

## THEME 4: PHYSICS OF DNA

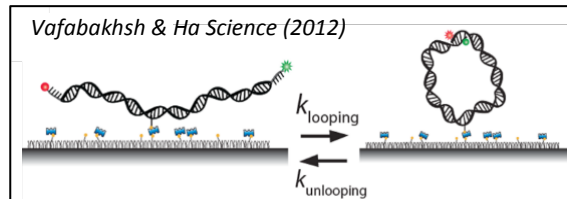
Students will participate in the following 2 modules:

### MODULE 1: EXAMINING DNA FLEXIBILITY BY SINGLE-MOLECULE FRET AND COMPUTATIONAL ANALYSIS

#### Part 1: smFRET measurement of DNA flexibility on sequences with varying modifications and genomic contexts

Laboratory: [Taekjip Ha](#) (Johns Hopkins University)

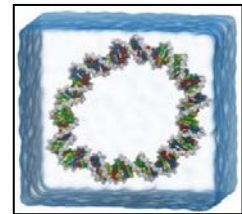
Students will learn how to perform single molecule FRET (smFRET) experiments using DNA looping and unlooping as an example. They will learn how to prepare a polymer passivated surface, how to acquire single molecule FRET raw data, how to extract time traces and histograms from the raw data, and how to analyze the kinetic data. In DNA looping, the students will perform looping of several DNA sequences and DNA with chemical modifications that will be compared to the DNA mechanical properties simulations (Part 2).



#### Part 2: Microscopic Mechanics of DNA

Laboratory: [Alek Aksimentiev](#) (UIUC Physics)

Students will build atomic-scale models of DNA fragments and determine the effect of DNA sequence on the local flexibility of DNA using [molecular dynamics](#) simulation. Students will use a Monte Carlo simulation method to relate the local flexibility of DNA to the DNA looping probability.



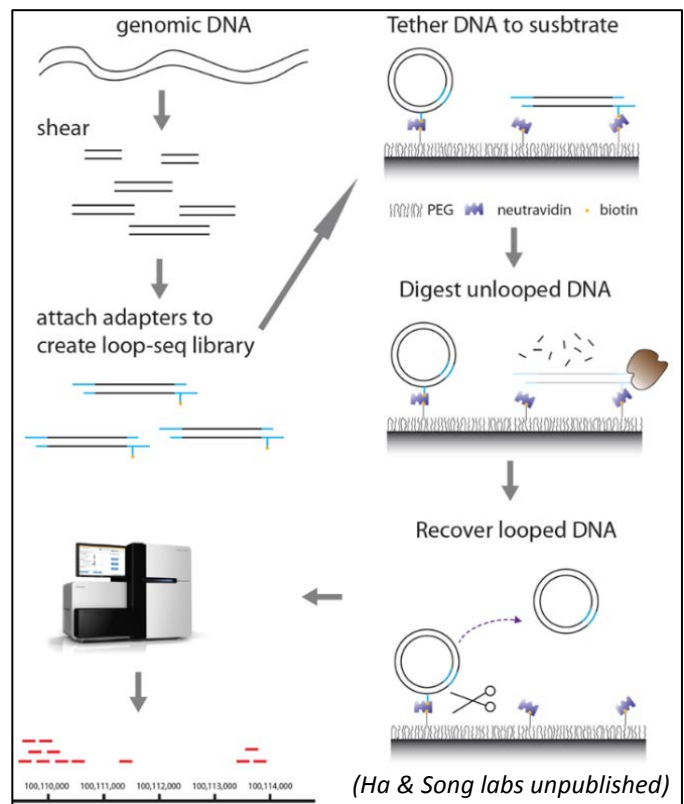
Aksimentiev lab

### MODULE 2: EXAMINING GENOME SCALE DNA FLEXIBILITY

#### Part 1: Loop-Seq: Genome scale DNA flexibility measurement using sequencing

Laboratory: [Taekjip Ha](#) (Johns Hopkins University)

Students will participate in performing surface-based looping of thousands of different sequences followed by exonuclease digestion to enrich the most flexibility sequences taken from a model organism. They will validate the protocol using smFRET looping analysis of the original library and looping-enriched libraries. They will participate in the sequencing of the original and looping-enriched library to determine the relative flexibility of these sequences. The sequencing data will be interpreted in the Song lab.



#### Part 2: Loop-Seq: Computational analysis of nucleosome positioning sequences

Laboratory: [Jun Song](#) (UIUC Physics & Bioengineering)

Students will learn how to perform quality control analysis of high-throughput sequencing data generated from Part 1 flexibility analysis. They will then apply regression and categorical spectral analysis methods to learn whether sequence periodicity plays a role in modulating the bendability of DNA around nucleosomes.