

Quadrant II – Transcript and Related Materials

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Module Name: Phytochrome: Discovery and structure

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Notes

Phytochromes are a class of photoreceptor in plants, bacteria and fungi used to detect light. They are sensitive to light in the red and far-red region of the visible spectrum and can be classified as either Type I, which are activated by far-red light, or Type II that are activated by red light. Recent advances have suggested that phytochromes also act as temperature sensors, as warmer temperatures enhance their de-activation.

All of these factors contribute to the plant's ability to germinate. Other plant photoreceptors include cryptochromes and phototropins, which respond to blue and ultraviolet-A light and UVR8, which is sensitive to ultraviolet-B light. In addition to their roles in nature, the light-induced interaction between a plant phytochrome and phytochrome-interacting factor (PIF) was used in 2002 to control gene transcription in yeast.

DISCOVERY

1932 - Borthwick and Hendricks showed that red light elicits germination of lettuce seeds, whereas far-red light inhibits the process. When Lettuce seeds were exposed to alternating red and far-red light, almost all seeds that

received red light in final treatment germinated, while others receiving far-red light did not germinate.

1952 – Borthwick, Hendricks and Parker demonstrated that red light inhibition of flowering in *Xanthium* could be reversed by a subsequent far-red light treatment. The action spectra for inhibition and promotion of flowering shows that the red light near 660nm and far-red light near 730nm respectively, are maximally effective. When plant is subjected to several consecutive radiations with red and far-red light in sequence, the flowering response is determined by the wavelength of the final exposure

Borthwick and his associates concluded that phytochrome, exists as two inter-convertible forms, one absorbing red radiation (Pr or P₆₆₀), the other with an absorption maximum in the far-red region of the spectrum (Pfr or P₇₃₀). The Pr form of pigment is converted by red light (R) to the Pfr form, conversely, far-red light (FR) changes the Pfr form of pigment to Pr.

In 1959- Butler and his associates first extracted phytochrome from etiolated Oat coleoptiles. It occurs as a chromo-protein in which the chromophore is a linear tetrapyrrole similar to C-phycoyanin. Most studies with phytochrome have used etiolated seedlings from which phytochrome has been obtained in highly purified form.

STRUCTURE OF PHYTOCHROME

Phytochrome is a soluble chromo-protein with a molecular mass of 250 kDa. It occurs as a dimer made up of two subunits, each of 125 kDa. Each subunit consists of two components —

- i. Light- absorbing pigment molecule, chromophore and
- ii. Apolypeptide chain, Apo protein.

Apo protein and chromophore together make up the holochrome.

The chromophore is a linear tetrapyrrole similar to phycoyanin termed phytochromobilin and it is a ring attached to the protein through thio-ether-

linkage to a cysteine residue. The absorption of red light provides the energy required to overcome a high activation energy for rotation around the double bond. There is further evidence that the protein also undergoes photochemically induced conformational changes. Phytochrome has two different chemical structures that are inter-convertible.

The forms are named by the color of light that they absorb maximally: **Pr** is a blue form that absorbs red light (660 nm) and **Pfr** is a blue-green form that absorbs far-red light (730 nm). When they do absorb these photons, they change chemically into the other form. Both have some absorption in the blue-end of the spectrum.

FUNCTION OF PHYTOCHROME

- i. Phytochrome plays role in germination of some seeds.
- ii. It plays role in developmental phenomenon like photomorphogenesis, photoperiodism and cleistogamy.
- iii. It also helps in formation of rhizomes and bulbs.
- iv. It plays role in seed dormancy, leaf abscission and synthesis of Gibberellins, Anthocyanins, Carotenoids etc.
- v. Phytochrome A and B have distinct roles in the regulation of plant growth and development.