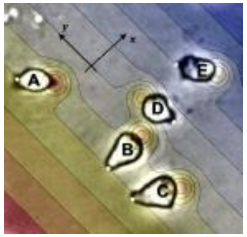
Physics 131- Fundamentals of Physics for Biologists I



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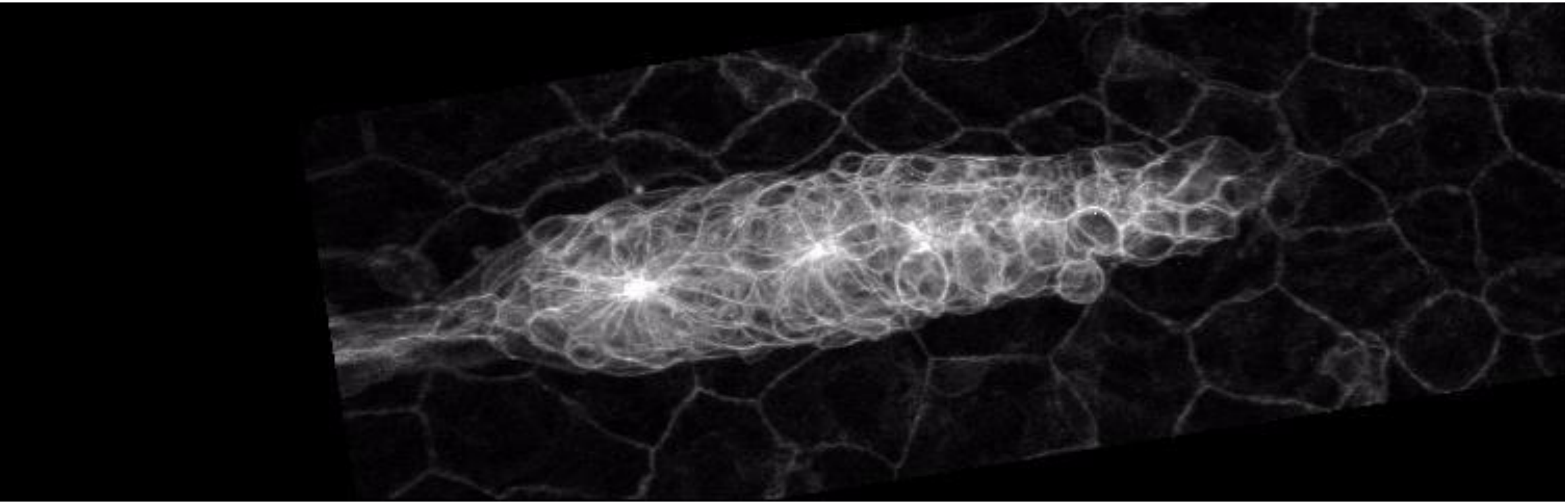
Technotronic - Pump Up The Jam



Zebrafish Lateral Line Migration
Deborah Hemingway, Losert Lab

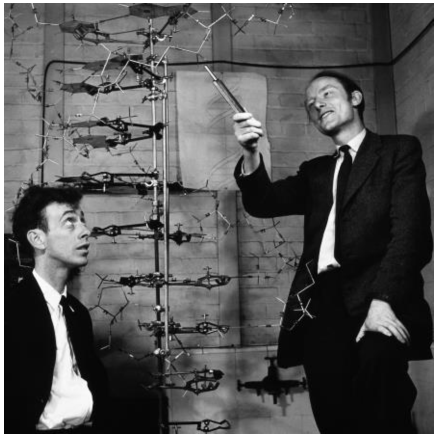
QUIZ 1

Outline

- **Models in Science and Physics**
- **Chapter 2: Kinematics:** Modeling Motion
    - Coordinates
    - Graphs
    - Vectors

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.



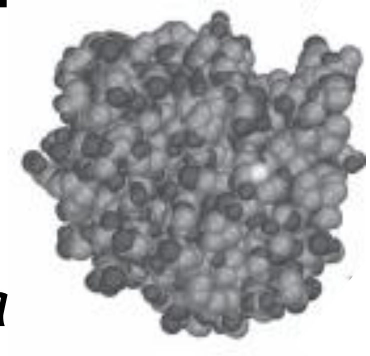
- A model may be almost anything –
  - A physical structure
  - An analog
  - An equation

- In a very real sense, everything we "know" in science is a model.

Navier–Stokes equations *(general)*

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

Group task: Develop a model of your favorite protein



- Work in groups of 3

Teaching and Learning Assistants will participa

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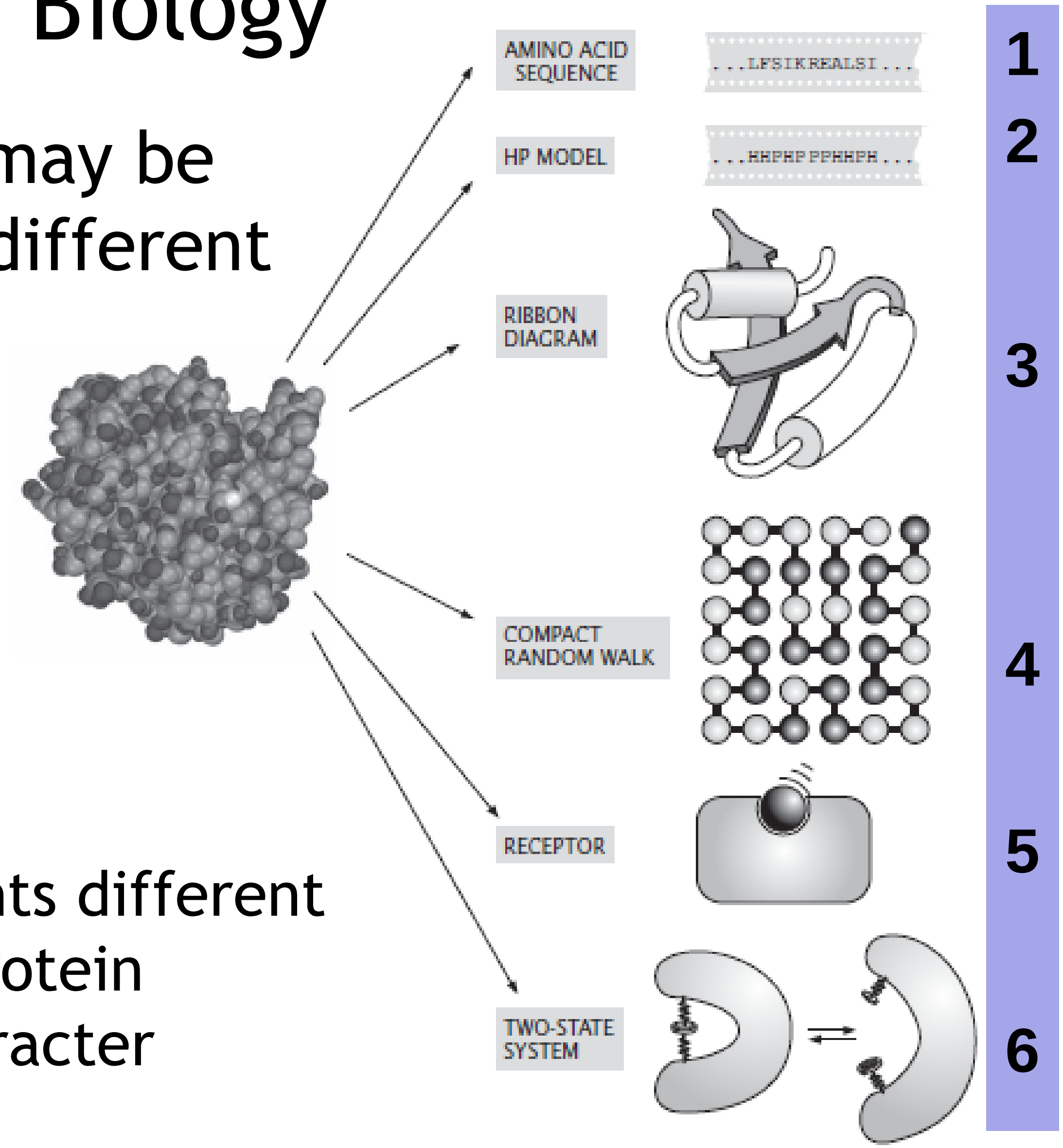
Modeling in Biology

The same system may be modeled in many different ways



Each model highlights different properties of the protein

- Hydrophobic character
- Folding property

From: Physical Biology of the Cell (Theriot, Kondev, and Phillips)

Group task: Write down more than one way to model the motion in this video

- Work in groups of 3, *Teaching and Learning Assistants will participate*

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.

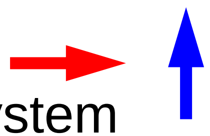
Outline

- **Models in Science and Physics**
- **Chapter 2: Kinematics:** Modeling Motion
  - Coordinates
  - Graphs
  - Vectors

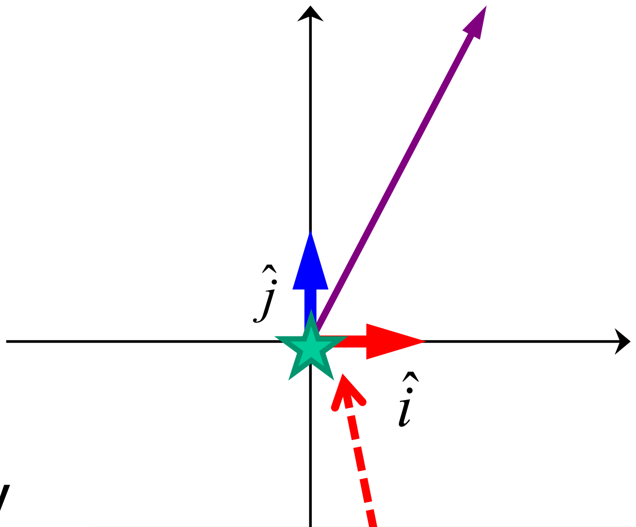
Coordinates in space

To specify the position of something we need a coordinate system.

- The coordinate system includes:
  - Picking an ***origin***
  - Picking perpendicular directions for the axes of the coordinate system



  - Choosing a ***measurement scale***



"unit" arrows set the measurement scale

- Each point in space in then specified by two numbers: the *x* and *y* coordinates (3 numbers in three dimensions)

- We can draw a position vector– an arrow drawn showing the displacement from the origin to that position.

Why is there no mention of a third dimension if all physical objects in the world are not 2D but actually 3D?

Vector - Reading questions/comments

Good Summary: *For our purposes involving physical systems, we will simplify the idea to two spatial coordinates for now. This is the idea behind a typical graph in which a position is given by the 2 coordinates (x,y), where the first coordinate lies along the x-axis, and the second on the y-axis. We can think of these coordinates as the distance from our origin (which must remain fixed in order for the graph to be valid). Furthermore, the position that the aggregate of the coordinates describes can be considered a sort of displacement from the origin.*

Summaries that are inadequate

I didn't quite understand this page as the others!!!!

Try to figure out whether it is the MATH on this page, the CONCEPTS, or e.g. the WORDING, or something else.

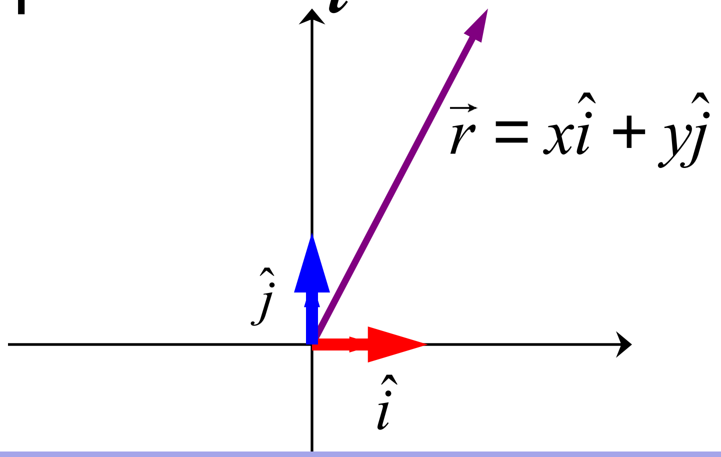
Physics joke: Momentum will get you pretty far in life.

2-dimensional coordinates

- We specify the direction and unit lengths of the two coordinate axes by writing $\hat{i}$ and $\hat{j}$
- A position a distance *x* from the origin is written as $x\hat{i}$
- Note that if *x* is negative, it means a vector pointing in the direction opposite to $\hat{i}$
- Vectors add algebraically:

$$\vec{r} = x\hat{i} + y\hat{j}$$

To move from start to end of vector $\vec{r}$ you need to take x steps in the $\hat{i}$ direction and y steps in the $\hat{j}$ direction



Would it be accurate to liken a vector to a line segment with a direction?

Graphing Position

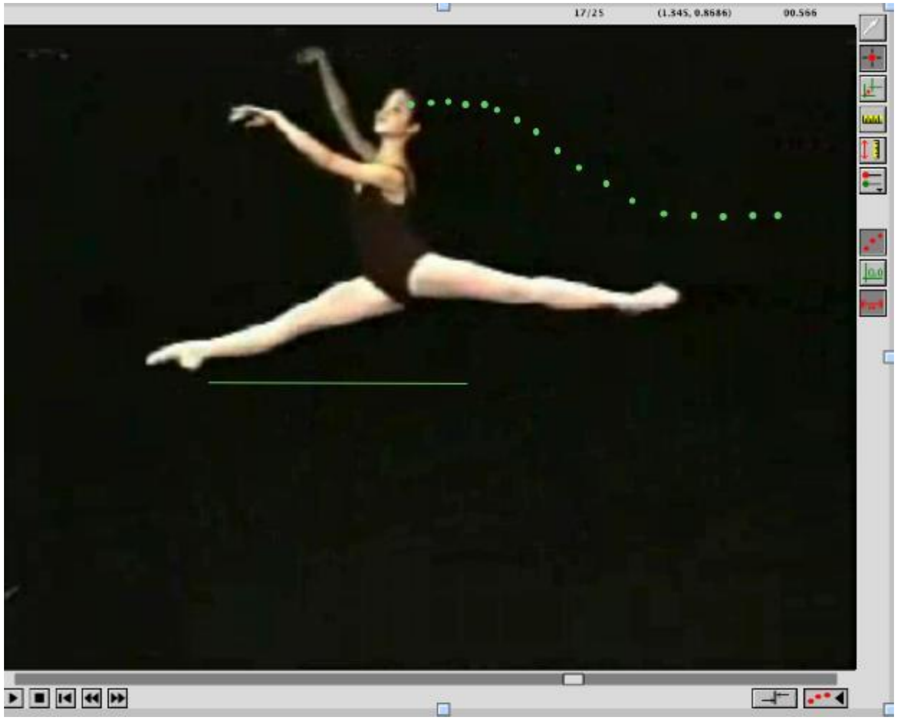
Describe where something is in terms of its coordinate at a given time.

Set up Coordinates

- Choose origin
- Choose **horizontal** and **Vertical** axes
- Choose scale

Take data from video

Construct different graphs



Where is t=0 on the graph?

1. At the far left
2. At the far right
3. You can’t tell, there is not enough information
4. I have no clue

Describing Motion: Time

- Time — if we're to describe something moving we need to tell <u>when</u> it is where it is.
- Time is a coordinate just like position
  - We need an origin (when we choose $t = 0$)
  - a direction (usually times later than 0 are +)
  - a scale (seconds, years, millennia)
- Note the difference between
  - clock reading, t
  - a time interval, Δt

The sonic ranger (motion detector)

- The sonic ranger measures distance to the nearest object by echolocation.
  - A speaker clicks 30 times a second. A microphone detects the sound bouncing back from the nearest object in front of it.
  - The computer calculates the time delay between and using the speed of sound (about 343 m/s at room temperature) it can calculate the distance to the object.