

RESEARCH ACTIVITY SHEET

2025 PhD selections

YOUR DETAILS

* Name & Surname

FRANCESCA BUFFA

* Affiliation IFOM

PHD PROJECT DETAILS

* Title of the proposed project

Multi-omics characterization of the cellular adaptation to suistained hypoxia

* Short description of the project (up to 300 words)

The major cause of mortality in cancer is metastasis. There is increasing evidence that the tumour microenvironment (TME) and its selective pressure is a major factor underlying both drug resistance and metastasis. Cancer cells emerge, adapt and evolve within the TME ecological niche, which imposes selective pressures on them, and is itself heterogenous and continuously changing. Hypoxia is one of the most striking TME traits differentiating cancer from normal tissues. Leveraging our own previous work and existing evidence that hypoxia remodels the TME into a pro-metastatic phenotype, we aim to reconstruct the changes in gene regulatory networks in normoxic and hypoxic conditions. The hypothesis is that this will identify vulnerabilities in a hypoxic TME, which could be targeted. To address this, we will produce multi-omics data in bulk and single cells, in time series, to reconstruct the molecular pathways used during adaptation of cancer cells to a hypoxic TME. Specifically, adding ATAC-seq data, to measure chromatine accessibility and identify regulatory regions, to RNA-seq data, which quantifies expression changes in time, will allow us to infer gene regulation under hypoxia. The project will involve both wet lab and computational techniques needed to analyse the data produced. The computational part will be done in collaboration with the AI team at Bocconi University.

* Indicate the main research area for the project described above Cancer Biology

If needed indicate a second research area for the project described above Molecular Biology

* Provide up to 3 key words for project:

Multi-omics, hypoxia, gene networks, microenvironment

YOUR LABORATORY ACTIVITIES DETAILS

* Main topic/s of the lab

Systems Biology, AI, omics, hypoxia, TME

* Short description of the lab activity (up to 500 words)

Our research combines computational and multi-omics techniques to decode how biological networks are rewired in a disease like cancer, where cancer cells evolve and interact within a complex and dynamic microenvironment. We search for gene networks, and associated 'signatures', that enable us to understand how normal cells rewire their molecular circuits to become cancer cells, and how they respond to microenvironment characteristics, such as low oxygen levels (hypoxia), or signalling from non-cancer cells. This helps us to understand cancer evolution, heterogeneity, and to predict therapeutic strategies that are most appropriate.

* Recent bibliography (max 5 references)

Defining hypoxia in cancer: A landmark evaluation of hypoxia gene expression signatures. Di Giovannantonio M et al. Cell Genom. 2025 Feb 12;5(2):100764. doi: 10.1016/j.xgen.2025.100764. Epub 2025 Jan 31.

Identification and validation of a machine learning model of complete response to radiation in rectal cancer reveals immune infiltrate and TGF β as key predictors. Domingo E et al. EBioMedicine. 2024 Aug;106:105228. doi: 10.1016/j.ebiom.2024.105228. Epub 2024 Jul 16.

New role of fat-free mass in cancer risk linked with genetic predisposition. Harris BHL et al. Sci Rep. 2024 Mar 27;14(1):7270. doi: 10.1038/s41598-024-54291-7.

Metabolic symbiosis between oxygenated and hypoxic tumour cells: An agent-based modelling study. Jayathilake PG et al. PLoS Comput Biol. 2024 Mar 15;20(3):e1011944. doi: 10.1371/journal.pcbi.1011944. eCollection 2024 Mar.

Single cell RNA-sequencing: A powerful yet still challenging technology to study cellular heterogeneity. Ke M et al. Bioessays. 2022 Nov;44(11):e2200084. doi: 10.1002/bies.202200084. Epub 2022 Sep 6.

* Group composition: total members, and roles distribution (PhD, postdoc, technician, etc.)

IFOM group: 2 postdoctoral researchers (1 joint with Bocconi), 1 PhD, 2 researchers predoc (one joint with Bocconi). Bocconi group: 1 assistant professor, 3 postdoctoral researchers (one in Oxford), 1 PhD, 2 predoc researcher assistants, and a variable number of interns/research students/visiting researchers.

Institutional page link

https://www.ifom.eu/en/cancer-research/researchers/francesca-buffa.php

Lab website link, if any

https://www.ifom.eu/en/cancer-research/research-labs/research-lab-buffa.php

Social media links, if any

https://uk.linkedin.com/in/francesca-buffa-578643b

If you prepare a video to promote your lab/project, please include the link below