Big overview: the lab works with proteins. Disassemble them in building blocks and reassemble by combining various building blocks. Once a new function is found, try to find an application.

Cheryl says the lab does both structural and synthetic biology. She relies on an engineering concept in the research: design – build – test – learn – repeat.

Trying to designing new functions and things based on how nature works.

2 parts – photoprotection and bacterial microcompartments

Kerfeld: Sigal

Photoprotection part

They are interested in aprotein OCP-Orange carotenoid protein

Found in many cyanobacteria, but not all. Under high light conditions. It performs known photochemical quenching (takes energy from PBS). PBS transfers light energy to the photosystem II and sometimes I. If there is too much energy, it can breach system. If that happens, the protein scomes and steals energy to dissipate into heat (not sure how the mechanism works). We do know that carotenoid is probably involved.

That is one part.

The other thing that they noticed is that many cyano have homologues to only part of thhe protein. Ocp (active) has two domains: modular protein. N-terminal domain and c-terminal domain, basically first and second half respectively, with a linker between them in the whole protein.

The genes that code for proteins that are similar to the ocp but only one half of it. For example, three protiens homologous n-terminal (fremyella – beronda [PBS article])

What they want to know is the difference in function between the two terminals.

In the whole protein, we do know there is a function. However we don’t know anything about the partial homologues. They do know quite a bit about the whole protein. There is a lot of research going on that (competitors: Blankenship in the US and collaborators: Diana Kirilovsky in France).

Sigal more focsed on the domain homologues.

There is a high sequence similarity, they bind carotenoids, one of the canthaxhanthi.

Another group member is going to test if they quench energy from PBS (in vitro).

One more hypothesis is that they quench singlet oxygen (ROS)

Big picture hypothesis: the homologues are the evolutionary ancestors of ocp, and they are still there. But since they are still expressed, they might have different functions and not be only redundant. Often, an organism expresses something that functions specifically.

**They are trying to use OCP and homologues to design a photoswitch (Project C in PRL) to do “something.” It could potentially be induced by high light and maybe carry electrons to the shell (microcompartment that Clem is working on). How the two parts of the lab are connecting.**

Clem and Raul

Bacterial Microcompartments: protein shells containing enzymes.

Carboxysomes: do CO2 fixation with rubisco around, and uses O2 efficiently

Metabolosomes: breakdown carbon for energy

2 goals for this and all Kerfeld lab projects

1. Fundamental research to understand how it works
2. Repurpose by converting into an application, in this case a shell becoming a bionanoreactor or receptor of other materials

Subprojects

Scaffold proj w/Ducat Lab

* Taking pieces from the micro shells and letting them reassemble alone. They form 2D structures. Graft enzymes in specific sequences on these structures in order to do things or make new products.

Rubisco project w/Montgomery Lab

* Rubisco fixes CO2 while Rubisco activase activates Rubisco. Plants have both while not all cyano have activase.
* The enzymes are modular (created of various domains, or partitions)
* Fundamental research to understand why not al cyano have activase, deconstructing the enzyme, and reintroducing to activase-deficient cyano 🡪 increase efficiency of fixation?