Genotyping: Fingerprinting DNA

Marco Cuellar

University of Iowa
Genotyping: Fingerprinting DNA

Introduction

The number of underrepresented minorities participating in science at all levels is low. One of the major reasons for this is the lack of opportunities this group has to engage in scientific activities. This limited exposure has given this group a single perspective. In order to truly gain interest and appreciation for science, many viewpoints must be experienced.

In response to the low number of underrepresented minorities participating in the sciences, I created a hands-on genotyping demonstration and gene building activity to engage K-12 students from diverse backgrounds to motivate and inspire them to pursue science in the future. Allowing the students to experience these activities face to face, not only made their exposure to the activities more interactive and hands-on, but allowed them to experience the science in a simple manner to get the most from the activities. This perspective, in turn, would increase the number of underrepresented minorities in science fields.

Implementation

After establishing partnerships with two other Latham Fellows and Iowa Upward Bound, we organized a conference called the Possibilities in Science: Knowledge for the Future. Underrepresented minority high school and middle school students were our primary audience. The conference included activities such as lab tours, poster sessions, and hands-on demonstrations to engage students in thinking about science. My genotyping demonstration was a part of the expo/poster session where students were able to approach my booth and learn about the genotyping process. Genotyping is a research technique that I have used frequently in my lab for the past two years. It is something I am familiar with and was comfortable sharing with the students.
**Figure 1.** Here I am having a discussion with a high school junior about the factors that go into determining the genetic make-up (genotype) of a mouse model.

While I was in the midst of planning the Possibilities in Science Conference, Lori, the Latham program director, presented another opportunity for a demonstration. The Iowa City STEAM Fest is an event where K-5 students from the local area participate in a variety of hands-on activities in science, technology, engineering, art, and math. The venue served as a perfect place to further my mission for my project and broaden my audience. Instead of replicating my genotyping demonstration, I decided to put together a gene making activity where the students were able to build the DAG 1 gene model and learn about concepts like mutations and genetically inherited diseases like muscular dystrophy. I work in a research lab that studies muscular dystrophy, and so tying in some of the research provided a way to make the activity more relevant or real to the students.
Figure 2. Here I explain autosomal recessive diseases, like muscular dystrophy, to a high achieving fourth grader at the Iowa City STEAM Fest.

**Genotyping: Fingerprinting DNA**

The genotyping demonstration was intended for the high school students, to expose them to a research technique used around the world to determine the genetic make-up of an animal model. I first explained the entire process of genotyping, describing critical steps like DNA extraction, DNA replication, and electrophoresis. Then I introduced the methods involved in interpreting results attained from all the steps, and identifying the genotype. After explaining the science, I had the students practice loading DNA into an agarose gel. Overall, I had 12 students participate in the demonstration with all of them commenting that this was their first time being exposed to such an activity and concept. To get this type of exposure to a part of science that many high schoolers don’t get to experience is what I wanted for these students. Because the demonstration was applicable to science that makes a major impact in the world of research, I think that is what made the activity exciting and something the students would find interesting.
Building the DAG 1 Gene

The building the DAG 1 gene activity was presented to a K-5 audience at the Iowa City STEAM Fest. First, I asked the students if they knew what genes are. This gave me a sense of how much they knew and how I would have to approach my explanations of the activity. I started with some quick background information on the DAG 1 gene and its importance in muscle function and development. In addition, I explained how if mutations arose in the gene, diseases like muscular dystrophy would occur. Then I had the students build a model of the DAG 1 gene out of colored beads and string that resembled DNA bases and strands. Once they completed building the gene, I had them compare their sequence to one that I had built. I asked them to tell me if they spotted any differences between the two genes, such as a difference in one colored bead. We called the strand I built the mutated strand or the “bad” gene, and I went on
to explain how genetic diseases occur. In total, about 200 students participated in the activity and found the activity of building the gene the most exciting part. My goal was to have students gain a sense of appreciation for genes and their functions in the human body. I knew by having the bead activity be kid friendly, the students would find the science interesting and motivated to learn about it.

![Image of gene models](image)

**Figure 4.** Two DAG 1 gene models built by a student (left) and by me (right). The left strand represents a normal or “good” gene, while the right strand is the mutant gene or “bad” gene.

**Future Directions and Conclusion**

The two hands-on demonstrations I put together can be used by future Latham Fellows with a facilitator’s guide I will develop. In addition, the partnerships I built with Upward Bound may be utilized to put on a future conference or another event. Robert Richards, the Upward Bound coordinator, was open to the idea of working with Latham Fellows for next spring.

I learned a lot from my project. For example, no matter how well you think you plan, there always seems to be something that comes up, and last-minute adjustments must be made. I
learned that each student learns differently, and finding out how to effectively communicate ideas and concepts to best meet their needs is important and critical to their views toward an activity. Overall, the project was a success and I think it meet its goals and missions of engaging and motivating students from diverse backgrounds.