**Unit Plan: Superbugs + Computational Thinking**

**Major Themes for the Unit**

* Scientific themes: Natural Selection
* Scientific practice: Modeling and Computational Thinking
* SSI: Antibiotic Resistance

**Driving Question**: How can antibiotic resistance be mitigated?

**Concepts needed to explore the driving question**

* Science concepts (Examples: carbon cycling, photosynthesis)
  + Natural selection- random mutation, initial variation, selective pressure, favorable trait, differential survival, reproduction, population shift
  + Antibiotic function
  + Antibiotic resistance mechanisms
* What social ideas and concerns influence negotiation of the issue?
  + Over prescription of antibiotics
  + Usage of antibiotics in food production
  + Policy and economics related to antibiotic usage

**Unit-level performance expectations**

* Develop a conceptual understanding of natural selection that accounts for a) genetic variation associated with particular traits, b) selective pressure that leads to differential reproductive success linked to these traits, and c) changes in trait frequencies within the population.
* Develop algorithmic explanations of natural selection in microbe, animal, and plant contexts.
* Use contextual algorithms to create a generalized natural selection algorithmic explanation for use in new natural selection contexts.
* Use algorithms as a basis for reasoning about novel problem situations.
* Demonstrate socio-scientific reasoning in response to complex SSI.
  + Identify and discuss sources of issue complexity.
  + Identify areas of uncertainty and ask related questions.
  + Analyze the issue from multiple perspectives.
  + Identify and discuss ways in which scientific evidence can inform issue resolution as well as limits on the use of scientific evidence.

**Unit assessment(s)**

* Algorithmic explanations of natural selection in the context of the laboratory investigation, the mountain sheep investigation, and the field mustard investigation– Formative
* Application of NS algorithms to propose a policy for mitigating antibiotic resistance – Formative & Summative
* Application of Socio-scientific Reasoning in the context of a policy recommendation - Formative & Summative
* Natural Selection Test; multiple choice (CINS) plus open-ended item (Opfer, Nehm & Ha, 2012) – Summative

**Acknowledgments**

The materials associated with the Superbugs Unit are based, in part, upon work supported by the National Science Foundation Transforming Undergraduate Education in Science (TUES) program under Grant 114062 and The Missouri Transect, a National Science Foundation EPSCoR Program, Cooperative Agreement IIA-1355406. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. The materials presented in Lesson 7. Mountain Sheep Model were created by the PRACCIS team is copyrighted, 2014, by the PRACCIS project team (Clark Chinn and Ravit Golan Duncan, Project Directors). All rights are reserved.

**Lesson sequence**

|  |  |  |  |
| --- | --- | --- | --- |
| Lesson (time) | Lesson Focus | Activities | Materials |
| 1 (45 min) | Introduce antibiotic resistance as a significant issue; create initial natural selection algorithm | Discussion, Lecture, Presentation, Algorithm creation | Lesson Plan 1  Students- Natural Selection Algorithm Handout; Know Your Sources Handout and Exploring Cases Handout |
| 2 (90 min) | ABR lab; introduce computational thinking; how antibiotics work | Data Collection, Lecture, Discussion, Group algorithm creation | Lesson Plan 2  Teacher- CT intro Power Point; antibiotics Power Point; Lab Guide for Instructors; Example Getting Ready Algorithms; [Link to the video](https://youtu.be/S9wvZkCSAU8); Intro to CT Video Transcript  Students- Lab Packet; Antibiotics Handout |
| 3 (90 min) | ABR lab; Big-horned sheep investigation; create sheep algorithm | Data Collection, Evidence analysis, algorithm creation | Lesson Plan 3  Teacher- Sheep Evidence Power Point; Antibiotics Power Point  Students- Lab packet; Sheep Evidence Evaluation Handout; Sheep Example Algorithms; Sheep Student Algorithm Handout |
| 4  (90 min) | ABR lab data collection and analysis; mechanisms of bacterial resistance; create bacteria algorithm | Data collection, Data analysis, Lecture, Discussion, algorithm creation | Lesson Plan 4  Teacher- Antibiotics Power Point  Students- Lab packet; Bacterial Algorithm Handout; Resistance Handout |
| 5 (45 min) | Field mustard investigation; create mustard algorithm | Evidence analysis, algorithm creation | Lesson Plan 5  Teacher- Field Mustard Power Point  Students- Field Mustard Evidence Evaluation Handout; Mustard Algorithm Handout |
| 6 (90 min) | Create generalized algorithms | Lecture, Discussion, Group algorithm creation, Peer feedback | Lesson Plan 6  Teacher- General Algorithms Power Point; [Link to the video](https://youtu.be/14omwM-3Y1Y); General Algorithm Video Transcript  Students- General Algorithm Handout |
| 7 (45 min) | Lateral gene transfer and review | Lecture, Discussion | Lesson Plan 7  Teacher- Antibiotics Power Point |
| 8 (90 min) | Policy Proposal introduction and work time | Discussion, Work time | Lesson Plan 8  Students- Perspectives Jigsaw Activity Handout, Policy Instructions; Resources Handout |
| 9 (90+min) | Policy proposal presentations; Summative test including a final natural selection algorithm | Presentations, Test | Lesson Plan 9  Students- Natural Selection Algorithm Handout |