Genetic Dissection of Cortical Circuits: From Cell Types to Motor Control

January 14

Tuesday, 12:30 pm

Weekly Colloquium

Billings Building
Rosedale Conference Room

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Abstract

An enduring challenge in neuroscience is to decipher the cellular basis underlying the functional architecture of the cerebral cortex that processes information and guides intelligent behavior. Despite its immense cellular complexity, certain fundamental aspects of cortical organization (e.g., major inter-areal processing streams, output channels, and local circuit templates) are stereotypic among individuals of the same species and are conserved across mammals. These basic network scaffolds and circuit modules are implemented by a large set of cardinal types of glutamatergic projection neurons (forming myriad processing streams and output channels) and GABAergic interneurons (forming local connectivity motifs), which are reliably generated through developmental programs rooted in the genome. These first principles provide the basis for a genetic dissection of cortical organization through systematic screening and fate mapping of its major circuit elements - a successful approach to neural circuits in Drosophila and the vertebrate spinal cord. The overarching theme of my research is to understand general principles underlying the assembly and organization of cortical circuitry by integrating multi-faceted studies of neuron types in the functional context of motor control in the mouse. In this talk, I will present 1) a summary of the systematic genetic targeting of glutamatergic projection neurons and GABAergic interneurons, 2) a discovery that GABAergic neuron types can be defined by their synaptic communication properties encoded in key transcriptional signatures, 3) progress in understanding a chandelier - pyramidal neuron microcircuit module, 4) recent findings on the functional organization and developmental trajectory of distinct pyramidal neuron types in controlling dexterous forelimb-orofacial movements and object manipulation.

1. Wang, B. S., Sarria, M. S. B., He, M., Crair, M. C., & Huang, Z. J. (2019). Retinal and callosal activity-dependent chandelier cell elimination shapes binocularity in primary visual cortex. bioRxiv, 612358.
2. Lu, J., Tucciarone, J., Padilla-Coreano, N., He, M., Gordon, J. A., & Huang, Z. J. (2017). Selective inhibitory control of pyramidal neuron ensembles and cortical subnetworks by chandelier cells. Nature neuroscience, 20(10), 1377.
3. Paul, A., Crow, M., Raudales, R., He, M., Gillis, J., & Huang, Z. J. (2017). Transcriptional architecture of synaptic communication delineates GABAergic neuron identity. Cell, 171(3), 522-539.

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