

Internship Proposal

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Project Title:

Dissecting the evolutionary origins of electric organs using zebrafish

Level:

Master Student

Project Summary:

Electric fish represent one of the most striking examples of evolutionary innovation in vertebrates, capable of generating precisely timed electrical discharges through specialized cells that compose the electric organ (EO) (Caputi, 2023). However, the evolutionary mechanisms underlying the origin of the EO, and the genetic changes that enabled its specialization, remain poorly understood.

Preliminary work has identified two candidate transcription factors (TFs) that may have played a central role in the evolutionary rewiring of genetic networks, enabling the emergence of EO-specific characteristics. This project aims to test this hypothesis by ectopically expressing these TFs in zebrafish and determining whether they can induce gene expression programs resembling those found in electric fish EO.

Work to be developed by the student:

The student will generate transgenic zebrafish lines, target transgene expression to defined neuronal populations, and apply fluorescence-based cell sorting combined with transcriptomic profiling to characterize the resulting molecular changes. By comparing the transcriptomes of manipulated zebrafish neurons with those of the EO of electric fish, we will assess the extent to which these transcription factors can drive an EO-like cellular identity or functions.

This project provides training in molecular biology, zebrafish transgenesis and genetics (Bordeira-Carriço et al., 2022), fluorescence-based cell isolation and transcriptomics (Lopez-Blanch et al., 2025), and bioinformatic analysis of gene expression data (Mantica et al., 2024). It offers an exciting opportunity to investigate one of the most fascinating evolutionary innovations in vertebrates, while gaining hands-on experience with state-of-the-

art approaches in developmental and evolutionary genetics.

The student will be co-supervised by Manuel Irimia (<https://www.crg.eu/en/programmes-groups/irimia-lab>) and José Bessa (<https://www.i3s.up.pt/research-group.php?groupid=112>), within an outstanding research environment at the interface of evolution, development, and functional genetics.



References:

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-Caputi, A. A. (2023). Living life with an electric touch. *J Exp Biol* 226, jeb246060.

-Lopez-Blanch, L., Rodríguez-Marin, C., Mantica, F., Iñiguez, L. P., Permanyer, J., Kita, E. M., Mackensen, T., Codina-Tobias, M., Romero-Ferrero, F., Fernandez-Albert, J., et al. (2025). Phenotypic impact of individual conserved neuronal microexons and their master regulators in zebrafish. *Elife* 13, RP104275.

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