Hippocampal neuron

Determining cell types is critical for understanding neural circuits but remains elusive in the living human brain. Current approaches discriminate units into putative cell classes using features of the extracellular action potential (EAP); in absence of ground truth data, this remains a problematic procedure.

Mosher et al. find that EAPs in deep structures of the brain exhibit robust and systematic variability during the cardiac cycle. These cardiac-related features refine neural classification. We use these features to link bio-realistic models generated from in vitro human whole-cell recordings of morphologically classified neurons to in vivo recordings. We differentiate aspiny inhibitory and spiny excitatory human hippocampal neurons and, in a second stage, demonstrate that cardiac-motion features reveal two types of spiny neurons with distinct intrinsic electrophysiological properties and phase-locking characteristics to endogenous oscillations. This multi-modal approach markedly improves cell classification in humans, offers interpretable cell classes, and is applicable to other brain areas and species [1].

Kaech et al. provided protocols for preparing low-density dissociated-cell cultures of hippocampal neurons from embryonic rats or mice. The neurons are cultured on polylysine-treated coverslips, which are suspended above an astrocyte feeder layer and maintained in serum-free medium. When cultured according to this protocol, hippocampal neurons become appropriately polarized, develop extensive axonal and dendritic arbors and form numerous, functional synaptic connections with one another. Hippocampal cultures have been used widely for visualizing the subcellular localization of endogenous or expressed proteins, for imaging protein trafficking and for defining the molecular mechanisms underlying the development of neuronal polarity, dendritic growth and synapse formation. Preparation of glial feeder cultures must begin 2 weeks in advance, and it takes 5 d to prepare coverslips as a substrate for neuronal growth. Dissecting the hippocampus and plating hippocampal neurons takes 2-3 h [2].

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Mosher CP, Wei Y, Kamiński J, Nandi A, Mamelak AN, Anastassiou CA, Rutishauser U. Cellular Classes in the Human Brain Revealed In Vivo by Heartbeat-Related Modulation of the Extracellular Action Potential Waveform. Cell Rep. 2020 Mar 10;30(10):3536-3551.e6. doi: 10.1016/j.celrep.2020.02.027. PubMed PMID: 32160555.
2)
Kaech S, Banker G. Culturing hippocampal neurons. Nat Protoc. 2006;1(5):2406-15. Epub 2007 Jan 11. PubMed PMID: 17406484.