Math + Biology: It adds up!

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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

Using mathematics and computational thinking

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

Obtaining, evaluating and communicating information
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
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

(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?

<table>
<thead>
<tr>
<th>Organ or Tissue</th>
<th>Energy Consumption (kcal)</th>
<th>Percent Energy Consumption</th>
<th>Ratio: % E consumption % Body Weight</th>
<th>Percent Body Weight</th>
<th>Weight (lbs)</th>
<th>Organ or Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adipose (fat)</td>
<td>67.5</td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td>Adipose (fat)</td>
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<tr>
<td>Muscle</td>
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<td>Liver</td>
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<td>3.96</td>
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<tr>
<td>Brain</td>
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<td></td>
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<td>3.08</td>
<td>Brain</td>
</tr>
<tr>
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<td>0.66</td>
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<tr>
<td>Kidney</td>
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<td></td>
<td></td>
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<tr>
<td>Other</td>
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<td></td>
<td></td>
<td></td>
<td>51.5</td>
<td>Other</td>
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</tbody>
</table>
Students model the disproportionate distribution of glucose throughout the body
Food for thought: What fuels us?

*Glucose, the endocrine system, and health*

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- Lesson 5: How does glucose dysregulation lead to disease?
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.

I’m as happy as a rat in the dark.

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 Influence on Memory in Young Rats

Saline Influence on Memory in Old Rats

Glucose Influence on Memory in Young Rats

Glucose Influence on Memory in Old Rats

Adrenalin Influence on Memory in Young Rats

Adrenalin Influence on Memory in Old Rats
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:

|---|------|------|------|------|------|------|------|------|------|------|

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

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

- Students learn about the ELISA Method

### Table: ELISA Method Results

<table>
<thead>
<tr>
<th>Concentration (micrograms/mL)</th>
<th>Absorbance of well 1 (AU)</th>
<th>Absorbance of well 2 (AU)</th>
<th>Absorbance of well 3 (AU)</th>
<th>Average AUs</th>
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<td>6.8</td>
<td>6.7</td>
<td>6.8</td>
<td>6.8</td>
</tr>
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</table>
Lesson 4: Where are toxicants and how much are we exposed?

- Students construct a standard curve using the absorbance data
Acknowledgements

• NIH, SEPA
• University of Illinois
  – Project NEURON

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Thanks!

For additional information visit: http://neuron.illinois.edu

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