<table>
<tr><td>Title</td><td colspan="2">Proto-ZOO-ology: A Problem-Based Protist Inquiry Unit
Lesson 2: It’s Alive . . . or is it?</td></tr>
<tr><td>Introduction</td><td colspan="2">Protists are used easily to examine classification systems, population diversity, life-sustaining processes, stimulus/response in the environment, and many other “big” concepts that are repeated when studying larger, more complex organisms. A strong foundation in these concepts at the unicellular level will improve student understanding throughout the life science/biology learning progression. The conceptual lens used throughout this unit is the student development of a zoo exhibit for protists. Lesson 2 continues to addresses the six characteristics of all living organisms, as AAAS (American Association for the Advancement of Science) assessment data indicates that only 50-53% of middle school students correctly identify that all cells/organisms have life-sustaining characteristics in common.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="2">1. Lesson Outcome: Through the observation of “glue monsters,” students will generate questions and design a series of experiments to determine if an item is biotic or abiotic according to the six characteristics of life.
2. Lesson Outcome: Students will communicate experimental findings and conclusions through an e-mail written to the fictitious NC Zoo board.
3. Unit Outcome: Students will create a poster that demonstrates the organelles, abilities, and importance of protists.</td></tr>
<tr><td>Curriculum Alignment/ Framework</td><td><u>NC Science 2009 Essential Standards</u>
7.L.1 Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.
<u>Common Core ELA/Literacy</u>
<u>CCR Anchor Standards for Writing</u>
Text Types and Purposes
• Write Arguments to Support Claims
Production and Distribution of Writing
• Produce Clear and Coherent Writing Appropriate to Task, Purpose, and Audience
Range of Writing
• Write Routinely for Range of Tasks, Purposes, and Audiences.</td><td><u>21st Century Skills</u>
Critical Thinking & Problem Solving
• Reason Effectively
• Make Judgments and Decisions
• Solve Problems
Communication & Clarification
• Communicate Clearly
• Collaborate with Others
Leadership & Responsibility
• Be Responsible to Others
<u>NC Professional Eval. Instrument</u>
Standard II: Respectful Environment for Diverse Learners
Standard III: Content Knowledge
Standard IV: Facilitation of Learning: Critical Thinking, Collaboration, Variety of Assessment Methods</td></tr>
<tr><td>Classroom Time Needed</td><td colspan="2">Lesson 2: 2 Class Periods: approximately 120 minutes, although class size will affect the timing of some activities</td></tr>
<tr><td>Teacher Preparation</td><td colspan="2">The teacher should have pre-ordered Duco ® cement from Flinn Scientific several weeks in advance to avoid high shipping costs. In addition, the teacher should have the MSDS on hand for the Duco ® cement during the lab activity. Pepper can be easily obtained in small packets through donations from a local fast food restaurant or cafeteria. The teacher may also want to practice releasing the “unknown.” The chart for students to record class data and the e-mail HW should also be prepared ahead of time. The other items in the “materials needed” section should also be gathered. The teacher also should have previously</td></tr>
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	discussed the six characteristics of life with these students.
Materials Needed	PPEs: splash goggles and aprons, Petri dishes (bottom only, 1 per group + teacher demo), tap water, Duco® cement modeling glue, wooden pencil & pencil sharpener, (black pepper can substitute for the pencil shavings), eyedroppers, toothpicks, hand lenses, toilet paper roll/construction paper (optional), overhead projector or computer camera & LCD projector/SmartBoard, prepared "NC Zoo e-mail" format (optional)
Technology	SmartBoard/LCD/ and camera or overhead projector for student viewing and directions, as well as student recording of group data
Prerequisite Knowledge/ Skills for Students	Through the earlier lesson "A Protist Protest," students have demonstrated or gained an understanding of the six characteristics of living organisms. If the teacher has elected to skip that initial lesson, the teacher must verify student understanding of this concept through other means prior to beginning this lesson to ensure student success. Students should be familiar with designing testable hypotheses, making experimental observations, and forming conclusions based on evidence. These skills may be scaffolded by the teacher according to student needs during the lessons—see "Lesson Modification Opportunities."
<u>Pre-Activities</u> Exploration Time Frame: 5 minutes	Exploration adapted from Flinn Scientific Publication #10227 "Glue Monsters-Are They Alive?" Day One The teacher will inform students that the NC Zoo, since announcing that it is considering opening a protist exhibit, has been offered an item that its discoverer claims is a protist that came from the Neuse River. However, the discoverer is suspected of having been involved in money-making scams in the past. The Zoo Board has learned that all protists meet the six characteristics of living organisms and is asking for students to observe the item to help the zoo determine whether or not the unknown item is a biotic organism and worthy of display at the NC Zoo. Since it is unknown what its effects are on the human body at this time, PPEs will be used during testing. The teacher will then: 1. Place one-half of a Petri dish on a white sheet of paper to video or on an overhead projector to project image onto a whiteboard or screen. 2. Fill the Petri dish about one-half full with tap water. 3. Release the "unknown" into the Petri dish by adding one small drop of Duco® modeling glue to the surface of the water. (Using a pipet to dispense the glue will hide the source of the "unknown" from the students or covering the tube with a decorated toilet paper roll or construction paper will work as well.) 4. Allow students time to observe the "unknown" move in the water, but stop the viewing BEFORE the "unknown" stops moving (about 5 minutes). 5. Ask students to share their observations from the display to this point. Ask students if they are ready to make their recommendation to the NC Zoo, or if there is more information needed to make the decision.
<u>Activities</u> Model	1. (5-10 minutes) The teacher will instruct students to work in pre-established groups (4 students each) to devise a number of tests to determine if the "unknown" is biotic. On the left side of students'

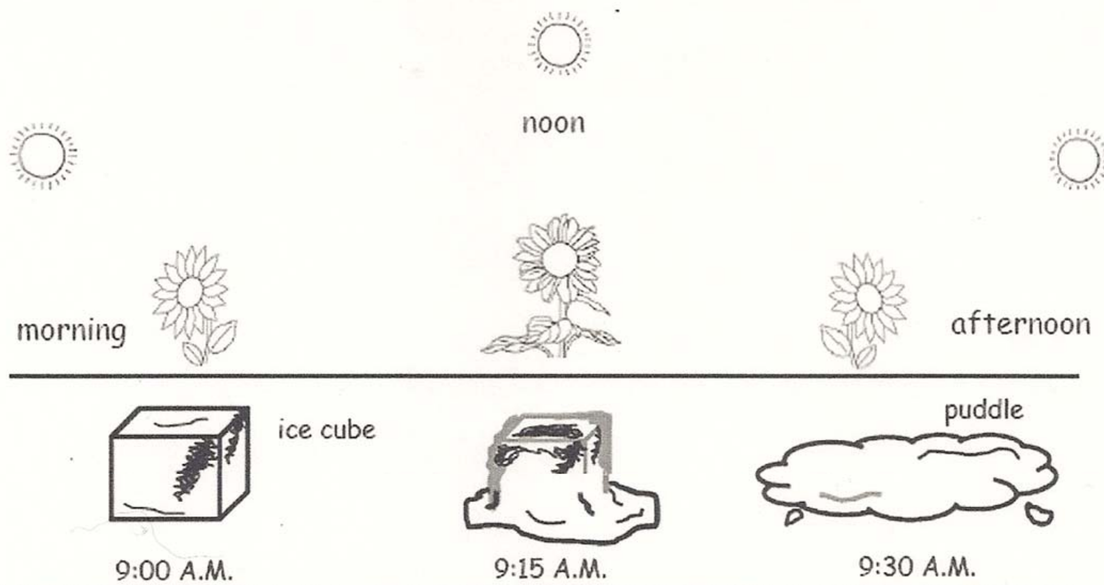
System Time Frame Day One: 40 minutes	interactive notebooks/journals, they should draw a 4-column chart labeled “Test,” “Method,” “Observation,” “Conclusion.” Groups should record and prioritize their tests in most to least important in case of time limitations. Groups should notify the teacher when they are ready to begin the first of their tests. Groups will not receive testing equipment until they have teacher approval for that test. PPEs should be distributed to students before testing begins. 2. (30 minutes) The teacher should provide a new “unknown” for each group as they state they are ready. The teacher should be prepared to replace unresponsive “unknowns” as time elapses. The teacher should be careful to rephrase “mine died” to “oh, did yours stop moving” to subtly remind students to make specific observations, not general conclusions. The teacher should be prepared to redirect students to the six characteristics of living things when designing their testable hypotheses—see suggestions below: a. If it is composed of 1 + cells, then it may be alive. (Teacher will provide a hand lens to view the “unknown” since the glue would prove damaging to a microscope’s lenses. Observations may be that there are no internal structures or that there appears to be a body and a tail.) b. If it uses an energy source like sunlight to make its own food, it is alive. (Teacher should be able to provide access to a window. Observations may include that the “unknown” lacks green chlorophyl to absorb sunlight or that the “unknown” stops moving even after exposure to sunlight.) c. If it takes in nutrients in its environment, then it may be alive. (Teacher should prepare some “unknown food” ahead of time Make the food by shaving small particles of wood and graphite from the tip of a wood pencil or use black pepper, both of which should have been “supplied” by the fictitious discoverer as food. Sprinkle a small amount near the “unknown.” Observations may be that the “unknown” moves towards it and may absorb it, but no change occurs in either the absorbed food or the “unknown.” More observant students may note a lack of waste produced and/or lack of digestion evidence.) d. If it responds to its environment, then it may be alive. (Teacher may allow students to add warmer or colder water, add “food,” touch the water with the tip of the toothpick as a negative stimulus, or any other reasonable test that the teacher is prepared to allow. Observations will vary depending on the test performed.) e. If it reproduces sexually, then it may be alive. (Teacher should add additional “unknowns” and students should watch them “interact” with each other. Observations may include that the “unknowns” move towards each other or apart, may or may not touch, but no new “unknowns” should be formed.) f. If it reproduces asexually, then it may be alive. (Teacher should allow students to use the toothpick to “divide” the “unknown” in two as a crude

Content Wrap-Up Time Frame Day One (10 minutes) Content Wrap-Up Time Frame Day Two (5 minutes)	replication of binary fission. Observations should be that the "unknown" parts will sink to the bottom and remain there unmoving. The separation does not result in a new living "unknown.") g. If it grows or changes, then it may be alive. (Allow students to observe the "unknown" over time. Some will note that it darkens in coloration.) h. If it has a definite life span, then it may be alive. (Allow students to put a drop of anti-bacterial soap or detergent in the water of the petri dish. The change in surface tension will cause the "unknown" to immediately sink to the bottom and not move. In addition, as other tests occur, a group should have at least one "unknown" stop moving. Both of these types of tests may result in the misconception that it has "died;" however, more astute observers will note that it could not have "died" if it was never proven to be alive.) 3. As students gather data, they should share their test results with the rest of the class through recorded data on a class spreadsheet, overhead, etc. to ensure that a range of test data is available for groups that did not complete all possible tests. 4. Students should ensure that all PPEs are returned and areas cleaned before dismissal. 5. For Day One Homework, students should respond to the "Plant vs. Ice Cube" prompt by recording their explanation in their interactive notebooks. Day Two 6. (5 minutes) Discuss student responses to the "Plant vs. Ice Cube" prompt. Students should recognize that the ice cube is physically responding to its environment, but that it lacks the other characteristics of living organisms. The purpose of this prompt is to help students draw the same conclusion about the "unknown," since it does not demonstrate all six characteristics. 7. The teacher should then put Day One's group observations back up for the class to view and discuss.
Guided Practice Day Two (30 min)	The teacher should guide the class through the process of drawing experimental conclusions for each of the six characteristics of living organisms. The teacher should be prepared to provide examples of real-world abiotic items behaving in the same manner as the "unknown." a. Composed of 1+ cells: inconclusive or abiotic-many abiotic items have parts, some that appear to be a "head," "body," or "tail," but are not made of cells b. & c. Metabolism: inconclusive or abiotic-the lack of digestion or waste products, plus the "running out of energy" when it stops moving can be compared to a remote control car wearing down its batteries d. Environmental Response: inconclusive or abiotic-the speeding up or

	slowing down of the water molecules themselves may be causing any changes, the toothpick may be causing changes in the surface tension, etc. e. & f. Reproduction: inconclusive or abiotic-no evidence of new “unknowns” is observed, if an organism did only live for 3-4 minutes, some sort of reproduction must occur for the species to survive g. Growth & Development: inconclusive or abiotic-a color change can be observed in abiotic items exposed to air/water like rust on unprotected metals h. Definite Life Span: inconclusive or abiotic-although the “unknown” stops moving, it must be proven to be alive before it can then be considered dead. No earlier proof exists.
Independent Practice Day Two (15 min)	Students should individually write an e-mail explaining their findings and conclusion to the NC Zoo that advises the zoo board to either accept or reject the Neuse River “unknown” donation (see Appendix).
Lesson Modification Opportunities	1. Depending on student experience with experimental design and observations, as well as the time frame possible, the teacher may choose to have students propose experiments, while the teacher performs the experiments in front of the class. The class then compiles the experimental observations together. This modification shortens the time frame for this lesson to one class period (60 min.). 2. Provide ELL students with the appropriate translation dictionary and group them with other students to ensure maximum participation. Illustrations with labeled names of the available experimental equipment may be provided to front-load this information. The e-mail format could also be given to the student in CLOZE format to ensure both participation and student understanding. 3. Provide EC students with group members who will maximize their strengths and mitigate their weakness. Illustrations with labeled names of the available experimental equipment may be provided to front-load this information. The e-mail format could also be given to the student in CLOZE format to ensure both participation and student understanding.
Summative/ Alternate Assessments	Student consideration/inclusion of the 6 characteristics when designing their zoo exhibit poster for protists; Written unit test Page Keeley’s “Functions of Living Things” probe from <u>Volume 1 Uncovering Student Ideas in Science</u>, pg 147 “Life on Mars” activity http://www.mysciencebox.org/lifeonmars
Supplemental Information	According to Kitchen Chemistry Experiment 26 “Scooting Glue,” http://river.vansd.org/14544/chemistry/kitchen_chemistry/exp26.html the Duco Cement is made up of a polymer in a water-soluble solvent. Before the drop of glue even hits the water, a skin of polymer forms around it. As solvent slowly diffuses out of the skin, the skin shrinks and repeatedly ruptures, momentarily

	allowing solvent to diffuse rapidly out of one side or another of the drop. When this happens, the surface tension of the water in the vicinity of the rupture suddenly decreases. The effect is like poking a hole in a stretched rubber membrane: the drop of glue is pulled in one direction, while the solvent is pulled across the surface tension in the opposite direction. This website also provides a test that indicates the movement of the glue is related to the surface tension of water, if the teacher wishes to demonstrate what is REALLY happening.
Critical Vocabulary	Prediction, observation, explanation, conclusion, 6 characteristics of living organisms (see Lesson 1) Abiotic: adjective used to describe non-living objects Biotic: adjective used to describe living organisms
Websites	http://www.flinnsci.com/Documents/demoPDFs/Biology/BF10227.pdf for the original Flinn Scientific Publication #10227 "Glue Monsters-Are They Alive?" http://www.slideshare.net/arholder/interactive-science-notebook-full-version for research supporting the use of interactive notebooks, as well as step-by-step instructions for teachers and students for their set-up and use http://shc.ncue.edu.tw/data/2-5.pdf for an educational research article discussing the effectiveness of constructivist methods like "Predict-Observe-Explain" http://assessment.aaas.org/ for Project 2061 test data bank items classified by topics, sub-ideas, and misconceptions for 6-8 and 9-12 grade levels
Comments	A common student misconception is to decide that an object is "living" when it meets just one or a few of the six criteria, instead of ALL six (i.e. Virus Debate). This misconception should be explicitly addressed during the content wrap-up of the "Glue Monster" activity prior to students writing their NC Zoo e-mails.
Author Info	Cate Colangelo, M.Ed. Science Education, NBCT Early Adolescence Science North Johnston Middle School Science Lead Teacher 17 years teaching experience Class of 2012 Kenan Fellow This lesson is part of my unit being developed for my NC DPI Kenan Fellowship implementing the 2009 Science Essential Standards. Kenan Fellowship Mentor: Mary Russell, NCDPI REGION 3 Professional Development Lead, Office of Educator Recruitment and Development

Plant vs Ice Cube Prompt



Both the sunflower and the ice cube above are responding to their environments.

Why then is the sunflower considered biotic (living) and the ice cube abiotic (nonliving)?

Plant vs Ice Cube Response Rubric

Level 4 Response:

Includes reference to all six characteristics, as well as specific mentions of how each item meets or doesn't meet these characteristics.

The ice cube is melting in the heat of the sunlight, while the sunflower is turning its head with the sun's motion as an environmental response. The reason why it moves is to maintain its metabolism. The sunflower is also made of many cells in its leaves, grows from a seed, reproduces to make other sunflowers, and dies. That is why it is biotic. The ice cube does not have any of these additional characteristics of life, so it is abiotic.

Level 3 Response:

Includes reference to all six characteristics in general, while stating which item meets or doesn't meet all six characteristics.

The sunflower is biotic because it demonstrates all six characteristics, not just environmental response. The ice cube is abiotic because it does not have any other characteristics of living organisms.

Level 2 Response:

Includes reference to specific characteristics of life, but doesn't reference the need to meet all six characteristics to be considered biotic.

The sunflower is biotic because it also grows and dies. The ice cube just melts and doesn't grow or die, so it is abiotic.

Level 1 Response:

Defines biotic and abiotic, but doesn't provide evidence for conclusion.

The sunflower is biotic because it is alive. The ice cube is abiotic because it isn't alive.

FROM:

TO: NC ZOO Board <nczooboard.zoo>

SUBJECT: Re: “Unknown” item test results and recommendation

Rubric for Scoring the NC Zoo e-mail:

4 (100): Makes recommendation against the Board purchasing the "unknown" based on the six characteristics of living organisms, referring specifically to at least three test results

3 (90): Makes recommendation against the Board purchasing the "unknown" based on only three test results, with vague reference to all six characteristics

2 (80): Makes recommendation against the Board purchasing the "unknown" based on only two test results, with vague reference to all six characteristics

1 (70): Makes a recommendation against the Board purchasing the "unknown" based on only one test result, with vague or no reference to all six characteristics