Center for Cell and Genome Sciences, Crocker Science Building

- an introduction
- science at the center

Villu Maricq, director
Erik Jorgensen, professor
Center for Cell and Genome Sciences
Department of Biology
University of Utah
where is science going?
interdisciplinary studies

- **biology**
  - genetic engineering
  - building artificial life
  - brain engineering

- **physics**
  - breaking the light barrier
  - laser tweezers
  - photodiodes

- **chemistry**
  - nanotechnology
  - light generating molecules
  - light-activated ion channels

Center for Cell and Genome Sciences
the Cell
at the intersection of chemistry, physics and biology

engineering the genome, imaging proteins
scientific disciplines are tribal

How do you break down the academic boundaries?
- Interdepartmental centers
Center for Cell and Genome Sciences
AN INTERDISCIPLINARY FACULTY
breaking academic barriers

centerers

Villu Maricq, director
Erik Jorgensen
Markus Babst
Richard Clark
Julie Hollien

founders

physics

Saveez Saffarian
Michael Vershinin

chemistry

Mark Ji
Jennifer Heemstra

Center for Cell and Genome Sciences
http://ccgs.utah.edu/
Crocker Science Building
A COMMON BUILDING

Center for Cell and Genome Sciences
http://ccgs.utah.edu/
Center for Advanced Microscopy

CUTTING-EDGE TECHNOLOGY

http://www.research.utah.edu/advanced-microscopy/

In the Center for Cell and Genome Sciences
Science at the Center for Cell and Genome Science

next generation basic research, health sciences, technological innovation, education

I. Basic research: Memory

II. Health sciences: Spinal injury

III. Technological innovation: Breaking the light barrier - Vutara

IV. Undergrad education: interdisciplinary capstone projects

V. Crocker Science Center: the building
the human brain
the hippocampus is required for the acquisition of memory
damage to the hippocampus leads to the loss of formation of new memories
information processing in the brain
information processing in the brain

model:
memory is a change in strength of connections
neuron

axon

synapse
memories exist at synapses
working on the human brain is impractical

Vesalius - 1543
understanding processes via model systems

• simpler
• works the same way
a model system - the nematode

simple nervous system
conserved molecules with human brain
the synapse
Jorgensen lab: four proteins required for strength of synapses

- Gq
- phospholipase
- uncoordinated-13 (UNC-13)
- SNAREs

vesicle with neurotransmitter
mouse UNC13 function the same way
human UNC13 function in the human brain
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spinal cord injury - nerve cells cannot regenerate
Bastiani /Jorgensen: neurons regenerate in the worm

cut axons regenerate poorly
Bastiani /Jorgensen: neurons regenerate in the worm

Ex[p-unc-47::dlk-1]
5 min/frame  6 hr movie

improving axonal regeneration
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cultured hippocampal neuron

Rotary shadow electron microscope image of a cultured wild-type hippocampal neuron.
the Cell

the cell is composed of many membrane bound organelles

but where are the proteins?
Aequorea victoria

Aequorin converts calcium binding into blue light

Green fluorescent protein converts blue light into green light
tagging proteins with fluorescent proteins

synaptotagmin

green fluorescent protein converts blue light (488nm) into green light
synaptotagmin-GFP is in the nematode brain but is too crude to determine where the protein is in cells
Green-fluorescent protein

2.5 nm
light is irreducible

green fluorescent protein

2.5 nm
light is irreducible

444 nm
the diffraction limit of light

the Abbe limit:

In light microscopy, objects can only be resolved if their distance is at least half the wavelength (diffraction limited).

(Ernst Abbe 1840 – 1905)
the diffraction limit
the size limit of light is broken

Stefan Hell
Max Planck Institute, Goettingen Germany
bi-plane - 3D super-resolution microscopy

Joerg Bewersdorf  
Brian Bennett
Till iMic-based biplane PALM microscope
Biplane microscope

4 um beads coated with caged fluorescein
Vutara SR-200

biplane 3D PALM microscope

USA, Czech Republic, Switzerland, Israel

CEO Stan Kanarowski, Salt Lake City, UT
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scanning PALM

(1) X-Y scanning mirrors

(2) photomultiplier acquires time-stamped photons

why? 3D, more photons, less money
the microscope build
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Crocker Science Building

A COMMON BUILDING
for interdisciplinary science

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http://ccgs.utah.edu/
the Crocker Science Building
formerly the Museum of Natural History

the facade of the old natural history museum, circa 2005

courtesy of bryan jones - jonesblog
the Crocker Science Building
formerly the Museum of Natural History
dinosaur hall, circa 2005
the Crocker Science Building
originally the University of Utah Library

the reading room, circa 1931
to be renovated

http://www.research.utah.edu/advanced-microscopy/giving.html
Science at the Center for Cell and Genome Sciences
University of Utah

1. Basic research
2. Health sciences
3. Technology and economy
4. Education for future