A hybrid individual-based model to explore the impact of electroporation on spheroid growth and DAMP release

Emma LESCHIERA, DVRC - Paris **Nicolas MATTEI**, IPBS - Toulouse
Clair POIGNARD, Inria - Rennes

Electroporation is a technique in which electric pulses are applied to cells in order to increase the permeability of cell membrane. In reversible electroporation (RE), the pulse duration is sufficiently short to ensure that the cell membrane reseals within several minutes. In irreversible electroporation (IRE), however, the pulses are too long, too numerous or their amplitude too high so that the cell membrane is irreversibly destroyed, and the cells are killed. While the cells are destroyed, the integrity of tissue remains preserved, making IRE very appealing for ablation of tumour. Recent studies have shown that IRE used for cancer treatment also induces immunogenic cell death (ICD), a form of cell death resulting in a regulated activation of the immune response. In particular, damaged or dying tumour cells release damage-associated molecular pattern molecules (DAMPs) which may ultimately trigger an immunological response.
In this talk, we present a hybrid model to investigate the ICD and regrowth of tumour spheroids exposed to IRE. In this model, a stochastic individual-based model tracking the dynamics of single tumour cells is coupled with a partial differential equation describing IRE dynamics. Here, the death of tumour cells and the release of DAMPs correlates with the intensity of the IRE electric pulses. The model is confronted to biological measures of DAMPS release and volume evolution of tumour spheroids submitted to electric pulses with different intensities. The results of computational simulations obtained from the proposed model shed light on the way in which the intensity of the IRE electric pulses may affect the regrowth of tumour spheroids, as well as their release of DAMPs.

Contact : emma.leschiera@devinci.fr