

Laidlaw Summer 1 Report

My summer research project has been an overall fantastic experience for me, both from the point of view of developing my research skills and growing as a young leader. I spent six weeks researching different ways to make an organic naturally occurring sugar, known as chitosan, porous and capable of capturing carbon dioxide from the air. I gained invaluable experience from working in a research lab alongside some exceptionally knowledgeable chemists. I learned a lot about myself over the course of this project as there were many ups and downs along the way. At times I surprised even myself with my research and leadership abilities and my newfound independence gained from working off my own initiative. I was also made aware of different aspects of myself that I still need to focus on and continue to work at in order to become the research leader I aspire to be.

My original project was designed to use metal organic frameworks, MOFs, that would combine the natural sugar, chitosan, to different metal centres to make porous materials. These porous products could then be used to take the harmful greenhouse gas, carbon dioxide out of our atmosphere cleaning up the air we breathe and reducing climate change. The real-world application of my project and its positive environmental impact was something that I was extremely excited about when starting out.

Unfortunately, it did not go to plan, and I was forced to adapt my original plan. I attempted to bond the metals to the sugar in many ways using multiple different starting materials, but the results were never porous. This meant I had to switch up my research and make the sugar porous using other substances.

The unpredictable nature of carrying out chemical reactions was something that I had underestimated, and this had a lot to do with why I had to change my project slightly. There is also a likelihood that I had under-researched the reactions and materials to be used, which was due to my naïve presumption that my reactions would give the desired results. This is something that I have definitely learned from and has impacted how I approach new projects in every area of my life.

I have gained a huge amount of knowledge about the working of a research lab, and this was mainly down to engaging and connecting with the other researcher in the lab. I had the opportunity to work alongside one of the researchers in my supervisor's group who is researching the carbon capture abilities of organic substances similar to the one that I was working with. This close proximity to such an experienced researcher in a field that I am so interested in was hugely beneficial. I was able to bounce ideas off him about certain experiments I wanted to carry out and how exactly to handle certain materials. I was taught how to operate a number of laboratory equipment that I had never

encountered before, which is now of great help to me in my own course work. I also learned about the lab etiquette like how to go about using equipment that someone else has made claim to or when it is ok to play music in the lab, which was something that had never crossed my mind before.

Another thing that I had not anticipated about working in the lab was the amount of time I had to spend waiting. I had expected a scientific research lab to be a very fast paced environment but in reality, I had to spend a lot of time waiting for analysis results, waiting for the use of certain equipment, and waiting for reactions to go to completion. I sometimes was forced to completely stop working on my project as I needed to wait on analysis results. It was necessary a lot of the time to get the analysis of one reaction product to ensure the reaction had worked and I could continue with the next step in the synthesis. As well as this I was not the only person working in the lab at the time and there was a limited number of certain pieces of equipment. Therefore, I had to wait for other people to finish their task before I could carry on with my project. There were also issues with the length of certain reactions that had to be carried out as it meant I had to leave them heated over night without supervision or sometimes for 3 days so I would have nothing to work with for 3 days. I found this planning out of the logistics of each synthesis difficult as I had to account for whether or not the reaction was safe to be left overnight unsupervised, and for how long it needed to be heated for. This was sometimes frustrating as sometimes it meant that I had to slightly change the procedure of a reaction in order to be able to safely carry it out in the timeline, which may have had an effect on the success of the reaction. It was particularly helpful, during the planning of synthesis', to be able to talk to the other researchers in the lab and pull from their experience. I learned to plan the reactions around my schedule so that if for example a reaction took 3 days, I would start it on a Friday so I would be able work with the product on Monday.

As time went on, I began to enjoy my time in the lab more and more as I got more comfortable with the equipment I was using and the people I was working alongside. Going into the project I had been quite anxious about how I would fare working off my own initiative. I knew that I would have no lab manual to rely on to instruct me on how exactly to carry out each step in my reactions which was initially very daunting, but I learned to really enjoy the freedom this gave me. I had to research different reactions that I thought could be useful and adapt procedures in research papers to fit around what I wanted to achieve. This was a new challenge for me that I learned to really enjoy.

As with everything there were of course aspects of the process that I did not particularly enjoy. The waiting around being one of them as it was simply something I was not used to. All my previous lab experiences had been in a very structured, tried and tested environment designed to keep students

busy for the allotted lab time. This project was very far removed from this, which was very welcome in some senses but difficult in others. As mentioned before there were whole days where I wasn't in the lab at all as a reaction took multiple days to go to completion. This was frustrating at times because six weeks is already a short timeframe to complete a research project in and by losing days at a time to waiting around it was even shorter. The other aspect that I didn't enjoy was the failed reactions. I naively went into this project believing that if I was very careful and exact in my measurements, I would end up with products that could have fantastic real-world applications, as in theory my plan was achievable. Unfortunately, chemistry is much more unpredictable than I had comprehended. It was very hard to deal with the initial failure of my project when my products were ineffective due to their lack of porosity. Fortunately, I was able to take my project in a slightly different direction that yielded better carbon capture results. While these results were far from world-changing it was still a great thrill to see something that was made by my own hands make the air that little bit cleaner.

In term of leadership, I believe I developed greatly over the course of this project. I learned so much about myself, what areas of leadership I enjoy and have grown to be good at, and what aspects of being a leader I still need to work on.

Through working on my summer project, I encountered different leadership styles from working with different researchers. Some led through giving instructions to other without being an active part of the task, others led by being supportive and always being around to offer advice and help out, and some led by example through demonstrating how things should be done. I learned that my style of leadership is closer to the latter. I don't particularly like speaking in front of groups and so I don't find myself giving orders or instructing others on how to do things. I prefer to show people how certain things are done and carry out tasks to a high standard rather than tell them how to do it. I have

As my research was purely scientifically based, I did not have to work with many people in a team environment. However, I did get to work in the same space as different members of the research group and this involved using aspects of teamwork, such as clear communication and understanding, to optimise my time in the lab while ensuring that I was not interfering with other projects. This was, as I have mentioned before, an overall very positive experience working alongside the other researchers.

I also learned a lot about my personal resilience and levels of determination while working on this project. There were many challenging aspects to carrying out a research project in such a limited time. There were times when reactions didn't go as planned and it came to a point where I would have to start from scratch again, which was very frustrating and disheartening. I was pleasantly surprised by my resilience in these situations and by how determined I was to get back into the research. I was able

to learn from the mistakes I had made and come up with different approaches to my end goal for the project.

I applied for this programme as I had an interest in research and wanted to get experience in a research lab while also making a real contribution to my field and possibly the wider world. The leadership aspect of the programme, while also interesting to me, was not a main reason for my application. However, this summer has shown me the importance of blending leadership and research. Without learning about myself and my strengths through the leadership development sessions, I do not think I would have been able to apply myself to my research project as successfully as I did. Through learning where my strengths lay, I was better able to approach challenges that I faced during the project as I had more confidence in my abilities. I had no idea what to expect from the leadership days with the program and so had no definite expectations about how I would find them. I thoroughly enjoyed many aspects of these days, in particular the practical aspects as I prefer to learn through doing rather than reading or hearing about things. The skills I have learned and are continuing to learn from them will be invaluable to me not just as a researcher but a leader in many different aspects of life.

In conclusion, this summer has been hugely beneficial to both my career as a researcher and to leadership aspirations. Carrying out my very own research project has really fuelled my passion for research and chemistry as a subject. I have gained confidence in my abilities to work independently in a lab and to carry out research with real-world applications. I have already learned so much about myself through the program and I look forward to continuing to do so.