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In-cell recording and stimulation of neural activity by engulfed microelectrodes

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Currently, neuroscientists study the electrical activity of large populations of neurons using arrays of extracellular microelectrodes (MEAs). Whereas this technology permits high density, simultaneous, long-term recording of extracellular field potentials, it is "blind" to sub threshold synaptic potentials generated by single cells and thus precludes the deciphering of large-scale processes of plasticity, learning and memory. Intracellular recordings of the full electrophysiological spectrum which includes sub threshold synaptic potentials, membrane oscillations and action potentials, are obtained only by the traditional sharp- or patch-microelectrodes and are limited to single cells at a time and for short periods of time.

Here, the development of novel arrays of protruding mushroom-shaped microelectrodes is presented. This neuro-electronic sensor is based on three converging cell biological principles: (1) the activation of endocytotic mechanisms by which the cultured cells are induced to actively engulf the protruding electrodes, (2) the tightening of the cleft between the cell's membrane and the engulfed electrode, generating high seal resistance, and (3) the localization of ionic channels in the plasma membrane that faces the active region of the sensor. This technology merges the advantages of extracellular MEAs and intracellular microelectrodes and enables for the first time long-term, multi-site, parallel in-cell recording of intracellular sub threshold neuronal events. Further development and application of this sensing modality will help steer brain-circuit research toward previously uncharted territories.

Biography

Aviad Hai has completed his Ph.D. from The Hebrew University and is now a postdoctoral fellow at the Massachusetts Institute of Technology. He has won the prestigious Edmond and Lili Safra Brain Center (ELSC) fellowship and the European Molecular Biology Organization (EMBO) fellowship. He is the first author of highly cited papers in the field of biosensors published in top journals such as Nature Methods, Lab-on-Chip and Biosensors & Bioelectronics.

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