Gene Expression Analysis Using Counting Statistics (Linda Song)

The quantitative study of gene expression *in vivo* calls for theoretical models that go beyond simple pictorial descriptions. In particular, we want to make systematic measurements which can be compared directly to thermodynamic models of gene expression in bacteria. In this project, we will explore a simple repression circuit involving Lac repressors. By using time-lapse video microscopy and image analysis, a simple fluctuation theorem will be used to count up the number of repressors in the bacterium which will be correlated with the measured level of gene expression.

DNA-DNA Interactions and Lambda Phage (David Van Valen)

We are interested in whether the energetics of DNA-DNA interactions plays a role in viruses infecting bacterial cells. To study this, we will attempt to package fluorescent and naked DNA into lambda phage capsids. We will also attempt to image the dynamics of DNA exiting the viral capsid, both into free solution and into living cells.

Using Protein Production to Measure DNA Looping (Daniel Jones)

We will attempt to measure the dynamics of in vivo DNA loop structures, using protein production as a readout of the presence (or absence) of DNA loops. We'll be taking and analyzing movies of *E. coli*, and tracking production of YFP over time. In this way, we hope to measure the timescales on which DNA loops are created and destroyed.

Mechanosensitive Channels and Cell Volume (Maja Bialecka)

Bacteria have to react very quickly to changing environmental conditions in order to keep a homeostatic balance and avoid permanent damage to the cell. In hyperosmotic environments, the cell loses water and plasmolysis occurs, while in hypoosmotic environments, water rushes into the cell and bacteria have to react very quickly (on the order of milliseconds) to equilibrate the hydrostatic pressure and avoid membrane rupture. *E. coli* has a several types of mechanosensitive channels that detect the tension in the membrane and open to relieve pressure at a critical value, but release many valuable molecules. We will use video microscopy to measure cell volume changes caused by mechanosensitive channels over time when exposing bacteria to different environmental conditions. The experiment will be run on wild type *E. coli* cells and mechanosensitive channels mutants. We will also use small concentrations of antibiotics to weaken the cell wall and study the morphological changes it may cause.

Bacterial pigments and Photosynthesis in the BBB ponds (Helen Bermudez)

We will identify pigments in several different cultures, including purple sulfur bacteria (Chromatium) using characteristic absorbance values and thin layer chromatography. Comparing the Caltech strain to species with other pigments may allow us to estimate and understand differences in energy yield and growth rates. We will be using mixed and single culture methods to isolate pigmented bacteria and investigating the plate count anomaly using a variety of media.