# PHOTOPERIODISM

For B.Sc. Part II (Sub.) Group C (Plant Physiology)


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**Lecture No.39**

## Photoperiodism ????

The plants in order to flower require a certain day length i.e., the relative length of day and night which is called as photoperiod. The response of plants to the photoperiod expressed in the form of flowering is called as photoperiodism

- In the year 1906, a commercial variety of tobacco, Maryland narrow-leaved, gave rise to a new mutant called **Maryland mammoth**.
- This new variety showed vigorous vegetative growth during the summer, but the plants did not set seeds before the cold weather set in.
- W. W. Garner and H.A. Allard, plant physiologists, came forward to investigate the cause.
- Finally they observed that these plants always bloomed during the short days of the winter months.
- The plants were made to flower even during the months of summer by cutting down the light period to seven hours a day.

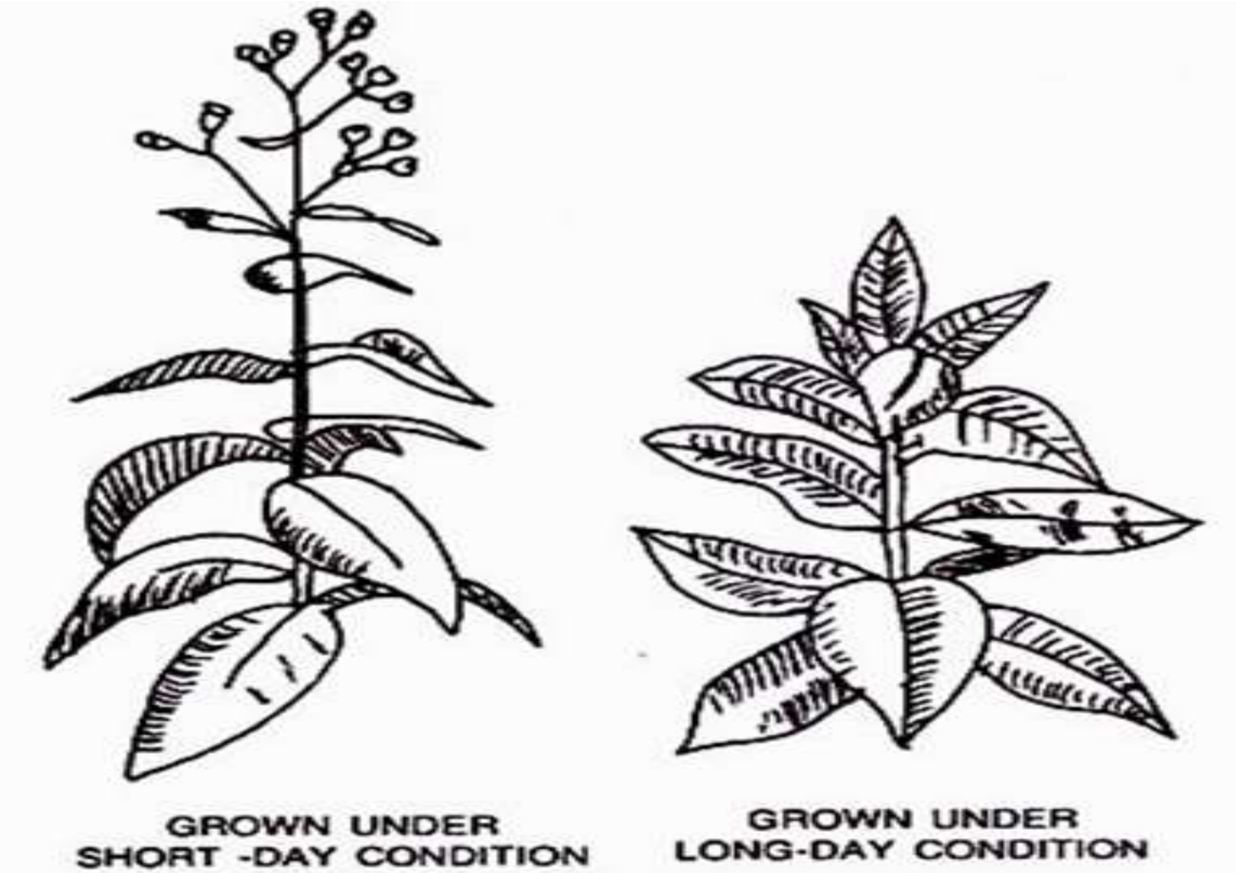



**Figure: Effect of day length on flowering of tobacco variety *Maryland mammoth* Plant.**

- Gamer and Allard published their investigations in the year 1920. They, however, concluded that flowering was caused by exposure to days made up of short light and long dark periods. Since then it has been known that an environmental factor of great significance in controlling flowering is **day length.**

Maryland Mammoth' variety of tobacco (*Nicotiana tabacum*) could be made to flower only when the daily exposure to the light was reduced below a certain critical duration and after many complex experiments concluded that 'the relative length of the day is a factor of the first importance in the growth and development of plants'.

Depending upon the duration of the photoperiod, they classified plants into three categories.

1. **Short-day plants (SDPs) :** Short day plant flower only in short days (*qualitative SDPs)*, or their flowering is accelerated by short days (*quantitative SDPs).*

- ✓ These plants require a relatively short day light period (usually 8-10 hours) and a continuous dark period of about 14-16 hours for subsequent flowering.
- ✓ Examples of these plants which are also known as long-night-plants are Maryland Mammoth variety of tobacco (*Nicotiana tabacum*) Biloxi variety of Soybeans (*Glycine max*), Cocklebur (*Xanthium pennsylvanicum*).
- ➢ In short day plants the dark period is critical and must be continuous. If this dark period is interrupted even with a brief exposure of red light (660-665 nm wavelength), the short day plant will not flower.

✓ Maximum inhibition of flowering with red light occurs at about the middle of critical dark period.

✓ However, the inhibitory effect of red light can be overcome by a subsequent exposure with far-red light (730-735 nm wavelengths).

✓ Interruption of the light period by dark does not have inhibitory effect on flowering in short day plants .

✓ Prolongation of the continuous dark period initiates early flowering in short day plants.

2. **Long-day plants (LDPs):** Long day plants flower only in long days (*qualitative LDPs)*, or their flowering is accelerated by long days (*quantitative LDPs).*

❖The essential distinction between long-day and short day plants is that flowering in LDPs is promoted only when the day length *exceeds a certain duration, called the* ***critical*** **day length, in every 24-hour cycle,** whereas promotion of flowering in SDPs requires a day length that is *less than the* critical day length.

✓The critical photoperiod, in such plants also, varies from species to species.

Long-day plants can effectively measure the lengthening days of spring or early summer and delay flowering until the critical day length is reached.

✓ Many varieties of wheat (*Triticum aestivum)* behave in this way.

✓Some common examples of long day plants (LDP) are barley (*Hordeum vulgare*), spinach (*Spinacea olemcea*), radish (Raphanus *sativus*), henbane (*Hyoscyamus niger*), onion (*Allium cepa*) and carrot (*Daucus carota*), etc. They normally flower in late spring or early summer

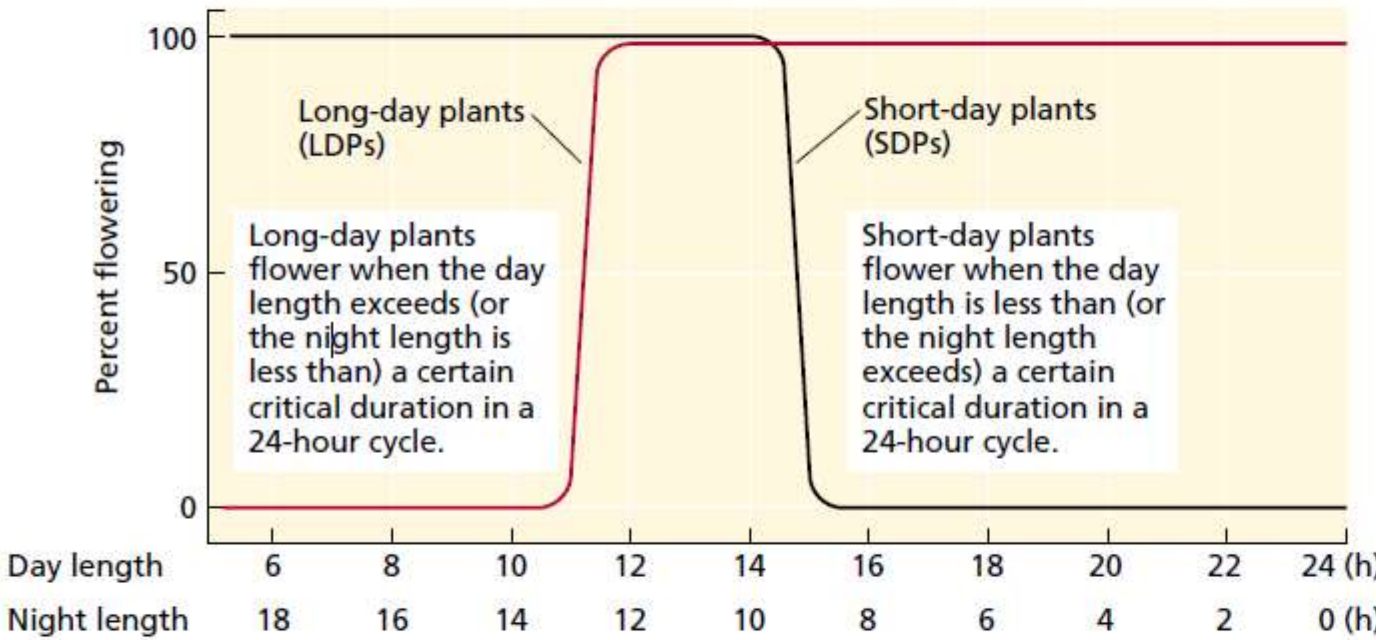
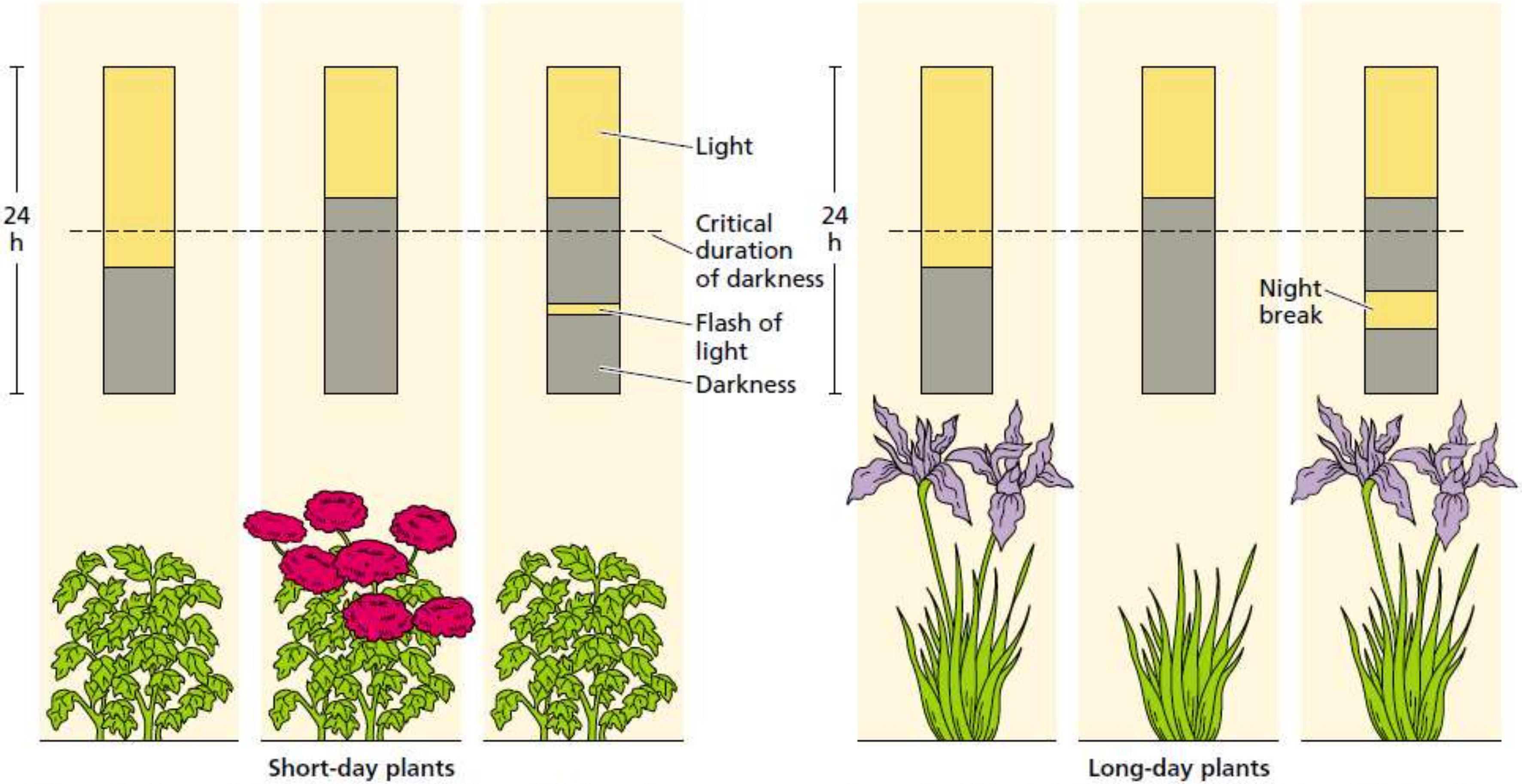



**Figure: The photoperiodic response in long- and short-day plants. The critical duration varies between species: In this example, both the SDPs and the LDPs would flower inphotoperiods between 12 and 14 h long.**




Short-day (long-night) plants flower when night length exceeds a critical dark period. Interruption of the dark period by a brief light treatment (a night break) prevents flowering.

Long-day (short-night) plants flower if the night length is shorter than a critical period. In some long-day plants, shortening the night with a night break induces flowering.

**Figure: The photoperiodic regulation of flowering: Effects on SDPs and LDPs**.

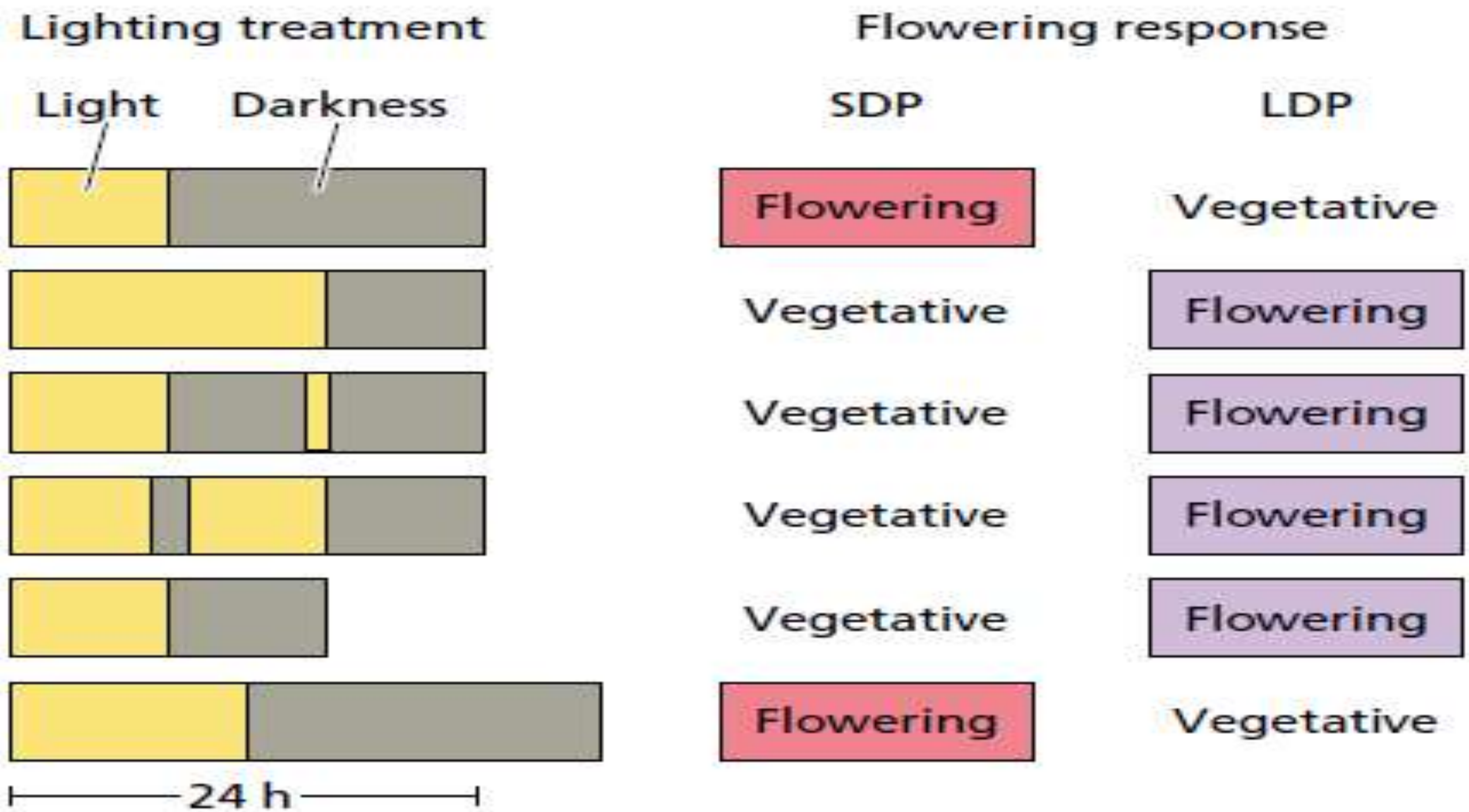



**Figure: The photoperiodic regulation of flowering: Effects of the duration of the dark period on flowering. Treating short- and long-day plants with different photoperiods clearly shows that the critical variable is the length of the dark period.**

**Day-Neutral Plants (DNP):**

✓These plants flower after a period of vegetative growth, regardless of the photoperiod.

✓In other words, they are unaffected by the day or night lengths, and flower around the year.

✓ Some common examples of day-neutral plants are cucumber (*Cucumis sativus*), cotton (*Gossypium hirsutum*), tomato (*Lycopersicum esculentum*), sunflower (*Helianthus annuus*), Maize (*Zea mays*) and some varieties of pea, etc.

**Critical Photoperiod:**

The critical photoperiod for long and short day plants greatly varies from species to species. For instance. *Chrysanthemum* and *Poinseltias* are both short-day plants, but *Chrysanthemum* form flowers when the days are shorter than 14.5 hours, whereas *Poinsettias* produce flower buds only when the days are less than 12.5 hours. Spinach and rose mallow are long-day plants, but spinach flowers when the days are longer than 14 hours, the rose mallow flowers when they are longer than 13 hours. In other words, the short-day plants flower only when the **days are shorter than a critical photoperiod**, and the long-day plants flower only when the days are **longer than the critical photoperiod**.

**The Leaf is the site of perception of the photoperiodic stimulus:**

✓The photoperiodic stimulus in both LDPs and SDPs is perceived by the leaves.

For example, treatment of a single leaf of the SDP *Xanthium* with short photoperiods is sufficient to cause the formation of flowers, even when the rest of the plant is exposed to long days.

✓Thus, in response to photoperiod the leaf transmits a signal that regulates the transition to flowering at the shoot apex.

✓The photoperiod-regulated processes that occur in the leaves resulting in the transmission of a floral stimulus to the shoot apex are referred to collectively as **photoperiodic induction.**

✓ Photoperiodic induction can take place in a leaf that has been separated from the plant. For example, in the SDP *Perilla crispa*, an excised leaf exposed to short days can cause flowering when subsequently grafted to a noninduced plant maintained in long days (Zeevaart and Boyer 1987). This result indicates that photoperiodic induction depends on events that take place exclusively in the leaf.

❖The floral stimulus is transported via the **phloem**

**Phytochrome is the primary photoreceptor in photoperiodism**

✓ Night-break experiments are well suited for studying the nature of the photoreceptors involved in the reception of light signals during the photoperiodic response.

✓The inhibition of flowering in SDPs by night breaks was one of the first physiological processes shown to be under the control of phytochrome .

✓ In many SDPs, a night break becomes effective only when the supplied dose of light is sufficient to saturate the photoconversion of Pr (phytochrome that absorbs red light) to Pfr (phytochrome that absorbs far-red light).

✓A subsequent exposure to far-red light, which photoconverts the pigment back to the physiologically inactive Pr form, restores the flowering response.

✓In some LDPs, red and far-red reversibility has also been demonstrated. In these plants, a night break of red light promoted flowering, and a subsequent exposure to far-red light prevented this response.

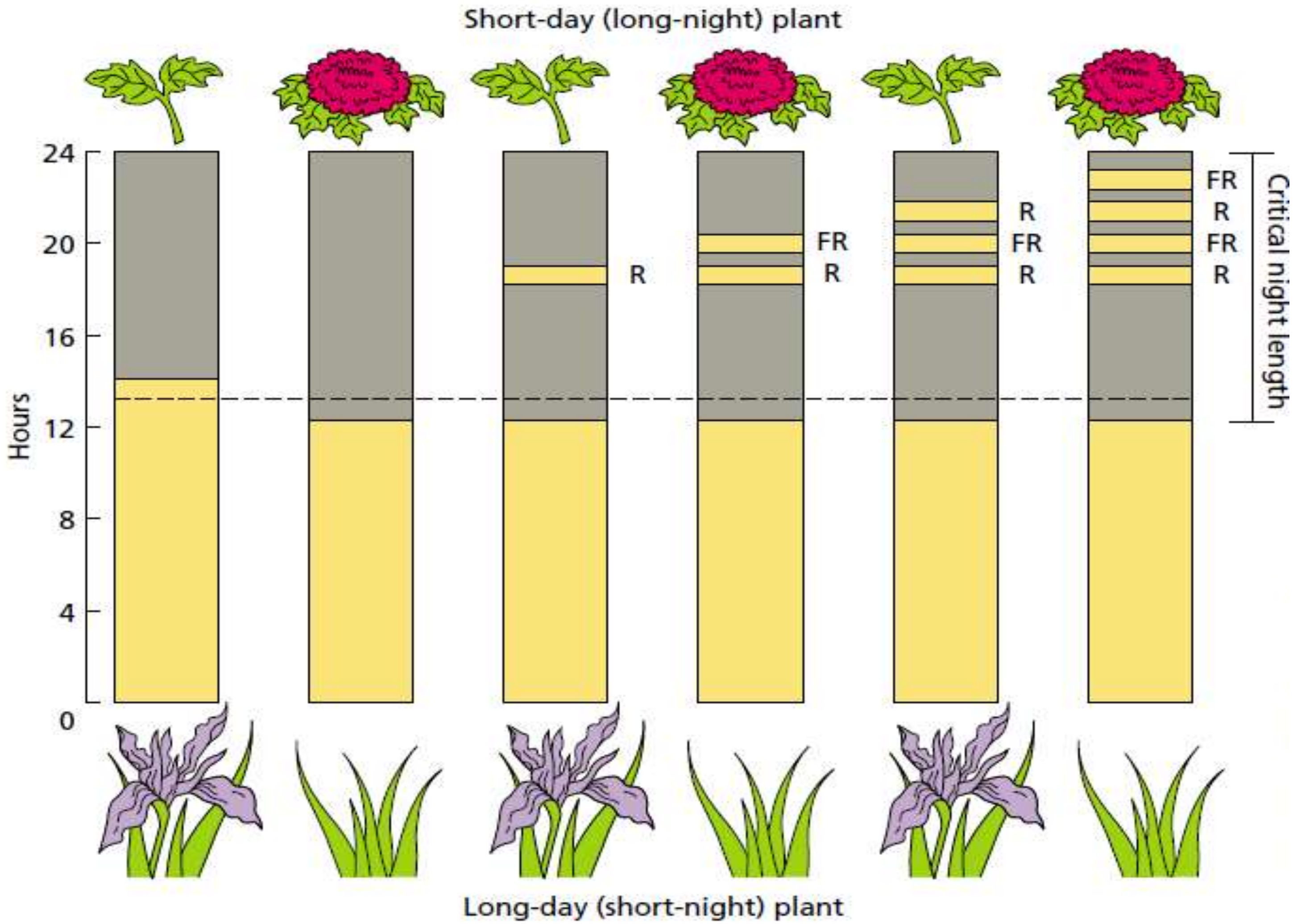



**Figure:** Phytochrome control of flowering by red (R) and far-red (FR) light. A flash of red light during the dark period induces flowering in an LDP, and the effect is reversed by a flash of far-red light. This response indicates the involvement of phytochrome. In SDPs, a flash of red light prevents flowering, and the effect is reversed by a flash of far-red light.

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# Thank You!!!