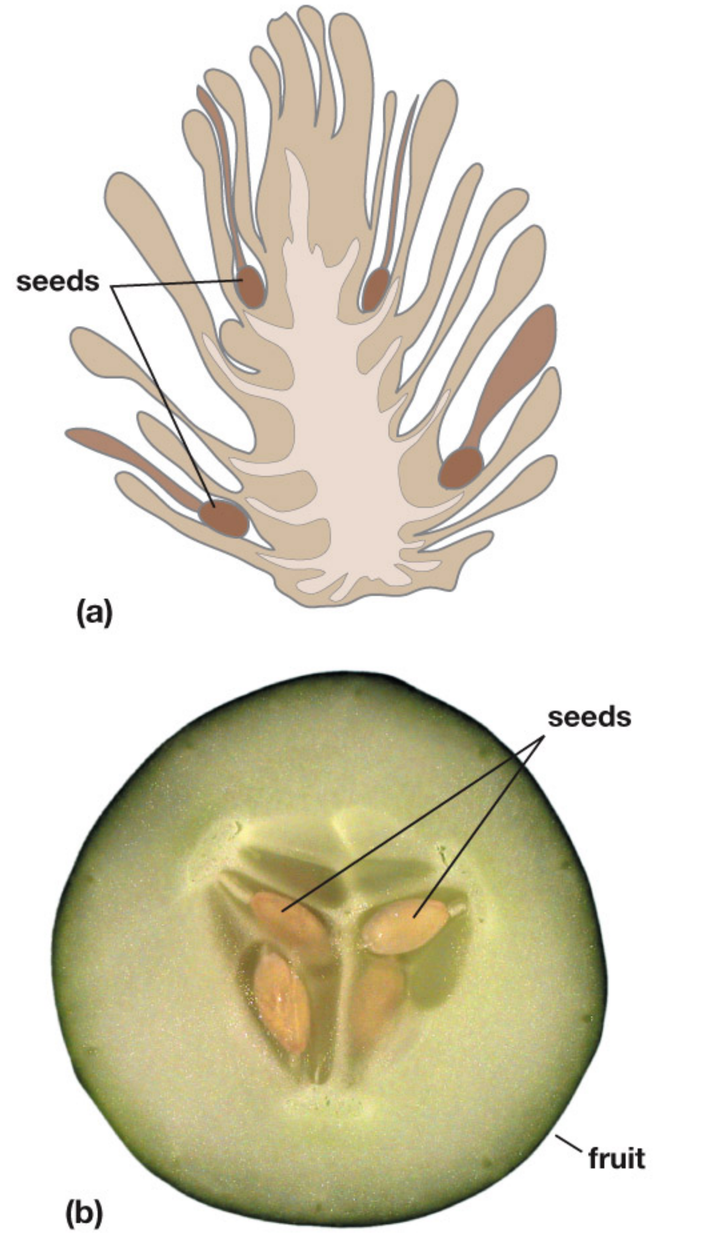


Figure 22.3 Plant Biology, 2/e

Figure 22.8 Plant Biology, 2/e

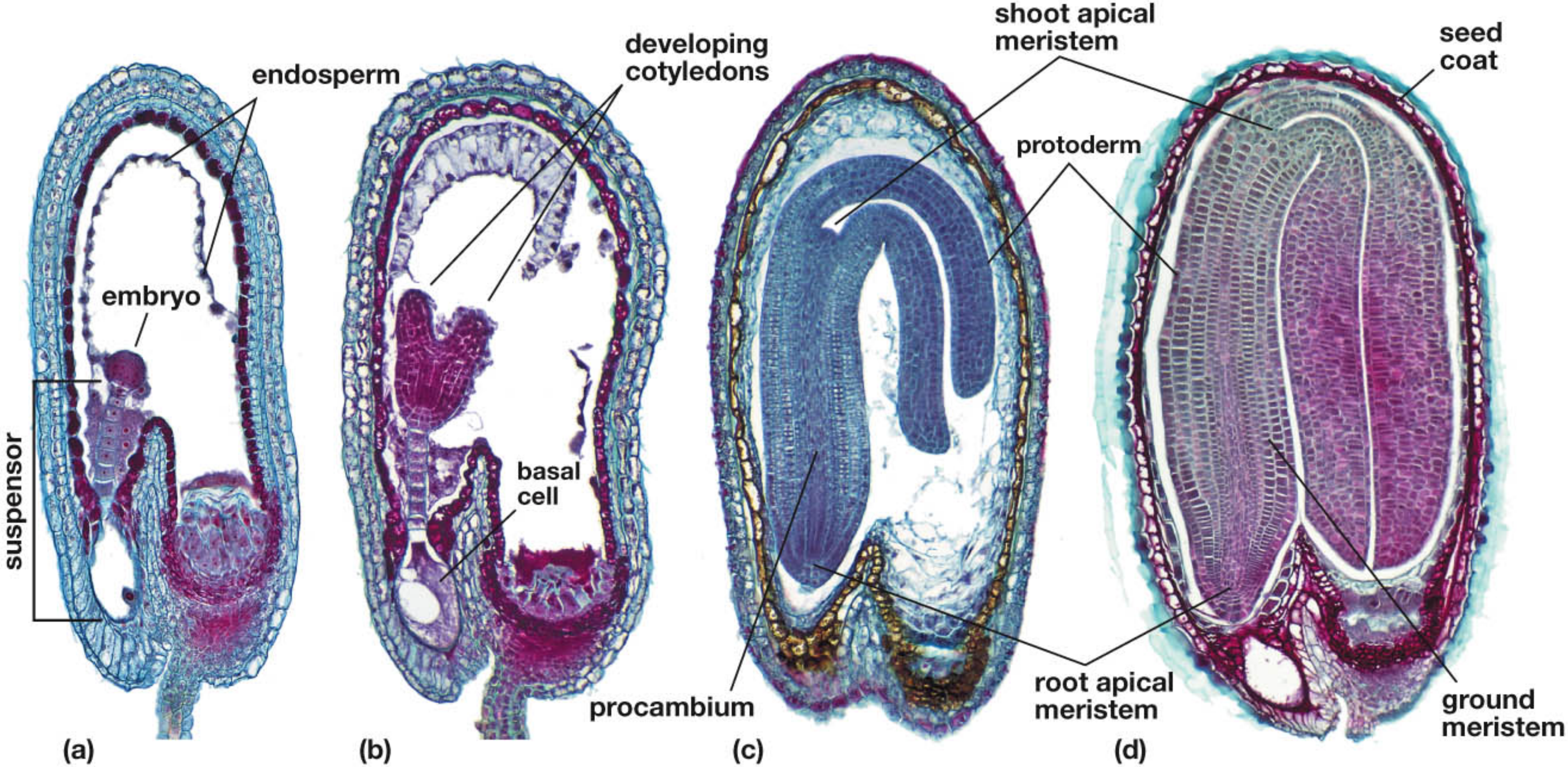
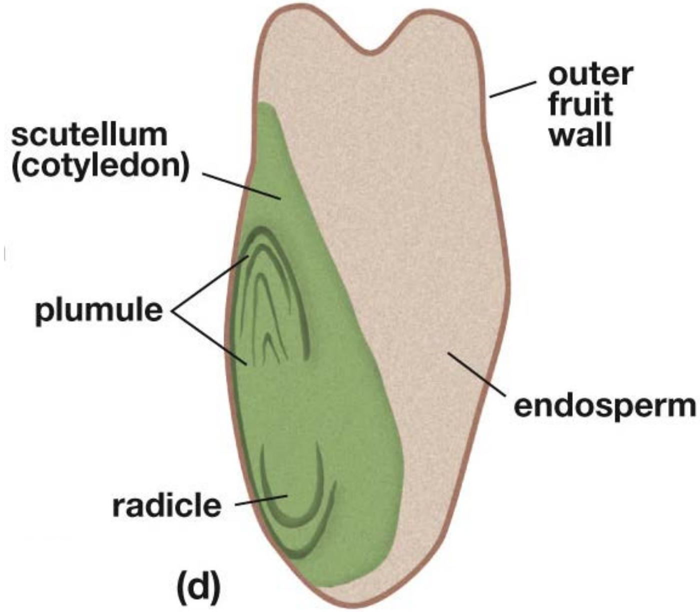


Figure 23.18 Plant Biology, 2/e

Coconuts have liquid and solid endosperm



Popcorn is mostly cooked starchy endosperm

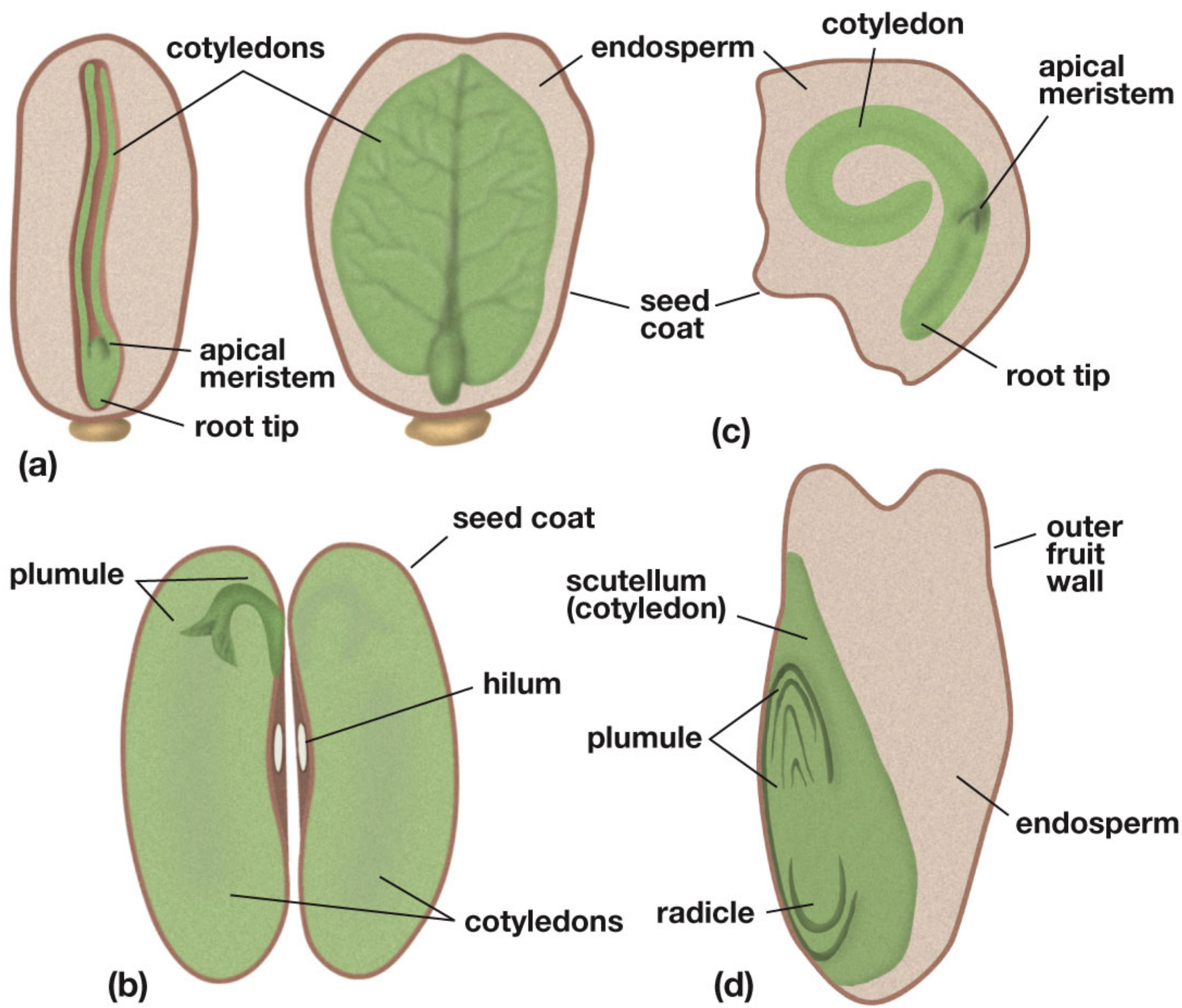
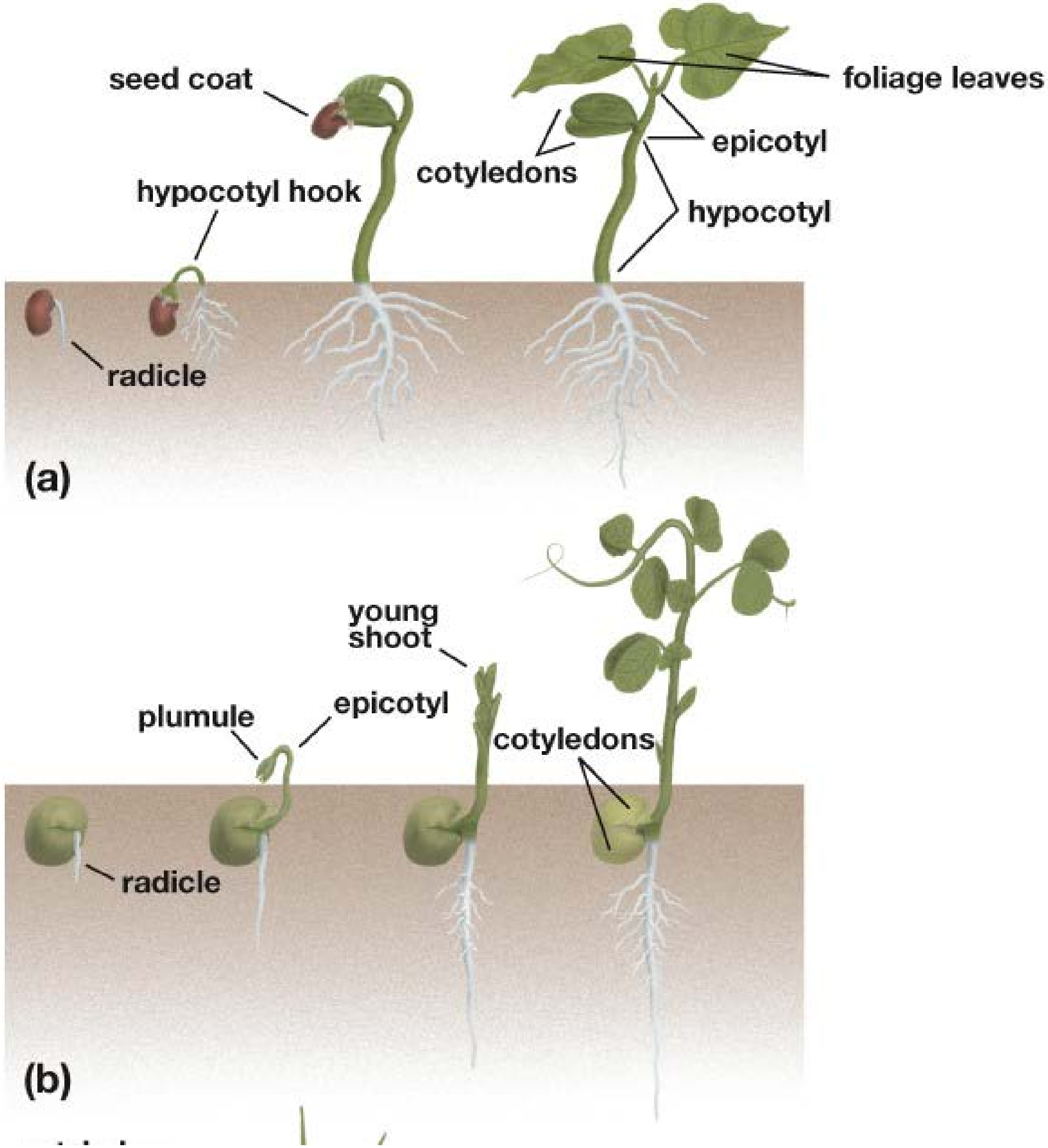
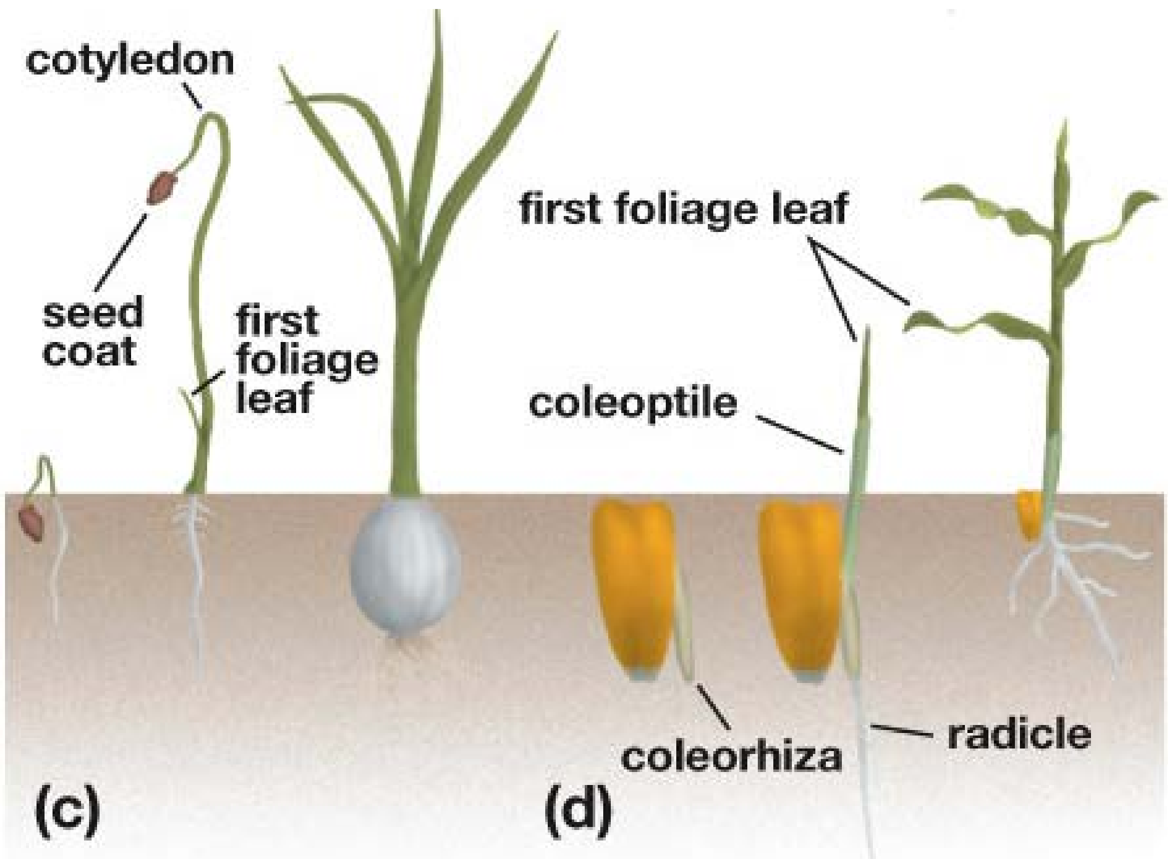
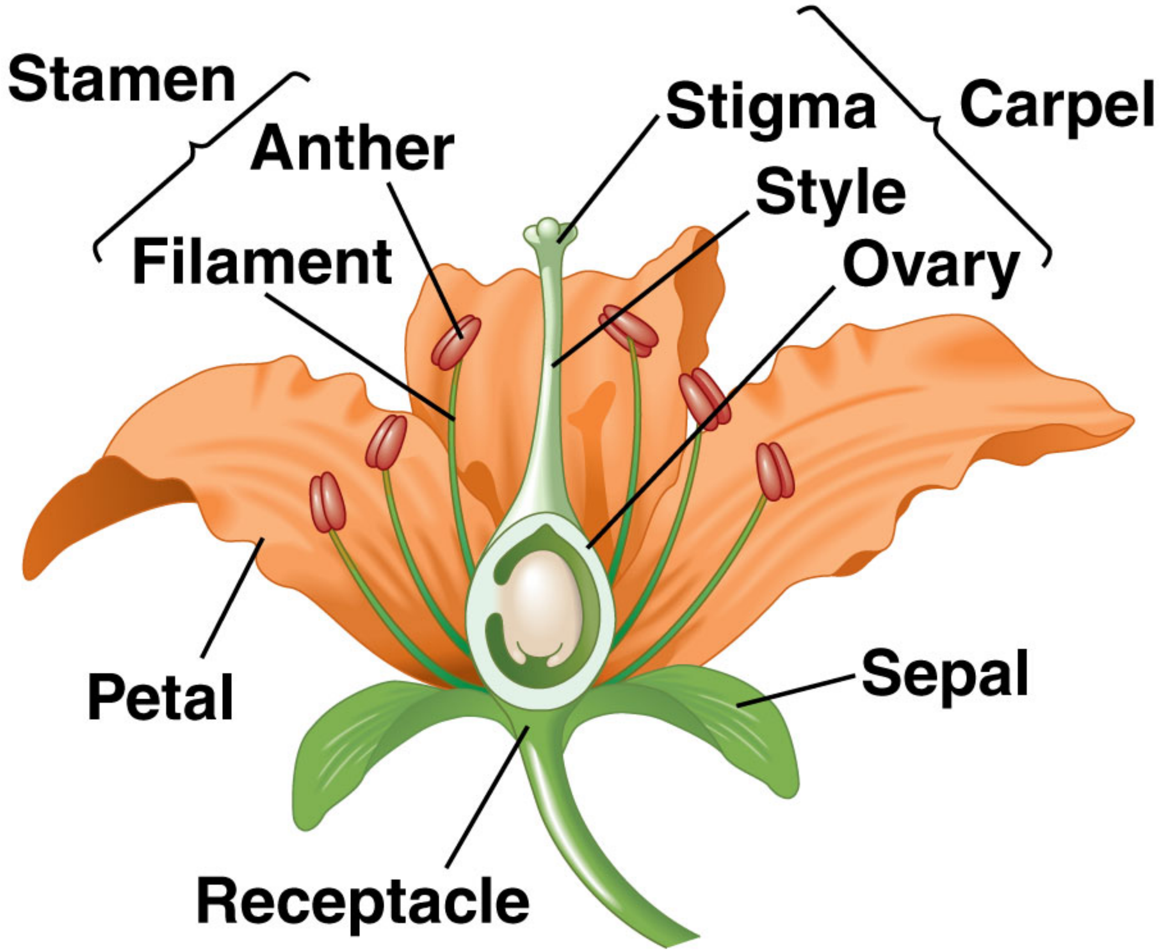


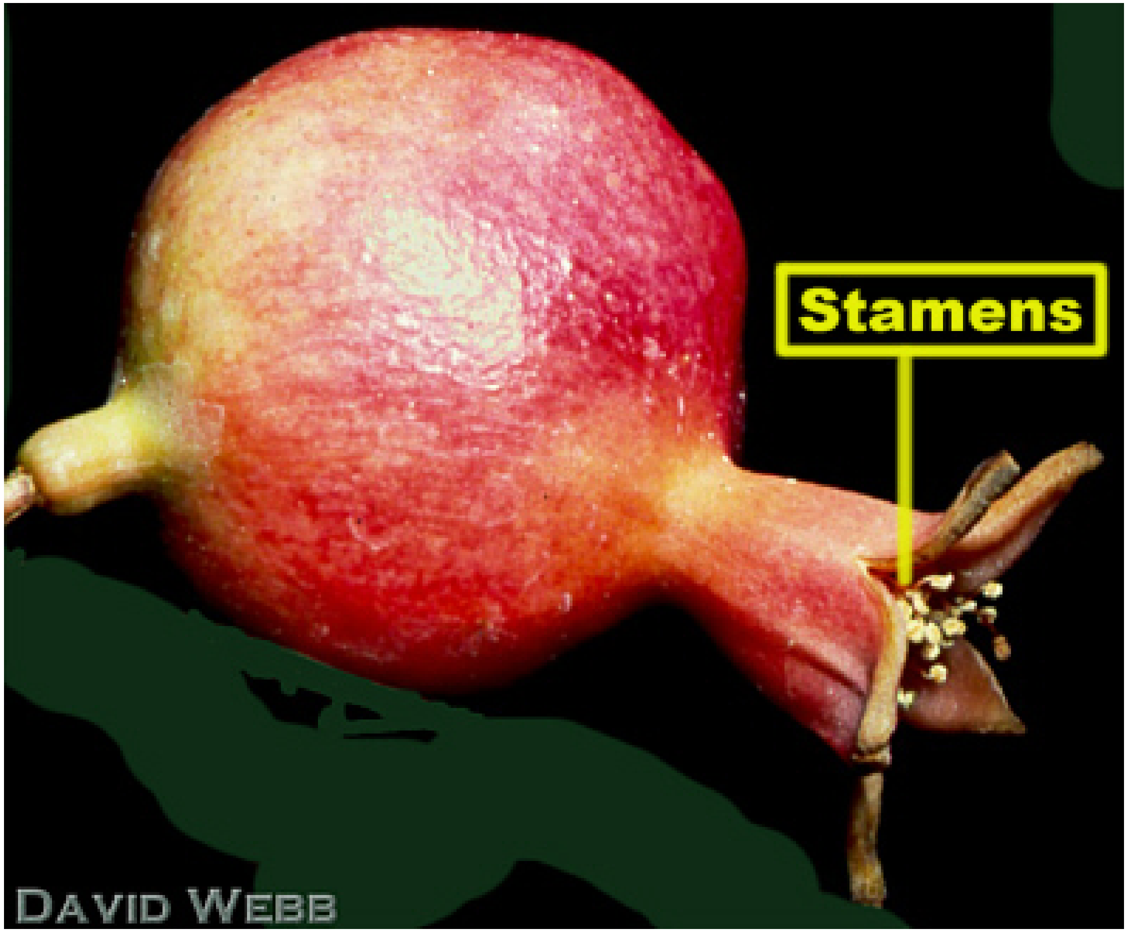
Figure 23.19 Plant Biology, 2/e


seed coat
foliage leaves
epicotyl
cotyledons
hypocotyl hook
hypocotyl
radicle
(a)
young shoot
plumule
epicotyl
cotyledons
radicle
(b)

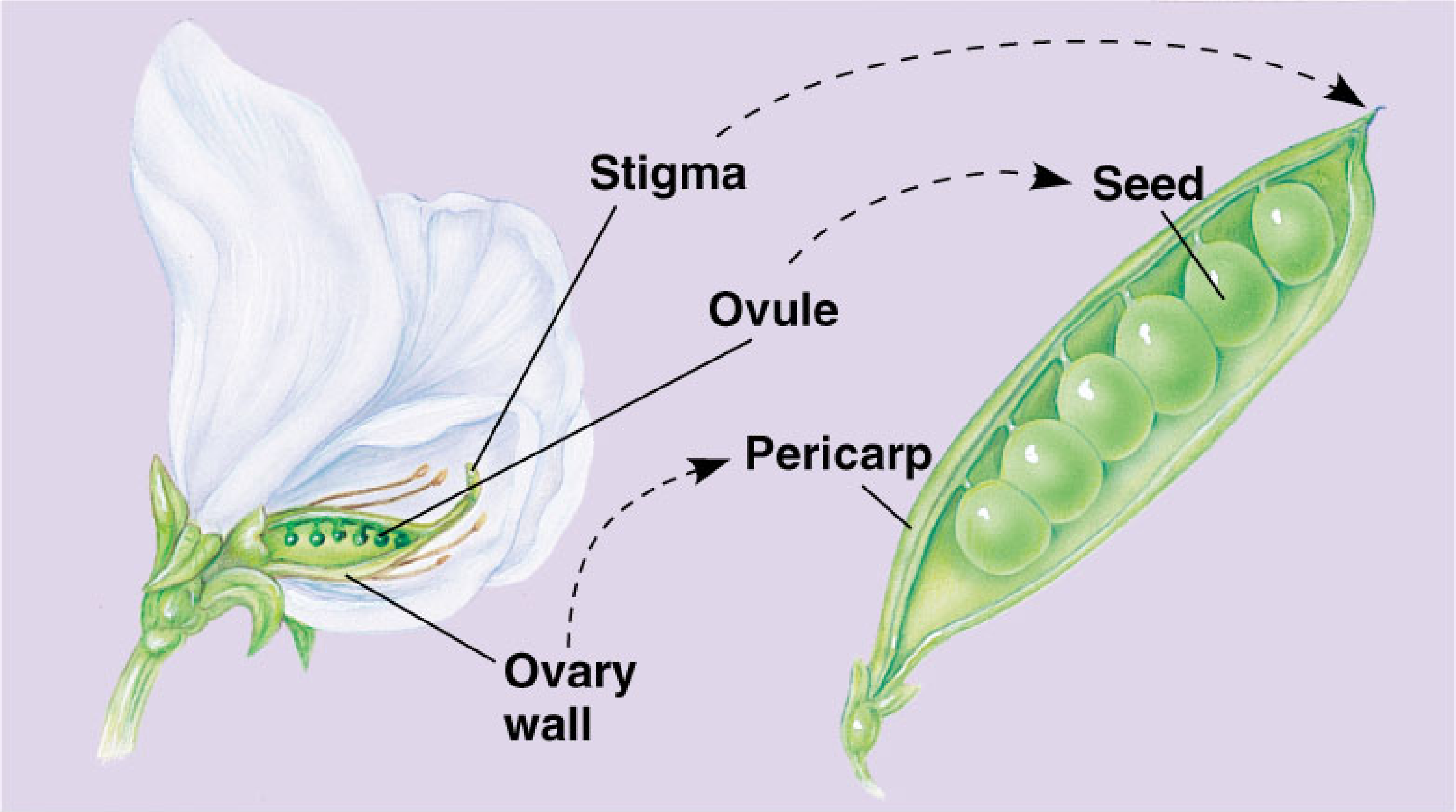

cotyledon
seed coat
first foliage leaf
first foliage leaf
coleoptile
coleorhiza
radicle
(c)
(d)



(a) Structure of an idealized flower



Developing pomegranate fruit


Stigma
Seed
Ovule
Pericarp
Ovary
wall

Simple fleshy fruits

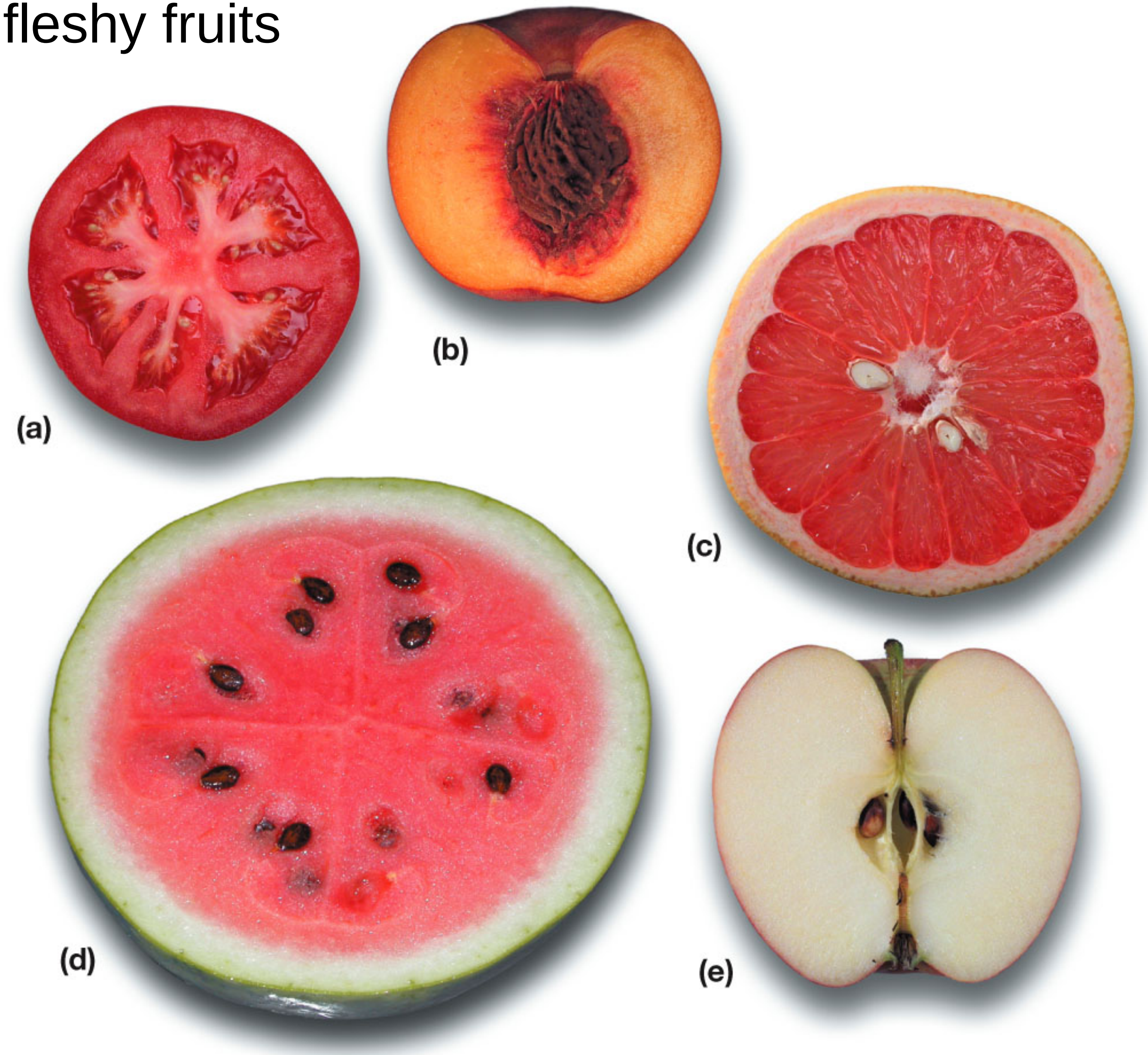


Figure 23.20 Plant Biology, 2/e

Dry dehiscent fruits

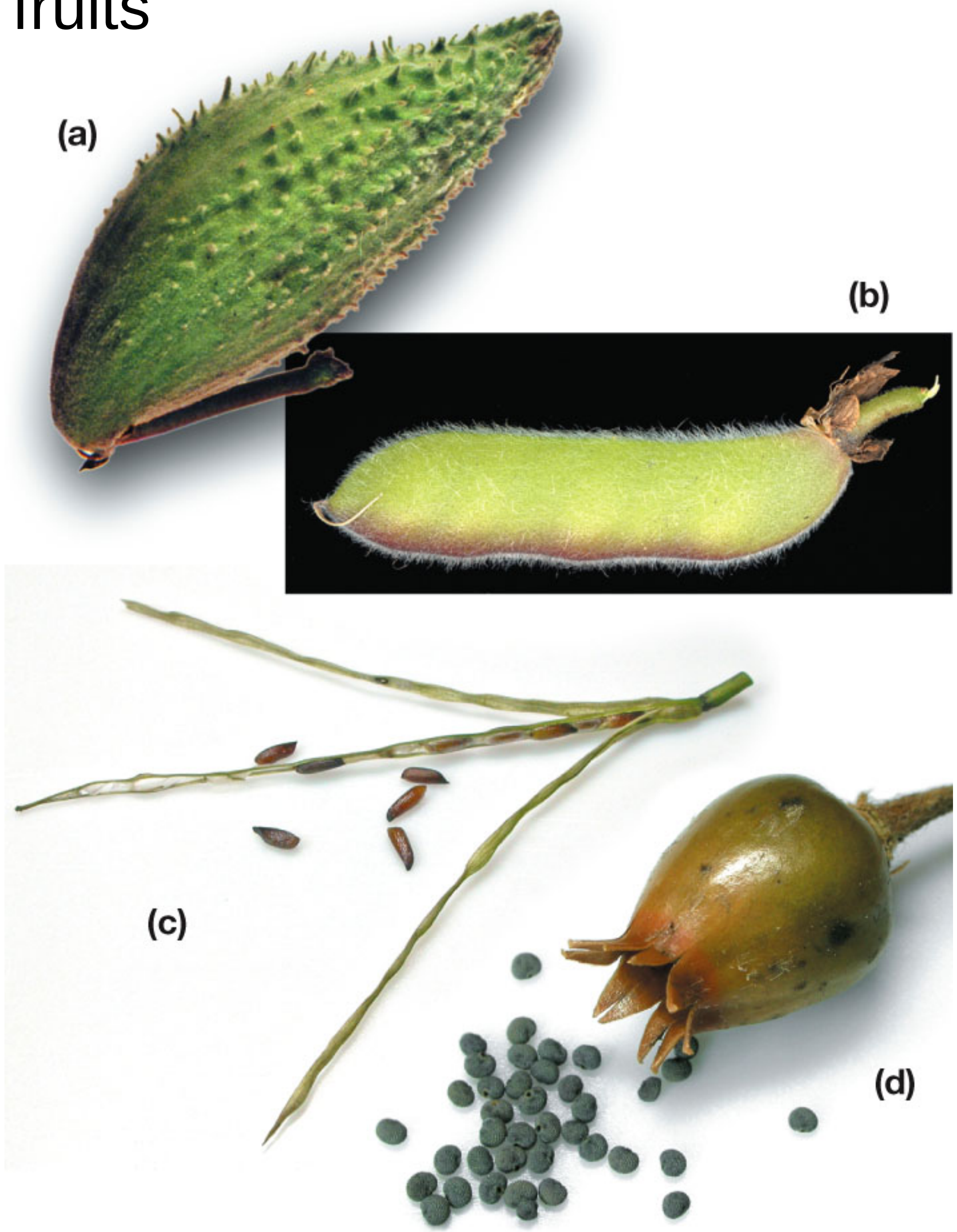


Figure 23.21 Plant Biology, 2/e

Dry indehiscent fruits

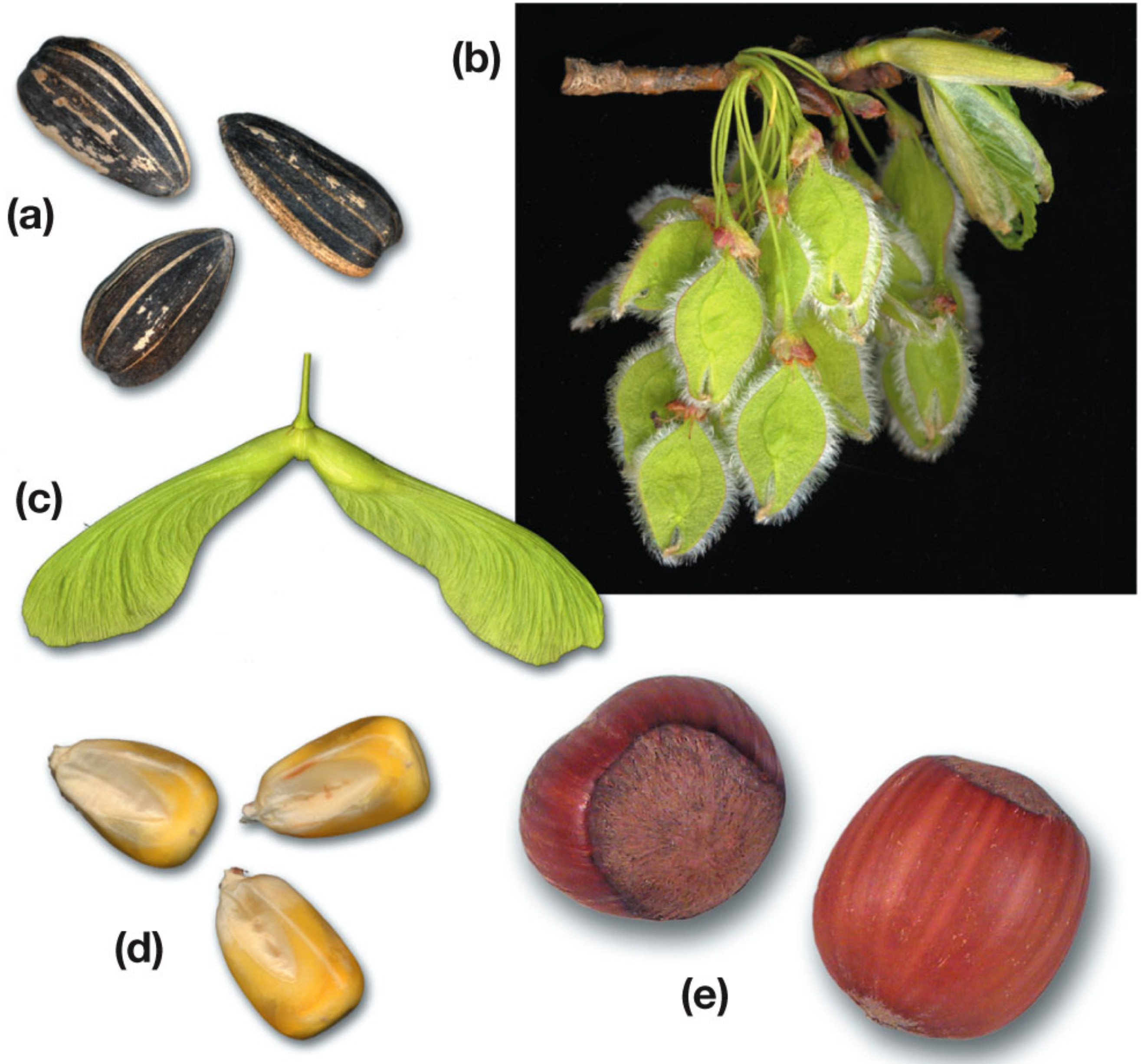


Figure 23.22 Plant Biology, 2/e

Complex fruits

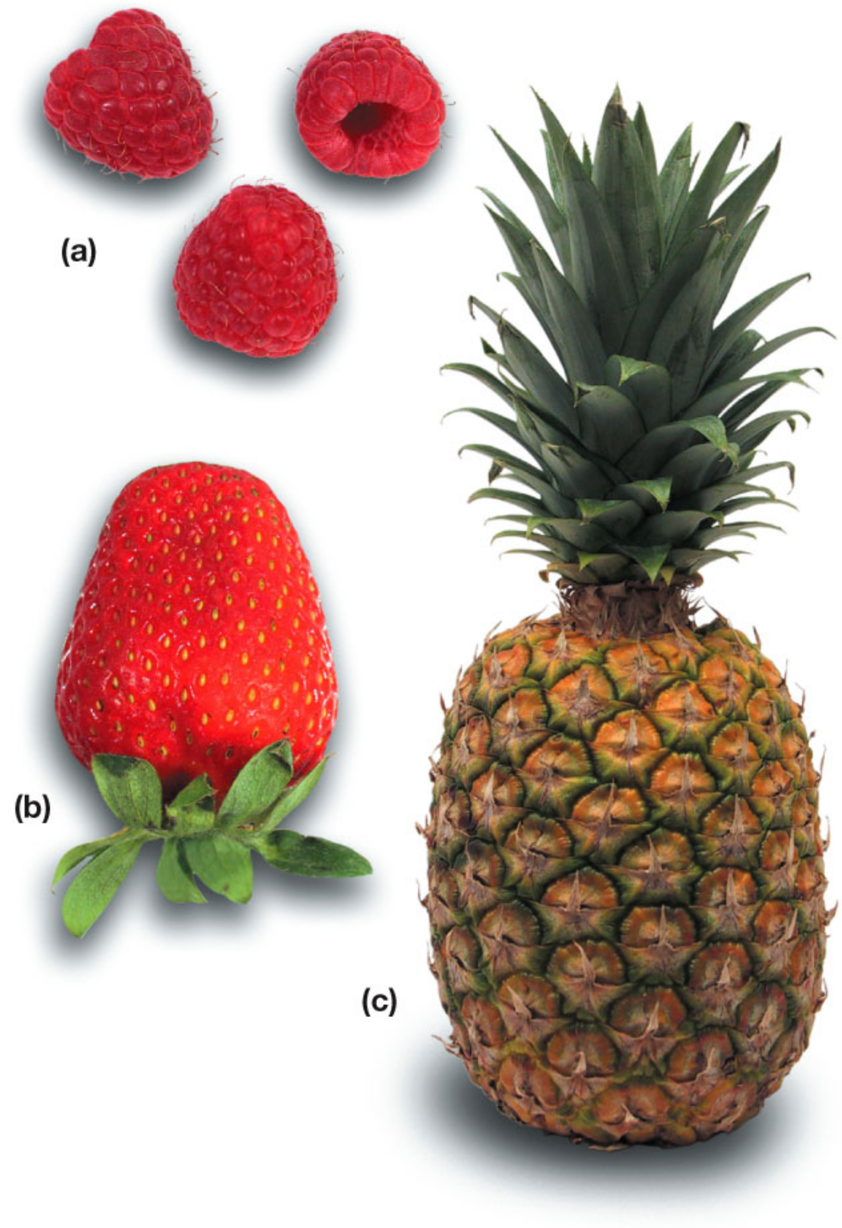


Figure 23.23 Plant Biology, 2/e

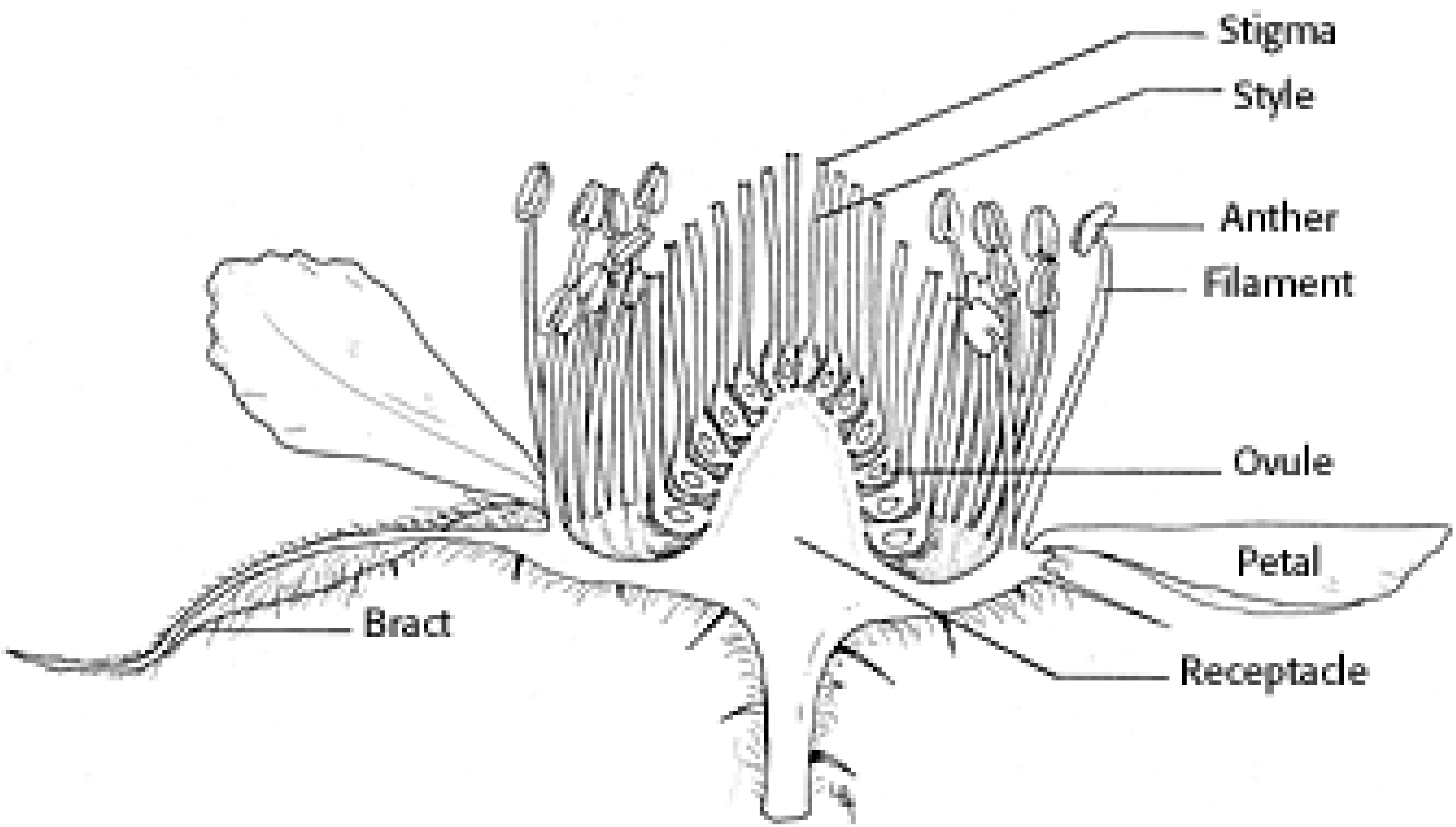
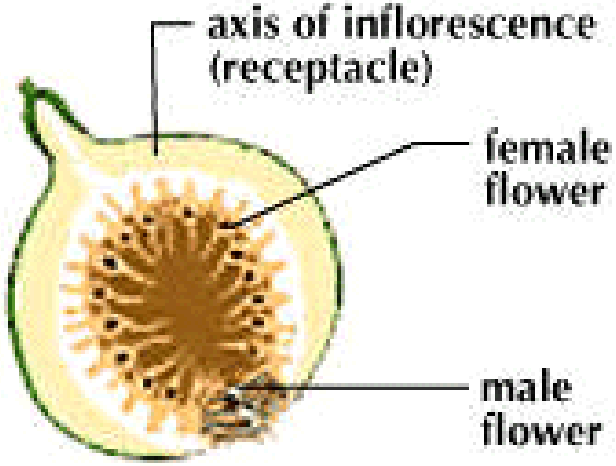
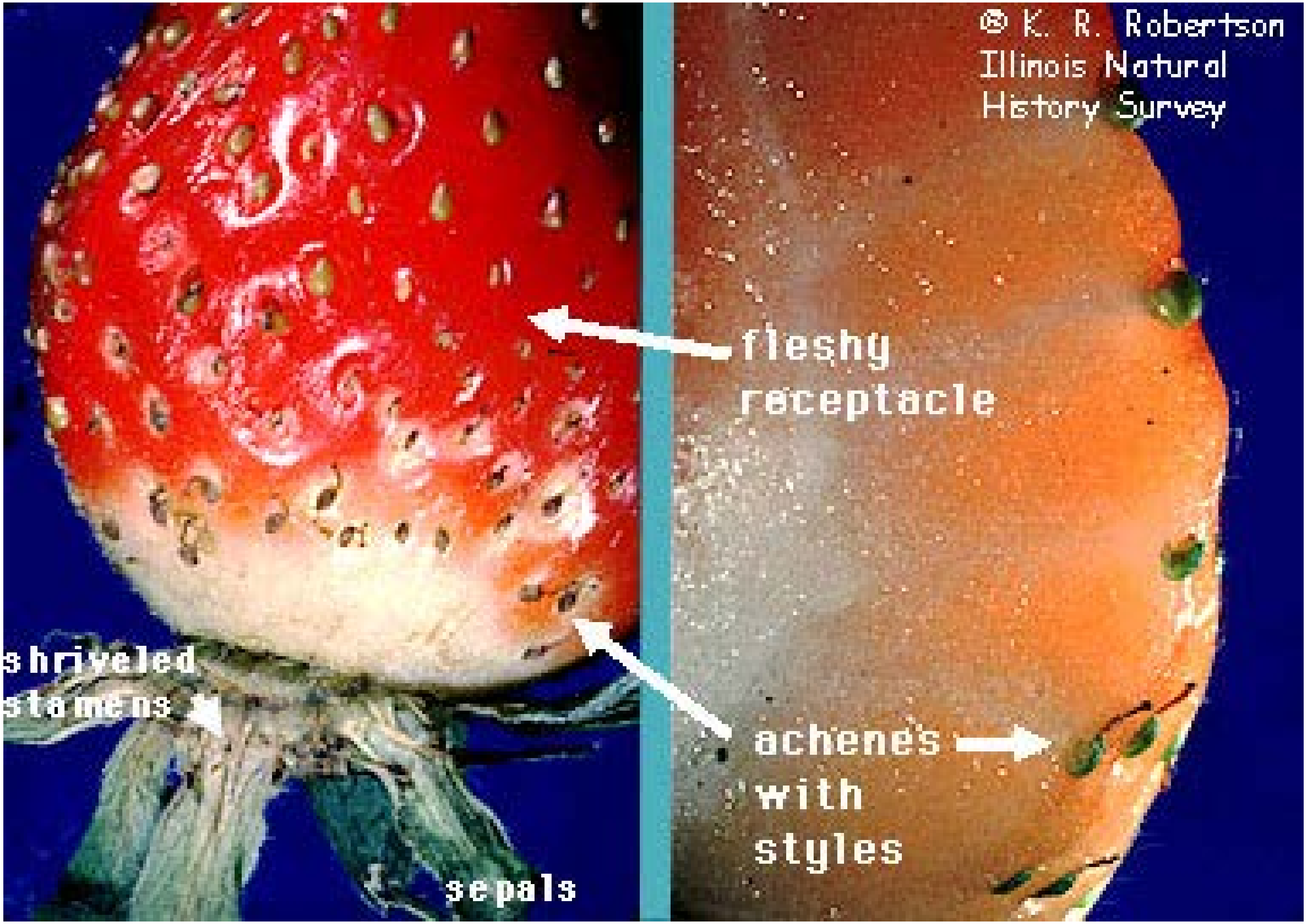


Figure 167. - Longitudinal section of 'Willamett' raspberry flower, x10.

Multiple (Compound) Fruit
(fig)



pineapple


© K. R. Robertson
Illinois Natural
History Survey
fleshy
receptacle
shriveled
stamens
achenes
with
styles
sepals

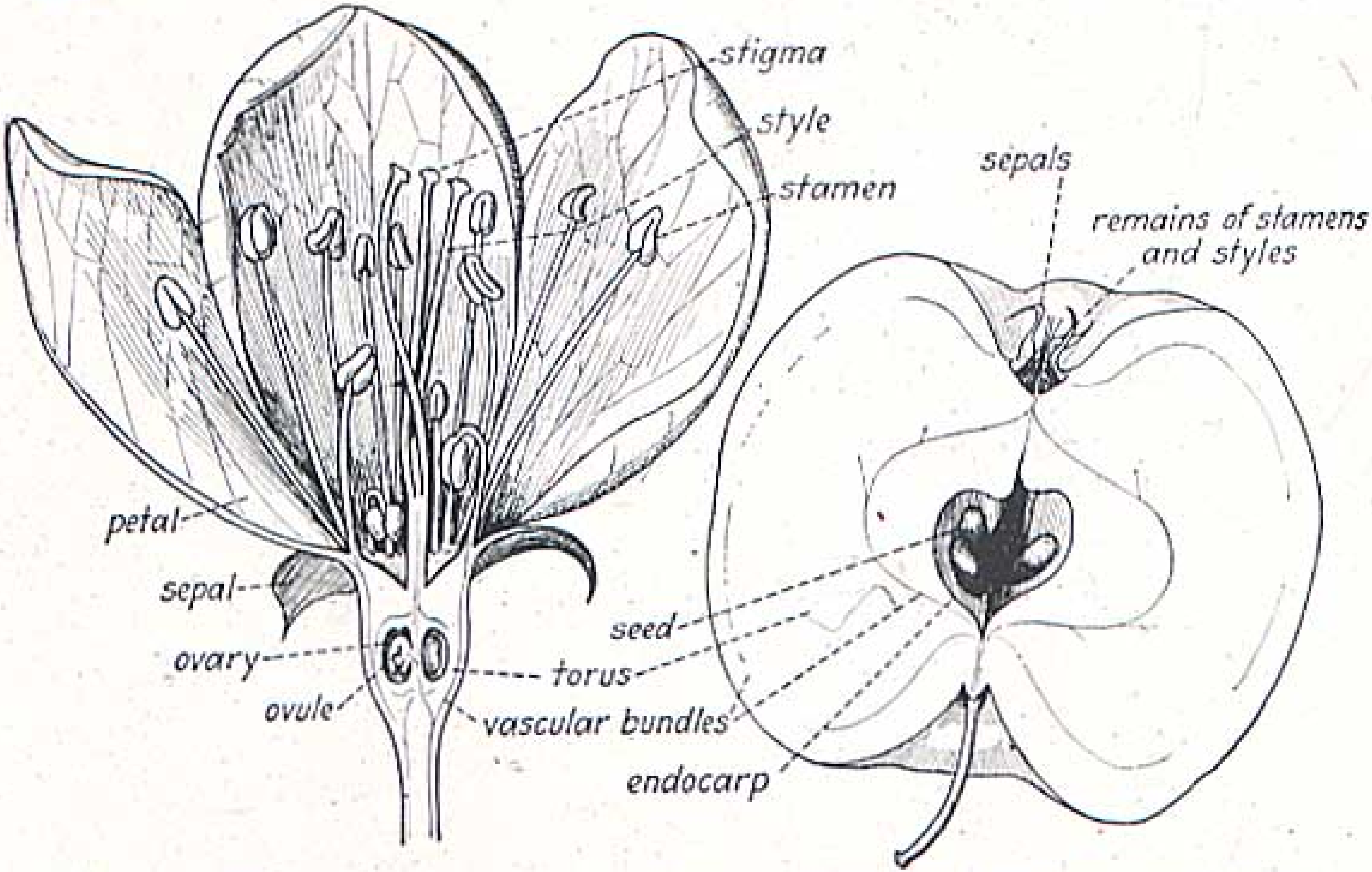


FIG. 381. Flower and fruit of apple (*Malus pumila*), cut lengthwise to show the relation of the parts of the flower to the torus.

Dispersal

Figure 24.32 Plant Biology, 2/e

Some seeds are dispersed when animals consume a fleshy fruit and drop the seeds elsewhere.

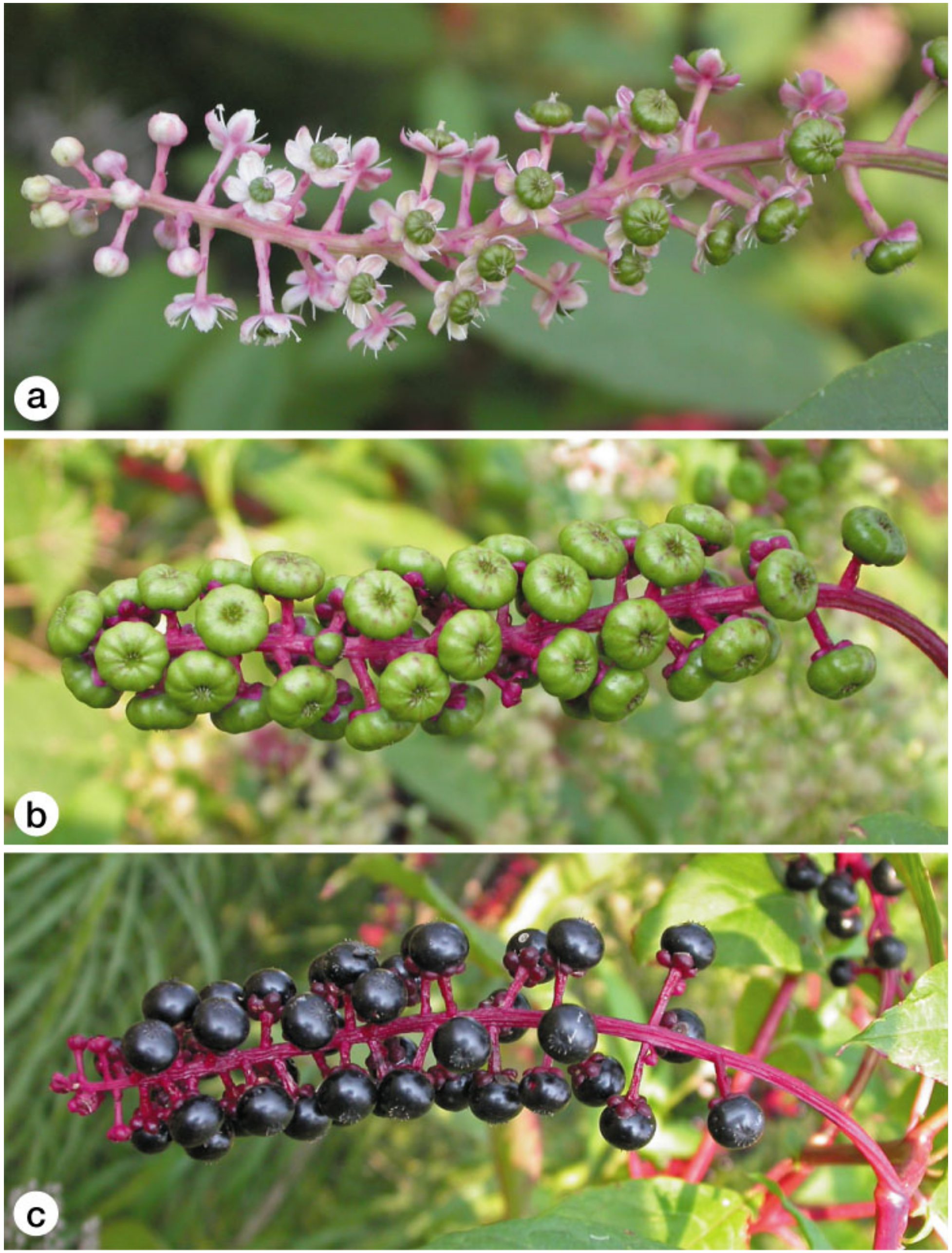
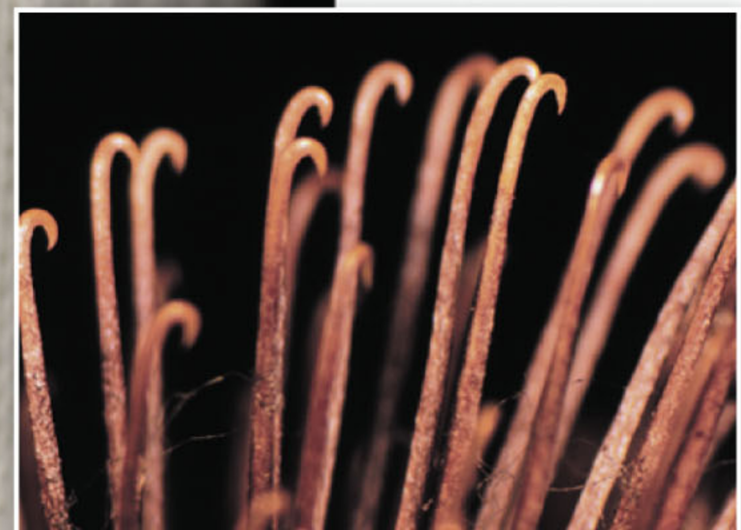


Figure 24.36 Plant Biology, 2/e

Some fruits and seeds are dispersed by wind.

(a) (b)

Figure 24.33 Plant Biology, 2/e



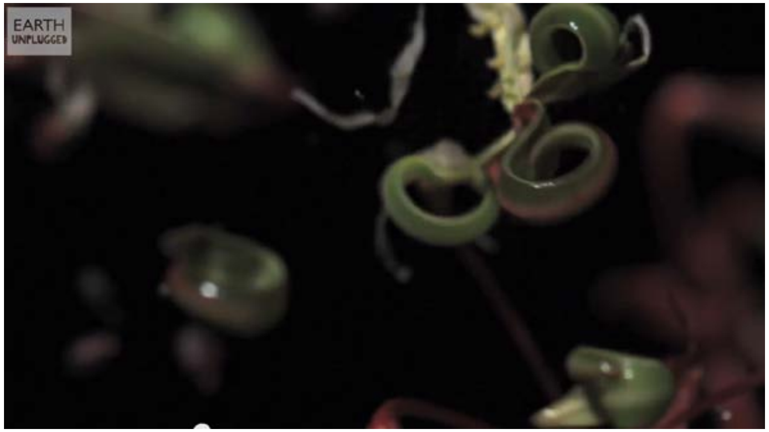
Some fruits stick to the fur or feathers of animals.

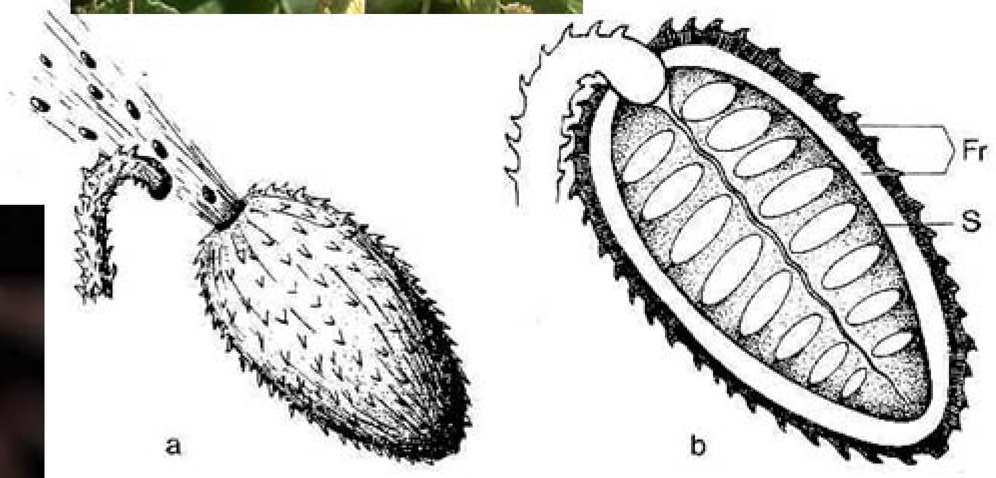
Figure 24.34 Plant Biology, 2/e

Water dispersal

Some plants have ballistic dispersal, in which seeds are ejected quickly from the fruit.

Squirting cucumber





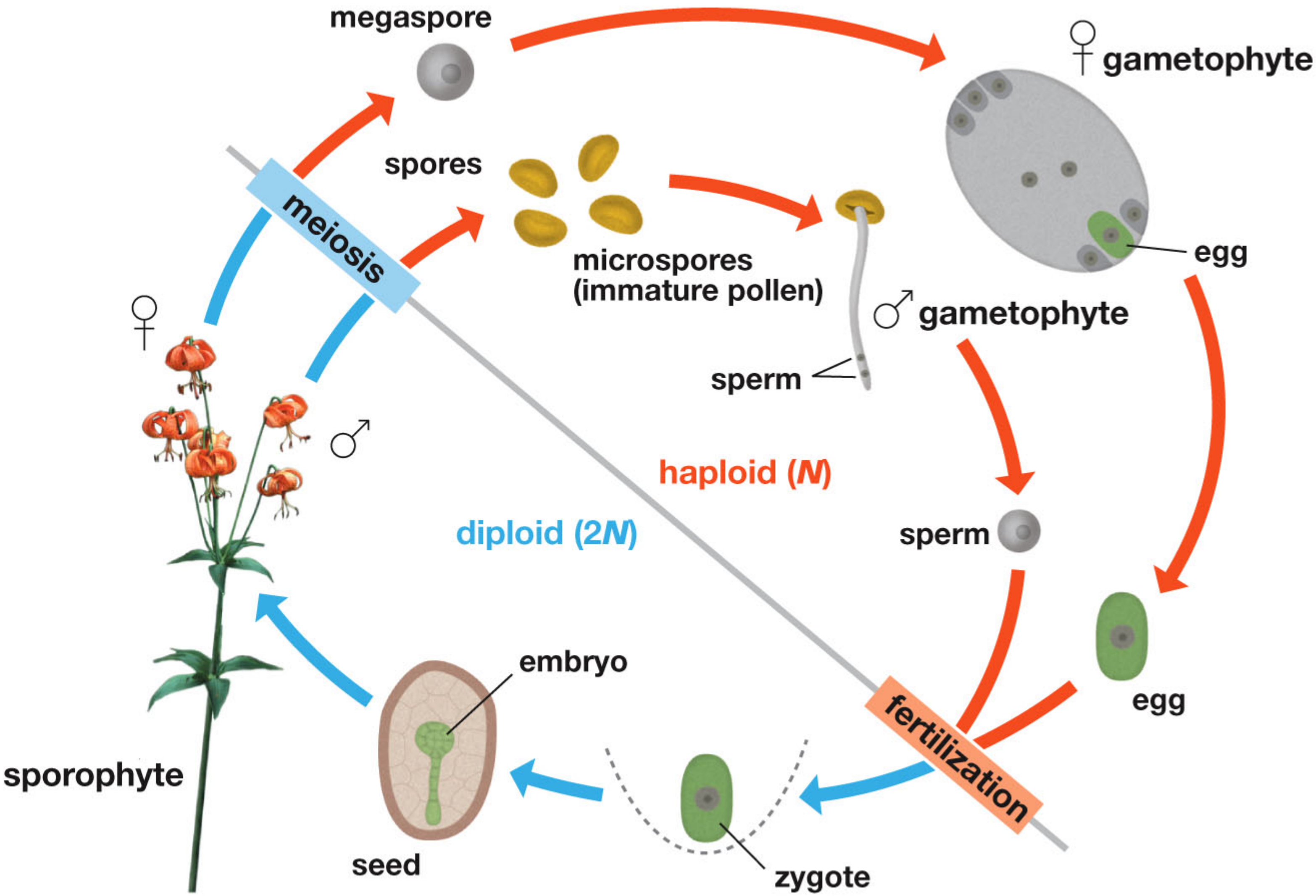
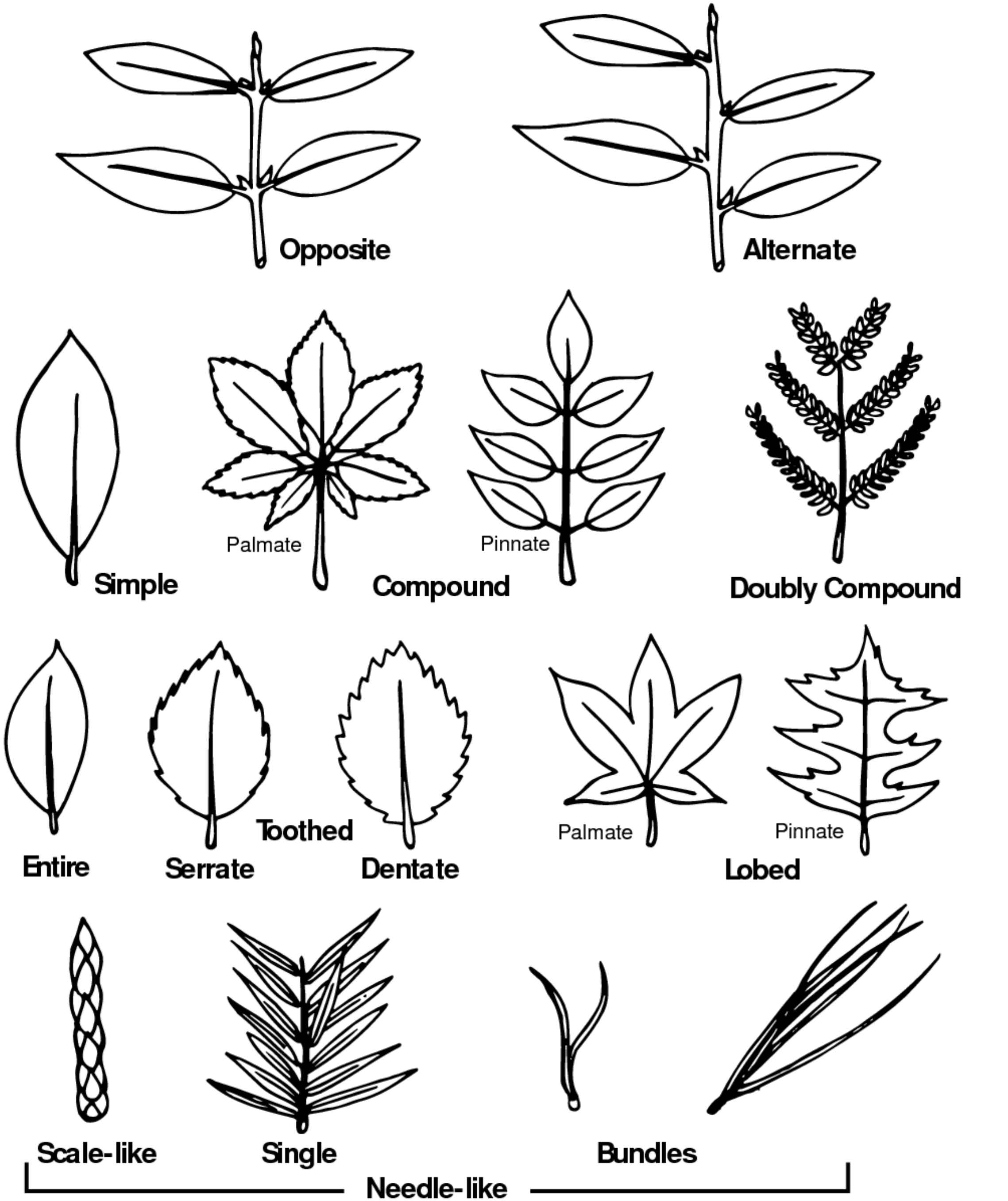


Figure 13.17 Plant Biology, 2/e



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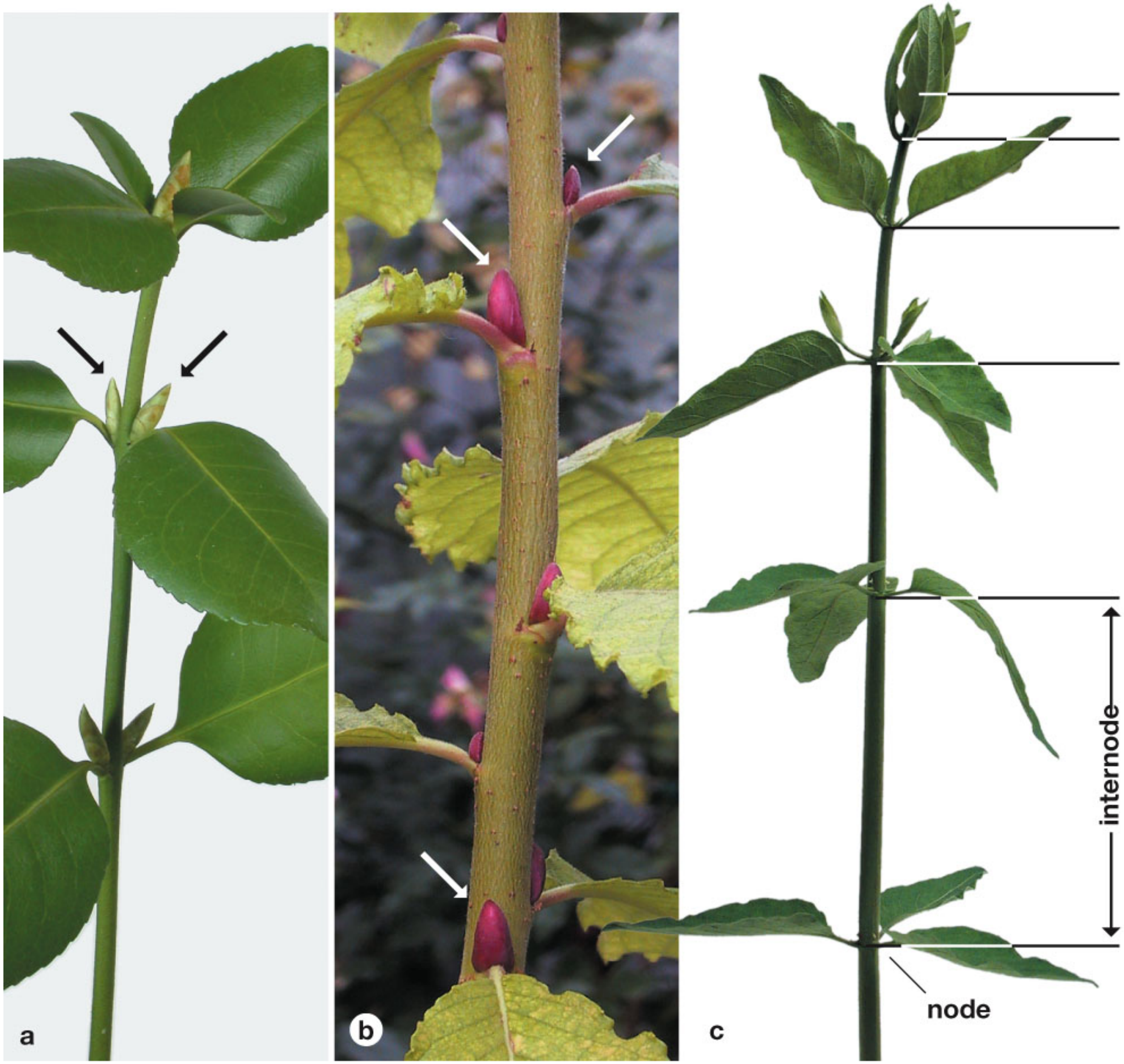

Figure 8.7 Plant Biology, 2/e