Abstract:
In Astrobiology, new technologies are being implemented in the search for extraterrestrial life. Interpreting results from new analytical techniques may require additional information about microbial properties. A catalogue of identifying characteristics, called biosignatures was created for bacterial and algal isolates from Greenland and Antarctic by measuring substrate utilization, UV/Vis absorbance, FTIR absorbance, and Raman spectroscopy. Organisms were chosen from environments analogous to Martian glacier systems. The spectral properties of these polar isolates could serve as a reference for interpreting results from Raman spectroscopy data from NASA’s Perseverance rover.
Substrate utilization was evaluated using EcoPlates on an Omnilog plate reader (Biolog, California, U.S.A.). UV/Vis measurements were conducted for bacterial pigment extractions and whole cells. FTIR analysis was performed for dried bacterial isolates.

Samples were paraformaldehyde preserved and analyzed through Raman spectroscopy with a 532 nm laser. UV/Vis absorbance spectra indicated that nine of the twenty-five bacterial isolates contained carotenoid pigments, and one contained the pigment violacein. UV/Vis analysis was effective at identifying the presence of pigments, but was not sufficient for distinguishing between the types of carotenoids. FTIR analysis identified general biological features such as lipids, proteins, and carbohydrates, but was unable to detect pigments. Raman analysis identified both the presence of carotenoid and violacein pigments, and the general cell features observed with FTIR. The degree of saturation of membrane lipids was evaluated for the bacterial isolates, and results showed that there was no pattern between the ratio of unsaturated to saturated fatty acids within the cells and growth temperature.

A principle component analysis was conducted using the averaged Raman spectra from each bacterial isolate to determine the regions of the spectra that contributed the variability between samples. This analysis revealed that the spectra of the bacterial isolates were more closely related based on colony color than phylogeny. Analysis of the algal isolates indicated that chlorophyll A and B were the most prominent features among the Raman spectra. These pigments fluoresced under exposure to the 532 nm laser, creating definitive biosignatures for algae. These analytical techniques proved effective at identifying cell properties that could serve as biosignatures for identifying microbial life.