How do small things make a big difference?

*Microbes, ecology, and the tree of life*

Teacher Workshop
July 28-30

Project NEURON and Project MICROBE
University of Illinois
Workshop Goals

• Experience Project NEURON/Project MICROBE Curriculum Materials as a learner and teacher

• Interact with University of Illinois Scientists and Science Educators

• Develop a community of teachers

• Integrate Curriculum Materials with your local curriculum
## Day 1: July 28

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**Day 1 Homework:** Find one example of microbes in the news
What is Project NEURON?

- Educators, scientists, and graduate students
- Curriculum development
  - Inquiry-based
  - Connect to standards
- Professional development
  - Summer institutes
  - Conferences

More information at: neuron.illinois.edu
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 (Whitaker Lab)

Teachers provide feedback (based on workshops and classroom enactments)
Participant forms & Pre-assessment
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 community look like?
- Lesson 5: How do microbes interact with humans?
- Lesson 6: What can happen when my microbiome is disturbed?
The Nature of Science in the NGSS (NGSS - Appendix H)

• “The integration of scientific and engineering practices, disciplinary core ideas, and crosscutting concepts sets the stage for teaching and learning about the nature of science.”

• The NOS Matrix (handout)
  – Learning outcomes for 8 major NOS themes

• Implementing Instruction
  – Students be metacognitive about NOS after doing the practices
  – Case studies from the history of science

*Take a couple of minutes to read these and keep them in mind as we go through the lesson.
Lesson 1: How did the tree of life change through history?

Learning Objectives

• Explain how and why scientific models can change over time (within the context of the tree of life model case study)
• Explain the role of technology in the advancement of science
• Explain how the model of the tree of life changed throughout history
“Tree of Life”

On a sheet of paper, draw what you think of when you hear the term “tree of life”.

Activity: Tree of Life Timeline

- Work in groups of 3-4
- Use the student sheet as a guide
- Focus on the big picture
- 20 minutes

Outline of steps:
Step 1: 1758 A → 1758 B
Step 2: 1866 A → 1866 B
Step 3: 1969 A → 1969 B
Activity: Tree of Life Timeline

• Work in your groups of 3-4

• Using diagrams and words, tell the story of the tree of life model.

• 10 minutes
Tree of Life Timeline

Linneaus (1758)

Haeckel (1866)

Whittaker (1969)
The 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 community look like?

• Lesson 5: How do microbes interact with humans?

• Lesson 6: What can happen when my microbiome is disturbed?
Lesson 2: What is the current tree of life model?

Learning Objectives

• Draw and label an accurate sketch of the current molecular tree of life indicating the three domains and their evolutionary relationships

• Explain how Woese’s discovery affected the scientific community

• Explain the major concepts of molecular methods and how they work

• Construct an argument regarding the use of the term “prokaryote” and its implications
In the 1970s, advances in science and technology allowed scientists to examine genetic information found in DNA and RNA to determine the relationships between species. Using the reasoning that groups of organisms with a lot of genetic information in common were more closely related to each other than others that had less in common, scientists began to reorganize the tree of life...
Activity 1: Molecular Tree of Life

Bacteroidetes spp.
ACATTAGCCACTGTCCTTGCACATATCGGCCCATTGGAGCT

Giardia intestinalis
AGGCTTCCAAACCTGTTCACTCTTCGCACTATCGGGCCATTGAGCT

Methanosarcina spp.
AGGCTATCCACTTTCCTCACATATCGGGCATTGGAGCT

Sulfurobus islandicus
AGGCTATACACTGCTTACTGAGTATCGGGCCATTGGAGCT

Thiobacillus spp.
ACATTAGCTACTCCTGCCACTCTTCGAGTTTCGGGCCACATTGGAGCT

Acinonyx jubatus
AGGCTTCCAAACCTGTTCACTCCTTCTGACATATCGGACCATTGGAGCT
Activity 2: To use or not to use “prokaryote”

Figure 1B
The three-domain molecular tree of life.

Cartoons of the two models of evolution. The triangles indicate divergences of genetic lines (e.g., species) within the groups represented by each triangle.

Previous model: Eukaryotes evolve from prokaryotes

Current model: Three domains with a common origin

Baumgartner, L.K. & Pace, N.R. (October 2007)
Activity 3: NYT article on Woese discovery

Questions for students:

• How did Woese identify archaea as a separate domain?
• How did the scientific community respond? Why?
• How did Woese’s findings affect the world of microbiology?
• What is the role of microbes in this story?
• What is the importance of continuing to study microbes?
How do you think Carl Woese’s new tree of life model has affected microbiology research?
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Day 1 Homework: Find one example of microbes in the news
Discussion: Nature of Science in NGSS

• How could you use these lessons in your classroom?
  – To teach about the Nature of Science?
• What went well?

• What did not go well?

• How would you use this or modify it for your classroom?
Break: 15 minutes

Followed by: Seminar by Rachel Whitaker
Homework:
Find one example of microbes in the news
Thanks!

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

E-mail:  
neuron@illinois.edu