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Teaching Statement

In recent years the National Academies of Science, as well as public and private funding agencies, such as the National Institutes of Health, the National Science Foundation and the Burroughs Wellcome Fund, have expressed the need for a new generation of scientists able to work and teach at the interface of the physical and the life sciences. I belong to one of the first generations of mathematicians cross-trained in mathematics and molecular biology. My career started with a B.Sc. in pure mathematics and an honors thesis entitled *Applications of knot theory to the study of DNA*. During my PhD, after taking the core courses required for a mathematics major, I selected a dissertation topic in mathematical biology, took graduate courses in biology, attended and presented my research in biology conferences and seminars, did a 2-month rotation in a molecular biology laboratory, and established close and long-lasting collaborations with experimental groups. My studies were partially funded by a Burroughs Wellcome Fund *Training at the Interface* fellowship through the Program in Mathematics and Molecular Biology (PMMB). My interdisciplinary training continued and was enhanced during my postdoc. I am a mathematician at heart with a passion for molecular biology, and expertise in both fields. Having been trained at the intersection of these two disciplines, but always based in a mathematics department, I can contribute an informed vision to the creation of cross-disciplinary courses and undergraduate programs in Mathematical and Computational Biology.

A. Teaching Experience

I here report on my experience teaching and mentoring in mathematical biology. However, I have also taught a variety of mathematics courses. As a Visiting Assistant Professor at the UC Berkeley Math Department (2000-2001; 2003) I taught upper division *Abstract Algebra* and *Numerical Analysis*, with high student ratings in both courses. Since joining SFSU in 2005 I have taught several courses in the mathematics curriculum.

I have a long history of integrating research with teaching and student mentoring. I have co-developed two interdisciplinary undergraduate and graduate courses: DNA Topology (Math 414/714); and Methods in Mathematical Biology (Math 814). The DNA topology course is offered yearly and is funded by an NIH-MARC grant (PI Frank Bayliss). Both courses have a core research component and require students to undertake a research project, to detail their findings in a scientific paper or grant proposal, and to make a formal oral presentation of their work at the end of the semester. DNA Topology is taught in a room equipped with video-streaming capabilities. Students use the recordings for study and self-evaluation. In

Spring 2010, the course was streamed to a classroom led by Prof. Mario Eudave-Muñoz at UNAM's Math Institute (Mexico). Similar plans were made with Professor Shimokawa from Saitama University in Japan, and Professor Soteros at the University of Saskatchewan (Spring 2011). This has allowed for the cross training of students who don't have access to specialized courses in mathematical biology.

When teaching I am always very rigorous, emphasizing the importance of the details and the logic behind the theories. I try to sell the idea that mathematics is a language, and that once you learn and understand this language and its structure you can apply it to any problem regardless of the subject. I believe that at the undergraduate level, applications can often be found to illustrate and motivate even the most complicated theory.

I have been deeply involved in undergraduate research mentoring in mathematical and computational biology. I have been a research mentor for over 20 UC Berkeley and SFSU undergraduates (8 female, 4 underrepresented minorities) from different majors and at all stages of their degrees. All students have worked on projects within DNA topology, which usually involved learning a fair amount of mathematics, as well as the underlying molecular biology, and implementing the theory in the computer. I have several publications co-authored by undergraduates (highlighted in the CV). Since 2005 I have mentored 12 graduate students, of whom 7 are female and 6 are from underrepresented groups. I have also mentored a postdoc and several research technicians. Several of my undergraduate and graduate students have joined PhD programs (*e.g.* MIT, UCD, UCSC, U. of Iowa, FSU), gone to medical school (*e.g.* UCLA) or joined the workforce (*e.g.* Department of Defense, Oracle, ICSI Berkeley). I am committed to increasing participation of students from groups underrepresented in mathematics. I am successful at attracting and inspiring them to achieve things that they did not think possible. This is one of the most rewarding aspects of my job.

B. Mathematical Biology: Future

This is a time of very rapid change for Biology. In the last two decades the field has become very quantitative, enormous amounts of data are pouring out of experimental laboratories and, in order to process these data, Biology needs all the help it can get from more quantitative sciences. Universities are moving to meet these needs, but more slowly than needed. While some interdisciplinary graduate programs exist, few programs address undergraduate interdisciplinary training. Aware of these problems, the NIH, NSF and DOE requested a report from the National Academies on how to build upon recent developments in biology. In 2009, the National Academies compiled *A New Biology for the 21st century*. The report emphasizes the need of collaboration among scientists and engineers from many disciplines beyond what is currently in place. The New Biology Initiative is a truly interdisciplinary endeavor where mathematicians, computer scientists, physicists, engineers and chemists form a community integrated within Biology to tackle society's big problems. "The New Biologist is not a scientist who knows a little bit about all disciplines, but a scientist with deep knowledge in one discipline and a "working fluency" in several." The report recommends that the Initiative invest in interdisciplinary training at the undergraduate and graduate levels, as well as in the training of teachers. New departments and institutes able to provide interdisciplinary training are slowly emerging. While these become well established, traditional departments need to collaborate in the creation of undergraduate programs that provide training for future more complete scientists. From my perspective a mathematics department is in a unique position to provide solid background in mathematics and statistics and, in particular, experience and training in quantitative thinking. And I have specific ideas on how this can be achieved.

Broad dissemination: As part of my NSF CAREER grant, I aim to reach out to the general public to promote the understanding of DNA topology and to broaden access to knowledge which has, until now, been reserved for the scientific community. I propose the following activities: 1) develop modules for a Math Circle for children Grades 1 to 5 to develop their three-dimensional geometrical intuition, thereby giving them tools to observe and appreciate the mathematics embedded in the world that surrounds them; and 2) collaborate with the California Academy of Sciences (CAS) with the long-term goal of developing an exhibit on DNA topology for the museum. As early as first grade, math phobia is instilled in many children, perpetuated by prejudices of parents and older siblings, media exposure, and the style or quality of the math instruction they receive. Presenting mathematics in a highly visual, kinestetic and interdisciplinary setting using three-dimensional tools, computer animations and hands-on activities will reverse the effects of these prejudices in many children. This approach complements traditional more passive styles of instruction, helps students grasp concepts that otherwise remain abstract, and allows the children to experience the thrill of discovery. In Fall 2011, my colleague Sergei Ovchinnikov and I joined forces with the San Francisco Math Circles to create an elementary program. In Spring 2012 I led a section for 2nd and 3rd graders, this Fall I am leading one for 4th and 5th graders. Undergraduate and graduate math students help develop these activities. These students thus explore the impact of research on society and gain valuable experience teaching various age groups and communicating complex scientific information to a general audience. The program is particularly good for girls and children from inner-city schools, who often come from underrepresented minority communities. These activities are well in line with the focus in STEM education emphasized by federal agencies.