Hisabori Wakabayashi Lab

Survival strategy of phototrophic organisms

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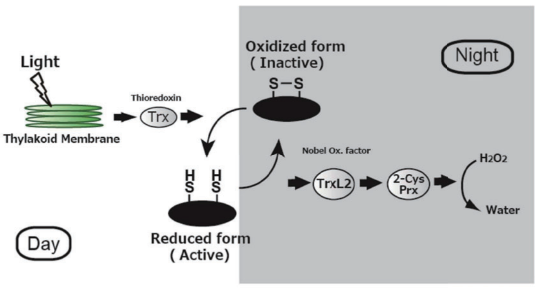
http://www.res.titech.ac.jp/~junkan/Hisabori_HomePageE/index.html

Our recent findings in how phototrophic organisms survive in the changing light conditions.

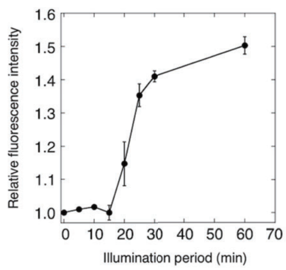
1: How do plants rest at night?

Photosynthesis, the process by which plants generate food, is a powerful piece of molecular machinery that needs sunlight to run. The proteins involved in photosynthesis need to be “on” when they have the sunlight, but need to be “off” in the dark, when photosynthesis is not possible. They do this by a process called “redox regulation”—the activation and deactivation of proteins via changes in their redox (reduction/oxidation) states. However, molecular mechanisms for “off” switch has been a long standing question. Our group identified two proteins, constituting the thioredoxin-like2 (TrxL2)/2-Cys peroxiredoxin (2CP) redox cascade, that help control the reoxidation of these photosynthetic proteins by modifying key parts of the molecular players (Yoshida et al., 2018 PNAS).



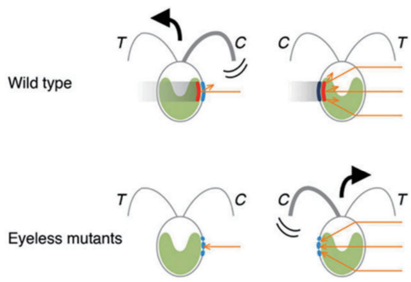
2: Genetically encoded sensor tracks changes in oxygen levels with very high sensitivity

Oxygen is a major player in the biochemical processes that make life on earth possible. Being able to rapidly and accurately measure oxygen levels inside living cells could be useful in several areas of biology. We developed a new type of oxygen sensor that detect changes in cellular oxygen levels with high sensitivity and named ANA sensor (**an**aerobic/**a**erobic sensing fluorescence protein). ANA is a fusion protein of the direct oxygen sensor protein, or DosP, from the bacterium *E. coli* and a fluorescent protein. Fluorescence of this genetically encoded sensor increased in the presence of oxygen and decreased in the absence of oxygen in vivo (Nomata and Hisabori, 2018 Sci Rep).



3: Shedding light on phototaxis of green algae

Chlamydomonas reinhardtii is a unicellular green alga that lives in fresh water throughout the world, and notably, the cells can change their swimming directions upon sensing light, which is referred to as phototaxis. However, in spite of their widespread use as a model organism, the role of pigments in the subcellular organelle called “eyespot” in determination of the sign of phototaxis (direction of cell movement relative to light sources) is still unclear. By isolation of pigment-less mutant, we found the light shielding property of the eyespot pigments is essential for determination of phototactic sign. Cells behave as lenses to focus and condense light onto photoreceptors, and without the pigment, cells swim in an opposite direction (Ueki et al., 2018 PNAS).



4: Division of labor between hemispheres of multicellular spheroidal alga for phototaxis

As a photosynthetic alga, the spheroid *Volvox rousseletii* must move in a light-sensitive way to survive. It achieves this by beating numerous flagella toward its posterior end for swimming forward and turning via changing the direction of flagellar motion from back to front if it perceives light. Exactly how this movement is regulated remains unclear. We developed a new method to demembranate (or “kill”) *V. rousseletii* with a detergent and reactivate the motility of dead spheroid by addition of ATP. By this method, we found that regulation of flagellar motility in the posterior hemisphere and the posterior hemisphere is different, and the difference enables *V. rousseletii* to show quick phototaxis (Ueki and Wakabayashi, 2018 PNAS