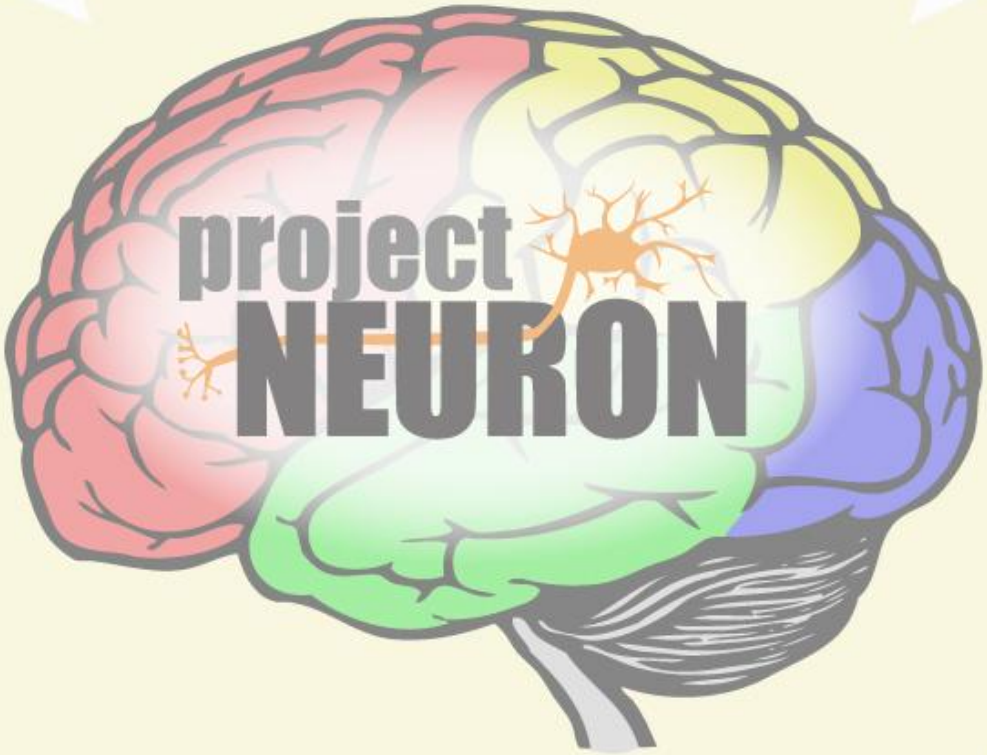
Math + Biology: It adds up!



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University of Illinois

National Institutes of Health

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD

Supported by the National Institutes of Health

What is Project NEURON?

- At the University of Illinois
- Educators, scientists, and graduate students
- Curriculum development
  - Inquiry-based
  - Connect to standards
- Professional development
  - Summer institutes
  - Conferences

Project NEURON Curriculum Units

- **Do you see what I see?**
  - *Light, sight, and natural selection*
- **What can I learn from worms?**
  - *Regeneration, stem cells, and models*
- **What makes me tick…tock?**
  - *Circadian rhythms, genetics, and health*
- **What changes our minds?**
  - *Toxicants, exposure, and the environment*
  - *Foods, drugs, and the brain*
- **Why dread a bump on the head?**
  - *The neuroscience of traumatic brain injury (TBI)*
- **Food for thought: What fuels us?**
  - *Glucose, the endocrine system, and health*
- **What makes honey bees work together?**
  - *How genes and environment affect behavior*
- **How do small things make a big difference?**
  - *Microbes, ecology, and the tree of life*

Available at:
neuron.illinois.edu

An Iterative & Collaborative Development Process

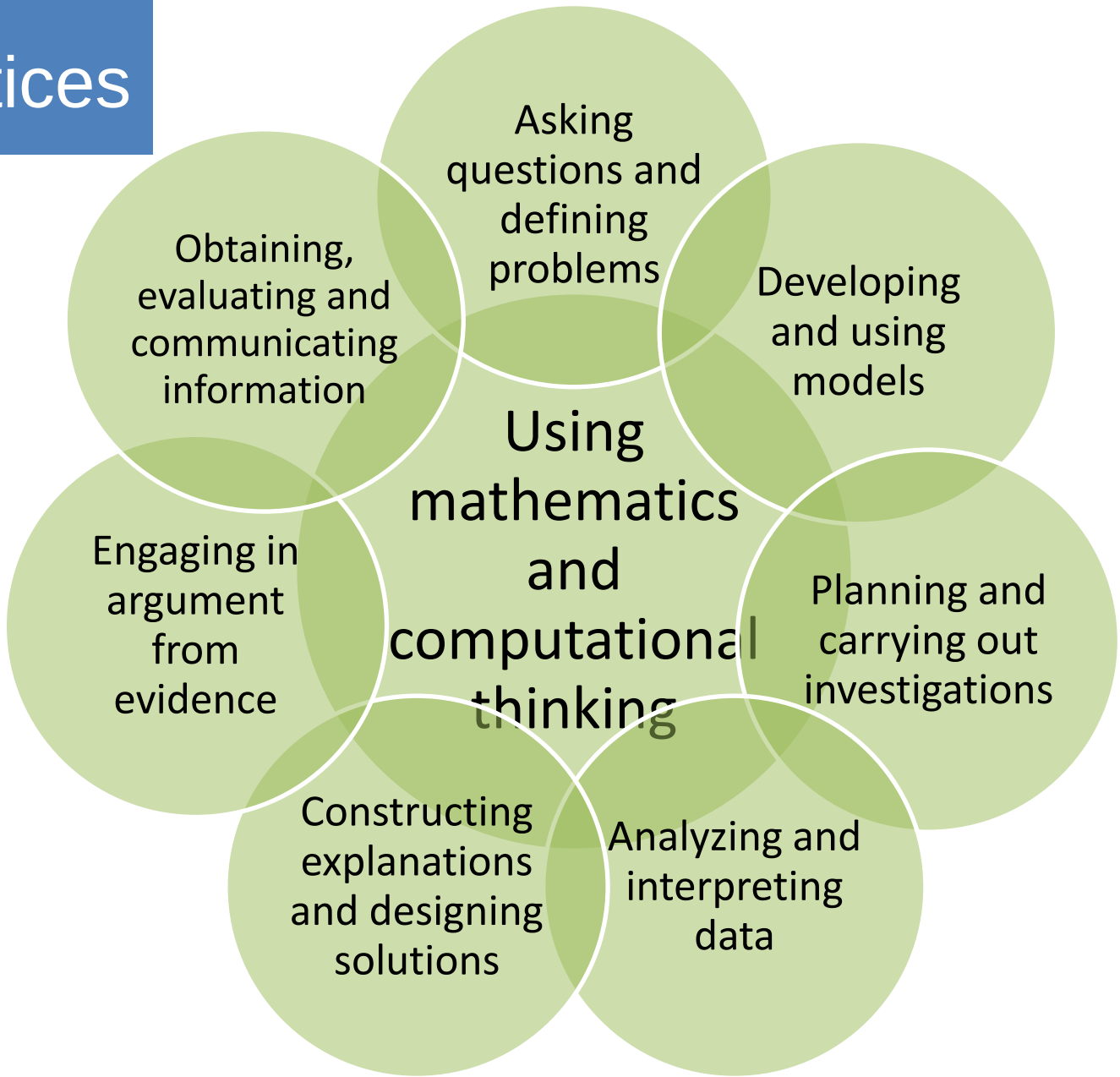
Determine main understanding goals and develop unit outline

Develop and revise lesson plan and student materials

Scientists provide feedback

Teachers provide feedback
(based on workshops and classroom enactments)

NGSS Scientific Practices



CCSS – Mathematical Practices

1) Make sense of problems and persevere in solving them.
2) Reason abstractly and quantitatively
3) Constructive viable arguments and critique the reasoning of others
4) Model with mathematics
5) Use appropriate tools strategically
6) Attend to precision
7) Look for and make use of structure
8) Look for and express regularity in repeated reasoning

Activity: Microbial Scale & Mural

Curriculum Unit

How do small things make a big difference?

Microbes, ecology, and the tree of life

- Lesson 1: How did the tree of life change through history?
- Lesson 2: What is the current tree of life model?
- Lesson 3: What are microbes?
- Lesson 4: What does a microbial ecosystem look like?
- Lesson 5: How do microbes interact with humans?
- Lesson 6: What can happen when my microbiome is disturbed?

Lesson 3: What are microbes?

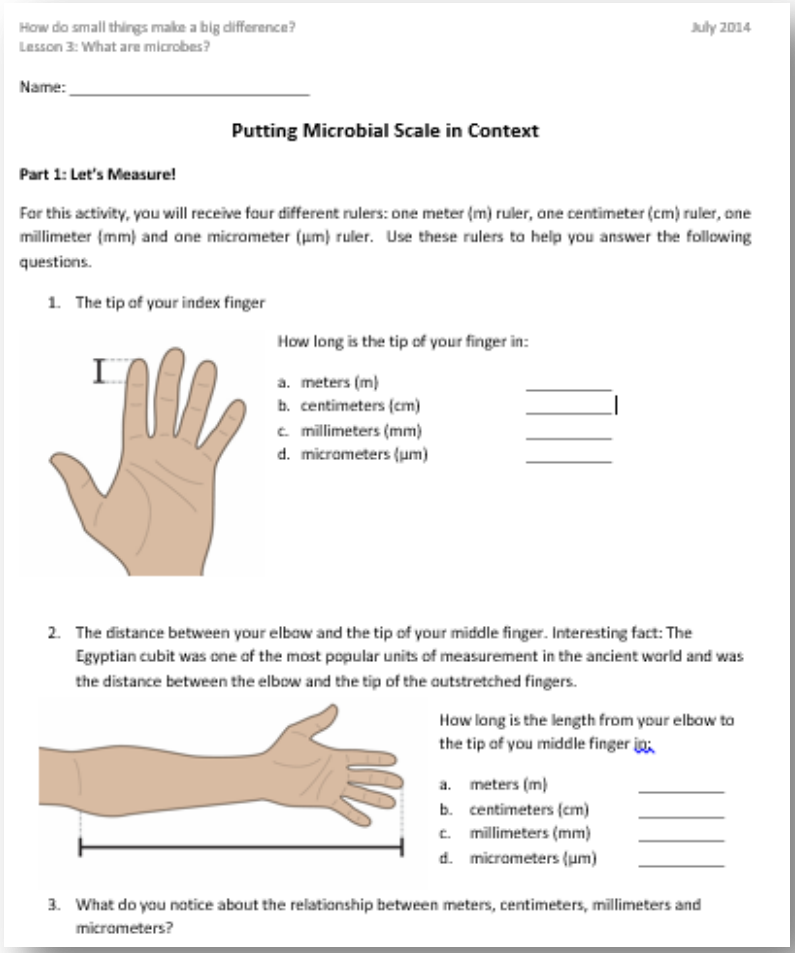
Learning Objectives

- **Examine the diversity** of microbes
- **Construct conversion tables** to calculate measurements in different units
- **Calculate** the size of microbes
- **Construct** a microbe mural to scale

Part 1: Putting Microbial Scale in Context

Practicing conversions and becoming familiar with the microscopic scale.

Work through the student sheet using the customized rulers provided



How do small things make a big difference?
Lesson 3: What are microbes?

July 2014

Name: _____

Putting Microbial Scale in Context

Part 1: Let's Measure!

For this activity, you will receive four different rulers: one meter (m) ruler, one centimeter (cm) ruler, one millimeter (mm) and one micrometer (µm) ruler. Use these rulers to help you answer the following questions.

1. The tip of your index finger

How long is the tip of your finger in:

a. meters (m) _____
b. centimeters (cm) _____
c. millimeters (mm) _____
d. micrometers (µm) _____

2. The distance between your elbow and the tip of your middle finger. Interesting fact: The Egyptian cubit was one of the most popular units of measurement in the ancient world and was the distance between the elbow and the tip of the outstretched fingers.

How long is the length from your elbow to the tip of you middle finger in:

a. meters (m) _____
b. centimeters (cm) _____
c. millimeters (mm) _____
d. micrometers (µm) _____

3. What do you notice about the relationship between meters, centimeters, millimeters and micrometers?

(5 minutes)

Part 2: Microbe Mural Activity

Putting on your “microscope eyes”…

How would a period, which measures 0.5 mm, look like if it were magnified 5,000 times?

Part 2: Microbe Mural Activity

Putting on your "microscope eyes"…

With a specific microbe:

- Magnify it 5,000 times (what units will you use?)
- Use the following colors
  - **Archaea – pink**
  - **Bacteria – yellow**
  - **Eukarya – green**
- Construct it to scale using the rulers provided
- Place on the magnified period to compare their size

(5-10 minutes)

Microbe Mural Activity

Talk with a partner about:

- How does the activity promote NGSS Scientific Practices and CCSS Mathematical Practices? Which ones?
- How could you incorporate this activity into your curriculum?
  - To align with NGSS
  - To incorporate math concepts
- What accommodations/modifications would you make to teach this in your classroom?

Math + Biology: More Project NEURON activities

Curriculum Unit

Food for thought: What fuels us?

Glucose, the endocrine system, and health

- Lesson 1: Why is glucose important for the body and brain?
- Lesson 2: How are glucose levels regulated in the body?
- Lesson 3: How does adrenalin affect the body and the brain?
- Lesson 4: How do glucose and adrenalin affect memory in aging populations?
- Lesson 5: How does glucose dysregulation lead to disease?

Lesson 1: Why is glucose important for the body and brain?

Learning Objectives

- **Use calculations to develop a model** that shows how the body allocates energy/glucose to organs disproportionately
- Explain homeostasis in the context of glucose
- Explain that glucose can only pass a cell membrane via glucose transporters

Lesson 1: Why is glucose important for the body and brain?

HOW MUCH ENERGY DO YOUR ORGANS NEED?

Organ or Tissue	Energy Consumption (kcal)
Adipose (fat)	67.5
Muscle	366.6
Liver	360
Brain	336
Heart	120
Kidney	120
Other	278.4

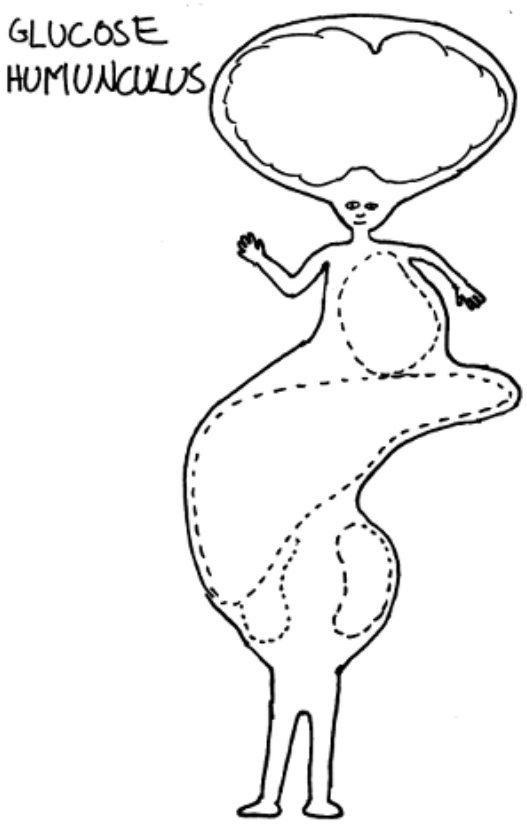
Percent Energy Consumption	Ratio: $\frac{\%\ E\ consumption}{\%\ Body\ Weight}$	Percent Body Weight

Weight (lbs)	Organ or Tissue
33	Adipose (fat)
62.17	Muscle
3.96	Liver
3.08	Brain
0.66	Heart
0.66	Kidney
51.5	Other

Students calculate the energy required by each organ.

“Glucunculus” Drawing

Students model the disproportionate distribution of glucose throughout the body



Curriculum Unit

Food for thought: What fuels us?

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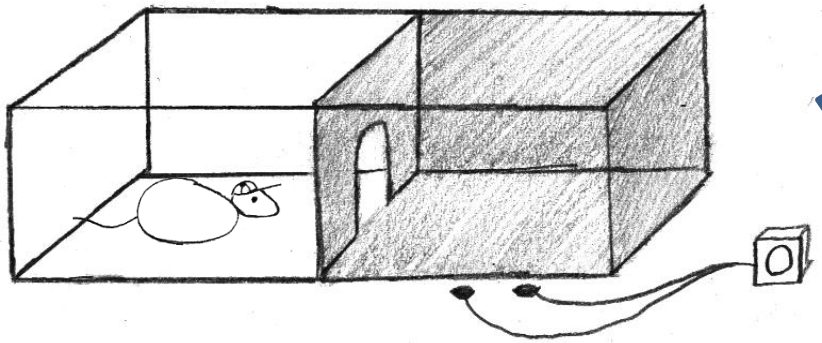
Lesson 4: How do glucose and adrenalin affect memory in aging populations?

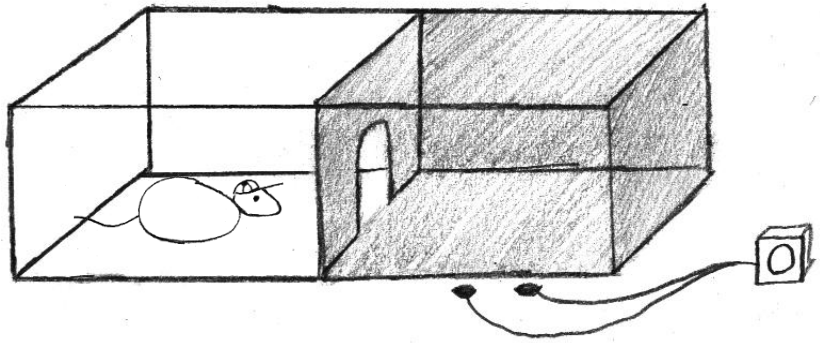
Learning Objectives

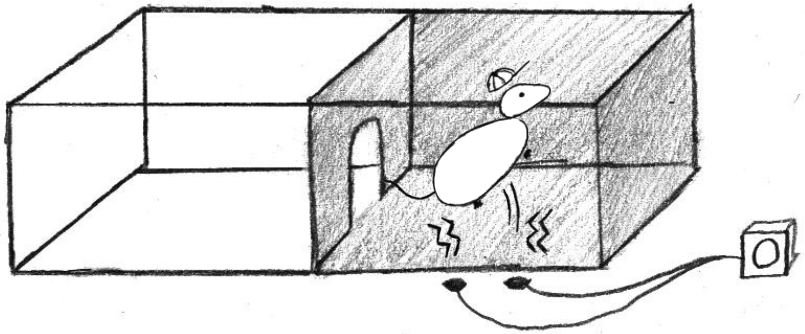
- **Design and conduct an experiment** about age-related differences in memory.
- **Graph data and develop a scientific explanation** based on the results of the experiment.

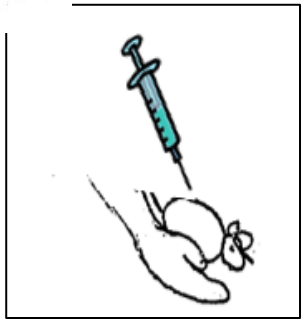
Inhibitory Avoidance Task

Testing the effect of glucose and adrenalin on memory.





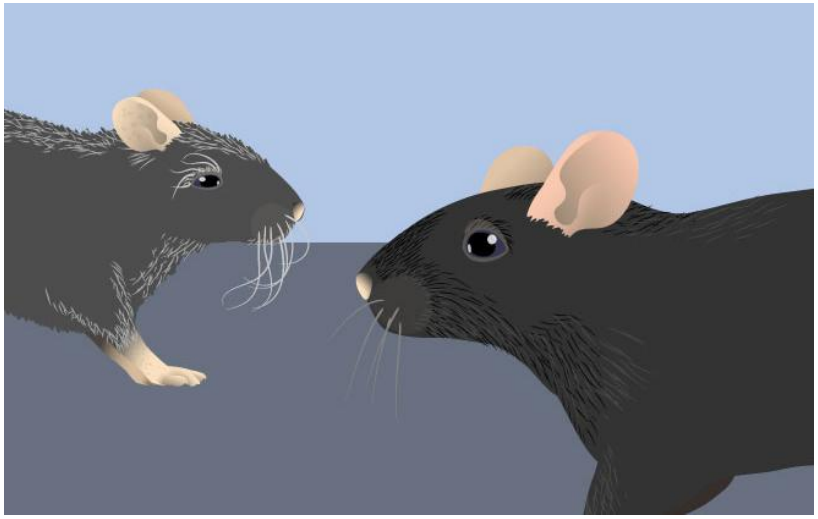




Injected with: saline, glucose, or adrenalin

Rat Recall Experiment

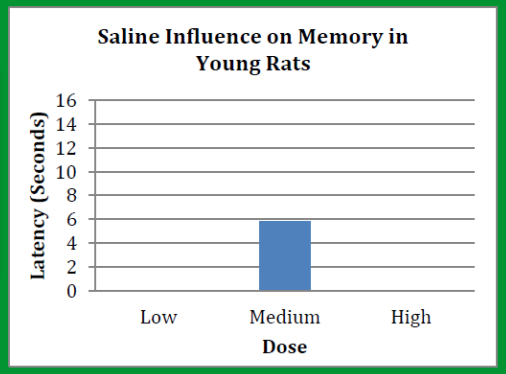
Driving question for experiment: How do adrenalin and glucose affect memory in aging populations?

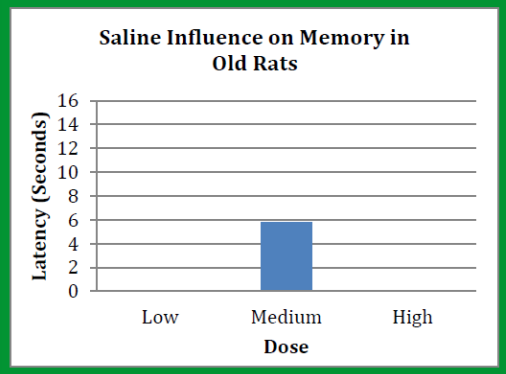


http://www.neuron.illinois.edu/simulations

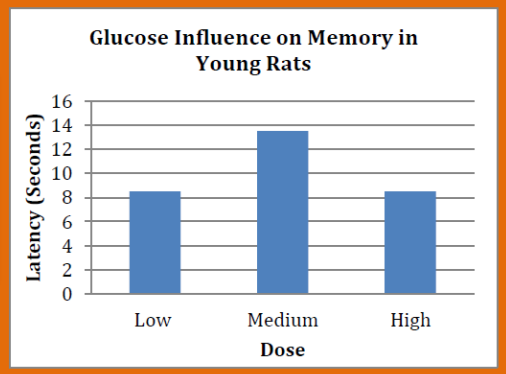
Rat Recall Experiment: Results

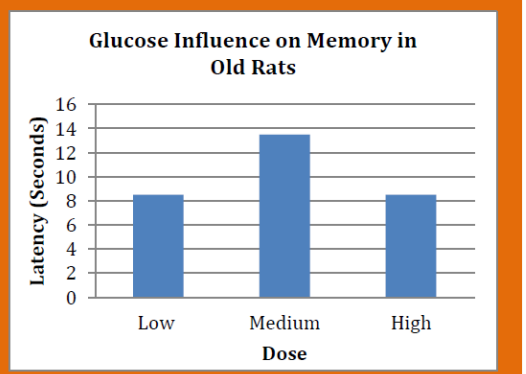
Saline



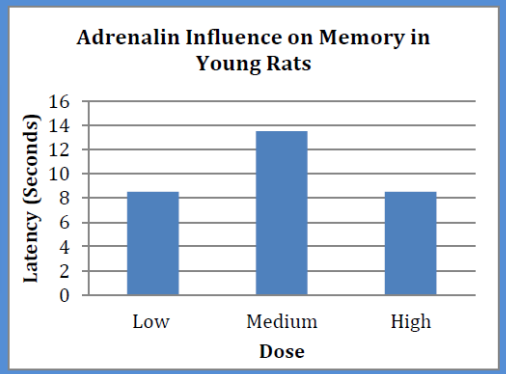


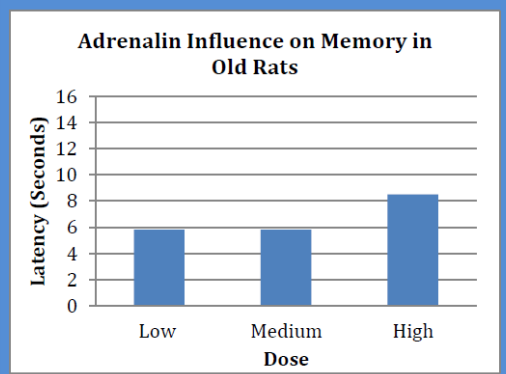
Glucose





Adrenalin





Discussion: Glucunculus and Rat Recall Activities

- How do these activities promote NGSS Scientific Practices and CCSS Mathematical Practices?
- How could you incorporate this activity into your curriculum?
  - To align with NGSS
  - To incorporate math concepts
- What accommodations/modifications would you make to teach this in your classroom?

More Math + Bio Lessons

- Why dread a bump on the head?

  Exploring the data behind brain injury

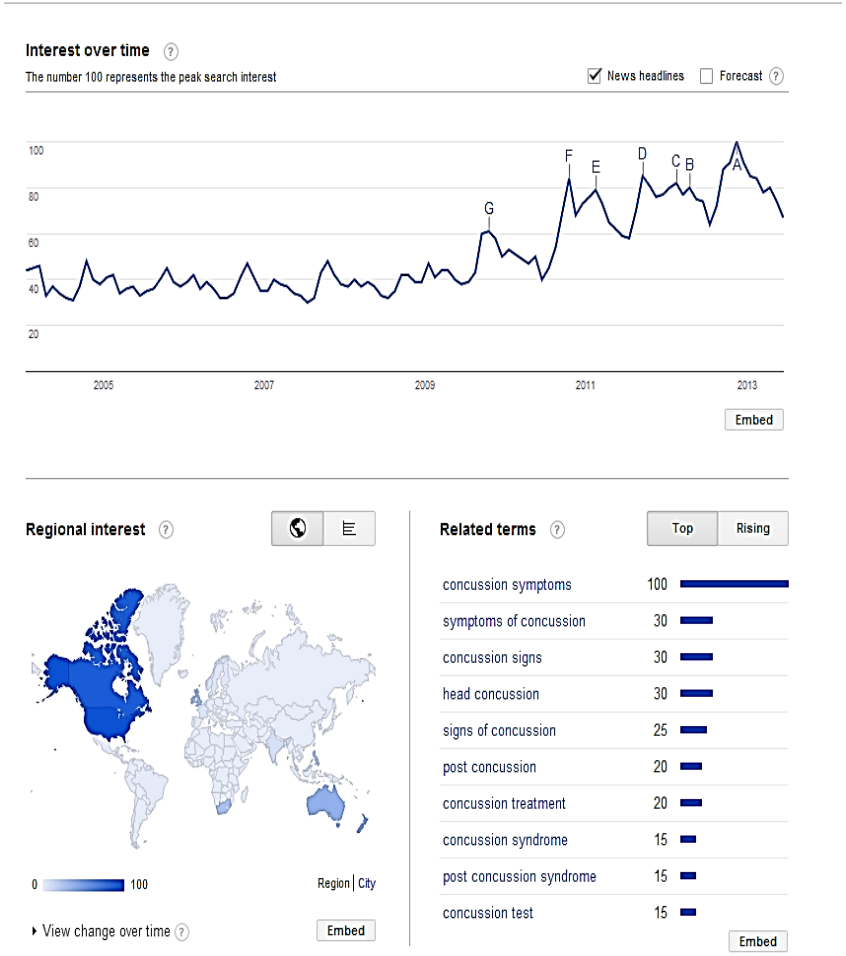
- What changes our minds?

  Where are toxicants and how much are we exposed?

Lesson 6: Exploring the data behind brain injury

- Students examine trends on the web and analyze statistical data

- Students learn about the public's interest in different aspects of TBI



Lesson 6: Exploring the data behind brain injury

- Students construct their own interest graphs

Sketch the interest graph for "Concussion" below:

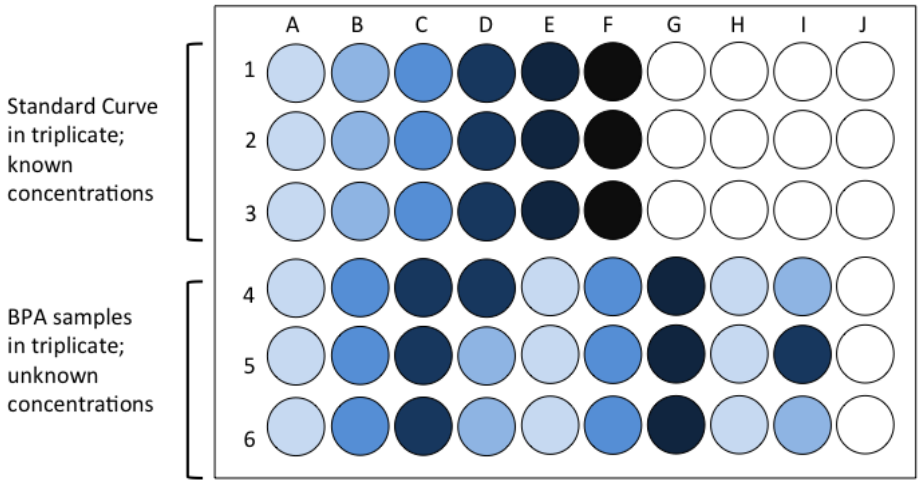
2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

Sketch the interest graph for "Concussion" compared to "Traumatic Brain Injury" below:

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

Lesson 4: Where are toxicants and how much are we exposed?

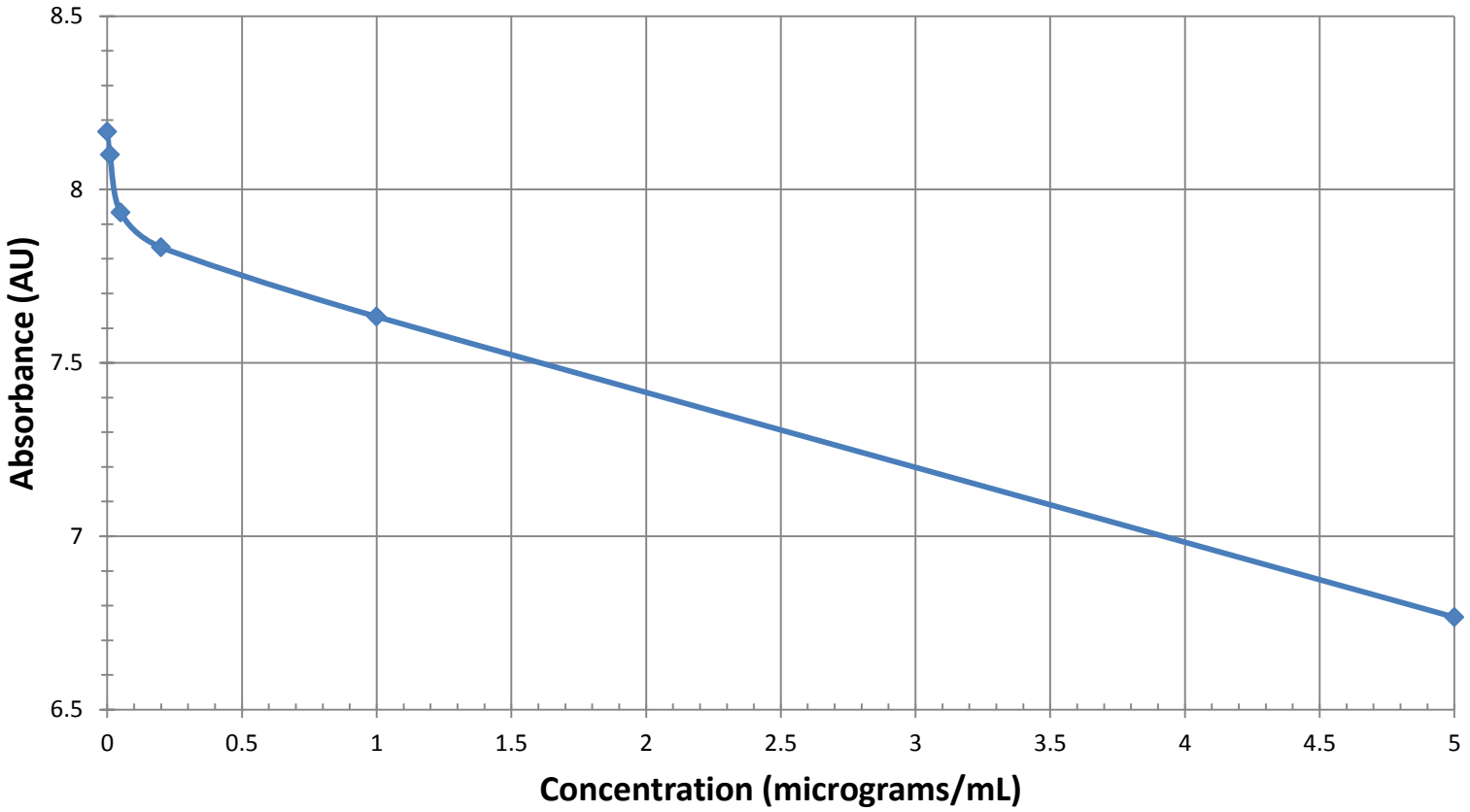
- Students learn about the ELISA Method



Concentration of known quantities (micrograms/mL)	Absorbance of well 1 (AU)	Absorbance of well 2 (AU)	Absorbance of well 3 (AU)	Average AUs
0	8.3	8.1	8.1	8.2
0.01	8.3	8.0	8.0	8.1
0.05	7.9	7.9	8.0	7.9
0.2	7.8	7.7	8.0	7.8
1.0	7.6	7.5	7.8	7.6
5.0	6.8	6.7	6.8	6.8

Lesson 4: Where are toxicants and how much are we exposed?

- Students construct a standard curve using the absorbance data



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Thanks!

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