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[P-17]

Low Density Patterned Neural Networks on Microelectrode Arrays using Microcontact Printing

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Neuronal networks were patterned with poly-L-lysine (PLL) using microcontact printing (μ CP). Polydimethylsiloxane (PDMS) stamps were fabricated with relief structures resulting in patterns of 2 μ m-wide lines for directing process growth and 20 μ m-diameter circles for cell soma attachment. During the stamping procedure, the PLL-inked circles were aligned to electrode sites in order to locate neuronal cell bodies in the vicinity of the recording electrode sites. Rat embryo hippocampal neurons were cultured on the stamped microelectrode arrays. Spontaneous activity was observed at 10-14 days in networks using neuron densities as low as 200cells/mm². Synaptic activity was monitored using microelectrode arrays (MEAs). Immunocytochemistry demonstrated the distribution of dendrites along the lines and the location of foci of the presynaptic protein, synaptophysin, on neuron somas and dendrites. Scanning electron microscopy demonstrated single fluorescent tracks contained multiple processes. Evoked responses of selected portions of the networks were produced by electrical current stimulation of specific electrodes sites. In addition, the pharmacological characteristics were examined by the bath application of high K⁺ (10-12 mM) and the application of DNQX, an AMPA antagonist, which blocked all spontaneous activity, suggesting that the activity is excitatory and mediated through glutamate receptors.

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- [2] James C, Spence A, Dowell-Mesfin N, Hussain R, Smith K, Craighead H, Isaacson M, Shain W, Turner J, Extracellular recording from patterned neuronal networks using planar microelectrode arrays. IEEE Trans Biomed Eng 2004;51;1640-8.