ME480 project - Bacterial growth under pressure

Tentative due date: Dec 22 at midnight.

In lecture 2, you had the opportunity to hear about the work of Laure Le Blanc on the growth of bacteria in confined environments. Her findings were recently reported in a preprint (link).

One of the key features of this work is the use microfabricated chambers that enable constrained growth of bacterial populations without affecting nutrient access. Upon reaching confluency, bacteria must push against the chamber walls to further grow. One can measure the deformation of the chamber to compute the pressure exerted by bacterial growth onto the walls of the device. This pressure is called growth-induced pressure, and denoted GIP.

In this project, we simply ask you to replicate the analysis of Figure 1 of this article. In particular, we ask you to write your own image analysis pipeline to replicate the graph shown in Figure 1D.

Format – One part of the report is expected to be written as a *JupyterLab* notebook. In addition, provide the output files of segmentation which will be accompanied by a report to explain the key methodologies, analysis steps, results and a brief discussion.

Data - We provide a selection of raw microscopy images used in the article, including images of 5 chambers with bacteria and 4 acquired along calibrations. The chambers were fluorescently labeled to enable automatic detection of wall deformations. Additionally, we provide similar images of the calibration channel, where known pressures were applied at the inlet. These images should be used to construct a calibration curve.

The data can be accessed on the following switch drive folder**to update:
https://drive.switch.ch/index.php/s/wbjpc1qmO9yzvOV
password: mechanosensing

Here is a description of the movies:

Chamber-1_top.tif, Chamber-2_top.tif, …, Chamber-5_top.tif

- Timelapse spinning-disk acquisition of chamber edges at the top of the chambers
- The chamber walls were fluorescently labelled using the FM1-43 dye
- Deformation occurs due to the growth of *E. coli* bacteria, once they reach confluency (*data not shown*, see Figure 1.B)
- 30 min frame interval
- Pixel size: 0.06587 µm

Calibration-1_top.tif, Calibration-2_top.tif, …, Calibration-4_top.tif

- Images of the calibration channel acquired at the top of the channel, and more precisely at the same height than the chambers
- The walls were fluorescently labelled using the FM1-43 dye
- No bacteria were introduced in this channel
- Stack of images acquired at 8 different pressures applied at the inlet
- Applied pressures: 0 mbar (image 1/8), 200mbar (image 2/8), 400mbar (image 3/8), 600mbar (image 4/8), 800mbar (image 5/8), 1000mbar (image 6/8), 1500mbar (image 7/8), 2000 mbar (image 8/8)
- Pixel size: 0.06587 µm