Network anatomy and *in vivo* physiology of visual cortical neurons

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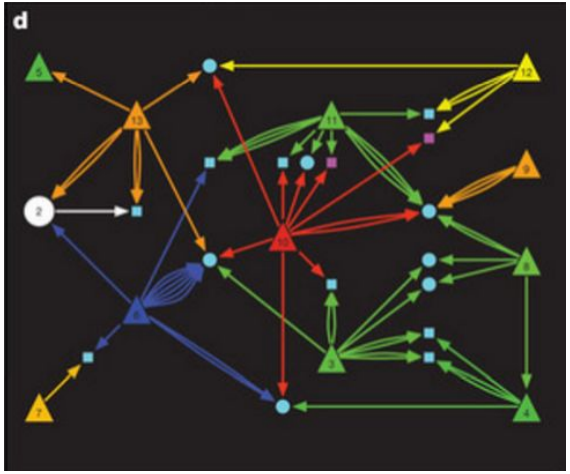
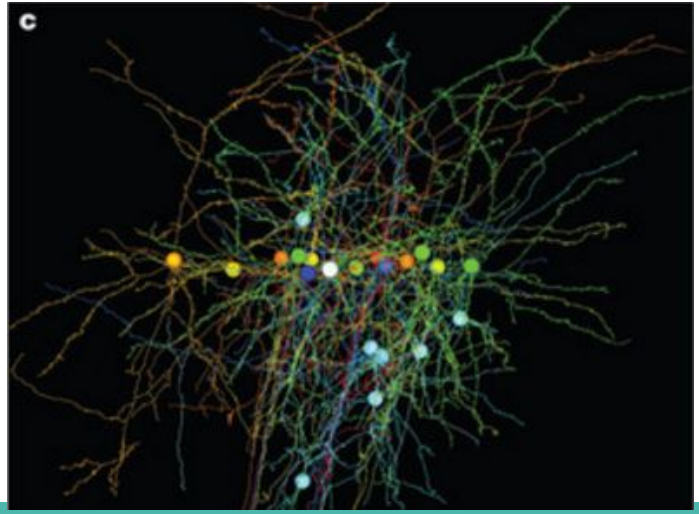
Presented by Eric Huang

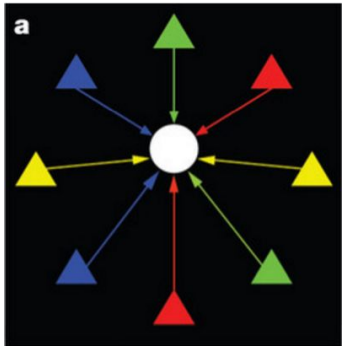
Summary

- Can we study the relationship between the structure and function of the cortex *in vivo*?
- How?
  - Two-photon calcium imaging
  - Electron microscopy
- Trace neuron network in mice visual cortex
- Where do excitatory neurons transmit to? In what pattern?





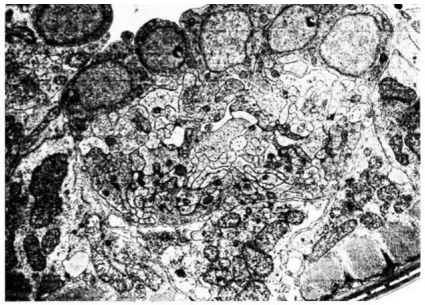
Opportunity

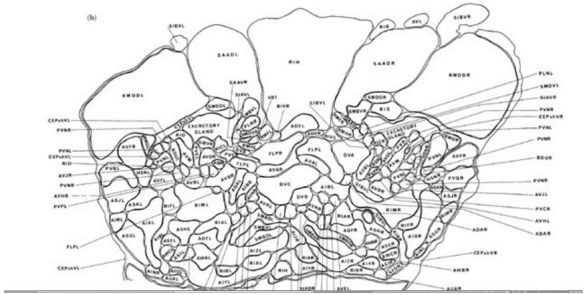


- Hypothesized neural patterns of connections shown using physiological data but not in living organisms
- Technology like EM is ideal for characterizing cortical network structure
- Improvement in computer speed and storage allow analysis of huge volume of cells

Challenge

- Incomplete understanding of network structure
- Limiting factors of computer speed and storage capacity

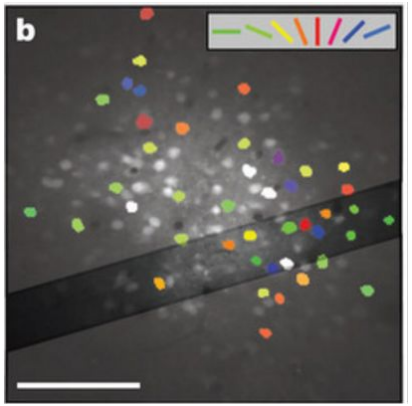


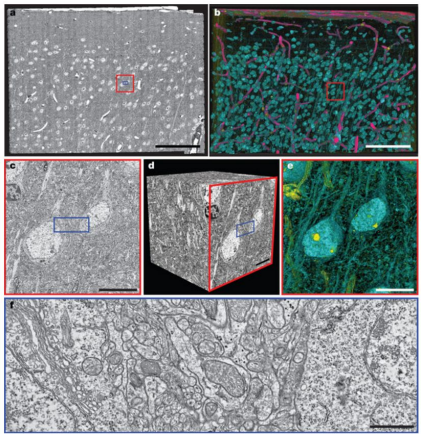


Action

Test stimulus orientation of group of neurons

- Use *in vivo* two-photon calcium imaging





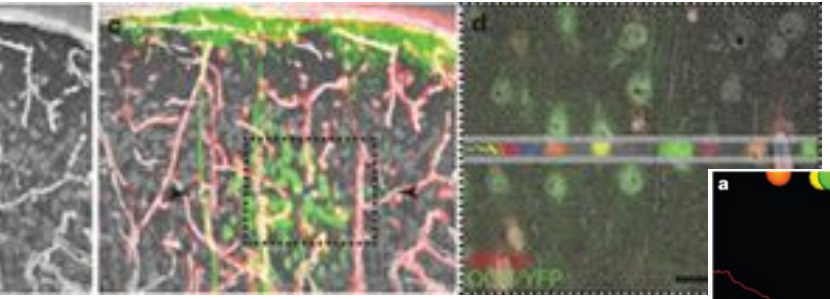
Get 3D TEM images of mice cortex tissue

- Slice up a bunch of tissue into very thin sections (40-45nm thick)
- Take pictures with TEM cameras
- Convert to 3D by stitching together image layers

Action

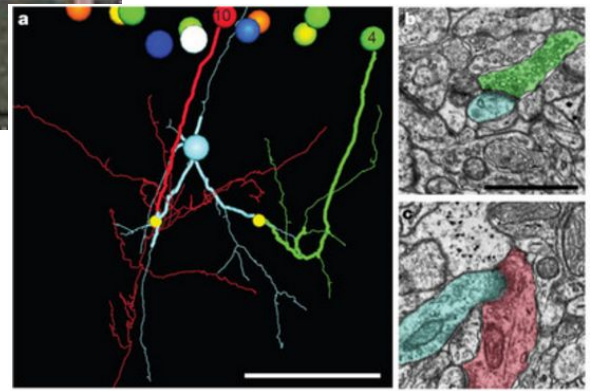
Categorize groups of cells based on function

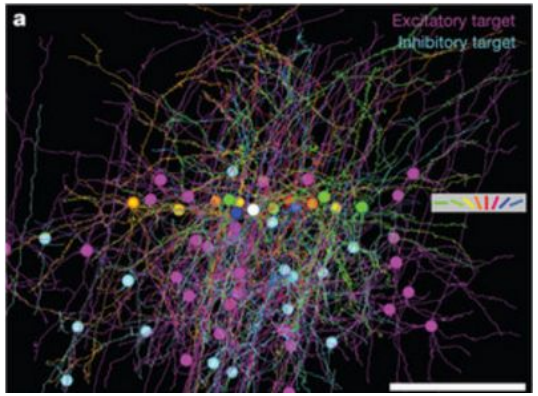
- Overlay calcium image with EM image



Trace neurons, noting location of each synapse

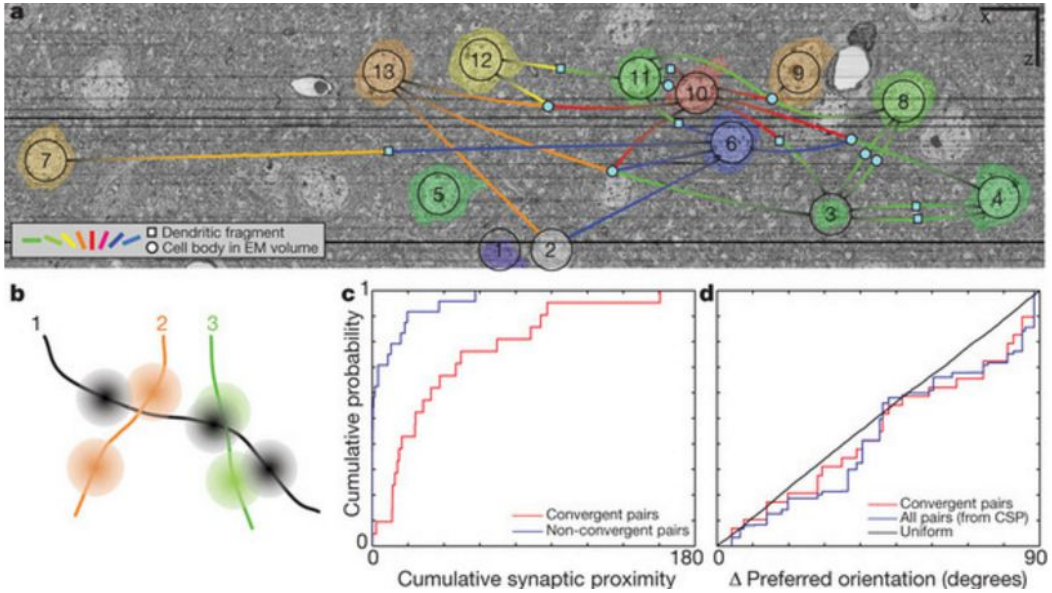
- Make a map of these connections
- Categorize as either excitatory or inhibitory





Resolution

“The strongest predictor of whether two axons converged on a common target was found by examining how many of their synapses were nearby in space”



Future

- Can link prediction from physiological data to actual anatomy
- More EM image volume will enable more connections to be traced
- Advancements in calcium imaging allow more data to be collected
- **= opportunities to understand how neuronal circuits process information**