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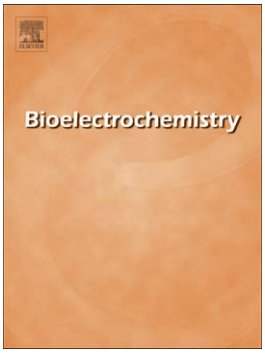

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ACCEPTED MANUSCRIPT

Dynamical modeling of tissue electroporation

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Abstract

In this paper, we propose a new dynamical model of tissue electroporation. The model is based on equivalent circuit approach at the tissue. Considering two current densities from cells and extracellular matrix, we identify the macroscopic homogenised contribution of the cell membranes. Our approach makes it possible to define a macroscopic *homogenised* electric field and a macroscopic *homogenised* transmembrane potential. This provides a direct link between the cell scale electroporation models and the tissue models. Finite element method adapted to the new non linear model of tissue electroporation is used to compare experiments with simulations. Adapting the phenomenological electroporation model of Leguèbe *et al.* to the tissue scale, we calibrate the tissue model with experimental data. This makes two steps appear in the tissue electroporation process, as for cells. The new insight of the model lies in the well-established equivalent circuit approach to provide a homogenised version of cell scale models. Our approach is tightly linked to numerical homogenisation strategies adapted to bioelectrical tissue modeling.

Keywords:
Electroporation, biological tissue, electric field, phenomenological modeling, theory of pores

1. Introduction

Electroporation-based therapies (EPT) consist in applying high voltage short pulses to tumor cells (typically several hundred volts per centimeter during about one hundred microseconds) in order to create defects in the cell membrane. They provide interesting alternatives to standard non surgical ablative techniques, for instance for deep seated tumors located near vital organs or important vessels. However, even though the rationale of electroporation is quite well quantified at the cell scale, the lack of numerical models of tissue electroporation prevents the systematic use of these therapies in cancer treatments. In particular, the computation of the time-dependent electric field within biological tissues is a

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