PhD POSITION

Extrachromosomal DNA, genome instability and cellular rejuvenation

ANR REJUVENATE project – Contact : charvin@unistra.fr

Charvin laboratory – Biotechnology and Cell Signalling (BSC), ESBS, Strasbourg, France

BACKGROUND

How does genome instability remain confined to one cell, and under which conditions can it be transmitted to subsequent generations? Extrachromosomal DNA (ecDNA) provides a powerful system to address this question because it can arise stochastically, replicate independently and segregate asymmetrically during cell division. In budding yeast, extrachromosomal rDNA circles accumulate in ageing mother cells but are normally retained away from newborn daughters. This asymmetric inheritance may preserve daughter-cell rejuvenation, but it remains unclear whether rejuvenation fails because ageing mothers begin to transmit ecDNA, because broader chromosomal instability emerges, or because both processes occur together.

SPECIFIC PhD PROJECT

The PhD student will investigate the dynamics and functional consequences of ecDNA inheritance during replicative ageing in Saccharomyces cerevisiae. The project will combine long-term microfluidics and live-cell fluorescence microscopy, yeast genetics and inducible ecDNA systems, quantitative mother-daughter lineage tracking, direct measurement of daughter-cell rejuvenation and replicative lifespan, imaging of chromosome segregation, and targeted genomic characterization. The student will quantify ecDNA formation, amplification, retention and leakage, test whether ecDNA inheritance is sufficient to impair daughter-cell rejuvenation, and determine whether chromosome-level instability provides additional predictive power. Experimental work will be closely integrated with automated image analysis, statistical inference and quantitative modelling.

Keywords: cellular ageing; genome instability; extrachromosomal DNA; budding yeast; single-cell biology; microfluidics; quantitative live-cell imaging; yeast genetics; lineage tracking; image analysis; probabilistic modelling; biophysics; genomics.

RESEARCH ENVIRONMENT

The project will be carried out in Gilles Charvin's group within the Biotechnology and Cell Signalling laboratory at the École Supérieure de Biotechnologie de Strasbourg (ESBS), University of Strasbourg and CNRS. ESBS offers a highly interdisciplinary environment at the interface of fundamental biology, biotechnology and quantitative sciences. The host laboratory has strong expertise in genome integrity, DNA-damage responses and chromosome biology, while the team brings together complementary skills in yeast genetics, microfluidics, quantitative microscopy, automated image analysis, statistical physics and mathematical modelling. The required microfluidic, imaging and computational platforms are already operational.

CANDIDATE PROFILE

We seek a highly motivated candidate with a Master's degree or equivalent in cell biology, molecular biology, genetics, biotechnology, biophysics, bioengineering or a related discipline. The candidate should have a strong interest in interdisciplinary and quantitative biology, enjoy combining experimental and computational approaches, and be willing to work across traditional disciplinary boundaries. Previous experience in yeast genetics, fluorescence microscopy, microfluidics, image analysis or programming would be advantageous, but expertise in all these areas is not required. Curiosity, scientific rigour, autonomy, teamwork and good communication skills in English are essential.

SKILLS ACQUIRED

The successful candidate will receive broad interdisciplinary training in yeast molecular genetics, long-term microfluidic experiments, quantitative fluorescence microscopy, single-cell lineage analysis and experimental design. They will also gain experience in automated image processing, statistical analysis, quantitative modelling.

SELECTED PUBLICATIONS FROM THE LAB

- Morlot S. et al. Cell Reports 28, 408–422.e4 (2019).
- Aspert T. et al. eLife 11 (2022).
- Malyavko A. et al. bioRxiv 2026.03.20.713207 (2026).

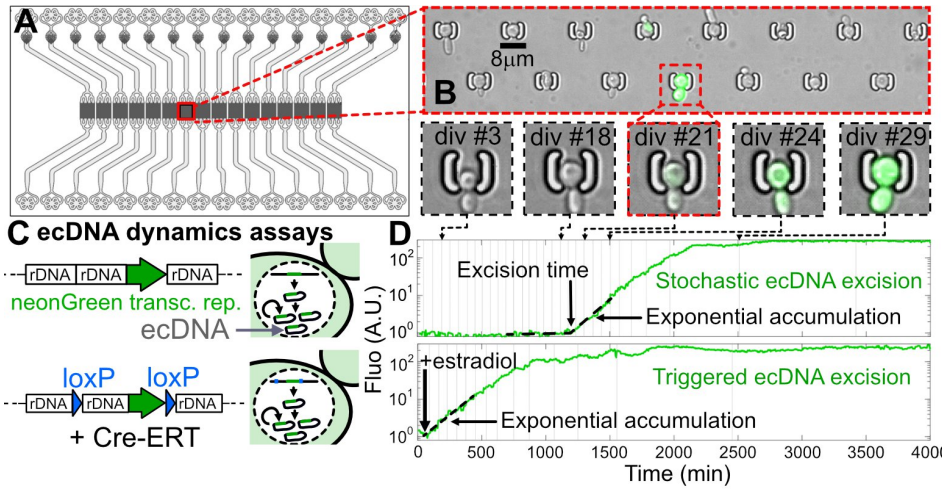

Figure. Single-cell analysis of ecDNA dynamics in ageing budding yeast.
(A–B) Microfluidic device and representative time-lapse images of an individual yeast lineage showing the onset of ecDNA reporter fluorescence. (C) Endogenous and Cre-ERT–inducible ecDNA reporter systems. (D) Single-cell fluorescence trajectories illustrating either stochastic ecDNA excision followed by exponential accumulation or triggered ecDNA formation after estradiol addition.

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