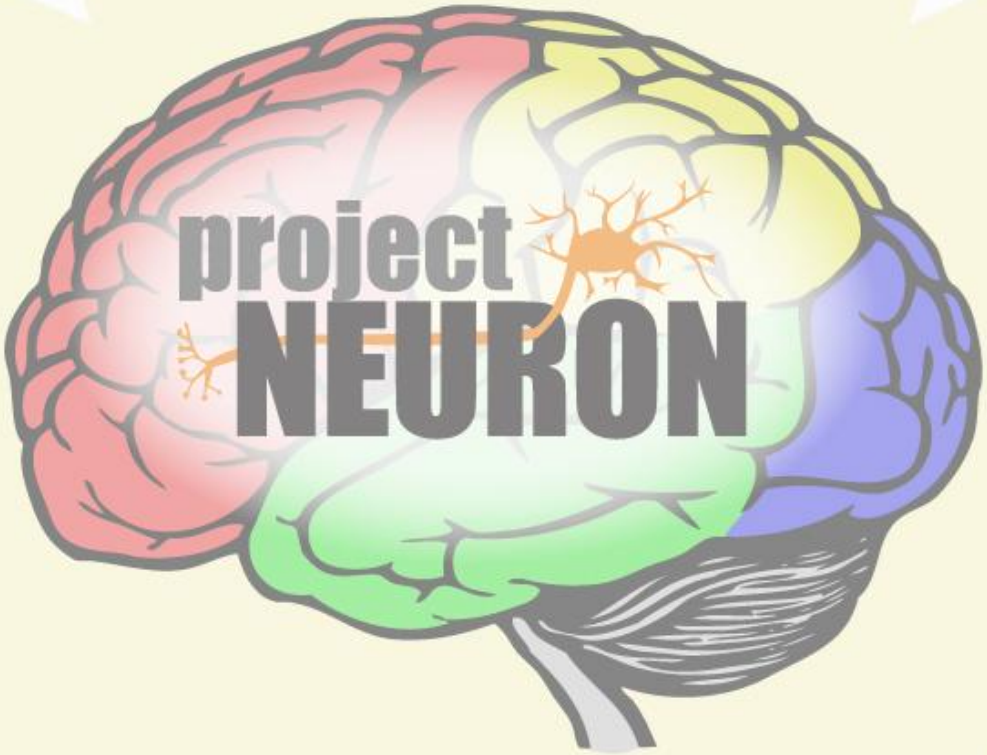
Integrating Math in a Biology Classroom



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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

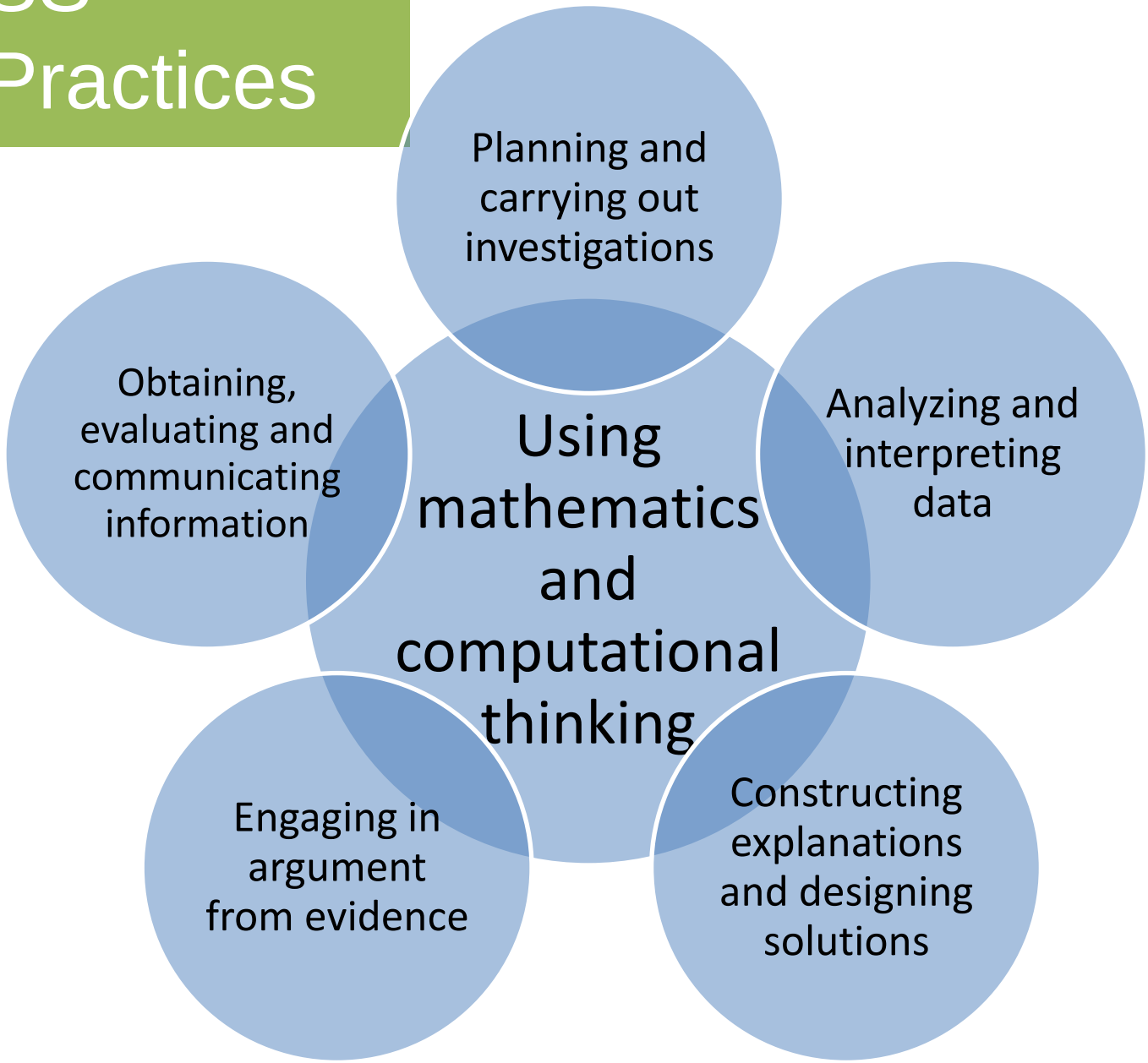
Determine main understanding goals and develop unit outline

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 Practice

Session Activity 1

Rat Recall Experiment

- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model with mathematics

Session Activity 2

Microbial Scale and Mural

- Reason abstractly and quantitatively
- Model with mathematics
- Use appropriate tools strategically

Session Activity 3

ELISA Investigation

- Make sense of problems and persevere in solving them

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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?

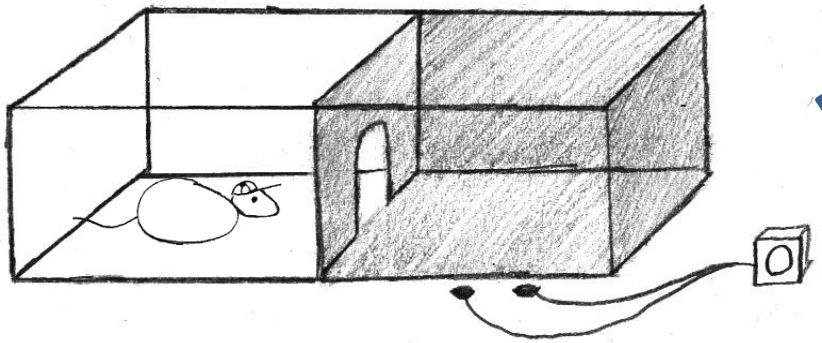
Lesson: How do glucose and adrenalin affect memory in aging populations?

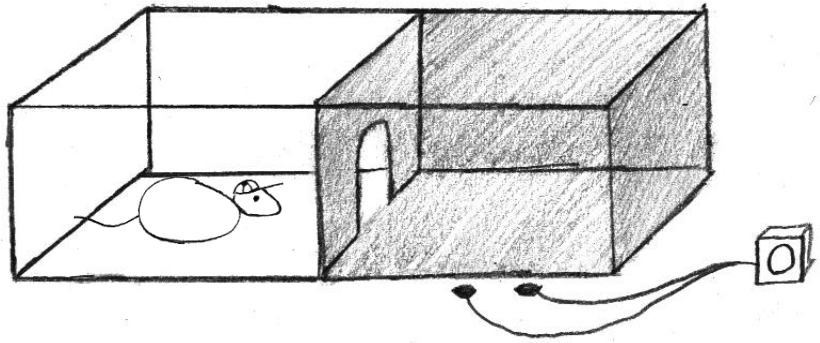
Learning Objectives

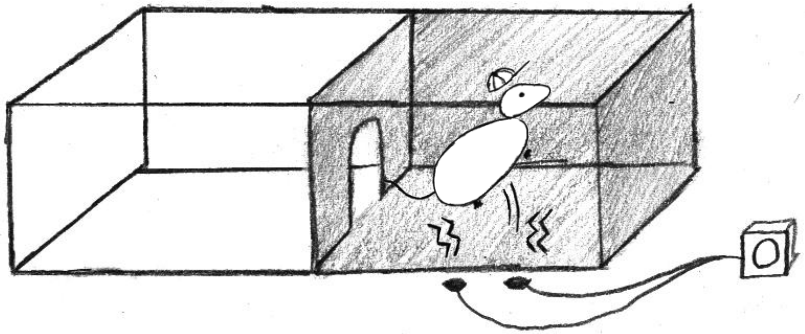
- **Design and conduct an experiment** about age-related differences in memory.
- **Graph data and develop a scientific explanation** based on the results of the experiment.

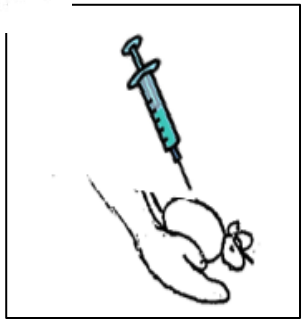
Inhibitory Avoidance Task

Testing the effect of glucose and adrenalin on memory.



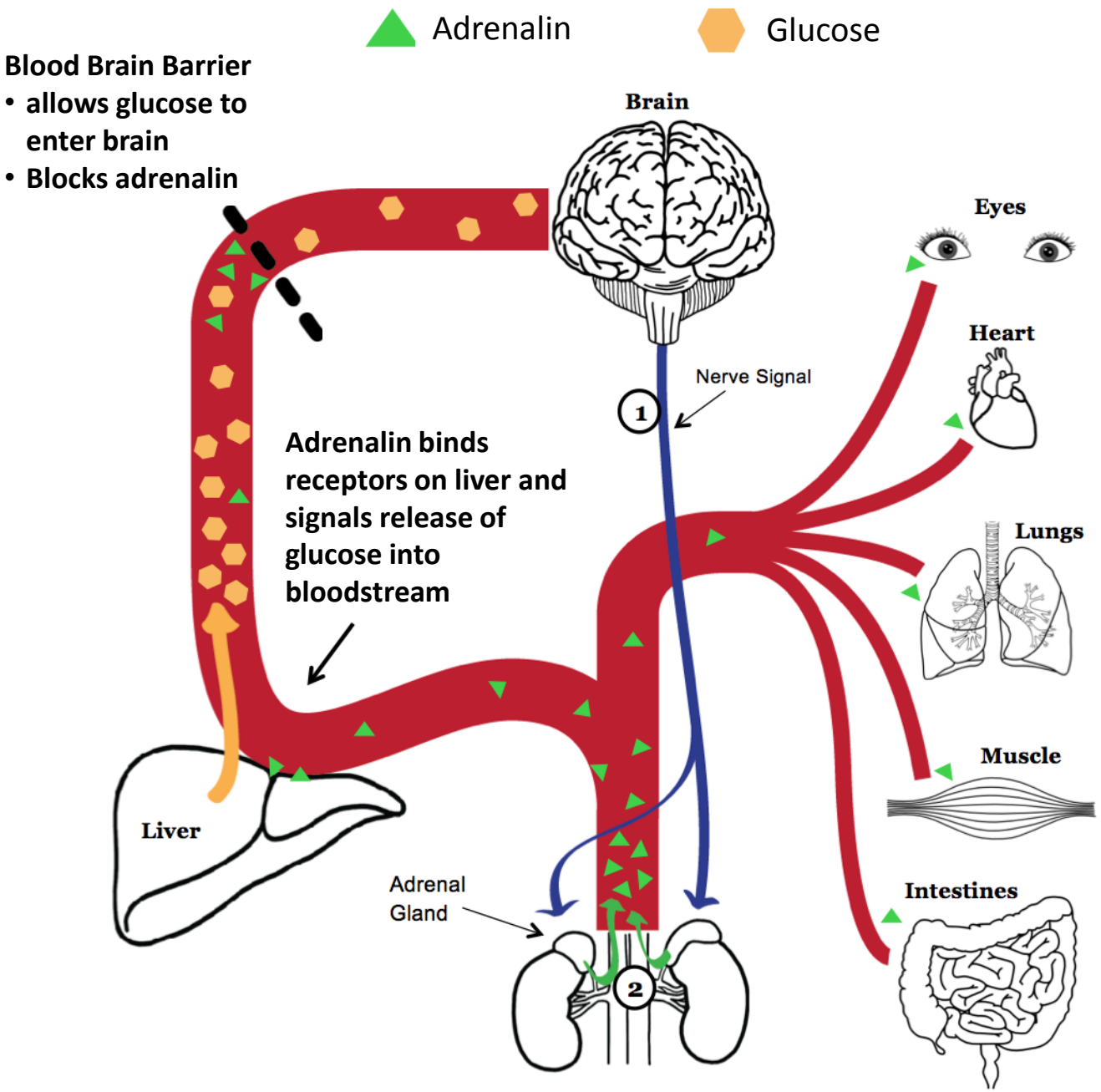






Injected with: saline, glucose, or adrenalin

Glucose & Adrenalin



Rat Recall Experiment

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

Age	Treatment type	Treatment dosage
• Young • Old	• Saline • Glucose • Adrenalin	• Low • Medium • High

Rat Recall Experiment

Do adrenalin and glucose affect memory in aging populations?

1. Develop a hypothesis to test (today: divide up trials)
2. Open Rat Recall on the laptops
3. Choose the appropriate variables for your trials
4. Conduct the experiment (run 3 trials for each set of variables)
5. Collect and graph data (use the average of the 3 trials)
6. Draw conclusions

	Young	Old
	Saline: ~6 seconds	Saline: ~6 seconds
	Young rats Glucose	Old rats Glucose
	Young rats Adrenalin	Old rats Adrenalin

(15 minutes)

Results

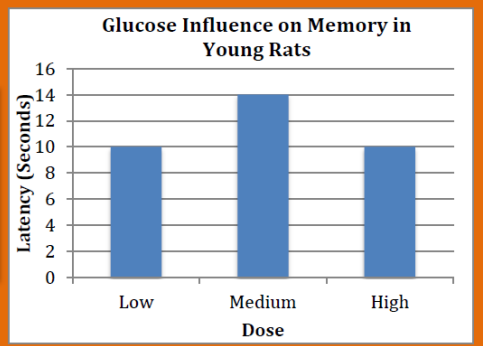
Young

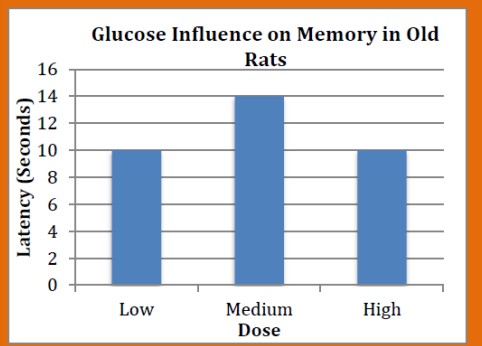
Old

Saline: ~6 seconds

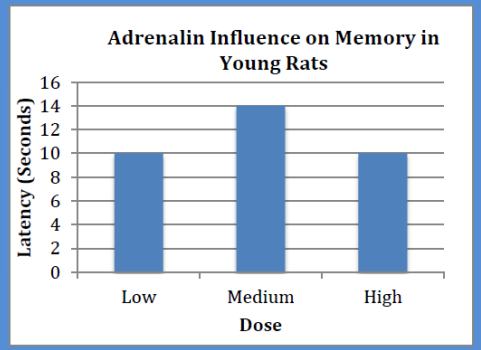
Saline: ~6 seconds

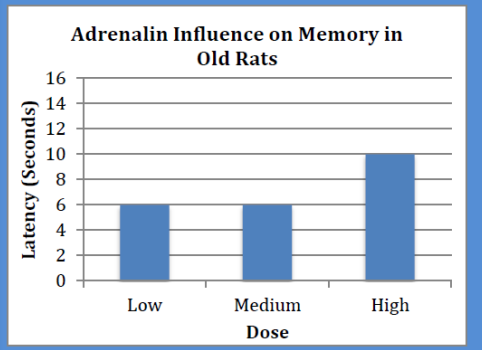
Glucose





Adrenalin





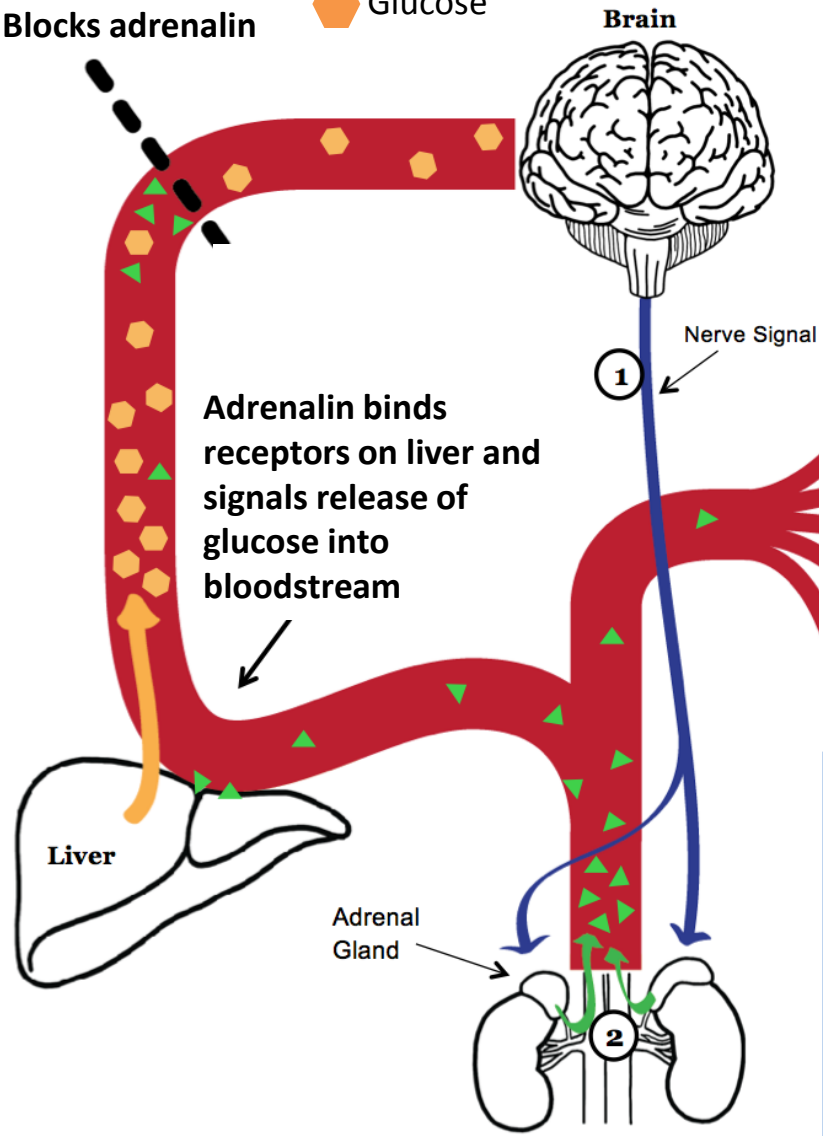
Results

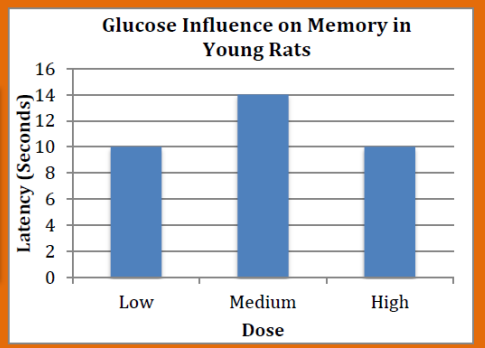
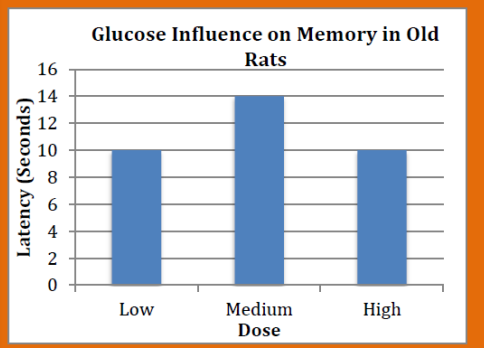
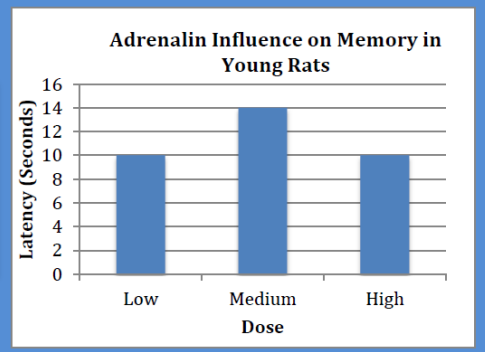
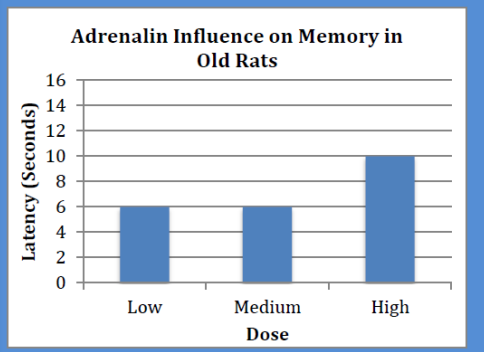
Glucose & Adrenalin

Blood Brain Barrier
- **allows glucose to enter brain**
- **Blocks adrenalin**

Adrenalin

Glucose



	Young	Old
	Saline: ~6 seconds	Saline: ~6 seconds
Glucose		
Adrenalin		

Rat Recall Activity

Reflect on the activity by discussing with a partner:

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

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?

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Lesson: What are microbes?

Learning Objectives

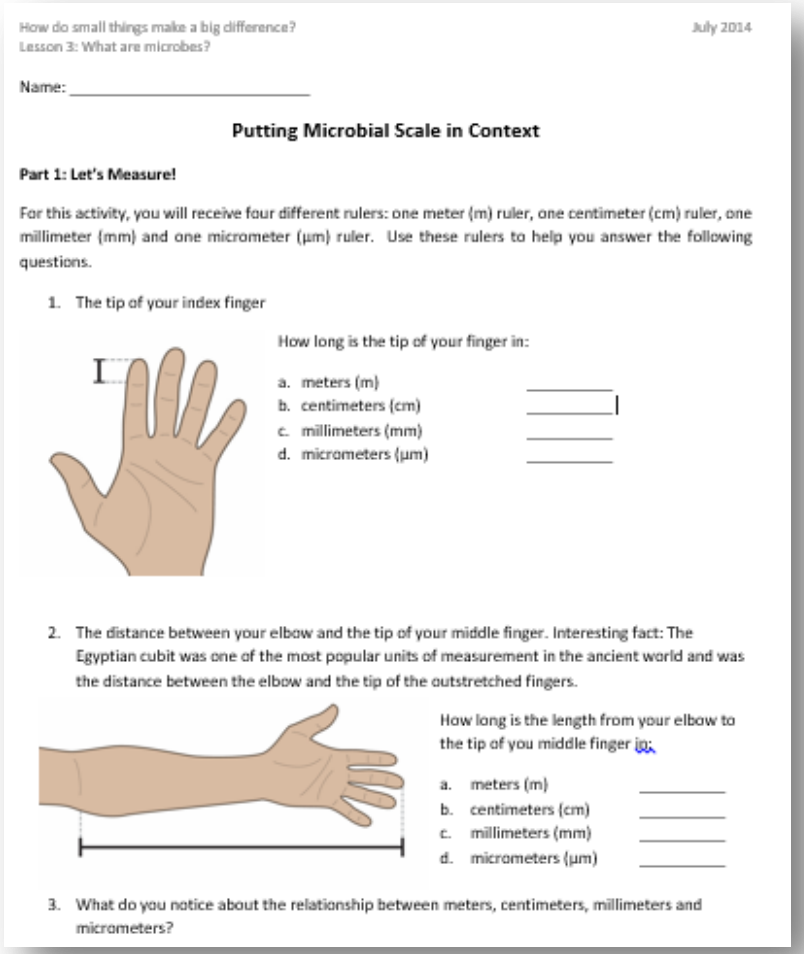
- **Examine the diversity** of microbes
- **Construct conversion tables** to calculate measurements in different units
- **Calculate** the size of microbes
- **Construct** a microbe mural to scale

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

(5 minutes)



How do small things make a big difference? July 2014
Lesson 3: What are microbes?

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?

Part 2: Microbe Mural Activity

Construct a microbe mural to examine aspects of microbial diversity such as their size, habitat and metabolic properties.

- How would a period, which measures 0.5mm, 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 (use appropriate units)
  - 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

Reflect on the activity on your own:

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

Curriculum Unit

What changes our minds?

Toxicants, exposure, and the environment

- Lesson 1: What changes our minds?
- Lesson 2: How do we define what changes our minds?
- Lesson 3: How does the environment magnify our exposure to toxicants?
- Lesson 4: Where are toxicants and how much are we exposed?
- Lesson 5: How can an environmental toxicant affect *Daphnia*?
- Lesson 6: Toxicants in action: What changes the cell?
- Lesson 7: If it's harmful, why do we use it?

Curriculum Unit

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

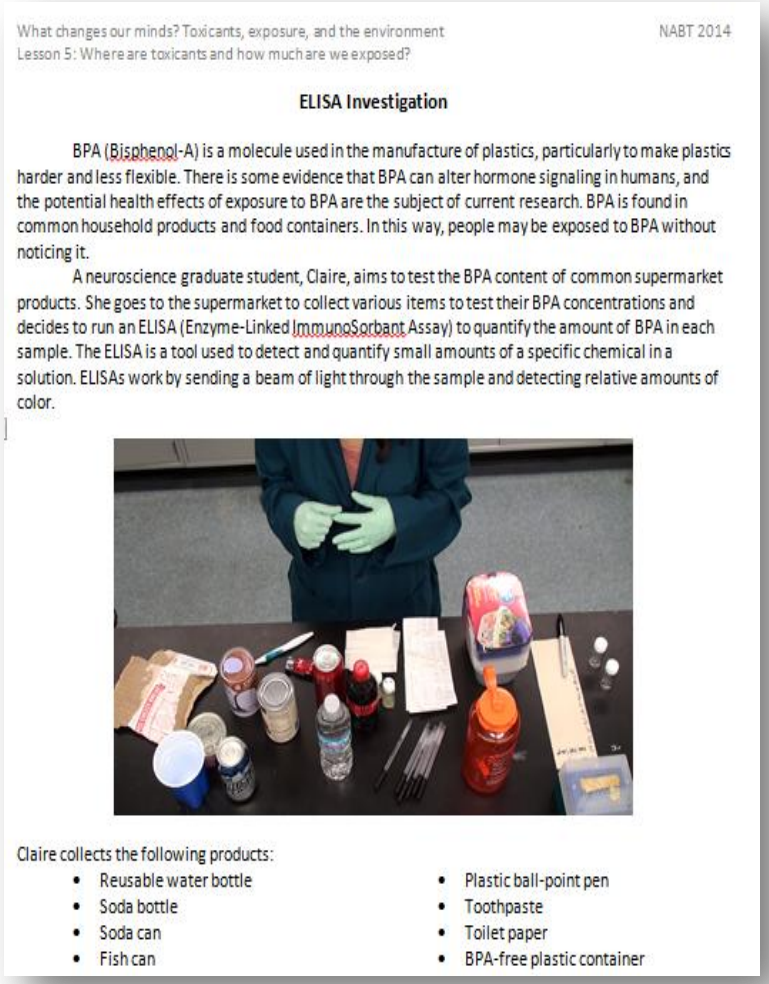
Learning Objectives

- **Describe exposure to toxicants** and how scientists monitor levels of toxicants in the body.
- **Define, create, and interpret a standard curve** to determine the quantity of an unknown.
- **Explain** how toxicant levels can be quantified using the ELISA method.
- **Compare the ELISA method** to other methods that evaluate the concentration of unknown samples.

ELISA Activity

Use the ELISA method to quantify how much toxicant is present in a sample.

- Browse through the Student Sheet to see the connections between science and math.



What changes our minds? Toxicants, exposure, and the environment NABT 2014
Lesson 5: Where are toxicants and how much are we exposed?

ELISA Investigation

BPA (Bisphenol-A) is a molecule used in the manufacture of plastics, particularly to make plastics harder and less flexible. There is some evidence that BPA can alter hormone signaling in humans, and the potential health effects of exposure to BPA are the subject of current research. BPA is found in common household products and food containers. In this way, people may be exposed to BPA without noticing it.

A neuroscience graduate student, Claire, aims to test the BPA content of common supermarket products. She goes to the supermarket to collect various items to test their BPA concentrations and decides to run an ELISA (Enzyme-Linked ImmunoSorbant Assay) to quantify the amount of BPA in each sample. The ELISA is a tool used to detect and quantify small amounts of a specific chemical in a solution. ELISAs work by sending a beam of light through the sample and detecting relative amounts of color.

Claire collects the following products:

- Reusable water bottle
- Soda bottle
- Soda can
- Fish can
- Plastic ball-point pen
- Toothpaste
- Toilet paper
- BPA-free plastic container

Discussion

- How does the activity promote NGSS Scientific Practices and CCSS Mathematical Practices?
- What accommodations/modifications would you make to teach this in your classroom?
- How could you incorporate this activity into your curriculum?
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Acknowledgements

- NIH, SEPA
- University of Illinois
  - Project NEURON

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Thanks!

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