PHYTOCHROME-MEDIATED LIGHT SIGNALING IN PLANTS

Pill-Soon Song,[1,2] **Chung-Mo Park**[1], **Zigmund Luka,**[1] **Giltsu Choi**[1] **and Jeong-Il Kim**[1,2]

[1]**Kumho Life & Environmental Science Laboratory, Kwangju 506-712, Korea**
[2]**Department of Chemistry, University of Nebraska, Lincoln, NE 68588, USA**

The phenomenon of various responses of plants to light are broadly defined as photomorphogenesis which is mediated by phytochromes. The plant pigment proteins phytochromes are a molecular light sensor or switch for photomorphogenesis involving a variety of growth and developmental responses of plants to red and far-red wavelength light. Underscoring the photomorphogenesis mediated by phytochromes is the light signal transduction at molecular and cellular levels. For example, a number of genes activated by the phytochrome-mediated signal transduction cascade have been identified and characterized, especially in *Arabidopsis thaliana*. The light sensor/switch function of phytochromes are based on photochromism of the covalently linked tetrapyrrole chromophore (phytochromobilin) between the two photoreversible forms, Pr and Pfr. The photochromism of phytochromes is brought about by ultrafast primary photoprocess based on the isomerization of the tetrapyrrole chromophore. The "photosensor" Pr-form ("switch off" conformation) of phytochromes strongly absorbs 660 nm red light, whereas the "switch on" Pfr-conformation preferentially absorbs 730 nm far-red light. The latter is generally considered to be responsible for eliciting transduction cascades of the red light signal for various responses of plants to red light including positive or negative expression of light-responsive genes in plant nuclei and chloroplasts. In this lecture, we will discuss the structure-function of phytochromes in plant growth and development.

Phytochromes in higher plants include gene family members phyA, B, C, D and E. Recently, phytochrome-like pigment proteins have also been discovered in prokaryotes, possibly functioning as an autophosphorylating/phosphate-relaying two-component signaling system (Yeh *et al.*, 1997). The Pfr form triggers the signal transduction pathways to the downstream responses including the expression of photosynthetic and other growth-regulating genes. The components involved in and the molecular mechanisms of the light signal transduction pathways are largely unknown, although G-proteins, protein kinases and secondary messengers such as Ca^{2+} ions and cGMP are implicated. The 124-127 kDa phytochromes form homodimeric structure; the N-terminal half contains the chromophore phytochromobilin for light absorption and the C-terminal half includes both dimerization motif and regulatory box where the red light signal perceived by the chromophore domain is recognized and transduced to initiate the signal transduction cascade.

Quasi-elastic light scattering and other measurements indicated that gross tertiary structures of Pr and Pfr phyA are similar. However, Pr→ Pfr phototransformation is accompanied by subtle conformational change in the apoprotein moiety, detectable by proteolytic mapping, CD and fluorescence, and other methods [reviewed in Furuya & Song, 1994]. The N-terminal peptide chain, corresponding to approximately 60 amino acid residues, assumes random coil conformation in the Pr form. Upon Pr→ Pfr phototransformation, it "captures" the Pfr-chromophore out of the hydrophobic binding pocket. The chromophore:chain interaction then is induced to fold into