Directed evolution of Rubisco for improved carbon dioxide capture and conversion

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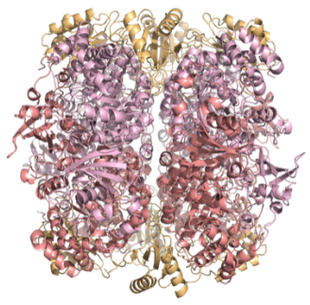
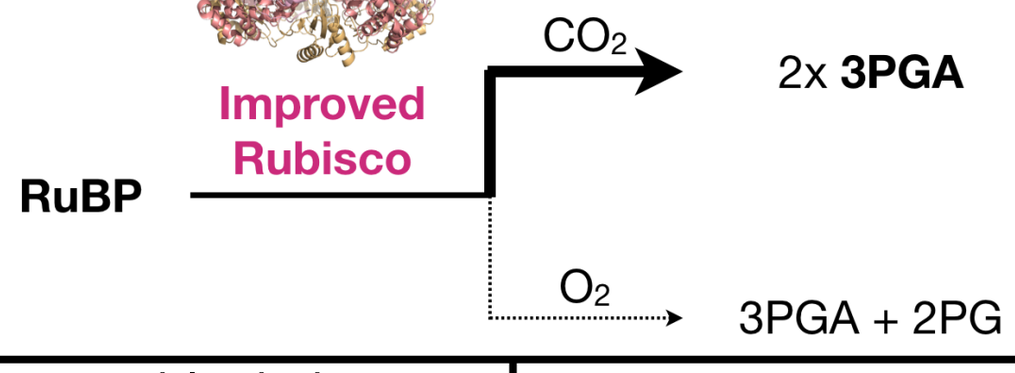
Research objectives

- *Improve plant Rubisco through directed evolution to achieve 5-fold increase in k_{cat}^{C} while maintaining CO_2 specificity*
- SOA: Modest (< 2-fold) improvements in bacterial or algal Rubiscos using flawed methodology
- Innovation: New platform for Rubisco directed evolution based on direct detection of reactivity, address Rubisco biogenesis during evolution, evolve plant Rubiscos
- Start: TRL1
- End: TRL2 exit criteria met



- Higher carboxylation k_{cat}
- Maintain CO_2 specificity
- Compatible with plant biogenesis



Approach

- Develop new selection platform that monitors Rubisco reactivity with RuBP and 2PG biosensors
- Increase Rubisco folding and assembly during directed evolution through chaperonin/assembly factor co-expression
- Engineer assembly factors to tolerate mutations in Rubisco large subunit substrates
- Evolve *Arabidopsis thaliana* Rubisco (AtRubisco) using new selection and improved methodology
- After activity evolution, re-optimize for compatibility with native AtRubisco biogenesis machinery

Potential impact

- Provide a platform for directed evolution of Rubiscos from variety of organisms
- Improve photosynthetic efficiency in plants
- Reduce power and water use requirements by increasing Rubisco carboxylation rates
- Reduce Rubisco leaf protein investment to improve harvest index
- Increase crop yields for both for space exploration and agriculture on Earth