

Effect of After School STEM Activities on Students

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Abstract

A group of consecutive 12 genes from the microorganism *Kytococcus sedentarius* (Ksed_04590 – Ksed_04700) were annotated using the collaborative genome annotation website GENI-ACT. Newark BAASE had a group of 12 students annotate these genes. Different extracurricular STEM programs that have introduced high school students into this field has helped to bring interest into this vast realm. Programs similar to BAASE which have introduced a deeper understanding of science into high schools across the nation have facilitated the growth of participation into extracurricular STEM programs. This participation has opened up doorways and opportunities of learning. Even those who don't have an interest in pursuing a career or degree in this field still show interest and a passion to learn more regarding this topic.

Introduction

Genes from *Kytococcus sedentarius* were assessed in terms of the general genomic information, amino acid sequence-based similarity data, structure-based evidence from the amino acid sequence, cellular localization data, potential alternative open reading frames, enzymatic function, presence or absence of gene duplication and degradation, the possibility of horizontal gene transfer, and the production of an RNA product.

During our after school BAASE (Biology and Advanced Science Explorations) program, we assessed the gene for all of the aforementioned items and were educated on these things and what they actually meant. This knowledge intrigued many of us and gave us the opportunity to find something that we may love. Other extracurricular programs such as ours have increased the growth of interest into the STEM field and have lead more students into the pursuit of a STEM career.

This activity has allowed us to narrow down what we really want to do. Even though it has not particularly given us interest in the field of genetics, it has broadened our range of knowledge on what we really love doing. This program has given us a love of learning knew things and exploring the unknown. It has let us explore one miniscule point of STEM, and let us learn that there is an abundant amount of topics that can take a lifetime to explore and learn about. We developed a better understanding and appreciation of expanding our knowledge and trying something new.

Even though we may have not particularly gained an interest in the field of genetics, the program has definitely broadened our horizons into what different parts of STEM can offer.

Methods and Materials

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

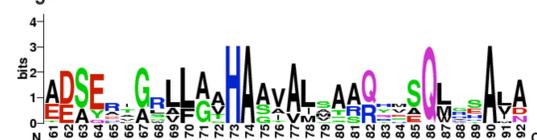
By participating in the BAASE program, it has widened our horizons in the field of STEM. When starting the project, we didn't know what story our genes had to unfold; but as we started, we learned that there was much more to the genes than just an amino acid sequence.

For example, in one of the gene annotations, it was noted that there was a number of amino acids missing from the original sequence. This intrigued the student because they wanted to learn more about what the gene was coded to do and why it was missing what it was missing.

As we furthered the project, careful note was taken to the differences in the WebLogos (Figure 1) and the conservation of the different sequences that made up that specific gene. We also noticed differences in cellular localization; Figure 2 showing the amount of transmembrane helices of the gene product. This made students begin to compare the differences from their gene to the person's next to them, making them think about what makes their gene different from the others.

When starting the project, all members of our group had interest in pursuing a career in bioinformatics and gene annotations and were looking at possibly making a career out of it. Throughout the project and even after, there is still a fascination about the topic itself, but as for pursuing a career in the field, there is not as much interest. Although, we all liked different aspects of the program.

Figure 1:



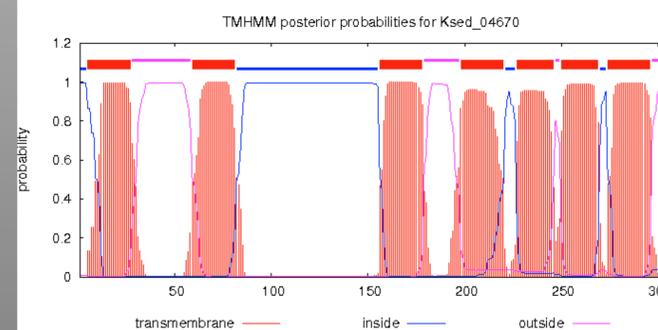
Joe Goodman very much enjoyed the technological aspect and figuring out what technology is capable of. He also enjoyed delving into the realm of the unknown and exploring things he did not previously know about. He can see himself improving the way computers and technology functions to help scientists further investigations into the still unknown parts of the scientific world. Joe plans on pursuing a career in computer sciences. This extracurricular activity helped him realize that his ideal interest was not in genetics, but rather technology.

Mckenna Martin enjoyed the learning aspect. She enjoyed seeing what each gene did in the organism and how it affected everyday life. Mckenna enjoys learning about how living things function and how they adapt to everyday challenges. Although she thoroughly enjoyed this project, she discovered that bioinformatics and genetics is not her desired career path. But she does plan to stick with STEM and become an Emergency Room Physician.

Ashley Watrous found that she would like to continue with the STEM path. While only being a freshman, she has time to think about what she would like to pursue in the plentiful career options that STEM has to offer. Ashley did find out however, genetics is not a strong point of interest for herself at this point and would like to continue exploring all of the possibilities STEM has to offer as she furthers her high school career.

This project has made us realize that STEM is more than just an advanced math or science course. It is an endless continuum of new discoveries. We have spent an entire school year focusing on just one small section of what stem has to offer. But in reality, there are so many branches of STEM that any one of us could pursue. Such as medicine, physics, biology, chemistry, engineering, statistics, accounting, electrical engineering, and so much more. Before we started the project, we believed that there were only minimal opportunities that could be achieved when following the STEM field of knowledge. Realizing that there are so many fields, we are able to broaden our spectrum of choices that will determine what we do in the future. This allows us to find exactly what we want and will love doing for the rest of our lives.

Throughout this project, we realized how important trying something new is. As mentioned previously, we have been able to expand our knowledge about one certain topic, and it has allowed us to find out that our particular interest was not this particular topic. By trying this out, we have realized that gene annotation isn't for us. However, it may have sparked interest in someone and have shown them what they really want to do in their life. Finding out what you love doing in high school is extremely beneficial, so you don't have to waste thousands of dollars in college to discover that you don't like something.



Teamwork was another aspect that was apart of this BAASE program. We learned that we needed to help others; to give our knowledge to them and have them give their knowledge to us. This spread of knowledge allows for things to get done and for them to be understood. As one person fell a little behind during the annotation, another member of BAASE would help them. This interdependence lead to teamwork and stronger bonds being formed between members. Even though most STEM fields are described as "nerdy" or "geeky", which are usually terms designated to social outcasts, the fields of STEM are highly dependent on communication and working with others. Without this communication, there is no spread or growth of knowledge, which is an extremely vital part to STEM. The growth of popularity of STEM has been highly influenced by this spread of knowledge, and let students learn something new and explore something they may have never otherwise had an interest in. Extracurricular STEM activities have had great successes in doing this. Furthermore, this growth in interest in STEM leads to an improving world around us. With more students gaining interest in these fields, more advancements will be made that can affect the entire world. Extracurricular STEM activities get students excited about this vast amount of fields and spark something in them that can make these world-changing advances, which they would've never done before.

Conclusion

This program allowed us as high school students to successfully annotate a gene using the GENI-ACT software. The genes did not differ far off from the original proposal of results, making it appear that the software was annotated correctly. We learned a lot about ourselves and about how important STEM is to the world and to all of our futures.



References

Sims et al. (2009). Complete genome sequence of *Kytococcus sedentarius* type strain (541T). *Standards in Genomic Sciences*, 12 - 20.

Acknowledgments

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