Maribeth Oscamou

Statement of Interest and Commitment

The importance of mathematical modeling of infectious diseases has become evident to me in recent years with the 2002-2003 SARS outbreak, the 2004-2005 influenza vaccine supply shortage in the US, and the nearly 3 million people that are dying per year in the world from HIV/AIDS [1, 2, 3]. The fact that several countries including the US, UK, and Canada have begun incorporating mathematical models of infectious disease into their epidemiology policy decisions indicates the public's increasing awareness of the vital role mathematical research will play in tracking and limiting the spread of deadly infectious diseases around the world [4, 5]. The Advanced Study Institute on Mathematical Modeling of Infectious Diseases in Africa and the following capstone workshop provide an ideal opportunity for graduate researchers to be trained in mathematical epidemiology and control of infectious diseases by experts in the field. I believe I am an excellent candidate for the institute because I am interested in the topic, have a strong mathematical background, and have previous experience applying mathematical analysis to biological dynamical systems. Additionally, I am committed to continuing the research project that I begin at the institute as a part of my current thesis, and I am interested in exploring mathematical epidemiology as a potential area for post-doctoral research.

As a fourth year graduate student in the Applied Mathematics PhD program at the University of Colorado at Boulder, my current thesis projects in mathematical biology involve modeling and analysis of dynamical systems at the cellular level, including cellular signaling and helicase DNA translocation. There are many similarities between the mathematical analysis I conduct at the cellular level and some of the mathematical analysis used in models of infectious disease. For example, one of my research projects involves mathematically modeling the TGF-beta/Smad signaling system in epithelial cells. I am collaborating with experimentalists at the University of Colorado who provide data and detailed descriptions of the known chemical reactions in the signaling system. To model the system, we assume mass action kinetics for the chemical reactions, leading to a continuous time nonlinear system of ODEs. The rates of most of the chemical reactions are unknown, thus the ODE system contains a large number of unknown parameters. The goal of the research is to use experimental data and our mathematical model to find a probability distribution of parameters that are consistent with the data, and use that distribution to identify combinations of parameters that are most important in controlling the signaling. We utilize a variety of mathematical techniques to accomplish this including dynamical system/bifurcation analysis, least squares global optimization for parameter estimation, sensitivity analysis, and Markov Chain Monte Carlo simulations.

Many of the mathematical methods listed above are also used in analysis of models of infectious disease. Thus, attending the institute and participating in the ensuing research project will provide an ideal complement to my current thesis projects, through utilizing similar mathematical methods to model and analyze a biological dynamical system at the population level. At the same time, modeling infectious diseases would expose me to new aspects of mathematical modeling not present at the cellular level, such as accounting for economic or social factors that may affect the spread or control of the disease or the effect of age on the likelihood of being infected. In addition, deterministic models are only one of many types used to model infectious disease, and I am interested in learning more about other models being used, including stochastic and network models.

Because the institution I attend does not currently offer any classes in mathematical epidemiology, the institute will provide me with an ideal opportunity to be introduced to mathematical epidemiology by the experts in the field. It also provides the unique opportunity to collaborate with graduate students and researchers not only from the US, but from Africa—a country where some of the most important research in infectious disease is being conducted. The capstone workshop following the institute will also be an important time to learn how we, as mathematical modelers, can work collaboratively with public health officials to use the models to influence public policy and combat disease spread. It is essential that we discuss and address the realities and challenges of implementing sustainable, cost effective and economically viable solutions. I am excited the institute's culminating workshop will provide a way for this interaction to occur.

As a new student of mathematical epidemiology, the two weeks at the institute will expose me to a variety of important potential research projects in the area. I am committed to finding and continuing a project that will complement my current thesis projects. My thesis advisor, Professor Meredith D. Betterton, has agreed to mentor me in this research. In addition, Professor David M. Bortz (Applied Mathematics, University of Colorado), who has done previous work in mathematical models of HIV, has agreed to be an additional mentor for my project. My long term goal is to enter academia, thus upon completion of my PhD, I plan to do post-doctoral research. I am very interested in attending this institute and participating in the research project as a way of exploring mathematical epidemiology as a potential area for post-doctoral research.

The spread of infectious diseases in Africa and throughout the world is becoming a problem that only multidisciplinary teams of scientists, mathematicians, and public health officials can take on. I believe that my passion for being part of the solution to this issue, my background in mathematical modeling of biological dynamical systems and my interest in incorporating research in mathematical epidemiology into my current thesis make me an ideal candidate for this program.

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