

Reconstruction of the Genome-scale Metabolic Model of *Picochlorum renovo*

Objective

Picochlorum renovo has shown to be a fast-growing species that is resistant to heat and high salinity, making it a prime candidate for a future source of bioproducts at industrial scale. Our objective is to create a metabolic model of *P. renovo* in order to contribute to the current scientific understanding of *P. renovo*.

Background

Microalgae are unicellular plants with the ability to perform photosynthesis and produce algal biomass¹. Algae store energy as lipids and triglycerides, which can then be extracted to be used for production of biofuel, food, and other products we rely on² in an environmentally friendly and sustainable way. *Picochlorum renovo* has shown to be a fast-growing species that is resistant to heat and high salinity, making it a prime candidate for a future source of bioproducts at industrial scale. The manual curation of a metabolic model of *P. renovo* would allow further understanding of this microalga at metabolic level with information on the systematic biology of metabolism and biochemical transformations.

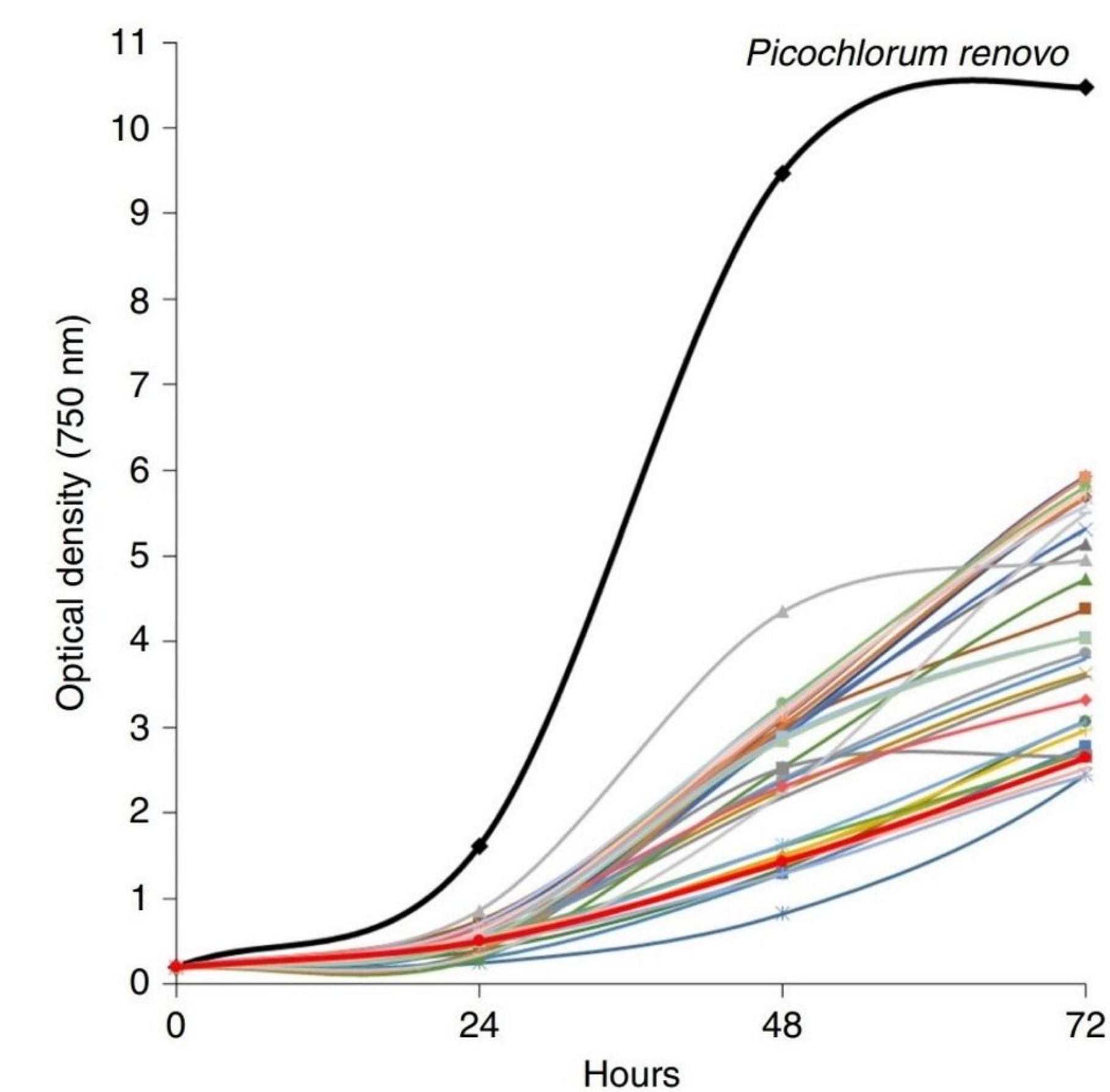
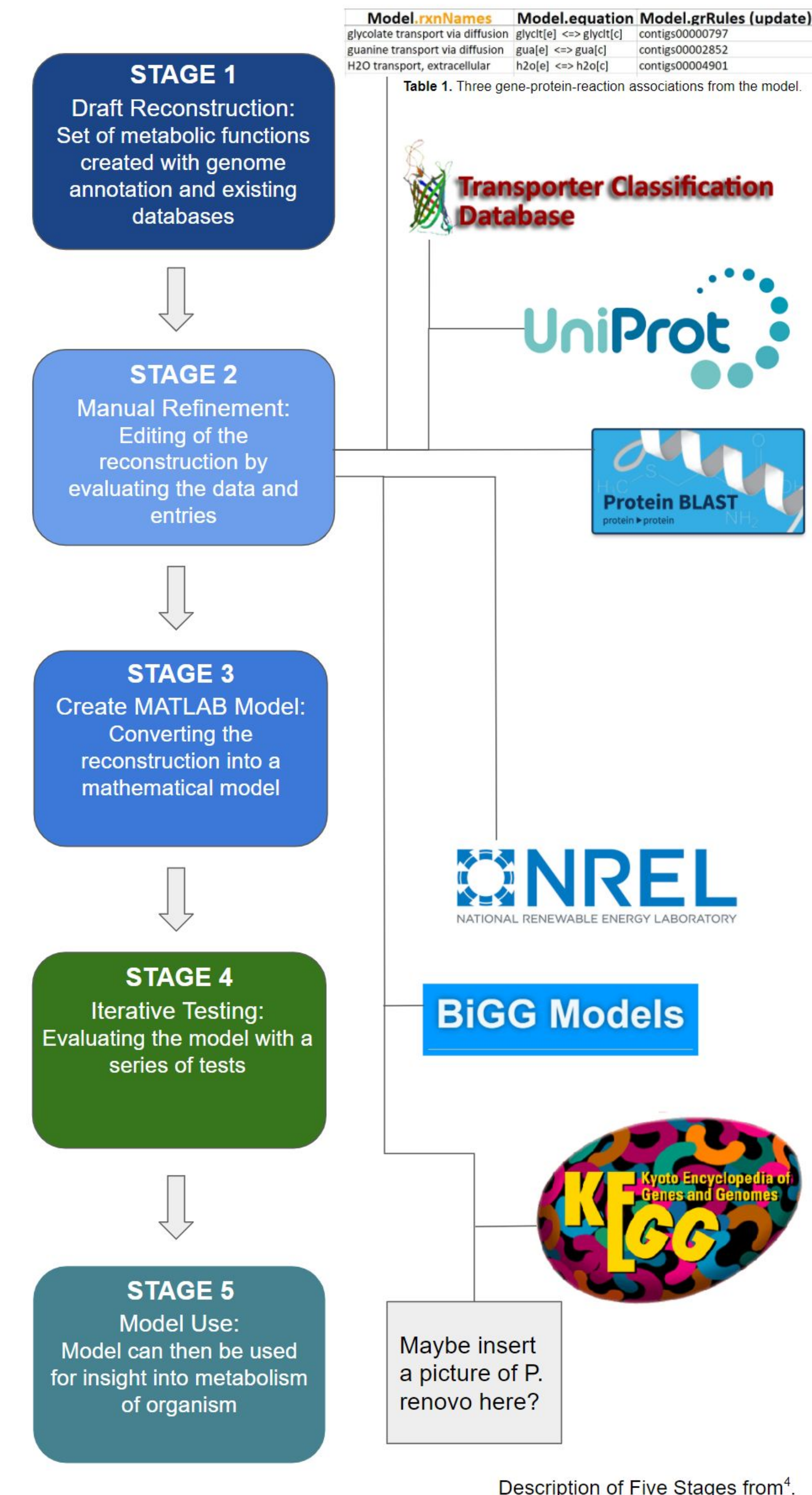


Figure 1. Graph depicting growth of *Picochlorum renovo* against other microalgal species in simulated outdoor conditions³.

Theory/Methods



References

- 1] M. Benedetti, V. Vecchi, S. Barera, et al., Biomass from microalgae: the potential of domestication towards sustainable biofactories, *Microb. Cell Fact.* 17 (2018) 173. <https://doi.org/10.1186/s12934-018-1019-3>.
- 2] R. H. Wijffels, M. J. Barbosa, An Outlook on Microalgal Biofuels, *Sci.* 329 (2010) 796–799. <https://science.sciencemag.org/content/329/5993/796>.
- 3] L. R. Dahlin, A. T. Gerritsen, C. A. Henard, et al., Development of a high-productivity, halophilic, thermotolerant microalga *Picochlorum renovo*, *Commun. Biol.* 2 (2019) 388. <https://www.nature.com/articles/s42003-019-0620-2>.
- 4] I. Thiele, B. Ø. Palsson, A protocol for generating a high-quality genome-scale metabolic reconstruction, *Nat. Protoc.* 5 (2010) 93-121. <https://www.nature.com/articles/nprot.2009.203>.

Results

Model.rxnNames	Model.equation	Model.grRules (update)
glycolate transport via diffusion	glyclt[e] <=> glyclt[c]	contigs00000797
guanine transport via diffusion	gua[e] <=> gua[c]	contigs00002852
H2O transport, extracellular	h2o[e] <=> h2o[c]	contigs00004901

Table 1. Three gene-protein-reaction associations from the model.

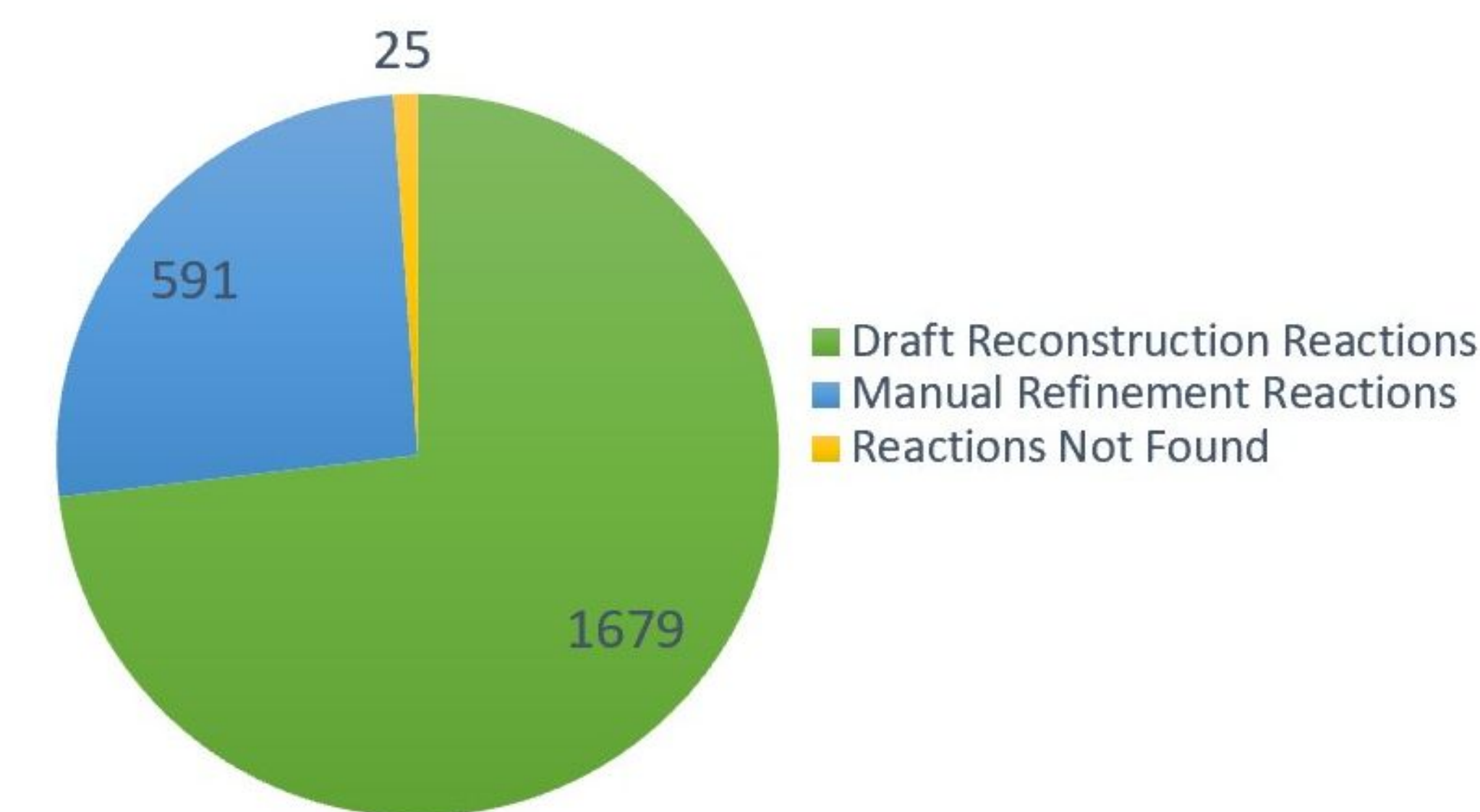


Figure 2. Pie chart showing the number of reactions added and also not found during the manual refinement.

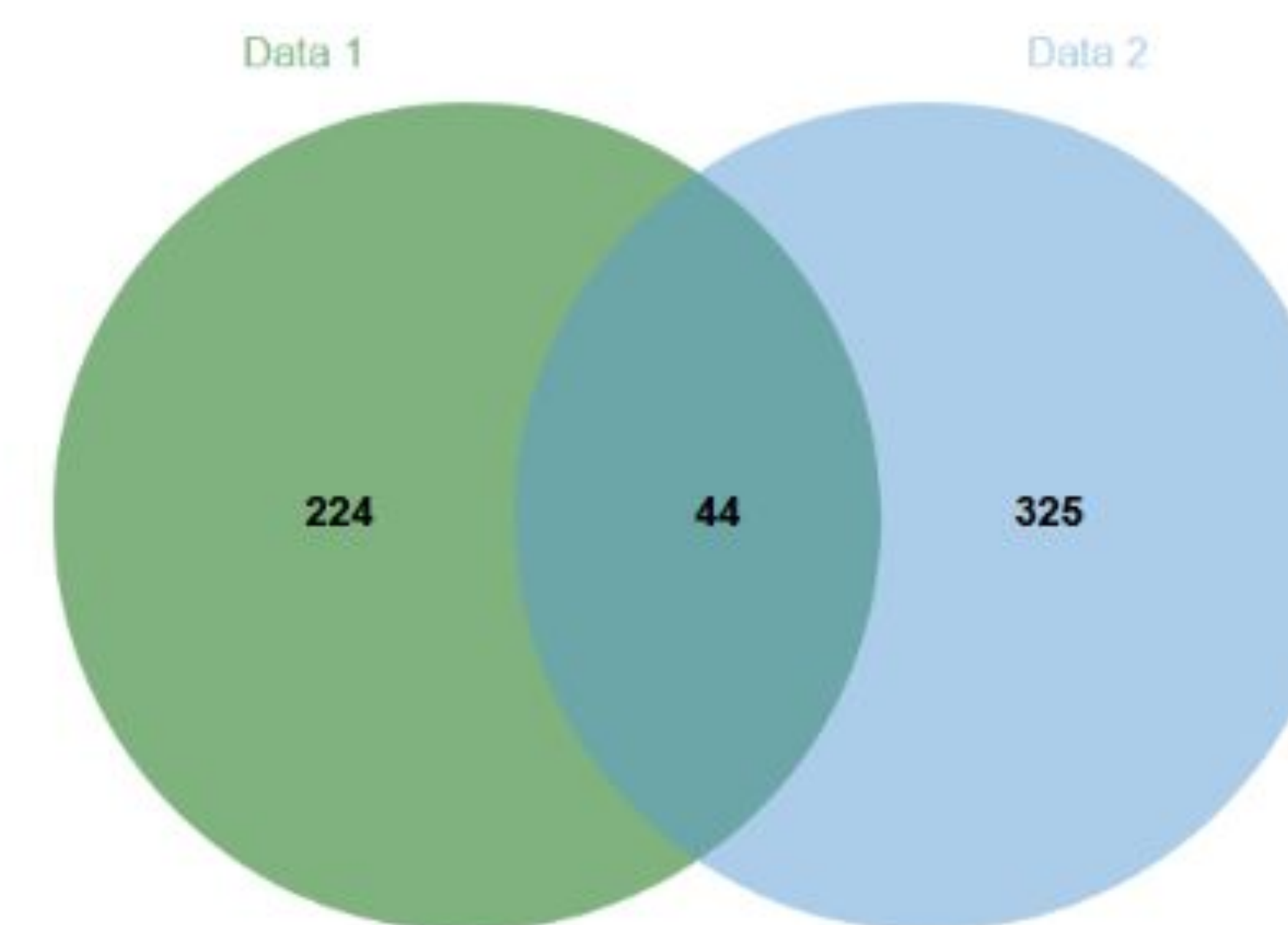


Figure 3. Venn diagram showing the distribution of metabolites between the two datasets from NREL.

Name	Metabolite ID in PicreModel	BIGG ID	KEGG
Linoleic acid	lnc[c]		
L-Lactic acid	lac-l[h]		
2-[(5Z,8Z,11Z)-icosatrienoyl]-sn-glycero-3-phosphoethanolamine		pear_hs	
Tryptophan	trp-l[c]		
D-Glucono-delta-lactone	gal14l-l[c]		
2,4-Dichlorotoluene			https://www.gen
9-HOTrE			N/A

Table 2. Seven metabolites from one of the NREL datasets, sorted by Metabolite ID, BIGG ID, or KEGG ID. Sorted 100 most abundant from both datasets.

Discussion

Since *P. renovo* is an aspiring source of sustainable fuel and energy and capable of consuming CO₂ and other greenhouse gases, the mass production of *P. renovo* is a vital solution for globally replacing the fossil fuels and implementing biofuels. The **completed metabolic model of *P. renovo* accurately depicts the interactions of *P. renovo* with environment and other microorganisms.** The analysis of these interactions will precisely provide the systems biology of *P. renovo* as well as genomic organization and metabolism. As a result of the curated metabolic model of *P. renovo* with illustrations of its systems biology, the efficient growth mechanism in response to different environmental factors and other microbes can be designed. Therefore, systematic and scientific design in methods of planting the *P. renovo* outdoors for mass production ultimately promote biofuels and sustainable energy.

Conclusion

- The creation of the metabolic model of *P. renovo* will contribute to the scientific understanding of its genomic organization and metabolism.
- The model was created through the refinement of an initial metabolic model and converted into a computational model.
- The completed metabolic model of *P. renovo* is used to examine different metabolic capabilities and induce biological hypotheses.
- The next step would be to use the model for insight, and to refine if necessary.

Acknowledgement

Thank you to Dr. Karsten Zengler and Dr. Cristal Zuniga for their warmest guidance and mentorship. In addition, thank you to GEAR program, Alejandra Arguelles, Lisa Trahan, Ved Vakharia, and Dr. Katya Evdokimenko for this opportunity.