PHYTOCHROME

It has already been seen that a brief exposure with red light during critical dark period inhibits flowering in short day plants and this inhibitory effect can be reversed by a subsequent exposure with far red light. Similarly the prolongation of the critical light period or the intrruption of the dark period stimulates flowering in long day plants. This inhibition of flowering in short day plants and the stimulation of flowering in long day plants involves the operation of a proteinaceous pigment called as phytochrome.

* The pigment phytochrome exists in two different forms —
  (i) Red light absorbing form which is designated as P_R.
  (ii) Far - red light absorbing form which is designated as P_{FR}.
* These two forms of the pigment are photochemically interconvertible.
* When P_R form of the pigment absorbs red light (660 - 665 mμ), it is converted into P_{FR} form.
* When P_{FR} form of the pigment absorbs far-red light (730 - 740 mμ), it is converted into P_R form.
* The P_{FR} form of the pigment gradually changes into P_R form in dark

$$P_R \underset{730-740\ m\mu}{\overset{660-665\ m\mu}{\rightleftharpoons}} P_{FR}$$

Darkness

It is considered that during the day the P_{FR} form of the pigment is accumulated in the plant which is inhibitory of flowering in short-day plants but is stimulatory in long-day plants. During critical dark period in short-day plants, this form gradually changes into P_R form resulting in flowering. A brief exposure with red light will convert this form again into P_{FR} form thus inhibiting flowering. Reversal of the inhibitory effect of red light during critical dark period in SDP by subsequent far-red light exposure is because the P_{FR} form after absorbing far-red light (730-740 mμ) will again be converted back into P_R form.

Prolongation of the critical light period or the interruption of the dark period by red light in long-day plants will result in further accumulation of the P_{FR} form of the pigment thus stimulating flowering in long day plants.

In recent years the prosthetic group or the chromato... of the pigment phytochrome has been isolated and shown ... an open tetrapyrrole which is related to phycocyanobillin ...

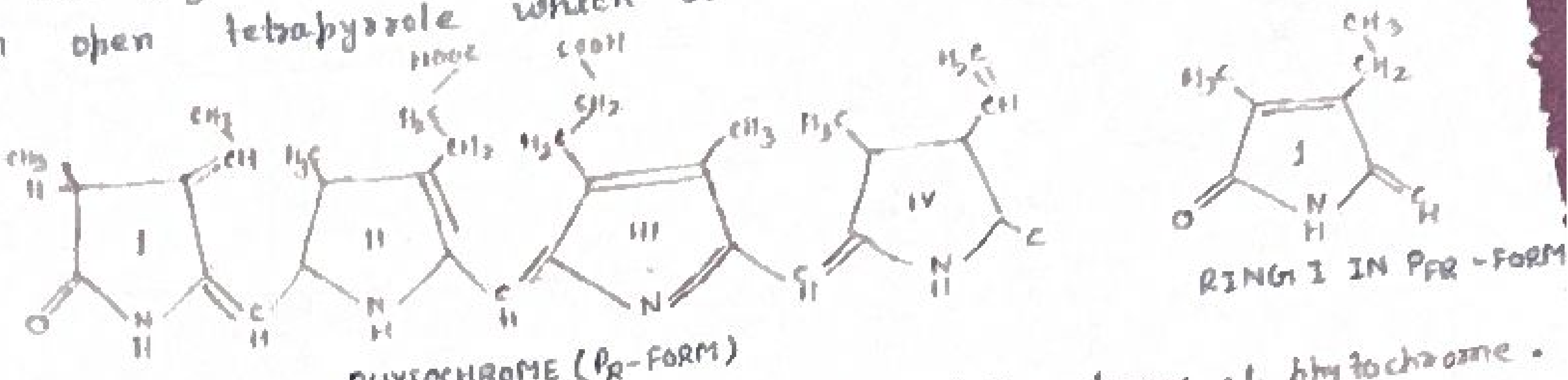
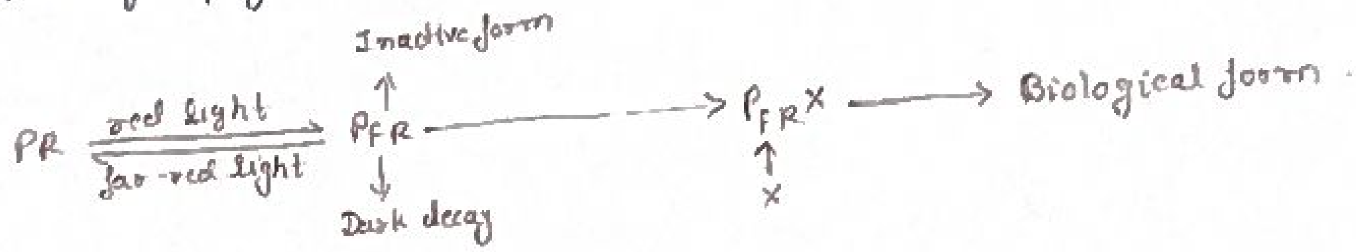


Fig:- Structures of chromatophores of P_R and P_{FR} forms of phytochrome.

Phytochromes have been detected in wide range of plants in an... sperms, gymnosperms, bryophytes and algae. Etiolated seedlings ... grown in dark have been used extensively in this connecti... They have directly been detected in different parts of seedli... in roots, hypocotyls, cotyledons, coleoptiles, stems, petioles, leaf b... vegetative buds, floral receptacles, infloresences, developing frui... and seeds. Presence of phytochrome has also been shown in... ly in other plant materials. Phytochromes are believed to be located on cell membranes.

In the recent past spectrophotometric examinations have ... Briggs and others to assume that most of the phytochrome is p... in an inactive form.

Hartman the German physiologist has proposed a modif... scheme of phytochrome action :



Ac/to him the biologically active form of phytochrome is som... unknown derivative of P_{FR}. The fact that phytochrome has been ... in several different physical forms and that several contrad... observations have been made, workers have concluded that P... (or $P_{FR}X$) may undergo two or more reactions only one of w... leads to the biologically active form. Evans (1975) says th... P_{FR} (or $P_{FR}X$) – " Control the flow of reactive substances into

linked and competing synthetic pathways."
The short day and long day plants are believed to
differ due to relative rates of Pfr and Pr interconversion. It is
felt that a high level of Pfr maintained during a long dark
period is needed for the flowering of a short day plant whereas
in a long day plant low Pfr processes are critical. It may also
be said that the differences between short day and long day
plants may not be due to the phytochrome alone.

Mechanism of Phytochrome Action :-

The exact mechanism of the action of phytochromes is not known.
They act probably - (i) by controlling active transport of ions and
molecules across membranes probably by regulating ATPase activity
(ii) by controlling the activity of membrane bound hormones such as
gibberellins.
(iii) modulating the activity of membrane bound proteins.
(iv) ac/to Galston and coworkers hydroxylation of flavonoid compounds
is affected by phytochromes. Mohr, however suggests that radiation
influences some 'basic metabolic change in the cell' responsible
for many different effects, and influences on flavonoid hydroxylases
presumably represent only one such change.
(v) Works of K.V. Thimann and coworkers suggest that phytochrome
action involves the synthesis of nucleic acids and enzymes which
may be responsible for physiological changes. Mohr and others
have found evidence to suggest that phytochrome effects are mediated
by activation of genes that code for specific messenger RNA
molecules which in their turn code for specific enzymes. The enzymes
then bring about the biochemical changes resulting to several observed
physiological responses.
(vi) There are certain responses due to red or far-red light which
are too fast to be explained by the gene activation or repression
hypothesis. Nyctinastic (Photonastic) movements of flowers are good
examples of such rapid responses. The time needed for such responses
is so short that it can not allow gene activation, mRNA synthesis,
enzyme synthesis and enzymatic changes. It is therefore, b
that Pfr in such cases causes a quick rise in the perm

of membranes to solutes. Increased solute concentration causes endosmosis and increase in turgor pressure of the cells of pulvinus which results in closing movements of leaves. Phyt... some in such cases may act by affecting the permeability of the membrane.

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