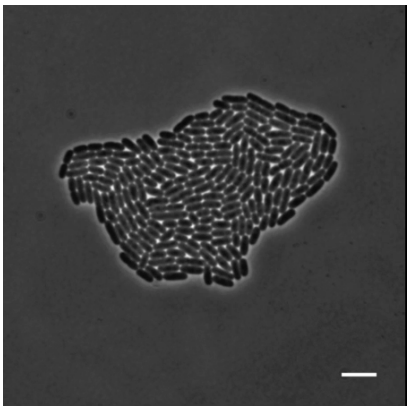
Bacterial colony growth

MEP or BEP - BN / Idema group - theoretical biophysics

A single bacterium in a nutrient-rich environment will not stay lonely for long - by rapidly dividing, it will soon create a colony that grows exponentially. Since no two bacteria can occupy the same space, the growing bacteria inside the colony constantly interact and re-orient to accommodate everyone, resulting in patterns like the one shown in the figure on the right.



Bacterial colony originating from a single common ancestor. The colony's shape is a direct consequence of the interaction between the bacteria as they grow and divide.
Image source: Tans lab (TU Delft/ AMOLF).

In this project, you will simulate the developing colony, accounting for growth, division and mechanical interaction between the bacteria. You will use your simulation to predict which possible colony types you can get (qualitative – BEP), and additionally (MEP) devise quantitative measures by which you can directly compare your simulation results with experimental data.

To simulate the bacteria, you need a reliable model of bacterial growth and of the various interactions between two touching/colliding bacteria. The bacterial growth is well characterized, and can be modeled to follow actual experimental observations, which we obtain from the Tans lab (TU Delft / AMOLF). The most basic interaction between two bacteria is repulsive - touching bacteria that grow will repel each other to avoid overlapping. You'll start your simulations with just those interactions, then add other interactions like bacteria sticking together as you go along, every time considering the effect on the final colony's shape, as well as other properties like regularity and density.

Once you have a working model for colonies formed by wild-type bacteria, you can introduce further constraints, reflecting knockout strains also studied in the Tans lab. At the completion of the project, you'll have learned to work with both computer simulations and biological experimental data. Moreover, if your project is successful, you'll have contributed to understanding which biological and physical parameters are relevant for colony and biofilm formation (and, equally importantly, which parameters are not).