



## RESEARCH TOPIC DASMEN5

### Understanding colonization resistance from a single-cell perspective

#### Curriculum DASMEN Standard

##### Laboratory name and address

Tumor microenvironment Unit – Humanitas Research Hospital

##### Datascience Supervisor

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##### Abstract

Since the '60s we know that disturbing the gut microbiome with antibiotics leads to an increased susceptibility to inflammation caused by pathogens [1]. This observation led the scientific community to discover one of the major contributions of bacteria to human health: the ability of the resident community to protect us from pathogen colonization, named colonization resistance [2]. Despite more than 70 years of studies, the precise mechanisms that prevent pathogenic invasion are still poorly understood [3].

One of the reasons for the lack of knowledge of why colonization resistance varies across bacterial communities is that research has often neglected the role of individual cell behaviors, i.e., the ability of genetically identical bacterial cells to behave in distinct ways due to a combination of deterministic and stochastic factors [4,5].

The successful candidate will combine theory and experiments bringing a single-cell perspective to the study of colonization resistance.

##### Scientific references

Mathematical modeling and theories applied to bacterial cell physiology and ecology. Stochastic simulations and image analysis of large images. Data interpretation. The successful candidate is expected to learn some experimental techniques: culturing cells, performing microfluidics experiments and microscopy that allow for single-cell data.

[1] The Integrative Human Microbiome Project. *Nature* 569, 641–648 (2019)

[2] Bohnhoff, M. & Miller, C. P. Enhanced susceptibility to salmonella infection in streptomycin-treated mice. *J. Infect. Dis.* 111, 117–127 (1962)



[3] Stern, C. D. The 'Omics' Revolution: How an obsession with compiling lists is threatening the ancient art of experimental design. *BioEssays* 41, 1900168 (2019)

[4] Ackermann, M. A functional perspective on phenotypic heterogeneity in microorganisms. *Nat. Rev. Microbiol.* 13, 497–508 (2015)

[5] Hockenberry, A. M., Micali G., Tak'acs G., Weng J., Hardt W.-D., Ackermann M. Microbiotaderived metabolites inhibit *Salmonella* virulent subpopulation development by acting on singlecell behaviors. *PNAS* 118, 31:e2103027118 (2021)

### **Type of contract**

Scholarship of € 21.000 gross per year awarded by Istituto Clinico Humanitas. This sum is subject to IRPEF income tax and exempt from social security contributions.

Borsa di studio pari a € 21.000 annui lordi erogata da Istituto Clinico Humanitas. Importo soggetto a tassazione IRPEF ed esente da contribuzione previdenziale.