Case Study 2: Experimental Measurements of the Diffusion Coefficient

Transport in Biological Systems

Fall 2015

Overview

In this Case Study, you will continue to develop your ability to manipulate and understand key approaches to diffusive processes, this time using both modeling and experiment. This Case Study builds on work done in Exercise 2. In this case, we are interested in measuring the diffusion coefficient in a hydrogel sitting on a membrane (it becomes another 2-membrane problem). We will split work between in-class time and out-of-class time.

Experimental approach

There are several approaches to measuring diffusivity experimentally, which we will discuss more in class. Briefly, there are a number of variations on the set up laid out in Exercise 1. These generally assume that steady state is reached in the hydrogel and membrane much, much faster than the concentration in the two baths change. There are numerous ways to set this up. There are also transient approaches, which can be solved as seen in the end of Chapter 6 of Truskey. Finally, there are approaches such as FRAP (fluorescent recovery after photobleaching) which involves bleaching an area and watching as the fluorescence returns due to diffusion. All of these methods utilize fluorescent probes. For class on Monday, September 28th you should:

1. Decide which method you would like to pursue and sketch out your experimental setup.
2. Begin to enumerate the appropriate controls needed.
3. Develop an estimate for relevant time- and lenth-scales using equations developed in Exercise 2 or in Chapter 6.

We will have in-class time on October 1st and 5th to perform experiments. You will likely need to perform more experiments outside of class time.

Objectives and Deliverables

The objective of this course is for you to apply concepts and skills in modeling and simulation, as well as experimental work, to problems in biological transport. I therefore recommend that, as an individual, you develop your knowledge and abilities in all aspects of the course. Towards this objective, I believe that there is tremendous benefit in working with other people and highly recommend that you perform this work in groups of 2-3. I do not, however, want you to develop a divide and conquer strategy - ideally all members of your team will be committed to and engaged in developing integrated skills in modeling and simulation of problems in biological transport. This means that during working times, I should be able to

ask any member of your group about any aspect of the work. For this case study, you should work with 1 or 2 other people.

Your final work should include appropriate equations, modeling results, and experimental results and be written in the style of a primary research paper. Prepare your manuscript in the style of IEEE in which you present your results. Your document should be 3-4 pages and should include the following:

- title
- authors
- brief abstract
- introduction (includes background and significance)
- methods
- results and discussion, including relevant figures (no more than 4)
- references cited

The draft of this report is due electronically by midnight on October 15th. You will receive a review of the manuscript within a few days. The final report is due on October 22nd.