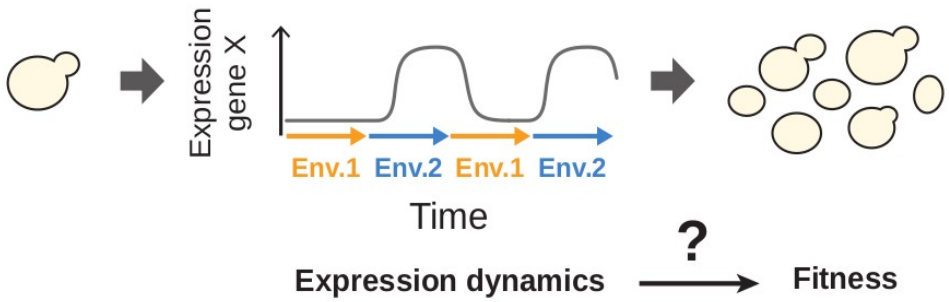
ÉCOLE NORMALE SUPÉRIEURE DE LYON

Stage de Master 1&2 / Master 1&2 Internship



Costs and benefits of gene expression regulation in dynamic environments (PhD position available)

Date of the offer: Anytime from October 2025 to July 2026

Tuteur du stage et Laboratoire d'accueil / Internship supervisor and Host laboratory:

Laboratoire / Lab : Laboratoire de Biologie et Modélisation de la Cellule (LBMC)

Chef d'équipe / Team leader (name, function, e-mail and telephone):
Gaël Yvert, Directeur de Recherche CNRS, gael.yvert@ens-lyon.fr, 04 72 72 87 17

Encadrant du stage / Supervisor for the internship (if different):
Fabien Duveau, Chargé de Recherche CNRS, 04 72 72 80 67

Personne à contacter / Contact e-mail: fabien.duveau@ens-lyon.fr

Adresse du stage / Address of the internship:
Laboratoire de Biologie et Modélisation de la Cellule (LBMC), UMR5239.
ENS de Lyon, 46 allée d'Italie, 69007 Lyon.

Site internet de l'équipe / Team Website :
http://www.ens-lyon.fr/LBMC/gisv/index.php/en/

Langues parlées dans l'équipe / Languages spoken in the lab: French, English

Anciens étudiants encadrés / Previous ENS student (e-mail if any) :
Mathieu Weber (stage M1 AgroParisTech), mathieu.weber@agroparistech.fr
Quentin Boussau (stage M1 en 2021), quentin.boussau@ens-lyon.fr
Félicie Giraud-Sauveur (stage L3 en 2020), felicie.giraud-sauveur@ens-lyon.fr

UNIVERSITÉ DE LYON

ENS DE LYON

Titre du projet de recherche / Research project title:

Costs and benefits of gene expression regulation in dynamic environments

Mots clés / Keywords :

Inducible expression • Dynamic control • Periodic stress • Fitness • Budding yeast

Techniques: Yeast genetics • CRISPR/Cas9 bioengineering • Auxin-inducible degron 2.0 • Quantitative flow cytometry • Competitive growth assays • Automated cell culture • Data analysis with R

Description du projet / Project description (subject and technics):

One of the most fascinating and singular properties of life is its capacity to adapt to dynamically changing environments. Understanding the mechanisms that contribute to such adaptation is a fundamental challenge for evolutionary biology and also for biomedical research. Yet, the cost and benefits of regulating the expression of particular genes in fluctuating and steady environments remain largely unknown.

To fill this knowledge gap, we recently implemented in yeast cells (*Saccharomyces cerevisiae*) a genetic system allowing us to control the temporal dynamics of expression of a target gene (auxin-inducible degron 2.0). The student will harness this tool to determine how the expression dynamics of genes involved in osmoregulation (*GPD1*, *FPS1*) or histone methylation (*BRE2*) contribute to growth when cells are exposed to diverse regimes of periodic and steady hyperosmotic stress. By performing competition experiments when both gene expression and environments are allowed to fluctuate over time, we aim to understand how the regulation of gene expression can be shaped by natural selection.

This project will offer the opportunity to learn basic molecular biology techniques, CRISPR/Cas9 genome editing, flow cytometry, programming of a liquid-handling robot, quantification of growth rates and computational analyses while addressing a fundamental biological question. **It is part of an ambitious european project (eGRIDE) for which funding for a PhD is available. Please contact Fabien Duveau if you are interested or need further information.**

Publications du laboratoire ou revue recommandée sur le sujet / Lab publications or recommended review on the subject (5 max):

Siddiq MA*, **Duveau F***, Wittkopp PJ. Plasticity and environment-specific relationships between gene expression and fitness in *Saccharomyces cerevisiae*. Nat Ecol Evol. 2024 Dec;8(12):2184-2194. *contributed equally.
https://www.nature.com/articles/s41559-024-02582-7

Barrere *et al.* Alternating selection for dispersal and multicellularity favors regulated life cycles. Curr Biol. 2023
https://www.sciencedirect.com/science/article/abs/pii/S0960982223003196

Yesbolatova *et al.* The auxin-inducible degron 2 technology provides sharp degradation control in yeast, mammalian cells, and mice. *Nat Commun*. 2020 https://www.nature.com/articles/s41467-020-19532-z

Keren *et al.* Massively Parallel Interrogation of the Effects of Gene Expression Levels on Fitness. *Cell*. 2016 https://www.sciencedirect.com/science/article/pii/S009286741630931X?via%3Dihub

Bleuven and Landry. Molecular and cellular bases of adaptation to a changing environment in microorganisms. *Proc Biol Sci*. 2016 https://royalsocietypublishing.org/doi/10.1098/rspb.2016.1458

Duveau *et al.* Fitness effects of altering gene expression noise in *Saccharomyces cerevisiae*. *Elife*. 2018 https://elifesciences.org/articles/37272