Plant Hormones Ch. 39

- I. Plant Hormones- A compound produced by one part of the plant
- Hormones- A compound produced in one area of an organism and has an affect on an another area.
- A. Plants grow toward the light
- 1. Phototropism- growth toward or away from the light
- 2. Shoot toward light= positive
- 3. Differential growth of cells on opposite side of shoot
- 4. Cells on opposite side elongate faster

Table 39.1 An Overview of Plant Hormones

Hormone	Where Produced or Found in Plant	Major Functions
Auxin (IAA)	Embryo of seed, meristems of apical buds, young leaves	Stimulates stem elongation (low concentration only), root growth, cell differentiation, and branching; regulates development of fruit; enhances apical dominance; functions in phototropism and gravitropism; promotes xylem differentiation; retards leaf abscission
Cytokinins	Synthesized in roots and transported to other organs	Affect root growth and differentiation; stimulate cell division and growth; stimulate germination; delay senescence
Gibberellins	Meristems of apical buds and roots, young leaves, embryo	Promote seed and bud germination, stem elongation, and leaf growth; stimulate flowering and development of fruit; affect root growth and differentiation
Brassinosteroids	Seeds, fruit, shoots, leaves, and floral buds	Inhibit root growth; retard leaf abscission; promote xylem differentiation
Abscisic acid	Leaves, stems, roots, green fruit	Inhibits growth; closes stomata during water stress; promotes seed dormancy
Ethylene	Tissues of ripening fruit, nodes of stems, aging leaves and flowers	Promotes fruit ripening, opposes some auxin effects; promotes or inhibits growth and development of roots, leaves, and flowers, depending on species

- B. Coordination of growth and development - 5 major classes of hormones

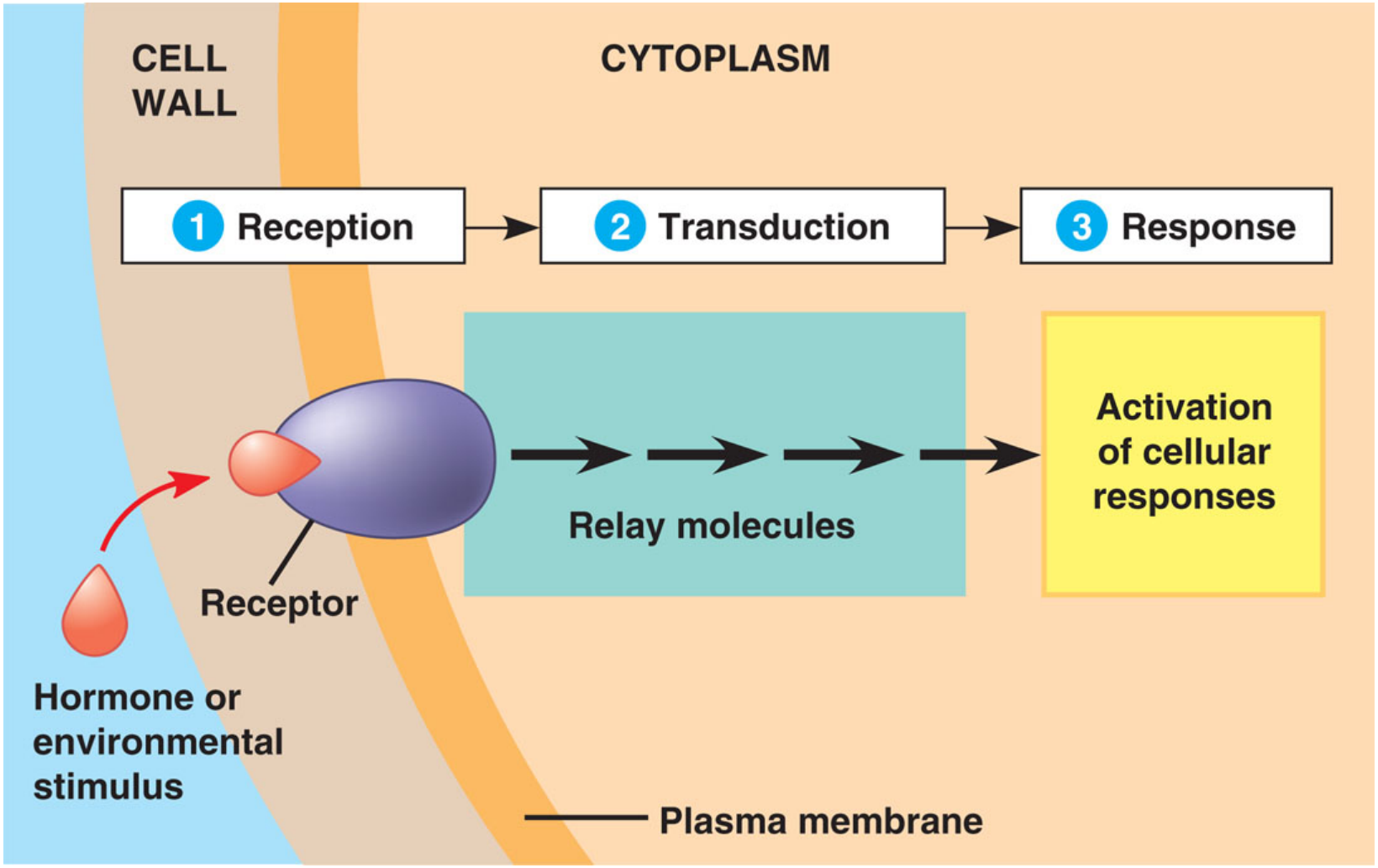
- Auxins (IAA)
- Cytokinins
- Gibberellins (GA)
- Abscisic acid
- Ethylene

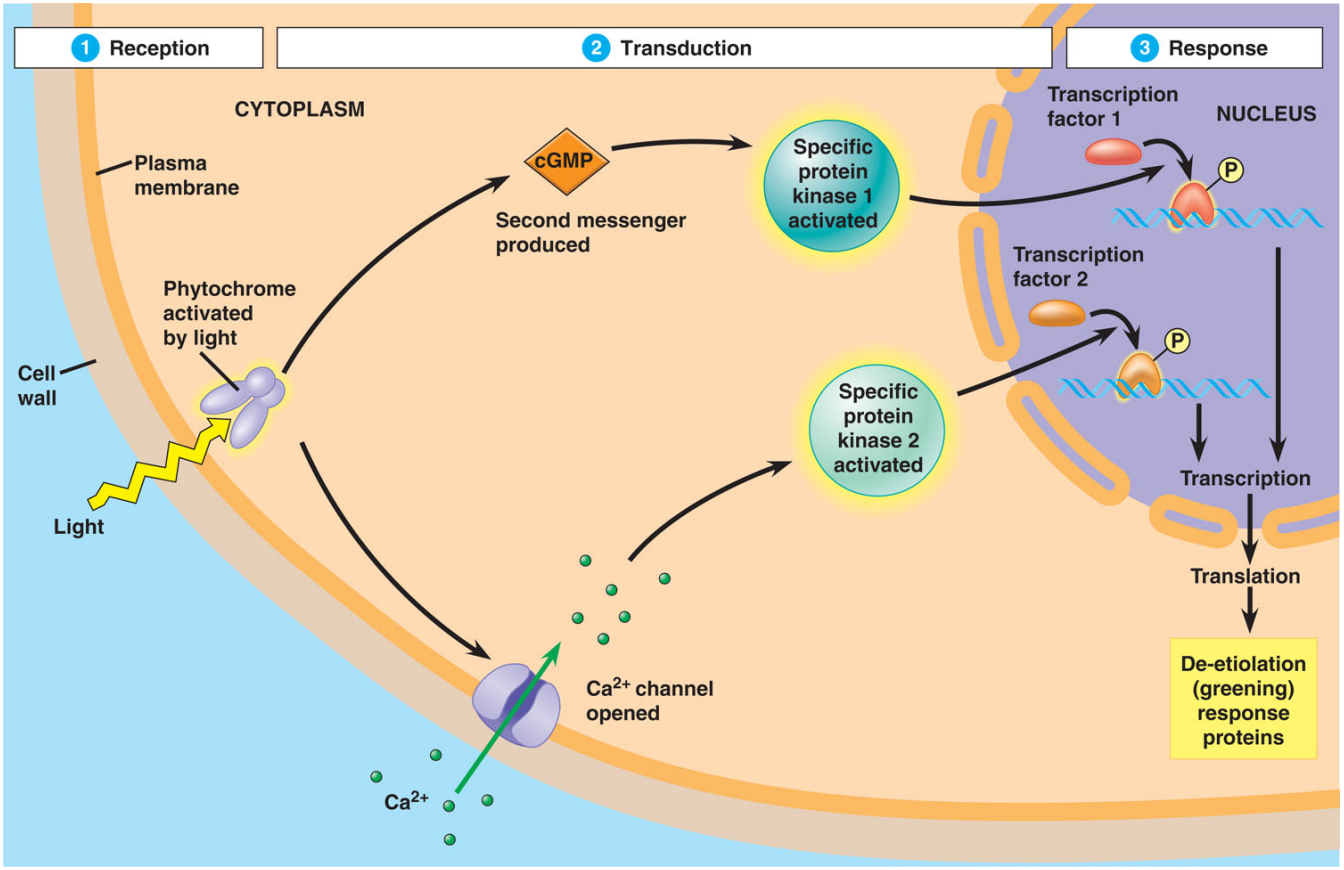
Auxin

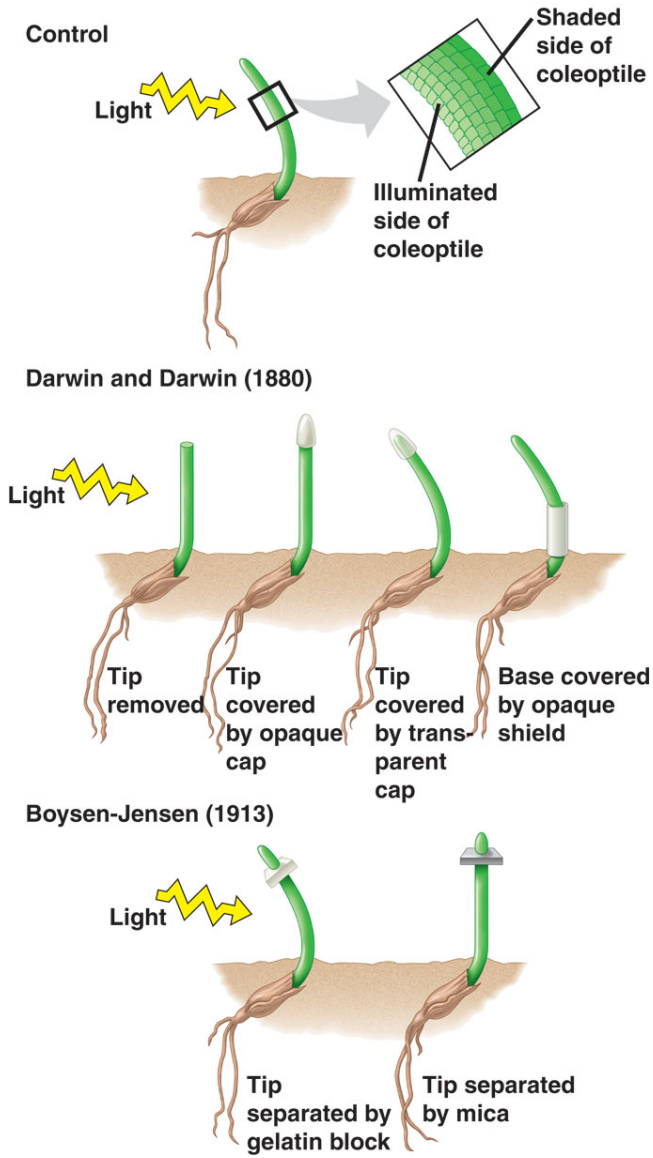
(a) **Before exposure to light.** A dark-grown potato has tall, spindly stems and nonexpanded leaves—morphological adaptations that enable the shoots to penetrate the soil. The roots are short, but there is little need for water absorption because little water is lost by the shoots.

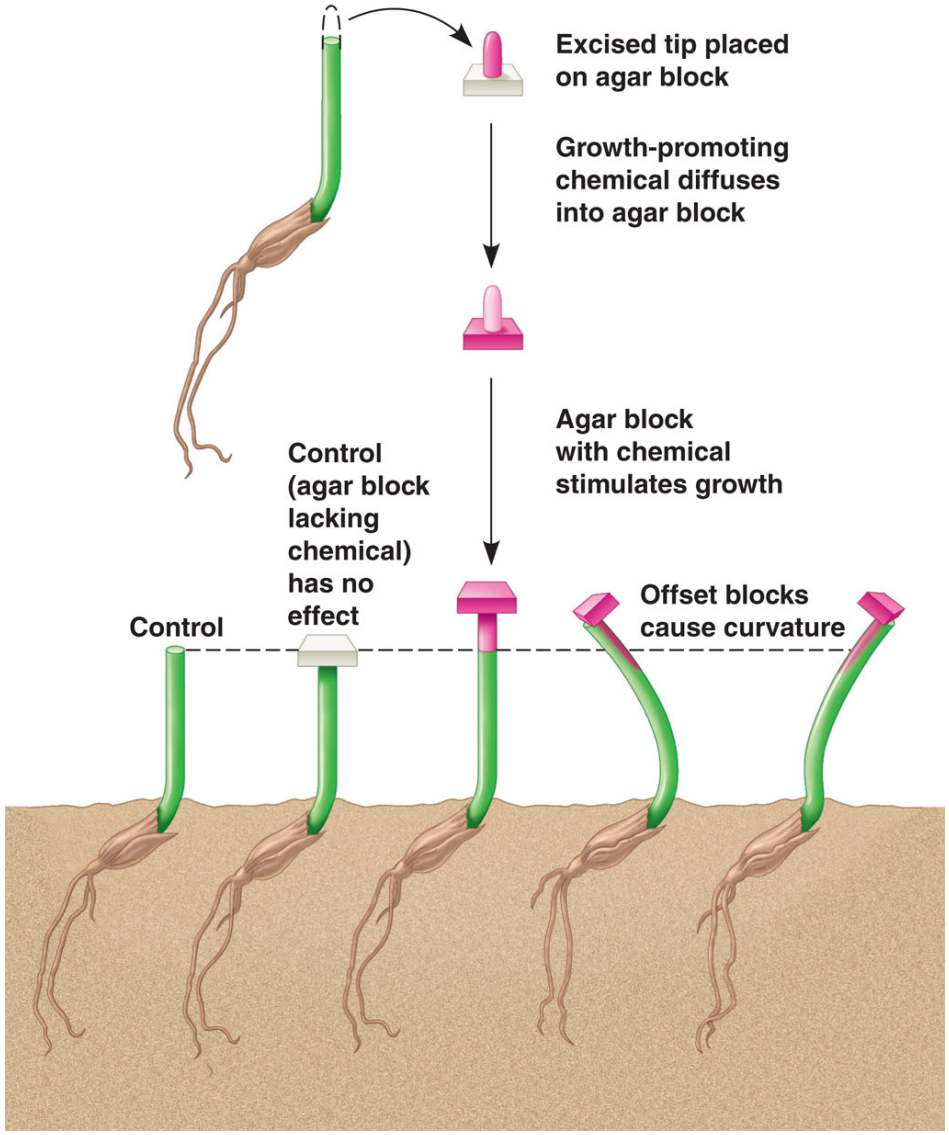
(b) **After a week's exposure to natural daylight.** The potato plant begins to resemble a typical plant with broad green leaves, short sturdy stems, and long roots. This transformation begins with the reception of light by a specific pigment, phytochrome.

- 1. Auxin- promotes elongation of young shoots (Indoleacetic acid)
  - a. The major site of auxin production is apical meristem
  - b. Affects secondary cell growth by inducing vascular cambium and secondary xylem
  - c. Promotes fruit growth


CELL WALL
CYTOPLASM
1 Reception
2 Transduction
3 Response
Activation of cellular responses
Relay molecules
Receptor
Hormone or environmental stimulus
Plasma membrane


1 Reception
2 Transduction
3 Response
CYTOPLASM
NUCLEUS
Plasma membrane
cGMP
Second messenger produced
Specific protein kinase 1 activated
Transcription factor 1
P
Transcription factor 2
Phytochrome activated by light
Cell wall
Light
Specific protein kinase 2 activated
Transcription
Translation
De-etiolation (greening) response proteins
Ca^{2+} channel opened
Ca^{2+}

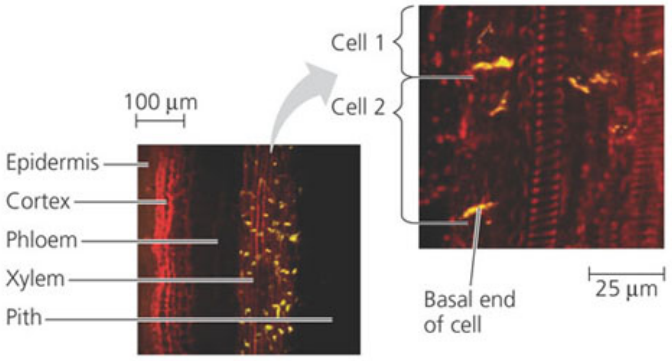

Control
Light
Shaded side of coleoptile
Illuminated side of coleoptile
Darwin and Darwin (1880)
Light
Tip removed
Tip covered by opaque cap
Tip covered by trans-parent cap
Base covered by opaque shield
Boysen-Jensen (1913)
Light
Tip separated by gelatin block
Tip separated by mica


Excised tip placed on agar block
Growth-promoting chemical diffuses into agar block
Agar block with chemical stimulates growth
Control (agar block lacking chemical) has no effect
Control
Offset blocks cause curvature

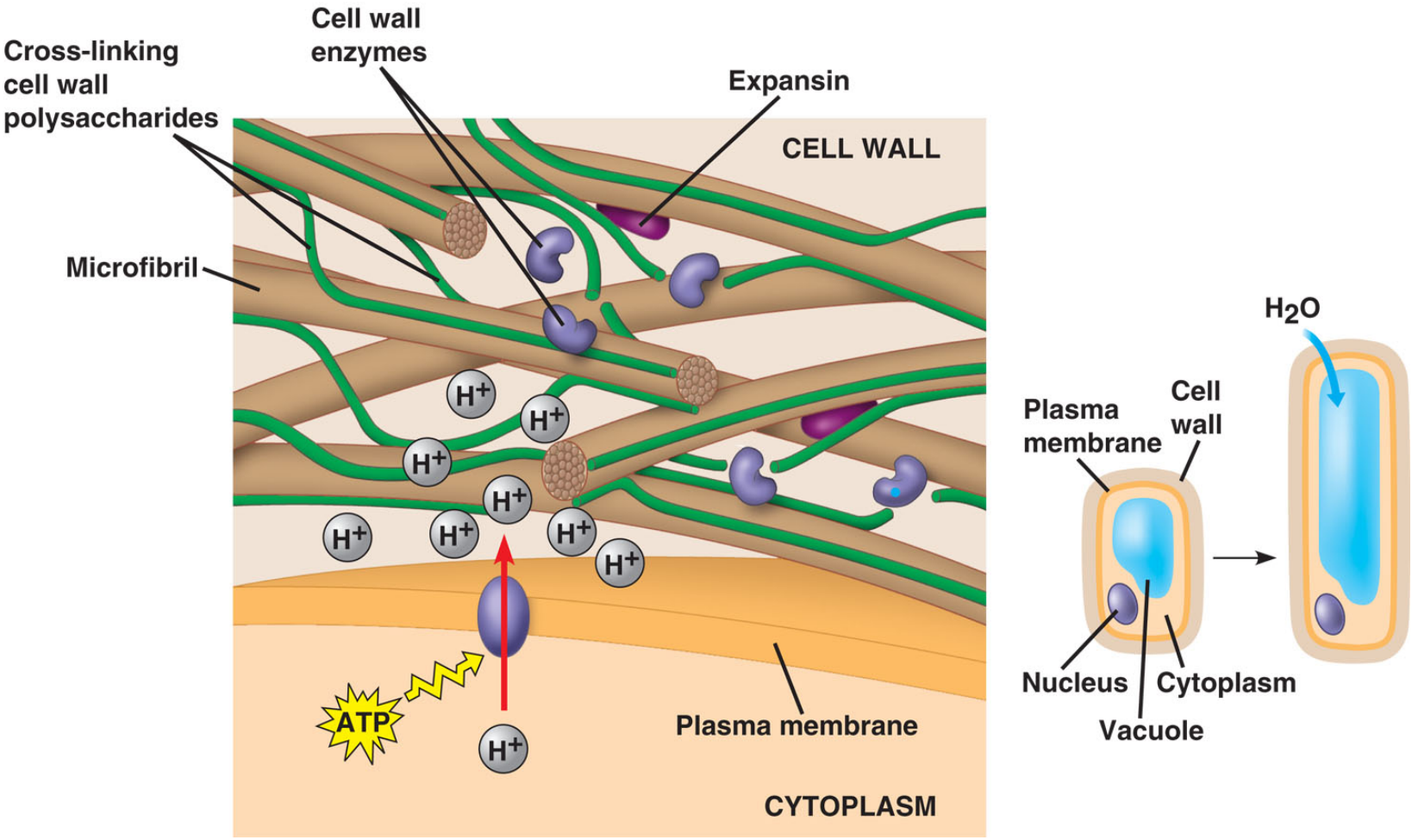
Flourescent tag used to show auxin location in a plant

EXPERIMENT To investigate how auxin is transported unidirectionally, researchers designed an experiment to identify the location of the auxin transport protein. They used a a greenish-yellow fluorescent molecule to label antibodies that bind to the auxin transport protein. They applied the antibodies to longitudinally sectioned *Arabidopsis* stems.

RESULTS The left micrograph shows that the auxin transport protein is not found in all tissues of the stem, but only in the xylem parenchyma. In the right micrograph, a higher magnification reveals that the auxin transport protein is primarily localized to the basal end of the cells.



CONCLUSION The results support the hypothesis that concentration of the auxin transport protein at the basal ends of cells is responsible for polar transport of auxin.


Cross-linking cell wall polysaccharides
Cell wall enzymes
Expansin
CELL WALL
Microfibril
H+
ATP
Plasma membrane
CYTOPLASM
H2O
Plasma membrane
Cell wall
Nucleus
Cytoplasm
Vacuole

- 2. Cytokinins - stimulates cytokinesis
- a. Cell division and cytokinesis
- 1. Moves in xylem sap
- 2. Stimulates RNA and protein synthesis
- 3. Works in conjunction with auxin

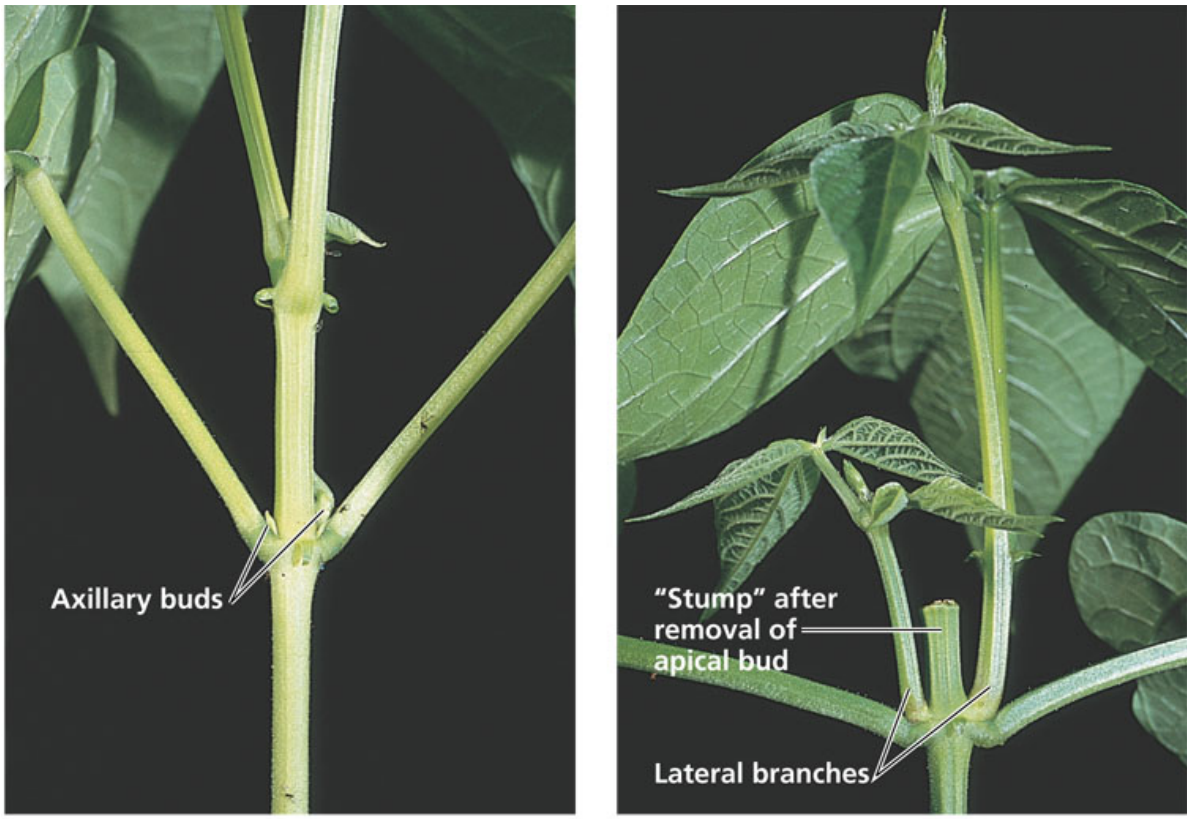
b. Apical dominance

1. cytokinins and auxin are antagonistic- auxin from terminal bud causes shoot to lengthen.

2. Cytokinins from roots stimulate axillary bud

- 3. Auxin stimulates lateral root formation cytokinins restrain it.
- c. Anti-_aging - slows leaf deterioration

Plant b has apical bud removed so axillary buds grow

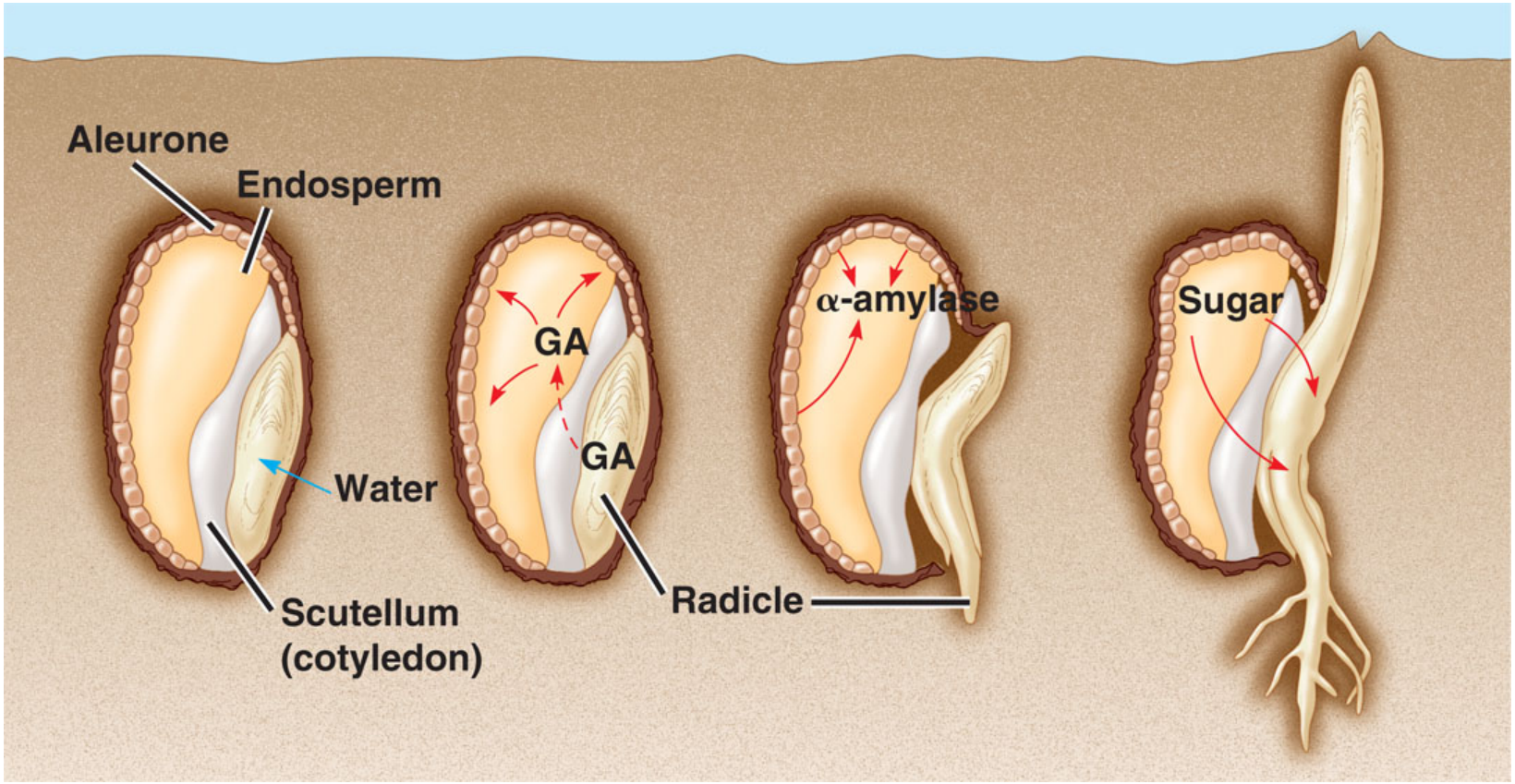


(a) Intact plant

(b) Plant with apical bud removed

- 3. Giberellins- 80 different kinds
    - a. Stem elongation- produced in the roots and young leaves
        1. stimulate cell division, growth of leaves
        2. causes bolting- rapid growth of floral stems
    - b. Fruit growth- controlled by Giberellins and auxin
        1. Grapes are sprayed to grow bigger
    - c. Germination- signals seeds to break dormancy

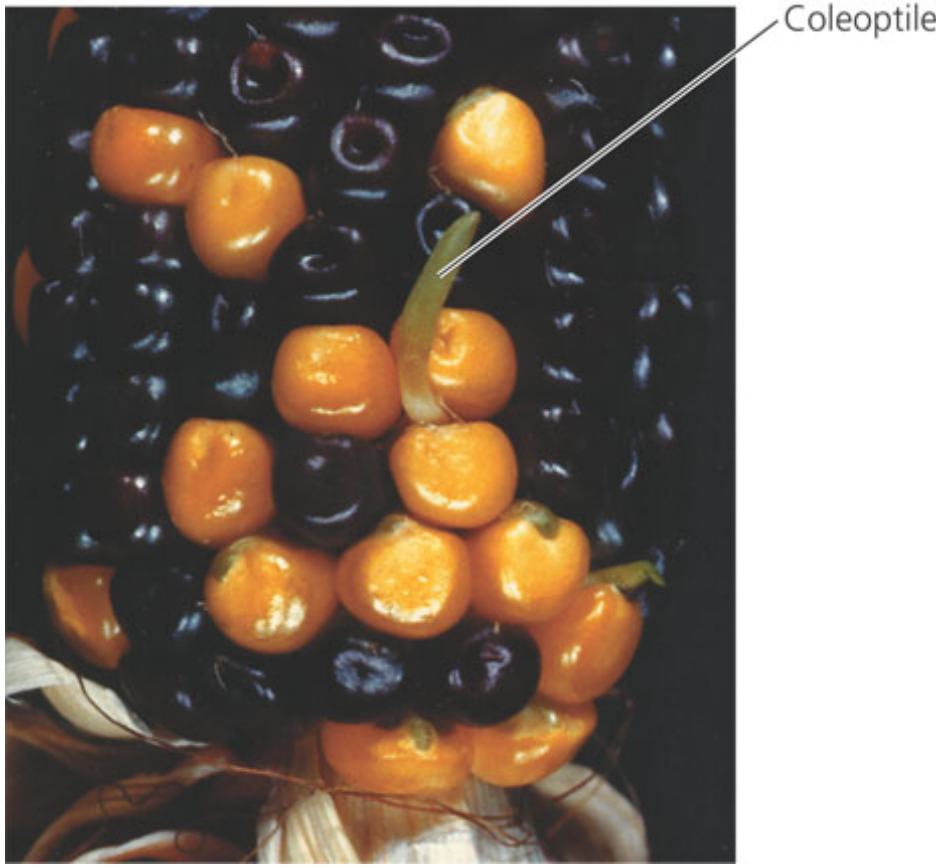
Grapes on the right treated with gibberellins


Aleurone
Endosperm
Water
Scutellum
(cotyledon)
GA
GA
Radicle
α-amylase
Sugar

- 4. First isolated from *Brassic* pollen in 1979, brassinosteroids are steroids chemically similar to cholesterol and the sex hormones of animals.
  - a. Brassinosteroids induce cell elongation and division in the stem
  - b. They also retard leaf abscission and promote xylem differentiation

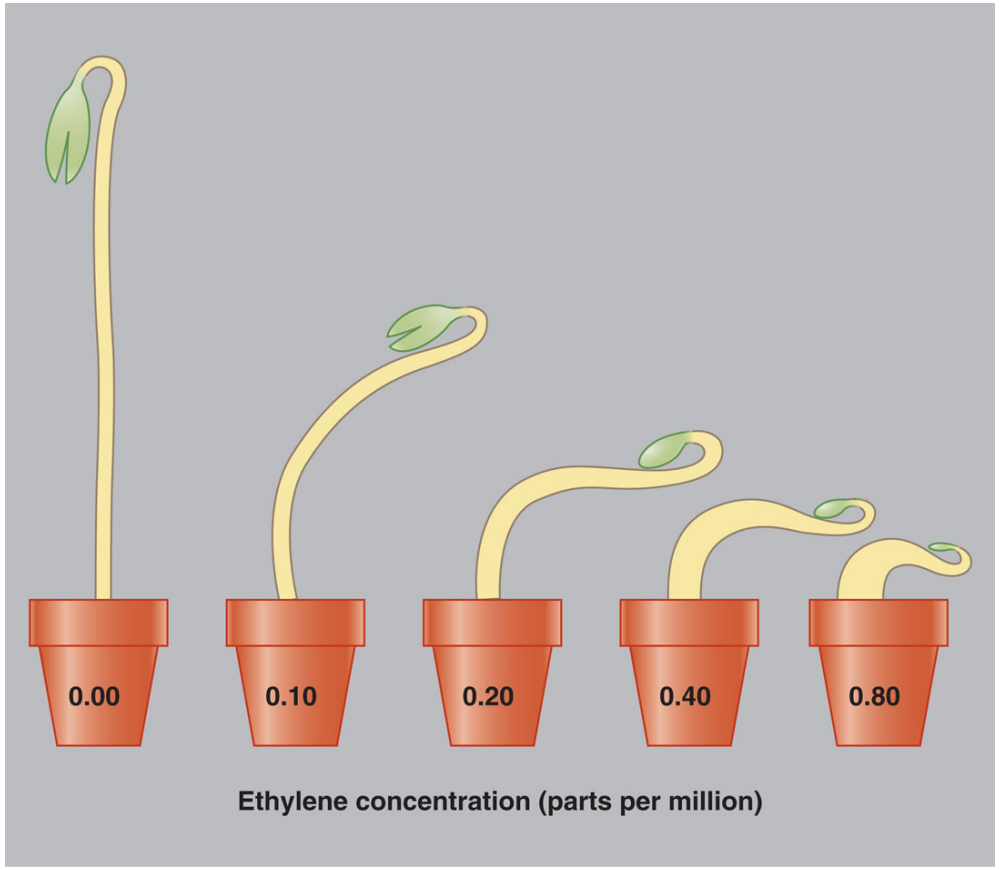
- 5. Abscisic Acid- helps prepare plants for winter by suspending growth
- a. inhibits cell division in vascular cambium
- b. onset of seed dormancy
- c. stress hormone - closes stomata

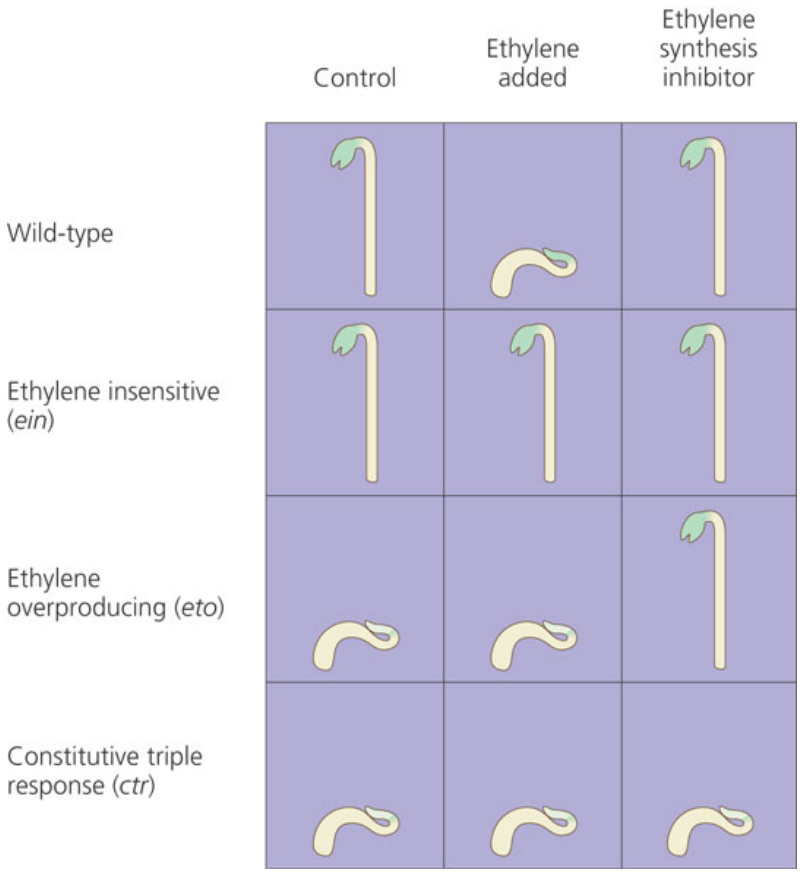
Without abscisic acid the mutant corn seed sprouts



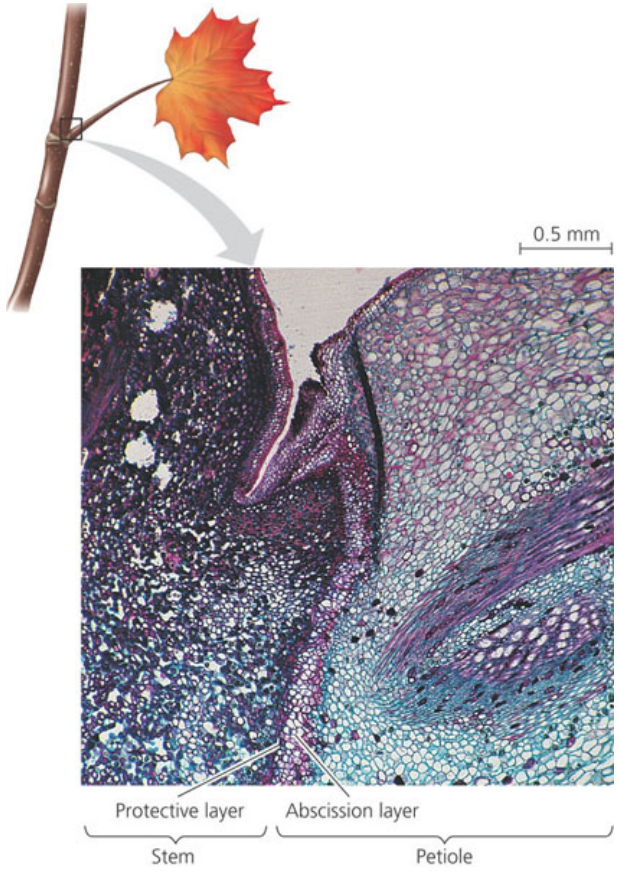
- 6. Ethylene- Gaseous hormone- induced by high auxin, inhibits growth
- a. Senescence- aging, fruit ripening and leaf abscission
- b. fruit ripening- aging cells release more ethylene
- 1. spreads from fruit to fruit
- 2. Leaves lose pigment
- c. Leaf abscission- prevents dessication
  1. leaf nutrients are sent to storage
- 2. short days and cool temperature

The triple response to an obstacle induces ethylene production



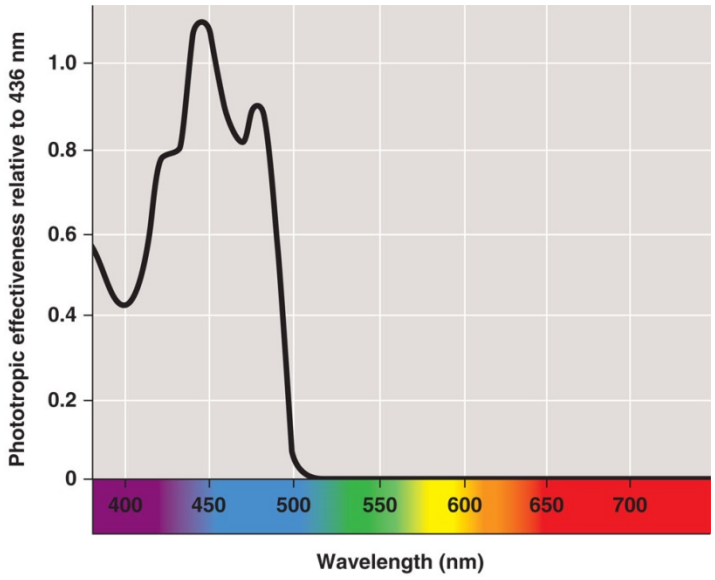

Control
Ethylene added
Ethylene synthesis inhibitor
Wild-type
Ethylene insensitive (ein)
Ethylene overproducing (eto)
Constitutive triple response (ctr)

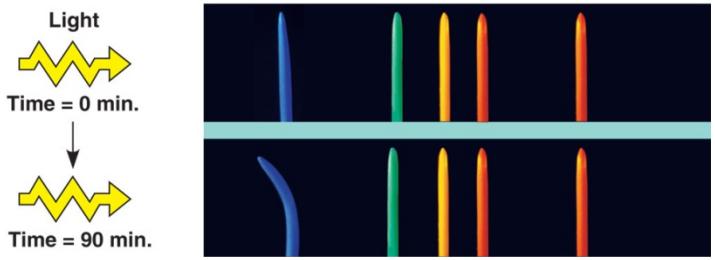
The change in balance of auxin and ethylene causes abscission



- II. Plant Movement
- A. Tropism- growth toward stimuli
- 1. Phototropism- see early note
- 2. Gravitropism- orientation of plant in response to gravity
- a. roots down, stems up
- 3. Thigmotropism- response to touch- may be increased ethylene

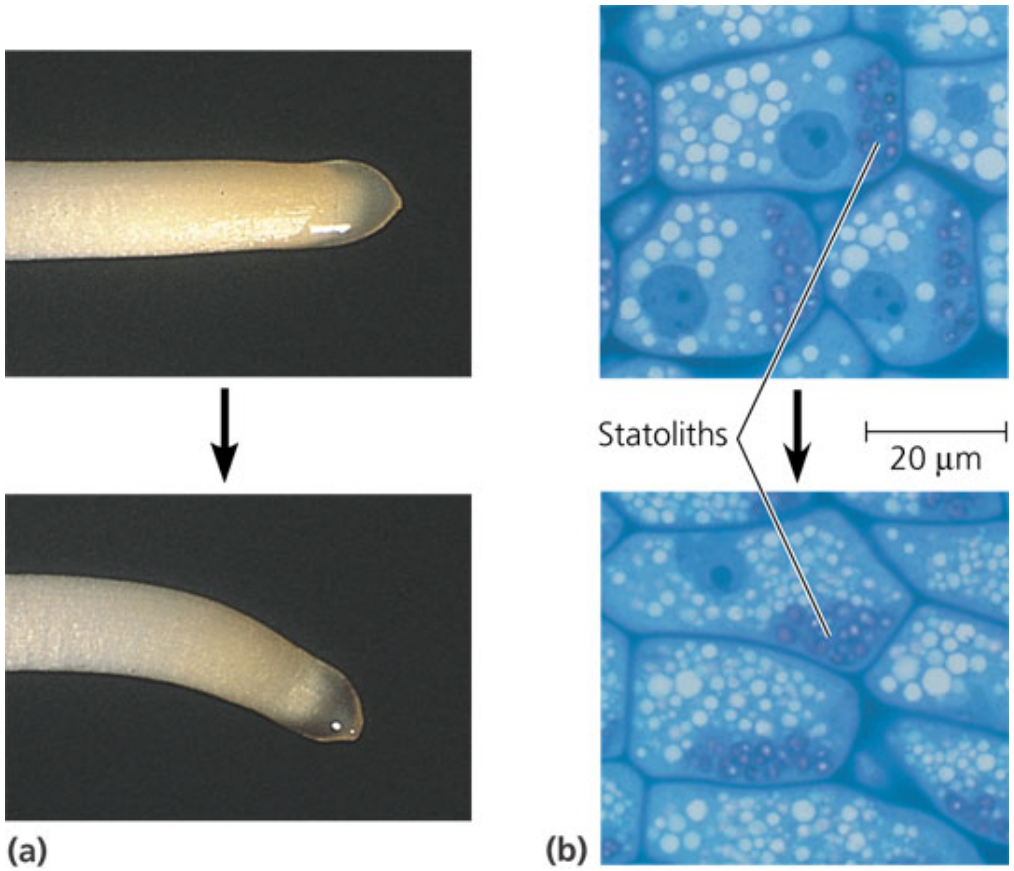
Phototropism





QuickTime?and a
YUV420 codec decompressor
are needed to see this picture.

Gravitropism



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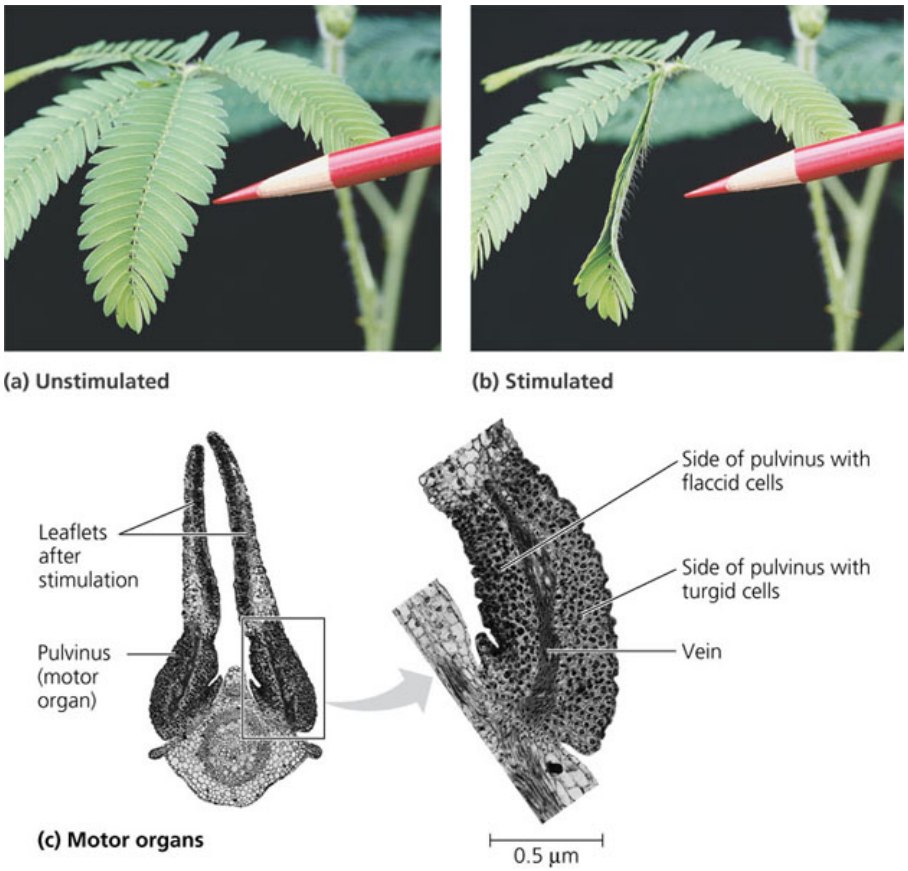
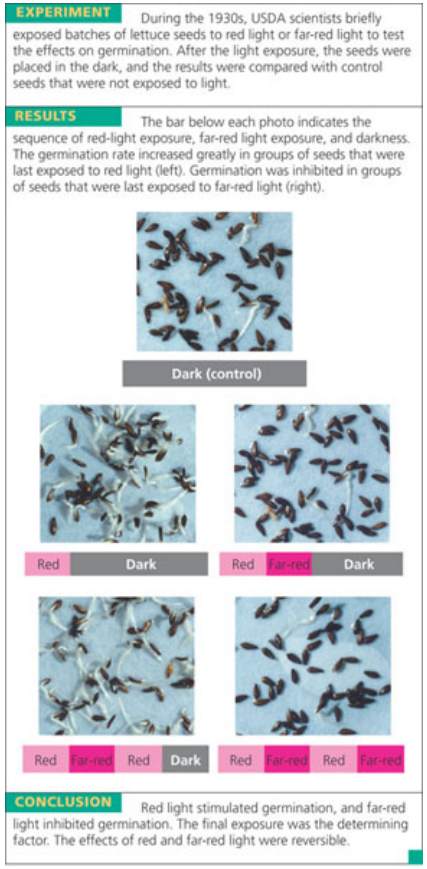
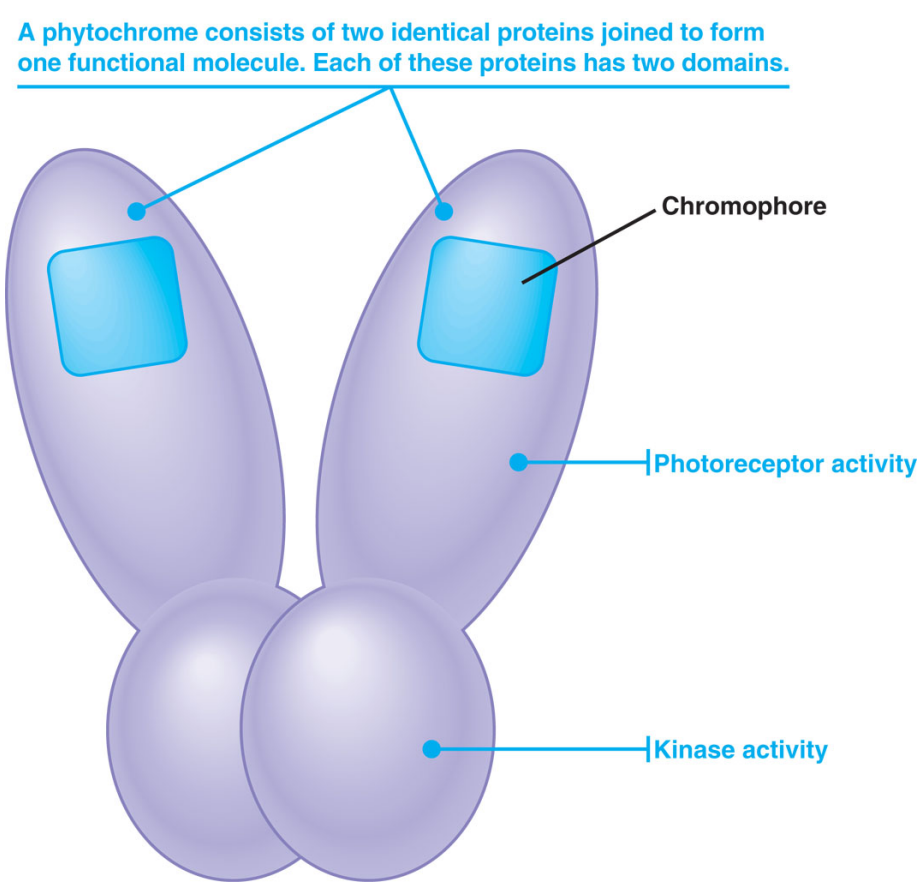
Thigmotropism

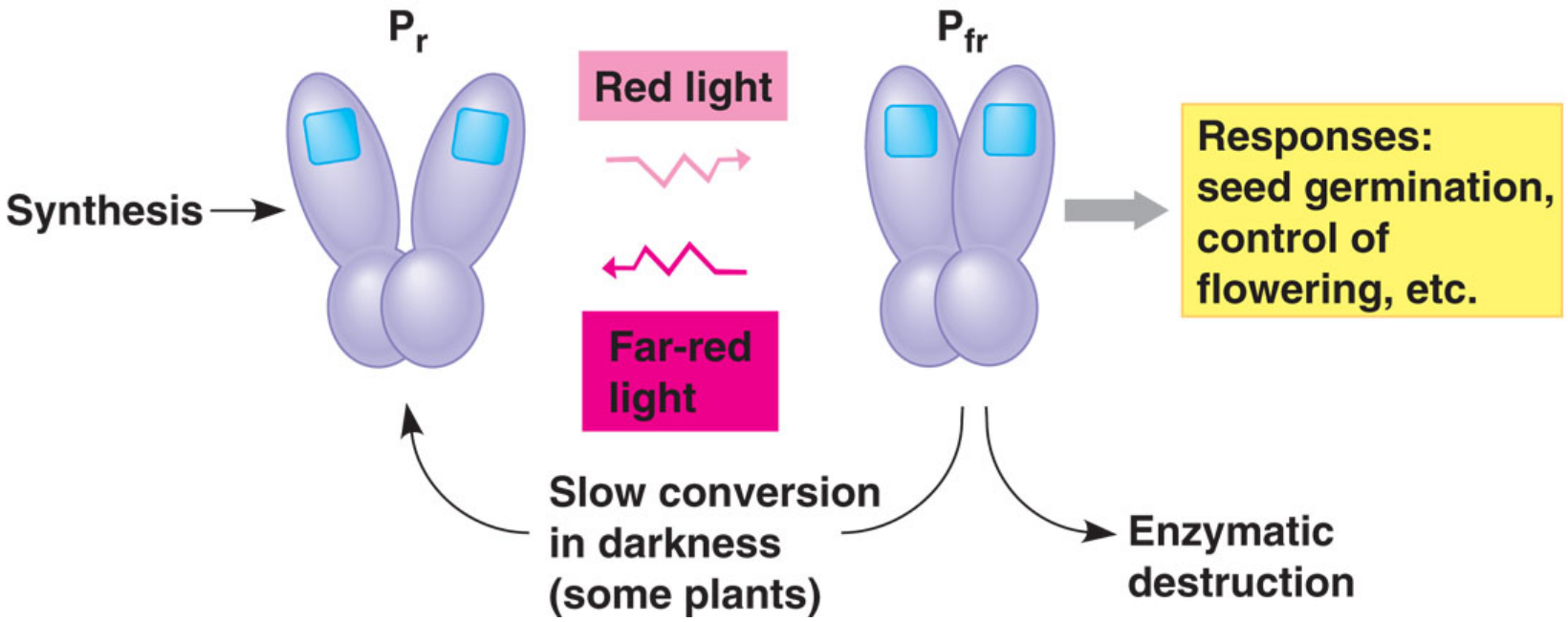


QuickTime?and a
YUV420 codec decompressor
are needed to see this picture.

Far red light inhibits germination while red light inhances it



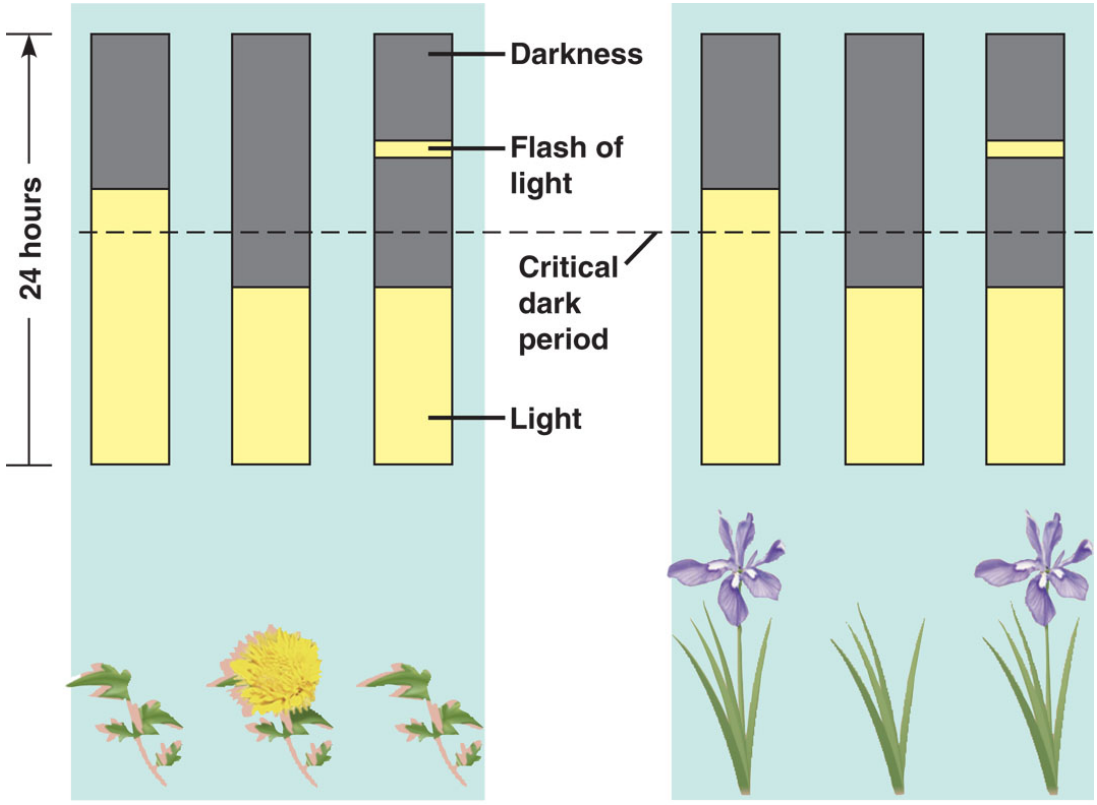

A phytochrome consists of two identical proteins joined to form one functional molecule. Each of these proteins has two domains.
Chromophore
Photoreceptor activity
Kinase activity

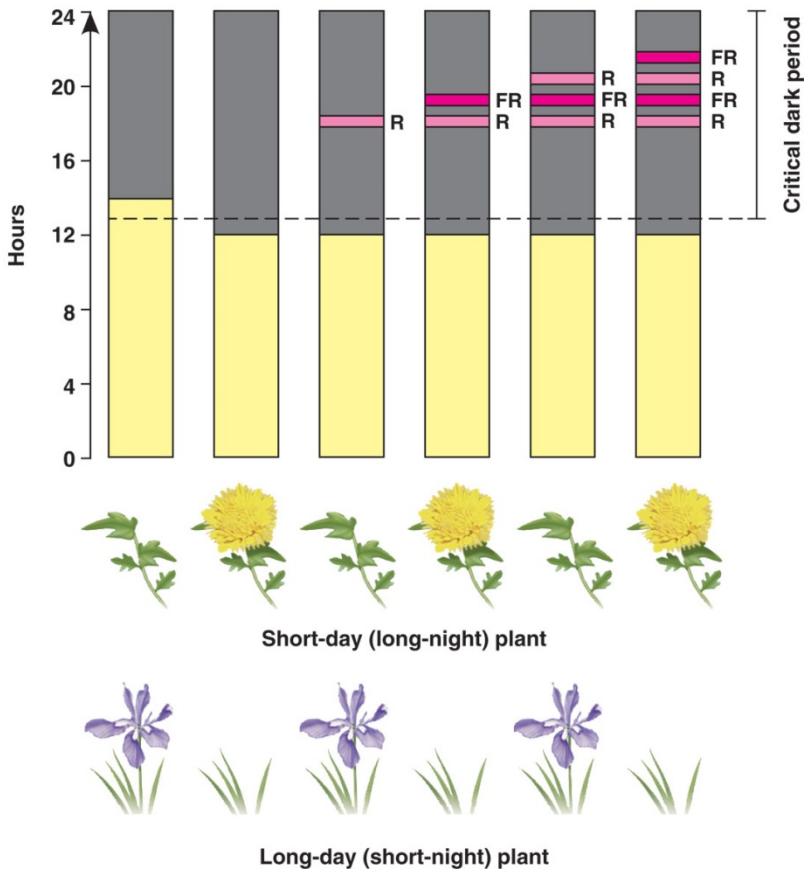

P_r
P_{fr}
Red light
Far-red light
Synthesis
Responses: seed germination, control of flowering, etc.
Slow conversion in darkness (some plants)
Enzymatic destruction

Sleep movments

Noon

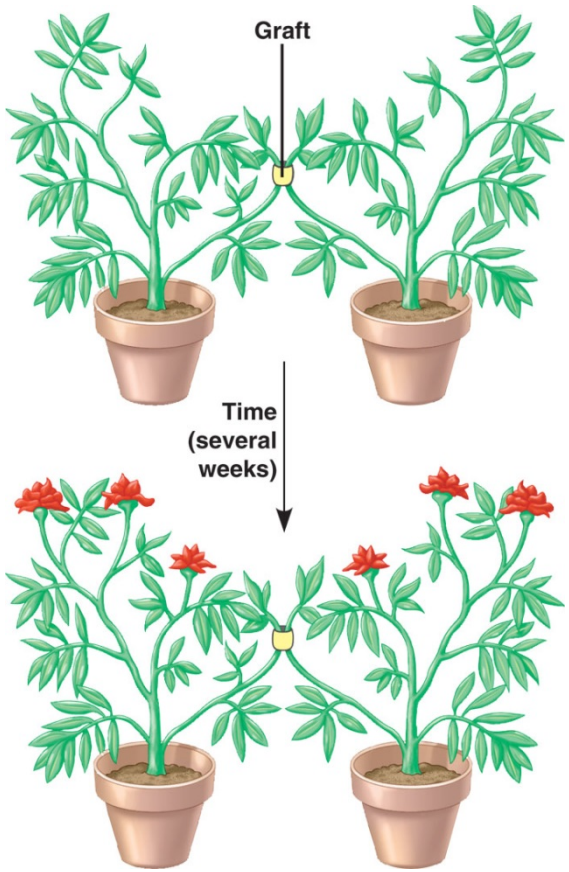
Midnight

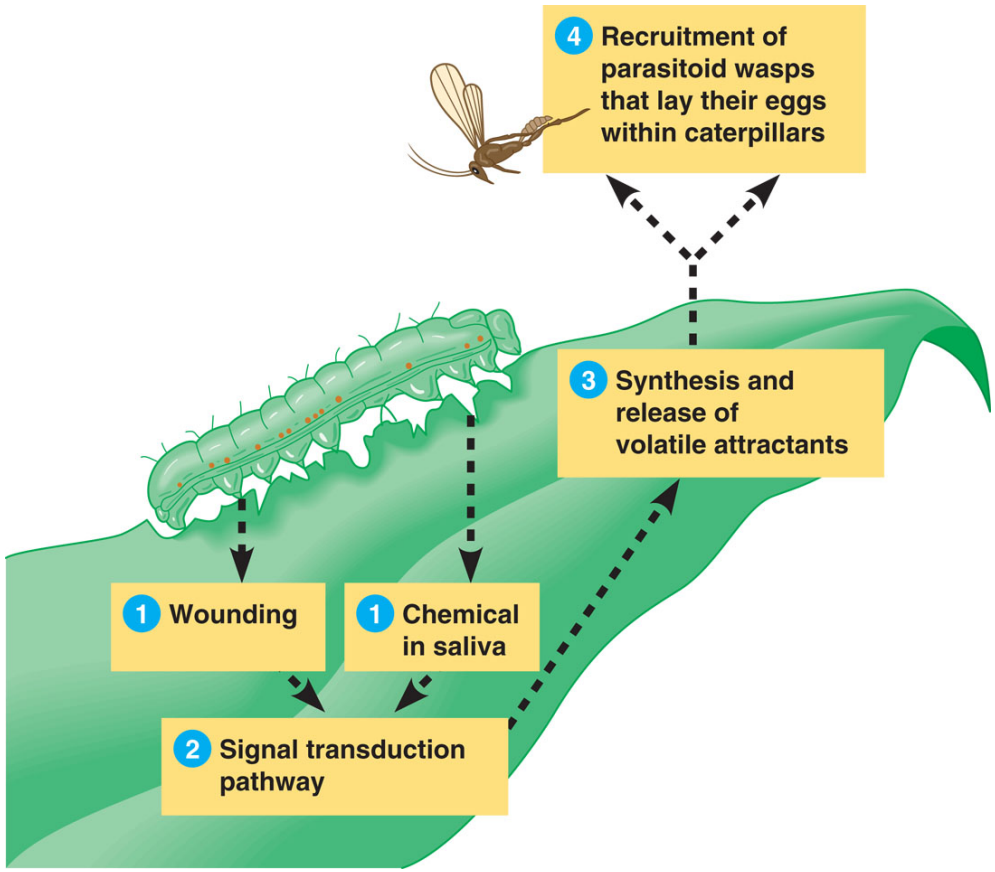

24 hours
Darkness
Flash of light
Critical dark period
Light
(a) "Short-day" plants
(b) "Long-day" plants

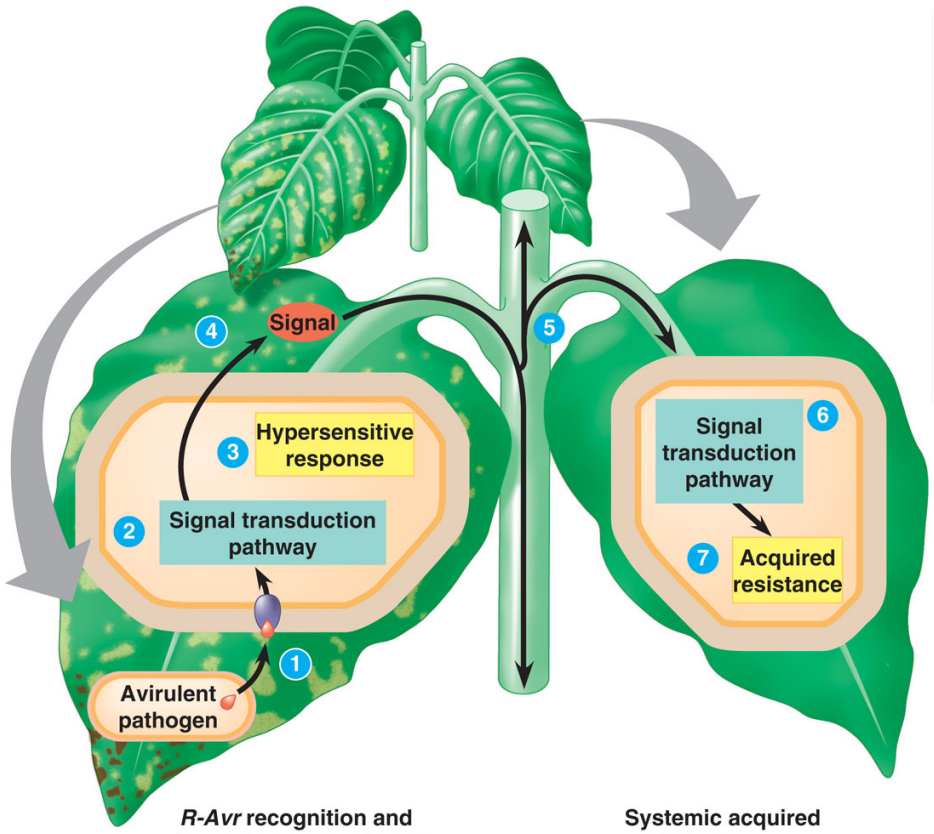

24
20
16
12
8
4
0
Hours
R
FR
R
R
FR
R
FR
R
FR
R
Critical dark period
Short-day (long-night) plant
Long-day (short-night) plant

- III. Control of daily and Seasonal responses
- A. Biological clocks - circadian rhythms- plants have sleep movements and opening and closing of stomata.
- 1. Circadian rhythm- physiological cycle (24hrs)
- a. most are cued to dark and light
- b. Once off it could take days to reset (jet lag)
- B. Photoperiodism- plants response to day length
- 1. Photoperiodism and flowering- control
  a. short- day= light shorter than critical period (late summer, fall, winter)
  b. long-day= light period longer than a critical period (late spring/summer)
- c. day-neutral= unaffected by day length.

Flowering signal (florigen)




4 Recruitment of parasitoid wasps that lay their eggs within caterpillars
3 Synthesis and release of volatile attractants
1 Wounding
1 Chemical in saliva
2 Signal transduction pathway


Signal
4
5
Hypersensitive response
3
Signal transduction pathway
2
Avirulent pathogen
1
Signal transduction pathway
6
Acquired resistance
7
R-Avr recognition and hypersensitive response
Systemic acquired resistance

examination

- Q1. 請說明光合作用色素之組成 (主要色素及輔助色素)，舉例說明植物適應光強及光質改變之色素變化 (25%)
- Q2. 說明質體 (plastid) 的演化過程 (25%)
- Q3. 說明Auxin (生長素) 之酸性生長 (25%)
- Q4. Ethylene 是一種氣態植物荷爾蒙，說明triple response (25%)