As a faculty member, my research plan will be to build an experimental lab focusing on single cell and single molecule measurements that combine micromanipulation experiments, microfluidics and fluorescence microscopy. The two research areas I will focus on when starting my biophysics lab are: (1) the accessibility of

DNA within eukaryotic cells and how it is controlled by the cell and (2) how interacting populations of single cell organisms evolve within constrained and non-ideal environments.

My first research project will study how DNA organized into chromatin is accessed within the cell. It is known that DNA is less accessible within chromatin and that the expression of genes is regulated through remodeling chromatin structure. However, it is not known what levels of organization within chromatin must be changed for DNA to be accessed and how chromatin remodeling complexes induce these conformational changes. To understand how DNA is accessed, my lab will use a single molecule approach that combines FRET detection while applying a force or twist to study modified versions of the FRET (Fluorescence Resonance Energy Transfer) pair labeled nucleosome arrays I am currently constructing in the Widom Lab.

By simultaneously measuring FRET while applying a force and/or twist, my lab will measure molecular conformational changes induced by an applied force and twist. This will determine the force necessary to induce conformational changes within a single biomolecule. Determining what parts of nucleosome arrays move for DNA site exposure and the forces required to induce these changes will directly test models of how DNA is accessed. Chromatin remodeling factors will also be studied by determining if an applied force enhances or suppresses their remodeling activity, which will directly test the current models of how chromatin is remodeled.

My second research project will focus on the population dynamics of E coli with the colicine plasmid addiction system in constrained environments. These experiments will determine how variations in complicated external conditions affect population behavior and how external conditions affect biofilm development, differentiation and formation of micro-colonies. The experiments will be done in microchannels and microchambers that will be constructed with soft lithography techniques. The different types of bacteria will be observed through the expression of different fluorescent proteins. The experiments will track, in real time, how the different types of bacteria evolve spatially and temporally.

These experiments will require setting up two microscopy systems, soft lithography facilities and a molecular biology/biochemistry lab. I will set up most of this within my own lab, however some of the equipment I will need could be accessed through shared facilities. I am also interested in developing collaborations with the Physics, Chemistry and Biology departments where both ideas and resources could be shared.

In addition to conducting research, I am excited about the teaching responsibilities of an Assistant Professor. Clearly, teaching is the main goal of any university and, for an assistant professor, is an important component of the position. I enjoyed my teaching duties when I worked as a teaching assistant during graduate school and am excited about teaching again at the university level.