

Our bodies are home to trillions of bacteria that make up a vibrant and ever-changing community known as the microbiome. This community plays a vital role in keeping us healthy by helping with digestion, supporting our immune system, and even influencing our brain function. Among these, the gut microbiome is especially important because it affects many aspects of our overall health. Connections between the gut and other organs — like the brain, liver, heart, and skin — show how the microbiome's balance can impact our entire body. When this balance is disturbed, known as dysbiosis, it can lead to various health problems like inflammation and metabolic diseases.

Although modern scientific techniques like DNA sequencing have helped us learn a lot about the microbiome, most studies stop at identifying bacteria at the species level. But bacteria from the same species aren't all the same — different strains can behave in very different ways. For example, strains of *Faecalibacterium prausnitzii* are known to promote health, while different strains of *Blautia wexlerae* can have very different effects depending on their specific features. To truly understand how bacteria influence our health, we need to go beyond the species level and study them at the strain level.

This project aims to explore how differences between bacterial strains shape human health and disease. I will focus on one type of bacteria known for its complex relationship with disease and create a detailed system to identify how different strains affect our health. The approach includes:

- Building a detailed library of bacterial strains enriched with information about their functions.
- Identifying distinct bacterial strains from global microbiome studies.
- Studying the Polish gut microbiome to see how local strains compare to those found worldwide.

By studying bacteria at this high level of detail, I hope to solve some of the long-standing mysteries in microbiome research, such as why certain bacterial species are sometimes linked to disease and sometimes not. Using advanced genomic data, I aim to refine current knowledge and create tools that can be applied to studying other bacteria. The findings could directly improve diagnostic and treatment methods based on the microbiome, with a special focus on benefiting the Polish healthcare system.

This project also fits into the growing effort to connect microbiome research with personalized medicine. By understanding the unique roles of different bacterial strains, I hope to improve health outcomes and pave the way for innovative treatment strategies tailored to individual patients.