

Laidlaw Programme: Personal Reflections Report

1. Reasons for Undertaking the Laidlaw Programme

The study of genetics through engineering is at the forefront of modern research and is, I believe, a solution to many of the world's current problems. It is the topic of which I am most passionate. The Laidlaw Programme allowed me to get involved in my supervisor's genetics project – such an opportunity was thrilling for me. It meant that I could further my scientific knowledge and skills in my vacations, rather than taking a far less rewarding unscientific job. I have to admit that I didn't appreciate that The Laidlaw programme would furnish me with many other leadership skills and networking opportunities. The latter is something I value highly in retrospect.

2. The Programme's Impact on my Future

a. Research Experience

Throughout this programme, I have gained a seemingly endless list of specialised skills in many different areas of the Biosciences which will be forever useful in my future career. Firstly, within the subject area of ecology, I have learnt how to successfully grow *Arabidopsis* strains in the UK's climate, in soil and on agar plates, which allows efficient sectioning of seedlings for study. Secondly, I have learnt much about plant physiology, especially regarding the three zones of cell proliferation in an *Arabidopsis* individual: the root meristem, the cambium and the apical meristem. I now understand their patterning and recognise wildtype and mutant plant sections throughout the developmental stages to adulthood. Thirdly, as well as learning many specific cell signalling pathways of *Arabidopsis* vascular development, I have an understanding of the general types of cell signalling pathways and processes that can exist in cells from all divisions of life. With this basis of knowledge I am able to understand gene-promoter interactions behind many current genetic engineering techniques, (especially involving *Arabidopsis* and *E.coli*), to the extent that I could attempt to design an experiment with specific promoters and vectors in mind for testing a certain hypothesis.

After a few weeks of my first summer's work, I learnt many other methods of research and experimentation from the Biological conference that I attended. Here I listened to guest speakers from all over the world who talked about their research covering a wide range of fields - from environmental genomics down to the microbiology of plant disease. As the guest speakers had worked with *Arabidopsis* as a model plant species, this gave me guidance and ideas on how to approach both my current project and any potential future projects. For example, I found David Salt's talk on his work on the evolutionary significance of ionomic variation particularly interesting. He uses Genome Wide Association Mapping of *Arabidopsis* plants in their natural habitat to enhance understanding of salinity tolerances in all crops. This technique could be applied in my project to establish which soil types will promote the cellulose yield of the genetically engineered crops.

From a personal employability perspective, the most obvious commodity that the scholarship has given to me is basic necessary laboratory skills. Simple skills include protective garment regulation, waste management, identification of corrosive materials, knowledge of storage conditions of certain substances, the making of common buffers and the use of basic machines such as centrifuges, PCR machines, microscopes and microtomes. These learnt skills mean I can now walk into many laboratories in the world and need little direction in the use of the common substances and machines found there.

I gained more specialised skills within plant physiology research with my studying of Arabidopsis histology: how to suspend samples of plants in plastic, how to mount stubs and section roots, how to fix and dye slides and the careful observation of the sections using microscopy at different magnifications. I have also learnt how to perform DNA and RNA extraction of plant matter which is an intricate process and a skill that is in demand. The most complicated skills I feel I learned were those of qPCR, and the new RNA extraction technique only learnt in the second summer of my project using magnets. The stripping of a Barley plant in young inflorescence stage down to the inflorescence, (the beginning of its flower, deep within the blades of sheathes), using only my hands was particularly challenging and intricate. I now hold this as one of my specialised plant handling skills.

I also learnt valuable skills needed for genetic engineering processes which are very relevant for my career plans. I now have experience in running DNA on gels using different wells, gel sizes, loading dyes and buffers, and experience in running PCR machines and the alterations needed for different primers and Taq polymerases. I am now also familiar with more complex engineering processes which I can execute without supervision. These include the process of cloning a gene, use of online databases such as TAIR for its sequence confirmation, the process of E coli transformation including the knowledge of different temperatures and durations for growing colonies and the identification of successful bacteria colonies. These processes involve the use of UV, ethidium bromide, liquid nitrogen and dry ice which I can now safely use.

I was introduced to the field of Bioinformatics only in the second half of my project. I am now completely familiar with online genetic databases, certain tool utilisation for blasting genetic sequences to identify orthologues, expression databases, and analysis of co-expression data in order to find novel genes involved in the genetic network of interest. My career plans are based around genetic research of some kind and so these skills I have acquired will be essential in my future employability. In addition, the Masters course I now wish to apply for is Bioinformatics, in order to advance my computational skills in handling and analysing biological data. This project has therefore inspired academic career direction and will hopefully aid me in my candidacy for a Bioinformatics Masters.

I particularly like the fact that my project is linked to the environmental effort through its potential expansion of the biofuel industry and its address to global food security. I am very passionate about these topics and now know the impact that genetic research could have on them. Career-wise I intend to explore more of the links between genetic research, the environment and food security, in the hope of drastically enhancing living standards and environmental quality through application of genetically engineered products.

As well as academic knowledge, I have also gained vital cognition into the world of scientific research. New concepts including the funding process, which skills are considered valuable, the benefits of a lab technician, writing conduct, the publishing process, how the international scientific community communicate with each other, the laboratory hierarchy system, and the laws regarding transformed mutant species are all now familiar to me.

b. Leadership Skills

This programme's emphasis on leadership has also gifted me with invaluable skills which have given me breadth. The scholarship has allowed me to undergo multiple leadership training days a year which led me to discover and develop the set of leadership skills that I possess. I highly enjoyed and engaged with these workshops. I was taught many attributes which I would not have without the Laidlaw leadership program. I found that my strongest skills lay in organisation, delegation of group work and facilitating and supervising group counsels- a kind of referee if you will. These characteristics greatly assisted the practicalities and organisation of my project and enabled me to work effectively in a team without being too dependent on the more experienced lab members.

Due to the capital-intensive instruments used in my project, I had constant support and advice from my supervisor and other lab members during my first summer. Despite this, conducting such a project required many vital leadership skills. Many facilities and material that I used during my project required pre-booking or pre-ordering which depended upon organisation and efficiency in my work - my evening time involved going over lists of things to be done the next day. By planning my long-term aims, I learnt to allow room for multiple attempts at cloning, which is a very temperamental process.

During genetic engineering there can be some waiting around between PCR runs, slide fixing, stub mounting and plant growing sessions. Therefore, during my first summer I also supported a master student with her project which was researching a similar set of transmembrane receptors to mine. I also helped Dr Etchells with his ongoing research into the wider picture of all possible interactions involved in Arabidopsis vascular development. This exposure to laboratory group work allowed me to use and expand certain skills such as patience, reliability and responsibility.

The second year of my genetic engineering project enhanced my leadership skills. In the Easter break, through contacts I made in my first summer's work in the biosciences department, I headed an exhibition on plant evolutionary genetics at the Durham School Science festival. This involved a 10-minute interactive presentation about the evolutionary tree and mating techniques of plants, before supervising an activity which I designed in order to communicate the subject matter more effectively. This 30-minute exhibition was run for classes of school children (10 to 20 students in a class, aged between 12 and 16) eight times a day, for three days. These three days strengthened my leadership skills and experience more than any other single experience. I had to engage my creative side by designing and handmaking 'bee' gloves used by the children to transfer nectar from and to paper flowers. My practical organisational side was applied to designing the exhibition, borrowing plants from the botanical gardens and running it on time, every time. My public speaking skills, patience with classes of children, and enthusiasm for my subject were all put to the test eight times a day – and each day my skills improved. I headed the exhibition team of myself and two assistants which required strong leadership skills from me to guide my team (who were actually my superiors as PhD students which made it all the more challenging!)

During the second summer laboratory research period, I had a huge amount of independence in my project that is not often found in an undergrad's work within a laboratory. My supervisor gave me the freedom to choose my own candidate genes for which to investigate, but was always there for guidance or advice. This meant I had to run the ship for my project – organising multiple parts to my project, all either needing different locations or equipment or reference to different experts. I also had to ensure I was updating my supervisor on the latest discoveries and direction that my project had taken during any time outside of the laboratory.

My supervisor talked me through and demonstrated the different steps of the new laboratory techniques I would need, which then allowed me to pass on this information to a younger undergraduate working in the lab. I was shadowed by him as I talked him through the qPCR prep steps before he then carried them out in front of me, only interjecting if he needed hints or tips. The transition that I made from student to teacher throughout the six weeks taught me skills in patient and accurate direction to ensure effective communication and teaching of technical information.

Overall, I believe different parts of my scholarship work have required different leadership qualities – for example, passing on information to others, and the development of ideas and the planning of the execution of them. This has therefore broadened my ability to adapt to different leadership roles in life.

c. Networking

I have come away from this programme with some very close, talented, and inspiring friends. In addition, I am in the process of organising a science communications event in which three other scholars and I will present a series of interactive talks on how scientific research can have positive implications for tackling climate change. This should happen in November. Without the programme I would never have found myself in such a fortunate position of such inspiration and guidance and I am most grateful for such a chance. Though I did not attend the conference of scholars from multiple universities last year as I was studying in Vancouver, I am attending the next one at UCL.

3. Improvements to the Programme

It is difficult to be critical of a program from which I have benefitted so much in so many different ways. To clutch at straws, I would say that the structure of the leadership training days could be improved. I very much enjoy the interactive activities, whether they are debating, physical team challenges or team brain puzzles to solve. I appreciate at the start of the day there needs to be an introduction to the theory of leadership, but I found that these presentations were too long, which resulted in lapses of concentration as they were non interactive.

4. Giving Back to the Programme

I will be actively involved in giving back to the programme in the coming years. I wish to be a mentor to a scholar from the cohort below me. I wish to attend all events, whether local or in a new city, which involve the sharing of research experiences with other scholars. I also wish to carry on organising science communication events which I have already explained above, in order to inspire a new generation of scientists and leaders to realise and share our experiences. I hope to be active on the Laidlaw Scholars Network, keeping in contact with likeminded scientists in order to create opportunities for all and to share ideas and knowledge to facilitate more effective research throughout the world. I will be able to pass on the leadership training and research experience that I have gained during my Laidlaw Programme to others and look forward to doing so.