



2022 Ph.D. Opportunities in Geddes Lab at NDSU

We seek to fill two three-year funded PhD level graduate student positions under the supervision of Dr. Barney Geddes at the Department of Microbiological Sciences at North Dakota State University. Positions will begin Spring, Summer or Fall 2022. The ideal applicants will have significant experience in molecular biology and microbial genetics.

A Microbial Symbiont for N₂-Fixing Cereals

The PhD projects build on previous research developing fundamental understandings and systems to support a “holy grail” of synthetic biology - engineering nitrogen fixing cereals. While advances have been made towards developing cereal root nodule organs, to fully realize the dream of N₂-fixing cereals we must uncover foundational knowledge that guides the development of a compatible rhizobium symbiont that will “boot-up” in a cereal root nodule and efficiently deliver nitrogen to the host. Using synthetic biology, microbial genomics and large-scale genome-manipulation the Ph.D. students will work on complementary projects to develop this knowledge. These projects will involve 1) Deciphering the minimal genetic programming required for rhizobia to perform as optimal symbionts for their legume partners 2) Experimental engineering of new-to-nature symbioses between rhizobia and non-host legumes as a model system to uncover and overcome the challenges associated with achieving root nodule invasion and nitrogen-fixation in future root-nodule forming cereals.

We value diversity as a source of strength, creativity and innovation, and believe we will grow and learn better together with a diverse team. Interested candidates should contact Dr. Barney Geddes (barney.geddes@ndsu.edu) with a letter of motivation and CV. Formal applications will be submitted through the NDSU Graduate School. Review of applications will begin immediately and continue until positions are filled.

Relevant Publications:

- Geddes, B.A., Kearsley, J.V., Huang, J., Zamani, M., Muhammed, Z., Sather, L., Panchal, A.K. and Finan, T.M., 2021. Minimal gene set from *Sinorhizobium (Ensifer) meliloti* pSymA required for efficient symbiosis with *Medicago*. *Proceedings of the National Academy of Sciences*, 118(2), p.e2018015118.
- Ryu, M.H., Zhang, J., Toth, T., Khokhani, D., Geddes, B.A., Mus, F., Garcia-Costas, A., Peters, J.W., Poole, P.S., Ané, J.M. and Voigt, C.A., 2020. Control of nitrogen fixation in bacteria that associate with cereals. *Nature microbiology*, 5(2), pp.314-330.
- Geddes, B.A., Paramasivan, P., Joffrin, A., Thompson, A.L., Christensen, K., Jorin, B., Brett, P., Conway, S.J., Oldroyd, G.E. and Poole, P.S., 2019. Engineering transkingdom signalling in plants to control gene expression in rhizosphere bacteria. *Nature communications*, 10(1), pp.1-11.
- Mus, F., Crook, M.B., Garcia, K., Costas, A.G., Geddes, B.A., Kouri, E.D., Paramasivan, P., Ryu, M.H., Oldroyd, G.E., Poole, P.S., Udvardi, M.K., Voigt, C. W., Ané J-M., and Peters, J. W. 2016. Symbiotic nitrogen fixation and the challenges to its extension to nonlegumes. *Applied and environmental microbiology*, 82(13), pp.3698-3710.
- Geddes, B.A., Ryu, M.H., Mus, F., Costas, A.G., Peters, J.W., Voigt, C.A. and Poole, P., 2015. Use of plant colonizing bacteria as chassis for transfer of N₂-fixation to cereals. *Current opinion in biotechnology*, 32, pp.216-222.

