Photoperiodism

- History
- Photoperiodism and flowering
- Flowering response
- Flower initiation
- Biological clock

History

- Demonstrated in 1920, Maryland mammoth tobacco mutant for flowering
- Daylength cause

Daylength

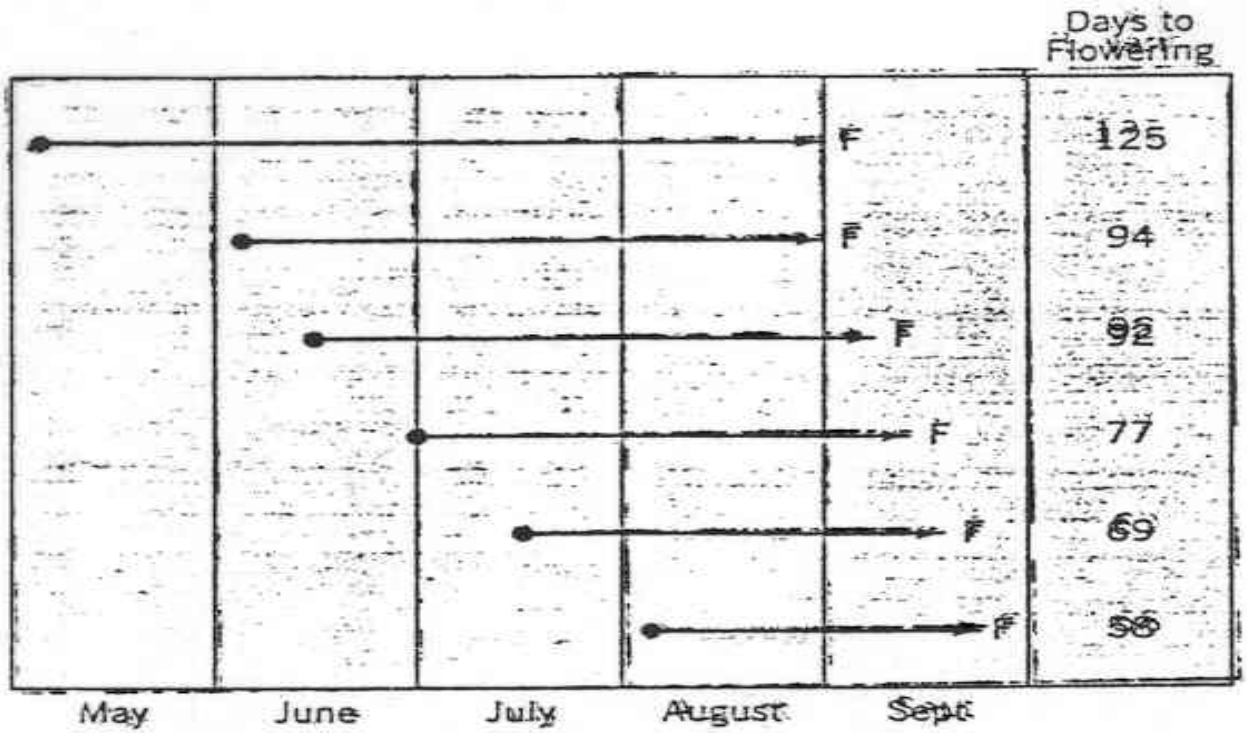
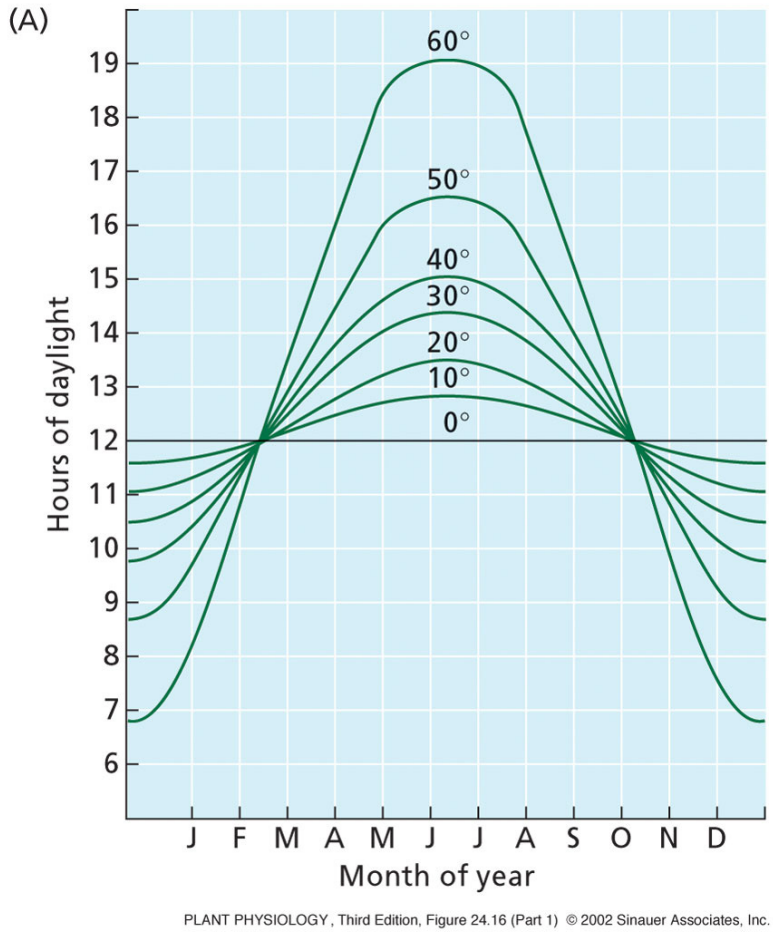


FIGURE 19.1 September soybeans. Soybeans (*Glycine max*, cv. Biloxi) sown over a three-month period all flower within a three-week period in September.

Photoperiodism and flowering

- Regulation of development by length of day
- Changes as you move from equator
- More predictable than climate: ie first frost



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Long day and Short day plants

- **Long day plants**
- flower when daylength exceeds a critical duration
- **short day plants**
- flower when daylength is less than a critical duration

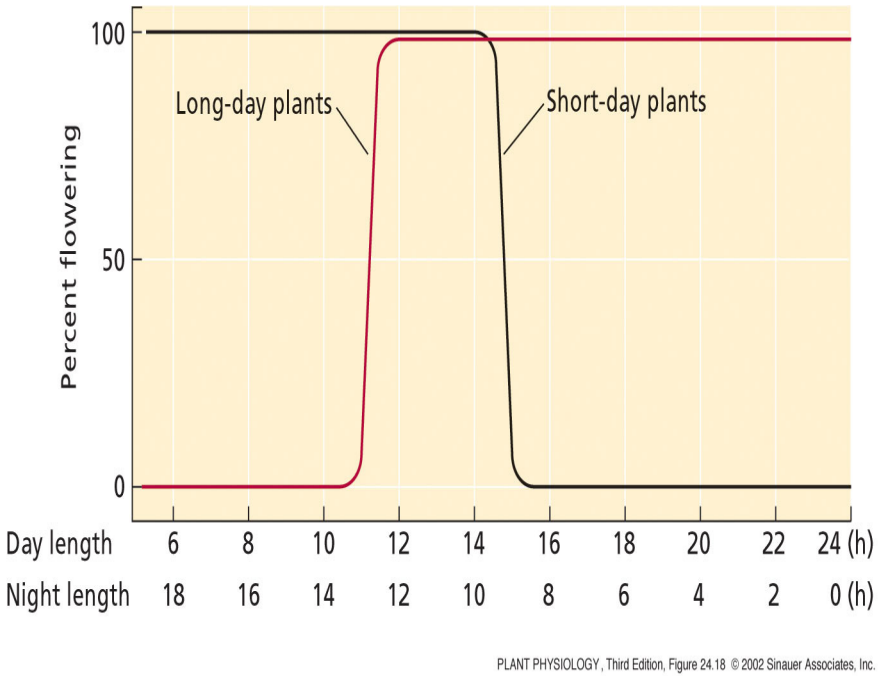

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TABLE 20.1 Representative plants exhibiting the principal photoperiodic response types.

Short-Day Plants	
Chenopodium rubrum	red goosefoot
Chrysanthemum sp.	chrysanthemum
Cosmos sulphureus	yellow cosmos
Euphorbia pulcherrima	poinsettia
Glycine max	soybean
Nicotiana tabacum	tobacco (Maryland Mammoth)
Perilla crispa	purple perilla
Pharbitis nil	Japanese morning glory
Xanthium strumarium	cocklebur
Long-Day Plants	
Anethum graveolens	dill
Beta vulgaris	Swiss chard
Hyoscyamus niger	black henbane
Lolium sp.	rye grass
Raphanus sativus	radish
Secale cereale	spring rye
Sinapis alba	white mustard
Spinacea oleracea	spinach
Triticum aestivum	spring wheat
Day-Neutral Plants	
Cucumis sativus	cucumber
Gomphrena globosa	globe amaranth
Helianthus annuus	sunflower
Phaseolus vulgarus	common bean
Pisum sativum	garden pea
Zea mays	corn

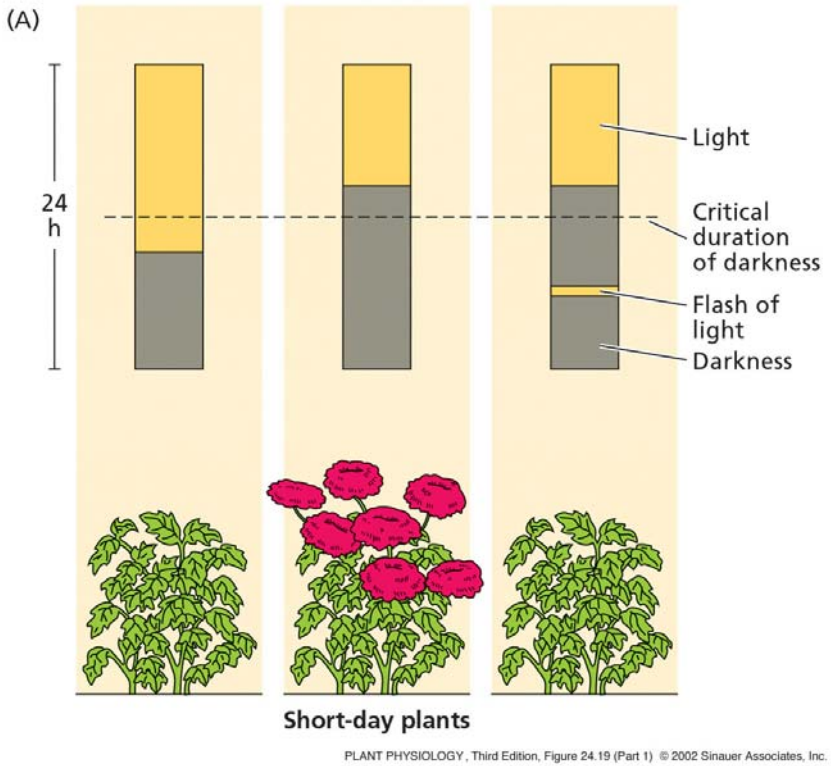
Dual Day length plants

- **Long- Short day plants: long days followed by short days**
- Kalanchoe

- **Short – Long day plants: sequence of short days followed by long days**
- Trifolium (white clover)

- **Day neutral plants:**
- no seasonality
- depends on developmental status of plant

Patterns



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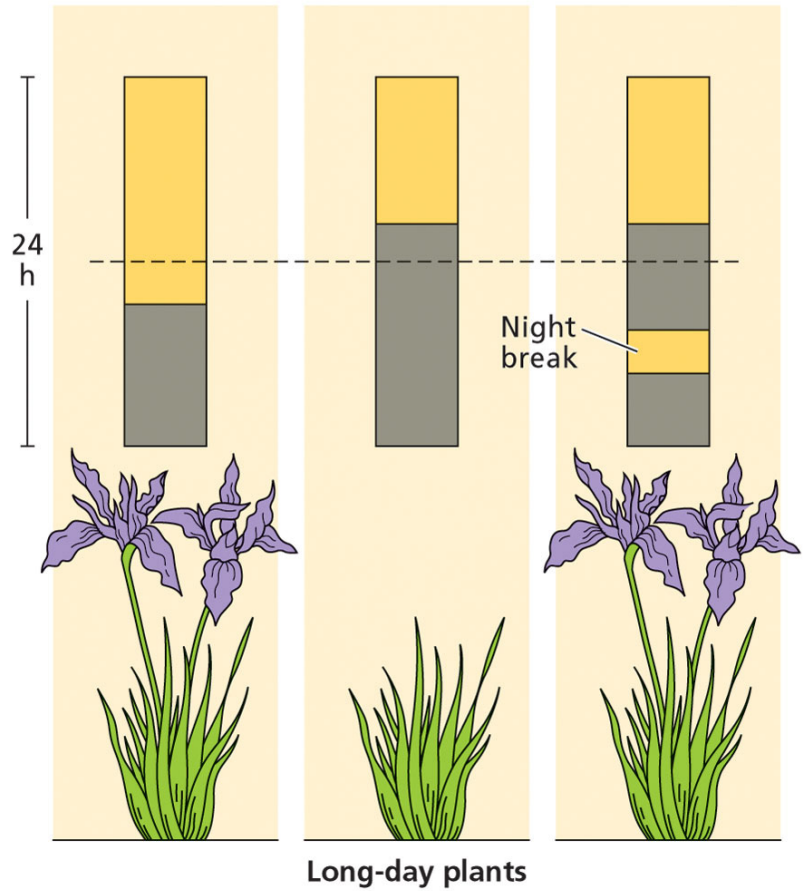

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Flowering response

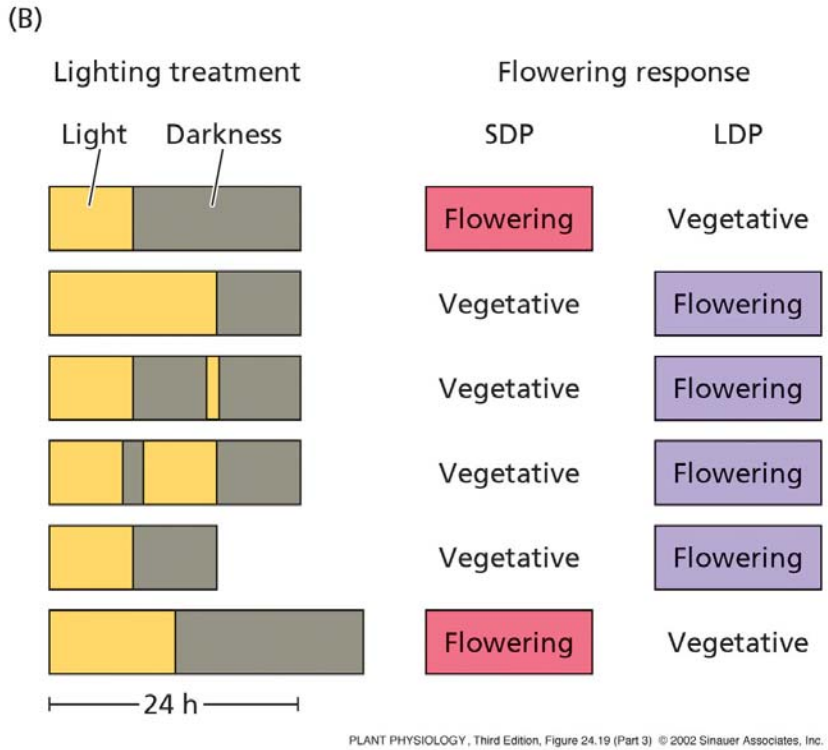
- # of induction cycles
- critical daylength vs critical night length
- light interruption experiment
- red light/far red light
- photoreverisible
- phytochrome

TABLE 24.1
Length of juvenile period in some woody plant species

Species	Length of juvenile period
Rose (*Rosa* [hybrid tea])	20–30 days
Grape (*Vitis* spp.)	1 year
Apple (*Malus* spp.)	4–8 years
Citrus spp.	5–8 years
English ivy (*Hedera helix*)	5–10 years
Redwood (*Sequoia sempervirens*)	5–15 years
Sycamore maple (*Acer pseudoplatanus*)	15–20 years
English oak (*Quercus robur*)	25–30 years
European beech (*Fagus sylvatica*)	30–40 years

Source: Clark 1983.

Phytochrome response



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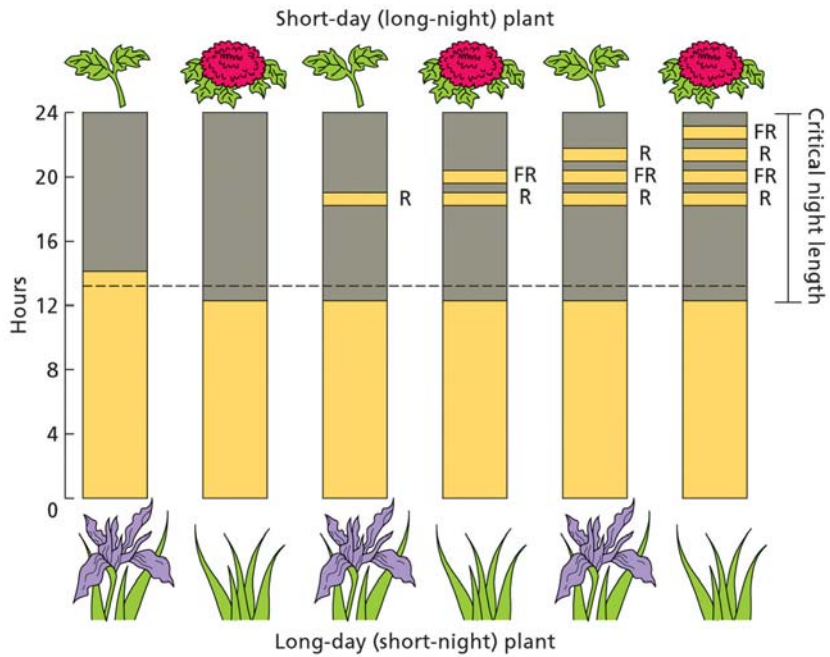

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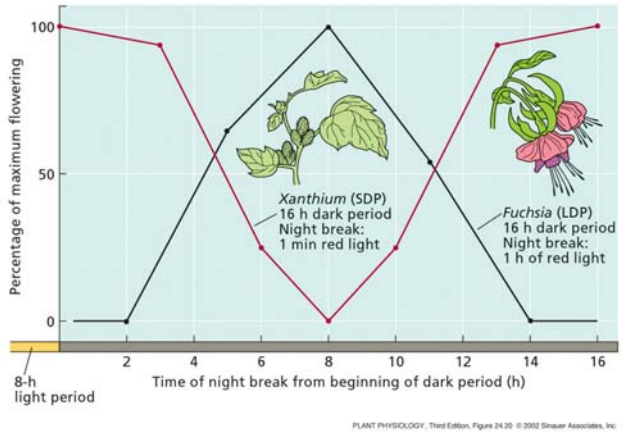
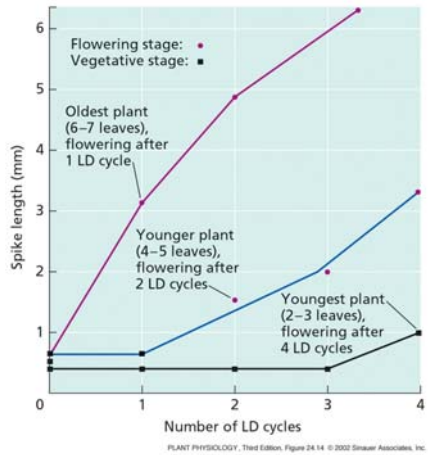
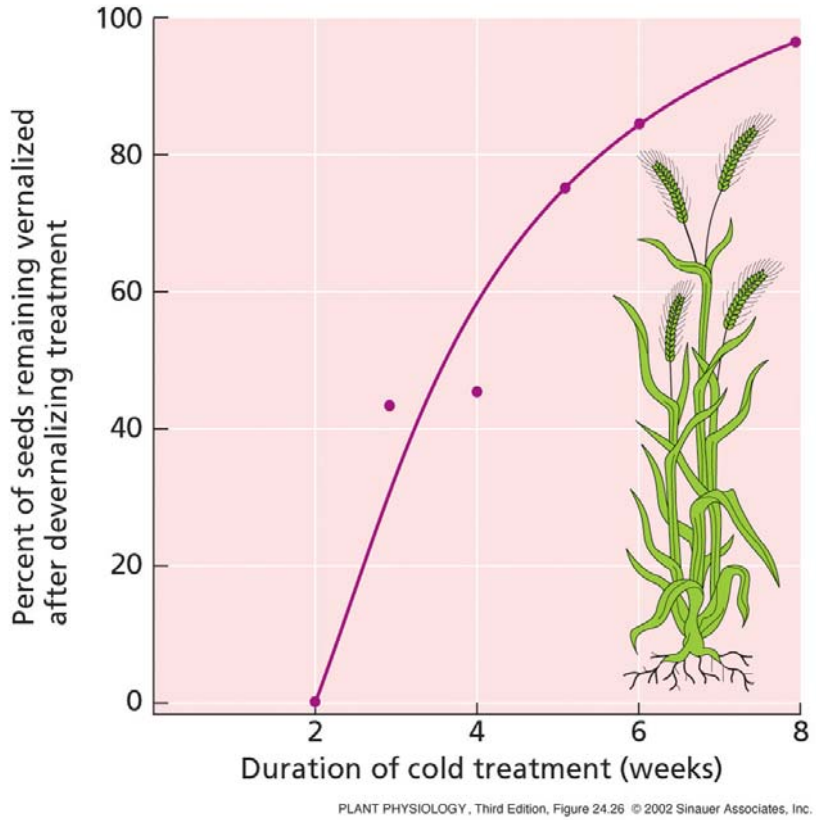
Variations

- ripeness to respond
- from cotyledon stage to 30 or 40 years of age
- qualitative vs quantitative: absolute or just longer or shorter days
- # of inductive cycles to flower: one to many
- mixed photoperiods: long to short, short to long





Vernalization



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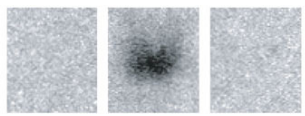
Flowering locus gene

40 days cold

no cold

FLC mutation, no cold



FLC mRNA

Flower initiation

- perception
- leaf data
- grafting experiments
- substance: "florigen",
- role of gibberellins in LD plants
- floral meristem changes

Perception

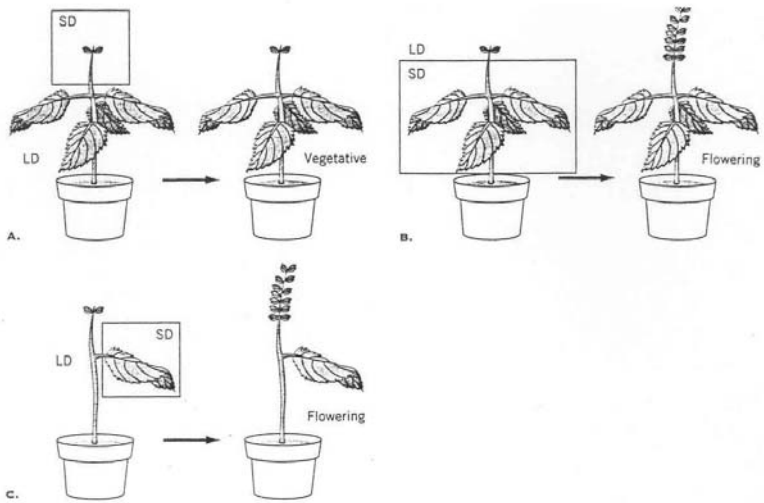


FIGURE 19.5 The role of the leaf in perception of the photoperiodic stimulus in the short-day plant *Perilla*. (A) Plants remain vegetative when the shoot apex is covered to provide short days and the leaves are maintained under long days. (B) Plants flower when the leaves are given short days but the meristem is maintained under long days. (C) Flowering will occur when only a single leaf is provided short days. (Based on the work of M. Chailakhyan, *Canadian Journal of Botany* 39:1817, 1961. Reprinted by permission.)

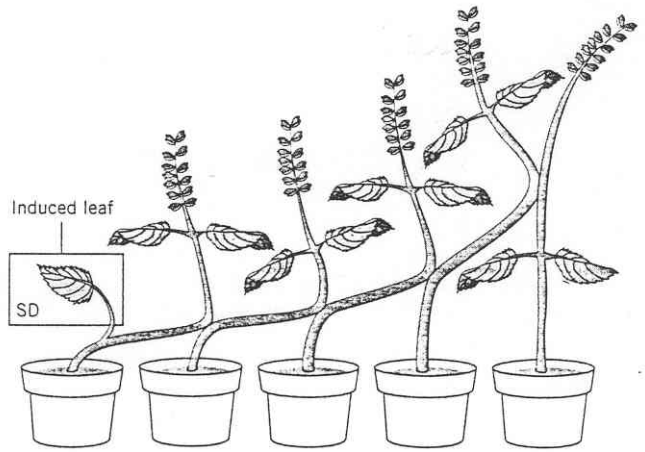
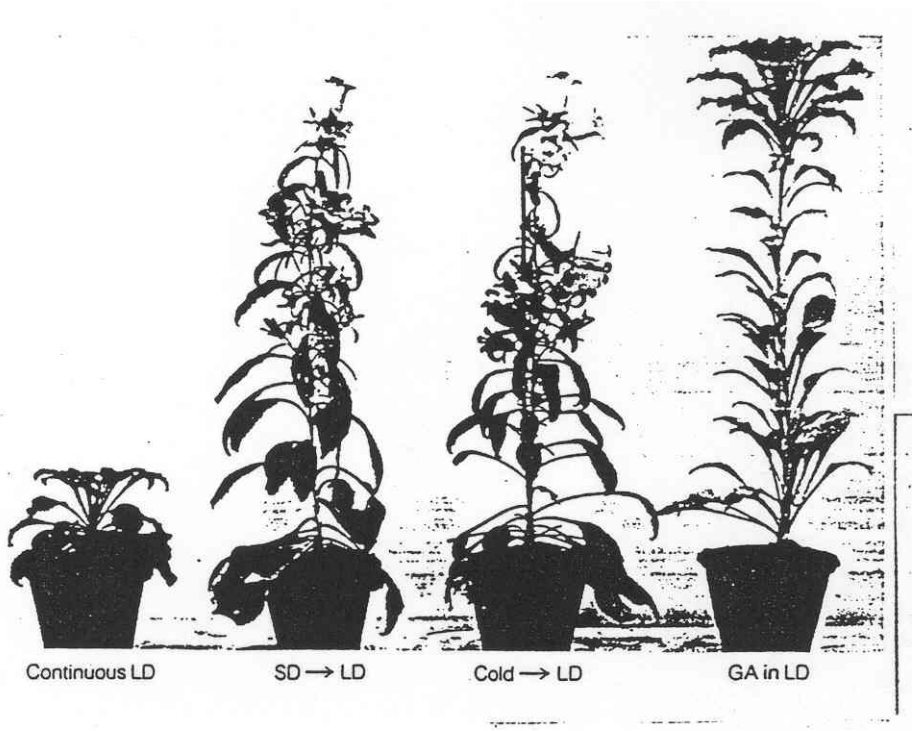


FIGURE 19.6 Transmission of the floral stimulus in grafted plants. Several plants are "approach" grafted and the terminal plant is induced to flower. All plants will flower, indicating that the floral stimulus has been transmitted from the single induced leaf through all of the plants.

Treatment

FIGURE 21.13. The control of flowering in the SDP *Campanula medium*. When grown in continuous long days, the plants grow as rosettes and the stem does not elongate. Eight weeks of short days followed by long days result in both elongation and flowering. The short days can be substituted by eight weeks of cold temperatures. Application of GA_3 results in stem elongation but not in flowering induction. (From Wellensiek, 1985.)



Floral Stimulus

TABLE 24.2
Transmissible factors regulate flowering.

Donor plants maintained under flower-inducing conditions	Photoperiod type[a,b]	Vegetative receptor plant induced to flower	Photoperiod type[a,b]
Helianthus annus	DNP in LD	*H. tuberosus*	SDP in LD
Nicotiana tabacum Delcrest	DNP in SD	*N. sylvestris*	LDP in SD
Nicotiana sylvestris	LDP in LD	*N. tabacum* Maryland Mammoth	SDP in LD
Nicotiana tabacum Maryland Mammoth	SDP in SD	*N. sylvestris*	LDP in SD

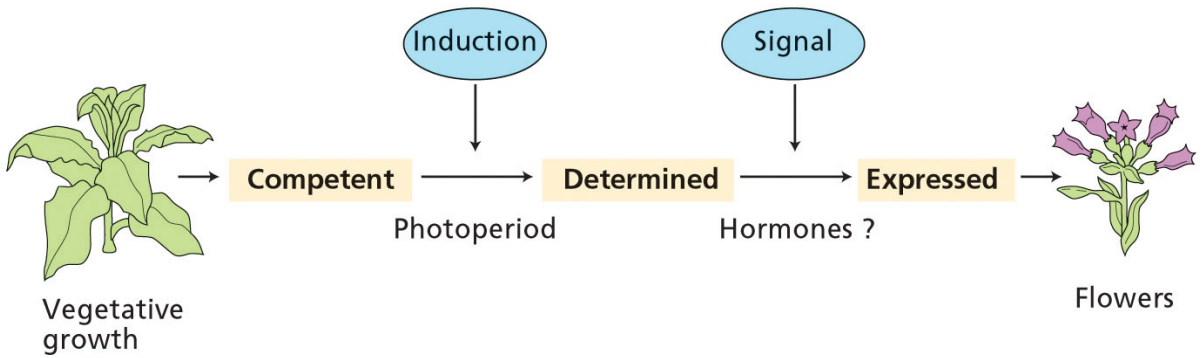
Note: The successful transfer of a flowering induction signal by grafting between plants of different photoperiodic response groups shows the existence of a transmissible floral hormone that is effective.

[a]LDPs = Long-day plants; SDPs = Short-day plants; DNPs = Day-neutral plants.

[b]LD, long days; SD, short days.

Steps to flowering

- Phytochrome
- Blue light receptor



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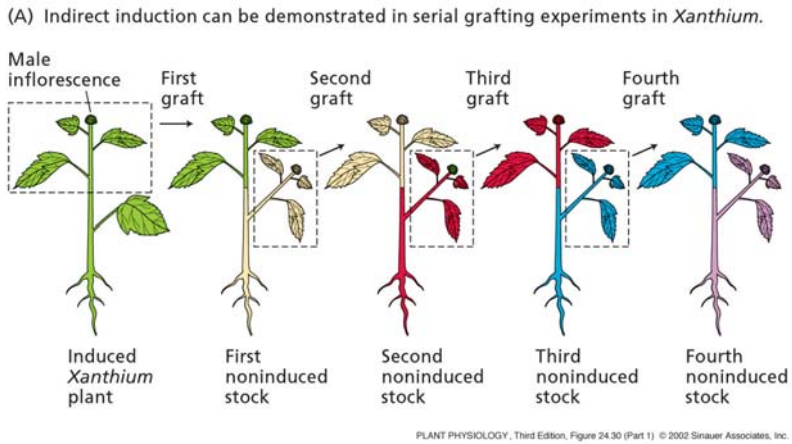
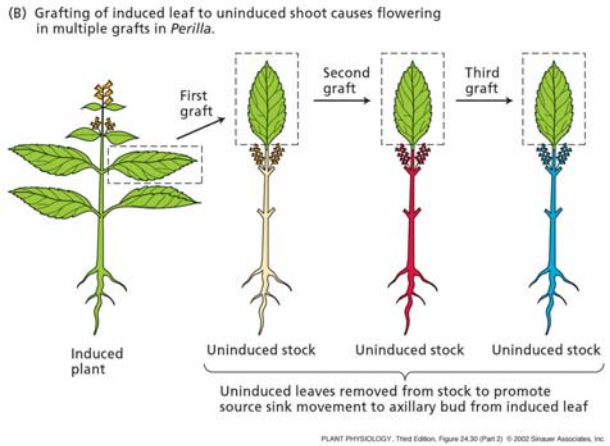
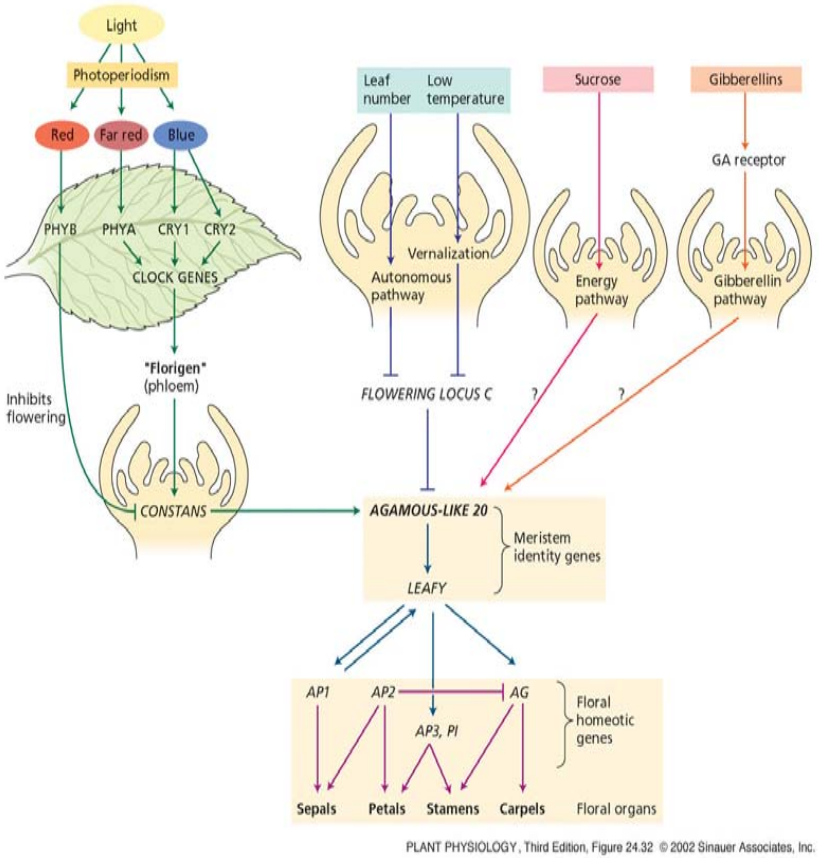
Grafting experiments





- Transmissible substance
- Source sink movement
- Possible in phloem?
- Substance?

Four Pathways



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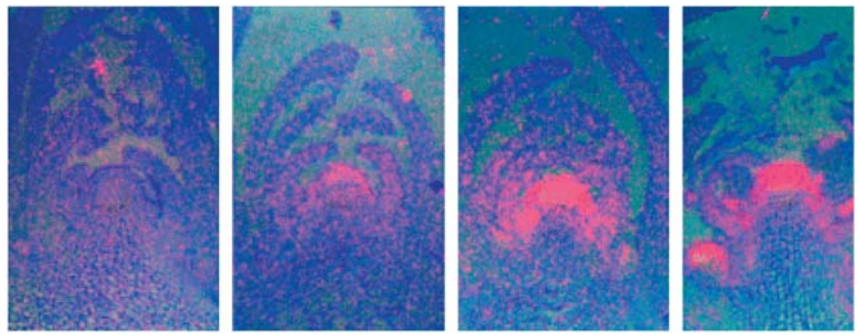

0 h 18 h 42 h 5 d

Shift from SD ---→ LD
Increase in expression of AGL20