Institute: Institute of Environmental Sciences

Topic: Microbial cell quiescence: from cell to population on the example of yeast Saccharomyces cerevisiae

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dr Bogna Smug (MCB UJ)

Background information:
Cells keep facing a decision between proliferating and quiescence. Quiescence, a state in which cells temporarily cease proliferation, is the most common cellular state and it is observed ubiquitously: from single cell organisms to mammals, and in particular in stem and cancer cells. Quiescent cells not only need to survive stressful environmental conditions, and face aging, but they also need to retain the ability to reenter the cell cycle. Then they need to be able to proliferate when the conditions are favourable, and to give rise to healthy offspring. This is why understanding how cells 'decide' to enter quiescence is a fundamental question in developmental and evolutionary biology. It has also important medical implications for studies on cancer or stem cells. Nevertheless, very little is known about the molecular and environmental determinants of quiescence entry and exit.
Although single cells are self-sufficient, they usually live in colonies and biofilms, namely: in populations composed of multiple cells. In such populations individuals often interact and synchronize their decisions which may lead to phenotypic heterogeneity in the population. Since ~ 60% of all microorganisms on Earth is in the quiescent state, and the long-term survival of microbial populations depends on quiescent cells and spores, the process of phenotypic differentiation inside colonies as well as studying the survival strategies Is an intriguing question for biologists.

The main question to be addressed in the project:
Role of the population density and both physical and social environment signals in the single cell decisions of entering and exiting quiescence

Information on the methods/description of work:
Experimental evolution, molecular techniques, bioinformatics, optionally: mathematical modelling.
The work will consist mostly of the laboratory work. However, it will be done in collaboration with a mathematician (dr Bogna Smug) therefore we offer an opportunity to learn additional mathematical and data analysis techniques.

Additional information (e.g Special requirements from the student) **:**
fluency in English (B2),
basic experience in data analysis (preferably in R),
ability and interest to work in the microbiology laboratory
strong motivation to pursue independent research

Place/name of potential foreign collaborator:
Prof. Isabelle Sagot and Dr Damien Laporte Biology of Quiescent Cells group.
Centre National de la Recherche Scientifique BORDEAUX, FRANCE
We will apply for grants that cover travel expenses between Poland and France, possibly offering a double degree (Polish and French), see: https://www.pologne.campusfrance.org/pl/bgf-doktorat-cotutellecodirection

References (max.3**):**
[1] On the ecological significance of phenotypic heterogeneity in microbial populations undergoing starvation M Opalek, B Smug, M Doebeli, D Wloch-Salamon Microbiology Spectrum 10 (1) 2022
[2] The cell biology of quiescent yeast – a diversity of individual scenarios, Isabelle Sagot and Damien Laporte, Journal of Cell Science (132), 2019
[3] Adaptive Roles of SSY1 and SIR3 During Cycles of Growth and Starvation in Saccharomyces cerevisiae Populations Enriched for Quiescent or Nonquiescent Cells DM Wloch-Salamon, K Tomala, D Aggeli, B Dunn G3: Genes, Genomes, Genetics 7 (6) 2017