This research project is dedicated to exploring, characterising, and applying cold-active enzymes and bacterial strains from Arctic and Antarctic environments, specifically focusing on their relevance to regenerative agriculture. Collaboratively undertaken by the University of Gdansk and the University of Warsaw, this joint project embarks on the isolation, cultivation, and analysis bacterial strains extracted from polar soils. The emphasis lies in pinpointing bacterial strains showcasing diverse enzymatic activities related to polysaccharide utilisation. A valuable microbial collection will be created for potential application for regenerative agriculture through genomic analyses and enzymatic activity assays on selected strains.

Another pivotal dimension of the project entails pioneering a high-throughput screening method utilising microfluidics. This innovative approach aims to identify genes encoding functional polysaccharide-degrading enzymes in *Escherichia coli*, with the overarching goal of significantly expediting bioprospecting and providing a valuable resource for downstream applications.

Furthermore, metagenomic data from Arctic soil samples will be harnessed to identify novel genes encoding polysaccharide-degrading enzymes. Leveraging sequence- and structure-similarity-based approaches, the project aims to explore the structural diversity of these enzymes, selecting candidates for further analysis and potential utilisation in biotechnology, particularly in regenerative agriculture.

Upon identification, the genes encoding target enzymes will undergo expression, and proteins will be meticulously purified, focusing on optimising their laboratory-scale production. The project seeks to validate the efficacy of earlier proposed selection approaches for active and applicable enzymes. Comprehensive characterisation, encompassing studies on substrate specificity, temperature, pH, and salinity ranges, will offer insights into the biochemical and biophysical properties of the purified enzymes. This process aims to identify thermal and chemical stability determinants and assess the enzymes' potential applicability in regenerative agriculture.

The project’s final phase involves a laboratory-scale microcosm experiment, evaluating the suitability of the developed preparation, comprising cold-active strains and enzymes, for regenerative agriculture purposes. This experiment will assess the impact of selected strains and enzymes on the bioprocessing of fruit and vegetable residues and the decomposition of postharvest plant residues in a soil environment.

In summary, this interdisciplinary project seeks to advance our understanding of cold-active enzymes and bacterial strains derived from polar environments, exploring their potential applications in regenerative agriculture. Consequently, the presented project addresses global challenges related to the search for innovative solutions, aiming to foster the development of more sustainable and productive agricultural practices.