Vigre Semester report
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The Spring semester brought a new branch of research in cancer modeling. My original research from previous semesters in this field focused on tumor growth due to nutrient and pH concentrations, as well as growth induced stress in the tissue. This semester, I added a new component, which is the examination of chemotherapeutic treatment and immune system response to cancer, and their effects on tumor development.

As a result of this new facet of my research, I delayed my Oral exams slightly until September of 2007 (I had originally proposed April 2007). This delay was so that I could incorporate this immunological research as part of my exam, since I hope it will be an important part of my dissertation research.

The research I worked on this semester was two-fold. As mentioned earlier, I worked on a model which treated tumor growth interactions with the immune system and chemotherapy. This research was primarily in conjunction with my advisor Dr. Alain Goriely of Math, and Dr. Ardith El-Kareh of Physiology. The model was initially an expansion of a few existing models in the literature, but after consulting with a colleague in Immunology (Dr. Emanuel Akporiaye) and surveying the immunological literature further, we have taken a new tack by incorporating some recent results on regulatory T Cells. Previous models had dealt with tumor cell inhibition of immune system effector T cells directly. New research suggests the importance of regulatory T-cells cannot be ignored. We are building a new model which incorporates this regulatory mechanism. As far as we can tell, no other models have been published examining this mechanism.

On the dynamical side of tumor growth, I continued to study papers which treated the tumor system as a poroelastic medium. This treatment deals with solid and fluid constituents, and the fluid pressure serves as the mechanism for fluid and cell movement. Current models use a single solid constituent, but I expanded the formulation to include tumor cells of different types, governed by their own properties, and also competition among cell types. By using the equations for nutrient and pH concentration from an earlier model we built, I will create a poroelastic spatial model which incorporates stress and competition among cell types.

For my course work, besides three credits of independent study for my research, I took the Applied Math laboratory class. The main subject of the class was learning the governing mathematics of liquid crystals, and applying them to experiments that were available in the lab. The class was work-intensive, but very rewarding. The application of complex models to observed phenomena was very interesting, and by the end of the semester, my lab partner and I were able to apply a recent model of liquid crystal alignment to our lab samples and derive some results which we had not encountered in the literature. While the results would need to be formalized to consider possible publication, it was exciting to be able to apply recent theory to what appeared to be a basic experiment on first glance.

In the Biomath seminar, the semester was split in three. The first third dealt with pattern formation in bacteria. I presented in this section, giving a talk on the formation of fruiting bodies in bacteria colonies. The second part of the semester was about insect behavior, specifically how bees manage their honey collection. While I didn't present in this section, I found the ideas very interesting with regards to how colonies signal each other, and it made me think about how some of the ideas could be applied to cell colonies in a tumor. The third part of the semester, we each presented on our own research.

The professional development component of my research involved the mentoring of an undergraduate research project. This was for the Math 485 class, taught by Dr. Wang. I mentored a group of five students who worked on an epidemiology project. They worked from a central paper and associated references to reproduce a model of disease spreading using a small-world network and appropriate parameters. They also extended that model beyond the original paper to examine fatalities. As a mentor, I was able to apply some of the philosophies which I had studied in Fall 2006 with Dr. Lega as preparation for the mentoring. The group was very successful in their project.

This coming semester I will focus on passing my oral qualification exam in September, and continuing my research. I am taking six units of independent study for my research. I am also taking the partial differential equations course. For professional development, I will be working with the Math 322 course in the development of online material to demonstrate concepts taught in the class.

On the research front, I have three goals for the semester. First, to pass the oral exams. Second, to finish developing the model of immune-tumor-chemo interactions that I started this semester, and run simulations to check the model against experimental/clinical trials. Third, to form 2 and 3 dimensional models of poroelastic tumor growth, incorporating nutrient and pH concentrations, as well as competitions among multiple tumor cell types.