"I have learnt that in life as well as business, it is important to be authentic to the person you are, and not afraid to show a little vulnerability along with your individual flair. Whether you are passionate about dancing, trombone, cricket, gardening, or a bacteria called GD, your passions can shape the world around you."

A Clean Horticulturalist

My trip to England: The pursuit of a career in horticulture while keeping clean hands

Grace M Scott

Hi, my name's Grace and I'm a horticulturalist who likes to have clean hands. I'm a fan of sparkling white clothes and gleaming, ethanol sterilised surfaces; but also a lover of lush nature and the dizzying natural diversity of the world around us.

Separating wheat endosperm from husks and awns at a field trial in Rothamsted

Before this trip I found out that I can study plants in the lab, keep clean hands, and combine my love of nature and science to do something that will help people. I want to use my unique skill set to create a type of crop that needs no nitrogen fertiliser, which will be more sustainable and more accessible to communities struggling with food security.

Along the way, I've become passionate about agriculture and microbiology, particularly fascinated with the way that symbiotic bacteria can work in harmony with plants to help them meet their nitrogen requirements.

In studying this area I realised that an innovation boom was occurring in England, with two institutes working toward the same goal in different ways. Azotic Technologies in Nottingham, John Innes Centre in Norwich and Rothamsted Research in Harpenden each had me for a week. I am incredibly thankful that BBM Youth Support has given me the opportunity to visit all of them, along with attend an international experimental biology conference and work in cutting edge research facilities with some of England's most incredible minds.

A friend I made on the campus of University of Nottingham

As my first solo trip, I learnt more about myself and my own capabilities in the world around me. I learnt that I, a 47kg woman, can carry a 28kgs of luggage up three flights of stairs on the London underground. Apart from science, I was also taught how to salsa dance to "Mr Brightside" by a Mexican, ruined a pair of high heels by going for a 3am walk with new friends on Brighton's infamous pebble beach, and began a lifelong addiction to an English biscuit called a Jaffa cake. I met great people from all over the world, experienced the chaos of Brexit first hand and even shook hands with a squirrel.

Although I was nervous before my departure that I would be lonely; my England, Singapore and Central Europe trip turned out to be the busiest and most incredible six weeks of my life. I am also excited to announce that I was offered a work placement for a postgraduate degree with Azotic Technologies working on my dream bacteria! My next step is to find funds to take up this Masters program and I am working hard to find ways to take this opportunity.

My first stop in England was Azotic Technologies in Nottingham. Azotic technologies works on a bacterium called *Gluconaceterbacter diazotrophicus*(GD), which is able to colonise every cell within a plant and take nitrogen from the air to meet the plants nitrogen requirements. It also boosts plant growth and metabolism and can reduce fertiliser requirements by up to 50%.

Nancy, a Masters student from Mexico and I in a field of barley treated with GD

Initially, I hadn't heard of GD but quickly became eager to learn more about this super bacteria. GD has so many benefits, but I am only able to share a few as the inventor of the technology is an ex secret service agent and I'm under threat of death if I share any company secrets (just kidding…sort of…) but I can tell you some things about GD that make me very excited:

Gluconaceterbacter diazotrophicus on a media plate

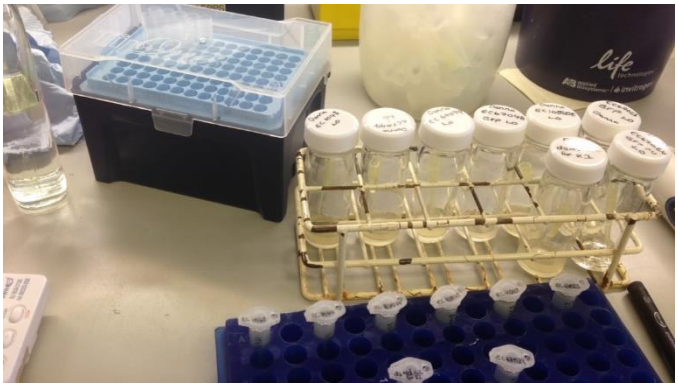
1. GD is a naturally occurring bacteria that has been safely consumed in sugarcane juice for centuries
2. It is cost effective and could be distributed to communities suffering from agricultural hardship
3. It can be organic certified to help it reach the market
4. It has so far worked with every single plant or crop they have tried so far!

This bacteria makes me excited because it can achieve the same purpose as my initial idea, but does not require genetic engineering and therefore will reach the market faster. In my time at Azotic, I helped with experiments with finding salt tolerant strains, visited the field trial and performed molecular analysis on grass samples.

Innovative recycling: using pipette tip boxes to grow plants

I enjoyed my time in Nottingham so much, I have decided I would like to come back! I have found a Masters degree in Applied Biotechnology at University of Nottingham that will allow me to return to do work experience in Azotic's labs. I am currently exploring the possibilities of post graduate research scholarships which will help cover the fees of university in England, but I am very keen to pursue this avenue of research and hope to be back by the end of 2016.

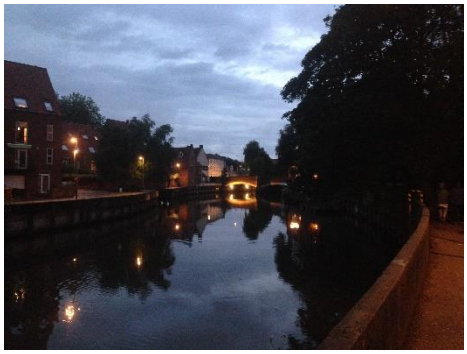
When I was organising my trip to England, the John Innes Centre was the first institute on my list. I had heard about their huge Bill and Melinda Gates Foundation funded project working on root nodules, and I was excited to talk to their scientists about their progress.



My set up for performing a genetic transformation of *E. coli* bacteria

In the uphill battle to get in contact with their scientists, I was reminded of a saying that I heard from a Japanese scientist: "*If a door slams in your face, just keep knocking."* After a few weeks, emails sent to five different people, four dead end international phone calls and chasing connections through previous work experience contacts, I was finally able to secure a place!

JIC's research on crop improvement focuses on root nodules, a symbiotic relationship that forms when plants create small swellings on their roots to house nitrogen fixing bacteria. This relationship happens naturally in legumes like soybeans, and JIC is studying the genes involved to see if they can be used to create other crops with this relationship. So far, this is proving difficult but they are making progress.



The beautiful channel in Norwich

While at JIC, I learnt about calcium spiking in the root cambium when beneficial bacteria are sensed. To measure calcium spiking, they use a microscopically fine needle to inject a small amount of dye that reacts with calcium to create a fluorescent reaction. I also genetically transformed and cloned *E. coli* bacteria that will be used to create useful plasmids for genetic modification of plants.

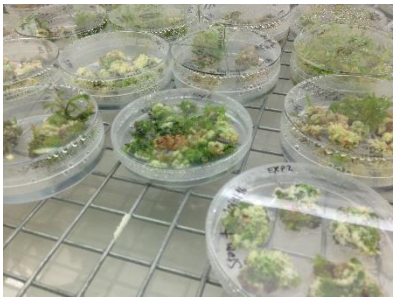
Wearing hairnets in the greenhouse with Leonie, a PhD student from Switzerland

The John Innes Centre was very different to any lab I had visited before. As one of the world's top research institutes, I found it interesting to see how focused and hardworking all of the scientist were. There were more strict quality controls in place, including hair nets in the climate controlled greenhouses! I also enjoyed the city of Norwhich, which had lots of interesting history including Tudor houses, a Victorian arcade and a castle.

ROTHAMSTED RESEARCH

Holding a willow stem culture

My third week was at Rothamsted Research in Harpenden which has a rich history. In fact, the first inorganic fertiliser (Superphosphate) was invented there by Sir John Bennet Lawes in 1843 and the existence of Rothamsted Manor was recorded in 1212. These days, Rothamsted focuses on researching agriculture with practical applications to industry and food security.

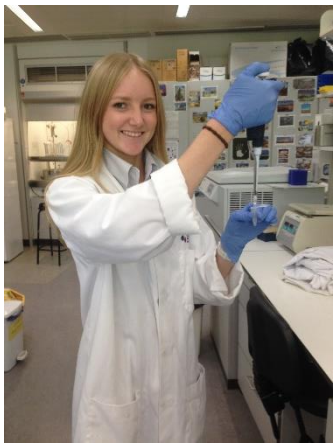


Masses of undifferentiated plant cells

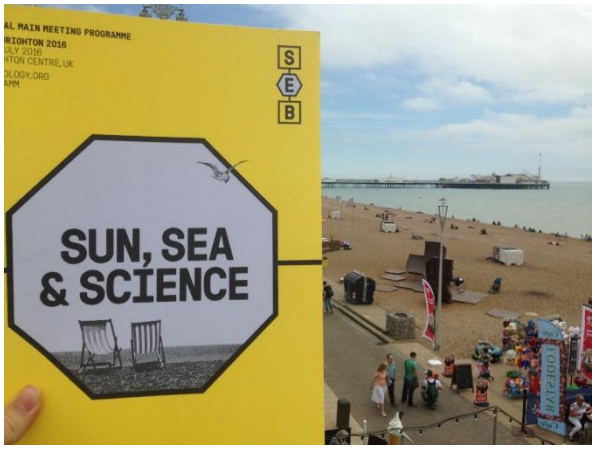
From Mon 27th-Fri 2nd I was mentored by Belinda Townsend, who is also an Australian who grew up around 5 minutes away from me. Belinda works specifically on looking at how we can increase sugar yields in sugar beet, and organised me a comprehensive tour with an array of different scientists around the institute. My first day included a tour of the chemical analysis machines, including Nuclear Magnetic Resonance (NMR) which involves floating a vial of liquid on a cloud of nitrogen gas and using magnetic resonance to read which chemicals are in the vial. They are using this technology to look for compounds in willow trees which could potentially be new pharmaceutical compounds with a number of applications. I was shown their controlled growth facilities which they use to genetically modify wheat plants via transformation of tiny undifferentiated cells, like embryonic tissue, to introduce new traits to the wheat crop for research

After collecting soil core samples in the field trial

Later in the week I was taken out to a field trial on wheat that has been running for 170 years on the effects of cultivation techniques and fertiliser. Although it was raining, I was given a pair of mud-proof pants and wellies and taught how to take core samples of soil for microbe analysis. This data will show the population of bacteria and fungi in the soil around these plants under different treatment. I was also asked to help with wheat seed collection for protein analysis for two PhD students. It is surprisingly tricky to separate wheat endosperm from the awns and husks!



I really enjoyed Rothamsted's fun atmosphere and found the scientists very friendly. I had a lot of fun staying in the "haunted" Rothamsted Manor with the other residents from around the world, laughing at the noises we heard in the night and the way that the paintings eyes seem to follow you. I was even taught how to cook pasta in the microwave by an Italian!

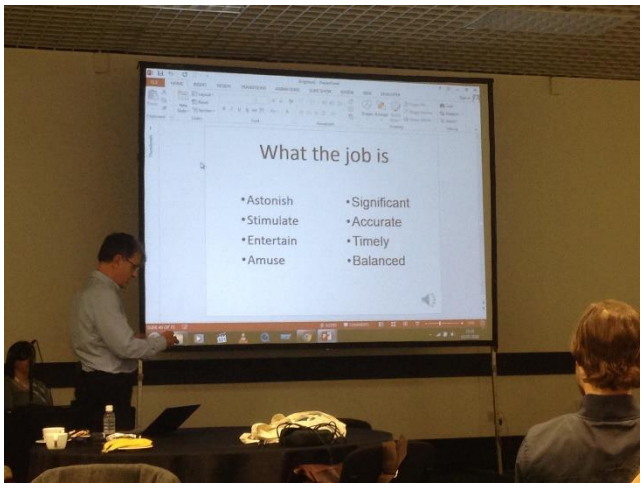


In my last week in England, Belinda recommended I attend the Society of Experimental Biology conference in Brighton. After I first arrived in Brighton, I was shocked to see the beach didn't have sand! Although it was too cold for a swim, I really enjoyed the fun atmosphere and interesting people I met, such as a Haitian who taught me to play the bongo.

On the beach with two human biologist from Germany

The Society of Experimental Biology is a broad range society, and the talks at the conference ranged from plant science, to studying the effects of climate change on sea slugs, to using pressure pads to measure the jumping force of a flea.

The sessions I found most interesting were on science communication. My favourite tip was :"Do what you want to do boldly, and others will help you" from Alun Anderson, a former science writer. I also was fortunate enough to meet Clare Marriot, who is a researcher and lecturer at Brighton University. Clare was very helpful in helping me network and make the most of my opportunities, and it was great to meet a role model who is enthusiastic about seeing students succeed. Belinda was a great help in networking and got me in contact with a few people who are currently helping me explore options for my trip back.



Alun Anderson presenting on what the job as a science communicator involves

I also got to talk to one of the scientists I had been looking for at JIC who was away at the time. Giles Oldroyd is the scientist behind the root nodules project, and despite missing his session I managed to catch up with him later. Giles was kind enough to share his current advancements with me and share insights on technologies offered by other companies. I learnt a lot in our short chat.

On my very last day in England, I was lucky enough to be able to go to the conferences formal dinner at the Brighton Dome. This ended up being a lot of fun, with great food, dancing and a late night trip to the beach! I had to catch my flight to Croatia at 7 the next morning, so I had to leave Brighton at 3am and ended up pulling off an allnighter- who'd have thought that the most fun night in England would be at a formal conference dinner!

Conclusion

Bromeliad at Kew Gardens

You may be wondering-so what now? Good question! As I mentioned earlier, I am keen to return to England to work on my new favourite bacteria, *Gluconacterbacter diaztrophicus*. As I write this, I am on a plane back from the Australian Cotton conference on the Gold Coast, where I have been discussing opportunities for funding with industry and my scholarship providers. After introducing them to GD, scientists and industry representatives are becoming as excited as I am about the potential of this bacteria to improve agriculture.

Enjoying a half pint in London's Soho district

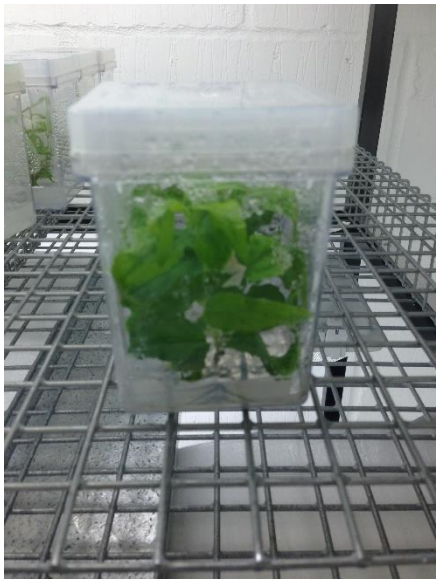
I have spoken to the Cotton Research and Development Corporation (CRDC) and they are enthusiastic about funding a project to test the efficiency of GD on cotton, as nitrogen is one of their greatest costs and concerns. Nothing is set in stone yet, but this could be my ticket to get back to England and work on something I really believe in.

On that note, I would like to thank all of you at BBM and The Australian Institute of Horticulture for believing in me to make the most of this scholarship. At the conference, we talked about how women in science often struggle with "imposter syndrome" and second guess themselves and their abilities. I think it is only human that like most people, I sometimes struggle with self-confidence and feel nervous in professional settings. Without being too mushy, I would like to thank you for believing in me when I didn't always believe in myself, and gifting me with an opportunity to grow myself as a person.

Giant Lillypads at Kew Gardens

Getting lost in Piccadilly with Taylor from Canada

I have learnt that in life as well as business, it is important to be authentic to the person you are, and not afraid to show a little vulnerability along with your individual flair. Whether you are passionate about dancing, trombone, cricket, gardening, or a bacteria called GD, your passions can shape the world around you. After six weeks on my own, I have become more independent, built upon my self-confidence and learnt more about science than I could ever have imagined. Thank you for giving me this opportunity!

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