MicroC: a Simulation Environment to Study Evolution and Growth of Heterogenous Cell Populations

MicroC is a novel computational framework for conducting in-silico biological experiments and generate or test new hypotheses. MicroC may be used to study the effects of mutations and cell-cell or cell-microenvironment interactions on the dynamics of cell growth. Almost all features of MicroC (networks, cell-microenvironment, cell-cell interaction, mutations) can be customized by the user.

MicroC is accessed via a web portal and uses the supercomputing cluster of Oxford University (ARC), to simulate biological experiments. It offers an interactive environment for visualizing the results.

How does it work?

1. Define parameters and files for job submission
2. Experiment results
3. Impact results in detail
4. Cell decisions over time
5. Averaged data (all repeats)
6. Detailed data (all repeats)
7. Many repeats for statistical validity

Case Studies:

I. Cell Heterogeneity

MicroC may be used to study population heterogeneity, because each cell is modeled individually. In this experiment (10 repeats), we simulate 8 different cell populations, using the same gene network, but different mutation profiles. Differences on gene status activation may be traced down to single cells.

II. Cellular (micro)environment

We test cells under hypoxia and under normal oxygen conditions, to evaluate the effect of oxygen on the cell population. We observe that under the hypoxic condition, growth is slower. This is because under hypoxia part of the simulated spheroid becomes necrotic, and affects overall proliferation rate.

III. Cell signalling

We test the hypoxic and well-oxygenated condition, for signalling cells, by introducing EGF in our experiment. We observe that there is more growth when EGF is produced and the population heterogeneity affects overall proliferation rate.

Substances (e.g. EGF) determine cell-cell interaction

Gene regulatory networks determine cell behaviour

Mutations define cell populations

Oxygen flow defines cellular microenvironment

III. Cell signalling. We test the hypoxic and well-oxygenated condition, for signalling cells, by introducing EGF in our experiment. We observe that there is more growth when EGF is produced and the population heterogeneity affects overall proliferation rate.

Professor Francesca Buffa
Computational Biology and Integrative Genomics Group
University of Oxford
francesca.buffa@oncology.ox.ac.uk