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Earth is an ocean planet. Some 90% of our biosphere is under water, and 50% of that is more than 3000 meters deep. The deep ocean is one of the most biodiverse places on earth and new organisms and habitats are constantly being discovered. Recent phylogenetic analysis even suggests that the first primordial single-celled organisms may even have started near a deep-sea hydrothermal vent. Despite the prevalence and importance of life under extreme ocean pressures, extremely little is known about the structure and function of biomolecules under these conditions. This project will focus on how the known “rules of life” may need to be rethought and how much of our foundational molecular biology might have arisen under extreme conditions in the early Earth’s oceans or deep underground. Students working on this project will help develop and use high-pressure versions of common molecular biological techniques, particularly “ultra high pressure” size-exclusion chromatography coupled to X-ray and visible light scattering. We’ll also learn about extremophiles, phylogenetic methods, molecular clocks, and how extreme pressure alters fundamental molecular biology.