This summer, thanks to your generous grant, I participated in research at the Center of Genomic Regulation in Barcelona. The study was in computational neuroscience and focused on creating a computational model of the rat dentate gyrus. The dentate gyrus is the gateway to the hippocampus and is crucial in pattern separation and memory formation. My work was a simple, functional model of a slice of the dentate gyrus that exhibits oscillations when activated. Khashayar Baghizadeh, whom I worked with on the project, was a tremendous teacher throughout the internship. I now feel comfortable in the subject and am keen to continue working on the model I have created.

The goal of my internship was to learn about the construction of computational brain models. As the brain is an unimaginably complex structure, these neuron network model try to capture the bases of just a part of our brain. With a realistic and functioning model one can test different disease states. Regular brain pattern, but also epileptic activity can be seen with these models. I created a fragment of dentate gyrus for exploring how changes in Down Syndrome (DS) impact the network. With accurate brain model, experiments that are now done on animals or humans could be done on these computational models.

My work first started with developing a structural model of the neuron network. The neuronal types and cell positions were specified. Although the neuron arrangement changed throughout the project, the model was finally a square two-dimensional plane on which all the cells lay. The edges of plane were connected to form a torus to avoid the edge effect. Then, the neurons were connected based on brain dissection data and distances between the neurons on the torus. I used differential equations to replicate the voltage changes in every neuron type and chemical synapse dynamics. With the network complete, a current input would elicit a network activation that spread across the cells. It was crucial to mimic the natural network structure every step of the way. Although the torus does not seem the most biologically relevant, the connections of the neurons are all based on dissection and measurements that were obtained in those.

The grant enabled me to focus entirely on the institute's work, and I could spend as much time as needed on the project. As part of the lab, I learned about my colleagues' projects and

the academic career I aim to pursue. I presented my work in lab meetings to inform my colleagues and PI of my research aims and progress. This was an excellent opportunity to familiarize myself with giving presentations and to receive valuable feedback. I attended talks of renowned researchers in the institute to broaden my knowledge outside of neuroscience as well.

During the internship, I learned the importance of a thorough literature review. Despite using accurate neuronal data through my functional model, final validation could be done by comparison with voltage recordings of the dentate gyrus and with other computational models published. Regarding my coding skills, I have improved in Python and learned the basics of Rust. I plan to continue learning in both languages to broaden my computer science knowledge. Due to the size of computational models, the data structures used were crucial to decrease computational time. Although in the two and a half months of work, I was able to construct the structural and functional model of a small portion of the dentate gyrus, the final aim of the project is still ahead. Now, I am focusing on decreasing the computational time further and then testing the model with tasks such as pattern separation. These tasks will show the healthy network output. By adding the Down Syndrome (DS) disease changes, I can see how DS affects network output. This can indicate which DS changes impact the network most and possibly are the ones responsible for memory impairments. Then, a drug action can be modeled with the network, and the drug's efficiency is preliminarily tested. My model serves as a basis for Khashayar Baghizadeh's thesis project. His project will involve an anatomically realistic neuron arrangement and will model the dentate gyrus full-scale. My simpler model will serve as a crucial component in validation. The head of the lab, Mara Driessen, was pleased with my work and proposed to write a paper when the model is fully validated.

I am very grateful to the Queen Mary University Expedition grant for the chance to participate in this research. I hope to pursue computational neuroscience in academia and, later, possibly industry.