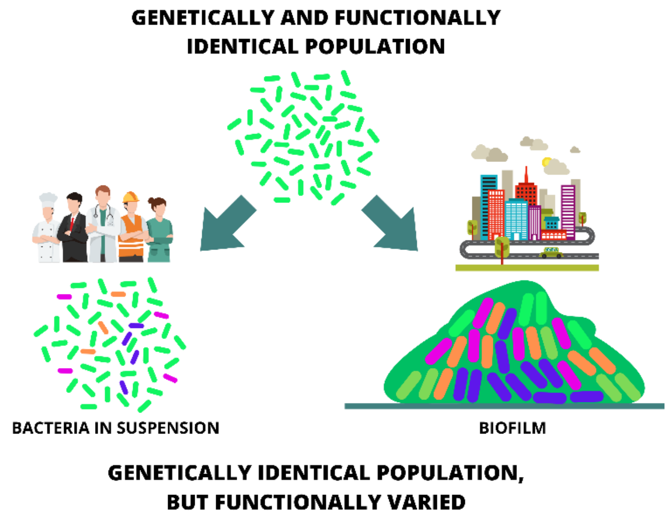
## Why do bacteria in biofilms behave differently even when they're genetically identical?




Have you ever wondered how bacteria survive in harsh conditions like antibiotics, lack of nutrients, or changing environments? One of their secrets lies in making biofilms – dense, complex communities resembling microbial towns or even cities, that bacteria form on surfaces. You've likely heard of them: they form plaque on your teeth, slime in a kitchen drain, and are a major problem in hospitals and water purification systems. In these communities, bacteria stick together and cooperate, but surprisingly, not all of them behave in the same way even when they share the same genetic information. Some cells grow fast, others barely grow at all. Some become tolerant to antibiotics while others remain sensitive. They also share tasks – some produce structures and molecules necessary to stick together, some are busy producing goodies, whereas others are transporting them like couriers. This is similar to a human society, in which each individual has well-defined role. Scientists call this phenomenon "phenotypic heterogeneity": here "phenotype" represents different bacterial "jobs" and "heterogeneity" is a synonym for "diversity". But what is the source of this diversity? After all, bacteria do not think and plan in the way we humans do. Do bacteria randomly select which "jobs" to perform? Or do they decide based on what environment they sense around them? Do they gather in 'trade unions' located in the same area, or are dispersed within the community? How often do they change their microbial 'jobs' and why? This interdisciplinary project aims to answer these questions.

### What will be done in the project?

In this project, I will develop a microfluidic device with channels and rectangular micro-pockets, where *Escherichia coli* (*E. coli*) bacteria will form biofilms. These microfluidic devices will allow me to control bacteria's environment and observe their growth in time-lapse. I will be able to distinguish different phenotypes within the biofilm by inserting fluorescent "reporter" genes into the bacteria. These markers will cause the bacterium to glow with a particular color when a specific gene is active. This will enable me to track biofilm functional diversity in time and space. I will also measure the pH and oxygen concentration in different biofilm regions to see how they affect bacterial behavior.

### Why does this matter?

Understanding why and how bacteria in biofilms diversify is much more than an interesting scientific question; it also has practical implications. Biofilms are a leading cause of chronic infections and are notoriously difficult to treat because some bacteria within them can survive very high concentrations of antibiotics. Biofilms also play an important role – both as a foe and a friend - in agriculture, food production, water systems, and industry. Understanding how to predict and manipulate bacterial behavior in biofilms is a step towards a future in which we can control biofilms behavior and let it do our bidding.