Physics 131- Fundamentals of Physics for Biologists I

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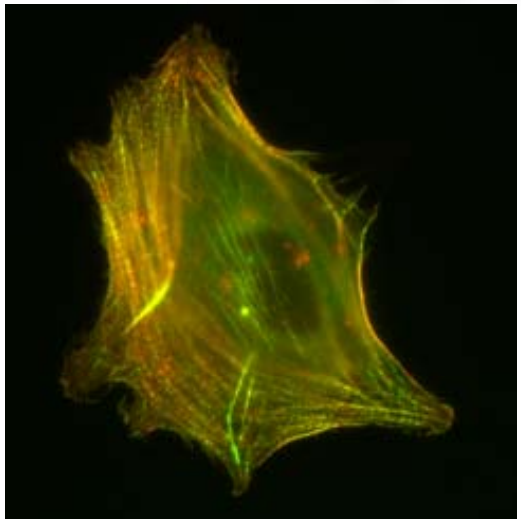
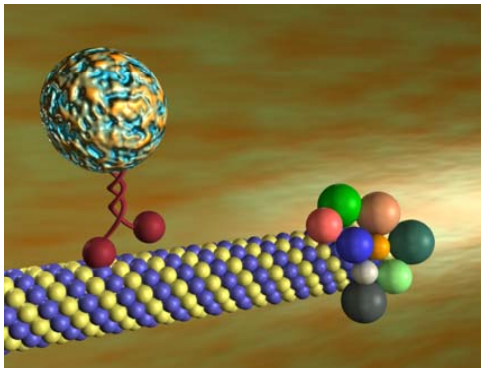
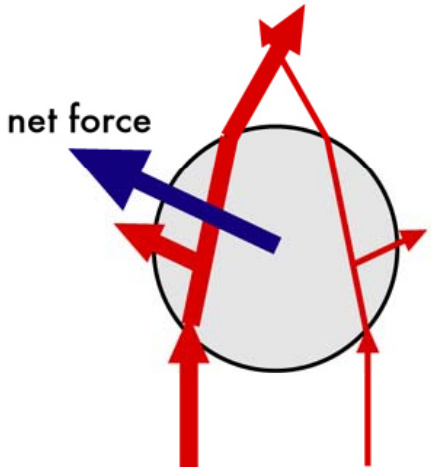






What is PHYSICS?

- If it's living and moving, it's Biology
- If it's chemicals and stinky, it's Chemistry
- If it's rocks and solid, it's geology

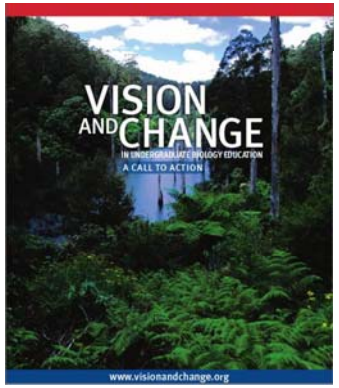
- Physics is everything else and can be applied to Biology, Chemistry, Geology … so … Physics is the study of just about everything!

A little about me

- Dr. Arpita Upadhyaya
- Originally from India
- I am an assistant professor in the Physics department
- Also in the Institute for Physical Science and Technology (IPST, Bldg 85, Room 1115A)
- My research is in the Physics of Living Systems or **Biophysics**
- My research involves studying the movement of tiny components inside our body (“microscopic”)
- What I love doing: Using a microscope to peer into cells
- A real life hobby: Photography

WHY ARE YOU HERE?

- **Over the past decade there have been increasing calls to modernize the education of biology and pre-med students.**
- **This class is part of a national project sponsored by the Howard Hughes Medical Institute and the National Science Foundation to respond to the *Scientific Foundations for Future Physicians Report* (2009)**
- **This report calls for multi-disciplinary competency-based science education to better prepare students for medical, pharmacy, and veterinary schools and also to better educate students who are studying the basic biological sciences.**



The new Phys131/132 Sequence

The goal of this new physics course sequence is to provide you with competency in **physics** relevant to **living systems**

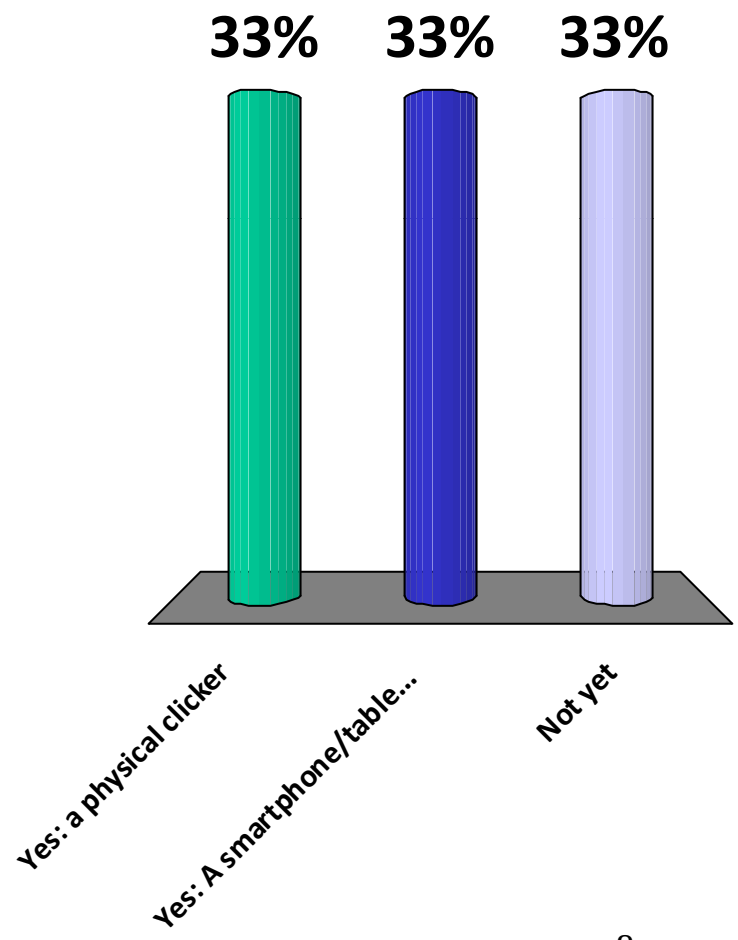
- Funding from HHMI (Project NEXUS)
- Tested in last two-three years
- We will do surveys to further improve the course
- You may see course observers in the back row
- There will be TAs and Learning Assistants in class
  - Learning Assistants (LA) are peer educators who have taken the class before

NEXUS/Physics

- The goal of this course is to help you understand the physics you need for advanced bio, chem, and professional school classes.
- This course is a new national model created here. We have tested it for two years in small classes.
- This is our second implementation in a large class and we will still be figuring out what works and what can be done to improve.
  - Help us by signing our consent forms and taking our surveys
  - And provide feedback

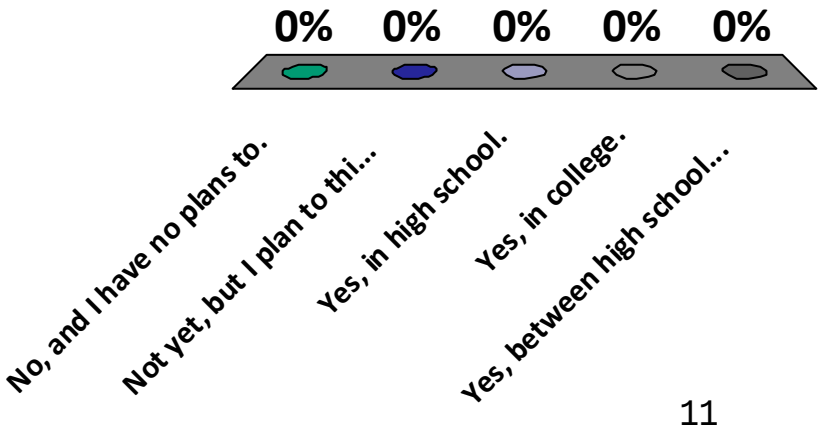
Do you have a clicker?

A. Yes: a physical clicker
B. Yes: A smartphone/tablet that is set up to click
C. Not yet



Have you done research?

A. No, and I have no plans to.
B. Not yet, but I plan to this year or next.
C. Yes, in high school.
D. Yes, in college.
E. Yes, between high school and college



How many college science courses have you completed?

A. 0

B. 1-2

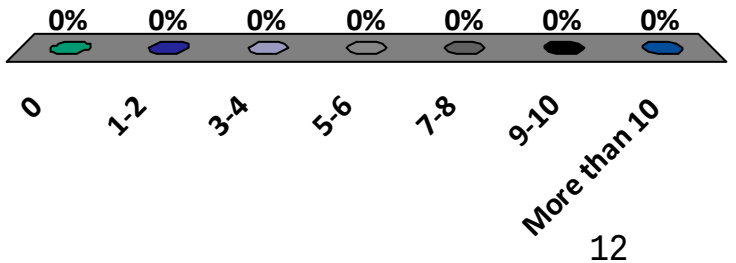
C. 3-4

D. 5-6

E. 7-8

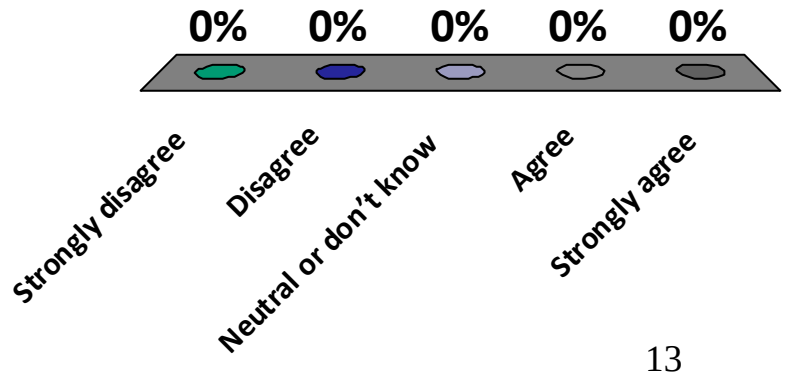
F. 9-10

G. More than 10



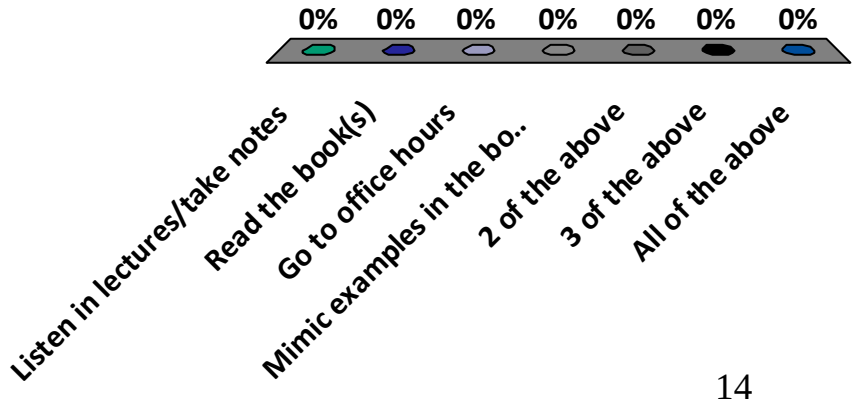
As a scientist or health care professional, I expect to try to deeply understand the biology I have learned; but, for ***this*** class, I expect to learn basic facts.

A. Strongly disagree
B. Disagree
C. Neutral or don't know
D. Agree
E. Strongly agree



Of all the things I can do, the **best** way for ***me*** to learn the material in a class has been to…

A. Listen in lectures/take notes
B. Read the book(s)
C. Go to office hours
D. Mimic examples in the book (math)
E. 2 of the above
F. 3 of the above
G. All of the above



Reading Scientific Text: Which of the following **are valuable ways** for reading complex scientific text (a research paper, an advanced textbook

A. One or more from {1,2,3}
B. One or more from {4,5}
C. One or more from {6,7}
D. A and B
E. A and C
F. B and C
G. A, B, and C.

1. Read it quickly (scan) to get a sense of it.
2. Read it multiple times
3. Highlight important ideas of results.
4. Read it carefully (line-by-line) making sense of difficult ideas.
5. Try to identify specific elements you don't understand.
6. Try to see how the text might relate to other things you know.
7. Try to see what might be "the next step".

Reading Scientific Text: Which of the following **are ways you actually use** for reading scientific text (textbooks, class handouts...)

A. One or more from {1,2,3}
B. One or more from {4,5}
C. One or more from {6,7}
D. A and B
E. A and C
F. B and C
G. A, B, and C
H. I don't read them

1. Read it quickly (scan) to get a sense of it.
2. Read it multiple times
3. Highlight important ideas of results.
4. Read it carefully (line-by-line) making sense of difficult ideas.
5. Try to identify specific elements you don't understand.
6. Try to see how the text might relate to other things you know.
7. Try to see what might be "the next step".

Mathematical equations:

What are they good for in your science?

A. One or more from {1,2}
B. One or more from {3,4}
C. One or more from {5,6}
D. A and B
E. A and C
F. B and C
G. A, B, and C
H. Not much

1. For carrying out calculations.
2. For solving for unknowns.
3. For understanding concepts
4. For understanding qualitative relationships
5. For making models of real world systems
6. For thinking about real world systems

Mathematical equations:

What do you feel **you** can you use them for **now**?

A. One or more from {1,2}
B. One or more from {3,4}
C. One or more from {5,6}
D. A and B
E. A and C
F. B and C
G. A, B, and C
H. Not much

1. For carrying out calculations.
2. For solving for unknowns.
3. For understanding concepts
4. For understanding qualitative relationships
5. For making models of real world systems
6. For thinking about real world systems

NEW in the Course (1)

Focus on Sense-making

NEW in the Course: (1) Focus on Sense-making

- This is a class very much about *making sense of physics*, not just about learning facts or equations.
- To make sense of physics you will need to actively think about, and discuss physics. *The class and lab activities are designed for this*.
- Whether you learn something in class critically depends on your active participation in class and lab activities.

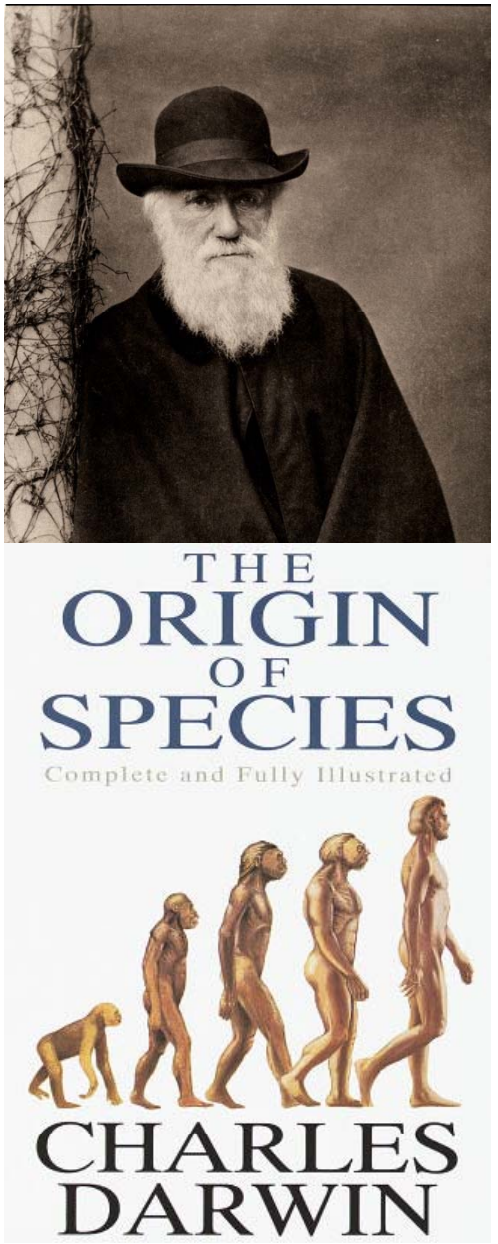
- You will need to work with your classmates!
  - In labs you will work in groups of four to design and carry out experiments and discuss results.

Overarching themes

- Thinking physically
  - Mechanism
  - Coherence
  - Multiple representations
- Models
  - Identifying key elements
  - System schema
- Math
  - Quantifying your experience
  - Thinking with equations
- Thinking about your thinking
  - Debugging
  - Checking
  - Strategizing
- Connecting to what you learn in biology and chemistry classes!

On the use of Mathematics

….”in after years I have deeply regretted that I did not proceed far enough at least to understand something of the great leading principles of mathematics, for men thus endowed seem to have an extra sense.”



How we do it

- Reading first / Flipped class
- Working in groups
- Problem solving
  (serious homework!)
- Thinking on tests
- Non-protocol labs

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What you need to do (for points)

For details see the course website:

http://www.physics.umd.edu/courses/Phys131/spring2014/index.html

Reading: Read a few wiki-pages (we replaced the textbook with a wiki) before each class. *Summarize 2-3 of these pages and write one question about them.*

Weekly Homework: Working together in course center (Physics Building Rm 0208) is encouraged. You must prepare solutions yourself

Labs (different from what you may expect. **Fun**!)

Weekly Quizzes (lowest score dropped)

Two Midterm Exams (with Makeup possibility)

Final Exam (without Makeup possibility)

What you need to pay attention to!

- There are ~1000 points in this class!
  - Two hour exams @ 100 pts each
  - One final exam @ 200 pts
  - Labs @ 200 pts
  - HW and reading @ 200 pts
  - Eleven Quizzes @ 10 pts each (lowest dropped)
  - Clickers & surveys (participation) 100 pts

Reading First

- There are readings to do before every lecture. (due at 11PM the night before)
- For some of these readings you have to write brief summaries and ask a question. (pts)
- Part of the goal is to help you learn to read scientific text more professionally.
  - Working out difficult issues.
  - Connecting what you are reading with other things you know.
  - Thinking about the next step.

Web links for readings

- **Homepage**
  - *http://www.physics.umd.edu/courses/Phys131/spring2014/*
- **Schedule with links to reading**
  - *http://www.physics.umd.edu/courses/Phys131/spring2014/ScheduleU.html*
- **WebAssign assignments (RA#)**
  - *http://www.webassign.com/*
- **Full text**
  - *http://umdberg.pbworks.com/w/page/68358897/Working%20content%20I%20%282013%29*

Lab/Recitation

- Recitation starts this week

  - a number of surveys

- Lab starts this week with
  - You get help on installing ImageJ, an image analysis software we need for labs and HW
  - Actual labs will start the week of 2/03

Labs

- Work in groups of 4
- Experiments last 2 or 3 weeks.
- NOT just protocol – you learn powerful tools and explore questions on your own.
- We do both macro and micro experiments.
- Lab reports written and handed in during lab.

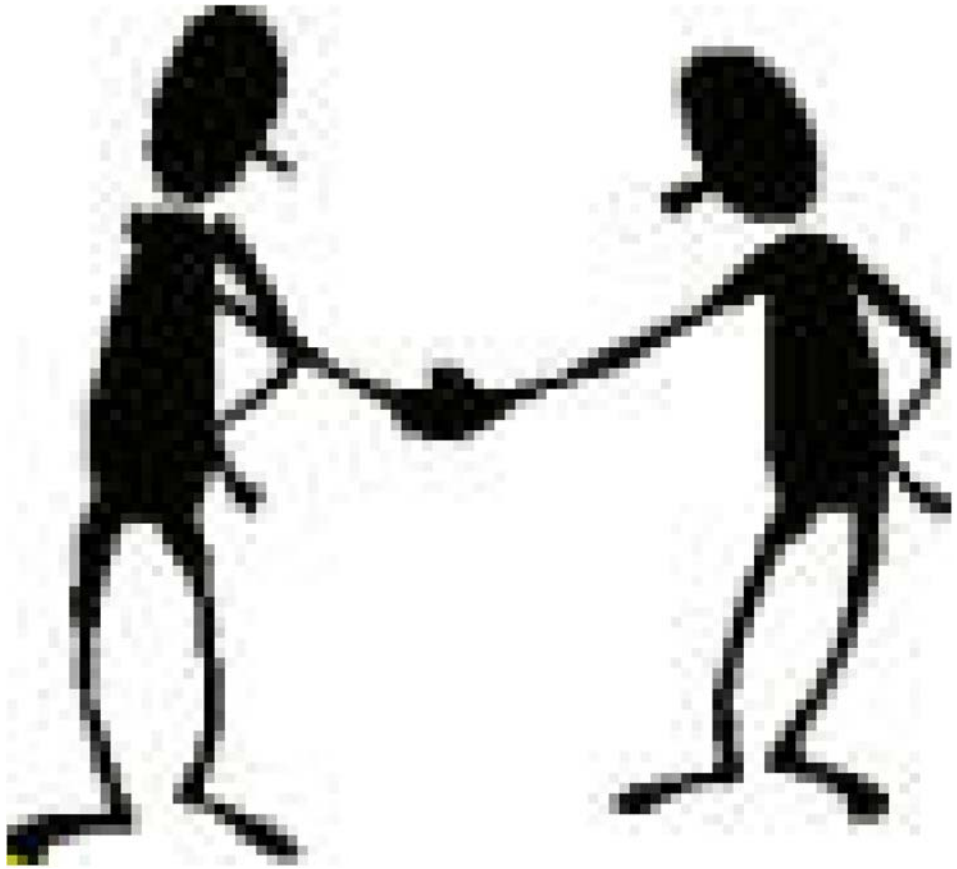
Working in groups

- Science is not just a collection of facts or even of methods: it's a conversation.
- One of the things you have to do in learning to solve hard problems is to ask yourselves questions that lets you bring up what you know. It's often best to learn to do that by asking others.
- Good communication skills and the ability to work in teams are highly valued in modern workplace environments (including health care).

Group activities

- In-lecture clicker questions.
  - You get a point each time you share an answer with the full group.
- Group problem solving in recitation.
- Working in groups in lab.
- Find a group to work with on HW!
  - Our homework can be very hard if you try to do it yourself. It is designed for working together.
  - Course Center highly recommended.
  - How to do this without copying?!

Introduce yourself to a few of the folks around you!



Problem Solving

- Physics is very much about learning to apply general principles to new situations. (Like medical diagnosis)
- These applications are often NOT amenable to automated thinking (algorithms).
- Problems in this class will NEVER be “plug and chug” or just using an equation to calculate something.
  - Essays
  - Modeling (creating equations)
  - Sense-making
  - Estimation (NOT guessing)
  - Representation translation & coherence building.

Learning to think scientifically

- How do you learn?
- How does the world work?
- Sometimes you're fighting your own brain!
- We're about to try some experiments.
- Please do the best you can – but follow instructions!

Learning to think scientifically

- Sometimes you're fighting your own brain!
  - 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**")
  - 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!
  - Preconceived ideas

Question Assumptions!

Coherence – Your safety net

- We will be establishing fundamental principles that we can (almost) always trust as "**stakes in the ground**."

- The links among the different views creates a "**safety net**" that protects us against errors of recalled or reconstructed memory.