Transgenic Silkworms- A Spider Silk Alternative
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Abstract: Spider silk, one of the strongest biomaterials in the world, gets a lot of attention for its unique abilities. However, because of their cannibalistic and territorial tendencies, spiders are hard to farm. In order to mass-produce the spider silk protein, our lab utilizes transgenic goats, *Escherichia coli*, and alfalfa. However, the natural spider silk protein is very large (>250 kDa) and so far, these methods have not been able to produce proteins of that size with a high yield. As a result, the fibers spun mechanically from the synthetic protein lack the quality of naturally spun silk. The answer to this problem is found in transgenic silkworms. The silkworms are easy to farm, are capable of producing large proteins, and spin the fibers themselves. Through genome editing, the spider silk gene can be inserted into the silkworm genome, and the resulting fibers spun by the silkworm are stronger than the mechanically spun synthetic spider silk, making them a great alternative option for the mass production of spider silk.

Introduction: The current methods being used to mass produce the synthetic spider silk protein used in our lab cannot yet produce proteins as big as the natural spider silk protein. As a result, the mechanically spun synthetic fibers are not as strong as natural spider silk. Silkworms, however, are capable of producing big proteins, are easy to farm, and spin the fibers themselves. This project aims to create a transgenic silkworm that will produce the spider silk protein and spin strong fibers.

Methods: In our lab, we use the CRISPR/Cas9 genome editing system to edit the silkworm genome. It allows for specific, low toxicity genome editing. The CRISPR/Cas system is a bacterial immune response system, which is capable of dealing with even the most fast-evolving viruses. It can also be taken advantage of as a genome editing system.

Results: Flow cytometry, PCR, and sequencing data confirmed the success of the genome edit. Mechanical properties of the transgenic silkworm silk were 40-50% higher than the original silkworm silk.

Conclusions and Future Plans: Although spider silk is one of the strongest biomaterials known to man, spiders are hard to maintain in the lab. Because of this, research with the spider silk protein has been expanded to transgenic organisms. Among the most successful is the transgenic silkworm. We are currently working on a new generation of silkworms with hopes to produce silk with even better mechanical properties.