Physics and cell biology: studying why cell membranes bend

Collaboration with

Carl Grossman, Catherine Crouch (Physics)

and Kathleen Howard (Chemistry)

SWARTHMORE

I am on leave next year ....

… so I am not taking summer students in 2014.

BUT I expect to take students in summer 2015.

How and why cell membranes bend

- Membrane shapes change in many critical cellular processes (such as movement, division)

Viral infection and shape changes

- Viruses package themselves into “buds”
- Proteins in the membrane cause the bending!

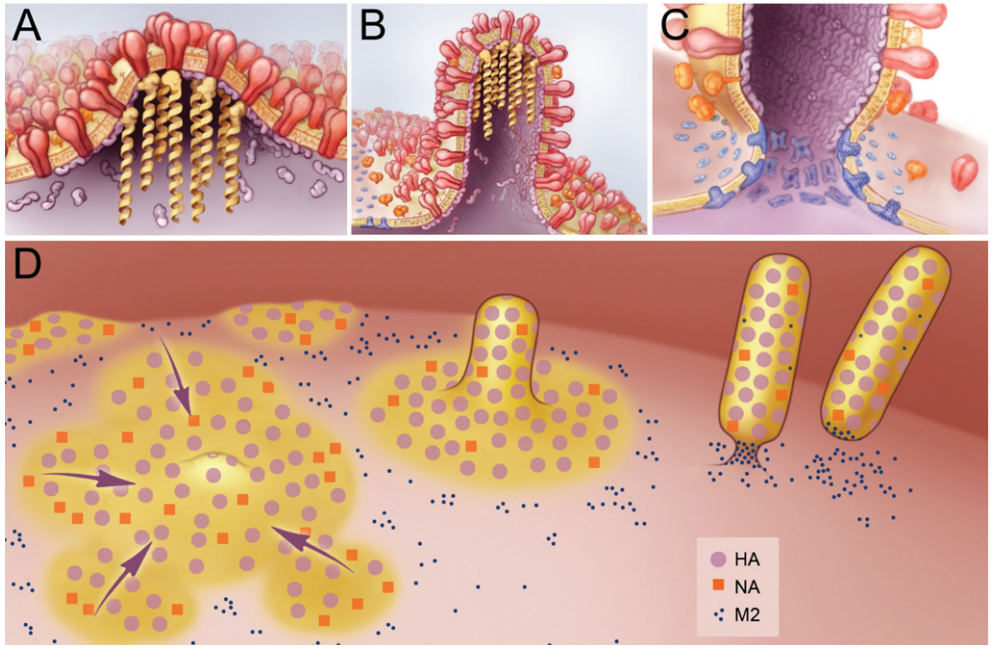

Figure from Rossman (2011).

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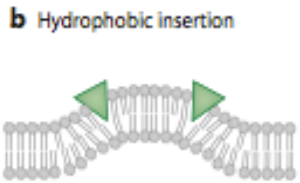
Research questions

How are shape changes caused by:

- Protein structure
- Membrane structure

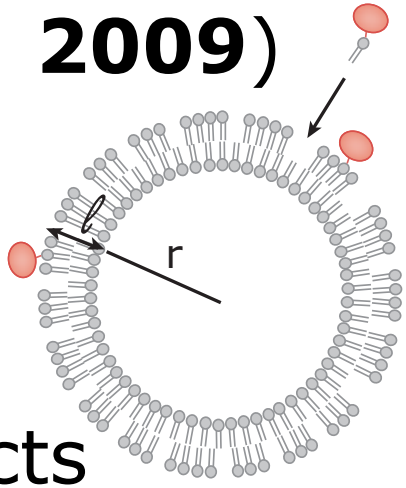
Possible simple mechanism



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



Figures from Baumgart et al (2011), Bhatia et al (2009).

Statistical model

Just like a gas adsorbing to a metal surface

→ Langmuir isotherm

$$B([P]) = \frac{B_{\max}}{1 + K_d / [P]}$$

$$B \equiv \frac{\text{bound protein}}{\text{membrane area}}$$

$$[P] \equiv \text{protein concentration}$$

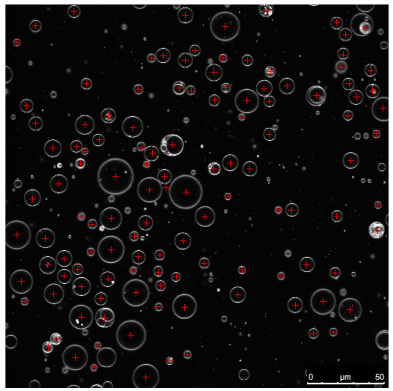
$$K_d \equiv \frac{[P][L]}{[PL]} \text{ dissocation constant}$$

Gives a functional form that can be tested

Experimental methods

Optical studies:

- quantitative confocal microscopy
- image processing
- fluorescence correlation spectroscopy



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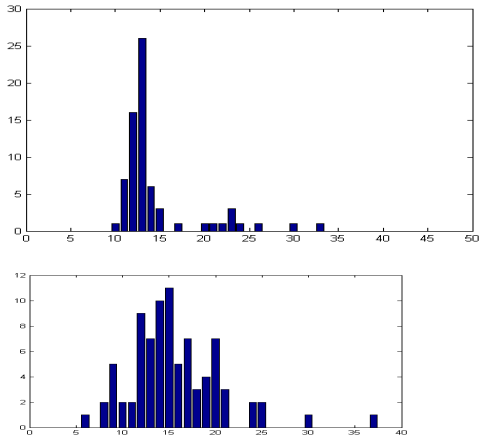

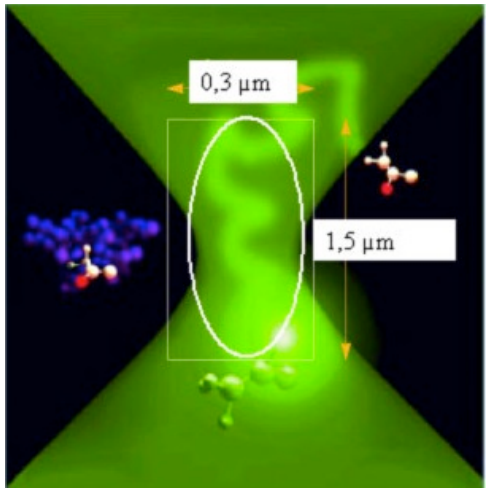

Integrated internal intensity

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What makes teaching physics effective for life science students?

Collaboration with curriculum developers at Universities of Maryland and Minnesota

and Ann Renninger (Education)

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Research questions

- How do life science examples aid students in learning physics?
- Are some life science examples better than others?

To learn more ....

I'm always happy to talk about these exciting questions!

ccrouch1@swarthmore.edu

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