Electroporation of cells and tissues - interactive e-learning course

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Duration of the experiment: app. 90 min
Max. number of participants: 18
Location: Computer room (CIT)
Level: Basic

PREREQUISITES

No specific knowledge is required for this laboratory practice.

The aim of this laboratory practice is to provide the participants with basic knowledge on local electric field distribution in cells and tissues exposed to high voltage electric pulses (i.e. electroporation pulses) by means of interactive e-learning course content. The e-learning content is based on the available knowledge from the scientific literature.

PROTOCOL OF THE E-LEARNING COURSE

The participants will be gathered in a computer-computer classroom providing each participant with a computer. A short test will be given to establish the baseline knowledge before the e-learning course.
Within the first part of the e-learning course we will bring together the educational material on basic mechanisms underlying electroporation process on the levels of cell membrane, cell and tissues as a composite of cells (Figure 1).

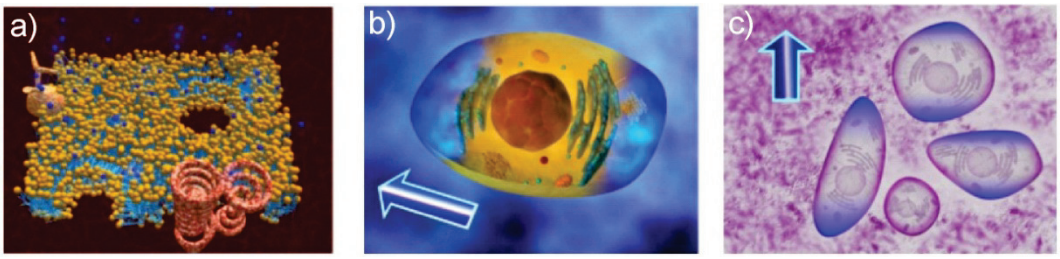

Figure 1: Introduction of small molecules (blue molecules) through a cell membrane (a) into an electroporated cell (b) and into the successfully electroporated cells within an exposed tissue (c) (Čorović et al., 2009)

Within the second part of the course we will provide basic knowledge on important parameters of local electric field needed for efficient cells and tissue electroporation, such as: electrode geometry (needle or plate electrodes as illustrated in Figure 2, electrode position with respect to the target tissue and its surrounding the tissues (Figure 3), the contact surface between the electrode and the tissue, the voltage applied to the electrodes and electroporation threshold values. This part of the e-learning course content will be provided by an interactive module we developed in order to visualize the local electric field distribution in 2D and 3D dimensional tissue models.
The objective of this module is to provide:
- local electric field visualization in cutaneous (protruding tumors) and subcutaneous tumors (tumors more deeply seeded in the tissue);

- guideline on how to overcome a highly resistive skin tissue in order to permeabilize more conductive underlying tissues and
- visualization and calculation of successfully electroporated volume of the target tissue and its surrounding tissue (i.e. the treated tissue volume exposed to the electric field between reversible and irreversible electroporation threshold value Erev < E < Eirrev) with respect to the selected parameters such as: number and position of electrodes, applied voltage on the electrodes.

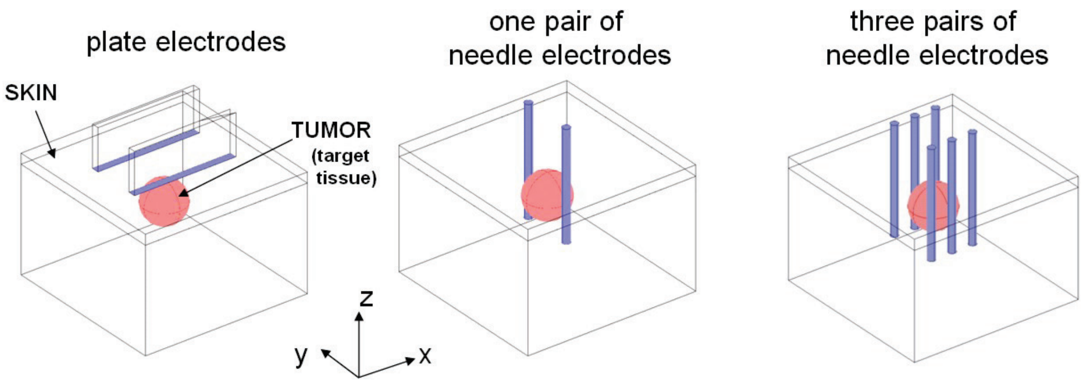

Figure 2: Plate electrodes vs. needle electrodes with respect to the target tissue (e.g. tumor tissue)

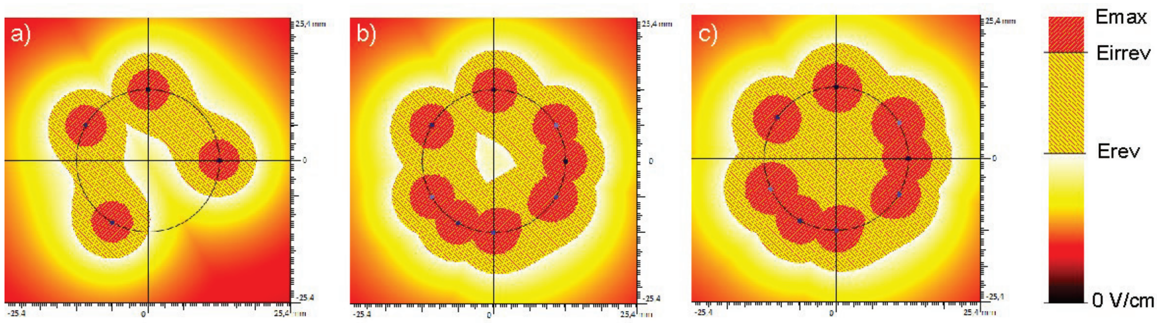

Figure 3: Electric field distribution within the tumor (inside the circle) and within its surrounding tissue (outside the circle) obtained with three different selection of parameters (number and position of electrodes and voltage applied): (a) 4 electrodes, (b) 8 electrodes and (c) 8 electrodes with increased voltage on electrodes so that the entire volume of tumor is exposed to the $E_{rev} < E < E_{irrev}$.

After the e-learning course the pedagogical efficiency of presented educational content and the e-learning application usability will be evaluated.

FURTHER READING:

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Edhemovic I, Gadzijev EM, Brecelj E, Miklavcic D, Kos B, Zupanic A, Mali B, Jarm T, Pavliha D, Marcan M, Gasljevic G, Gorjup V, Music M, Pecnik Vavpotic T, Cemazar M, Snoj M, Sersa G. Electrochemotherapy: A new technological approach in treatment of metastases in the liver. *Technol Cancer Res Treat* 10:475-485, 2011.

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NOTES & RESULTS