

## NGSS Connections chart - Adv level activities

Lab protocol part 1 - smooth round ancestor strain to wrinkly spreader morphology using LacZ+ and LacZ- strains of Pseudomonas fluorescens as a model of evolution

Standard: HS LS4-2 Biological Evolution, Unity and Diversity			
<p><b>Performance Expectations:</b> Students will use lab techniques and technology to observe morphological changes in a species over many generations; students will collect data on specimen reproductive rates; observe mutations which lead to morphological changes; suggest ideas re: competition/mutation processes that lead to class results.</p> <p><b>HS LS4- 2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.</b>  <i>[Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species.</i>  <i>[Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]</i></p>			
Dimension	NGSS name/citation	Connections to activity	Other resources
<b>Science and Engineering Practices</b>	<p><b>- Obtaining, Evaluating, and Communicating Information:</b> progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).</p>	<p>Students will use a standard lab protocol, individually choose a problem statement as an avenue to focus their analysis and research; they will document and evaluate the results on a daily basis relative to their choice of topic; they will then present their data graphically, and textually in a formal lab report, using the activity information recorded in their lab journal.</p>	<p>Students will need to research at least 2 outside sources for reference to either evolution or biofilm bacteria and how this information connects to their findings for their final presentation.</p>
<b>Disciplinary Core ideas</b>	<p><b>LS4.B: Natural Selection</b> - The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)  <b>LS4.C: Adaptation</b> Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)</p>	<p>Students will be able to observe/ document reproduction ratio's of both the lacZ- and lacZ+ strains of Pseudomonas fluorescens; students will also observe/document morphological structures/ changes from the ancestor strain to the final offspring plates, as a result of selection processes.</p> <p>Students will make hypothesis and suggestions re: the 4 adaptation factors and correlation to the lab protocol.</p>	<p>Documentation of plate results by each student lab group in their lab journal of the colony numbers and type from even day lab protocol (day 0, 2, 4, etc)</p>
<b>Crosscutting concepts</b>	<p><b>Patterns</b> Different patterns may be observed at each of the scales at which a system is studied and can</p>	<p>As students record evidence from plating results of P.flu lacZ- and lacZ+, discussions</p>	<p>Supplemental reading on morphology of wrinkly</p>

	provide evidence for causality in explanations of phenomena.	in class will develop ideas of causality, which may include topics of competition, resource use, benefits, etc ; Observation of morphological changes/ patterns will lead to discussions in which students will be asked to suggest ideas re: DNA mutations. Based on supplemental readings, students will be asked to predict causality for this particular species, and other biofilm species.	spreaders and natural selection  Optional use of other species data patterns to compare/ contrast  Student observations of patterns will be reported in both their lab journal and a formal lab report.
<b>Connections to Nature of Science</b>	<b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future	Students will use evidence to support scientific laws, related to both data for this lab, and extrapolate how this works in the world past and present with reference to other organisms with morphological changes. Class discussions of other biofilms ie: stromatolites, cystic fibrosis, etc or larger organisms connections.	Research papers - found on own, those supplied with the lab, and the historical outline of evolution ideas as a references

**Recommended student Assessments for this unit:**

- 1) Students keep a lab journal of process and findings, including the questions and writing prompts presented within this protocol and the student lab sheets. Journal will be graded at the end of the experimental process.
- 2) Ask lab partners to present their specific claims and findings to the class. At this time it is important to emphasize salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details. Additionally students can be evaluated on the following public speaking skills: use appropriate eye contact, adequate volume, and clear pronunciation (refer to Common core public speaking rubric for more ideas)
- 3) Students individually present their findings in a formal written lab report with research citations, charts and diagrams, etc. (see rubric suggestions) Use of an online grading program is useful for students to receive feedback on both their writing skills and scientific presentation on technical lab reports. (Turnitin.com)