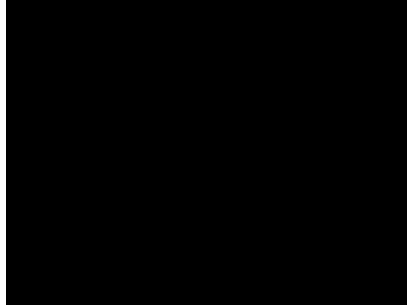


January 23, 2013

Physics 132

Prof. W. Losert

**Physics 132****Video of the day**

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Physics 132

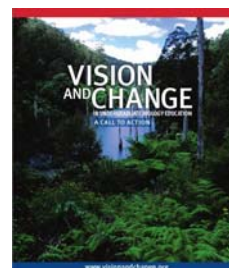
**1**

## What's different about this class?

- PHYS 131/132 is designed to respond to calls from biology researchers and medical schools to prepare students with the skills to take full advantage of the amazing new tools of 21<sup>st</sup> century biology and medicine.

*Scientific Foundations for Future Physicians Report (2009)*

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**2**

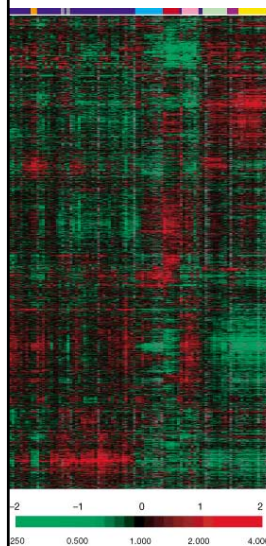
- Both the content and pedagogy have been modified
- Class is part of a development and education research project funded by HHMI and NSF

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### One example of the new biology and medicine



20000 Genes

**New data:** Measure the number of RNA made by ALL 20,000 human genes!  
(for 400 Lymphoma patients)

**New medical insight:** Treatment efficiency much better for patients with some genetic profiles “Personalized Medicine”

**New biological challenge:** No simple facts can be seen in the data “gene X is associated with Lymphoma”.

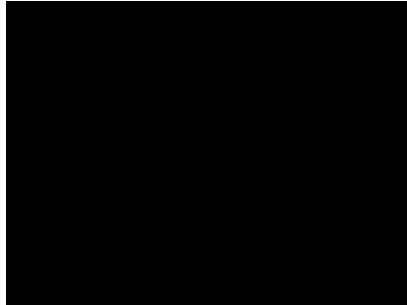
Then how could this information help develop new treatments?

Group genes by function -> the information becomes more coherent

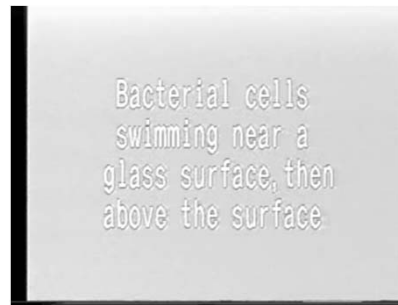
400 patients (L. Staudt, NCI, Nature 2000)

## A simpler challenge from Phys131

- How do white blood cell (neutrophil) chase bacteria



White blood cells  
From: Carole Parent, NCI  
Motion: 10  $\mu\text{m}/\text{min}$



Bacteria  
From: Howard Berg, Harvard  
Motion:  $\sim 10 \mu\text{m}/\text{sec}$

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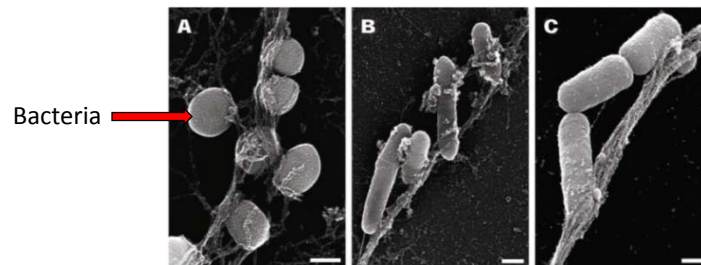
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- How do slow (10 micron/min) white blood cells chase fast (10 micron/sec) bacteria?
- Build a model?

Brinkman et al: Neutrophil Extracellular Traps (NETs)

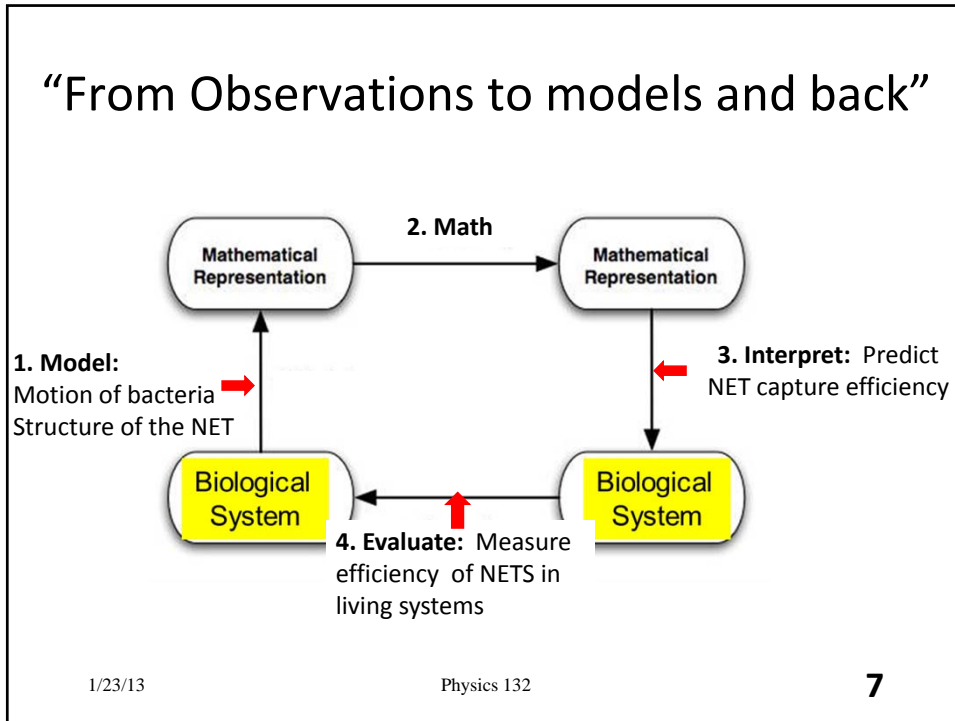
- White blood cells spill their DNA (they can survive a day w/o DNA) and bacteria get entangled in it



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### Which of these steps is most important?

1. Build Model
2. Solve Math
3. Interpret Solution
4. Evaluate System
5. All
6. None

Option	Percentage
1. Build Model	50%
2. Solve Math	0%
3. Interpret Solution	0%
4. Evaluate System	50%
5. All	0%
6. None	0%

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## Key aims of 132

- Learning to think scientifically
  - Build model
  - Solve math  Usual focus of intro physics class
  - Interpret solution
  - Evaluate System
  
- Learning physics relevant for understanding the living world

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## Learning physics relevant for understanding the living world

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>■ <b><i>What's in</i></b> <ul style="list-style-type: none"> <li>– Newton's Laws</li> <li>– Energy</li> <li>– Electric forces &amp; energy</li> <li>– Fluids</li> <li>– Molecular models</li> <li>– Random motion               <ul style="list-style-type: none"> <li>➢ Diffusion (Fick's law)</li> <li>➢ Kinetic theory</li> <li>➢ Second law of thermo</li> </ul> </li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>■ <b><i>What's out</i></b> <ul style="list-style-type: none"> <li>– Projectile motion</li> <li>– Circular motion</li> <li>– Universal gravitation</li> <li>– Torque and statics</li> <li>– Momentum</li> <li>– Collisions</li> </ul> </li> </ul> |
|---|---|

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## What do I mean by knowing physics?

- I do NOT mean being able to memorize an equation
- I mean the ability to apply your physics knowledge to build an equation or model in order to solve a new problems.
- So how do does our brain tackle new problems

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## How does our brain tackle new problems?



- The mind works on two levels: unconscious and conscious.
- Memory is not simply based on recall of information (computer memory is...) but based on partial recall of pieces connected by “plausible” links.
- **Our brain appears wired to link any new task to our existing knowledge**

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## The Stroop Task

I will show you a slide with a list of color names.

Each word will be printed in a colored ink.

Pair off in groups of twos.

One of each pair will be the reader, the other the checker.

The reader will have 20 seconds to read off the *COLORS THAT THE WORDS ARE PRINTED IN.*

The checker will count the number of words gotten and the number correct.

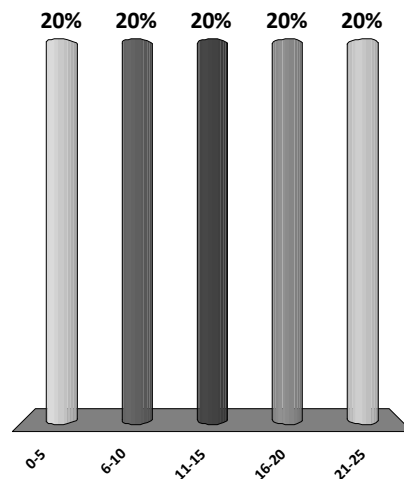
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13

Checkers: How many colors did your partner name?



1. 0-5
2. 6-10
3. 11-15
4. 16-20
5. 21-25



Checkers: How many colors did your partner get right?



1. 0-5
2. 6-10
3. 11-15
4. 16-20

Now do it again – remember:  
say the color ink the word is printed in!

RED	GREEN	BLUE	YELLOW	PINK
ORANGE	BLUE	GREEN	BLUE	WHITE
GREEN	YELLOW	ORANGE	BLUE	WHITE
BROWN	RED	BLUE	YELLOW	GREEN
PINK	YELLOW	GREEN	BLUE	RED

11/17/04

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Wash U



Checkers: How many colors  
did your partner name?



1. 0-5
2. 6-10
3. 11-15
4. 16-20

Checkers: How many colors  
did your partner get right?



1. 0-5
2. 6-10
3. 11-15
4. 16-20

Try it in your own brain!  
Memorize these numbers





3 5 2 9 7 4 3 1 0 4 8 5

1 4 9 2 1 7 7 6 2 0 1 3

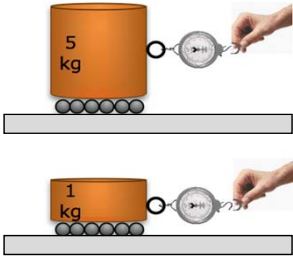
- In the color example, prior experience is not coherent with the task. Here prior prevents us from carrying out the task effectively.
- In the number example, you saw how our brain can use prior experience effectively (1492 is a number with meaning).

## Aim of Pedagogy: Building a web of knowledge

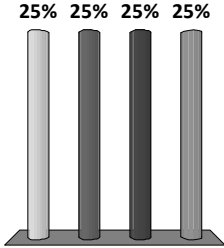
- How do we build a reliable web of knowledge?
  - **Knowledge of Foothold ideas:** Build experience with physics concepts we can count on in a wide variety of circumstances
  - **Experience in how to connect the foothold ideas:** Finding coherence in how you solve multiple solutions

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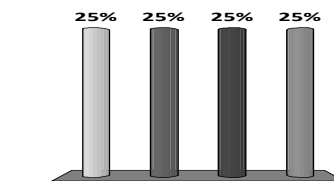
You are pulling two weights along a table with equal force. Which one would speed up faster?



25% 25% 25% 25%  
 The 1 kg weight  
 The 5 kg weight  
 would speed up th...  
 is not enough in...

1. The 1 kg weight
2. The 5 kg weight
3. They would speed up the same way.
4. There is not enough information to tell.

The Professor drops two metal spheres, one of  $\frac{1}{2}$  kg, the other of 2 kg. They hit the ground at (almost) exactly the same time. Which of the following statements is true?



1. The force of gravity on the 2 kg weight is greater than the force on the  $\frac{1}{2}$  kg weight
2. The force of gravity on the 2 kg weight is less than the force on the  $\frac{1}{2}$  kg weight
3. The force of gravity on the 2 kg weight is the same as the force on the  $\frac{1}{2}$  kg weight.
4. There is not enough information to tell.