Design of a System for Measurement of Electrically-Stimulated cardiac Myocyte Transmembrane Potential Variations with mechanical Stretch using a Fluorescent Approach

James E. Duverger[1], Philippe Comtois[1,2]
[1]*Montreal Heart Institute*
[2]*Department of Physiology, Institute of Biomedical Engineering – Université de Montréal*

Cardiomyocytes are electrically-active heart cells whose electrical properties vary with the environment electrical and mechanical characteristics. Variations in myocytes electrical properties are known to play a role on abnormal rhythms.

The purpose of the project is to design a system for measurement of the transmembrane voltage variations of electrically-stimulated cardiomyocytes under different mechanical stretch levels using a fluorescent approach.

The isolated cardiomyocytes are seeded on a 10mm x 10mm x 0.127mm silicon sheet held by a pair of pliers, coupled to a stretcher apparatus made of a linear guide system an a computer controlled linear stepper motor. The cells are kept in bubbled Krebs solution and are electrically stimulated during the 10 minutes staining by the voltage-sensitive dye di-4-Anepps (Invitrogen) at 10 mmol/L concentration. Field electrical stimulation is done by a pair of carbon electrodes whose anode is grounded and cathode receiving voltage from a digital to analog converter (TLC7226CN). The light source is a green LED array (wavelength = 523nm, NTE Electronics Inc.), with intensity controlled by a Darlington array receiving TTL signals. The emitted fluorescence is filtered ($\lambda > 610$nm), converted to voltage with a fast photodiode (S1226-5BK, Hamamatsu), and amplified by an instrumentation amplifier (AD524ADZ, Analog Digital Inc). The voltage is then digitized with a National Instruments card (NI USB-6221), and saved for post-experiment analysis. Each sub-system of the bioinstrument has been tested separately. The whole system is being tested with cardiac-derived HL1 cells for quantification of the signal-to-noise ratio and optimization of excitation intensity.