Project report 2020

MicroCell

Microsystems for Cell Engineering

MAIN PARTICIPANTS



Jean-Paul RIEU [a]	Kenichi FUNAMOTO [b]	Atsushi SHIRAI [b,c]

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OVERVIEW *(keep within this page)*

Starting year: 2017 **Current researchers** (permanent/non-permanent): 12 person-month/year

Positioning *(Multiple selection allowed – total 100%)*	Transportation	Energy	Eng. for Health
Materials and structure design			75 %
Surfaces and interfaces			25 %
Simulation and modeling			

Other:

Include partner from ☒ Outside ELyT ☐ Industry

Main funding source(s)
☒ Public project(s) ☐ Industrial ☐ Own resources

IFS CRP/LyC project? ☒ Yes ☐ No

For main projects: Agency / year / name of project *(up to 3, past projects in gray)*

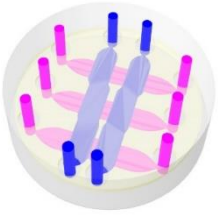
- CNRS, MITI, APP Modélisation du Vivant 2019-2020
- IFS LyC project 2019-2020
- CNRS, Invited researcher position for K. Funamoto (2 months in 2019)

Estimated annual budget: 30 k€

Highlights & Outstanding achievements *(3-5 bullet points)*

- We have designed a microfluidic device to control oxygen gradients
- We have shown that Dicty cells migrate toward rich O_2 regions (aerotaxis) within the 0-2% region only.
- A publication has been submitted to Elife
- We have published a work on the rolling of neutrophil-like cells on biomimetic endothelium

Illustration *(5x5 cm² max)*



PROJECT DESCRIPTION

Background (10 lines max; Calibri 11)

It is well known that eukaryotic cells sense oxygen tension and change their behaviors accordingly either by regulating gene expression. It is less known that they can also move to regions of favorable oxygen level (aerotaxis). Using a self-generated hypoxic assay, we showed at iLM that the social amoeba Dictyostelium (Dicty) displays a spectacular aerotactic behavior. When a cell colony is covered by a coverglass, cells quickly consume the available O_2 and move outward of the hypoxia area, forming a dense expending ring moving at a constant speed. Although this self-generated hypoxic assay is very simple, to get further insight in the O_2 sensing mechanisms, we need to develop microfluidic devices for controlling oxygen tension and to investigate the cell responses to various types of O_2 gradient as functions of gradient steepness and absolute O_2 level.

Key scientific question (2 lines max; Calibri 11)

Design a new device to study aerotaxis adapted from Funamoto's microfluidic devices for observations of cancer and endothelial cells [Funamoto, Lab Chip, (2012), Integr. Biol., (2017)].

Research method (8 lines max; Calibri 11)

We have fabricated a very efficient microfluidic device enabling to control the O_2 concentration in the range of 0.5-20% within 15 min with gas channels positioned just above the media channel with cells. An effort was made to include O_2-sensing polymer films inside the device. The device was fabricated in NanoLyon facility during a two-month stay of Funamoto and Hirose at iLM in 2019. Then, it was successfully tested with Dicty during that stay. Dicty cells responded to the 0-2% range of O_2 concentration. This is extremely low O_2 concentration and indicates a very efficient O_2 detection mechanism for those cells.

Research students involved *(gray color for previous years)*

Ph.D. candidates (years, institution):

- S. HIROSE (2020-present, Tohoku University)

Master/Bachelor students (years):

- S. HIROSE (2019-2020, Tohoku University)

Visits and stays *(gray color for previous years)*

FR to JP (date, duration):

- J.-P. Rieu (Dec 2019,5 days)
- J.-P. Rieu (June 2019,5 days)
- J.-P. Rieu (Nov 2018, 5 days)

JP to FR (date, duration):

- K. Funamoto (Feb 2020, 4 days)
- K. Funamoto (Sept 2019, 2 months)
- S. Hirose (Sept 2019, 2.5 months)

COMMUNICATIONS AND VALORIZATION

Journal publications *(gray color for previous years)*

	Authors	Title	Journal	Vol.	pp. / ID	Year	DOI
1	O. Cochet-Escartin, M. Demircigil, S. Hirose, B. Allais, P. Gonzalo, I. Mikaelian, K. Funamoto, C. Anjard, V. Calvez, J.-P. Rieu	*Hypoxia triggers collective aerotactic migration in Dictyostelium discoideum*	Elife (under review)			2020	https://www.biorxiv.org/content/10.1101
2	A. Shirai, Y. Sugiyama, J.-P. Rieu	*Differentiation of neutrophil-like HL-60 cells strongly impacts their rolling on surfaces with various adhesive properties under a pressing force*	Technology and Health Care	26(1)	93-108	2018	doi: 10.3233/THC-171052

Conferences *(gray color for previous years)*

	Authors	Title	Conference	Date	City	Country	DOI *(if applicable)*
1	K. Funamoto, J.-P. Rieu	*Microfluidic Tools to Study Aerotaxis in Eukaryotic Cells*	Elyt Workshop	17-19 Feb 2020	Vogüé	France	
2	O. Cochet-Escartin, M. Demircigil, S. Hirose, K. Funamoto, C. Anjard, V. Calvez, J.-P. Rieu	*Hypoxia triggers collective aerotactic migration in Dictyostelium discoideum*	CNRS MITI, AAP Modélisation du Vivant	13 Feb 2020	Paris	France	
3	O. Cochet-Escartin, S. Hirose, K. Funamoto, C. Anjard, J.-P. Rieu	*Hypoxia triggers collective aerotactic migration in Dictyostelium discoideum*	The 20th International Symposium on Advanced Fluid Information (AFI2020)	28 Oct 2020	On-line	Japan	

4	S. Hirose, J.-P. Rieu, K. Funamoto	*Evaluation of Dictyostelium migration under oxygen concentration gradient*	The 17th International Conference on Flow Dynamics (ICFD2020)	30 Oct 2020	On-line	Japan	
5	S. Hirose, J.-P. Rieu, K. Funamoto	*Motility analysis of Dictyostelium discoideum under oxygen gradient by microfluidic device*	The 31th JSME Conference on Frontiers in Bioengineering (in Japanese)	12-13 Dec 2020	On-line	Japan	

Patents *(gray color for previous years)*

	Inventors	Title	PCT #	Year

Others *(gray color for previous years)*

	People	Event	Description	Date