Biophysical studies of cell membranes and
Research into student learning

Catherine Crouch and Kathleen Howard (Chem)

Catherine Crouch and Ben Geller
Cell membrane curvature

- Membrane shapes change in many critical cellular processes (such as movement, division)
- How are such changes caused by:
  - Protein structure
  - Membrane structure
Possible simple mechanism

Proposed mechanism for surface binding proteins
(Bhatia, Stamou, et al, EMBO J. 2009)

- Hydrophobic part wedges into membrane defects
- Higher curvature (bending membrane more) → more defects

Do membrane proteins use this mechanism?

Experiments

- Need to understand and optimize physical properties of simple model system (vesicle with just the membrane protein of interest)
  - Light scattering
  - Fluorescence correlation spectroscopy
Fluorescence correlation spectroscopy

Probes diffusion of single fluorescent objects
Fluorescence correlation spectroscopy

Probes diffusion of single fluorescent objects
Vesicle dynamics

Can we observe *rotational* diffusion in vesicles with only a few fluorescent molecules?

Involves:
- Bench chemistry preparing vesicles
- Optical experiments
- Data analysis
Do life science students use what they learned in physics later on?

Collaboration with Ben Geller, Sara Hiebert Burch (Biology), and colleagues at University of Maryland.
Tessa Williams ‘17
Haley Gerardi ‘17
Max Franklin ‘19
Fai Wisittanawat ‘13
Jess Li ‘19
Research questions

- Do students carry what they learn in physics forward into later biology courses and research?
- What aspects of a physics course support students to do so?
Methodology

- The best PER research combines **quantitative** (statistical) analysis of pre/post survey questions with more **qualitative** analysis (interviews, ethnographic classroom observation, open-ended survey questions)

- There is an opportunity to gain skills that are relevant to both teaching and research
How interested were you in these life science contexts?

Data analyzed over 4 years (2012 - 2015), $N = 194$

Geller et al. (submitted)
Does interest score depend on prior course experience?

Example 1: Neural Signaling

Prior course experience is not a simple proxy for class year

Data analyzed over 6 years (2012 - 2017), $N = 256$
Does interest score depend on prior course experience?

Example 2: Cell Membrane Potential

Data analyzed over 6 years (2012 - 2017), $N = 256$

Prior course experience is again not a simple proxy for class year.

Same ~0.5 point bump is seen for the dielectric constant example among students who have taken biochemistry, where that topic is discussed.
To learn more ....

Ben and I are always happy to talk about these exciting questions!
If you would like to do research with us during Summer 2018, please make an appointment to discuss this further with one or both of us

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