# 47th Annual Midwest/Southeast Photosynthesis Meeting: “Poster Presentation” Example/Template

Presenting on Zoom/Webex is significantly distinct from presenting in a regular poster session, as such a few considerations may help you be more effective if you are thinking about how to convert your poster idea (or even existing poster) for a virtual presentation.

The following slides give a few tips to consider and walk through the conversion of an (old) poster into a format that would be good for a Zoom/Webex presentation.

General considerations:

- You want to be able to run through your presentation quickly (<10 minutes) – if someone joins part way through you talking with someone else, they won't have the same opportunity to look at the poster to 'catch up' to the conversation.
- Image-heavy slides that minimize text are best. Where you have to have text, make sure it is large enough to be viewed easily (your attendee may be on a small laptop and presentation may only fill a portion of their screen)
- Think of simplifying your main storyline into 4-6 slides: you can have supplemental slides to elaborate or for questions you anticipate may be common.

Right: an example poster that I had to describe some of our lab's co-culture work.

The slides that follow are an example of how one might convert that poster into a 5-6 slide presentation.

Feel free to drop much of the words (no one will be able to come 'visit your poster' without you there) so no need for someone to understand without you there to explain.

**Animations are now possible – use 'em!**

Also consider condensing to core ideas and keeping other items present as backup slides if people ask questions that may be easy to predict.

# Improving Synthetic Cyanobacteria/Heterotroph Consortia with Rational Design: Engineering Spatial Positioning to Improve Stability and Metabolite Exchange


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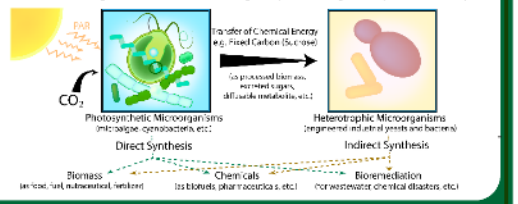
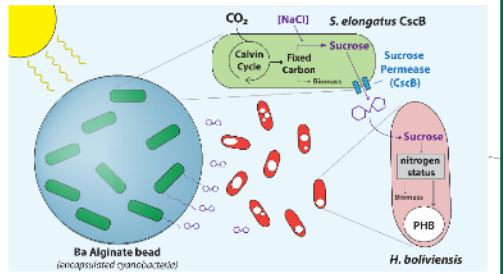
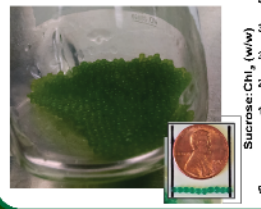
## Abstract

Increasingly, microbial consortia are being investigated for their potential in a variety of biotechnological applications. Work in our group is exploring the use of a sucrose secreting strain of cyanobacteria (*S. elongatus* CscB) as the basis for a flexible photoproduction platform as a strain that can support the metabolism of a variety of different heterotrophic microbes. We observe that *S. elongatus* CscB can support multiple heterotrophic strains, both workhorse laboratory models (i.e. *E. coli*; *B. subtilis*, *S. cerevisiae*, and *A. vinelandii*) and less common, but industrially relevant strains (i.e. *A. vinelandii* and *H. boliviensis*). In preliminary work, we see that such synthetic consortia can be used to capture and convert solar energy into a variety of products, depending on the heterotrophic "conversion module" that is paired with the sucrose secreting cyanobacteria. We also see that some of these synthetic consortia can be relatively stable over time and in the face of perturbation. In ongoing work, we are exploring multiple strategies to futher strengthen and stabilize such systems for the realities of scaled cultivation (e.g. contamination, selection against production genes, & product recovery).

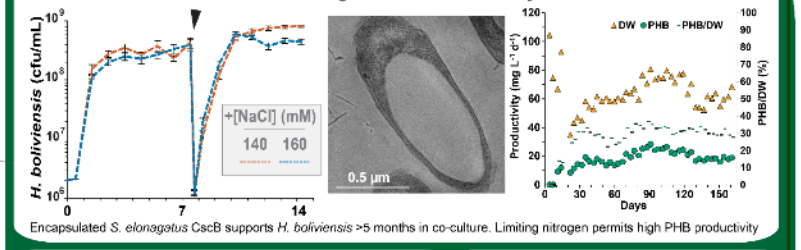

## Benefits of Encapsulating *S. elongatus* CscB



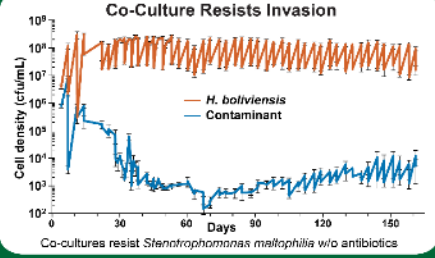

Encapsulating cyano cells in an alginae hydrogel still allows (and even improves) sucrose secretion. Further, separation of the heterotrophic microbe is facilitated while [cyanobacteria] is maintained. Restricted division may stabilize genetic circuits against mutation.

## Co-Culture Produces High Levels of PHB Stably Over 5 Months



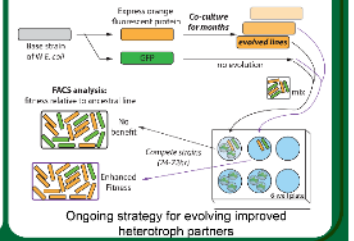

Encapsulated *S. elongatus* CscB supports *H. boliviensis* >5 months in co-culture. Limiting nitrogen permits high PHB productivity

## Co-Culture Resists Invasion



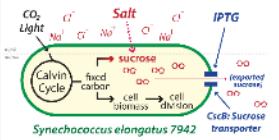

Co-cultures resist *Stenotrophomonas maltophilia* w/o antibiotics

## Evolving Highly Integrated Pairs?



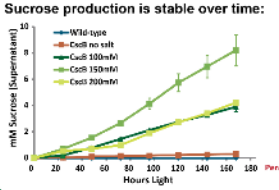

Ongoing strategy for evolving improved heterotroph partners

## Sucrose secretion by *S. elongatus* CscB

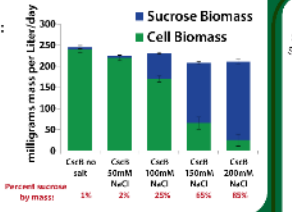



*Synechococcus elongatus* PCC 7942 that has been engineered to express the sucrose/proton symporter CscB is able to secrete cytosolic sucrose into the media headspace. Sucrose naturally bioaccumulates as a compatible solute in response to osmotic stress.

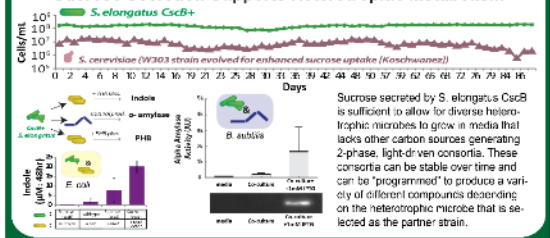
**Sucrose production is stable over time:**




**Sucrose production is tunable:**

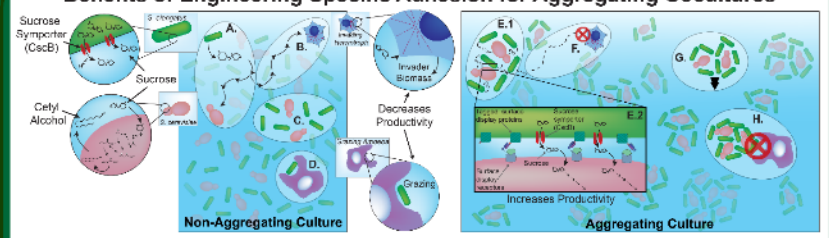



## Sucrose Secretion Supports Heterotrophic Metabolism



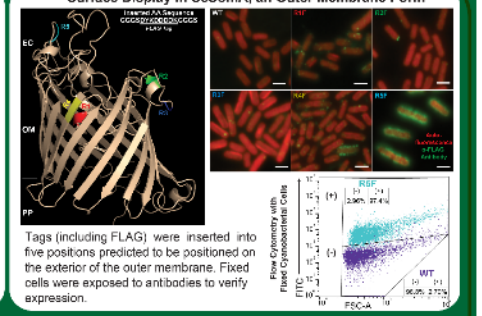

Sucrose secreted by *S. elongatus* CscB is sufficient to allow for diverse heterotrophic microbes to grow in media that lacks other carbon sources generating 2-phase, light-driven consortia. These consortia can be stable over time and can be "programmed" to produce a variety of different compounds depending on the heterotrophic microbe that is selected as the partner strain.

## Benefits of Engineering Specific Adhesion for Aggregating Cocultures



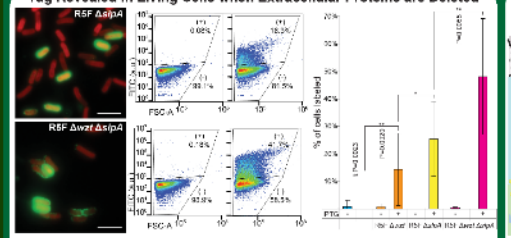

A) Planktonic cultures have long sucrose diffusing lengths. B) Diffuse sucrose is accessible by invading heterotrophs. C) Harvest of cells in planktonic cultures is energy-intensive due to large void volume and low sedimentation rates. D) Grazing predators can destabilize large-scale cultivars. E 1-2) Engineered cell-cell binding could permit inter-species flocculation in engineered consortia; F) reducing the diffusion distance for sucrose, G) increasing sedimentation rates and biomass recovery, H) potentially discouraging size-limited predators.

## Surface Display in *Se*SomA, an Outer Membrane Porin



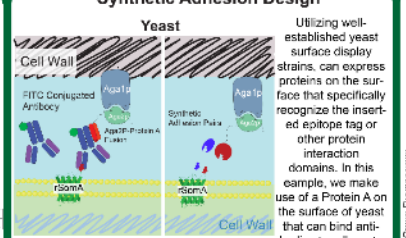

Tags (including FLAG) were inserted into five positions predicted to be positioned on the exterior of the outer membrane. Fixed cells were exposed to antibodies to verify expression.

## Tag Revealed in Living Cells when Extracellular Proteins are Deleted



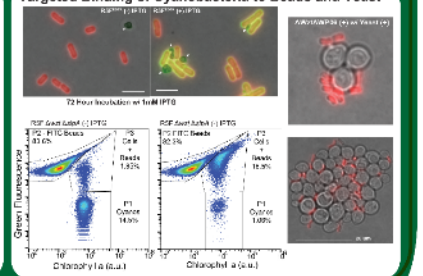

Knockout of a predicted surface layer protein (*slpA*) and O-antigen factor (*wzt*) significantly improves accessibility of surface epitope on SomA.

## Synthetic Adhesion Design




Utilizing well-established yeast surface display strains, can express proteins on the surface that specifically recognize the inserted epitope tag or other protein interaction domains. In this eample, we make use of a Protein A on the surface of yeast that can bind antibodies to adhere to cyanobacteria

## Targeted Binding of Cyanobacteria to Beads and Yeast





## Acknowledgements:

Funding for this work was provided by the National Science Foundation (#135682).



## References:

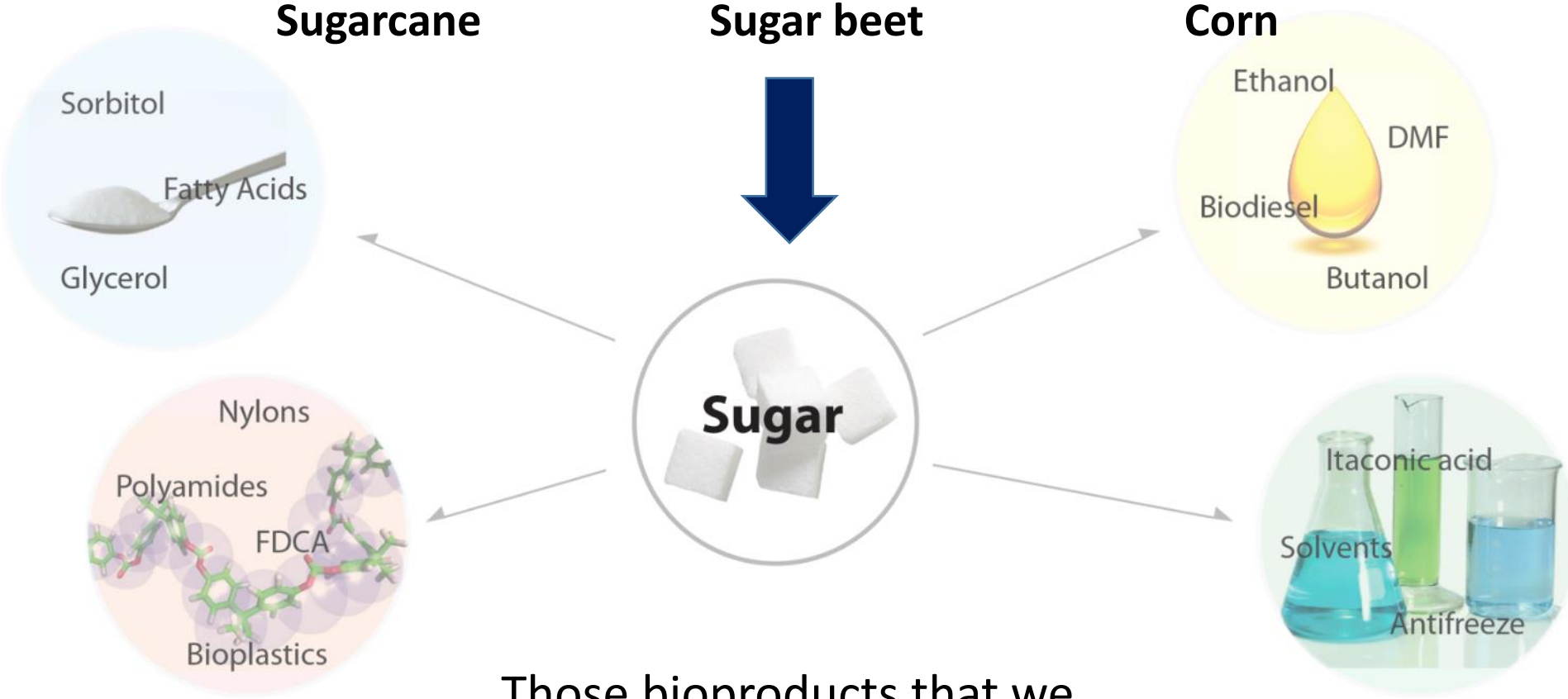
Ducat, Daniel C., et al. "Rerouting carbon flux to enhance photosynthetic productivity."
Applied and environmental microbiology 78.8 (2012): 2660-2668.

# Sugar is the “Currency” to Make Many Bioproducts

**Sugarcane**

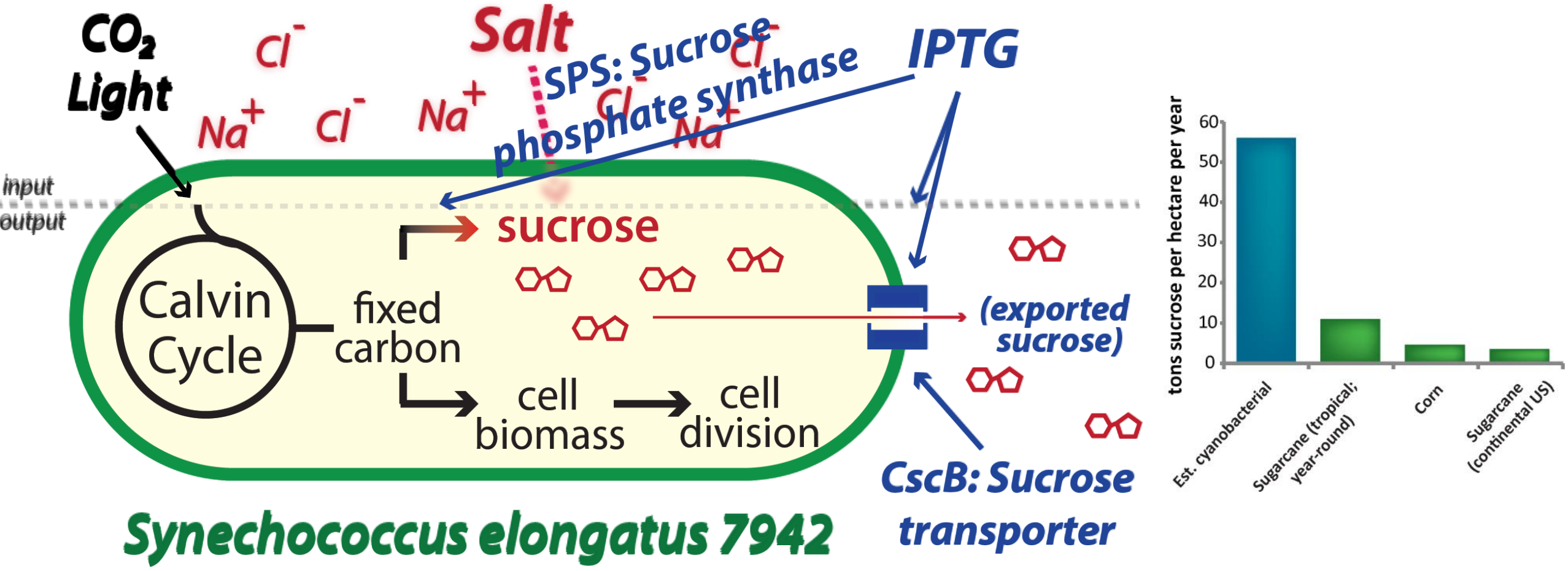
**Sugar beet**

**Corn**




Those bioproducts that we
have a high demand for (e.g. biofuel, bioplastic) require large amounts of feedstocks.

# Can we design a cyanobacteria to be a more efficient sugar-producing crop than plants?

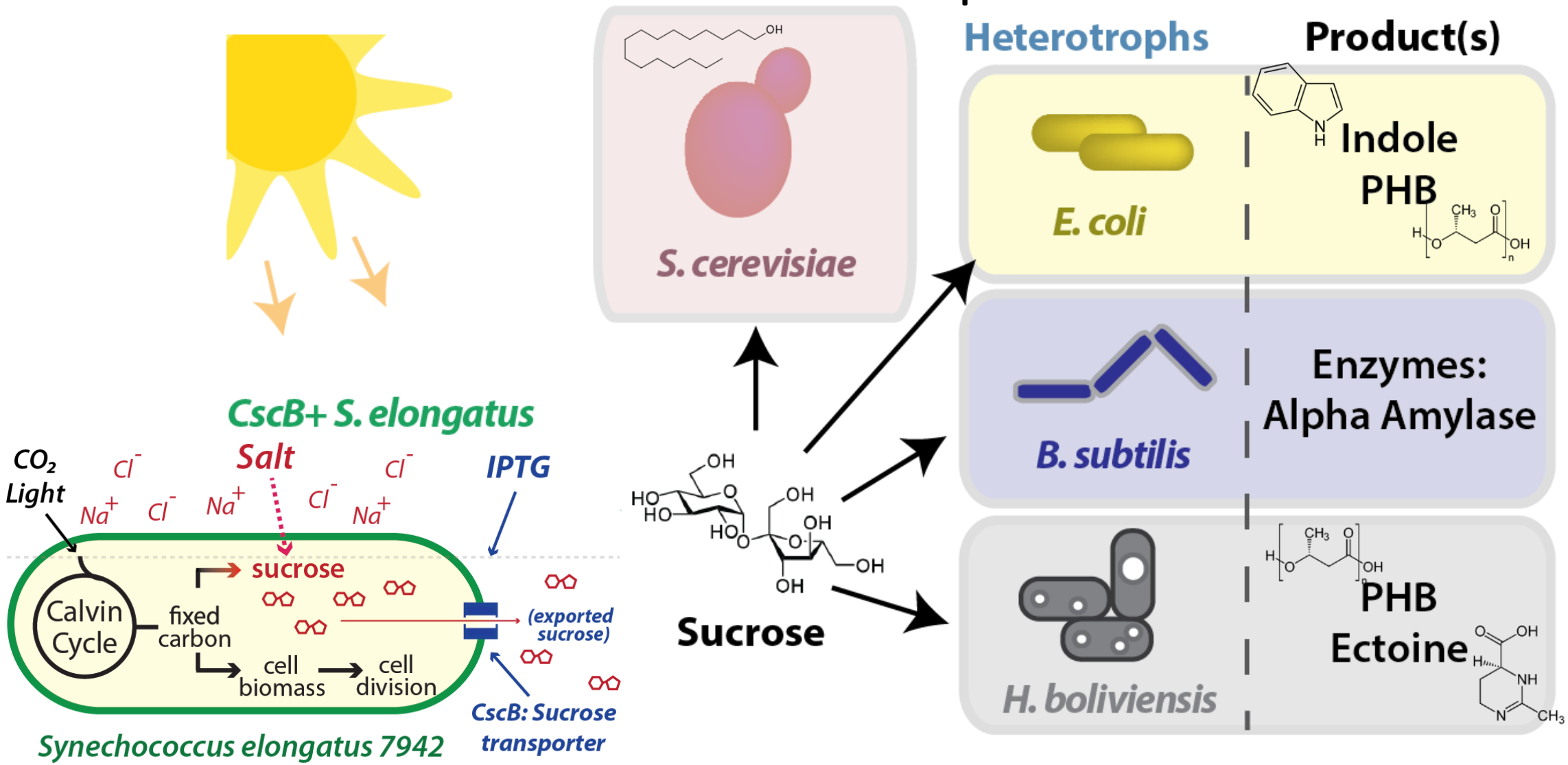



~85% of total fixed carbon can be diverted towards sucrose.


Ducat, DC., et al. *Applied and environmental microbiology* 78.8 (2012).

Abramson BW, et al. "Increased Photochemical Efficiency in Cyanobacteria via an Engineered Sucrose Sink" *Plant Cell Phys*. (2016)

# Concept for Flexible Cyanobacteria/Heterotroph Consortia for Light-Driven Production of Bioproducts



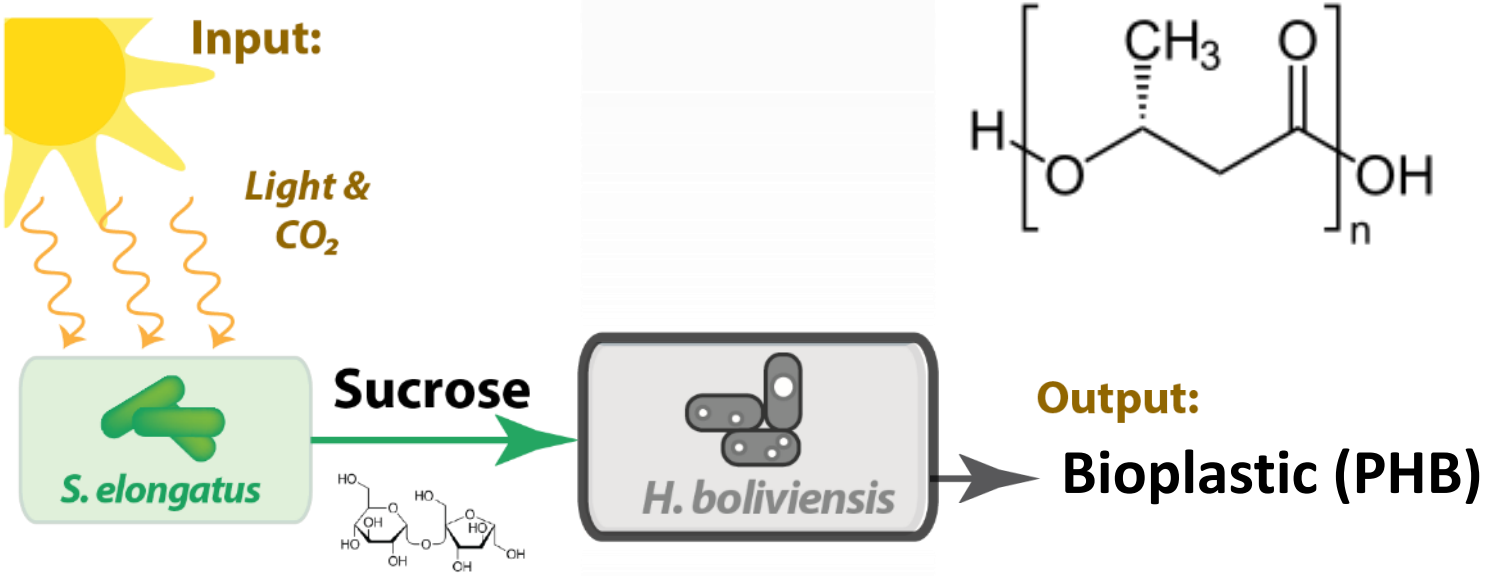


Hays, Stephanie G., et al. "Synthetic Photosynthetic Consortia Define Interactions Leading to Robustness and Photoproduction." JBE (2017) 11.1 4.

Weiss, Taylor et al. "Designing stable, synthetic, light-driven cyanobacteria-heterotroph consortia for bioproduction." 44 *Metabolic Engineering* (2017): 236-245

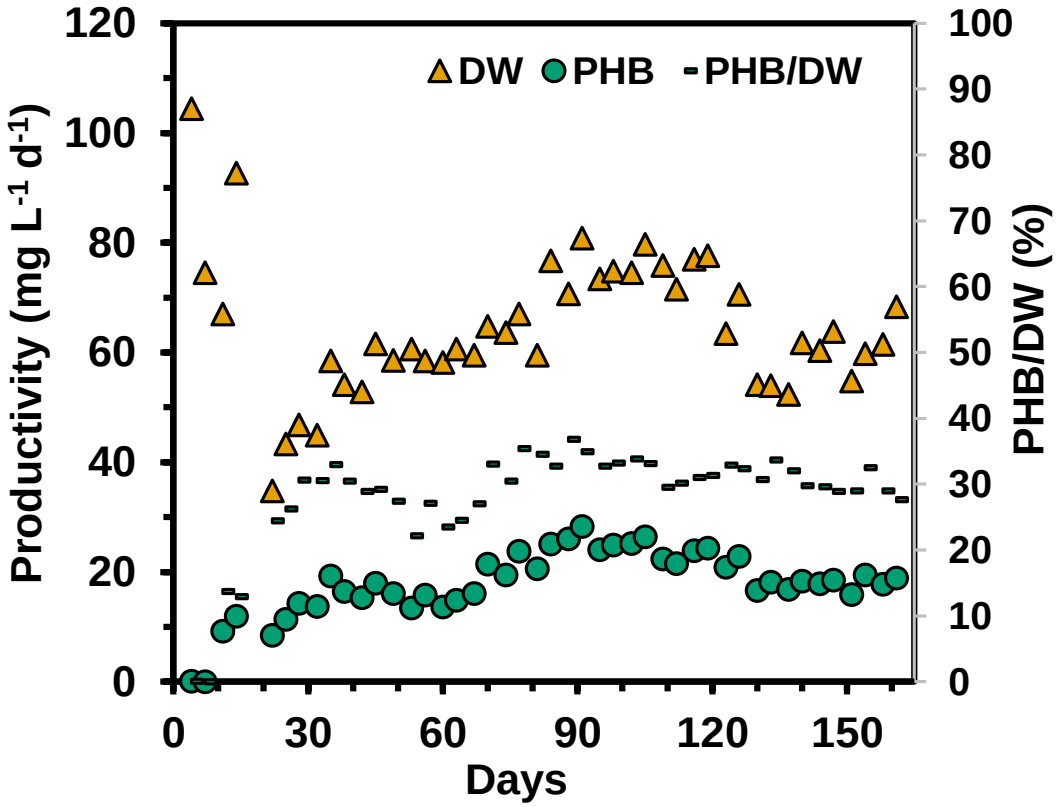
Fedeson, Derek T., et al. "Biotransformation of 2, 4-dinitrotoluene in a phototrophic co-culture of engineered *Synechococcus elongatus* and *Pseudomonas putida*." *Under Review/BioRxiv* (2019).

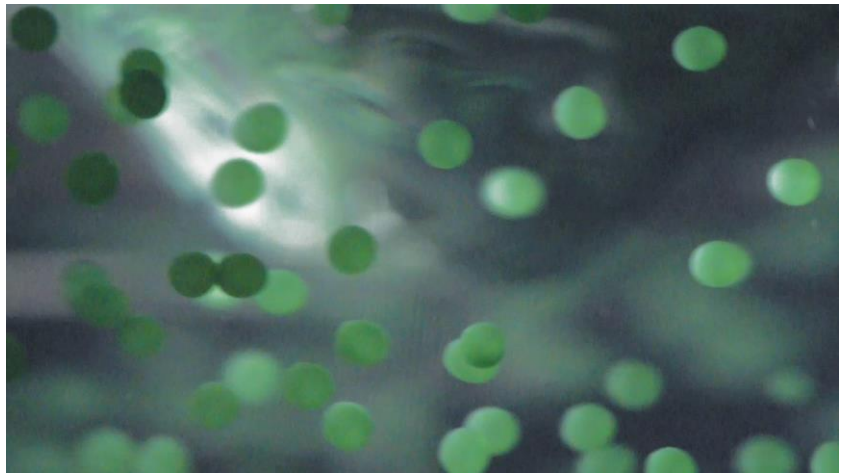
# Bioplastic (Polyhydroxybutyrate) from Light-Driven Consortia







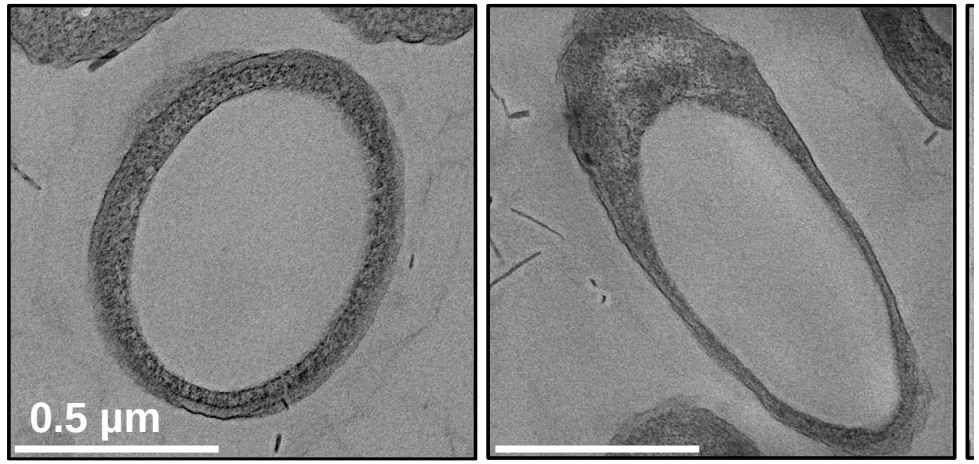


Co-cultures can be productive and stable over time. By specializing metabolism across different microbial species, we can sometimes achieve higher productivity than by trying to engineer a single monoculture.

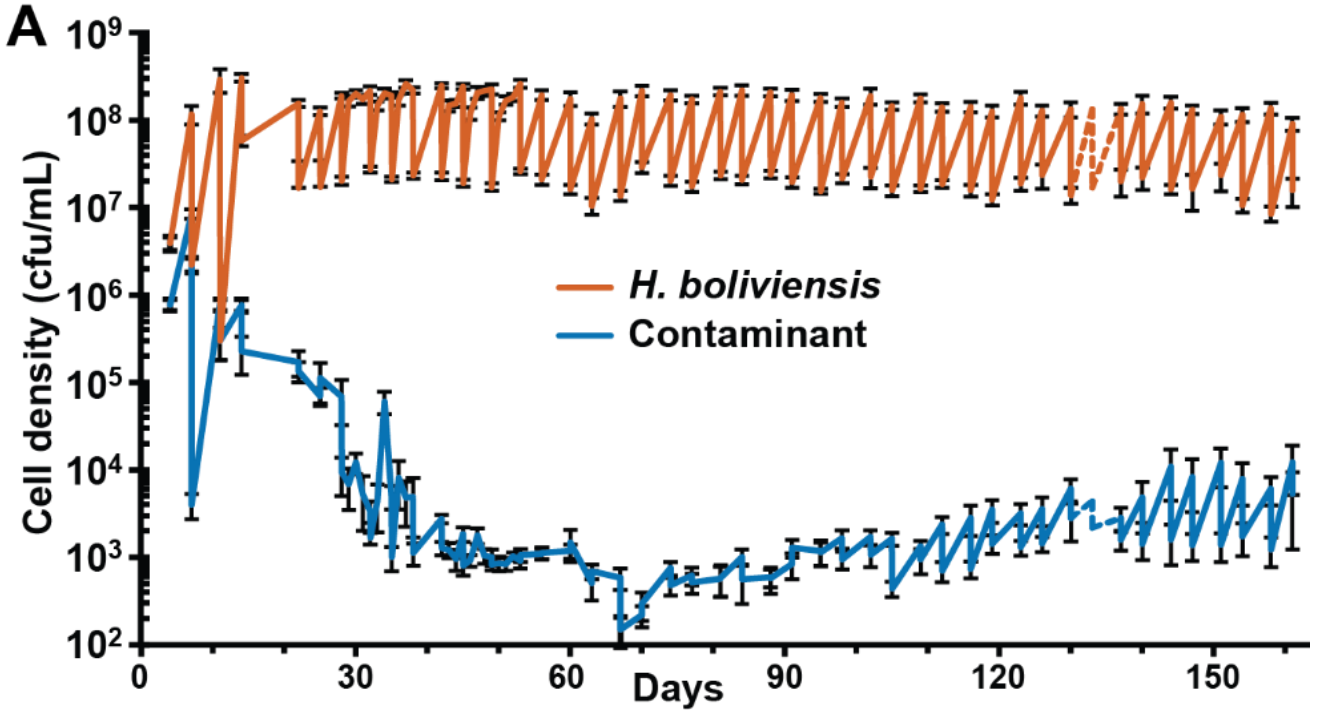
Weiss TL, Young E, Ducat DC. Metabolic engineering 44 (2017): 236-245.

# *Halomonas boliviensis* Outcompetes a Common Lab Contaminant (*Stenotrophomonas maltophilia*)

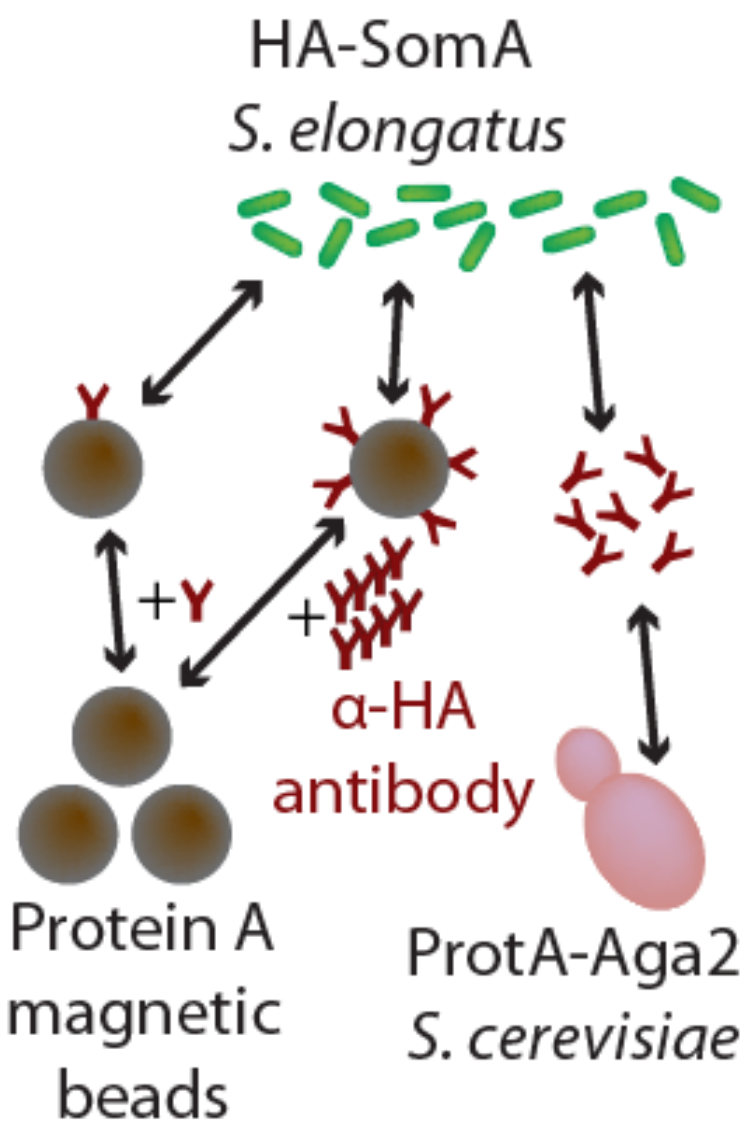


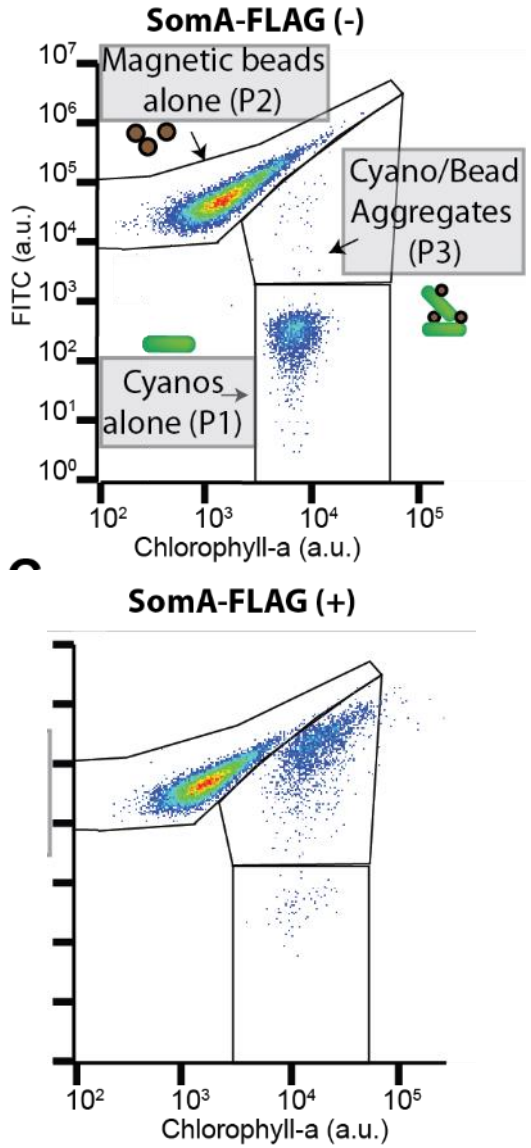

~30% of harvested dry weight = PHB biomass.

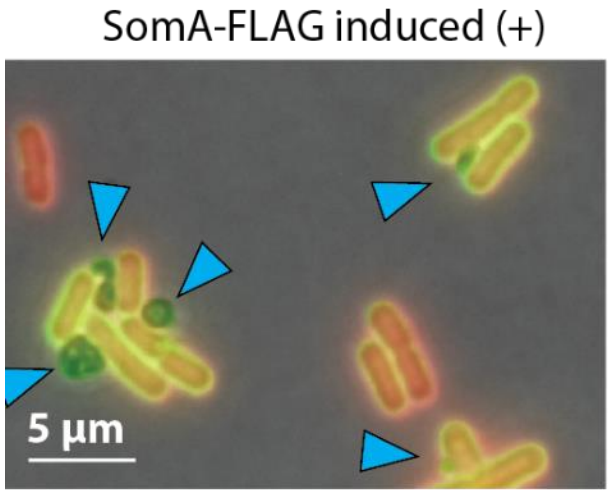
~5% conversion yield of sucrose → PHB

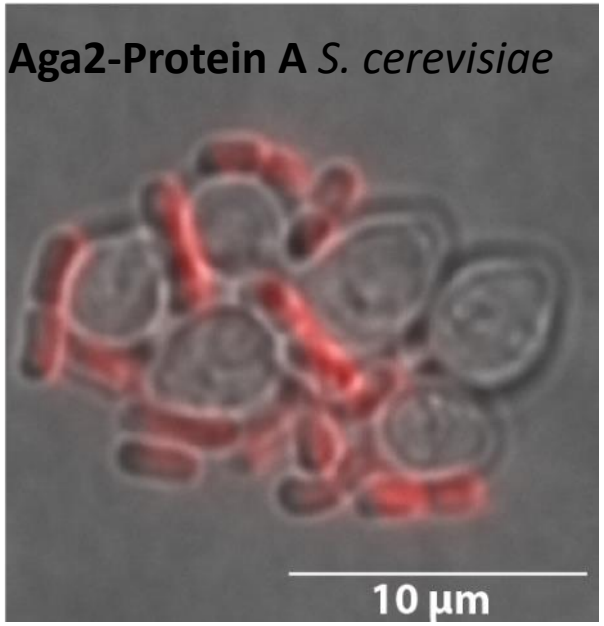


# Cyanobacterial Surface Display Permits Binding to Targets (Cellular and Abiotic) with an Antibody Mediator




Fedeson DT, Ducat DC. Cyanobacterial surface display system mediates engineered interspecies and abiotic binding. *ACS SynBio (2016)*

# Summary & Conclusions

***S. elongatus can be engineered to efficiently secrete sucrose***

- *The output of sugar is competitive with plant-based feedstocks*

## Source Sink Balance

- *Engaging the heterologous sucrose secretion pathway causes short-term enhancements in rate, and efficiency of the light reactions of photosynthesis (*
- *Output from these cultures can be modulated in a "plug-n-play" fashion by using a wide variety of heterotrophs*

## Modular Cyanobacteria/Heterotroph Communities

- *Secreted sucrose can support heterotrophic microbes in artificial co-cultures with light and $CO_2$ as the sole inputs*
- *Output from these cultures can be modulated in a "plug-n-play" fashion by using a wide variety of heterotrophs*
  - *Stability and flexibility of platform opens opportunities as a synthetic microbial ecology platform*
- *Cyanobacterial surface display enables binding of cells to other targeted surfaces, including other microbes*
  - *This could be used to test the capacity of spatial organization to decrease cheating*
- *Heterotrophs can be co-evolved for 100s of generations with sucrose-secreting cyanobacteria*
  - *Possible insight into species-independent mechanisms for becoming better cyanobacterial partners?*

# Other considerations for ‘virtual posters’

- Remember to use your mouse to point out things as you are talking about them.
- Attendees, please remember that it can be difficult for the presenter to view chat windows while in presenter mode. Just pipe up and ask!
- Presenters, you may wish to close extra windows/programs to avoid confusion while “at your poster”, to keep your system running fast and smoothly, and to avoid sharing screen with any personal information.
- Don’t be afraid to pull up other media sources or mix up the presentation style a bit. Ask those who come to your poster if they want the quick version or a little more in depth. You can have other slides/files at the ready to show for those who want a little more detail.