Name of the Institution: University of Ljubljana

Web: http://www.uni-lj.si/en/

Name of the TEMPUS CRH-BME representative (for your Institution):
Prof. Damijan Miklavcic

BME GROUP/LABORATORY PRESENTATION

Full name of the group:
Laboratory of Biocybernetics
Department of Biomedical Engineering
Faculty of Electrical Engineering, University of Ljubljana
Head: prof. Damijan Miklavcic
Homepage: http://lbk.fe.uni-lj.si/

Since its foundation in 1963 the Laboratory of Biocybernetics has been involved in the study of interaction between electromagnetic fields (EMFs) and biological systems. This includes both the investigation of harmful effects of EMFs on organisms and the exploitation of beneficial effects of EMFs for therapeutic and diagnostic purposes. During the period from the mid-1960s to the end of the 1970s, the major research topic was Functional Electrical Stimulation (FES). Since 1980s, our main field of research are the investigations of the influence of electric currents and electromagnetic fields on the physiological state of cells, tissues, organs, and the body as a whole. The major direction pursued in our group is cell membrane electroporation with its applications in biology, biotechnology, and medicine, particularly electrochemotherapy of tumors (ECT) and gene therapy based on gene electrotransfer (EGT). To gain an insight into the studied phenomena, we are determining, both analytically and numerically, the distribution of currents and fields within cell suspensions and tissues. We are also developing the electronic devices for application in these fields of research, as well as information technology for clinical trials. We are cooperating with several research institutions and industrial partners from around Europe. Within the CLINIPORATOR project of the 5th EU Framework (2000-2003), we have collaborated with partners from France, Belgium, Denmark, Germany, Italy, and Sweden, in developing a prototype of a clinical electroporator – a device for ECT and EGT in patients. Within the ESOPE project (www.cliniporator.com) of the 5th EU Framework (2003-2005), we have worked with four medical and research centers from France, Denmark, Ireland, and Slovenia, in establishing standard operating procedures for electrochemotherapy and electrogenetherapy. Within the ANGIOSKIN project of the 6th EU framework (since 2005) we teamed up with partners from France, Belgium, Italy, Denmark and Germany in developing a system for skin EGT, which is characterized by delivering the genetic material and electric pulses through hollow needle microelectrodes.

BME EDUCATION

COURSES AVAILABLE IN ENGLISH? (IF YES, ON WHICH LEVEL?)

- BSc: 0
- MSc: 0
- PhD: 0

ECTS: Total number

- BSc: 0
- MSc: 0
- PhD: 0

BILATERAL AGREEMENTS WITH OTHER UNIVERSITIES? (LIST THOSE UNIVERSITIES)

NONE

MAIN BME INTERESTS

- Electroporation and electroporation-based technologies
- Biomedical instrumentation and signal processing

ACTIVE PROJECTS

National

- Research Programme: Electroporation-Based Technologies and Treatments (2009-2014)
- Infrastructure Programme: Network of research infrastructure centers at University of Ljubljana (2009-2014)
- Center of Competence: Biomedical Engineering (2011-2013)
- New Lipid Model Systems for Determination of Electroporation Basic Mechanisms (2010-2013)
- Drug Delivery Into and Across the Skin by Means of Electroporation, Iontophoresis and Radiofrequency Heating (2009-2012)
- Development of Methods and Systems for Risk Assessment in Various Target Groups Exposed to EMF (2009-2012)
- Unifying Method for Generating Milli, Micro and Nanosecond Electropermeabilization Signals for Effective Gene Electrotransfection (2009-2011)
- Synthesis of new ruthenium compounds and their application in tumor electrochemotherapy (2008-2011)

International

- Argentinian-Slovenian Cooperation in Science and Technology: Electrochemo-therapy of Tumors: Numerical and Experimental Models (2009-2011)
- Austrian-Slovenian Cooperation in Science and Technology: Ruthenium Compounds and their Possible Applications in Electrochemotherapy (2009-2010)
- Croatian-Slovenian Cooperation in Science and Technology: Numerical Modeling of Electric Field Distribution in Electrochemotherapy of Esophagus Malignant Tumors (2009-2010)
- French-Slovenian Scientific Cooperation (PROTEUS programme): Optimization of Electroporation Protocols for Gene Transfection In Vitro (2011-2012)
- French-Slovenian Scientific Cooperation (PROTEUS programme): Electroporation of Planar Lipid Bilayers; Experimental and Molecular Dynamics Approach (2010-2011)
- German-Slovenian Scientific Cooperation: High Electric Field Diagnostics of Intracellular Organelles (2005-)
- Romanian-Slovenian Scientific Cooperation: Study of cells electrical properties and functional status after electroporation (2010-2011)
- USA-Slovenian Scientific Cooperation: Optimization of pulse parameters for electroporation of cellular organelles (2011-2012)

RECENT PUBLICATIONS (LAST 2 YEARS)

2010

- Batista Napotnik T, Reberšek M, Kotnik T, Lebrasseur E, Cabodevila G, Miklavčič D. Electropermeabilization of endocytotic vesicles in B16 F1 mouse melanoma cells. Med. Biol. Eng. Comput. 48: 407-413, 2010.
- Čemažar M, Jarm T, Serša G. Cancer electrogene therapy with Interleukin-12. Curr. Gene Ther. 10: 300-311, 2010.
- Čorović S, Županič A, Kranjc S, Al Sakere B, Leroy-Willig A, Mir LM, Miklavčič D. The influence of skeletal muscle anisotropy on electroporation: in vivo study and numerical modeling. Med. Biol. Eng. Comput. 48: 637-648, 2010.
- Daugimont L, Baron N, Vandermeulen G, Pavšelj N, Miklavčič D, Jullien MC, Cabodevila G, Mir LM, Préat V. Hollow microneedle arrays for intradermal drug delivery and DNA electroporation. J. Membrane Biol. 236: 117-125, 2010.
- Faurie C, Reberšek M, Golzio M, Kandušer M, Escoffre JM, Pavlin M, Teissié J, Miklavčič D, Rols MP. Electro-mediated gene transfer and expression are controlled by the life-time of DNA/membrane complex formation. J. Gene Med. 12: 117-125, 2010.
- Haberl S, Miklavčič D, Pavlin M. Effect of Mg ions on efficiency of gene electrotransfer and on cell electropermeabilization. Bioelectrochemistry 79: 265-271, 2010.
- Haberl S, Pavlin M. Use of collagen gel as a three-dimensional in vitro model to study electropermeabilization and gene electrotransfer. J. Membrane Biol. 236: 87-95, 2010.
- Hudej R, Turel I, Kandušer M, Ščančar J, Kranjc S, Serša G, Miklavčič D, Jakupec MA, Keppler BH, Čemažar M. The influence of electroporation on cytotoxicity of anticancer ruthenium (III) complex KP1339 in vitro and in vivo. Anticancer Res. 30: 2055-2064, 2010.
- Jarm T, Čemažar M, Miklavčič D, Serša G. Antivascular effects of electrochemotherapy: implications in treatment of bleeding metastases. Expert Rev. Anticancer Ther. 10: 729–746, 2010.
- Kljun J, Petriček S, Žigon D, Hudej R, Miklavčič D, Turel I. Synthesis and characterization of novel ruthenium(III) complexes with histamine. Bioinorg. Chem. Appl. 2010: 183097, 2010.
- Kos B, Valič B, Kotnik T, Gajšek P. Poklicna izpostavljenost elektomagnetnim sevanjem. Elektroteh. Vestn. 77: 200-207, 2010.

- Kos B, Županič A, Kotnik T, Snoj M, Serša G, Miklavčič D. Robustness of treatment planning for electrochemotherapy of deep-seated tumors. J. Membrane Biol. 236: 147-153, 2010.
- Kotnik T, Pucihar G, Miklavčič D. Induced transmembrane voltage and its correlation with electroporation-mediated molecular transport. J. Membrane Biol. 236: 3-13, 2010.
- Kranjc M, Županič A, Miklavčič D, Jarm T. Numerical analysis and thermographic investigation of induction heating. Int. J. Heat Mass Transfer 53: 3585-3591, 2010.
- Marjanovič I, Haberl S, Miklavčič D, Kandušer M, Pavlin M. Analysis and comparison of electrical pulse parameters for gene electrotransfer of two different cell lines. J. Membrane Biol. 236: 97-105, 2010.
- Miklavčič D. Objavljanje rezultatov raziskav – pisanje člankov. Elektroteh. Vestn. 77: 75-84, 2010.
- Miklavčič D, Snoj M, Županič A, Kos B, Čemažar M, Kropivnik M, Bračko M, Pečnik T, Gadžijev E, Serša G. Towards treatment planning and treatment of deep-seated solid tumors by electrochemotherapy. Biomed. Eng. Online 9: 10, 2010.
- Miklavčič D, Towhidi L. Numerical study of the electroporation pulse shape effect on molecular uptake of biological cells. Radiol. Oncol. 44: 34-41, 2010.
- Olaiz N, Maglietti F, Suarez C, Molina FV, Miklavčič D, Mir L, Marshall G. Electrochemical treatment of tumors using a one-probe two-electrode device. Electrochim. Acta. 55: 6010-6014, 2010.
- Pavlin M, Flisar K, Kandušer M. The role of electrophoresis in gene electrotransfer. J. Membrane Biol. 236: 75-79, 2010.
- Trontelj K, Ušaj M, Čurin Šerbec V, Miklavčič D. Zlivanje celic z elektrofuzijo. Med. Razgl. 49: 247-254, 2010.
- Trontelj K, Ušaj M, Miklavčič D. Cell electrofusion visualized with fluorescence micro-scopy (Video Article). J. Visual Exp. 41: 1991, 2010. [FLV (video)] [PDF (abstract)]
- Ušaj M, Trontelj K, Miklavčič D, Kandušer M. Cell–cell electrofusion: Optimization of electric field amplitude and hypotonic treatment for mouse melanoma (B16-F1) and Chinese hamster ovary (CHO) cells. J. Membrane Biol. 236: 107-116, 2010.
- Vrhovec J, Rudel D, Pajntar M, Maček Lebar A. A uterine electromyographic activity as a measure of labour progression. Zdrav. Vestn. 79: 109-116, 2010.
- Županič A, Čorović S, Miklavčič D, Pavlin M. Numerical optimization of gene electrotransfer into muscle tissue. Biomed. Eng. Online 9: 66, 2010.

2009

- Čorović S, Bešter J, Miklavčič D. An e-learning application on electrochemotherapy. Biomed. Eng. Online 8: 26, 2009.
- Kandušer M, Miklavčič D, Pavlin M. Mechanisms involved in gene electrotransfer using high- and low-voltage pulses — An in vitro study. Bioelectrochemistry 74: 265-271, 2009.
- Kramar P, Miklavčič D, Maček Lebar A. A system for the determination of planar lipid bilayer breakdown voltage and its applications. IEEE T. Nanobiosci. 8: 132-138, 2009.
- Kramar P, Miklavčič D, Maček Lebar A. Merjenje lastnosti ravninskih lipidnih dvoslojev. Elektroteh. Vestn. 76: 293-298, 2009.
- Kranjc M, Županič A, Jarm T, Miklavčič D. Optimizacija indukcijskega segrevanja z numeričnim modeliranjem in genetskim algoritmom. Elektroteh. Vestn. 76: 63-68, 2009.
- Lacković I, Magjarević R, Miklavčič D. Three-dimensional finite-element analysis of joule heating in electrochemotherapy and in vivo gene electrotransfer. IEEE T. Diel. El. Insul. 15: 1338-1347, 2009.
- Mazères S, Šel D, Golzio M, Pucihar G, Tamzali Y, Miklavčič D, Teissié J. Non invasive contact electrodes for in vivo localized cutaneous electropulsation and associated drug and nucleic acid delivery. J. Control. Release 134: 125-131, 2009.
- Pavlin M, Miklavčič D. The effective conductivity and the induced transmembrane potential in dense cell system exposed to DC and AC electric fields. IEEE T. Plasma Sci. 37: 99-106, 2009.
- Pavlović I, Kern T, Miklavčič D. Comparison of paper-based and electronic data collec-tion process in clinical trials: Costs simulation study. Contemp. Clin. Trials 30: 300-316, 2009.
- Pucihar G, Kotnik T, Miklavčič D. Measuring the induced membrane voltage with di-8-ANEPPS (Video Article). J. Visual Exp. 33: 1659, 2009.
- Pucihar G, Miklavčič D, Kotnik T. A time-dependent numerical model of transmembrane voltage inducement and electroporation of irregularly shaped cells. IEEE T. Biomed. Eng. 56: 1491-1501, 2009.
- Reberšek M, Kranjc M, Pavliha D, Batista Napotnik T, Vrtačnik D, Amon S, Miklavčič D. Blumlein configuration for high-repetition-rate pulse generation of variable duration and polarity using synchronized switch control. IEEE T. Biomed. Eng. 56: 2642-2648, 2009.
- Sabotin I, Maček Lebar A, Miklavčič D, Kramar P. Measurement protocol for planar lipid bilayer viscoelastic properties. IEEE T. Diel. El. Insul. 15: 1236-1242, 2009.

- Todorović V, Serša G, Flisar K, Čemažar M. Enhanced cytotoxicity of bleomycin and cisplatin after electroporation in murine colorectal carcinoma cells. Radiol. Oncol. 43: 264-273, 2009.
- Ušaj M, Trontelj K, Hudej R, Kandušer M, Miklavčič D. Cell size dynamics and viability of cells exposed to hypotonic treatment and electroporation for electrofusion optimization. Radiol. Oncol. 43: 108-119, 2009.
- Valič B, Gajšek P, Miklavčič D. Current density in a model of a human body with a conductive implant exposed to ELF electric and magnetic fields. Bioelectromagnetics 30: 591-599, 2009.
- Vrhovec J. Evaluating the progress of the labour with sample entropy calculated from the uterine EMG activity. Elektroteh. Vestn. 76: 165-170, 2009.

COLLABORATION WITH OTHER INSTITUTIONS (OPTIONAL)

Universities:

- Université catholique de Louvain (Brussels, Belgium)
- University of Zagreb (Zagreb, Croatia)
- Universität Bielefeld (Bielefeld, Germany)
- Sewanee University of the South (Sewanee, Tennessee, USA)

Research Centers:

- Institute of Oncology Ljubljana (Ljubljana, Slovenia)
- Jozef Stefan Institute (Ljubljana, Slovenia)
- Institut de Pharmacologie et de Biologie Structurale (Toulouse, France)

Medical Institutions:

- Institute of Oncology Ljubljana (Ljubljana, Slovenia)
- Institut Gustave-Roussy (Villejuif, France)

Other (industrial partners):

- Igea S.p.A. (Modena, Italy)
- ISKRA Medical (Ljubljana, Slovenia)