

Math Biology USRA project with Leah Keshet, Dept of Mathematics, UBC  
Project 1: Simulations of interacting cells in an epithelium.

An epithelium is a sheet of cells, in which cell division, adhesion, relative motion, and deformation can take place. Studying how rules governing single cells affect the sheet as a whole is an important aspect of developmental biology and cancer biology. This summer project involves installing and adapting software to explore cell-cell interactions in a sheet of living cells. The student will be asked to install pre-existing software CHASTE (University of Oxford), and to learn how to run this software and make simple tests and alterations to explore specific problems.

[http://www.cs.ox.ac.uk/chaste/cell\\_based\\_index.html](http://www.cs.ox.ac.uk/chaste/cell_based_index.html)

Required skills: experience and ability using object-oriented programming, C++, Linux and OSX. Some background knowledge in biology is desirable. Mathematics courses including calculus, differential equations, needed. Ability to work independently and solve/troubleshoot is essential. Preference will be given to students with solid computational background in CS courses. Experience with modeling (e.g. M 345, M361, M462) would be an extra bonus.

NOTE: if successful, this project has the potential to develop into a continued work-study program or to a graduate (MSc) project with Leah Keshet.

Technical Steps would include:

Installation in one of the following ways – (a) download as an Ubuntu package (instructions on the Chaste public wiki: <https://chaste.cs.ox.ac.uk/trac/wiki/InstallGuides/UbuntuPackage#a2a.FoRCodeUSERSratherthandevlopers>). Or (b) OSX; there are some instructions at <https://chaste.cs.ox.ac.uk/trac/wiki/InstallGuides> but best to install a Linux virtual machine and run Chaste on that.

Getting started: reading through tutorials at <https://chaste.cs.ox.ac.uk/trac/wiki/UserTutorials>. These contain information on how to code up various types of simulations. See, in particular, cell-based Chaste tutorials, such as <https://chaste.cs.ox.ac.uk/trac/wiki/UserTutorials/CellBasedDemo>. The tutorials show how to simulate a 2D collection of cells proliferating and interacting mechanically using different modelling approaches (Voronoi tessellation, overlapping spheres, and vertex models). There are also tutorials on how to create new classes for implementing different functionality – for example, creating a new class for a different cell-cell interaction force. A summary of existing functionality in Chaste at present can be found in a recent article: (<http://www.ploscompbiol.org/article/info%3Adoi%2F10.1371%2Fjournal.pcbi.1002970>). The examples in this paper have corresponding user tutorials: <https://chaste.cs.ox.ac.uk/trac/wiki/PaperTutorials/Plos2013>. Many publications using Chaste have associated user tutorials.

