Why Don't Antibiotics Work like They Used to?
EQuIP Rubric for Science Evaluation

Unit Name: Why Don't Antibiotics Work like They Used to?
Grade: 9, 10
Date of Review: January 2019
Overall Rating (N, R, E/I, E): E
Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 3
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3
Total Score (0-9): 9
Click here to see scoring guidelines

This review was conducted by the Science Peer Review Panel using the EQuIP Rubric for Science.

Category I Criteria Ratings		Category II Criteria Ratings		Category III Criteria Ratings	
A. Explaining Phenomena/Designing Solutions	Extensive	**A. Relevance and Authenticity**	Extensive	**A. Monitoring 3D Student Performances**	Extensive
B. Three Dimensions	Extensive	**B. Student Ideas**	Extensive	**B. Formative**	Extensive
C. Integrating the Three Dimensions	Extensive	**C. Building Progressions**	Adequate	**C. Scoring Guidance**	Extensive
D. Unit Coherence	Extensive	**D. Scientific Accuracy**	Extensive	**D. Unbiased Tasks/Items**	Extensive
E. Multiple Science Domains	Adequate	**E. Differentiated Instruction**	Extensive	**E. Coherence Assessment System**	Extensive
F. Math and ELA	Extensive	**F. Teacher Support for Unit Coherence**	Extensive	**F. Opportunity to Learn**	Extensive
		G. Scaffolded Differentiation Over Time	Adequate		

Summary Comments

This unit is a fantastic example of three-dimensional integration. The options provided for varying involvement in the bend 1 bacterial plating investigations provides necessary flexibility with regard to time, budget and resource availability will be incredibly helpful to educators.

The Assessment System greatly informs teaching and learning and sets a new bar for future units. The original assessment system was significantly enriched in this updated version, broadened in scope, and made consistent throughout the document. Assessment by the teacher (and student self-assessment) is facilitated in a variety of ways. Assessment Icons are included in teacher support boxes throughout the teacher guides, a separate folder that contains all assessment documents has been included in addition to a table is also included outlining assessment types and locations throughout the unit.

The "Assessment System in the Evolution Unit" document is an exciting addition to this storyline and an invaluable tool for educators. Knowing what types of assessments arise and when across the unit will undoubtedly result in more purposeful and meaningful teaching and learning in the classroom. The LPE / formative assessment table will encourage and assist educators in productive formative assessment in three-dimensions with much less preparation and time commitment.

The wealth and robustness of student work examples and guidance to teachers with regards to important aspects of student learning throughout the storyline and across the students’ arc of learning will prove invaluable. The amount of well documented teaching and learning is undeniable and invaluable.

The reviewers greatly appreciated all the guidance from the authors in the “Front Matter” document.

Note: The reviewers did not find a Teacher’s Guide for lesson 10 in the Lesson 10 Google Drive folder.

Category I. NGSS 3D Design

Score: 3

I.A. Explaining Phenomena/Designing Solutions: Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.
ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.
iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A Explaining Phenomena/Designing Solutions: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that learning is driven by students making sense of phenomena and/or designing solutions to a problem.

Student questions and prior experiences related to the problems motivate sense making. In Bend 1, lesson 1, students are introduced, through a video, to a young girl named Addie who has an antibiotic-resistant pathogen. This young person's inability to get well through traditional measures serves as a driving question throughout the unit. Prior to watching the video, students are asked to reflect on their own past experiences with illness or the experiences of their family members with illness. Students are asked to generate questions "that arise from careful observation of phenomena…to…seek additional information" from Lesson 1. Students' prior experiences related to the phenomenon are elicited through discussion of illnesses (their own or someone in their family) and their use of medicine. Questions, such as, "Can this happen to me?" arise. Lesson 3a asks students to gather data about use of antibiotics in the family.

The focus of the lessons within the unit supports sense making of phenomena. Throughout Bend 1 and 2, students engage in a series of experiments with bacteria. These occur in lessons 5a – 5e. Throughout these experiments, the results of previous experiments act as the phenomena for the next investigation. Another case study (Bend 2 – Juncos) is used to test out ideas with other populations and to figure out additional mechanisms that might be responsible for Addie's dilemma and the change in Juncos. Many of the suggested prompts included in the Teacher's Manual promote sense-making by the students.

Addie's sickness and more importantly the inability of antibiotics to help her is a driving phenomenon in Bend 1 and is a strong enough phenomenon to be referenced throughout the entire unit where appropriate.

Suggestions for Improvement
N/A

I.B. Three Dimensions: Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. Provides opportunities to *develop and use* specific elements of the SEP(s).
ii. Provides opportunities to *develop and use* specific elements of the DCI(s).
iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions.

Science and Engineering Practices (SEPs): Extensive

The reviewers found extensive evidence that students have the opportunity to use or develop the SEPs in this unit.

Throughout the unit, students are provided opportunities to develop and use specific elements of the Science and Engineering Practices. For example, during lesson 5a, students design and carry out experiments to test the effects of antibiotics on bacterial growth. Engagement in this science and engineering practice is deliberately selected to aid students in sense making of disease-resistant antibiotics. Ultimately, the experiment the students conduct helps them understand how antibiotics move through the body and the effects of different concentrations of antibiotics on bacteria. Students are provided repeated opportunities to use specific elements of all eight Practices as well as being given opportunities for developing specific elements of the Practices. For example, in Lesson 4, students develop a model of a simple system. In Lesson 3b, students develop and use a model to generate data to support explanations and to predict phenomena. Then, in Lesson 6, students develop and use a model based on evidence to illustrate the relationships between components in their explanations. Lesson 7 has students develop a model to illustrate and predict the relationships between variables to provide mechanistic accounts and/or predict phenomena. Lessons in Bend 1 also develop students' ability to plan and conduct investigations. Modeling, planning, and conducting investigations continue to be developed in Bend 2 and 3, while arguing from evidence and obtaining, evaluating, and communicating information are purposefully being developed in Bends 2 and 3.

Disciplinary Core Ideas (DCIs): Extensive

The reviewers found extensive evidence that students have the opportunity to use or develop the DCIs in this unit.

Students are provided multiple opportunities to develop and use specific elements of the DCIs. For example, as students move through a progression of experiments in lessons 5a – 5e, they are working with an element of DCI LS4.B, "The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population." Students begin to develop understanding of inherited traits vs. learned behavior in Bend 2 with the Juncos (LS4.C) and evidence of common ancestry (LS4.A) in Bend 3. Lesson 11b provides an opportunity to understand how scientists determine if a behavior is inherited or learned by reading journal articles about bee studies and applying that thinking to Juncos. Lessons in Bend 3 deliberately develop students' understanding of how genetic information provides evidence of evolution by examining karyotypes then adding variation in the expression of genetic

information of traits like wing length and tail length in Lesson 16. By Lesson 20, students were revising their common ancestry models to explore other factors that might account for speciation in Junco populations.

Crosscutting Concepts (CCCs): ***Extensive***
The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit.

Students are provided multiple opportunities to develop and use specific elements of the CCCs throughout the unit. The CCCs of Patterns and Cause and Effect are emphasized throughout the unit. These are the CCCs in the five performance expectations identified in the unit. "Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena" was used to try to answer questions about Addie. A timeline of events was created to examine any large-scale patterns, then bacteria were cultured to examine patterns at a microbial scale. Variations in expressed traits were examined in Junco populations including mapping populations in different environments, and variations in genotypes were explored through karyotype analysis. These investigations led to "classification or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced, thus requiring improved investigations and experiments." "Mathematical representations" and "empirical evidence" were used in lessons 3b, 5b, 10, 13, 5e, 17b, 18, and 22. "Cause and effect relationships can be suggested and predicted for complex natural systems… by examining what is known about smaller scale mechanisms within the system." For example, in lesson 13, students are encouraged to recognize the relationship between alleles and behavior as one of cause and effect. Students were provided opportunities to develop understanding that "[e]mpirical evidence is required to differentiate between cause and correlation and make claims about specific cause and effects" in Lessons 7, 11a, 11b, 15, 20, 22, and 23. Additional crosscutting concepts (systems, structure and function, scale) were used as well.

Suggestions for Improvement
N/A

I.C. Integrating the Three Dimensions: Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and/or designing solutions to problems. Student sense-making of phenomena requires performances that integrate elements of the three dimensions. For example, in lessons 5a and 5b, students design and carry out an investigation that develops and uses an element of LS 4.B and encourages them to identify patterns, make predictions about patterns they might see in the future, and to recognize how cause and effect apply to their data.

Each lesson organically uses the three dimensions to make sense of phenomenon driven by student questions. The Mission Board and Driving Question Board are public evidence of the resulting thinking and learning.

Suggestions for Improvement
N/A

I.D. Unit Coherence: Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.
ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations. Each lesson builds on prior lessons by addressing questions raised and cultivating new questions. Each of the lessons presented in the Teacher Guide provides, at the top of the document, a section titled "Previous Lesson… Where we've been." This provides a very succinct synopsis of what has come before and is linked via an arrow to what students will be doing and what questions will be addressed in the current lesson.

Each experience promotes questions from the students and those questions drive subsequent learning. Suggested prompts in the teacher's guide provide assistance to teachers that help focus student thinking and assist in maintaining a logical conceptual flow.

There are multiple mechanisms embedded in the unit that explain how prior learning will be built upon. One such mechanism exists at the end of each lesson synopsis in the Evolution Storyline and is titled "Next Steps." For example, in lesson 5a, at the bottom of the box titled "What We Figure Out" the lesson states "We are excited to check on our future results, but know that it will take a couple of days to see the effects (just like it did in lesson 3a to 3b). We think we have figured out some pieces to help us answer some of the questions on our Driving Question Board, 'Why did antibiotics stop working for Addie?' So we want to take stock of the questions we answered and what we figured out so far in the next class and regroup."

Many of the student worksheets included first ask students to revisit ideas arrived at during the previous lesson. For example, the lesson 18 student activity sheet starts with the following "18.1 - Connecting to the Previous Lesson - Q1: What did we decide we could figure out by comparing the relationship between the alleles found in the mountain population males, and the alleles in the UCSD offspring?" This reinforces unit coherence and helps students move toward proficiency in the identified performance expectations.

The Teacher's Manual provides "Alignment to the Standards" with each lesson that includes the targeted PE as well as CCSS Math and ELA where appropriate. The overview page includes the targeted PEs that are being built toward with that lesson. Some of the "Getting Ready: Teacher Preparation" sections for a new lesson include connections to DCIs from the middle school, which could be useful to teachers for determining gaps in understanding. Each lesson performance expectation includes the targeted component of the targeted DCIs (and SEP and CCC).

Suggestions for Improvement
N/A

I.E. Multiple Science Domains: When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.
ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that links are made across the science domains when appropriate. A connection to **ESS3.A** was made in lesson 15 via a differentiation box on page 8 of the teacher's guide. This is an opportunity for teachers to connect to concepts around cost-benefit analysis depending on prior high school grade band experiences.

This is a very life science-oriented unit and the PEs identified and addressed are very appropriate for the multiple phenomena within the storyline. The addition of more connections across domains would help students better understand the interconnectedness of the science domains. Opportunities for connections do exist, via differentiation boxes or otherwise, with other domains.

Suggestions for Improvement
As the placement of this unit in a sequence of high school grade band learning is not indicated, students may be able to draw on previous knowledge and make connections to their understanding of biogeography, climate change, the age of the Earth, etc. Additionally, a potential connection to PS4, Energy and Radiation exists, particularly in the progression from lesson 4 to 5, as students may wonder what other means exist for killing bacteria beyond antibiotics and antiseptics.

I.F. Math and ELA: Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA: Extensive

(None, Inadequate, Adequate, Extensive)

The unit provides grade appropriate connections to the Common Core State Standards in English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects for many lessons. At the end of each lesson in the Teacher Guide, there is a section entitled "Alignment with Standards." Almost all of lessons 1 – 12 include a section within this in which they indicate the CCSS math and ELA connections.

There are numerous lessons that have students reading multiple texts on the same subject, using complex texts, and communicating in authentic forms. For example, in Lesson 4, students use information from the CDC. In Lesson 10, climate data are used, and additional data are included in Lesson 11a to use as possible evidence. Students use information from scientific journal sources in Lesson 11b, and excerpts from a primary source are used in Lesson 12. Students use aerial photographs

and methodology and results from a scientific journal article in Lesson16 to determine how to develop a model of population migration patterns. A technical article on karyotyping was used to determine how to make sense of Junco blood data. Three different articles were used in Lesson 20 to provide methodology and results for analyzing breeding patterns. Students were also required to gather information from a range of media sources – videos, Google Earth, and simulations. As a possible summative opportunity, students synthesized information and created an infographic about antibiotic use for the general public.

Suggestions for Improvement
N/A

Overall Category I Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category I
Criteria A-F
3: At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2: At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1: Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Category II. NGSS Instructional Supports

Score: 3

II.A. Relevance and Authenticity: Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).
ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.
iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authority: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world.

Students engage in meaningful scenarios that reflect the practice of science as experienced in the real world throughout the unit. In Bend 1, students are working with the case study of a young person who has a drug-resistant disease. Throughout Bend 1 and Bend 2, students are engaged in authentic experimentation working with bacteria in lessons 5a – 5e. In Bend 2, students work with relatively recent data from scientific journals and use this data in their sense making of phenomena.

A Mission Board is displayed that helps to make the connection between what is being studied and its applicability to their own families, neighborhood, and communities. Students are expected to communicate their learning about antibiotic abuse to their larger community to educate them about the importance of taking their entire course of antibiotics.

There are many opportunities for students to make connections between the central phenomenon of the unit. In Bend 2, starting with Lesson 14, students generate how aspects of the natural selection model apply to other organisms. This model is centered on topics of reproduction, trait variation, scale of the system, and interactions that will allow students to generalize their model to other organisms. In Lesson 20, students develop what scientists use called a common garden experiment. Students analyze data collected from primary scientific literature from common garden experiments.

Suggestions for Improvement
N/A

II.B. Student Ideas: Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas.

Students are provided many opportunities to express, clarify, justify, interpret and represent their ideas and to respond to peer and teacher feedback orally and/or in written form as appropriate.

Throughout the unit, students are encouraged to use an Incremental Model Tracker (IMT) to work through and clarify their understandings and how those understandings change over time. Teachers are provided guidance on using the IMT in the form of the "How Can Teachers Use the Incremental Model Tracker?" in the Front Matter on page 31. The unit provides specific suggestions for where to find opportunities to express, clarify, and interpret student responses on the IMT so that teachers might use it as a means of formatively assessment.

Suggestions for Improvement
N/A

II.C. Building Progressions: Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:
Explicitly identifying prior student learning expected for all three dimensions
Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions.

This unit identifies and builds on students' prior learning. Specific support to teachers for tracking and building upon prior learning in all three dimensions is not explicitly provided.

PEs included in the MS grade band are indicated in the storyline Front Matter.

The crosscutting concept of systems is a focus of this storyline. Students are repeatedly called on to think about different aspects of this phenomenon and related phenomena as systems. This begins in Lesson 1, as students are asked to consider Addie as a system. Repeatedly throughout the Bend systems are called out (specifically, for example, in lesson nine number six). At the end of Bend 1, lesson 13, students are assessed with a novel scenario. In this scenario they are comparing 2 fields with different populations of aphids. These fields are referred to as systems without clarification - students at this point in the unit are expected to be able to use systems thinking to consider the phenomenon presented.

While the CCC of systems is called out and clearly built upon throughout the storyline, how prior learning will be built upon is not clearly explained for this or other dimensions that are a focus for this storyline.

Suggestions for Improvement

Including a table for each dimension across all lessons within each Bend would allow for tracking of student learning in each dimension and how each is built upon each time it is encountered by students as they move through the Bends.

It is recognized that the LPE table with assessment opportunities is a powerful tool and can facilitate teachers in tracking progress through dimensions. It does not, however, identify prior learning and explain how this learning will be built upon.

II.D. Scientific Accuracy: Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically accurate and grade appropriate scientific information.

This this storyline provides guidance to teachers to support differentiated instruction throughout.

Appropriate alternatives for students who are English language learners, have special needs or read below grade level have been provided. For most of the learning activities in the lessons, teachers are provided "Differentiated Strategies and Alternative Activities" indicated consistently via the "Teacher Support" section of the Learning Plans (the right-hand column).

For example, in lesson 28 students are asked to write down steps in an evolution of bacteria experiment. Provided to the teacher are strategies to employ to help struggling students, such as "project this set of steps for students to refer to" and to provide students with a written document that summarizes the steps in a different format. There is also a group discussion strategy provided for ensuring that all students understand the purpose of each of the steps in the procedure they have been asked to outline.

Guidance for teachers for aiding students who may need reading support is included throughout the unit. The following is from the Teacher Support Section of lesson 19, "As you introduce the close reading portion of the lesson, you may wish to differentiate the activity based on what you know about your students as readers. A complex scientific text poses unique challenges for students, and some may require additional support as they tackle the text. Consider the options below to differentiate for students who struggle with complex scientific texts:

- Pair students with differing abilities (one strong reader with one weaker reader) to complete the activity together.
- Pull a small group of students and read closely together. Think aloud as you read together to let students in on your comprehension strategies.
- Complete the reading as a large group, reading one section at a time and drawing out the big ideas of the text."

Additional strategies for supporting students struggling with text are included repeatedly throughout the storyline, including but not limited to lessons 2,11 and 26.

Extra support for students who are struggling to meet the targeted expectations is provided. Again, this support guidance appears in the Teacher Support section of the teacher's guide. The following is an

excerpt from the document submitted with the storyline. The document explains to reviewers how many of the issues brought up in the original peer review document have been addressed. Each of the supports indicated in the excerpt below have been checked and verified by the PRP team.

"We have added many specific differentiation strategies to support struggling students. For example, in Lesson 7 there are specific instructional strategies to support students with the mathematical thinking needed. The home learning reading for lesson 11 has multiple sections
which can be assigned based on the needs of the students to both support struggling students and provide appropriate challenge to others. …Lesson 18 provides specific suggestions to support students in understanding the abstract data collection methods. Lesson 28 provides specific strategies to support students in understanding the experimental evolution study."

In the lesson 11 example cited above, students are creating eight graphs, half of which are more challenging than the other half. This difference is noted as is the opportunity to use this fact as a differentiation strategy in the Teacher Support section, "Also, the reproduction assignments are slightly easier to complete than the antibiotic assignments so that would be another way to differentiate based on your students' needs."

Extensions for students with high interest or who have already met the performance expectations are interspersed throughout the storyline.

For example, after lesson 26, students are asked to engage with three sets of data about mutation rates, mitochondrial DNA and the Y chromosome (Data sets A, B and C) and answer questions about them as part of their home-learning experience. For those students (or classes) that might want or benefit from extensions to their learning or are of high interest, authors have included an article about speciation and what it means to be different species.

Suggestions for Improvement

The following was indicated in the "Response to Peer Review Panel Feedback" document submitted by the authors for Section II, criterion E, "*Lesson 10 provides additional investigations if students are struggling to make the connection between having fewer pores and being harder to kill by antibiotics,"* however there is no Teachers Guide for lesson 10 so this cannot be verified.

The following was indicated in the "Response to Peer Review Panel Feedback" document submitted by the authors for Section II, criterion E, "*In Lesson 13 students who struggle with reading could be assigned to group C* "Partner Needs*" for a shorter, more straight-forward reading assignment*." The PRP team, however, was unable to identify the corresponding assignment or support guidance in Lesson 13.

II.E. Differentiated Instruction: Provides guidance for teachers to support differentiated instruction by including:

i. Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.
ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.
iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide guidance for teachers to support differentiated instruction throughout.

Appropriate alternatives for students who are English language learners, have special needs or read below grade level have been provided. For most of the learning activities in the lessons, teachers are provided "Differentiated Strategies and Alternative Activities" indicated consistently via the "Teacher Support" section of the Learning Plans (the right-hand column).

For example, in lesson 28 students are asked to write down steps in an evolution of bacteria experiment. Provided to the teacher are strategies to employ to help struggling students, such as "project this set of steps for students to refer to" and to provide students with a written document that summarizes the steps in a different format. There is also a group discussion strategy provided for ensuring that all students understand the purpose of each of the steps in the procedure they have been asked to outline.

Guidance for teachers for aiding students who may need reading support is included throughout the unit. The following is from the Teacher Support Section of lesson 19, "As you introduce the close reading portion of the lesson, you may wish to differentiate the activity based on what you know about your students as readers. A complex scientific text poses unique challenges for students, and some may require additional support as they tackle the text. Consider the options below to differentiate for students who struggle with complex scientific texts:

- Pair students with differing abilities (one strong reader with one weaker reader) to complete the activity together.
- Pull a small group of students and read closely together. Think aloud as you read together to let students in on your comprehension strategies.
- Complete the reading as a large group, reading one section at a time and drawing out the big ideas of the text."

Additional strategies for supporting students struggling with text are included repeatedly throughout the storyline, including but not limited to lessons 2,11 and 26.

Extra support for students who are struggling to meet the targeted expectations is provided. Again, this support guidance appears in the Teacher Support section of the teacher's guide. The following is an excerpt from the document submitted with the storyline. The document explains to reviewers how

many of the issues brought up in the original peer review document have been addressed. Each of the supports indicated in the excerpt below have been checked and verified by the PRP team.

"We have added many specific differentiation strategies to support struggling students. For example, in Lesson 7 there are specific instructional strategies to support students with the mathematical thinking needed. The home learning reading for lesson 11 has multiple sections
which can be assigned based on the needs of the students to both support struggling students and provide appropriate challenge to others. …Lesson 18 provides specific suggestions to support students in understanding the abstract data collection methods. Lesson 28 provides specific strategies to support students in understanding the experimental evolution study."

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Extensions for students with high interest or who have already met the performance expectations are interspersed throughout the storyline.

For example, after lesson 26, students are asked to engage with three sets of data about mutation rates, mitochondrial DNA and the Y chromosome (Data sets A, B and C) and answer questions about them as part of their home-learning experience. For those students (or classes) that might want or benefit from extensions to their learning or are of high interest, authors have included an article about speciation and what it means to be different species.

Suggestions for Improvement
N/A

II.F. Teacher Support for Unit Coherence: Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).
ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

The unit supports teachers in facilitating coherent student learning experiences over time.
For example, throughout the unit they work with a Driving Question Board. This mechanism helps students remember the larger questions they are trying to answer as they engage in lesson – level activities to support their understanding. The Addie case study is revisited in Bend 2 as bacterial growth is analyzed and again to wrap up the unit.

Another example is the "Next steps" sections at the end of each lesson synopsis in the "What We Figure Out" sections in the Storyline document. Including information about previous learning on student handouts is another example of connecting learning experiences over time.

For each lesson, lesson performance expectations crafted by the authors are included. These reinforce the three-dimensional nature of the NGSS for the instructor and are often at the element level of the dimension.

Suggestions for Improvement
N/A

II.G. Scaffolded differentiation over time: Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time.

The unit engages students in many SEPs and CCCs repeatedly across the lessons and the content becomes more challenging and complex as the unit progresses. Students are increasingly applying acquired knowledge to novel situations. Additionally, support in the form of differentiation and scaffolding is provided at many moments during which students are engaging in the practices. The PRP team was unable to find sufficient evidence that that support was scaffolded over time to award a score of Extensive.

A deliberate effort is shown to develop students' independence relative to their performances against the elements of the 3 dimensions over time.

Lesson 2: student jigsaw summaries of different resources (data) of infected populations of people with resistant bacterial infections to find a pattern in the collected data by the CDC.

Lesson 4: teacher is provided suggested questions/prompts for this lesson that explicitly asks students for patterns. "What patterns or contradictions do you notice across all of the responses we heard? What else do you notice that you think might be significant?"

Lesson 4.1 Student Activity Sheet – Using Mathematical Thinking (Letter H in Teacher's Guide) This gives suggested support for students in developing appropriate graphing skills. This is in preparation for students to develop a model of their understanding from evidence in Lessons 3b, 5, and 7. "Students will need to use this labeling approach to their graph in future lessons" (page 49, Teacher's Guide).

Lesson 3b: Students are expected to compare and contrast data sets and find patterns in how people pick up bacteria from the environment. This evidence is used to answer specific questions to student-generated investigations. (Letter F, page 61, Mathematical and Computational Thinking, Teacher Guide)

Lesson 5: Students design their own experiment and use data to develop a graph of what their bacteria growth/population represent.

Lesson 7: Students develop an explanation using data and graphical representation (model) of the population of bacteria.

Suggestions for Improvement
N/A

Overall Category II Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category II
Criteria A-G: **3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria **2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1:** Adequate evidence for at least three criteria in the category **0:** Adequate evidence for no more than two criteria in the category

Category III. Monitoring NGSS Student Progress

Score: 3

III.A. Monitoring 3D student performances: Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena and/or design solutions.

The unit elicits direct, observable evidence of three-dimensional learning. For example, in Bend 2, lesson 13, students develop and revise a model. In part, the model reflects the cause and effect relationship between CORT and bird behavior. Students are working with elements of LS 4.B "natural selection only occurs if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information – that is, trait variation – that leads to differences in performance among individuals."

Suggestions for Improvement
N/A

III.B. Formative: Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative: Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction.

Many formative assessment opportunities are provided throughout the unit and consistently identified in the Teacher Support Boxes. For example, at the end of lesson 8a step 5, students complete the "next steps" of their "Student Activity Sheets," which asks them to process the data they have collected, prepare data tables for the next class and to revisit their IMTs. They are to complete these as home learning if they are unable to finish them in class. While not part of the scripted lesson necessarily, teachers are told the following in the Teacher Support Box in the Teacher Support Section, "You may decide to collect the entire set of Student Activity Sheets the following day in order to assess students' entire investigation plan." Many such opportunities are noted this way throughout the unit.

Teachers are also provided guidance in facilitating student self-assessment after any type of discussion – group, partner etc. A "Student Self-Assessment Discussion Rubric" is provided for both large group and small group discussions that allow students to self-assess on the quality of their engagement in the discussion. To clarify, these do not address content or performance in the three dimensions.

In the "How Can Teachers Use the Incremental Model Tracker (IMT)?" document in the Front Matter on page 31 it is suggested that teachers use the IMT as a means of formative assessment, and clarity on how to do this is provided in the "Assessment System in the Evolution Unit" document. Included is also information on how students can use the IMT to self-assess.

Formative assessment opportunities in the form of Students Electronic Exit Tickets (SEETSs) (lessons 5, 7, 10, 16, 20, 23) – as well as a formative assessment opportunity from lesson 22 are indicated by lesson number in the "Assessment System in the Evolution Unit" document. Information in the "Assessment System in the Evolution Unit" also informs teachers during which lessons these opportunities exist and how to use the SEETSs as a means of formative assessment. The document also provides teachers with a brief synopsis of the SEET for each lesson.

For example, at the end of lesson 7 (and all lessons having SEETs), teachers are prompted to provide a URL to students which takes them to a survey. This is the SEET and formatively assesses not just student understanding of concepts by asking them to interpret data in the form of multiple choice questions but asks them to reflect on the quality of their contributions to the class discussion and to reflect of their level of understanding of the content from that lesson.

As an additional tool for educators, authors have provided guidance for using the lesson performance expectations (LPEs) to guide formative assessment for each lesson. This resource is part of the "Assessment System in the Evolution Unit" and takes the form of a table. Included in this table are the lesson performance expectations for each lesson as well as opportunities within that lesson to assess student progress towards those LPEs. For specific evidence of this see Category III Criterion E.

Suggestions for Improvement
N/A

III.C. Scoring guidance: Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance: Extensive

(None, Inadequate, Adequate, Extensive)

Aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers are robust in this unit.

A clear and detailed points-based rubric has been created for use in Pre-Assessment (optional) and End of Unit / Post assessment. The assessment itself covers all PEs in the unit and 2 versions (of assessment and corresponding rubric) are provided.

At the end of Bend 1 students engage in a transfer task, "How did this population of insects become more resistant over time." Included with this transfer task is a detailed rubric allowing teachers to track components of the model students develop. While this will likely be modified over time as it is used in classrooms, it is an excellent starting point for teachers.

At the end of Bend 1 there is also a second optional summative assessment called "Mission Board Challenge: Optional." As with the other summative assessments, a detailed rubric is provided for guidance.

In addition to rubrics for summative assessment opportunities, the unit provides guidance to teachers regarding student responses for most of formative assessment opportunities throughout the unit. For example, the "At Home Learning" at the end of lesson 7 asks students to summarize major points from the lesson in their IMT. Provided to the teacher is an example of student work and important aspects of understanding to look for.

Suggestions for Improvement

Lesson 9 is not included in the Overall Unit Assessment document as an opportunity for assessment but is called out as an important moment in assessing student understanding in the "Response to Peer Review…" document. The specific additions indicated in the "Response…" document do not show up in the "Lesson by Lesson" table either. A similar situation occurs regarding lesson 11 (and perhaps 6 and 12?). This is only noted as guidance so that these assessment opportunities may be added in appropriate locations to facilitate assessment if appropriate, as the authors have a much more complete vision of how all parts of the Storyline are meant to work together.

Consider adopting a common rubric format across assessments. For example, the rubric for the transfer task at the end of bend one categorizes student performance as "mastered, developing or missing" while the rubric for the Info Graphic Challenge uses a four-point scale.

The transfer task for bend one is challenging (as it should be). The directions are detailed and many. Consider developing a differentiated version of the assessment for those students who may be challenged by the reading level and organization of the assessment or providing guidance for teachers as to how to maintain the integrity of the task and help students who might need help making sense of the assessment task.

In the "Assessment System for the Evolution Unit" document, a link to the key is provided for the SEET in lesson 5, but not for other SEETs. For example, there are multiple choice questions in the SEET for lesson 7, but no key is provided in the "Assessment System for the Evolution Unit" document.

III.D. Unbiased tasks/items: Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples.

Version 3.1 of this Storyline includes summative assessment items. These assessments include unbiased tasks. These tasks, while novel for the students, ask students to apply understanding, practices and crosscutting concepts that they have worked with across the unit. Because of this, all students should have a very similar shared experience and knowledge base from which to draw. The assessment asks students to create a model to explain why pesticides no longer work on a population of aphids. While

students may not be familiar with aphids, enough background knowledge is provided, and students have been collectively and independently modeling populations of bacteria and antibiotic resistant bacteria over the course of Bend 1.

Suggestions for Improvement

The lesson 13 assessment includes a few new vocabulary words (e.g., enzyme, pesticides, organophosphate) that are appropriately explained; however, they might provide a challenge for some students. Consider providing a glossary for these new words for students, or a way for teachers to introduce these new words to students in a different context before the assessment.

While the directions for the model construction are clear, it may be helpful for some students to have a checklist of items they need to include in their model so that they can be confident they have included all necessary model components. Alternatively, present the directions for what needs to be included in a bulleted list.

Make explicit in lesson 13 what information students are to place in each of the distribution graphs.

III.E. Coherent Assessment system: Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System: Extensive

(None, Inadequate, Adequate, Extensive)

This storyline includes a comprehensive pre-, formative and summative assessment system that addresses three-dimensional learning.

The "Assessment System in the Evolution Unit" document is the key component of the coherent assessment system developed for this unit. As previously mentioned, within this document is a table indicating opportunities for pre-assessment, formative assessment and summative assessment, assisting educators in establishing a meaningful vision of the ark of assessment and expected learning across the unit.

As previously mentioned, within the Assessment System document is a table including LPEs for each lesson in the unit. Accompanying each LPE are opportunities for student assessment towards the LPEs. For example, in Lesson 27 - which has three LPEs, the following guidance is provided,

> *"The model demonstrating DNA differences across generations for given mutation rates can be co-constructed as a class. Student use of the model can be assessed throughout the remainder of the lesson.*
> *Q 5, Q 6 and Q 7 on the Student Activity Sheets can be used as evidence for student progress on the second LPE. The co-constructed class models for mutation rates can be used to support struggling students.*
>
> *Q 8 and Q 9 can be used as evidence to determine student progress towards meeting the third LPE."*

The clarity of the LPEs (and therefore the 3D focus of each lesson) and the guidance with regards to assessment opportunities for each lesson strongly encourage formative assessment in all three dimensions.

Suggestions for Improvement
N/A

III.F. Opportunity to learn: Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback

Rating for Criterion III.F. Opportunity to learn: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts. This storyline provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCC's and as well to receive feedback on this work.

The IMT is an excellent way for students to demonstrate understanding of DCIs throughout the unit while engaging in the practice of modeling and various CCCs. In the right-hand column of the IMT students include their sense making of the anchoring phenomena as well as lesson level phenomena they encounter throughout the unit. Educators are encouraged repeatedly to refer back to the IMT as a means of formatively assessing student understanding and providing feedback.

For example, in lesson 12 students work on developing a list of concepts around natural selection (DCI) they will need to include in the model (SEP) they are creating. They are prompted to compare 2 systems (CCC) they have been working with and identify patterns (CCC) between the systems. In addition to this instructional piece, teachers are given a list of the important components that students should be including as well as interactions between them. This facilitates productive feedback.

As also previously mentioned, the SEETs at the end of many of the lessons also provide opportunities for individual students to display evidence of their learning and receive feedback from teachers.

As mentioned earlier, the authors support teachers in formatively assessing individual students on their three-dimensional learning by providing the lesson level performance expectation(s) and detailing opportunities for formative assessment for these for every lesson. For example, in lesson 21 students are engaging with the following lesson level performance expectation, "Construct a written argument based on data and evidence from a primary source research article to explain how differences in the amount of CORT produced/released in juncos could provide mechanism linking how differences in alleles in juncos could result in differences in their behavior." Teachers are directed to use the student work on the Student Activity Sheets as a means of formative assessment for this LPE. They are guided to specific sections (page 2 of Next Steps, the model and the Conclusions section on page 3) to look for evidence of specific aspects of the LPE in student work. Educators are also guided to ask students to orally defend their work as a means of gathering more evidence and providing feedback.

Suggestions for Improvement
N/A

Overall Category III Score (0, 1, 2, 3): 3

Unit Scoring Guide – Category III
Criteria A–F: **3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion **2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1**: Adequate evidence for at least three criteria in the category **0**: Adequate evidence for no more than two criteria in the category

Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 3
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3
Total Score: 9
Overall Score (E, E/I, R, N): E

Scoring Guides for Each Category
Unit Scoring Guide
Category I (Criteria A-F): **3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C **2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C **1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C **0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F)
Category II (Criteria A-G): **3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria **2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1:** Adequate evidence for at least three criteria in the category **0:** Adequate evidence for no more than two criteria in the category
Category III (Criteria A–F): **3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion **2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1**: Adequate evidence for at least three criteria in the category **0**: Adequate evidence for no more than two criteria in the category

Overall Scoring Guide
E: Example of high quality NGSS design—*High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)* ***E/I: Example of high quality NGSS design if Improved—****Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)* ***R: Revision needed—****Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)* ***N: Not ready to review****—Not designed for the NGSS; does not meet criteria (total 0–2)*