



# Using the Annotation of *K.sedentarius* Locus tags Ksed\_04620, 04660, & 04670 to enhance STEM experiences in a Secondary School setting

Justin Patterson, Sarinah Hernandez, Angela Otterbein, and Shawn Flanagan

Biology And Advanced Science Explorations, Newark High School, Newark, NY and the Western New York Genetics in Research Partnership

## Abstract

After-school STEM (science, technology, engineering, and math) subject programs help increase knowledge and interest for children and teens. There is also substantial evidence that these STEM learning programs that are getting children excited about these topics, helping them build real-life skills, and build proficiencies. After-school STEM programs have shown to improve grades in STEM related subjects as well. Having after-school programs help by giving kids extra time to engage in the STEM subjects, but also by doing things in a different manner than school, so it helps with different types of learners, for example most after-school and are not high stakes test-related

A wide variety of subjects fall into each of the four terms. Jobs in the STEM-related careers are some of the fastest increasing and well-paid jobs in the 21<sup>st</sup> century. In a report that had been done, it estimated that by 2018 projection the United States will need 8.65 million workers in STEM jobs, computing being more than 2/3 of them.

4 genes from the microorganism *Kytococcus sedentarius* (Ksed\_04620, Ksed\_04650, Ksed\_04660, and Ksed\_04670) were annotated using the cloud based website GENI-ACT. The Genbank proposed gene product name for each gene was assessed in terms of the basic genetic information, sequence-based similarity data, structure-based evidence, cellular localization data, enzymatic function, presence or absence of gene duplication and degradation, and the possibility of horizontal gene transfer. Students worked cooperatively in school and after school as part of an extra-curricular activity, BAASE, recently established at Newark High School.

## Introduction

For many schools, an after-school STEM (science, technology, engineering, and mathematics) program is a part of the extracurricular activities catalog. These programs provide learning, without giving the student a grade. The STEM program infuses science, technology, engineering, and math to prepare students for careers in the 21<sup>st</sup> century (Boston). This program teaches and further educates students who might be already interested in any of the previous topics. Some students may be trying something new, in an effort to see if it appeals to them.

After-school STEM programs are good for increasing knowledge and interest in certain topics. Surveys have gone on to prove this. For example, in Harrisburg, PA at a Girls Inc. site, a survey was conducted where they asked girls yes or no questions. For example: 1.) "I know what a scientist does," and 2.) "Not having science would be okay with me" (Alliance). The questions were asked before and after an extra-curricular STEM program. Before the program, the first question was answered with 45% "yes" and the latter was answered with 40%. After the program, the questions were answered with 1.) 99% "yes" and 2.) 3% "yes" (Alliance). STEM programs are a great way to teach students about science, technology, engineering, and math. Here at Newark High School, an open process allowed several students to participate in a program focusing on genomics. Each Newark High School student of BAASE. (Biology And Advanced Science Explorations) had their own take on the after-school program, and their own learning experience that they took away from participating in this program.

From 2002-2013, the Newark Middle School Science Club rose to prominence as being the largest extra-curricular activity offered to the students in our district. Advanced topics such as forensics, DNA analysis, and paleontology encouraged a surge in in-school science elective selections at Newark High School. BAASE was established to reinvigorate this drive and the Western New York Genetics in Research Partnership was selected as the first activity.

*Kytococcus sedentarius*, a gram positive bacterium and a chemoheterotroph was used as an organism of interest for this project. This bacterium was selected because it has yet to have been thoroughly studied utilizing bioinformatics (Sims et al., 2009).

## Methods and Materials

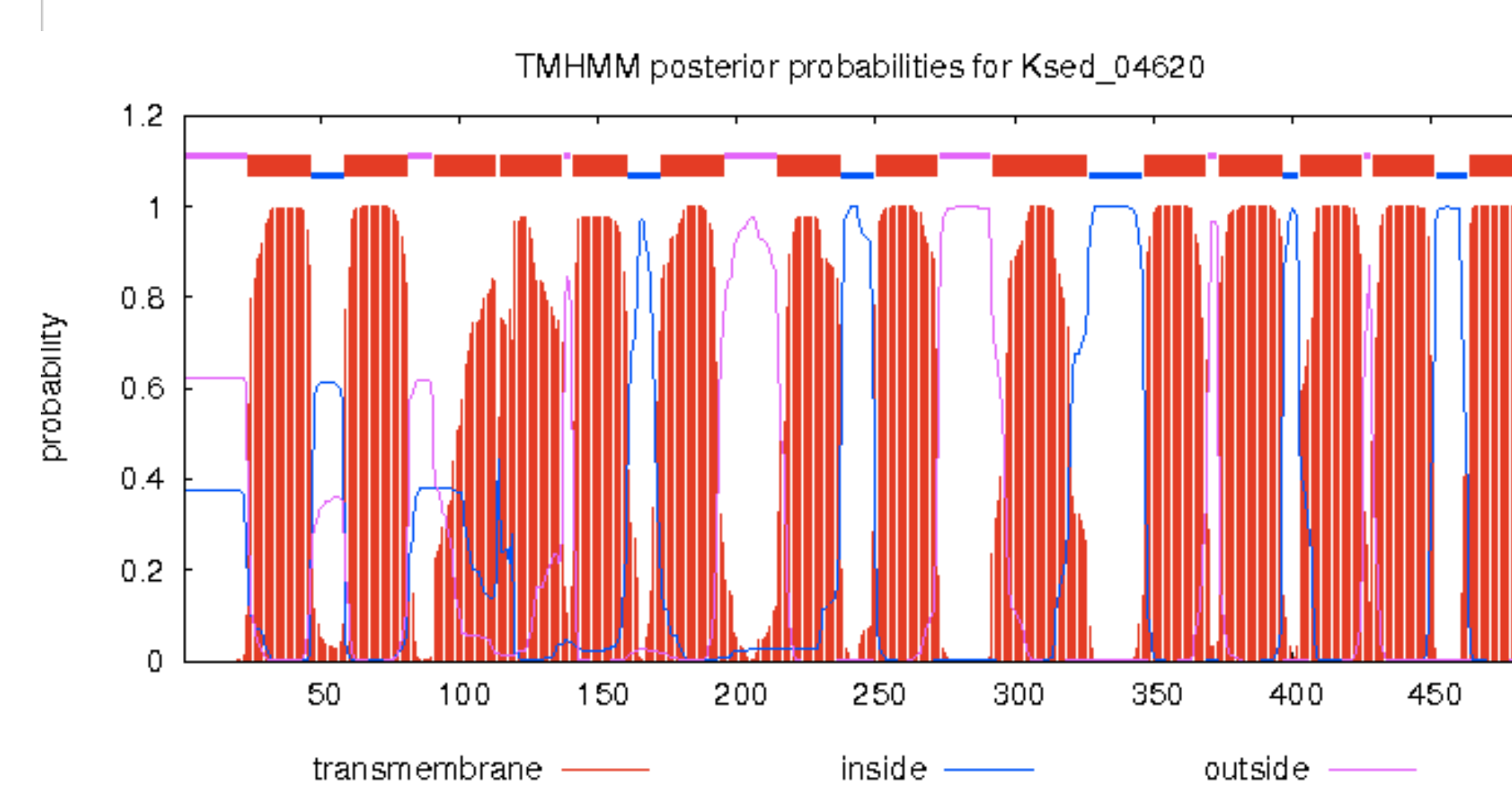
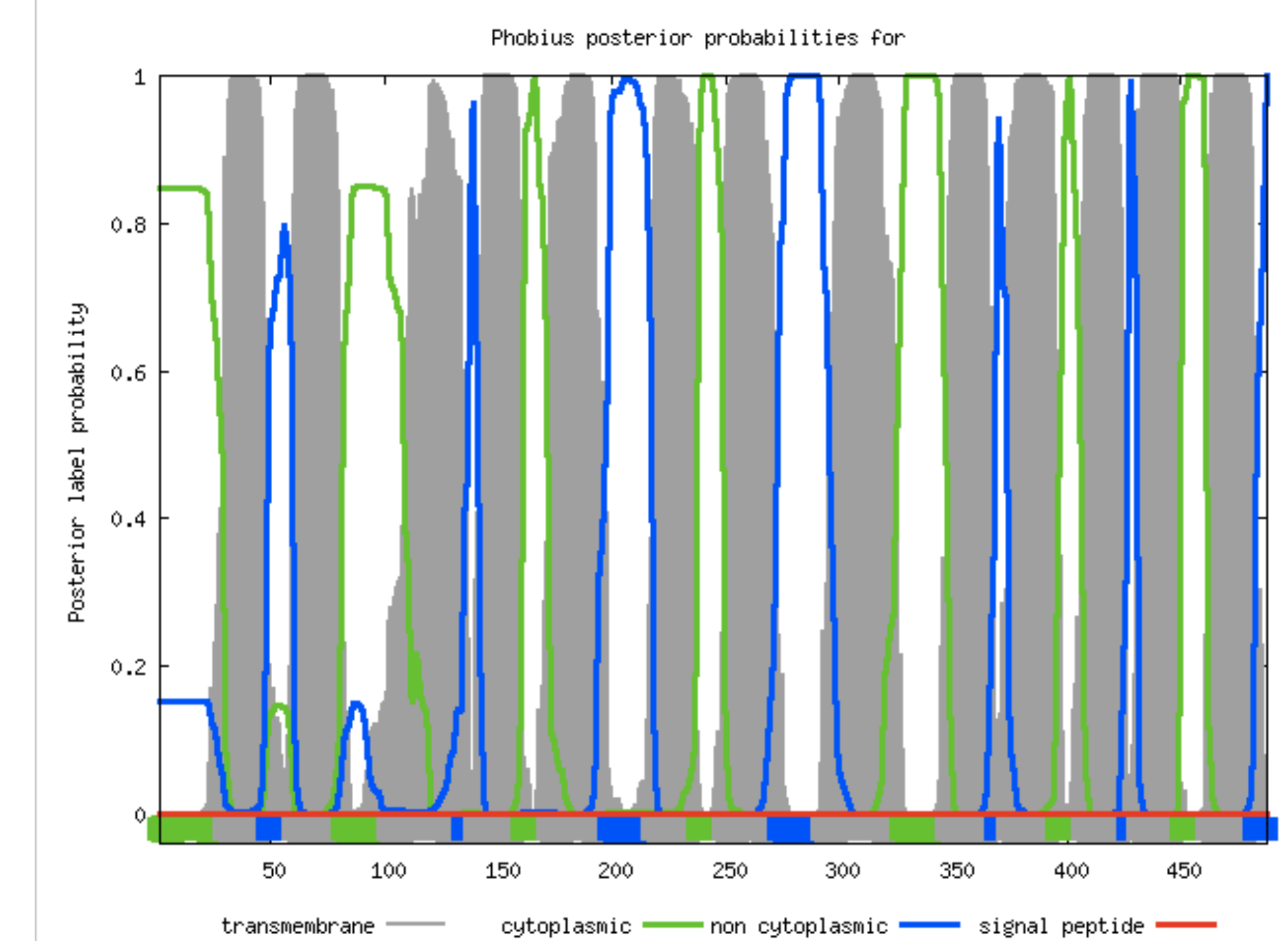
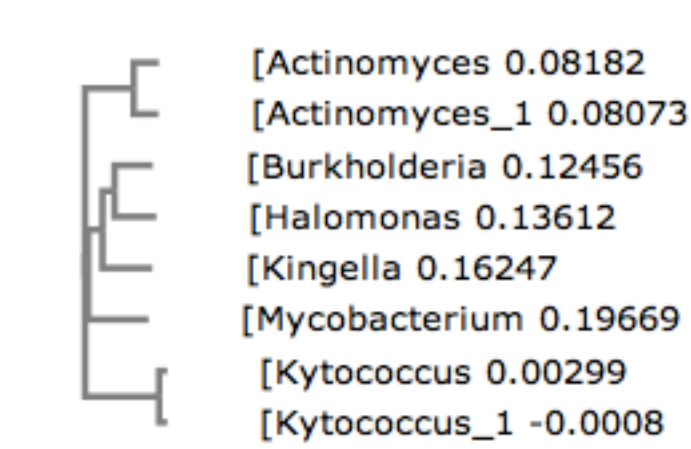
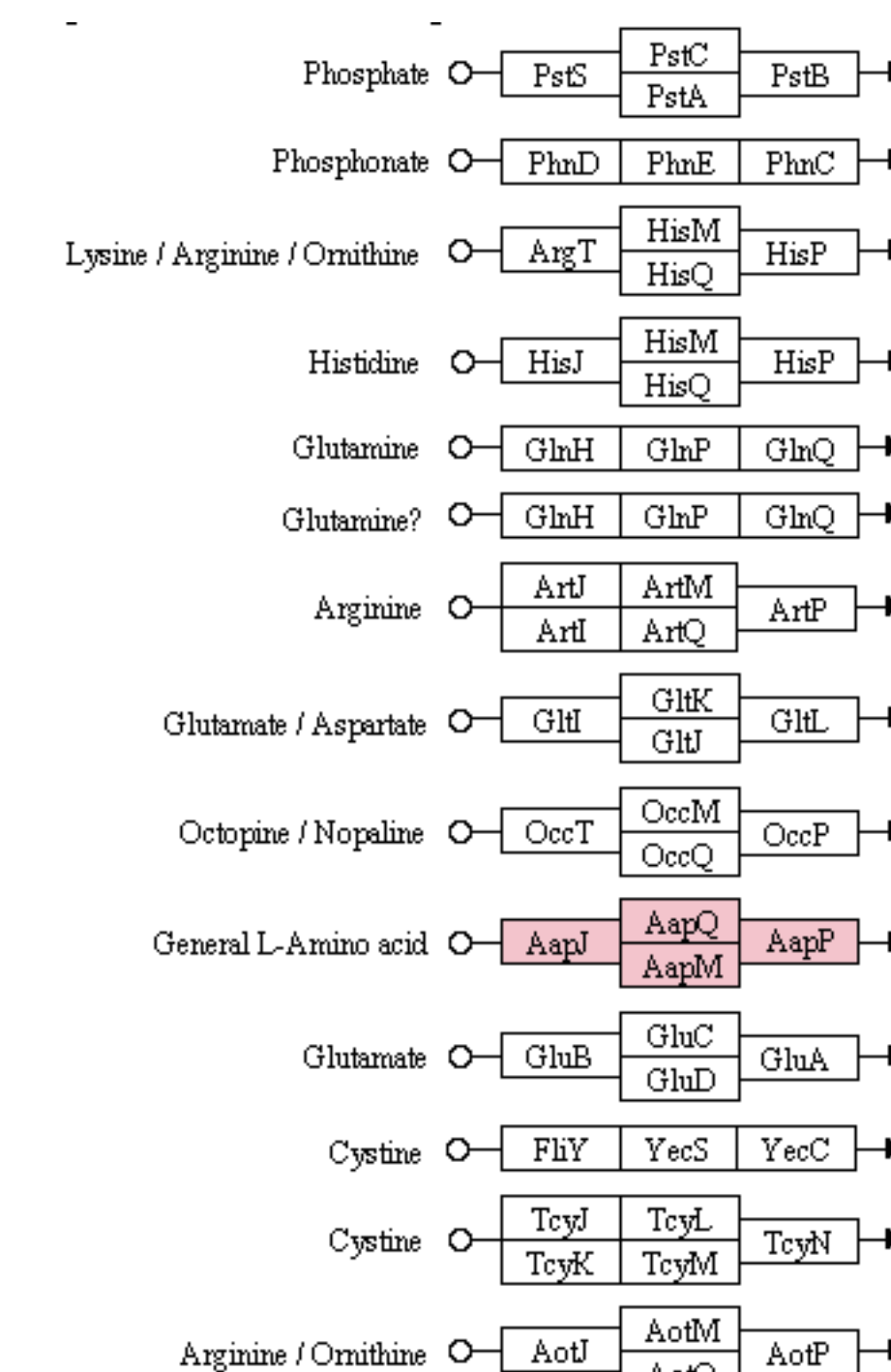
On transfer to the Newark High School, Shawn Flanagan established, with student support, the Biology And Advanced Science Explorations (BAASE) group to foster extra-curricular interest in biology. Working with the State University of New York at Buffalo, participation in the Western New York Genetics in Research Partnership was established. Students worked with teachers and researchers to explore gene annotation as an avenue to develop new skills and interest using GENI-ACT, a cloud-based gene annotation notebook.

Modules of the GENI-ACT (<http://www.geni-act.org/>) were used to complete *Kytococcus sedentarius* genome annotation. The modules are described below:

Modules	Activities	Questions Investigated
Module 1- Basic Information Module	DNA Coordinates and Sequence, Protein Sequence	What is the sequence of my gene and protein? Where is it located in the genome?
Module 2- Sequence-Based Similarity Data	Blast, CDD, T-Coffee, WebLogo	Is my sequence similar to other sequences in Genbank?
Module 3- Cellular Localization Data	Gram Stain, TMHMM, SignalP, PSORT, Phobius	Is my protein in the cytoplasm, secreted or embedded in the membrane?
Module 4- Alternative Open Reading Frame	IMG Sequence Viewer For Alternate ORF Search	Has the amino acid sequence of my protein been called correctly by the computer?
Module 5- Structure-Based Evidence	TIGRFam, Pfam, PDB	Are there functional domains in my protein?
Module 6- Enzymatic Function	KEGG, MetaCyc, E.C. Number,	In what process does my protein take part?
Module 7- Gene Duplication/ Gene Degradation	Paralog, Pseudogene	Are there other forms of my gene in the bacterium? Is my gene functional?
Module 8- Evidence for Horizontal Gene Transfer	Phylogenetic Tree,	Has my gene co-evolved with other genes in the genome?
Module 9- RNA	RFAM	Does my gene encode a functional RNA?

## Results

Due to this STEM program, the effect on what we thought of these fields, (science, technology, engineering and math) changed within the course of the project. Among the 4 people in my group, who in the beginning had a real interest and curiosity in STEM and what gene annotation is, 3 out of the 4 still aspire to take on a STEM related field as a career. Along with learning that STEM was something most of us took an interest in, we also learned more about what it actually was and did work on it to discover more. We also found that yes we liked what we learned about gene annotation, but this taste of what it was has compelled us to try and dig deeper in our free time. Although 1 person in our group didn't like the gene annotation aspect of STEM, this person was urged to check out some different STEM related programs.



Various diagrams and figures of interest from the project

## Conclusion

The after-school science club BAASE (Biology And Advanced Science Explorations) gives students with ambition an opportunity to learn more about science and to explore gene annotation through group discussion, individual problem solving, and critical thinking. This afterschool program helped to feed the ambitious side any good scientist possesses and has taught us much more than just gene annotation. This club has been an experience helping us, not only now, but in the future, in deciding where our journeys in life may take us. The higher level critical thinking could also help us in the future with other tasks we may get faced with.

In the words of participant Mashewske "It made me more aware of the process with cells and made me more interested with what and how cells make up our bodies." In this program we explored in great detail the microscopic things unable to be seen by the naked eye. Knowing how gene annotation works adds curiosity and appreciation. Participant Patterson says "I feel that I had little to no knowledge on this topic, but after going through this program I feel motivated to learn more."

After-school STEM programs like BAASE get students to become more enthusiastic about the topics discussed. This program amazed me and can leave students with a deeper appreciation about the great detail that can be taken away from things, that a century ago no one even knew existed let alone all the scientific discoveries that can rise out of it. These new findings, unearthed everyday are very small strides that add up to achieve a greater purpose. Getting students engrossed in STEM programs like this could help shape the future of those involved.

## References

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