

Summer Abroad in Beijing

Arthi Puri

West Lafayette, Indiana

The World Food Prize Foundation

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Peking University

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Acknowledgements

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A special thanks also goes to my mentors at Peking University. I would like to thank Guo Dongshu, with whom I performed most of my research, Dr. Kang, Dr. Gu, and Dr. Qu. I would also like to thank all the members of the Life Sciences Lab for helping me not only in lab work but also in taking me to dining halls, showing me around the campus, enjoying new sights with me, and helping me with all the little glitches along the way. My experience in China would not have been as amazing without the kindness and guidance from these people.

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Lastly I would like to thank my parents and friends for all their love, support, and advice on how to tackle a summer abroad, I would not have been able to stay strong without all of you.

Without each and every one of these people, I would never had had this incredible life-changing experience, and I immensely appreciate all the help that has been given to me.

About Me

My name is Arthi Puri and I was born and raised in West Lafayette, Indiana, a campus town that is home to Purdue University. I graduated a week before departing for Beijing and am now a freshman at Indiana University.

During my junior year in high school I received an email about an opportunity to discuss international hunger issues and become part of something bigger than my small town. It immediately sparked my interest. I decided to write my paper about malnutrition in India, as I had seen it first-hand whenever I visited my grandparents in New Delhi, India. After writing my paper for the World Food Prize youth institute it opened my eyes to what is happening outside the United States. While writing about the paper informed me about all the corruption and cyclic issues in the world, being able to discuss my findings with experts in the topic intrigued me to the point where I realized that I needed to take the next step and try to make at least a small amount of change in this worldwide problem.

I attended the Global Youth Institute as a senior in high school in 2013 and was able to meet former Borlaug-Ruan interns who convinced me the internship was an opportunity I could not afford to miss. Along with listening to inspiring stories from the interns, I also was able to meet my idol and a friend of my grandfather, Dr. M.S Swaminathan. I will never forget the moment when he gave me a big hug and said, "I am so proud in the path you have chosen to follow."





Life Sciences Lab at Peking University (PKU), Borlaug-Ruan Internship in Beijing China

For the Borlaug-Ruan Internship, I was assigned to study at Peking University in Beijing, China. Peking University, a major research university, was established in 1898. When I found out I was going to spend my summer in Beijing I was so excited because I had always wondered what China was like, and finally got the opportunity to not only visit, but also to live there and become close with the members of the lab. Peking University is one of the top and most competitive and prestigious universities in China. It has approximately 15,128 undergraduate students. Every year, Peking University has around 2,000 international students who study there as well because of their strong international relations school.

Peking University is home to 30 colleges and 12 departments. Currently the university has 216 research institutions. An interesting fact is that more than 400 PKU alumni have become presidents at other universities all over China.

PKU is located in the Haidian District of Beijing, near the Summer Palace and the Old Summer Palace, both of which I was lucky enough to visit.

I was not expecting the campus to be overwhelmingly beautiful but I soon found

out that PKU is renowned for the traditional Chinese architecture and gardens. People from all over China would come to take pictures at the gates of the university while younger students would take tours.



As soon as I arrived at PKU, Dr. Kang surprised me with a bike that I would use to ride to lab every day. On the first day I was introduced my graduate mentor and now close friend, Dongshu, who was very excited to be able to teach me about the techniques they learn in lab and was excited to practice her English with me. Before arriving at PKU I was nervous about being a clueless high schooler who did not have enough lab experience and would not be able to keep up with the rigor of the project. Those worries diminished rapidly as I had such an amazing mentor who taught me everything I needed

to know and made sure I could follow along. The lab had around 40 graduate students who all had their own research project, not including the undergraduates who were shadowing and helping the graduate students. Everyone I met was extremely kind and generous and made sure I was taken care of. At Peking University I studied in the life sciences lab, specifically the laboratory for Protein Engineering and Plant Genetic Engineering. For my research, I did purely lab work. The lab's goal is to practice genome editing of model organisms as it is essential for gene function analysis and is thus critical for human health and agricultural production. Recently the lab has started studying CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) technology. CRISPR systems are adaptive defense systems in prokaryotic organisms to fight against alien nucleic acids.

My Project

During my internship I was assigned a project in order to analyze the function of a specific enzyme when inserted into rice as a way for researchers to insert and target genes in the DNA. The organism I was assigned to work with was rice as it is a major crop all around the world and especially in Asia. For my project I had to determine whether the enzyme Isce-131 could cut a gene in the rice called a GUUS gene and recombine it into a GUS gene.

This topic is significant because it analyzes the function of certain genes in rice and creates a way for researchers to insert targeted genes into the DNA. Genome editing of crops and other organisms is essential for gene function analysis and is therefore critical to enhance human health studies as well as agricultural production. The application of CRISPR/Cas system in plants has not been reported and rice is a major crop in the grass family, feeding half of the world's population. Rice is also used as a model monocot plant for biological studies because it has a relatively small genome compared to other cereal crops and is easy to be manipulated genetically. The work in this lab paves the way for large-scale genome editing in rice, which is important for quality improvement and yield

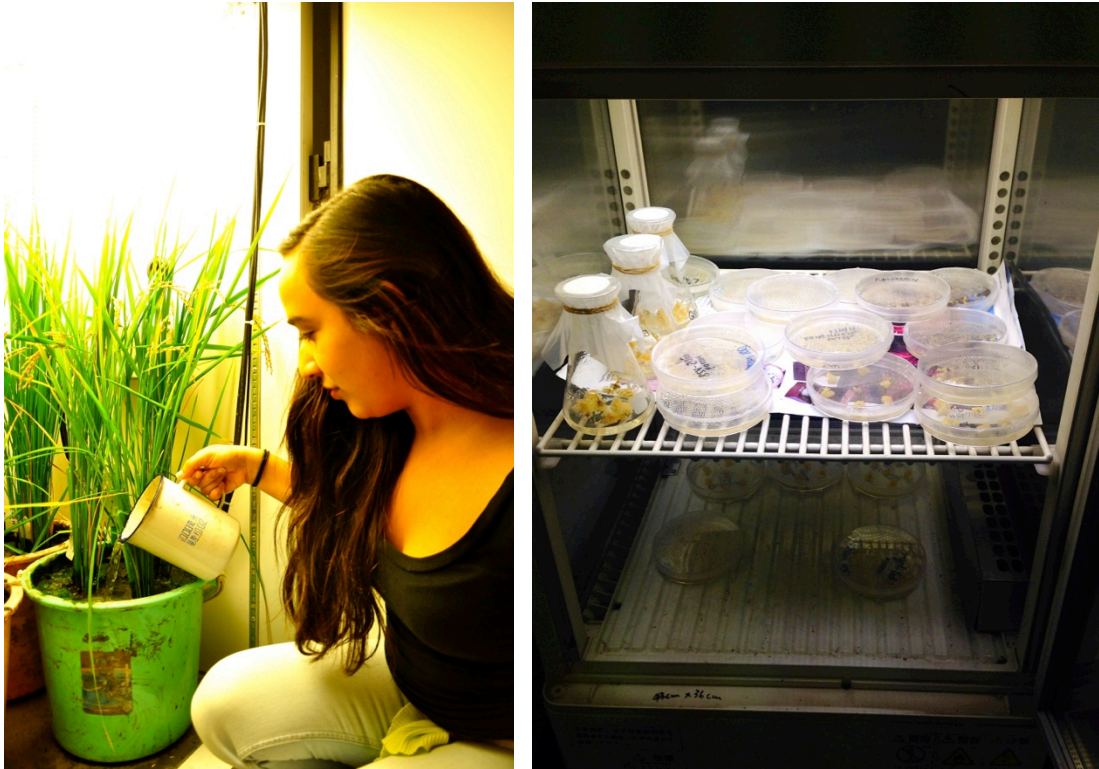
increase of rice.

For the first week out of eight weeks of my stay in Beijing I was instructed to read papers and past research about the organism I would soon be working with (rice) to get a good understanding of the structure.

There were three main segments of my project: the first was growing the rice seeds so that the vectors could be inserted into them. The second part of the project was creating the vectors and plasmids, fusing the gene and enzyme together to be inserted into the rice. The last step along the way was actually inserting the genes into the rice and obtaining results.

Inducing the Rice Seeds

To allow for error in the experiment, we prepared 500 seeds though we only needed around 60 seeds. The first step was to peel the seeds from the rice stalk. Then the seeds had to be washed in water and ethanol. After letting the seeds soak and rinse, we had to make nutrient-rich medium so the seeds could grow a callus, or a mass of cells derived from the rice tissue. The rice callus had to be inserted onto the medium in a sterilized hood so that no bacteria would contaminate the seeds. The seeds then had to be put in a chamber where they would grow for another three weeks.



Creating the plasmids

The second part of the experiment is creating the plasmids, or the combination of the enzyme and gene, that will eventually be inserted into the rice callus. In order to accomplish this step many procedures are used such as, E.Coli Transformation, Plasmid Extraction, PCR to clone genes, DNA Purification, Topo Reactions, LR Reactions. These procedures are all used to fuse the different fragments of the vectors together.



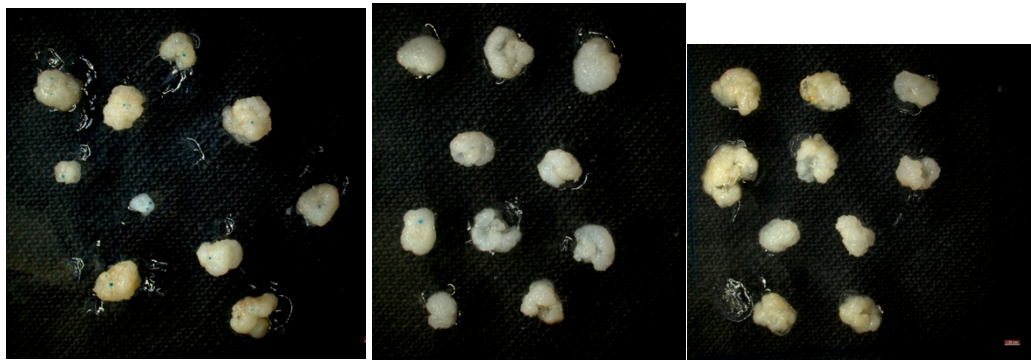
Inserting the plasmids into the rice

A machine called a gene bombardment gun (pictured below) was used to insert the gene into the rice callus. Then a reagent was put into the callus. The purpose of the reagent was to turn the callus blue when the enzyme recombines the GUUS gene into a GUS gene in the rice, thus supporting the hypothesis. After letting the rice callus soak in with the reagent overnight, we were able to obtain results.



Results

As seen in the pictures below, the rice calluses that contain both the GUUS gene and the Isce-131 enzyme all had blue spots because the enzyme succeeded in recombining the GUUS gene into the GUS gene. The other two controls (the callus with just the gene and the callus with just the enzyme) remained white as they were separated from each other.



GUUS+Isce-131

GUUS

Isce-131

Conclusion

We showed that transgenic rice could be generated through the CRISPR/Cas technology and that the Isce-1 enzyme in rice can recombine different genes. A follow up experiment could be whether the CRISPR/Cas system can be applied successfully to other crops with more complicated genomes such as maize and wheat.

In Relation to Food Security

While my project was only a small portion of what the PKU life sciences lab works towards, it was still a small step in creating plants and crops that can be sustainable enough to alleviate hunger across the world. The findings that the Isce-131 enzyme was successful was helpful to the other lab students because they now know that this specific

enzyme will work for recombining genes in the rice, and perhaps in the future recombine a gene that will make rice resist drought for example.

My Contributions

During my stay at Peking University I helped other students with their procedures along with my own research. Some tasks that were given to me were making medium for the whole lab or running PCRs to clone genes and then running gels in order for the students to analyze the gene function. The more information known about gene function, the more enhanced food security will be, and there is a better path to create technologies that can feed a whole population.

Experiencing Beijing

I arrived in Beijing on June first, a week after I graduated high school. I loved being in a new country, and being completely independent for the first time. Even people speaking in a different language made me smile, though I could not understand any of it. The first day I walked to the lab by myself and on the way I ran into Dongshu, the graduate student who would be helping me in the lab and outside of the lab for the next two months. She introduced me to everyone that day and each one of them were all so nice and eager to practice their English with me. The first couple days were very nerve-wrecking as I was still getting adjusted but thanks to all the generosity from the lab members and Dr. Kang, Dr. Gu, and Dr. Qu, I was more than taken care of. I soon learned the traditions of the lab. Because of the intense heat, Dongshu and I would buy watermelon every day from fruit stores on the campus and bring it back to the lab for an after lunch dessert. There are 11 dining halls on the campus and I found food I loved at every dining hall, without having the same meal twice. Every weekend Dongshu and other lab members would take me out after a hard week of experiments and we would tour the city and see great sights and try food from many different provinces of China. While in Beijing I got the opportunity to visit the Forbidden City, climb the Behai Tower, the visit the campus of CAU where I met another Borlaug-Ruan intern, Amaleah Mirti. It

was interesting to feel the vibe of a different campus as I had only talked to students from PKU and seen the campus life there. I was also able to visit the National Museum of China where I learned all about ancient Chinese History and the different Chinese dynasties that I never got the chance to learn about in high school. The other sights I saw were Tiananmen Square, the 2008 Beijing Olympic Stadium, Yuanmingyuan Park, and a very big mall called the Gate City Mall.



Forbidden City



Behai Tower



CAU Campus



Gardens of CAU



Yuanmingyuan Park



Dining hall at PKU



Forbidden City



Yuanmingyuan Park – Lotus Garden



Beijing Olympic Stadium



Dr. Huo at Graduation

Being in China and conversing and becoming close with students who were not my age helped me mature as I learned about their culture and their norms. It was very interesting to me to compare and contrast the environments in America and in China.

Unlike some other interns, I did not see food insecurity on a daily basis in Beijing. Though I knew Beijing was a very populated city, I did not know the extent of it until I saw it myself everywhere I went. The high density of people in the city is what made me realize that there is not enough food to go around, and if there is, it is not nutritional. Though I, and none of the members in the lab have experienced true hunger, we are informed about the effects of it and therefore are dedicated to trying to create new technologies to help people in need. Being in an environment where students would work from 8 A.M to 1 A.M because they were so devoted to their research inspired me to follow the same passions of which we all share.



Saying farewell to my amazing friends and mentors whom I will never forget at the Beijing Airport, JinXhe, Dongshu, Dr. Huo.

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