FutureNeuro Summer Internships 2025 in Brain Research

We are inviting applications from high-achieving undergraduates planning to pursue a research career in the field of neuroscience. The paid summer placements will equip the applicant with practical research experience and an insight into neurological research.

Deadline for application is 22nd April 2025.
(Application Form and Project list below)

FutureNeuro is the Research Ireland Centre for Translational Brain Science and focuses on developing new technologies and solutions for the treatment, diagnosis, and monitoring of neurological, psychiatric and neurodevelopmental conditions. Our unique multi-disciplinary preclinical and clinical research addresses the major challenges in improving how we diagnose neurological disorders including the implementation of genomics, the development of next-generation precision and disease-modifying treatments and the rapid progress of data science to glean powerful insights from clinical datasets.

FutureNeuro recruits the best PhD candidates and Post-doctoral researchers and equips them with multidisciplinary skills for a career in academic, clinical and industry-related research. Our paid Summer Internship for 5 high-achieving science undergraduates is designed for students interested in pursuing a research career in FutureNeuro and neuroscience. The candidates will be supervised by an investigator from the FutureNeuro network. See below for the projects on offer and eligibility criteria.

About Us : Hosted by RCSI, our research network combines integrated expertise from eight leading universities (TCD, UCD, DCU, MU, SETU, UCC and UG) and a national research-active clinical network. Building on our strong focus on epilepsy and motor neurone disease, we leverage cross-disease expertise to deliver advances into other neurological diseases (e.g. Parkinson's, MS), psychiatry and neurodevelopmental disorders and the serious co-morbid aspects of these conditions. We work with world-leading companies to address mutually-identified scientific challenges and public engagement and patient involvement is core to our mission. http://www.futureneurocentre.ie/

The projects on offer are:

1. Development of a Novel Workflow to Enable Large-Scale Multiomics of Microglia from Human Patient Tissue
2. Investigation of Sleep and Circadian Rhythm Disturbances in Mice Models of CDKL5 Deficiency Disorder
3. Targeting Inhibitory Signalling in Epilepsy via the Purinergic P2X7 Receptor
4. Genetic Ancestry Links between Celtic Populations within the Northwest of Europe
5. Rare Variant Burden as a Risk Factor for Common Forms of Epilepsy as Ascertained by UK Biobank
6. Analysing the Role of RNA Methylation in Epilepsy Development and Associated Behaviour

See Appendix I for project descriptions and supervisors.

RCSI, 123 St. Stephens Green, Dublin 2.

Eligibility and Application Process for Summer Internship

- Applicants will be selected based on academic performance and their application form.
- Candidates must have completed 3rd or 4th year of an undergraduate life-science degree (e.g. physiology, biomedical, biochemistry, genetics etc.).
- Each candidate will be required to submit a short application and CV.
- The candidate must demonstrate an interest in pursuing a research career (e.g. PhD).

Practicalities of FutureNeuro Summer Internship

- The Summer Internship with run *for 6 to 8-weeks (June – August 2025*). Final dates will be agreed with FutureNeuro supervisor.
- The location of the Summer Internship will be agreed with the supervisor but will most likely be at the FutureNeuro supervisor's academic institution or a hybrid model.
- Garda vetting may be required.
- A stipend of *€250 per* week will be provided by FutureNeuro (RCSI).

Deadlines

Completed application forms and a short CV should be emailed to louisethomas@rcsi.ie by 5pm Tuesday 22nd April 2025.

All successful applicants will be notified by 9th May 2025. Unfortunately, only successful candidates will be contacted.

We look forward to receiving your application.

Bridget Doyle
FutureNeuro Centre Manager
Email: bridgetdoyle@rcsi.ie

FutureNeuro Summer Internship 2025

Application Form (please delete previous pages and Appendix)

Your Selected Project - See Appendix 1 for project details
Project Name:

Your Personal Details
Name:
Address:
Telephone:
Email:

Your Academic Details:
Institution:
Faculty:
Degree:
Current year of study:
Student number:
Examination Results:

Year 1	
Subjects	
Results Overall	
Year 2	
Subjects	
Results Overall	
Year 3 (if applicable)	
Subjects	
Results Overall	
Year 4 (if applicable)	
Subjects	
Results Overall	

Academic Supervisor (who can be contacted as referee)
Name:
Email address:

FutureNeuro Summer Internship 2025
Application Form (continued)

Reason for Project Selection (max 100 words)

What do you hope to achieve from the Summer Internship? (max 100 words)

What are your career goals? (max 100 words)

Please submit application along with a short CV to:

Louise Thomas
FutureNeuro Admin Officer
Email: louisethomas@rcsi.ie

Appendix I

Summer Internship Project List

Project #1: Development of a Novel Workflow to Enable Large-Scale Multiomics of Microglia from Human Patient Tissue

Supervisor name and location: Dr. Michael-John Dolan, Department of Genetics, Trinity College Dublin

Project Outline: Microglia—the brain's immune cells—are central players in neurodegenerative diseases like Alzheimer's and multiple sclerosis. Genetic studies show that many disease-linked mutations affect microglial genes, making them a key target for research. However, studying human microglia is challenging, as these cells are difficult to extract and their nuclei are difficult to isolate specifically from frozen brain samples. This limits large-scale studies across diseases. The student will refine a novel fixation protocol developed in the lab to selectively isolate microglia from postmortem human brain tissue. These cells can then be analyzed using advanced genomic techniques, leading to deeper insights into brain health and disease.

Objectives:

- Optimize a microglia-specific isolation method first with mouse brain tissue.
- Assess the quality and yield of isolated microglia for molecular profiling.
- Using human tissue, generate a scalable workflow to enable large-scale studies of microglial function in neurodegenerative diseases.

Methodology: The student will work with mouse and human brain tissue, applying a novel fixation protocol to isolate microglia. They will learn molecular biology techniques, flow cytometry, fluorescence-activated nuclei sorting (FANS), and transcriptomic/epigenomic sample preparation.

Expected outcomes / Potential to form basis of PhD application: This project will establish a robust pipeline for isolating and profiling microglia from mouse and human brain tissue. After laying the groundwork for this technology over the summer, the student could further develop this approach and apply it to several human brain samples as a PhD project. By enabling large-scale multiomic studies, this approach has the potential to uncover novel disease mechanisms and therapeutic targets. If successful, the workflow could be further expanded to other brain cell types and disease models.

Project #2: Investigation of Sleep and Circadian Rhythm Disturbances in Mice Models of CDKL5 Deficiency Disorder

Supervisor/Location: Dr Omar Mamad, RCSI Physiology and Medical Physics, FutureNeuro

Project Outline: CDKL5 Deficiency Disorder (CDD) is a severe neurodevelopmental condition caused by mutations in the CDKL5 gene, leading to epilepsy, intellectual disability, and sleep disturbances. This project investigates the molecular and neuronal mechanisms underlying circadian rhythm disruptions in CDD using Cdkl5 knockout (KO) mice. By analyzing clock proteins (BMAL1, CLOCK, PER, CRY) and neuronal structures in the suprachiasmatic nucleus (SCN), we aim to identify biomarkers of circadian dysfunction. The study combines Western blot, qPCR, and Golgi-Cox staining to explore how CDKL5 loss affects circadian synchronization and neuronal integrity, providing insights for therapeutic interventions.

Objectives:

1. Determine the impact of CDKL5 loss on circadian clock proteins in the SCN.
2. Investigate neuronal structural changes in the SCN of Cdkl5 KO mice.
3. Identify biomarkers of circadian rhythm disturbances in CDD to guide therapeutic strategies.

Methodology: Using Cdkl5 KO and WT mice, SCN tissues will be collected for qPCR and Western blot to profile clock proteins (PER2, CRY1, CLOCK, BMAL1) and GSK-3. Golgi-Cox staining will assess neuronal morphology. Data will be analyzed to identify circadian disruptions and neuronal alterations in CDD.

Expected Outcomes / **Potential to form basis of PhD application**: This study aims to reveal how CDKL5 loss disrupts circadian rhythms and neuronal integrity in the SCN, providing the first biomarkers for sleep disturbances in CDD. Findings will elucidate the molecular and structural basis of circadian dysfunction, offering targets for therapeutic interventions such as clock gene modulation or synaptic repair. By linking CDKL5 deficiency to circadian and sleep abnormalities, this research will advance understanding of CDD pathophysiology and improve treatment strategies, potentially enhancing cognitive, motor, and behavioral outcomes for patients. The project's findings could form the foundation for a PhD, exploring broader implications of circadian dysfunction in neurodevelopmental disorders.

Project #3: Targeting Inhibitory Signalling in Epilepsy via the Purinergic P2X7 Receptor

Supervisor/Location: Dr Tobias Engel, Department of Physiology, RCSI

Project Outline: Several anti-seizure medications (ASMs) in clinical use are based on targeting the inhibitory GABAergic signalling system. However, these can cause serious side effects and alternative approaches are needed. Increasing data suggests a role for the ATP-gated P2X7 receptor (P2X7R) in epilepsy. Providing the proof-of-concept of the therapeutic potential of increasing P2X7Rs on GABAergic neurons, recent data from the supervisor show effective seizure suppression in several animal seizure models. To advance these findings into the clinic, next steps include carefully characterization of the effects of GABAergic neuronal P2X7Rs on neuronal functioning, and test the therapeutic potential in relevant pre-clinical models.

Objectives:

1. Analyze P2X7R function in GABAergic interneurons in physiological conditions and in epilepsy.
2. Evaluate the therapeutic potential of increased P2X7R function in inhibitory GABAergic interneurons on TBI-induced epilepsy.
3. Become familiar with laboratory work (basic lab techniques/in vivo experimentation) and presenting/discussing data during lab meetings.

Methodology: The student will learn how to analyse protein expression changes and brain pathology using basic laboratory techniques such as Western blotting, immunostainings and qPCRs. The student will also learn how to model brain diseases in vivo (TBI-induced epilepsy) and how to analyse disease-associated changes in behaviour and electroencephalogram (EEG).

Expected Outcomes / Potential to form basis of PhD application:
Outcome 1: Better understanding of the role of P2X7Rs in GABAergic interneurons.
Outcome 2: Further proof of the therapeutic potential of increasing P2X7Rs in inhibitory interneurons.
Outcome 3: Training in a diverse set of laboratory skills and learn how to present data via assisting and presenting data at weekly lab and department meetings
Outcome 4: Generation of pilot data for future PhD applications and opportunity to apply for future funding (e.g. PhD positions). The student will be closely supervised at a day-to-day basis – support includes 2 PhD students and two postdoctoral researchers including weekly meetings with the PI.

Project #4: Genetic Ancestry Links between Celtic Populations within the Northwest of Europe

Supervisor/Location: Dr Edmund Gilbert & Prof Gianpiero Cavalleri, School of Pharmacy and Biomolecular Sciences, RCSI

Project Outline: It is appreciated that the "Celtic" populations of Ireland, Wales, Cornwall, and Brittany have a shared genetic profile. Analyses demonstrating these links are however typically limited to a signal study population of interest, and a comprehensive study of the genetic links and the historical basis for this sharing has not been fully realised. In the Human Genetic Variation Research Group and Dr Gilbert's group, several datasets exist that provide high quality genetic references to these populations in addition to powerful haplotype-based methods to interrogate links. Understanding these links allows researchers to better understand shared genetic disease risk between these populations and thus confirm transferability of genetic risk profiles from one population to the other.

Objectives: This project aims to analyse the genetic links between Irish, Welsh, Cornish, and Breton populations. Thus, it has the objective to identify shared haplotypes between these communities, provide of model of their shared demographic history, and quantify the frequencies of disease relevant common variants to assess transferability of genetic risk profiles, including for neurological conditions such as ALS and epilepsy.

Methodology: This project will leverage existing SNP-array genotype data which records the genotypes of common variants. Variant phasing and imputation will identify carrier status of common risk variants, and bioinformatic haplotype-based methods such as identity-by-descent segment detection and "chromosome painting" will be used to quantify and model sharing patterns and population history.

Expected Outcomes / Potential to form basis of PhD application: The project is expected to provide an initial shared ancestry profile of the Celtic populations in the north-west of Europe, providing an explanation of the haplotype sharing patterns observed. Furthermore, explicit investigation of genetic risk variants will allow this project to inform on the ability of disease-associated variant frequencies in one Celtic population to predict risk in the other related Celtic communities. Results from this project would form the basis of a wider PhD project, providing further description of the shared population history, and the additional inclusion of rare variant datasets from next-generation-sequencing approaches to fully explore the sharing of rare, functional, variants and their distribution across the north-west of Europe – which informs on wider multi-site disease studies in these regions.

Project #5: Rare Variant Burden as a Risk Factor for Common Forms of Epilepsy as Ascertained by UK Biobank

Supervisor/Location: Prof. Gianpiero Cavalleri & Dr. Ifeolutembi Fashina, School of Pharmacy and Biomolecular Sciences, RCSI

Project Outline: Epilepsy is a group of brain diseases characterised by an enduring predisposition to unprovoked seizures. The genetic architecture of the epilepsies is studied to better understand how genes influence different forms of epilepsy. We know that pathogenic variants in hundreds of genes can cause rare, monogenic forms of epilepsy. We also know that damaging, ultra-rare variants in the same genes can confer risk for more common, but treatment-resistant forms of epilepsy. This project seeks to extend these findings to test whether burden for ultra-rare inferred-damaging genetic variants across monogenic epilepsy genes, confers risk for the relatively mild and treatment responsive forms of epilepsy ascertained by UK Biobank.

Objectives: We hypothesize that rare variants in coding regions of known epilepsy genes are overrepresented in common forms of epilepsy represented in the UKBiobank compared to controls.
To test this hypothesis, the student will

- Identify appropriate cases and controls within the UKBiobank
- Assess characteristics of these cases and controls
- Identify relevant lists of epilepsy-causing genes
- Use statistical tests to calculate rare variant burden in established epilepsy genes

Methodology:

- R for statistical analysis
- Ultra-rare variant burden analysis (gene-based and gene-set based)
- Remote research environments
- Cloud computing
- Process documentation
- Presentations
- Scientific writing

Expected Outcomes / Potential to form basis of PhD application: The student could gain further experience in scientific writing by producing a scientific report based on their findings. The research question could be extended to:

- Testing rare variant burden in other cohorts of epilepsy patients with milder, treatment-responsive epilepsy
- Testing the degree of rare variant burden conferred by different gene sets/ biological pathways on the UKBiobank cohort
- Testing the relationship between epilepsy PRS and rare variant burden in the UKBiobank cohort

Project #6: Analysing the Role of RNA Methylation in Epilepsy Development and Associated Behaviour

Supervisor/Location: Dr Gary Brennan, Conway Institute, University College Dublin

Project Outline: Epilepsy is a chronic neurological disorder affecting over 50 million people worldwide. Often caused by brain insults such as traumatic brain injury and stroke, these brain insults trigger widespread gene dysregulation which then promotes epilepsy development by activating pathological pathways such as inflammation, cell loss and synaptic reorganisation. Uncovering and understanding the gene dysregulation which drives epilepsy development may illuminate novel targets which can be targeted for therapy. RNA modifications are a recently discovered phenomenon which alter how RNA is processed. Our lab has uncovered widespread dysregulation of a common RNA modification, N6-methyladenosine (m6A), which involves the addition of methyl groups to messenger RNAs. This modification reduces the translational efficiency of the messenger RNAs.

Objectives: Explore how the m6A modification contributes to the overall gene dysregulation which characterises epilepsy using a combination of animal and cell models of seizures as well as transgenic and pharmacological tools.

Methodology: The student will learn a variety of in vitro techniques and also analyse in vivo data. Specifically, they will learn cell culture based methods, along with standard biochemical assays like qPCR and western blotting and will also analyse in vivo behaviour data provided to them by a member of the team. There is also the opportunity to develop computational skills using currently available datasets generated by the group.

Expected Outcomes / Potential to form basis of PhD application: This project will generate foundational data on m6A methylation patterns in epilepsy, offering new insights into the epitranscriptomic regulation of gene expression in the diseased brain. By mapping m6A changes in epileptic versus control tissue, we aim to identify key transcripts and pathways affected by differential methylation. These findings could reveal novel molecular mechanisms contributing to seizure susceptibility and chronic epilepsy. The project has strong potential to evolve into a PhD, expanding into functional studies of m6A-modifying enzymes, cell-type specific profiling, and therapeutic targeting of m6A pathways to modulate disease progression.