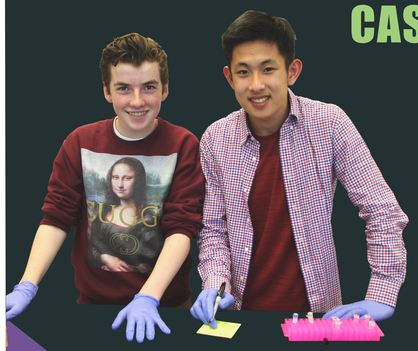
VISIBLE LEARNING PROJECT

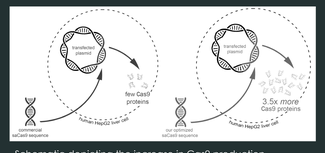
# NOVEL RESEARCH: MOLECULAR BIOLOGY IN ACTION IN THE UPPER SCHOOL

**In Applied Molecular Biology, teams of students work together to design and run novel biological research on a molecular scale. The research is targeted toward the largest biological problems of our decade: addiction, cancer, depression, biotechnology, and harnessing the power of the microbiome. These students work hand in hand with those in advanced experimental design analysis. Together they not only do advanced science but also deeply study the philosophy behind experimentation and the development of the architecture that has led to modern experimental paradigms. The two groups feed a third, the journal club that curates Science Thursdays, an attempt to educate the community at large about pertinent scientific information. All are parts of the research program that creates capable, intellectual, compassionate researchers. Though in its infancy, its goals are large and the program has already received national recognition.**

## *Improving the* CRISPR/CAS9 SYSTEM

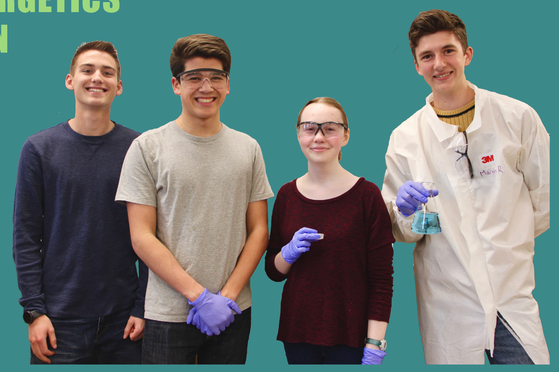


CRISPR-Cas9 gene editing technology shows great promise in the treatment of genetic diseases. However, the currently established mechanism of treatment by ex vivo delivery is mostly limited to blood diseases. Development of capability for in vivo treatment is critical to extending the technology to more diseases, but this method is limited by a challenging delivery process. Because the Cas9 construct is very large and the viral vectors used for delivery are very small, it is difficult for the viruses to efficiently carry the construct. Our project aims to compensate for the low delivery efficiency by optimizing the Cas9 gene to increase its protein expression levels. A success could counteract the existing delivery limitations and has potential to increase the viability of in vivo CRISPR-Cas9 treatments.




Schematic depicting the increase in Cas9 production.

## *We are studying the role of* CELLULAR ENERGETICS *in* DEPRESSION *using* WORMS

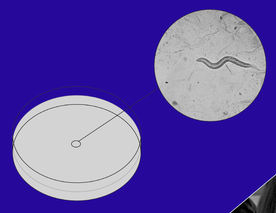


Depression is the leading cause of disability worldwide, and one of its most troubling and least well understood symptoms is the loss of reward firing in the brain. To try to understand how this decrease in reward firing may be affected by a specific protein, we are running a novel knockout experiment testing C. elegans worms to see whether worms that don't have MTCH-1 proteins have less reward firing than ones that do have MTCH-1 proteins. Worm reward firing may seem hard to measure, however, because worm reward firing has been associated with differences in worm movement in past studies. We are able to instead measure the worms' movement to get an idea of their firing levels. If our theory is correct, and MTCH-1 does affect reward firing, this experiment could impact our understanding of the analogous mechanisms of depression in the human brain, and could possibly even spur the creation of new treatments for those affected by depression all around the world.

## *We are studying* ADDICTION *and the* OPIOID EPIDEMIC

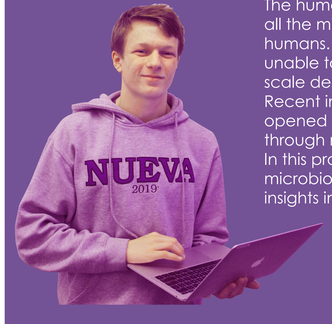
With the average lifespan of Americans decreasing for the second year in a row due to the ongoing opioid epidemic, now more than ever it is important to research drug addiction. We will be using C. elegans, a commonly used model organism for drug addiction experimentation, to determine the role of well-known tumor-suppressor/transcription factor p53 in methamphetamine addiction.

Current research shows that methamphetamine activates p53, which can cause cell death, which in turn leads to depletion of the reward system. Depletion of the reward system can lead to sucicidal thoughts and severe depression.



Pictured is the C. elegans worm used to test Apomorphine, Eltoprazine, and Bifepunox

## NEXT GENERATION SEQUENCING INSIGHTS *into how* HUMANS INTERACT *with* MICROBES




The human microbiome is the collection of all the microorganisms constantly surrounding humans. Up until now, we have been largely unable to study the microbiome on any significant scale despite its massive importance to public health. Recent innovations in DNA sequencing technologies have opened the door to studying the microbiome on a city-wide scale through metagenomics, sequencing DNA in order to detect organisms. In this project, we will use Next Generation Sequencing to survey the microbiomes of Caltrain stations up and down the Peninsula, hopefully gaining insights into how humans and microbes interact in man-made environments.

**"Our students bring uninhibited minds to research. These students have applied those minds to some of the most significant biological problems in the world, and the results are astounding. Every one of these research directions is entirely novel. Each research direction has the capability of making an impact on the body of knowledge that is science, and each direction is magnitudes above what you would see in a typical science class. This is the result of the effort of students who harness their creativity and try to fix the world."**

Luke D
*Upper School Biology Teacher*

## SCIENCE THURSDAYS

The system of science education nowadays is pretty dry, often taking the form of lectures and prepared experiments. Novelty in science is not something you are expected to learn in school, and except for the few discoveries that make it to pop science, experiments stay far away from the public sphere.

During Science Thursdays, we break these barriers, offering lectures that can appeal to anyone on what we believe are the most exciting, important, and relevant advancements in science. These presentations, from both students and teachers — and offered to anyone wo wants to learn — give the opportunity for excitement and novelty to be introduced to scientific education!




*The Visible Learning Project aims to document project-based learning initiatives preK–12 at Nueva. To explore more VLP documentation, please visit* **www.nuevaschool.org/academics/visible-learning-project**. *Please direct all questions, feedback, or ideas for future documentation to* **VLP@nuevaschool.org**.

THE Nueva SCHOOL