Students will participate in the following 2 modules:

**MODULE 1: EXAMINATION OF DNA REPAIR PROTEINS BY SINGLE-MOLECULE APPROACHES AND MOLECULAR DYNAMICS**

**Part 1:** Single-molecule measurement of a DNA repair helicase  
*Laboratory: Yann Chemla (UIUC Physics)*

Participants will carry out *in vitro* experiments on proteins in *E. coli* DNA repair pathways. Using state-of-the-art single-molecule techniques, such as optical tweezers and fluorescence microscopy, we will measure the unwinding activity of UvrD helicase, whose function is to unwind damaged DNA strands in the cell. Students will learn how to prepare samples, operate the instrumentation, and collect and analyze single-molecule data. Beyond measuring UvrD unwinding, we will investigate how helicase activity is modulated by accessory proteins (e.g. MutL, SSB) UvrD encounters during DNA repair.

**Part 2:** Molecular dynamics simulations of DNA repair proteins  
*Laboratory: Klaus Schulten (UIUC Physics)*

Students will be introduced to computational methods developed in the Schulten lab including the structure and sequence analysis program, Visual Molecular Dynamics (*VMD*), and the modeling program, Nanoscale Molecular Dynamics (*NAMD*), through lectures and hands-on simulation tutorials using a new QwikMD tool with example systems. Students in this unit will apply QwikMD to study structural dynamics of DNA repair proteins such as UvrD, MutL, RecA, and SSB.

**MODULE 2: MEASURING DNA DAMAGE IN LIVE CELLS**  
*Laboratory: Tom Kuhlman (UIUC Physics)*

By fluorescently labelling the mutation repair protein MutL, students will detect point mutations and DNA damage in living *E. coli* cells and in real time using fluorescent microscopy. We will subject cells to various conditions (e.g. UV light, repair protein deletions, and antibiotics), and study the rates and statistics of DNA damage and mutation.