ABSTRACT: Bacterial biofilms are colonies of surface-attached bacterial cells. Biofilms are the most ubiquitous form of life on the planet, appearing on almost all solid surfaces. They can cause health problems such as infections, dental plaque, and rusting metal structures and also be utilized to clear nitrates from waste water and to produce some household chemicals. Because they have a substantial impact on human life, it’s critical that we understand how to control and manipulate biofilms. One aspect of that is modeling the growth and development of biofilms under various environmental conditions. I present in this talk a model for biofilm growth and an asymptotic approximation method for computing oxygen concentration in a whole flow cell used to study bacterial biofilms. The method effectively reduces the dimensionality of the problem by one and thus makes the solution computationally tractable.

For mathematical models of biofilms to be properly compared to experimental observations, information about the local environment surrounding the observation location is needed. Experiments involving bacterial biofilms consist of growing colonies within flow cell chambers. The size of the flow cell chambers can vary, but what is common among these experiments is that (a) the region where observations are made is a small fraction of the chamber, (b) observations can be obscured when close to the fluid inlet, outlet, or sidewalls. Computing a biofilm model over a full flow cell is prohibitively expensive, while experimental measurements of environmental factors are only measurable at the inlet and outlet. Thus, there is a need to develop a model that can estimate the local environment in a flow cell and our asymptotic approach is one way to achieve that.