August 31, 2016 Physics 131 Prof. E. F. Redish

- **<u>Theme Music:</u> Paul Simon**
  When numbers get serious
- **<u>Cartoon:</u> Bill Waterson**
  Calvin & Hobbes

In this and all future classes

- **Please do NOT sit in the rows with the red tape on the aisle seats!**
  - **This will allow me to reach everyone when the class is in discussion mode.**
- **Please do NOT sit alone!**
  - **A major component of this class is having you learn to talk to each other about physics.**

An email from a student in last year's 131

...I am emailing because I wanted to let you know I recently took the new 2015 MCATs and I am very happy with my scores. I attribute a lot of the success on the exam to your 131 class and the skills I learned from your teaching. I took the old MCATs and was upset with my results, but with my new scores I feel a lot more confident in my chances of getting into a medical school.... I looked at scientific issues with a new perspective and was able to solve problems with less memorization and more critical analysis.

Not only did I significantly improve on the physical sciences section, I scored in the 97th percentile for critical analysis and reasoning. I approached most of the physics problems using logic, dimensional analysis, and basic knowledge versus pulling out complex formulas. If I ever struggled on a problem, I thought back to what you might have told us in class and was able to think of a unique way to solve it....

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Learning to think scientifically

- Sometimes you're fighting your own brain!
  - We often assume our intuition ("**folk physics**") is correct but don't check that it makes sense with what we see or with other things we know!
  - We often assume an immediate recall ("**one-step thinking**") is right – and the quicker and easier the recall the more we trust it!*
  - We often don't pay attention to the right things! ("**selective attention**")

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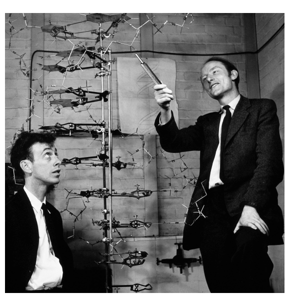
*** D. Kahnemann, *Thinking Fast and Slow* (Farrar, 2011). Also see our reading, "An evolutionary model of memory"**

Knowing-how-you-know icon: Coherence – Your safety net

- We will be establishing **fundamental principles** that we can (almost) always trust as "**stakes in the ground**."
- The **links** among our different views creates a "**safety net**" that protects us against errors of recalled or reconstructed memory.
- We will use our coherence to "**reconcile**" what we know about the world with a coherent physics picture.

Models

- What's a "model"?



Navier–Stokes equations *(general)*

$$\rho\left(\frac{\partial \mathbf{v}}{\partial t} + \mathbf{v}\cdot\nabla\mathbf{v}\right) = -\nabla p + \nabla\cdot\mathbf{T} + \mathbf{f}$$

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Models in science

- A model is something used to represent a system.
- It should have the most important features of the system being represented but leave out less essential details.
- A good model lets you figure out things about the real system that you might have trouble doing if you tried to pay attention to everything.
- A model may be almost anything –
  – A physical structure
  – An analog
  – An equation
- In a very real sense, everything we "know" in science is a model.

Is "species" a model?
If so, of what?

How about "genome"?

How about "protein"?
Come up with a model
of your favorite protein.

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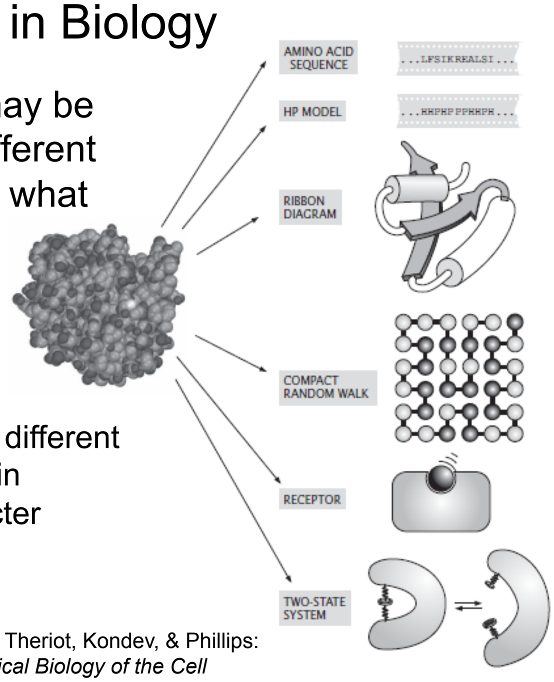
Modeling in Biology

The same system may be modeled in many different ways, depending on what you want to pay attention to.



Each model highlights different properties of the protein
- Hydrophobic character
- Folding property
- ...

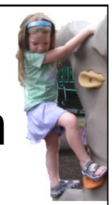
8/31/16 From Theriot, Kondev, & Phillips: *Physical Biology of the Cell*

Modeling in Physics

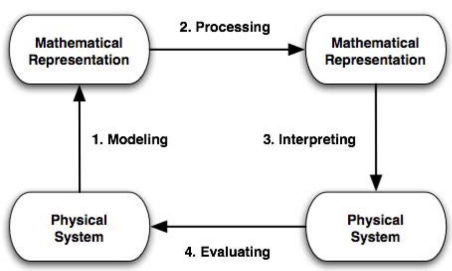
- Many of the models we use in intro physics are highly simplified ("**toy models**") to let us focus on just a few properties.
  - Point masses
  - Rigid bodies
  - Perfect springs

- These models let us first get a clear understanding of the physics. Then, more complex systems can be treated by building around that understanding.

Foothold ideas: Modeling the world with math



- We use math to model relationships and properties.
- From the math we inherit ways to process and solve for results we couldn't necessarily see right away.
- Sometimes, mathematical models are amazingly good representations of the world. Sometimes, they are only fair. It is very important to develop a sense of when the math works and how good it is.
- Mostly, the math we use differs in important ways from the math taught in math classes.



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