Contribution ID : **40** Type : **not specified**

Transport Phenomena in Biological Systems: Mathematical models of Cancer Invasion.

lunedì 28 febbraio 2022 17:25 (10)

In recent years, mathematical models are providing fundamental support in cancer research. By accounting for various biological and physical processes, these models can reveal insights into the dynamics of tumour growth and invasiveness, thereby allowing the development of pharmacological strategies to control tumour proliferation and invasion. The use of these tools is becoming increasingly widespread in the clinical field, predicting in some cases with a very high precision both the course of the specific patient and his response to therapies. Cellular automata are simplified, discrete mechanistic models where a cell population evolves autonomously in time according to pre-defined rules that capture elementary biological processes, such as cell proliferation, cell motility, and cell-cell interactions. In our work, a new in silico model able to mimic some of the peculiar characteristics of tumour cells, such as fast proliferation, high cell motility, impaired cell adhesion, and elevated sensitivity to chemotactic stimuli is proposed. The goal of this research, run in collaboration with Houston Methodist Academic Institute, is to investigate tumour growth and invasiveness and its response to specific pharmacological treatments. In particular, tumoral cell motility and invasiveness are investigated mimicking the evolution of cell tissues in 2D and 3D models. Numerical predictions are validated by direct comparison with experimental data developed in-vitro. 2D cell monolayer (Wound Healing) and 3D spheroids in Extracellular Matrix scaffold have been monitored by Time Lapse microscopy to obtain quantitative measurement of dynamic evolution in in vivo mimicking conditions.

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