**PhD studentship Project information**

**Funding Source:** CENTA DTP

**Proposed start date:** 25th September 2023

**Closing date for applications:** 11th January 2023

**Eligibility:** UK/EU/International

**Department/School:** Genetics

**Supervisors:** PI: Roberto Feuda, University of Leicester, [rf190@le.ac.uk](mailto:rf190@le.ac.uk)

Co-I: Ezio Rosato (University of Leicester), Dr Vengamanaidu Modepalli (Marine Biological Association, UK)

Collaborator: Prof. Simon G. Sprecher (University of Fribourg, Switzerland)

**Project Title:** The neurobiological bases of the Cambrian explosion*.*

**Project Description:**

**Project Highlights:**

* Nervous system
* Phylogeny
* Metazoa
* Monoamines

**Overview:**

While it is well established that the Cambrian explosion required a radical change in animal behaviour (e.g. predator-prey arms races), the innovation of the nervous system associated with the diversification of the animals are poorly understood.



**Figure 1.** A simplified time-calibrated species tree illustrating the origin of the key monoaminergic genes and the presence of neurons. A = Sturtian glaciation; B = Marinoan glaciation; C = Gaskiers glaciation; D = Occurrence of Ediacaran Biota/early animal fossils; and E = the Cambrian explosion (from Goulty et al., 2022)

Recently we discovered (Goulty et al., 2022) that the genes animals use the monoamine neurotransmitter (a small group of neuromodulators that controls for example, aggression and memory) originated in the bilaterian stem group, pre-dating the Cambrian explosion. This pattern of gene duplication, combined with their role in modulating behaviours, led us to speculate that the evolution of monoamines was one of the key bilaterian innovations associated with the Cambrian explosion. However, in the absence of molecular and functional data, it is not possible to rule out that non-bilaterians use alternative metabolic pathways to synthetize monoamines (e.g. Yu et al., 2022) or from the microbiota (Liu et al., 2020). This project aims to test the presence of monoamines in non-bilaterian animals using a combination of chemistry, evolutionary biology, and genomics. To this aim we have defined three objectives:

1. To test the presence of monoamines in non-bilaterian metazoans, you will use mass spectrometry.
2. To study the effect of monoamines on non-bilaterians behaviour.
3. To identify the putative monoaminergic neurons, you will study the co-expression of the monoamines pathway genes (see Goulty et al., 2022) by combing single-cell RNA-sequencing data and *in-situ* hybridisation.

This project uses a multidisciplinary approach and recently developed technologies (e.g., single-cell biology) and the field of molecular paleobiology to provide insight into key events in the diversification of animals. Importantly it relies upon model systems and protocols already established in my laboratory.

**Methodology:**

First, you will perform mass spectrometry on several non-bilaterians metazoans (sponges, placozoans, ctenophores and cnidarians) to evaluate the presence of monoamines. This will be complemented with a phylogenetic analysis of alternative monoaminergic enzymatic pathways (e.g. Yu et al., 2022).

Second, you will test whether the different non-bilaterian animals respond to the different monoamines. You will module the level of the monoamine and record the effect on behaviour using video recording (e.g. DeepCutLab Mathis and Mathis, 2020).

Finally, you will capitalize on existing single-cell RNA-seq data from different animals’ (Sebé-Pedrós, Saudemont, et al., 2018; Chari et al., 2021; as well as new dataset generated in the lab) phyla to identify neuronal diversity in the different groups and use whole-mount *in situ* hybridization to validate the neuronal diversity in carefully selected taxa.

In summary, this project will equip the candidate with a unique combination of cutting-edge expertise in experimental and computational biology, and the data analyses can be transferred to large, diverse sets of biological problems.

**Scientific environment**

The PhD student will join a large and successful Neurogenetics research grouping that includes 8 PIs, 14 PhDs students and 9 PDRAs working on different aspects of neurobiology (from electrophysiology and molecular neurogenetics to computational genomics). This position offers ample opportunity for training and collaboration with the U.K. and European laboratories. Finally, this project will also provide the opportunity to publish in international 4-star general journals, which are regularly generated by the Neurogenetics group.

**References:**

Chari, T., Weissbourd, B., Gehring, J., Ferraioli, A., Leclère, L., Herl, M., Gao, F., Chevalier, S., Copley, R.R., Houliston, E., Anderson, D.J. and Pachter, L. 2021. Whole-animal multiplexed single-cell RNA-seq reveals transcriptional shifts across Clytia medusa cell types. *Science Advances*. **7**(48), p.eabh1683.

Goulty, M., Botton-Amiot, G., Rosato, E., Sprecher, S. and Feuda, R. 2022. Neuromodulation by Monoamines is a Bilaterian Innovation. , 2022.08.01.501419.

Liu, Y., Hou, Y., Wang, G., Zheng, X. and Hao, H. 2020. Gut Microbial Metabolites of Aromatic Amino Acids as Signals in Host–Microbe Interplay. *Trends in Endocrinology & Metabolism*. **31**(11), pp.818–834.

Mathis, M.W. and Mathis, A. 2020. Deep learning tools for the measurement of animal behavior in neuroscience. *Current Opinion in Neurobiology*. **60**, pp.1–11.

Sebé-Pedrós, A., Chomsky, E., Pang, K., Lara-Astiaso, D., Gaiti, F., Mukamel, Z., Amit, I., Hejnol, A., Degnan, B.M. and Tanay, A. 2018. Early metazoan cell type diversity and the evolution of multicellular gene regulation. *Nature Ecology & Evolution*. **2**(7), pp.1176–1188.

Sebé-Pedrós, A., Saudemont, B., Chomsky, E., Plessier, F., Mailhé, M.-P., Renno, J., Loe-Mie, Y., Lifshitz, A., Mukamel, Z., Schmutz, S., Novault, S., Steinmetz, P.R.H., Spitz, F., Tanay, A. and Marlow, H. 2018. Cnidarian Cell Type Diversity and Regulation Revealed by Whole-Organism Single-Cell RNA-Seq. *Cell*. **173**(6), pp.1520-1534.e20.

Yu, J., Vogt, M.C., Fox, B.W., Wrobel, C.J.J., Fajardo Palomino, D., Curtis, B.J., Zhang, B., Le, H.H., Tauffenberger, A., Hobert, O. and Schroeder, F.C. 2022. Parallel pathways for serotonin biosynthesis and metabolism in C. elegans. *Nature Chemical Biology*., pp.1–10.

**Funding details:**

NERC CENTA studentships are for 3.5 years and are funded by NERC. In addition to the full payment of your tuition fees, you will receive the following financial support:

* Annual stipend, currently set at £ 17,668 (2022/3 – new figures to be confirmed spring 2023)
* Research training support grant £8,000 (RTSG)

\* If you do not meet the criteria for UK Fees you will need to fund the difference between UK and International fees for the duration of your studies.

\* A limited number of top up studentships to fund the difference between UK and International fees may become available but are not guaranteed.

For more details of the CENTA consortium please see the CENTA website: www.centa.org.uk.

**Entry requirements:**

Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject or overseas equivalent.

The University of Leicester [English language](https://le.ac.uk/study/research-degrees/entry-reqs/eng-lang-reqs) requirements apply where applicable.

**Application advice:**

To apply please refer to

<https://le.ac.uk/study/research-degrees/funded-opportunities/centa-phd-studentships>

With your application, please include:

* CENTA Application form - available to download on the How to Apply section of the above link
* CV
* Personal statement explaining your interest in the project, your experience and why we should consider you
* Degree Certificates and Transcripts of study already completed and if possible transcript to date of study currently being undertaken
* Evidence of English language proficiency if applicable
* In the reference section please enter the contact details of your two academic referees in the boxes provided or upload letters of reference if already available.

In the funding section please specify that you wish to be considered for Ref CENTAG2-GENE2-FEUD

In the proposal section please provide the name of the supervisors and project title (a proposal is not required)

**Project / Funding Enquiries to:** [**CENTA@le.ac.uk**](mailto:CENTA@le.ac.uk) **or** [jh592@leicester.ac.uk](mailto:jh592@leicester.ac.uk)

**Application enquiries to** [**pgradmissions@le.ac.uk**](mailto:pgradmissions@le.ac.uk)