

ENS – IISER Network / BIOSANTEXC Project Internship Proposal Form

Biology - Evolutionary Genetics

Internship title: Deep learning to estimate recombination rates

Keywords related with the subject (minimum 3):

Name of the laboratory(ies) at ENS and/or IISER: Experimental Evolutionary Genetics, Institut de Biologie de l'ENS (IBENS)

Name of the internship supervisor(s): Henrique TEOTÓNIO

Email(s): teotonio@bio.ens.psl.eu

Prerequisites for the internship: Coursework in Evolutionary Biology, Genetics and Statistics. Proficient with bash and Python or R.

Requested level: 4th year undergraduate to master level

Foreseen internship dates: April-June 2026

Internship type: ☒ 3-month internship

Internship proposal : Recombination is a fundamental parameter in genomics and evolutionary genetics. Recombination rates vary along chromosomes and between individuals (Johnston 2024), giving rise to population recombination rate landscapes that are expected to be correlated with rates of adaptation to novel environments (Parée and Teotónio 2025). Typically, recombination rates are estimated using cumbersome and expensive genetic crosses or inferred from comparative patterns of linkage disequilibrium (LD) between the genetic diversity found in natural populations. In this internship, the student will apply the deep learning software ReLERNN (Adrion et al. 2020) to estimate recombination rates in experimental populations of the nematode *C. elegans* with variable recombination landscapes, which have been whole-genome resequenced at several time-point but for which there is little information about LD patterns. Using simulations of experimental evolution with SLiM (Haller and Messer 2019), the student will contrast the ReLERNN results with existing genetic linkage maps for the populations with variable recombination landscapes (Parée et al. 2024).

- Adrion, J. R., J. G. Galloway, and A. D. Kern. 2020. Predicting the Landscape of Recombination Using Deep Learning. *Molecular biology and evolution* 37:1790-1808.
- Haller, B. C. and P. W. Messer. 2019. SLiM 3: Forward Genetic Simulations Beyond the Wright-Fisher Model. *Molecular biology and evolution* 36:632-637.
- Johnston, S. E. 2024. Understanding the Genetic Basis of Variation in Meiotic Recombination: Past, Present, and Future. *Molecular biology and evolution* 41.
- Parée, T., L. Noble, J. Ferreira Goncalves, and H. Teotónio. 2024. rec-1 loss of function increases recombination in the central gene clusters at the expense of autosomal pairing centers. *Genetics* 226.
- Parée, T. and H. Teotónio. 2025. Experimental tests on the evolution of sex and recombination and their adaptive significance. *Journal Evolutionary Biology*.