Phyotchromes

Activation of proteins is important in many aspects of life. Phytochromes, more specifically, are what are important for plant development. Without these proteins, plants could not germinate their seeds, synthesize their chlorophyll, elongate their seeds, and change the size, shape, and movement of their leaves. Phytochromes respond to light conditions, which makes sense, with light being an important part of plant development. Once the phytochromes receive light, they activate by sending multicomponent signaling cascades to start cellular processes, protein abundance, and nuclear architecture to regulate various aspects of plant development (Kaiseril & Chory, 2016).

The chromophore in phytochromes is bilin, part of the molecule that absorbs particular light wavelengths and enables the color we see. It is still not known how this may lead to the activation of the protein with structural changes. Phytochromes are relatively sensitive to red and far-red light on the spectrum, so they react strongly to red lights in a positive way. They have not been tested only to perceive red and far-red light, so the test is still relatively new. Phytochromes have the greatest range of activity out of all the photoreceptor families. They respond differently to spectral responses, photodynamics, and protein architectures (Kottke et al., 2018). Phytochromes are homologous to cyanobacteria chrome photoreceptors but are still different in their responses.

A review done in 2018 by Tilman Kottke, Aihua Xie, Delmar S. Larson, and Wouter D. Hoff found that phytochromes fit in the groupings of other receptors in which they remain to be seen in being classified by LOV, BLUF, and rhodopsins. When asked how they may fit into these groupings, Aihua Xie stated “If I make an intelligent guess, proton transfer occurs right before receptor activation of phytochrome, so phytochrome is very likely to use light-driven proton transfer to activate phytochrome activation. In this case, we should look for phytochrome's proton donor/acceptor.”. LOV and BLUF proteins are essential in the hydrogen-bonding network around the chromophore flavin. Phytochromes are found to be able to switch between stable dark-adapted states to photoactivated end states (Burgie & Vierstra, 2014).

With the growing discovery of the phytochrome family, the help of these studies has greatly impacted the families of biochemical and structural characterization of the family. This will help develop the agriculture community and allow scientists to understand plant sensitivity to different light environments better.

Citations:

Burgie, E. S., & Vierstra, R. D. (2014). Phytochromes: an atomic perspective on photoactivation and signaling. The Plant Cell, 26(12), 4568-4583.

Kaiserli, E., & Chory, J. (2016). The role of phytochromes in triggering plant developmental transitions. eLS, 1-11.

Kottke, T., Xie, A., Larsen, D. S., & Hoff, W. D. (2018). Photoreceptors take charge: Emerging principles for light sensing. Annual Review of Biophysics, 47, 291-313.