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Presentation Abstract

Program#/Poster#: 390.18/HH26

Title: A novel mea bioreactor measuring neural network activity continuously over long periods to study synaptic plasticity and pharmacological outcomes

Location: South Hall A

Presentation Time: Monday, Oct 19, 2009, 9:00 AM -10:00 AM

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Abstract: The ability of culturing neurons for a long time on MicroElectrode Array (MEA) devices plays a critical role in understanding some long-term behaviors of a neuronal network, such as the long-term synaptic plasticity. Moreover, pharmacological outcomes usually requires long recordings to evaluate the complete effects in the culture activity.
Applications involving MEAs in long-term analysis suffer from some limits imposed by the current experimental setup. The neurons, cultured on the MEA slices, are housed in an incubator; then they are extracted to record network electrical activity. This procedure can damage the cells (i.e. pH variation, sterility problems, medium evaporation) causing a gradual decline in the health of these cultures and, eventually, the cells apoptosis. Therefore experiments must be limited in time. Lots of solutions are in literature: some of them improve the cells survival but they need of an external incubator; others try to realize independent systems, able to autonomously control temperature, humidity and sterility but not gasses.
In this work we present the technological development of an experimental system to measure neural network activity with MEAs continuously over long periods in a controlled atmosphere. The bioreactor described aimed to overcome the above-mentioned limits, in order to provide a single tool that record and process on-line neuronal action potentials without the need of an external incubator.
The incubating chamber prototype was designed with Pro-Engineer Wildfire. It

was produced, from a cylinder block in polymethylmethacrylate (PMMA - Plexiglas), using rapid prototyping method (Roland Modela MDX-40). The MEA housing and a symmetrical small chamber, the temperature reference, were realised in the bigger one. The heating was obtained bathing a termoresistance in a water bath surrounding the incubating chamber. The gasses and the humidity control (95% Air, 5% CO_2; 95% steam) were developed using a commercial CO_2 and bubbling module. The electronic for the activity recording was placed on the external top of the device. The whole system was sterilized with Ethylene Oxide (ETO) in order to assure sterility requirement. Software simulations were used to optimize the on-line spike detection and clustering for future implementation on hardware.Preliminary prototype validation on biological environment shows a good capability of cells growth and preservation for long time; moreover, MEA's electrodes seem not to be spoiled by the incubating environment.

Disclosures: **E. Biffi**, None; **D. Ghezzi**, None; **A. Pedrocchi**, None; **G. Fiore**, None; **G. Ferrigno**, None.

Keyword(s): MICROELECTRODE

SYNAPTIC PLASTICITY

NEUROPLASTICITY

Support: MIUR Grant 2006093522_002, 2006

IIT grant on Biosensors and artificial biosystems

[Authors]. [Abstract Title]. Program No. XXX.XX. 2009 Neuroscience Meeting Planner. Chicago, IL: Society for Neuroscience, 2009. Online.