

Bench to Bedside Action Proposal

Title: Say What? Worms are Similar to Humans?

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Abstract: This action plan is designed to expose 9th grade Environmental Science students to biotechnology and the effects of manipulating environmental stressors on *Caenorhabditis elegans*. This unit is designed to use inferences of the environmental stressors of *C. elegans* and how it can be applied to humans. “*Caenorhabditis elegans* is a small free-living (not parasite) nematode that has been a popular model for development, cell biology, genetics, physiology, molecular biology, and biochemistry since the 1960’s” (Choe, 2015). Students will use these nematodes to investigate and manipulate the acidity of their environments and determine how this could be applied to human research. This unit will take place in three 100 minute block periods where investigation of *C.elegans* will be student centered using differentiated instruction. At the conclusion of this lesson, students Scientific Methods, lab procedures, and investigative research skills will be improved. Students will create a pamphlet brochure applying the *C. elegans* research to humans and how this could be used in further research. The pamphlet will allow students to bridge the *C. elegans* lab with human effects of the environment.

Rationale: In the young minds of 9th graders, they often have trouble linking their actions to environmental issues. Working with *C. elegans* will allow them to visualize the effects of acidity changes to an environment and the organisms in that area. *C. elegans* are being used as the subject of choice because of their similarity to humans. They have nearly the same amount of genes as humans (20,000) with intestines, muscles, gonads, nervous system and sensory receptors (Choe, 2015). These nematodes are also small, easy to manipulate, inexpensive, and have a short lifespan making it easy to see their different phases (Choe, 2015). “ Much of its nervous system and more than 5% of its genes are devoted to the recognition of environmental chemicals” (Bargmann, 2006). Chemosensory cues can result in retraction, motility direction changes, and changes in developmental stages. These behaviors are regulated by the amphid chemosensory organ that contains eleven pairs of neurons (Bargmann, 2006). These worms are great to study because their sensory structures, almost like a sense of smell, are sensitive to their environmental conditions (Sassa, Murayama, Maruyama, 2013). *C.elegans* will not tolerate pH levels above 10.5. However, *C. elegans* with structurally, or developmentally abnormal cilia will not avoid the increase pH levels indicating that the cilia are involved in the sensory structures of the worm (Sassa *et al.*, 2013).

C. elegans response to the environmental toxins is similar to how humans respond to environmental toxins (Choe, 2015). In this unit students will use this knowledge and infer how acidic environments can pose potential threats to humans. The use of biotechnology, student centered group labs, and project based assessments will be used to investigate *C. elegans* and the environmental stressors affecting their developmental structures.

Action Research Intervention:

Environmental Science is a course taken by ninth grade students at my school. This course is taken prior to Biology and serves as a pre-requisite to the course to obtain important information needed in Biology. During this unit, students are learning about the effects of pollution on humans and how different types of pollution can have a negative effect on humans. Because research cannot be conducted on humans, we will be using nematodes that are similar to humans to investigate the effects of pollutions in the environment. This lesson will focus on the different acidity levels and will conclude which acidity level hinders *C. elegans* development and which are favorable. This unit will take place in November of 2015 where it will align with the benchmarks for the course.

C. elegans response to acidic environments will be investigated and related to humans responses to those conditions as well. Students will create a biotech tool that is used in the lab to pick up the worm and manipulate them. Students will follow the lab protocol to determine the effects of acidic environments on *C. elegans*. Students will then create an information brochure linking their research to human applications. Differentiated instructed is being used in this unit to highlight the benchmarks of this unit.

Connections to Bench to Bedside Summer Institute:

A modification of Dr. Choe's *C. elegans* lab will be used to investigate the effects of acidic environments on *C. elegans*. During the institute, teachers learned the reasons why *C. elegans* are favorable to study and why the research could be applied to humans; *C. elegans* are similar in genes to humans.

Data Collection and Analysis:

A pre and posttest will be given to evaluate learning gains. These pre and posttest results will be used to determine if the lesson was effective in creating that bridge between lab research on *C. elegans* and its application to humans and the environment. The student made brochure will also provide evidence of student learning gains if the students are able to explain the relevance of this lab and the environmental dangers to humans.

Literature Cited:

Bargmann, C.I (2006). Chemosensation in *C. elegans*. Howard Hughes Medical Center.
Retrieved from http://www.wormbook.org/chapters/www_chemosensation/chemosensation.html

Choe, K. (2015). What worms can do for you: Simple models for molecular biology, genetics, development and physiology. Laboratory Manual pg 1-13. Retrieved from <http://choelab.weebly.com/>

Sassa, T., Murayama, T., Maruyama, I.N. (2013). Strongly alkaline pH avoidance mediated by ASH sensory neurons in *C. elegans*. *Science Direct*, 555, 248-252.

Budget and justification:

- Glass Pasteur Pipette- \$48.000 Qty- 1000
http://www.coleparmer.com/Product/Disposable_Pasteur_Pipettes_Plain_End_Soda_Lime_Glass_145_mm_1000-Cs/EW-25554-06
- Parafilm- \$ 25.00 Qty0 250 ft
<http://www.coleparmer.com/Brand/Parafilm/611?SearchTerm=parafilm>
- Worms- Provided by UF- Free
- Agar Plates with Two different Acidity levels for Worms- Provided by UF- Free
- Microscopes- Provided by Palm Beach Central High School or UF- Free

Permissions:

Since I am not in a lab classroom, I will need to switch with another teacher for the duration of this unit. I will need approval from the assistant principal and the teacher to do this. There are no other waivers or permission forms needed to conduct this unit.

SINGLE LESSON PLAN

Teacher: A. Barrios

Content Area/Grade: Environmental Science/ 9th Grade

Date: June 2015

Unit Name: Say What? Worms are similar to humans?

Unit Goal

What unit goal does this daily lesson address?

Effects of environmental differences on organisms
Effects of acidic conditions on *C. elegans* worms.

Standard(s)/Benchmark(s)

What standard(s)/benchmark(s) does this daily lesson address?

SC.912.L.17.15- Discuss the effects of technology on environment quality.
SC.912.L.17.20- Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

Students will understand that...

What should the students understand by the end of today's lesson?

Explain the effects of differences in acidity effect in *C. elegans*.
Explain how acid rain has a negative impact on the environment and the organisms.
Compare how humans and *C. elegans* are similar.

Essential Questions

What essential question(s) does this lesson address?

1. Why is research on *C. elegans* important to humans?
2. How do differences in pH affect *C. elegans*?
3. Why are these differences important for humans?
4. Explain dependent and independent variables.

Connecting Concepts

How will you review yesterday's content and connect today's lesson to it?

Yesterday we reviewed *C. elegans* and created a simple biotech tool that will be used in today's lab.

Organizing Students for Learning

How will students be organized today for the lessons activities?

Students will be in groups of three students for this lab.
Teacher will select the student groups.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge

Students will be asked to review knowledge of *C. elegans* learned in the previous class period. They will do this in a brief Think-Pair-Share review activity.

- ABC Brainstorming
- KWL
- Anticipation Guide
- Card Sort
- Think-Pair-Share

Explicit Instruction

Students will follow along with lab protocol to investigate information on *C. elegans*. Students will then follow lab procedures on how to conduct lab properly.

- Motivational Hook
- Lecture
- Demonstration
- Note-taking Guide

Lesson Sequence			Resources and Materials
Group Processing of New Information	Students will be asked to explain the purpose of this lab to their partners in order to begin the procedures.	<input type="checkbox"/> Jigsaw <input type="checkbox"/> Reciprocal Teaching <input type="checkbox"/> Concept Attainment <input checked="" type="checkbox"/> Think-Pair-Share	<input type="checkbox"/> Lab / Inquiry Activity <input type="checkbox"/> Computer <input type="checkbox"/> LCD Projector <input type="checkbox"/> Paper <input type="checkbox"/> Pencils <input type="checkbox"/> Whiteboards <input type="checkbox"/> Markers <input type="checkbox"/> Butcher Paper <input type="checkbox"/> Response Cards <input type="checkbox"/> Post-it Notes <input type="checkbox"/> Video Clip(s): <input type="checkbox"/> Website(s): <input checked="" type="checkbox"/> Lab Materials: Dissecting Microscope Worm Picks <i>C. elegans</i> worms Agar plates with varied pH levels
Elaborative Questioning	<ol style="list-style-type: none"> 1. What is the independent variable of this lab. 2. What is the dependent variable of this lab. 3. What are some control variables on this lab. 4. Which are our experimental groups and control groups? How do you know? 	<input checked="" type="checkbox"/> Inferential Questions <input type="checkbox"/> Analytic Questions <input type="checkbox"/> Philosophical Chairs	
Demonstrating Understanding	Students will answer post lab questions through journal prompts	<input type="checkbox"/> Graphic Organizers <input type="checkbox"/> Picture Notes <input type="checkbox"/> Flow Charts <input type="checkbox"/> Concept Maps <input type="checkbox"/> Mnemonics <input type="checkbox"/> Graffiti	
Reflection	Students will answer the following journal prompts: <ol style="list-style-type: none"> 1. Explain your results to the lab. 2. Explain how research with <i>C. elegans</i> can lead to inferences about humans. 3. Analyze <i>C. elegans</i> response to acid environments and apply that to human conditions. 	<input type="checkbox"/> Reflective Journals <input type="checkbox"/> Think Logs <input type="checkbox"/> Exit Ticket (Student Learning)	
Daily Progress Monitoring Assessment	Students will answer the above reflection questions as journal prompts.	<input type="checkbox"/> Quiz <input checked="" type="checkbox"/> Journal <input type="checkbox"/> Exit Ticket (for Content) <input type="checkbox"/> Response Cards	
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson? <ul style="list-style-type: none"> • The connection between <i>C. elegans</i> worms and the acidic environment with applications to humans. 			

UNIT PLAN	
Unit Title: Say What? Worms are similar to humans?	Content Area/Grade: Environmental Science / 9th
Teacher: A. Barrios	Implementation Time Frame: 3-100 minute block period
STAGE 1: THE DESIRED RESULTS	
What are my learning goals?	
Unit Goal	Standard(s)/Benchmark(s)
Students will understand	What standard(s)/benchmark(s) does this daily lesson address?
Effects of environmental differences on organisms Effects of acidic conditions on <i>C. elegans</i> worms. Steps of Scientific Method The relationship of animal studies and human Biotech equipment can used to enhance research	SC.912.L.17.15- Discuss the effects of technology on environment quality. SC.912.L.17.20- Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability. SC.912.N4.1- Explain how scientific knowledge and reasoning provide an empirically based perspective to inform society's decision making.
Related Misconceptions	Students will know...
What misconceptions are predictable?	Vocabulary, terminology, definitions
Worms are unrelated to humans Animal research is only conducted on vertebrates Animal research cannot be applied to humans Worms are boring creatures	Vocabulary: <ul style="list-style-type: none"> • Biotech • pH • Acid • Base • Nematodes • Biological process • Multicellular • Parasites • Hermaphrodite • Gonad • Pharynx • Embryos • Hypothesis • Dependent Variable • Independent variable • Control Group • Data • Chemosensory • Neurons • Cilia • toxins
Essential Questions	
What questions will foster inquiry, understanding and transfer of learning?	
<ol style="list-style-type: none"> 1. Why is research on <i>C. elegans</i> important to humans? 2. How do differences in pH affect <i>C. elegans</i>? 3. Why are these differences important for humans? 4. Explain dependent and independent variables. 	
Students will know...	
key facts, formulas, critical details, important events, important people, timelines	
Other Essential Knowledge	
Steps of the Scientific Method	
Students will be able to...	
Specific skills students will acquire as a result of this unit	
The effects of differences in acidity effect in <i>C. elegans</i> . Acid rain's negative impact on the environment and the organisms. Comparison of how humans and <i>C. elegans</i> are similar. Application of the Scientific Method	

STAGE 2: ASSESSMENT EVIDENCE

What evidence will show that my students have achieved the learning goals?

Performance tasks:

Through what specific “real-world” performance task(s) will students demonstrate their understanding of the learning goals?

Students will create a biotech tool to pick worms from the agar plate. Students will see evidence of abnormalities in worms placed in higher acidic environments. Students will relate this knowledge to the application of humans and our environment. They will demonstrate mastery of this by increasing their post test scores by 25%.

Rubric

By what criteria will “performance of understanding” be judged?

Students will take a pre and posttest. Scores will be compared on learning gains made after the unit was taught.

Other Evidence:

What other evidence needs to be collected in order to monitor student progress on these concepts and skills along the way?

Students will create a brochure linking their research on *C. elegans* with human applications.

Self-Assessment/Reflection

How will students reflect and self-assess their learning?

They will answer journal prompts and participate in discussions.

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES

What activities will help my students achieve the learning goals?

<p>What here</p>	<p>What is expected? How will you ensure that students are aware of the learning goals? Where are your students? How will you establish your students' prior knowledge?</p> <p>Learning goals will be posted on the board and reviewed at the beginning of every lesson. A discussion regarding scientific research and the steps will be conducted prior to the start of the unit. Students will already have a prior knowledge of the scientific method and will be able to apply that knowledge to the discussion.</p>
<p>Hook old</p>	<p>How will you hook students at the beginning of the unit? How will you hold their attention throughout the units?</p> <p>With animal studies ethical discussion. Creating their biotech tool and observing the worms will hold their attention.</p>
<p>Experience Explore quip</p>	<p>What critical input experience will help students explore the key ideas and essential questions? How will you equip your students with needed skills and knowledge?</p> <p>Students will investigate and research the application of <i>C. elegans</i> research to humans and our environment. Because <i>C. elegans</i> response to environmental toxins and stimulus are similar to humans, their response to acidic levels implies that humans would respond the same.</p>
<p>Reflect ethink ehearsing evising efining</p>	<p>How will you encourage students to reflect and rethink? How will you guide students in the process of rehearsing, revising, and refining their work?</p> <p>Students will have journal prompts and a brochure that will allow them the opportunity to reflect. I will guide the students and provide feedback while they are working on lab and brochure assignments.</p>
<p>Exhibit valuate</p>	<p>How will you help students to exhibit and self-evaluate their developing skills, knowledge and understanding throughout the unit?</p> <p>Students will self-evaluate using journal prompts and creation of informative brochure.</p>
<p>Tailor</p>	<p>How will you tailor your instruction to meet the different needs, interests and abilities of all learners in your classroom?</p> <p>Students will be paired in groups according to their learning needs. Higher level students will be placed with middle and lower level students to ensure that the groups are balanced. Unit will use differentiated instruction to ensure that all learners needs are being met.</p>
<p>Organize</p>	<p>How will you organize and sequence the learning activities to maximize the engagement and achievement of all students?</p> <p>Students will begin with the creation of the biotech tool and observation of worms and progress through to more difficult lab protocols which require transferring worms from plate to plate.</p>

Big Idea: Scientific Inquiry and Research Application		Standard(s)/Benchmark(s): SC.912.L.17.15- Discuss the effects of technology on environment quality. SC.912.L.17.20- Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability. SC.912.N4.1- Explain how scientific knowledge and reasoning provide an empirically based perspective to inform society's decision making.
Unit: Scientific Inquiry		
Grade: 9th Grade		
Score 4.0	<p>Explain Acid rain's negative impact on the environment and the organisms.</p> <p>Explain how <i>C. elegans</i> research can be applied to environmental studies for humans.</p> <p>In addition to Score 3.0, in-depth inferences and applications that go beyond what was taught.</p>	Creation of Informative Brochure
Score 3.0	<p>The student: Will be able to explain the effects of differences in acidity in <i>C. elegans</i>. Comparison of how humans and <i>C. elegans</i> are similar. Application of the Scientific Method to the lab</p> <p>The student exhibits no major errors or omissions</p>	Completion of lab questions and journal prompts
Score 2.0	<p>There are no major errors or omissions regarding the simpler details and processes as the student:</p> <ul style="list-style-type: none"> Recognizes or recalls specific terminology Biotech, pH, Acid, Base, Nematodes, Biological process, Multicellular, Parasites, Hermaphrodite, Gonad, Pharynx, Embryos, Vulva, Hypothesis, Dependent Variable, Independent variable, Control Group, Data, Chemosensory, Neurons, Cilia, toxins Performs basic processes, such as: Scientific Method steps recall <p>However, the student exhibits major errors or omissions regarding</p>	Participation in discussion
Score 1.0	With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes.	
Score 0.0	Even with help, no understanding or skills demonstrated.	