Brain-on-a-chip Engineering

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Bibliography

Education and Training

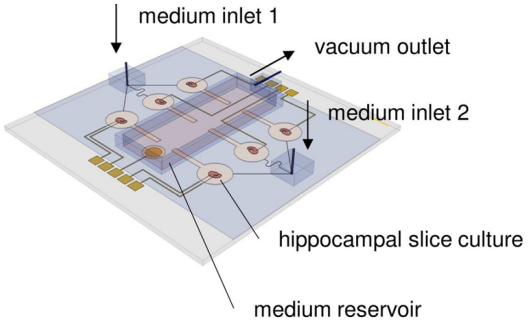
1999 – B.S. in Electrical Engineering and Computer Science, UC Berkeley
2002 – M.S. in Electrical and Computer Engineering, UC San Diego
2006 – Ph.D. in Electrical and Computer Engineering, UC San Diego
2006 - 2010 Postdoctoral Fellow, Center for Engineering in Medicine, Massachusetts General Hospital/Shriners Burns Hospital
2010 – 2011 Postdoctoral Fellow, Department of Neurology, Massachusetts General Hospital/Harvard Medical School

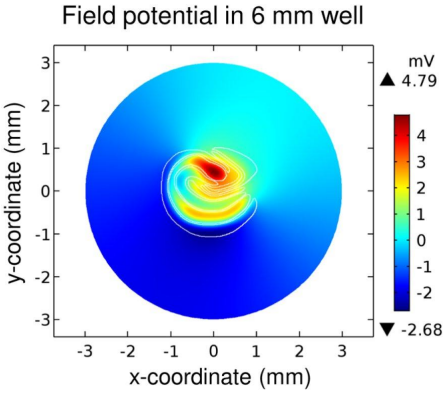
Recent Publications

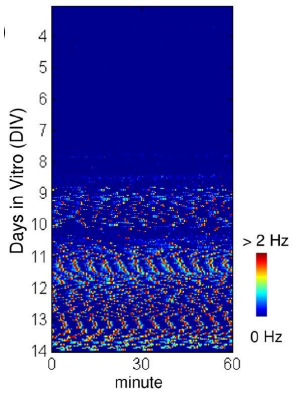
- Abedin MJ, Michelhaugh SK, Mittal S, Berdichevsky Y. 3D models of glioblastoma interaction with cortical cells. *Front Bioeng Biotechnol*. 2023 Mar 9;11:1150772. doi: 10.3389/fbioe.2023.1150772.
- Berdichevsky Y. Neuron-neuron attraction shapes morphology and activity of tissue engineered brain constructs. *Neural Regen Res.* 2022 Dec;17(12):2655-2656. doi: 10.4103/1673-5374.335815.
- Hasan MF, Berdichevsky Y. Neuron and astrocyte aggregation and sorting in three-dimensional neuronal constructs. *Commun Biol*. 2021 May 17;4(1):587. doi: 10.1038/s42003-021-02104-2.
- Ming Y, Abedin MJ, Tatic-Lucic S, Berdichevsky Y. Microdevice for directional axodendritic connectivity between micro 3D neuronal cultures. *Microsyst Nanoeng.* 2021 Sep 1;7:67. doi: 10.1038/s41378-021-00292-9.

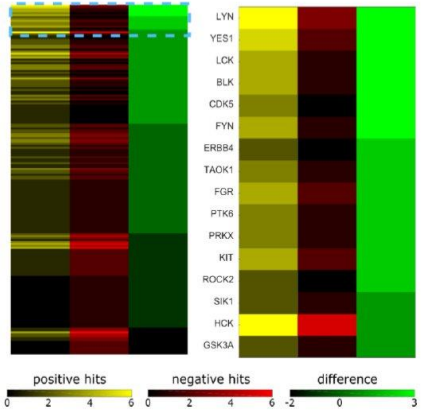
Keywords: brain-on-a-chip, epilepsy, neural network, 3D cortical models, living computer.

Epilepsy-on-a-chip









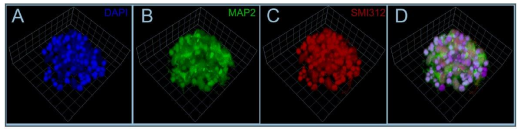
What is the technology being studied?
In vitro modeling of the development of epilepsy

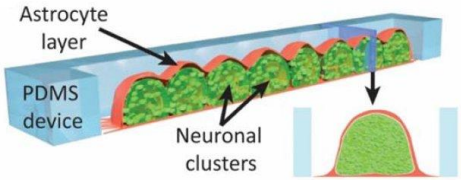
Why is this topic significant?
There are no drugs that can prevent or cure epilepsy. Animal models represent a significant bottleneck in the drug discovery pipeline. In vitro models can accelerate discovery of new treatments.

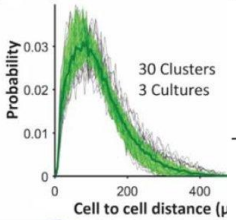
How is this topic studied?
Microfluidic devices, organotypic hippocampal slice cultures, electrode arrays and calcium imaging, biomarkers.

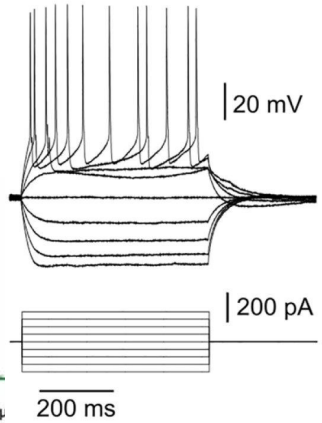
Future directions
Use of human derived cells and re-constructed tissues

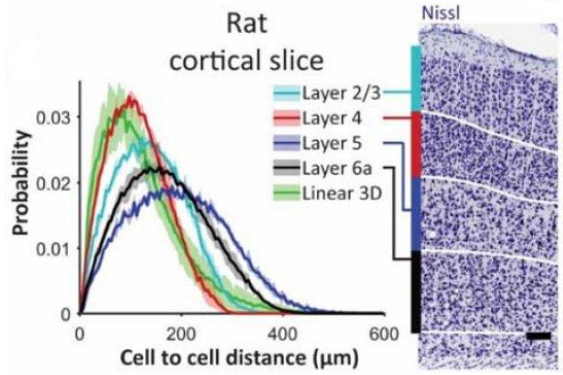
3D Cortex in Vitro

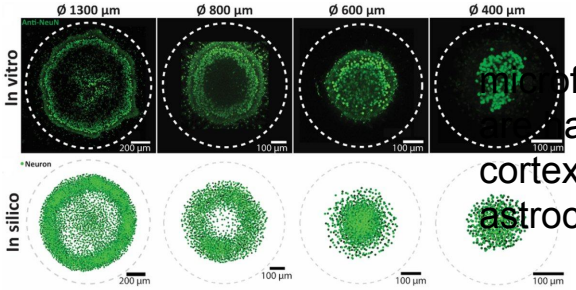












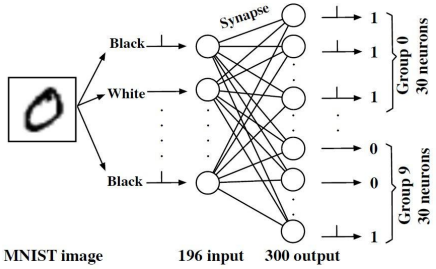
What is the technology being studied?
Engineering of 3D mammalian cortex *in vitro*

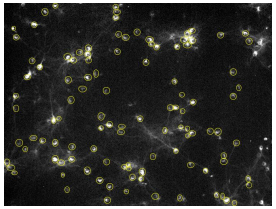
Why is this topic significant?
Neurodevelopmental and neurodegenerative disorders are a significant health burden. Development of new treatments can benefit from improved models capable of supporting high throughput experimentation

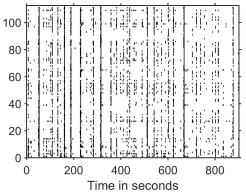
How is this topic studied?
Cell aggregation and sorting, microfabrication and tissue micro-confinement are harnessed to create models of 3D cortex from dissociated neurons and astrocytes

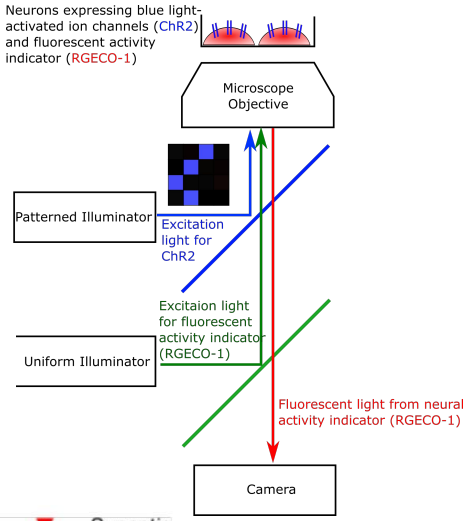
Future directions
Use of human cells, control of neural circuit formation

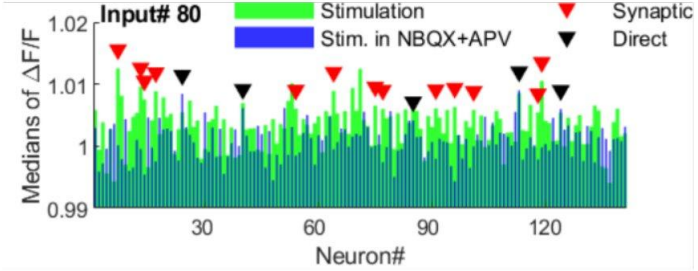
Living Neural Network











What is the technology being studied?
Inference and learning in a network composed of living neurons

Why is this topic significant?
Biological neural networks are more energy efficient than their *in silico* analogs. Improved understanding of computation in biological networks could lead to improved hardware and algorithms for machine learning.

How is this topic studied?
Networks formed *in vitro* from dissociated rat cortical neurons, optogenetics, patterned light stimulation.

Future directions
Modeling of neurological and psychiatric disorders

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