Monitoring structural dynamics of single molecules in living cells

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Mehta et al., PNAS (2016)
Revealing order in living systems
Multi-dimensional imaging and data driven discovery

Mehta...Tani, PNAS 2016.
Design and Function of Superfast Muscle in Calling Fish

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Steve Baylor,
Steve Hollingworth,
Frank Nelson

Matt Kittelberger, Al Mensinger

Non-Calling Fish

Calling Fish

5% Duty Cycle

100% Duty Cycle
Let’s talk!
- Jellyfish ecology
- Imaging techniques
- Molecular techniques
- Anyone need to track some plankton?
- Other...
New microscopy techniques invented at the MBL/ Michael Shribak

Orientation-independent DIC

Polychromatic polscope

E-mail: mshribak@mbl.edu
Origin and evolution of the vertebrate body plan
Andrew Gillis, Department of Zoology, University of Cambridge
Conserved effector proteins of metazoan immune systems – Peter Armstrong (UC Davis)

- The thiol-ester proteins, C3, C4, & C5 of the complement pathway, the $\alpha_2$-macroglobulins
- The pentraxins, C-reactive protein (CRP), serum amyloid-P component (SAP)
- Extracellular blood clot, fibrinogen/thrombin (vertebrates), coagulogen/cotting enzyme (Limulus)
Control of Cell Proliferation and Neurogenesis in the Visual System of Xenopus Tadpoles

Optic tectum

pSox2-bd::RFP / mitoGFP

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Light sheet imaging of neural responses in living organisms

**Research interests:**
- how is neuronal excitability regulated? hunger, sleep, learning, aging
- how do neural circuits drive behavioral choices? - attention during conflicting stimuli
- worm models of neuropsychiatric disorders
- screening chemical modulators of neural activity

**Neural Activity**
- calcium responses, many animals, many stimuli

**Microfluidics & Behavior**
- spatial and temporal chemical patterns

**3D Light Sheet Microscopy (Lillie 219)**
- less photobleaching than confocal
- isotropic xyz resolution

**Hydrogel Encapsulation**
- fast, gentle sample immobilization

**Long-term Imaging (hours)**
- 5 min
- 100% ΔF/F₀
- 617 nm LED
- coverslip
- hydrogel disk
- buffer
- 3D stage
- Piezoelectric objective stage
- Sample holder
- Z translation
- Excitation A
- Excitation B
- Camera A
- Camera B
- Camera C
- Lens
- Emission filter
- Dichroic mirror
- 1 mm
- C. elegans
- AWAR
- dendrite
- AWAL
- 5s
- 0.5 ΔF/F₀
- diacetyl
- AWA
- AWA::GCaMP
- [µM]
H+ flux measurements from retinal cells using ion-selective self-referencing microelectrodes.

Dynamic changes in receptive fields: Importance of Lateral Inhibition

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Physical properties of cells
Control of the properties of cells, mechanobiology

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I use math implemented on computers to solve multi-view image reconstruction problems in radiology and microscopy.

A CT scanner measures this:

You need mathematical algorithms implemented on computers to get this:

This is a dual-view light sheet microscope with sample grown on a mirror.

It measures four views at once and captures light over nearly 4pi. But views are anisotropic and contaminated by epifluorescence.

With math and algorithms inspired by CT, we reconstructed clean, isotropic images:
FUNCTION OF GAMMA-GLUTAMYL TRANSPEPTIDASE (GGT1) IN XENOPUS TROPICALIS

Marie Hanigan  
Dept of Cell Biology  
University of Oklahoma  
Health Sciences Center  
NXR 4th Floor Rowe

Enzymatic Activity of GGT1

Human Kidney stained for GGT1

GGT1 KO in Xenopus Topicalis

May have interfered with gastrulation

G, glomeruli
P, proximal tubules
D, distal tubules

72 hr post fertilization.