The Biological Solar Panel

Plants and algae are nature’s biological solar panels. By capturing light energy from the sun and converting it into dense energy molecules, through the process of photosynthesis, these organisms support most of life on our planet.

Photosynthesis is a complex system of processes and over 100 components that work together at the cellular level, and the processes happen in two parts, the so-called light-dependent and dark reactions.

In the first, photosynthetic organisms trap ‘raw’ sunlight energy that cannot be consumed by living things. The dark reactions capture carbon dioxide from the atmosphere and convert the captured light into sugars that lock up the energy for consumption.

The challenge: TITLE HERE?

Decades of research have taught us a lot about the photosynthetic components, but scientists still don’t have a full picture of how photosynthesis works as a whole.

Part of the difficulty lies in the fact that most research has taken place in laboratories and focused on individual components, instead of observing these components in their natural living conditions.

It is also difficult to study photosynthesis within one lab or a single discipline discipline, as the process spans a range of physical, biochemical, and structural areas of scientific expertise.

The solution: Understanding the solar panel holistically

The MSU-DOE Plant Research Lab aims to study the components and processes in a highly integrated way. We want to develop models on multiple scales that describe how photosynthesis works as a whole.

If we can understand the processes, as a whole, it will facilitate our long-term efforts to improve photosynthetic efficiency and increase crop yield, by redesigning different parts of the system to work better.

To achieve this goal, we work collaboratively across disciplines, spanning X NUMBER OF LABS, to answer these fundamental questions photosynthesis. Our participating researchers have expertise in various disciplines, including biophysics, biochemistry, physiology, photobiology, genetics, and cell biology.

We are currently studying photosynthesis from four angles:

1. We are focusing on chloroplasts, the engines where photosynthesis begins. We want to understand how the chloroplast membranes are created and maintained in living plants. We also want to examine how the chloroplast interacts with other parts of the cell that contribute towards photosynthetic processes. (Benning, Brandizzi, Hu)
2. We are exploring how the structural features of the biological panel influence the availability of carbon dioxide in the photosynthetic compartments. We also want to look at how photorespiration and Calvin-Benson cycle regulation work together. (Hu, Brandizzi, Ducat, He, Sharkey)
3. We are studying how the Calvin-Benson cycle energy outputs coordinate with changing light intensities in the surrounding environment. We also seek to understand how these outputs match with the light-dependent reactions of the cell. (Sharkey, Froehlich, Howe, Kramer)
4. We want to use engineered model plants (Arabidopsis) and cyanobacteria to understand how shifts in the allocation of carbon, the raw material for energy compounds, are sensed by these organisms. We also seek to understand how these alterations, in addition to other functions like defense or light detection, influence the activity of photosynthesis. (Ducat, Howe, Kramer, Montgomery, Sharkey)

With this diversity of perspectives, combined with the unique technologies at our disposal, we are well positioned to understand the biological solar panel in a more holistic way.