Evolution of Sick Humans

DEVELOPER: New Visions

GRADE: 9–12 **| DATE OF REVIEW:** April 2022

Educators Evaluating Quality Instructional Products

NextGen Science WestEd

EQuIP Report Template for Units

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E/I

TOTAL SCORE: 7

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	3	2

Click here to see the scoring guidelines.

This review was conducted by NextGenScience using the EQuIP Rubric for Science.

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

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EQuIP RUBRIC FOR SCIENCE EVALUATION

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. The unit is strong in many areas, including engaging students in figuring out relevant, real-world phenomena, supporting students to see connections throughout the unit storyline, and integrating literacy strategies.

During revisions and/or use in the classroom, the reviewers recommend paying close attention to the following focus areas in order to strengthen materials:

- **Strengthening the connection between student questions and instructional activities.** Although student questions are currently elicited, teachers might not have enough support to ensure that students questions can drive the learning.
- **Strengthening the learning and assessment focus on CCC elements.** Most learning and assessment supports in the unit currently focus on SEP and DCI learning goals. In particular, guidance is not provided to help teachers know what expected levels of proficiency look like for CCCs for each major assessment or what to do if students don't reach expected levels of proficiency.
- **Helping teachers and students clearly see what growth looks like for all learning targets**. Rubrics are currently provided that relate to some SEPs and DCIs, but not all learning goals are depicted on the rubrics. In addition, the rubrics are not currently written in student-friendly language, teachers are not supported to see to what level students are meant to perform during each section of the unit, and assessment targets (at the element level) are not specified for student performances.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes. In these cases, the criterion WAS met; the purple text is simply not part of the argument for that Extensive rating.

Unless otherwise specified, page numbers in the document refer to the page numbers listed on the Teacher Edition PDF.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

EQuIP Report Template for Units

EQuIP RUBRIC FOR SCIENCE EVALUATION

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that learning is driven by students making sense of phenomena because learning is driven by students figuring out an anchor phenomenon, investigative phenomena, and completing a design challenge related to a problem to solve. However, learning often seems to be driven by teacher-provided questions rather than by students' own curiosity.

An anchor phenomenon and several problems are used to drive learning in the unit, but the phenomenon and problems are not clearly stated as a true phenomenon and true problems. Related evidence includes:

- The unit anchor phenomenon is stated as "How have our environments and cultures changed over time? How have these changes impacted our health?" (page 2). As stated, this is a question rather than a phenomenon. The teacher is told "In this unit, students will explore the possible 'mismatch' between human bodies and modern environments by investigating phenomena at the protein level" (page 2). The anchor phenomenon is therefore assumed to be that modern human bodies are not well-adapted to modern lifestyles, although this statement is a conclusion rather than a phenomenon itself.
- Unit Opening: Here, the anchor phenomenon is stated as "Why would a high school student who recently arrived in New York City be unable to drink milk at lunch like her peers without getting sick?" (page 5). This is phrased as a question rather than as a phenomenon but is closely related to the phenomenon that a student is unable to drink milk without getting sick. This phenomenon is presented to students as a real-world story in the "Tell the Story" reading (Student Materials, page 3).
- Lactase Persistence 5E: In the Evaluate phase of the sequence the teacher is told "Remind students that they just examined the problem that some people experience and how the environment in a typical NYC school cafeteria is not designed to maintain their health in regards to lactose intolerance. They also just looked at an example of something that changed in our environment and lifestyle 10,000 years ago that impacts our health today. Let them know that

for people who are lactose intolerant, this is a mismatch between their body/genes and the modern western environment" (page 46). Students are therefore explicitly introduced to a problem.

- Leptin Resistance 5E: In the Evaluate phase, students return to the problem from the prior learning sequence: "Remind students that we are concerned with how to design a healthy school. Define the sub-problem we are focusing on in this learning cycle. Some people have developed leptin resistance due to a combination of environmental mismatch and genetic variations. Leptin resistance may lead to excess fat storage" (page 76).
- Unit Closing: "Students return to the anchor phenomenon and generate ideas on the mismatch hypothesis, why mismatch problems are occurring, and why this might be a problem we need to address" (page 120).

Investigative phenomena are used in the unit. However, when they are described in the introduction on page 2, they are phrased as questions rather than phenomena or problems. For example:

- Lactase Persistence 5E: "Why are some people able to digest dairy into adulthood but others cannot?" As stated on page 2, this question is closely related to the phenomenon that some people are able to digest dairy into adulthood but others cannot. A true phenomenon statement is correctly included on page 6.
- Leptin Resistance 5E: Page 2 states: "Why is obesity increasing globally? Why do some people gain weight easily but others do not?" These two questions closely related to two phenomena: obesity is increasing globally and some people gain weight easily but others do not. However, page 7 includes a true phenomenon: "some people are storing more fat than they used to (obesity is increasing)." The sequence actually starts with a different phenomenon of chubby babies: "Initiate the topic by prompting students to think about babies. Ask students to describe human babies; what they look like, what characteristics they have. Listen for the idea that human babies are often chubby. Use follow-up questions such as, 'Why do you think that is?' to surface students' initial ideas about the utility of fat storage, particularly in babies" (page 62). Later in this lesson, a problem is explicitly stated: "However, we are currently experiencing the problem that too many people are storing too much fat. The storage of too much fat, called obesity, may cause health problems such as diabetes and arthritis" (Leptin Resistance Text).
- Circadian Rhythms 5E: "Why do virtually all organisms have a day-night cycle? How might disruptions or environmental changes in the day-night cycle impact our health?" (page 2). The first of these two questions relates closely to the phenomenon that virtually all organisms have a day-night cycle. This is accurately stated on page 8: "All living organisms have day and night cycles that impact biological function."
- Common Ancestry 5E: "Remind students that in this learning sequence, they have investigated a new subproblem: There are many examples of the mismatch between our bodies, particularly specific molecules and proteins, and our current environment. It is unlikely that these molecules will evolve quickly enough to solve our mismatch diseases because they are highly conserved across a wide range of organisms" (page 115). Note that it is not clear that students learn about the time scale involved in evolution enough to fully understand the last sentence, meaning that related instruction is more likely to be teacher driven.

- Unit Closing: "How can we design a healthy school in terms of reducing mismatches between our bodies and our environment?" (page 2). This seems to be a design challenge aimed at solving the problem that there is a mismatch between human bodies and the environment. This design challenge is posed by the teacher rather than by the students in response to seeing the problem.

Student questions are sometimes used to drive instruction in the unit, but questions are often provided to students, resulting in teacher-driven learning. For example:

- In the Storyline and Pacing Guide, student questions for each part of the unit are listed for the teacher. The teacher is also told that "During the Driving Question Board routine, students ask questions related to why some people are able to digest dairy products as adults but others not. Once a category related to these questions has been articulated, let students know that they will be investigating this question over the next sequence of lessons to figure out how some people are able to digest dairy products into adulthood, while others not" (page 5). The reviewers assume that these directions mean that the teacher should not share the "Student Questions" list with the students but rather wait until one of those questions (or something very similar) is asked by students, but teachers are not told *not* to share the question list with students, so some students may see the questions before they have a chance to wonder themselves. For example, in the first 5E sequence of lessons about lactase persistence, the title of the sequence is given as, "Why are some people able to digest dairy into adulthood, but others not?" This question is repeated in the title of the Engage lesson. If this question is given to students, this given question would *drive* what happens in students' minds in terms of sense-making rather than students' own questions driving sense-making. The pattern for each 5E sequence currently might be interpreted as: 1) students are told what question(s) is(are) important, 2) the teacher asks students what questions they have, 3) teacher and textbook gives students tasks to accomplish related to the question(s) given to students.
- Unit Opening: Student questions are elicited and used to create a Driving Question Board (DQB). However, these questions come not directly in response to a phenomenon but to a teacher-provided guiding question: "Let them [students] know that they will be investigating why some teenagers and adults can digest dairy after infancy, while others like Kanna cannot and that this is important to figure out so that they can ensure that school is a safe and healthy place for all people. Have students independently come up with questions they think need to be answered in order to figure out why Kanna can't digest milk/dairy… As a whole class or in small groups, have students share and categorize their questions onto chart paper. Ideally, students should be able to combine and categorize questions into 3-5 larger categories of questions to investigate" (page 27). Facilitation notes are provided for the teacher to help students create meaningful categories on the DQB.
- Lactase Persistence 5E: "Remind students that they were interested in understanding how we digest milk, either as infants or adults. Point to or elevate student questions surfaced in the wonder category from the See-Think-Wonder from the Engage phase. Prompt students to suggest ways we could better understand what happens to dairy products in different people after they consume it. Elevate student ideas connected to investigating digestive processes

and/or contents from the digestive system (like intestinal fluid) in humans that have consumed dairy, animal models, or via a simulation" (page 34). "Listen for ideas that help us transition to thinking about why glucose would be present in intestinal fluid after drinking milk (in some people) when milk itself is not really sweet" (page 35). "Have students revisit the Lactose Intolerance Frequency Map, the See-Think-Wonder, and the set of questions they surfaced during the Engage phase. Which question(s) have we answered? What do we know now? Which question(s) are the most important to explore to better understand what happened with Kanna?" (page 38). "Probe students on how we might further compare the trait (can/can't digest dairy) between people. If DNA, heredity, or genetics are not brought up, remind students that in Unit 2 they looked at the genetic basis of immunity, so that the idea that we can compare DNA to better understand what is going on is surfaced by the class" (page 39). "Remind the class that while they now have a better understanding of why individuals, and even families like Kanna's, have difficulty digesting dairy, they still have unanswered questions about why whole regions of people are lactose intolerant and why the mutation (that confers lactase persistence) was beneficial and increased in some populations. Let them know that in order to figure out these unanswered questions, they will be watching a video about lactase" (page 44). "Prompt students to review their initial Driving Question Board (DQB) and determine which questions they have answered. Remind students that we want to design a school environment that promotes health and ask them what they think they need to know about these lifestyle changes (mismatches) to help redesign a school to better serve their health. Have students generate questions on post-it notes" (page 48).

- Leptin Resistance 5E: "Prompt students to revisit the DQB and point out questions about obesity, people getting larger, easier access to food, or sedentary lifestyles. Let students know that we will investigate these questions in this learning cycle" (page 62). This discussion might pull on student questions generated during the Evaluate session of the prior learning cycle (related to easier access to food and sedentary lifestyles), but that section does not guide teachers to facilitate the generation of student questions related to obesity and people getting larger, so students might feel as if this transition is very teacher driven. The teacher materials also do not guide teachers on what to do when students don't ask the listed questions related to obesity, so some teachers might understandably resort to telling students what the desired questions are, decreasing students' feelings that their curiosity is driving learning.
- Leptin Resistance 5E: "Have students identify their most important question, and use the group learning routine Rumors for students to share out their questions. Categorize questions as a class to surface important patterns and questions about fat storage" (page 63). In the Explore 1 phase: "Revisit the key questions from the Engage phase that surfaced from the Rumors routine. Ask students to identify which ones are the most relevant and testable. Surface ways in which these questions could be investigated in the classroom. Listen for students to say they can be investigated either through an experiment or through analyzing secondary data sets. If students do not bring up looking at the differences in genes or proteins between people, prompt them to remember the cause behind lactose intolerance" (page 64). The Explain 1 phase begins with "Remind students of the questions they surfaced during the Explore phase and elevate questions specifically about leptin, how it is made, and how it might work in the body. In order

to start investigating these questions in more depth, we can first look at where and how leptin is made" (page 67). In the Explore 2 lesson (page 75), the teacher instructions say to, "Revisit unanswered student questions from the Engage and Explore 1 phases." This is potentially an example of question iteration.

- Leptin Resistance 5E: To lead into learning about protein transcription and translation, students are given the following connections to their ideas and questions: "Scientists have identified several proteins that impact how we regulate fat storage and may play a role in obesity. One protein we will explore is a hunger regulating protein called leptin. Leptin is a protein-based hormone. Leptin is produced in our fat cells and helps to regulate hunger, thus how much energy we consume. It may be helpful to understand how leptin is created in fat cells so we can investigate the role it may play in obesity" (Student Materials, page 58).
- Circadian Rhythms 5E: "Return to the DQB and elevate questions about how sleeping patterns may have changed over time. Students may have also brought up the connection between sleep and obesity in the previous 5E learning sequence. Revisit these questions and prompt students to consider why humans (and all organisms that live longer than 24 hours) have distinct times when they are awake and when they sleep or enter a sleep-like state…In groups, have students brainstorm ways in which we can investigate how, when, and why most living things have periods of time they are awake and periods of time in which they sleep (or rest in some way)" (page 91). "Using class ideas or a combination of ideas across all classes, introduce the investigation and how it is based on student suggestions" (page 93). "Elevate unanswered student questions from the end of the Explore phase and from student questions documented on the See-Think-Wonder organizer. Connect student questions to the 5E level questions: Why do virtually all organisms have a day-night cycle? How might disruptions or environmental changes in the day-night cycle cause our health concerns? In order to further investigate these questions, have students work in triads to jigsaw the following resources" (page 96).
- Common Ancestry 5E: "If students do not bring these ideas up, provide further probing questions…Remind students that we are interested in understanding why evolutionary mismatches occur, and why our bodies aren't evolving to address these mismatches. In order to investigate these questions, students will use the NCBI Genetic Database to compare important molecules (or their receptors) to better understand variations in these molecules across different species" (pages 107–109). "Elevate unanswered student questions from the end of the Explore phase. Prompt students to identify 2–3 of their most important questions" (page 111). Then, the teacher tells students to read an article that provides the answers.

Prior Knowledge is elicited and used to motivate student learning throughout the unit. For example:

- Unit Opening: Student prior knowledge is engaged as students try to answer a teacher prompt: "Prompt students to brainstorm responses to the prompt: Why did Kanna feel ill after drinking milk and eating dairy, but her classmates did not?" (page 26).
- Lactase Persistence 5E: "Elevate ideas about the differences in glucose, and ask students to elaborate on what they already know about glucose. Students may say something about sweetness or that it is a simple sugar" (page 35). "Before diving into the lab, pause to surface student understanding of the basics of genetics from middle school" (page 39).

- Lactase Persistence 5E: "Prompt students to consider what other changes in our environment have occurred in the past 1,000+ years and how those changes might be impacting our health or how we live our lives. Have them share these ideas with a partner" (page 46).
- Leptin Resistance 5E: "Initiate the topic by prompting students to think about babies. Ask students to describe human babies; what they look like, what characteristics they have. Listen for the idea that human babies are often chubby. Use follow-up questions such as, 'Why do you think that is?' to surface students' initial ideas about the utility of fat storage, particularly in babies" (page 62).
- Circadian Rhythms 5E: "Prompt students to consider why humans (and all organisms that live longer than 24 hours) have distinct times when they are awake and when they sleep or enter a sleep-like state. Use the group learning routine Rumors to surface and categorize student ideas" (page 91).
- Circadian Rhythms 5E: "Facilitate students surfacing their prior understanding of a prototype (a first, typical, or preliminary model of something, from which other forms are developed or copied.)" (page 100).
- Lactase Persistence 5E: "DCIs from LS4.C Adaptations are not a part of this unit's PE bundle, but this task provides a great opportunity to review and reinforce these concepts that were foregrounded in Unit 2" (page 44).
- Common Ancestry 5E: "Use the group learning routine Rumors to surface and categorize student ideas about why there are so many examples of mismatch diseases" (page 107).

Engineering is embedded throughout the unit, although it is primarily used for students' application—rather than development of—science ideas. For example:

- At the beginning of the unit, the teacher is told "After being presented with the unit anchor phenomena, students are naturally inclined to want to do something about it - and thus student investigations across a unit are also motivated by the desire to solve the related problem. This engineering thread is intertwined with the anchor phenomenon, as the science figured out is useful in arguing for a causal explanation of the phenomenon and figuring out a design solution" (page 4).
- At the end of each 5E, students engage in an engineering task related to what they learned in that learning sequence. During these tasks students learn some ETS DCIs and have some opportunities to develop SEPs and CCCs, but do not explicitly develop science DCIs. However, they are given a rubric against which they measure their developing understanding of science ideas, and this continual rubric comparison might help them learn the science ideas written on the rubric.

Suggestions for Improvement

- Consider ensuring that learning sequences will feel authentically student-driven to students. For example, it could be helpful to emphasize to teachers that the sequence titles and given student questions are not meant to be given to students, and that teachers should try as much as possible to use students' own questions instead of the given questions in all classroom activities.

- Consider rephrasing the phenomena-related questions in the unit into phenomenon statements. This change could allow students more agency in choosing driving questions.
- In the Evaluate section of the Lactase Persistence 5E, consider adding guidance for the teachers to facilitate student discussion to help ensure that questions are generated related to obesity and people getting larger. This will help connect to the Leptin Resistance 5E that follows.
- Consider making the following Lactase Persistence 5E prompt a normal part of the lesson (i.e., not only suggested if students are unfamiliar with the work of an engineer), to help ensure that student ideas are engaged to motivate learning: "Additionally or alternatively, prompt students to brainstorm how they have used Science and Engineering Practices to figure out phenomena in previous units and science classes. Use their ideas about the scientific process and Science and Engineering Practices they have engaged with to compare the work and process of engineers" (page 47).
- Consider positioning the engineering task in the unit in such a way that students would be motivated to learn new science ideas while they work toward solving the problem.

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	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Although students have adequate opportunities to use and develop elements of all three dimensions, there is a mismatch between claims and evidence of student use of all three dimensions.

Full performance expectations (PEs) are listed as standards in most sections of the unit without clarification about which parts of the PEs are expected in that section, and the reviewers were unsure how to interpret these lists. Therefore, the elements that make up those PEs were assumed to be the learning goals for that section of the unit in addition to any specific elements listed in that section. There is also often a mismatch between the words color coded at the beginning of each lesson (indicating presence of one of the three dimensions) and both the expectations from the claimed PEs as well as the

elements claimed in the "Aspect of Three-Dimensional Learning." Teachers may therefore be confused about intended learning goals.

Science and Engineering Practices (SEPs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use the SEPs in this unit. Students are supported to use a sufficient number of SEPs at the high school level. However, there is mismatch between several of the SEPs claimed and evidence of student learning.

Asking Questions and Defining Problems

- *Ask questions that arise from examining models or a theory to clarify relationships.*
  - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section. In this section, students raise questions about map frequencies (e.g., page 32), but not specifically about models or theories.
  - Leptin Resistance 5E: This element is part of a claimed PE and is specifically claimed in this section. The teacher is told "Ask students to review their ideas on the author's theory, and prompt them to brainstorm a set of questions about the theory or points discussed in the text" (page 63).
  - Circadian Rhythms 5E: This element is part of a claimed PE. At the end of the Explore phase, the teacher is told to "Look & Listen For" student ideas such as "We still need to understand why organisms have day-night cycles, and why animals (humans) sleep. We still need to understand how different environmental variables may impact cycles and sleep quality -- and if we can evaluate causality between an environmental variable and sleep quality" (page 95). These examples of missing information are the closest the lesson comes to eliciting new student questions and is not related to examining models or a theory.
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students return to the DQB and determine which questions have been answered (page 121), but are not prompted to ask new questions in this lesson.
- *Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.*
  - Unit Opening: This element is claimed in this section (although not in the unit overall). Students are asked to "come up with questions they think need to be answered in order to figure out why Kanna can't digest milk/dairy" (page 27).
- *Evaluate a question to determine if it is testable and relevant.*
  - Leptin Resistance 5E: This element is not claimed but is used: "Revisit the key questions from the Engage phase that surfaced from the Rumors routine. Ask students to identify which ones are the most relevant and testable" (page 64).

Developing and Using Models

- *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
    - Lactase Persistence 5E: This element is claimed. Students are asked to "Generate an initial model: Demonstrate the relationship between chromosomes, DNA, genes, and proteins. Annotate your model as needed to clarify the relationships between chromosomes, DNA, genes, and proteins" (Student Materials, page 35). Students therefore are asked to develop a model to illustrate the relationships between components of a system, but are not asked to revise models.

Analyzing and Interpreting Data

- *Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.*
    - Common Ancestry 5E: This element is claimed. Students use websites to analyze similarities in amino acid sequences between different species (Student Materials, page 96).
    - Unit Closing: This element is claimed. However, reviewers did not find evidence of student use of this element.

Constructing Explanations and Designing Solutions

- *Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*
    - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section. The teacher is told "Have students use evidence from both investigations and models presented in this learning sequence and appropriate scientific reasoning to construct a scientific explanation in response to the guiding prompt: Why are some people able to digest milk into adulthood but others cannot? How do some people have this ability?" (page 41). A CER rubric is provided for student explanations (Student Materials, pages 44–45), but the rubric is not specific to this element versus similar middle school-level elements. For example, a "variety of sources" is not part of the criteria.
    - Leptin Resistance 5E: This element is part of a claimed PE and is specifically claimed in this section. Students are prompted: "Using evidence and scientific reasoning from this learning sequence, construct an explanation for why some populations of people might be experiencing an increase in excess fat storage (obesity)" (Student Materials, page 69).
    - Circadian Rhythms 5E: This element is part of a claimed PE. In the Summary Task, students are prompted: "Maintaining circadian rhythms, particularly getting enough rest or sleep, is essential to health. Explain how both genetic and environmental influences may lead to disruptions in sleep-wake cycles" (Student Materials, page 86). However,

specific criteria for the explanation are not given, so it is not clear that students would be expected to use the type of high school-level explanation indicated by the claimed element.

- Common Ancestry 5E: This element is claimed. Students are asked to "Construct a scientific explanation using evidence and scientific reasoning from the unit that explains the phenomenon under study: Why do we have mismatches between our genes (and traits) and our current environment?" (page 111).
- Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. At the beginning of the lesson the teacher is told "Students return to the anchor phenomenon and generate ideas on the mismatch hypothesis, why mismatch problems are occurring" (page 120). However, no additional details are given that indicate that students would be expected to construct high school-level scientific explanations of why mismatch problems are occurring.

- *Design and evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.*
  - Lactase Persistence 5E: This element is claimed. Students are introduced to a problem to solve and are asked "what they think they need to know" to help solve the problem (page 48) but they do not design a solution during this section of the unit.
  - Leptin Resistance 5E: This element is claimed. Students begin thinking about a solution to a problem: "Brainstorm solutions (What can we do about it to improve our schools?) Brainstorm is specifically addressing the obesity problem… What are the constraints when thinking about these solutions? Generate a list of three or more realistic criteria and two or more constraints, including such relevant factors as cost, safety, environmental concerns, and aesthetics that specify an acceptable solution to a complex real-world problem. Provide students with some examples of limitations and constraints" (page 76).
  - Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section. Students are asked to "Identify solutions. Brainstorm design elements that would be a part of your prototype design. As a group, identify 1-2 design elements that address the problem and subproblems, and satisfy the constraints and criteria. An optimal design element is high-leverage, meaning that it addresses more than one subproblem at a time. For each design element, provide a rationale that includes: How the science concepts you figured out in this learning sequence inform the decision to include that element" (Student Materials, page 88). "After students complete their responses, use the Circadian Rhythms Circadian Rhythms Engineering MiniRubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 101). Students therefore give general feedback, but prompts related to prioritized criteria and tradeoff considerations are not included.
  - Common Ancestry 5E: This element is claimed. "Encourage students to suggest ways in which they could evaluate or test their initial design. If needed, remind students that they created a survey in the 2nd learning cycle that could be used to gather data on the

elements of their design or to optimize their design" (page 115). Students therefore continue to design their solutions related to light/dark cycles in bedrooms.

- Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students are asked to create and evaluate final designs, and a design evaluation rubric is provided to students, including the following criteria: "The evaluation is clear and complete. It fully addresses the following components: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design" (Student Materials, page 104).

Engaging in Argument from Evidence

- *Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.*
  - This element is part of a PE that is claimed for this unit in the Biology Course Guide, but not in the materials for this unit itself.
  - Students are supported to use CER scaffolds many times in the unit (e.g., Student Materials, page 59), but each time, students are asked to write explanations rather than defending claims.

Obtaining, Evaluating, and Communicating Information

- *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).*
  - Leptin Resistance 5E: This element is claimed. The teacher is told "When students finish reading and have completed the See-Think-Wonder Organizer, prompt them to collaborate with their partner to develop a written summary of the assigned study (using the sentence frames given in the handout)" (page 65). Later in the lesson students are asked to "Write a final summary of the entire process using the terms: DNA, chromosome, gene, protein, codes, instructions, form, function" (Student Materials, page 58).
  - Circadian Rhythm 5E: This element is claimed. While students develop a bedroom prototype, they are asked to draw designs and respond to the following prompts in writing: "For each design element, provide a rationale that includes: How the science concepts you figured out in this learning sequence inform the decision to include that element, How examining the different components of the system and their function(s) informed your ideas on which design elements to include" (Student Materials, page 88).
  - Common Ancestry 5E: This element is part of a claimed PE. In the Summary Questions, students are asked to write answers to questions such as "How do the patterns in these data sets help you figure out the phenomenon under investigation?" (Student Materials, page 96).
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students present their final designs, and the rubric criteria state that a proficient performance includes student designs "presented as a 3D or drawn model"

with annotations, and that the design "provides a clear rationale for all 3 design elements that includes all of the appropriate scientific concepts, how all of the criteria and constraints informed the elements, and how the concept of structure and function informed the design" (Student Materials, pages 103–104).

- Note that students are not supported to communicate mathematically in the unit.

Disciplinary Core Ideas (DCIs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit. Students have opportunities to develop a sufficient number of DCI elements in the unit, and students use these elements to make sense of phenomena. However, several parts of claimed DCI elements are not fully developed in the unit.

LS1.A: Structure and Function

- *Systems of specialized cells within organisms help them perform the essential functions of life.*
  - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section. Students learn about some specialized organs (mammary glands, small intestine) and there is one reference to microvilli (specialized cells) on the DNA Reference Sheet.
  - Leptin Resistance 5E: This element is part of a claimed PE and is specifically claimed in this section. Students learn about the role that fat cells play in the Leptin Resistance Text (Student Materials, page 61).
  - Circadian Rhythms 5E: This element is part of a claimed PE. The Melatonin Text includes one mention of a specialized gland (pineal gland), and in the Explain section, students watch a video about how plants tell time. At time stamp 2:58 there is a brief mention of glucose and long polymer chains being made in plants.
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104).
  - Overall, students have opportunities to see examples of specialized cells during the unit, but do not explicitly discuss this idea as a generalizable concept that could be applied to other cell types.
- *All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.*
  - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section. The "Non-coding DNA Text" (Student Materials, page 43) includes the ideas from this DCI element.
  - Leptin Resistance 5E: This element is part of a claimed PE and is specifically claimed in this section. Students use this background information to learn about protein synthesis in cells (e.g., Protein Synthesis Text). The Elaborate section asks students to view a video

that has a simulation of cell function associated with insulin production, showing an approximation of DNA material and the workings of groups of cells.
- Circadian Rhythms 5E: This element is part of a claimed PE. The Melatonin Text includes one reference to proteins and hormones.
- Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104).

LS3.A: Inheritance of Traits

- *Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.*
  - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section. The "Non-coding DNA Text" (Student Materials, page 43) includes the ideas from this DCI element.
  - Leptin Resistance 5E: This element is part of a claimed PE. The ideas in this element are included in the Protein Synthesis Text (Student Materials, page 60).
  - Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section. However, students do not specifically discuss or use this DCI during the lesson.
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104).

LS3.B: Variation of Traits

- *In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.*
  - This element is part of a PE that is claimed for this unit in the Biology Course Guide, but not in the materials for this unit itself.
- *Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.*
  - This element is part of a PE that is claimed for this unit in the Biology Course Guide, but not in the materials for this unit itself.

LS4.A: Evidence of Common Ancestry and Diversity

- *Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.*
    - Unit Opening: although no DCI is individually claimed in this section. No specific evidence of DCI use was found in the section.
    - Common Ancestry 5E: This element is part of a claimed PE and is specifically claimed in this section. Students explore this idea, including in the "Common Ancestry Text," which tells them about the role of role of DNA in the ongoing branching of organisms into different species. In the Explore section students work with the NCBI database to look for patterns in genes across species.
    - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104).

LS4.C: Adaptation

- *Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.*
    - Lactase Persistence 5E: This element is claimed. Students' prior knowledge related to this DCI is elicited: "DCIs from LS4.C Adaptations are not a part of this unit's PE bundle, but this task provides a great opportunity to review and reinforce these concepts that were foregrounded in Unit 2" (page 44). In the Elaborate section, students watch a video that tells them how lactase persistence was a selective advantage in certain human populations. Note that the full element is not used or described in the video.
    - Unit Closing: This element is claimed. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104). However, it isn't clear that students will use the full element in their designs.
- *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.*
    - Lactase Persistence 5E: This element is claimed. Students' prior knowledge related to this DCI is elicited: "DCIs from LS4.C Adaptations are not a part of this unit's PE bundle,

but this task provides a great opportunity to review and reinforce these concepts that were foregrounded in Unit 2" (page 44). In the Elaborate lesson, students watch a video that tells them how lactase persistence was a consequence of evolution in certain human populations. Note that the full element is not used or described in the video.

- Unit Closing: This element is claimed. Students' final design evaluation rubric says, "The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits" (Student Materials, page 104). However, it isn't clear that students will use the full element in their designs.

ETS1.B: Developing Possible Solutions

- *When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.*
  - Leptin Resistance 5E: This element is claimed. Students are guided to consider constraints, and therefore might start building toward this idea: "Generate a list of three or more realistic criteria and two or more constraints, including such relevant factors as cost, safety, environmental concerns, and aesthetics that specify an acceptable solution to a complex real-world problem" (page 76). Students are also given an engineering rubric where they see that they need to identify appropriate constraints, although the range of constraints from this DCI is not included in the rubric (and therefore students have less support to learn the DCI).
  - Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section. Students are asked to "Identify the criteria and constraints. Think about your own sleeping space. What constraints might you face in redesigning your space? What criteria are important in developing your prototype design?" (Student Materials, page 87). However, students are not supported or prompted to show knowledge of the range of constraints discussed in this DCI (e.g., for cost, safety, reliability, aesthetics, and cultural impacts), and therefore are more likely use similar DCIs from lower grade levels.
  - Common Ancestry 5E: This element is claimed. Students are asked to "suggest ways in which they could evaluate or test their initial design" (page 115), but there is not evidence that students will use the range of constraints defined in this high school-level DCI element to evaluate their designs.
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. Students create final designs but there is not evidence that students will use the range of constraints defined in this high school-level DCI element to evaluate their designs.

ETS1.C: Optimizing the Design Solution

- *Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.*
  - Leptin Resistance 5E: This element is claimed. However, the reviewers did not find evidence of student use of this element. In the Evaluate section, students are asked

"What are the two subproblems we have identified?" However, breaking down problems into subproblems does not mean that students understand the importance of breaking down criteria.

- Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section. However, the reviewers did not find evidence of student use of this element. In the Evaluate section, the student handout guides them through designing a bedroom. The prescribed guided questions give students opportunity to break criteria down into smaller segments, but there is no evidence that students are expected to do or that they learn that it is an important process.
- Common Ancestry 5E: This element is claimed. However, the reviewers did not find evidence of student use of this element.
- Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. However, the reviewers did not find evidence of student use of this element.

Crosscutting Concepts (CCCs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit. Students are supported to use a sufficient number of CCC elements, but there is a significant mismatch between claims and evidence of student use of high school-level elements.

Patterns

- *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.*
  - Common Ancestry 5E: This element is part of a claimed PE and is specifically claimed in this section. Students are asked to look at patterns in both protein sequences and times of evolutionary divergence of different animals (page 110). They are then asked, "How do the patterns in these data sets help you figure out the phenomenon under investigation?" (Student Materials, page 96). The teacher is also told to "take time for" the key point: "Looking closely at patterns of evolution at different time scales helps us understand the pace of evolution and why our bodies can't (or don't) evolve quickly enough to resolve mismatch diseases because our current environment changed relatively quickly, while the evolution of advantageous traits does not happen at the same pace" (page 113). In the *Common Ancestry Engineering Journal*, students are prompted: "Did patterns in data collected in this learning sequence support a conclusion on causality? Why or Why not?....How does the pattern of data at the __ scale help you explain [phenomenon at different scale]?" (Student Materials, page 15).
  - Unit Closing: This element is part of a claimed PE in this section. However, the reviewers did not find evidence of student use of this element.

Cause and Effect

- *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*
    - Leptin Resistance 5E: This element is part of a claimed PE and is specifically claimed in this section.
        - In the Explore 1 section, students read articles with graphed data. Students use these data to discuss correlation in contrast to causation, and an optional sentence frame is given to students "The study design did/did not provide evidence that as to whether __ causes __ because __" (Student Materials, page 52).
        - The teacher is told to "Look & Listen For" student responses including "The data does not provide enough evidence to determine if leptin causes an increase in body fat (or vice versa); further investigation and empirical evidence would be needed" (page 67). Later, the teacher is told to "Look & Listen For" student responses including "There is some empirical evidence presented in these studies for the role of genetics in general body and weight and some feeding behaviors……There are some strong associations between some environmental factors such as food supply and fat storage, but more evidence is needed to identify causality" (page 71). This indicates that teachers are prompted to look for student understanding of the idea of empirical evidence.
        - The teacher is given a video that "may be helpful in leading a conversation on this topic" (page 73), although the video only supports student understanding of the Grade 6–8 element *Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation*, and the teacher is not told that the video content is at the middle school level.
        - Students are given a prompt to construct an explanation and are given terms they are to use in the explanation, including "cause/causal" and "empirical evidence" (Student Materials, page 71).
        - The teacher is told to "Look & Listen For" student responses including "In making claims on causality empirical evidence (e.g., randomized controlled trials) is needed to differentiate between cause and correlation" (page 74).
        - In the Summary Task, students are asked "How did you determine causality and what evidence did you use to differentiate between cause/effect and a correlation relationship?" (Student Materials, page 74).
        - In the Engineering Mini-Rubric, one of the descriptors is "Includes discussion of evidence needed to make claims about causality" (Student Materials, page 76).
    - Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section.
        - Students are asked "What additional evidence would you need to collect to differentiate causality and correlation between sleep disruption and that specific variable?" (Student Materials, pages 80 and 82) and later asked "Discuss

one example of cause and effect and how to differentiate between causality and correlation" (Student Materials, page 86).
    - In the *Circadian Rhythms Engineering Journal* students are prompted "Is the evidence discussed sufficient to conclude that __ caused __? If not, what additional evidence is needed?" (Student Materials, page 11).
    - The teacher is told to "Look and Listen For" student responses that include the idea "We still need to understand….if we can evaluate causality between an environmental variable and sleep quality" (page 97).
  - Unit Closing: This element is part of a claimed PE and is specifically claimed in this section. In the Design Rationale section, students are prompted "What additional evidence might you need to support your claim?" (Student Materials, page 22). However, the idea of empirical evidence is not explicit.

Structure and Function

- *Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.*
  - Lactase Persistence 5E: This element is part of a claimed PE and is specifically claimed in this section, including for the Summary Task. Students explore the structure of DNA and chromosomes in the lesson. In the *Lactase Persistence Engineering Journal*, students are prompted to "describe how investigating the properties and structures of DNA, enzymes, lactase, or lactose helped you design your solution" (Student Materials, page 6). In the summary task, students are prompted to "Describe one example from class in which you investigated a new system or structure to reveal how it works or to solve a problem" (Student Materials, page 48).
  - Leptin Resistance 5E: This element is part of a claimed PE in this section. The Elaborate lesson allows students to see a detailed simulation of cellular function, cellular components, and how those cellular components interact/function as associated with insulin production. Students are asked to "Discuss one example of the importance of investigating structures to better understand their function" (Student Materials, page 72). However, there is not evidence that students understand or use the idea that investigations require a detailed examination of the properties of different materials.
  - Circadian Rhythms 5E: This element is part of a claimed PE and is specifically claimed in this section. Students are told "We can think of our bedrooms and everything associated with when we sleep and wake up as a part of this system. In your group, identify the common components of the system, and sketch them out below. In your diagram, include a way to represent how different parts of the system interact." They are then asked to design a solution to the problem of sleep-wake cycles and are prompted to describe: "How examining the different components of the system and their function(s) informed your ideas on which design elements to include" (Student Materials, page 88).
  - Unit Closing: This element is part of a claimed PE in this section. The final design task rubric includes the specification that students describe "and how the concept of

structure and function informed the design" (Student Materials, page 104). However, an example of this is not given so evidence of use of a high school level CCC element was not found. In the Design Rationale section, students are prompted to "Describe the structures (or sub-structures) in your solution. Describe the function in your solution. What is important about the relationship between the structure (or sub-structures) and function in your solution that makes it a successful design?" (Student Materials, page 21). However, this student prompt does not distinguish the performance from the 6–8-level element *Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.*

- *The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.*
    - Lactase Persistence 5E: This element is claimed. Students begin to explore the structure of chromosomes, genes, and DNA in the lesson, and in the Summary Task, students are asked to respond to the prompt "Describe one example from class in which you investigated a new system or structure to reveal how it works or to solve a problem" (Student Materials, page 48). Students therefore use an understanding of the first part of the element.

Suggestions for Improvement

General

- Consider ensuring that the learning goals listed for each 5E sequence are consistent each time they are presented. They are currently communicated in many different ways in different parts of the unit, and those different ways do not currently seem to correspond with one another. Different teachers might notice different learning goal listings and all make different assumptions about the goals.
- Consider clarifying the learning goals to match what students are prompted to do. For example, if the materials only intend for students to engage with part of an element, consider clarifying that only part of that element is the learning goal (e.g., by crossing out, bolding, adding narrative, etc.). Alternately, consider adding opportunities for students to engage with the parts of the elements that are currently not included in the unit (see the purple text in the evidence sections above). In this analysis, it could be helpful to compare between students' expected prior knowledge from the corresponding middle school-level element to ensure the new high school-level proficiencies are developed. For example, to ensure that students have opportunities to use or develop one of the targeted CCC goals, *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects*, it could be helpful to compare side-by-side with the middle school-level CCC element that serves as a foundation for student learning in this unit: *Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation*.

Science and Engineering Practices

Circadian Rhythms 5E: When students are asked "Evaluate the limitations of the survey you designed. Describe how you could improve the survey to provide more accurate data" there is a great opportunity to add prompt details that would allow students to use this **Analyzing and Interpreting Data** element: *Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.*

Crosscutting Concepts

Consider providing students with opportunities to develop explicit understanding of the targeted CCC elements, such that they would be able to apply this understanding later in different contexts.

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and designing solutions to problems. There are at least two occasions in which the materials offer students the opportunity to use three dimensions in service of sense-making. However, a significant portion of the materials do not require student performances that integrate high school-level elements.

Related evidence includes:

- Circadian Rhythms 5E: Students are told "We can think of our bedrooms and everything associated with when we sleep and wake up as a part of this system. In your group, identify the common components of the system, and sketch them out below. In your diagram, include a way to represent how different parts of the system interact." They are then asked to design a solution to the problem of sleep-wake cycles and are prompted to describe: "How examining the different components of the system and their function(s) informed your ideas on which design elements to include" (Student Materials, page 88).
    - SEP: **Constructing Explanations and Designing Solutions**: *Design and evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, ~~prioritized criteria, and tradeoff considerations.~~*

  - CCC: **Structure and Function**: *Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.*
  - DCI: **LS1.A: Structure and Function**: *Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.*
- Common Ancestry 5E: Students are asked to look at patterns in both protein sequences and times of evolutionary divergence of different animals (page 110). They are then asked, "How do the patterns in these data sets help you figure out the phenomenon under investigation?" (Student Materials, page 96). The teacher is also told to "take time for" the key point: "Looking closely at patterns of evolution at different time scales helps us understand the pace of evolution and why our bodies can't (or don't) evolve quickly enough to resolve mismatch diseases because our current environment changed relatively quickly, while the evolution of advantageous traits does not happen at the same pace" (page 113).
  - SEP: **Analyzing and Interpreting Data**: *Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.*
  - CCC: **Patterns**: *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.*
  - DCI: **LS4.C: Adaptation** (prior knowledge from the previous unit): *Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.*

Suggestions for Improvement

- An increase in the number of opportunities for students to use grade-appropriate CCC elements in their sense-making would increase the evidence for this criterion. See suggestions for improvement under Criterion I.B.
- Consider clarifying the current claims of three-dimensional performances. Most of the current claims correspond with student activities that only use one high school-level dimension (DCIs), whereas students may be using parts of elementary-level SEPs and CCCs. It is normal and helpful for students to use this prior learning, but it would be helpful to clarify the expectations for teachers.

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	*Adequate (None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that lessons fit together coherently to target a set of PEs. Students are supported to see how almost all of the different parts of the unit fit together and have opportunities to develop proficiency in most—but not all—of the learning associated with the claimed PEs in the unit.

Related evidence includes:

- The idea of mismatch is a running theme that starts in the unit opener (dairy products in school lunches that some students cannot digest) and carries through all of the 5E sequences.
- The DQB is one feature that houses questions that potentially promote coherence across the 5E lesson sequences. There are several occasions for students to consider questions from the DQB throughout the unit. A typical DQB prompt looks like this: “Prompt students to revisit the DQB and point out questions about obesity, people getting larger, easier access to food, or sedentary lifestyles. Let students know that we will investigate these questions in this learning cycle.”
- Lactase Persistence 5E: Student questions resulting from seeing the experimental results are collected (page 35). Later in the lesson the teacher is told “Show students the map (from Engage) and elevate or point to unanswered questions from the Explore 2 phase and reiterate the question, ‘why are some people able to digest milk into adulthood but others cannot?’ Let students know that they will now make further sense of what they experienced during the Explore 2 in order to answer this question. Prompt students to review their initial DNA/protein model from Explore 1. Provide students with the Non-coding DNA Text and have students annotate the text, highlighting or underlining information that may be useful for refining or revising the DNA/Protein model responding to the guiding question” (page 41). “Remind the class that while they now have a better understanding of why individuals, and even families like Kanna’s, have difficulty digesting dairy, they still have unanswered questions about why whole regions of people are lactose intolerant and why the mutation (that confers lactase persistence) was beneficial and increased in some populations. Let them know that in order to figure out

these unanswered questions, they will be watching a video about lactase" (page 44). This connects to the unit opener about Kanna not being able to digest dairy products from a school cafeteria.

- Leptin Resistance 5E: "Prompt students to revisit the DQB and point out questions about obesity, people getting larger, easier access to food, or sedentary lifestyles. Let students know that we will investigate these questions in this learning cycle" (page 62). This discussion might pull on student questions generated during the Evaluate session of the prior learning cycle (related to easier access to food and sedentary lifestyles), but that section does not guide teachers to facilitate the generation of student questions related to obesity and people getting larger, so students may struggle to make connections between the different 5E sequences. Later in the sequence, teachers are prompted to get students to think about babies, especially baby fat. However, the connection between obesity in general and babies is not necessarily one that teenagers will make, resulting in a potential decrease in coherence.
- Leptin Resistance 5E: The Explain 1 phase begins with "Remind students of the questions they surfaced during the Explore phase and elevate questions specifically about leptin, how it is made, and how it might work in the body. In order to start investigating these questions in more depth, we can first look at where and how leptin is made" (page 67). The Explore 2 phase begins with "Revisit unanswered student questions from the Engage and Explore 1 phases. Students should have a better understanding of how proteins, like leptin, are created and the role leptin plays in regulating fat storage. However, students may still wonder about: The genetic and environmental reasons why some people store excess fat, Why leptin resistance is a problem in some people (but not everyone), Why fat storage is advantageous in some environments but not in others. In order to build on what students figured out in the Explore 1 phase, provide students with the Role of Genetics & Environment Investigation. Students will follow a similar process of engaging with research summaries to investigate what other factors may impact fat storage regulation" (page 69).
- Common Ancestry 5E: Student learning across the unit so far is connected together: "Prompt students to list the different things we've seen so far in this unit that are examples of humans having traits that don't 'match' well to our current environment" (page 107). Students use the group learning routine Rumors to "surface and categorize student ideas about why there are so many examples of mismatch diseases." The teacher guide provides desired student responses and even a set of teacher questions should students not provide the desired questions. The question about mismatches then connects to an investigation with this introduction: "In order to investigate these questions, students will use the NCBI Genetic Database to compare important molecules (or their receptors) to better understand variations in these molecules across different species." The investigation is followed by this prompt in the Explain lesson: "Elevate unanswered student questions from the end of the Explore phase. Prompt students to identify 2-3 of their most important questions." Then, the teacher tells students to read an article that provides the answers. Students therefore are supported to see how the different parts of the lesson fit together.

- Common Ancestry 5E: In the Evaluate phase, students are asked to return to their designs from the previous 5E cycle and to evaluate or test their designs (page 115). However, those designs relate to light/dark cycles so might feel disconnected from the present 5E cycle to students.
- Unit Closing: "Students return to the questions generated throughout the unit and react. What questions have been answered? Are there questions that we still need to investigate?" (page 121).

The following PEs are claimed as learning targets for the unit, but many of them include foundational elements that are not fully developed in the unit. See evidence under Criterion I.B:

- **HS-LS1-1**[3]: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- **HS-LS3-1**[3]: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- **HS-LS3-2**[1]: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- **HS-LS4-1**[3]: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- **HS-ETS1-2**[2]: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- **HS-ETS1-3**[2]: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

[1] This PE is claimed in the Biology Course Guide but not the Teacher Materials, which might lead to confusion.
[2] This PE is claimed in the Teacher Materials but not the Biology Course Guide, which might lead to confusion.
[3]: These PEs are stated as those that will be fully assessed: "At the end of the unit, teachers will have evidence in student work (tasks) related to the elements listed in this table and can therefore make claims at the end of this unit related to student proficiency for all three performance expectations" (page 15).

Suggestions for Improvement

- Consider providing ongoing guidance or prompts for teachers to help them determine whether students are seeing clear connections between the different 5E sequences as the story develops. It could also be helpful to give teachers ideas of ways to adjust their facilitation if students are not seeing the connections as clearly as the materials intend.
- Consider adjusting claims related to the PE targets or providing opportunities for students to fully develop the claimed PEs over the course of the unit.

- In the Evaluate section of the Lactase Persistence 5E, consider adding guidance for the teachers to facilitate student discussion to help ensure that questions are generated related to obesity and people getting larger. This will help connect to the Leptin Resistance 5E that follows.

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. The phenomenon can be addressed entirely within the life sciences domain, so links to other science domains are not needed for sense-making or problem solving. However, students are not supported to see links between science domains using crosscutting concepts.

There are no direct references to physics, chemistry, or Earth and space science. There are six references to *biochemistry*, all of which result from a restatement of a claimed PE (**HS-LS1-1**: *Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells*). The phenomena and problem driving the learning can be fully addressed within high school biology.

Suggestions for Improvement

Consider supporting students to see how their use of CCCs in life sciences in this unit relates to their use of the same CCC element in other domains (e.g., from previous units) in order to emphasize the purpose of CCCs as thinking skills that can be applied across science domains.

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 reviewers found extensive evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics and English language arts (ELA). Connections to CCSS are listed in the unit materials and students have many opportunities to apply ELA and literacy strategies in service of sense-making. However, students have few explicit occasions to use mathematics in the unit, and there are missed opportunities to connect to students' prior learning from middle school-level mathematics.

Ten CCSS for ELA/Literacy are listed in the unit introduction section on pages 15–16. Their inclusion is explained on page 11: "since an aspect of NGSS design is connections to Common Core Math and ELA standards, these connections are highlighted in this section." Connections to individual parts of the unit are described in those individual sections (e.g., page 30), along with various assertions about how the unit supports reading with strategies such as sequence chart, text annotation, text graffiti, and three-level guide.

Students have many opportunities to use ELA/Literacy standards in their science sense-making. For example:

- Many unit routines have potential connection to ELA standards. The ones described in the Course Guide include Anchor phenomenon, DQB, Class Consensus Discussion, Consensus-Building Share, Domino Discover, Ideal Carousel, Read-Generate-Sort-Solve, Rumors, and Think-Talk-Open Exchange. Each of these routines involves language, writing, and discussion, all of which are key features of ELA/Literacy standards.
- Unit Opening: Students analyze a short story, identifying important details in the text. The teacher is then told "Tell students to use those details to compose a paragraph that tells the story of the phenomenon" (page 25).
- Leptin Resistance 5E: "engage students with the literacy strategy, Text Grati. In groups of four, distribute one of the four quotes per student. Students have 1-2 minutes to quietly respond to their first quote by doing the following: Highlight or circle words that they don't understand, Ask a question, Add a thought or idea about the quote, Underline and annotate an interesting idea" (page 62).
- Leptin Resistance 5E: "Ask students to return to their home groups; each pair shares out about their study, using the written summary as a guide. Group members should be taking notes in the space provided as they listen to each summary" (page 65).

- Common Ancestry 5E: "Provide students with the Common Ancestry Text. Have students annotate the text looking for information relevant to their top 2-3 questions" (page 111). Students are therefore supported to see how ELA/Literacy supports their science learning.

Students have missed opportunities to explicitly apply their middle school-level mathematics prior learning. There are no places where calculations of any significance need to take place in order to make sense of a phenomenon. There are a few graphs, in the Leptin sequence (Student Materials, page 48) that show a positive correlation between leptin concentration and body mass and provide students opportunities to apply their prior learning in mathematics. However, students are not supported to discuss these correlations and best fit or to understand how mathematical correlations are needed to make sense of the leptin/body mass relationship.

Suggestions for Improvement

- Consider making explicit references, within the flow of lessons, to times when students need mathematics to make sense of phenomena. In those situations, it would be very helpful to mention the specific mathematics standards that students use, even if they are from prior grade levels (e.g., where students apply their middle school-level mathematics knowledge).
- When possible, consider supporting students to explicitly see how mathematics and science work together synergistically to produce deeper understanding of the world.

OVERALL CATEGORY I SCORE: **2** (0, 1, 2, 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

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

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 Authenticity	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 have many opportunities to connect the phenomena in the unit to their personal lives and community. However, teachers are not explicitly supported to cultivate student questions that come from their experience, community, or culture.

Phenomena used in the unit are authentic and engaging to students, and teachers are supported to make sure the phenomena and scenarios are accessible to all students and to make connections to students' lives and communities. Related evidence includes:

- Students are likely to see that the anchor phenomenon is important and relevant to people, and the focus on obesity in the Leptin Resistance 5E is likely to be similarly authentic and motivating to students.
- "If a teacher feels the anchor phenomenon will not be familiar or accessible to all students, we suggest relating it to similar, more familiar phenomena" (page 4).
- "We do not recommend spending more than two months on this unit, as our field testing showed that six to eight weeks is the maximum amount of time students can stay engaged with the unit-level anchor phenomenon" (page 17).
- Unit Opener: "Prompt students to discuss in pairs what they ate and drank yesterday or today in the school cafeteria for lunch. Have students share different food and drinks, and surface with the class that milk or other dairy products were an option at lunch (even if they didn't consume it themselves)" (page 24).
- Unit Opener: Students are exposed to the anchor phenomenon by reading a story about a new student from Japan who becomes ill after consuming dairy products from the school cafeteria.
- Unit Opener: "Not all students may be familiar with or connect to the concept that a person can't drink milk without getting sick, or even that not all cultures include dairy as a usual lunch time food. Prompt students to think about other types of foods or activities that only some

people (not everyone) have difficulty with or do not partake in because it is not a usual part of their culture. Students may discuss allergies to foods, or cultural/religious/environmental differences or preferences between different countries or geographic locations" (page 25). This could be a way to help teachers anticipate issues associated with students who have different experiences.

- Circadian Rhythms 5E: Students are supported to make connections to their communities: "In groups, propose a survey design using Google Forms that can be given to your classmates and your community….Provide the survey to as many people as possible… How can you design questions that are respectful and can be answered by anyone in your community?" (Student Materials, page 77).

Teachers have support to identify one sensitive topic that might arise during the unit. During the Leptin Resistance 5E, the teacher is told "It's important to stress that fat storage is a trait that evolved because it is advantageous. Conveying the positive and physiological aspects of fat storage is a good way to counteract fat-shaming and insensitive or inappropriate discussion around body weight. Be sure to be sensitive to thoughts from all students on this topic and keep the discussion positive and inclusive" (page 63). However, note that similar supports are not provided related to discussion of students' dietary restrictions that might arise during the unit.

Suggestions for Improvement

- Consider providing prompts or facilitation guidance to help teachers cultivate student questions that come from and make use of their experiences, communities, or cultures.
- In addition to reminding teachers to keep the discussion positive and inclusive during discussion of fat storage, consider providing specific ideas of discussion prompts that would keep the discussion positive and inclusive.
- Consider providing prompts or supports for teachers to attend to issues of student sensitivity during discussions of dietary restrictions or preferences due to cultural, religious, or environmental differences.

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 have many opportunities to clarify ideas, get feedback on ideas, discuss ideas, reflect on ideas, and reason with

ideas. However, note that some references to student ideas in the unit actually refer to times when students are expected to restate ideas they were told in readings or videos.

Students are supported to clarify and discuss their ideas throughout the unit. For example:

- Unit Opening: "Ask students to share their ideas with their group, with every individual identifying the details that they thought were important, then come to an agreement about which details are most important for telling the story of the phenomenon" (page 25).
- Lactase Persistence 5E: Student ideas are collected in response to seeing experimental results. Prompting questions include: "In describing the structure of the components, how do you think they are related to their function (or job)? What do you think is happening in this process, based on the structure and function of the components or parts?" (Student Materials, page 29).
- On the Summary Task at the end of each learning sequence, students are asked to respond to the prompts: "One person who helped me learn today: What did you learn from this person? _ One idea I contributed to my group or class:" (e.g., Student Materials, page 46).
- Leptin Resistance 5E: "Have students identify their most important question, and use the group learning routine Rumors for students to share out their questions. Categorize questions as a class to surface important patterns and questions about fat storage" (page 63).
- Leptin Resistance 5E: "Provide students with the Think-Talk-Open Exchange + Buzzwords Organizer so they can first individually write down their ideas to the guiding prompt…. After students have had an opportunity to individually write a response, group students into triads so they can discuss their ideas using the routine" (page 71). However, note that the ideas students share here might just be what they remember reading in the research articles from the previous activity, rather than their own ideas.
- Leptin Resistance: Students are prompted to write a reflection to the following prompt: "What are some new ideas you heard during your discussion with your group?" (Student Materials, page 70).
- Circadian Rhythms 5E: "In your groups, brainstorm what you would like to know about human day-night cycles and what factors might influence how long they sleep or how long they are awake in a 24-hour period" (Student Materials, page 77).
- Circadian Rhythms 5E: Teachers are told to "Prompt triads to generate a poster that best represents their ideas on the guiding question." However, directly before this activity, students watch a video, read an article, and watch a podcast that tells them the answers to the guiding question. Therefore, note that the ideas elicited are not likely to be students' own original ideas, but rather a reporting of what was in the mandatory reference material they just processed.

Students are supported to reflect on how their ideas change over time during the unit. For example:

- Lactase Persistence 5E: "Ask students, in light of the text, 'is there anything you'd change in your model of the two people on Making Sense of Dairy Investigation?' Ask students to share their responses with their group" (page 37).
- Unit Closing: "Prompt students to identify how their thinking has changed on the work of engineers and how an iterative design process can be used to solve societal problems" (page 123).

Students have opportunities to receive and apply feedback from both the teacher and their peers. However, most prompts are for either peer or self-assessment, so peer assessment might not occur much in classrooms. Related evidence includes:

- Lactase Persistence 5E: "Provide students with the Dairy Investigation Rubric. Ask students to use the investigation rubric to self and peer assess their progress on engaging with the investigation individually and as a group" (page 36). Although the Partner Rubric (Student Materials, page 32) is a valuable tool, peer assessment in this rubric is not related to student thinking or performance of learning goals. It therefore does not provide evidence related to the EQuIP rubric. The same comments apply to the DNA Comparison Investigation Rubric (Student Materials, pages 41–42).
- Lactase Persistence 5E: "Once students have completed an initial draft of their scientific explanation, have students use the CER Rubric to peer or self-assess their work. After students assess their models, provide time for them to revise their work" (page 42).
- Leptin Resistance 5E: "After completing their response, use the Leptin Resistance Engineering Mini-Rubric as self, peer, or teacher feedback on their initial design ideas" (page 77).
- Circadian Rhythm 5E: "After students complete their responses, use the Circadian Rhythms Engineering Mini-Rubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 101).
- Common Ancestry 5E: "After completing their responses, have students use the Common Ancestry Engineering Mini-Rubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 115).
- Unit Closing: "Provide students with the Final Design Task, the Final Design Rubric, and the opportunity to review all of the initial designs and associated feedback from throughout the unit" (page 122). Students therefore have an opportunity to apply the feedback they received on their design thinking.
- Unit Closing: "Use the Final Design Rubric to provide feedback as students are working" (page 123).

Suggestions for Improvement

- Consider distinguishing between times when students' own thinking is required and elicited versus when students are expected to remember facts that they have learned.
- Consider clarifying expectations related to peer assessment and prompting peer assessment other than as an alternative to self-assessment.

II.C. BUILDING PROGRESSIONS

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials identify and build on students' prior learning in all three dimensions because prior learning is described for all three dimensions, expected student learning during the unit is described, and a stated activity during which that learning is meant to occur is described for at least one element of each of the three dimensions. Together these data points can serve as learning progressions for those elements. However, this information is not available for all learning targets.

Prior learning for all three dimensions is described at the element level and expected student learning during the unit is described. Listed below are all instances of related evidence for SEPs and CCCs, and selected examples for DCIs:

- SEP: "This unit was intentionally designed to build on the second unit of this course, Humans vs Bacteria, in which students evaluate possible solutions to a global problem (avoiding global infectious disease outbreaks) and develop a scientific argument on the best possible solution. In The Evolution of Sick Humans, students continue to engage with developing solutions to a global problem using the design cycle to optimize a design solution" (page 3).
- SEP: "Students in middle school have previous experience outlining the criteria and constraints of successful solutions to a problem….In this unit, students investigate the societal problem of a mismatch between the evolutionary history of our bodies and our current environment, breaking the problem down into several subproblems that may be addressed through engineering design. Students evaluate possible solutions using limitations, criteria, and constraints in order to iteratively optimize a design solution" (page 12). "As it's likely the first time they are using this SEP at high school level, teachers need to gauge student proficiency early on and allow for paired and group-level initial designs" (page 14).
- SEP: "In middle school, students have previous experience critically reading scientific texts and communicating information in writing and oral presentations….This unit builds on the practice of Obtaining, Evaluating, and Communicating Information through scaffolded engagement with scientific literature, both written and graphical, and in communicating their ideas in multiple

formats" (page 13). Note that this idea is not listed in any of the unit "student ideas" sections (see below).

- DCI: "In middle school, students learn the basic organization of life and that all organisms are made up of cells. In high school, they examine how systems of specialized cells perform the basic functions of life. In this unit, students investigate how a series of important proteins and other biological molecules secreted from specialized cells interact with receptor molecules to initiate and regulate key life processes such as lactase digestion and energy storage" (page 13).
- DCI: "Students in middle school learn that genes determine proteins which determine traits in an individual….This unit supports students in developing a more complex understanding of the structure and function of DNA and how the expression of some genes may be impacted by the environment" (page 13).
- DCI: "Although feedback mechanisms are not a part of the PE bundle for this unit, this may be a good opportunity to review LS1.A that was addressed in Unit 1" (page 68).
- CCC: "Students in middle school learn that relationships may be causal or correlational and that correlation does not always imply causation. This unit builds on this understanding by engaging students in multiple opportunities to evaluate possible causal relationships using empirical evidence" (page 13). Note that this idea is not listed in any of the unit "student ideas" sections (see below).
- CCC: "Students in middle school analyze many complex natural and designed structures and systems to determine how they function…This unit engages students in considering the components of a school and the interrelationships between those structures and components to solve the problem of a mismatch between how our bodies work and our current environment" (page 13).

The statements above of what student learning will occur during the unit do not include progression information identified in the context of specific lessons. Specific waypoints of learning related to specific lessons are described for the targeted science DCIs in the lessons through listing of ideas that are developed during each part of the unit. However, although science DCI progressions are described in this way, only one idea related to an SEP and one idea related to a CCC are listed in these "student ideas" sections, indicating either that the other SEP and CCC elements from the targeted PEs for the units are not learning goals or that busy teachers will need to 1) figure out where this learning is meant to occur and 2) apply appropriate teacher moves to leverage the progression for enhanced learning. The SEP and CCC elements listed in the lesson-level progressions listings are:

- For SEPs:
  - Unit Opening and Unit Closing: One of the ideas listed that "students figure out" in this section of the unit is: "We may be able to design or manipulate our environment so that we can alleviate some of the mismatch diseases that cause suffering" (pages 5 and 10).
- For CCCs:
  - Lactase Persistence 5E and Unit Closing: One of the ideas listed that "students figure out" in this section of the unit is "Examining the component parts can help us understand the importance of shape in the functioning of enzymes and other biological molecules (lock and key model of enzyme function)" (pages 6 and 10).

These kinds of learning waypoints are also not listed for the ETS DCIs.

Leptin Resistance 5E: The teacher is told that **"**it may be challenging for students to differentiate between correlation and causation, and to identify what data or evidence they would need to make claims about causality" (page 73). They are given a video that "may be helpful in leading a conversation on this topic." However, the content of the video only supports student understanding of a middle school-level CCC element, but the teacher is not told that the video content is at the middle school level. Treating this review subject as new learning may make the learning sequence therefore less logical for students.

Suggestions for Improvement

For all elements that are intended learning targets, consider providing clear progressions information that shows when and how students are expected to build their understanding in each of the three dimensions.

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. Almost all scientific information in the unit was found to be accurate and grade appropriate. Only one minor inaccuracy and one misleading word choice were found:

- Unit Front Matter: Immediately under the table of contents it says, "This rapid change has contributed to many of the chronic health concerns modern people face. In this unit, students will explore the possible '*mismatch*' between human bodies and modern environments by investigating phenomena at the protein level." The term mismatch potentially conveys to students something non-positive about evolution since the term mismatch is rarely used as a positive thing in everyday language. Similarly, the unit title seems to suggest that only *sick* humans evolve and/or that evolution only operates on sick humans, whereas the evolutionary process does not distinguish organisms as sick or not sick. They either adapt or do not. The word "sick" has a potential moral overlay to it, suggesting that somehow evolution has a moral compass, selecting against sick people and for non-sick people. Sickle cell anemia is a selective

advantage in regions of high malaria occurrence, yet it could very well be considered as a "sickness"—something bad.

- Unit Opening: The Unit opening says, "All mammals can digest milk as infants, but modern humans are the only species that drink milk into adulthood." However, some adult animals of other species can drink milk.

Suggestions for Improvement

Consider using a word other than "mismatch" for the unit. The concept seems to be that evolution takes time. Species adapt to selective pressures, but not instantaneously. There is a time lag between a new or imposed selective pressure and the evolutionary manifestation. Perhaps "time lag" could fit into the description in some way.

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities that are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.

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	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction. General supports are provided for 1) multi-lingual learners, 2) learners who read well below grade level, 3) struggling students, and 4) students who have already met the PEs but supports related to students' CCC use are not included.

Supports are provided to help teachers differentiate learning for all students. For example:

- The Biology Course Guide describes the supports available on an "Equal Access for All Learners Framework" website, https://curriculum.newvisions.org/access/. This includes support for modifying assessments, modifying pacing, guidance for differentiated access points to learning, and modifying lessons for IEPs. However, these resources are not referenced during the lessons where they might commonly be needed.

- Classroom supports are indicated by an icon that is shown in the course guide (pages 9–10). The course guide says, "These are additional guidelines to support teachers with the facilitation of whole-class activities that utilize classroom resources such as posters, charts or notes on a physical or virtual white board." The use of posters, charts, and white boards represents multimodal instruction that accommodates students with different learning personalities.
- Leptin Resistance 5E: In the Engage section, a Classroom Support icon box says, "Print each quotation on separate large pieces of paper (11x14 or posters), so that students have adequate space to annotate in the margins." Placing quotations on a big poster can help students with vision impairment. Providing adequate space for annotation can help students who struggle with space limitations associated with notebook paper.

Supports are providing throughout the unit for students who struggle. Related evidence includes:

- Unit Opening: "If students are struggling, provide example questions or combine all of the questions generated across all classes to categorize into a few different categories of questions" (page 27).
- Lactase Persistence 5E: "If students need more information to make sense of the model, provide them with *Detailed Lock-and-Key Diagram*" (page 36).
- Lactase Persistence 5E: "If students struggle with attempting the model or have gaps in understanding from middle school, provide the DNA Reference Sheet (this scaffold can be used throughout the unit as needed)" (page 39).
- Lactase Persistence 5E: "Students may have trouble visualizing changes in society over the past 100 or 10,000 years — use the Visuals for Mismatch Hypothesis resources to support students in surfacing these ideas" (page 47).
- Leptin Resistance 5E: "If students need more time to make sense of the animations, allow them to watch them several times with the sound on. Additionally, students can follow along with the transcript that is provided below each animation" (page 67).
- Leptin Resistance 5E: "If students need additional support in writing an explanation, provide students with a CER organizer and CER rubric" (page 72).
- Circadian Rhythms 5E: "If students need support designing a form, provide the Example Sleep Questionnaire to get them started" (page 94).
- Common Ancestry 5E: "Students may struggle to visualize how embryo structure can be used to understand evolutionary relationships. Use this Guess the Embryo Matching Game to engage students in comparing embryos of different organisms" (page 111).
- Common Ancestry 5E: "If needed, continue to provide the CER Organizer and CER Rubric as scaffolds" (page 112).

Some supports are provided for students who read below grade level:

- Lactase Persistence 5E: "For students who need additional support with the Digesting Dairy text, use the Lactose Digestion in Infants video and Lactose Digestion in Infants - Transcript to supplement the text" (page 37).
- Leptin Resistance 5E: A reading scaffold is given for all students and a teacher note says "If students are reading at or above grade level, you may decide not to use the Text Graffiti scaffold

to engage students in the text. Alternatively, provide the guiding question in advance, and prompt students to predict what information related to the prompt may be in the text before reading" (page 63).

Some extensions are provided for students with high interest or who have already met the PEs, but most of these extensions focus exclusively on deepening students' DCI-related understanding. A few extensions support deepening SEP understanding, and none explicitly supports CCC-related understanding. Related evidence includes:

- Lactase Persistence 5E: "For students who are ready for additional data analysis: Using the data on pg. 9 of the article Patterns in the Distribution of Lactase Persistence have students calculate the frequency of lactose persistence (can drink milk) in multiple populations around the world. Then they can color code their own frequency map using a Labeled World Map and predetermined ranges for high, medium, and low frequency. Surface patterns and have the students generate questions about this investigative phenomenon (using the See-Think-Wonder)" (page 33).
- Lactase Persistence 5E: "For students with interest in this phenomenon or have met or exceeded the standard, provide the optional text, Cryptic DNA sequences may help cells survive starvation" (page 43).
- Leptin Resistance 5E: "Depending on student interest and readiness, provide students with the full scientific article to read or read portions of Serum Leptin Concentration Positively Correlates with Body Weight and Total Fat Mass in Postmenopausal Japanese Women with Osteoarthritis of the Knee and Fructose-induced leptin resistance exacerbates weight gain in response to subsequent high-fat feeding; additionally group students intentionally as the data in Fructose-induced leptin resistance exacerbates weight gain in response to subsequent high-fat feeding is the most complex" (page 65).
- Leptin Resistance 5E: "Depending on student interest and readiness, provide students with the full scientific article to read or read portions of Genetic Influences on Child Eating Behavior and The Global Childhood Obesity Epidemic and the association between socio-economic status and childhood obesity" (page 70).
- Leptin Resistance 5E: "Based on student interest and readiness, they may want to explore more about leptin and how scientists discovered the function of this protein. Prompt students to watch the optional video - How the Hormone Leptin Helps Regulate Appetite, and add new ideas to their explanation" (page 73).
- Circadian Rhythms 5E: "Depending on readiness and interest, students could use the online journal article, Tracking Rhythms in Plants, to read and analyze advanced data on plant day-night cycles" (page 94).
- Common Ancestry 5E: "Depending on student interest and readiness, provide students time to pose questions and explore the database" (page 109).

Suggestions for Improvement

- Consider referencing the "Equal Access for All Learners Framework" website during the lesson activities where it might have helpful related information, to ensure that teachers are reminded of the supports available to them at the point of use.
- Consider providing supports to ensure all students can build their understanding of CCCs, in addition to the supports already provided for SEPs and DCIs.
- Consider occasionally providing alternative individual activities for students who might not learn as well through group routines, which are currently used frequently for sense-making.

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 reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time because frequent guidance is provided to support teachers in linking student engagement across lessons. In addition, support is provided to help students figure out which of their questions are left unanswered and which are being answered in the next investigation.

The teacher is supported to understand the unit storyline. For example:

- In the Biology Course Guide, the teacher is encouraged to map the unit themselves and to complete student performance tasks before teaching the unit for the first time, therefore building an understanding of the unit storyline (Biology Course Guide, page 10).
- The teacher is given an overview of driving questions across the unit, including for each 5E sequence.
- A Storyline and Pacing Guide is provided to the teacher, describing an overview of what students do and what they figure out in each part of the unit. The overarching storyline is represented as a series of puzzle pieces that fit together slowly as the unit progresses. The primary question to be addressed in each lesson sequence is matched to various degrees of puzzle completion. This visual metaphor could help teachers envision a coherent storyline across the unit.

Teachers are provided with prompts throughout the unit to help students understand connections between the lessons. However, teachers are not often supported with ways to adjust facilitation prompts if student discussion does not produce the planned questions and ideas. For example:

- Circadian Rhythms 5E: This sequence begins (Engage lesson) by stating the overall sequence question, "Why do virtually all organisms have a day-night cycle?" This question is followed by another teacher directed question at the beginning of the Engage lessons, "Why do virtually all organisms have a day-night cycle?" The teacher is supposed to "*surface*" question from the DQB, which contains information from previous 5E sequences. The teacher questioning continues to elicit what students think could be done to investigate the stated questions. Idealized answers are provided. However, no teacher guidance is provided for when things don't go as planned and students do not provide the answers the teacher guides say are expected.
- Lactase Persistence 5E: In the Evaluate lesson, instructions tell the teacher, "Remind students of all the ideas they surfaced about how our environments have changed and how these changes may lead to mismatches (such as milk being served in the cafeteria). Display the list for all students to see. At this point, students should have a lot of new questions!" This teacher action links student ideas from the previous lesson to this new lesson, an example of teacher support for coherence. However, support is not provided about what to do if students do not have new questions.

Students are supported to see how their learning in the three dimensions connects to the unit storyline and to their sense-making. For example:

- At the end of each 5E sequence (e.g., Student Materials, page 74) students revisit the same Engineering Mini-Rubric that describes DCI and SEP ideas (CCC categories are listed but the ideas from the CCCs are not included), so the students explicitly see how the DCI and SEP ideas connect to what they were working on.
- Lactase Persistence 5E: Students are asked to self-score based on the prompt "I know how this investigation connects to our current unit" (Student Materials, page 31).
- Lactase Persistence 5E: Students are prompted to "Describe one example from class in which examining the structure of something helped you understand its function" (Student Materials, page 47).
- Circadian Rhythms 5E: "In the survey data, was there one variable that appeared to cause sleep disruption? What additional evidence would you need to collect to differentiate causality and correlation between sleep disruption and that specific variable?" (Student Materials, page 80).
- Circadian Rhythms 5E: "What are the science concepts that you figured out in this learning sequence that may help you create a design to address the problem and sub-problems?" (Student Materials, page 87).

Suggestions for Improvement

Consider adding guidance to help teachers facilitate student conversation if it does not go exactly as written (e.g., if students do not pose the same questions as those suggested in the materials).

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 adjust supports over time. Although explicit scaffolding strategies are not provided to teachers, the unit specifies that it only intends for students to develop two focal SEP elements, and there is evidence that each of those elements is developed. Students are supported to become more independent in using the elements during the unit. However, these elements are not fully developed to the claimed, high school level. Related evidence includes:

- *Design and evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.*
    - Teacher Background: **"**Also in service of helping students develop this SEP at the high school level, there is a progression of support in their use of the design process, with iterative opportunities to articulate problems, develop criteria and constraints, and evaluate possible design solutions. It is therefore the implications of these expected progressions that students might be unable to proficiently use this SEP at high school level early in the unit, but that they are able by the end of the unit" (page 14).
    - Lactase Persistence 5E: Students are introduced to a problem to solve and are asked "what they think they need to know" to help solve the problem (page 48) but they do not design a solution during this section of the unit.
    - Leptin Resistance 5E: Students begin thinking about a solution to a problem: "Brainstorm solutions (What can we do about it to improve our schools?) Brainstorm is specifically addressing the obesity problem… What are the constraints when thinking about these solutions? Generate a list of three or more realistic criteria and two or more constraints, including such relevant factors as cost, safety, environmental concerns, and aesthetics that specify an acceptable solution to a complex real-world problem. Provide students with some examples of limitations and constraints" (page 76).
    - Circadian Rhythms 5E: Students are asked to "Identify solutions. Brainstorm design elements that would be a part of your prototype design. As a group, identify 1-2 design elements that address the problem and subproblems, and satisfy the constraints and criteria. An optimal design element is high-leverage, meaning that it addresses more than one subproblem at a time. For each design element, provide a rationale that includes: How the science concepts you figured out in this learning sequence inform the decision to include that element" (Student Materials, page 88). "After students complete their responses, use the Circadian Rhythms Circadian Rhythms Engineering

MiniRubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 101). Students therefore give general feedback, but prompts related to prioritized criteria and tradeoff considerations are not included.

- Common Ancestry 5E: "Encourage students to suggest ways in which they could evaluate or test their initial design. If needed, remind students that they created a survey in the 2nd learning cycle that could be used to gather data on the elements of their design or to optimize their design" (page 115). Students therefore continue to design their solutions related to light/dark cycles in bedrooms.
- Unit Closing: Students are asked to create and evaluate final designs, and a design evaluation rubric is provided to students, including the following criteria: "The evaluation is clear and complete. It fully addresses the following components: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design" (Student Materials, page 104).
- Students are not supported to consider prioritized criteria or tradeoff considerations in the unit.

- *Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*
  - Lactase Persistence 5E: The teacher is told "Have students use evidence from both investigations and models presented in this learning sequence and appropriate scientific reasoning to construct a scientific explanation in response to the guiding prompt: Why are some people able to digest milk into adulthood but others cannot? How do some people have this ability?" (page 41). A CER rubric is provided for student explanations (Student Materials, pages 44–45), but the rubric is not specific to this element versus similar middle school-level elements. For example, a "variety of sources" is not part of the criteria.
  - Leptin Resistance 5E: Students are prompted: "Using evidence and scientific reasoning from this learning sequence, construct an explanation for why some populations of people might be experiencing an increase in excess fat storage (obesity)" (Student Materials, page 69). The teacher is told "If students need additional support in writing an explanation, provide students with a CER organizer and CER rubric" (page 72). Therefore, the CER supports are optional at this stage rather than provided to all students. Students act more independently to write explanations, although these explanations are likely at the middle school level.
  - Common Ancestry 5E: Students are asked to "Construct a scientific explanation using evidence and scientific reasoning from the unit that explains the phenomenon under study: Why do we have mismatches between our genes (and traits) and our current environment?" (page 111). The teacher is told "If needed, continue to provide the CER Organizer and CER Rubric as scaffolds" (page 112). Therefore, the teacher is prompted to only provide the CER supports for struggling students rather than for all students.

Students are expected to independently write explanations, although these explanations are likely at the middle school level.

Suggestions for Improvement

- Consider providing opportunities for students to fully develop all of the parts of the claimed SEP elements, or consider adjusting the claims to match what students are supported to learn.
- Consider making scaffolding and reduced scaffolding steps more explicit for teachers so they can make adjustments if necessary to support students' learning trajectories.

OVERALL CATEGORY II SCORE: 3 (0, 1, 2, 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

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

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	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena and design solutions. However, students have few individual-level opportunities to show evidence of their use of high school-level CCCs together with other elements, and teachers have little support to find evidence of student performance of most targeted SEP and CCC elements.

Related evidence includes:

- When describing the assessment system, the materials state that "we believe that the formative assessment tasks embedded in the materials (such as the Looks and Listen For notes, the Explore phase summaries, and the modeling done in the Evaluate phases), along with the Performance Task can serve as sufficient evidence of what students know and can do" (page 15).
- Teachers are told "In the performance task, students have the choice to use one of those crosscutting concepts in their response. Therefore, tailor assessment to the crosscutting concept that students use to better understand and respond to the task" (page 76). However, guidance is only provided related to some specific high school-level elements of the CCC that students might use, and information about what those might look like in a performance is not provided. There is only evidence that students will be assessed on a portion of the targeted CCC elements in the task. There is also no reference to what teachers should look for as evidence for three-dimensional learning, making it difficult for teachers to monitor it.
- Teachers are told "The unit-level Performance Task only targets a subset of three-dimensional learning goals informed by the bundled PEs for the unit. All other evidence of learning related to the other dimensions/elements in the PEs can be found within the instructional sequences." However, support is not provided about where (within a 5E sequence) to look for evidence of learning related to the other elements, as these elements often do not correspond to the stated three-dimensional performance that is color coded at the beginning of each section of the 5E sequence.
- Students have many opportunities to use two dimensions (SEPs and DCIs) together in group activities to demonstrate learning, although not for all targeted SEPs (see evidence under the SEP section of Criterion I.B). Students also have one opportunity to demonstrate individual-level evidence of three-dimensional learning. In the Circadian Rhythms 5E: Students are asked to design a solution to the problem of sleep-wake cycles and are prompted to describe: "How

examining the different components of the system and their function(s) informed your ideas on which design elements to include" (Student Materials, page 88). In this task, students use the following three dimensions:

- SEP: **Constructing Explanations and Designing Solutions**: *Design and evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, ~~prioritized criteria, and tradeoff considerations.~~*
- CCC: **Structure and Function**: *Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.*
- DCI: **LS1.A: Structure and Function**: *Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.*

Suggestions for Improvement

- Consider pointing out to teachers where students are intended to show evidence of learning in multiple dimensions, and which elements are meant to be used where.
- An increase in the number of opportunities for students to use grade-appropriate CCC elements in their sense-making would increase the evidence for this criterion. See suggestions for improvement under Criterion I.B.

III.B. FORMATIVE	
Embeds formative assessment processes throughout that evaluate student learning to inform instruction.	
Rating for Criterion III.B. Formative	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction. The unit includes many formative assessment opportunities, but little guidance is provided related to modifying instruction based on different levels of student performance in each of the three dimensions.

The Front Matter of the teacher materials mentions four places in which formative assessments are systematically embedded in the materials: 1) Look and Listen For call-out boxes, 2) Explore phrase summaries, 3) modeling done in the Evaluates, and 4) Performance Tasks. The "Look and Listen For" boxes only describe exemplar answers that are primarily DCI related. Formative assessment supports are not provided (e.g., what to do if student answers are not exemplary). Performance tasks in the

Evaluate sections of the unit provide prompts such as "remind," "facilitate," "surface their understandings," and "point out." These prompts can result in formative assessment data, but support is not provided for adjusting instruction depending on students' levels of understanding of each of the three dimensions. Related evidence includes:

- Suggestions are provided throughout the unit for addressing some needs of struggling students (see related evidence under EQuIP Criterion II.E). However, these suggestions are not related to students' CCC performance.
- Lactase Persistence 5E: "This routine is an opportunity to surface student thinking to the whole class and the teacher. It allows students to learn from each other and for the teacher to assess whether the class is ready to move to the next phase of instruction. Refer to the Course Guide for support with this routine" (page 33).
- Lactase Persistence 5E: Students are asked to construct explanations and the teacher is told "Provide the CER Organizer as a scaffold to students who need additional support" (page 42).
- Lactase Persistence 5E: Students are provided with an Engineering Mini-Rubric even before they begin their problem solving—this allows them to understand what they are building toward (Student Materials, page 49).
- Leptin Resistance 5E: "Students individually complete the Summary Task. This can be completed as an exit ticket or for homework. The results of this task can be used to make determinations about which students need more time to engage in sensemaking about how proteins are created and do the work of the body. This summary is really important! It's an opportunity to check in on each student's thinking at this point in the unit in a few different areas: 1) understanding how they are using the three dimensions, including the relationship between DNA, genes, proteins, and traits to make sense of a phenomenon, 2) ideas about how they and their peers are building knowledge together, and 3) how they think the class consensus discussion went. It's important to get all of this from individual students so you know these things on a student-by-student basis" (page 73).
- Unit Closing: "Provide students with the Argument Evaluation to complete individually" (page 123). However, this document was not found in the unit materials.

Suggestions for Improvement

At key learning points for each of the targeted elements of the three dimensions, consider providing guidance to teachers about how to adjust instruction depending on different levels of student proficiency. For example, if a student has not shown the expected level of performance with a CCC element, consider providing guidance that would support that student's CCC-related learning.

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	*Inadequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found inadequate evidence that the materials include an aligned rubric and scoring guidelines that help the educator interpret student performance. Assessment targets (specifying the element level of each of the three dimensions) are not listed for student assessment opportunities, and guidance is not provided to help teachers interpret different levels of student performance for most learning targets in the unit.

Related evidence includes:

- Suggestions are provided throughout the unit for addressing some needs of struggling students (see related evidence under EQuIP Criterion II.E). However, these suggestions do not include guidance for what teachers should look for to determine whether students would benefit from these extra supports.
- Lactase Persistence 5E: Students are asked to construct explanations, and a CER rubric is provided for both self- and peer assessment (Student Materials, pages 44–45). However, the rubric is not specific to a high school-level SEP element versus similar middle school-level elements. For example, a "variety of sources" is not part of the criteria.
- An Engineering Mini-Rubric is given to students many times during the unit. It includes features related to all three dimensions, but the CCC dimension is sometimes only referred to with CCC category words (e.g., "**Cause and Effect**") rather than grade-appropriate CCC ideas (one exception was found: in the Leptin Resistance mini-rubric, grade-appropriate **Cause and Effect** element wording is used) (Student Materials, page 76). In addition, most of the rubric language is not student friendly. For example, one rubric bullet point says to evaluate the explanation with the following criteria: "An initial description of the design cycle includes: 1) Identifying the problem & subproblem(s), 2) Brainstorming solutions, 3) Using science concepts and/or research to inform the initial solution, 4) Identifying appropriate criteria and constraints." This seems to be a listing of selected NGSS/Framework phrasings rather than wordings that would help students understand what to do. Similarly, another performance indicator says, "Includes an explanation of some science concepts that link evidence to the claim, but are insufficient (one or more concepts that should have been included are not included) or some are inappropriate and how the concept of structure and function informed the design is addressed but insufficient."
- Unit Closing: "Provide students with the Argument Evaluation to complete individually" (page 123). However, this document was not found in the unit materials.

- Student work samples are not included in the unit, including for the final design challenge. However, written examples of the different rubric components are included for both teacher and students. For example: "An example of a design element that appropriately addresses at least 2 subproblems is planning a rooftop garden that students would work in" (Student Materials, page 103).

Suggestions for Improvement

- Consider adjusting rubrics to ensure that high school-level elements of all three dimensions are described. Since students have some choice of CCC category, example rubric guidance could be described for specific elements that students might choose. Currently, rubrics include only mentions of category-level (e.g., "**Cause & Effect**") descriptors.
- Consider either providing rubrics in student-friendly language or providing guidance for the teacher to work with the students to write the rubrics during the unit.
- Consider providing various examples of students' design challenge work products to help teachers understand the level of performance expected of students.
- Consider providing answer keys to handouts and prompts given to students.
- Consider providing guidance about specific assessment targets (e.g., if only part of an element is targeted in an activity) and features of student performances that teachers could look for during key learning moments in the unit.

III.D. UNBIASED TASK/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. Vocabulary and examples in the unit are generally grade appropriate, student prompts are presented in more than one modality, and students have the opportunity to make some choices in the modality and content of their assessments.

Related evidence includes:

- Tasks are generally communicated both from the teacher (orally) and in the Student Materials (in written form).
- Unit Opener: There is support for helping all students understand the context of the unit: "Not all students may be familiar with or connect to the concept that a person can't drink milk

without getting sick, or even that not all cultures include dairy as a usual lunch time food. Prompt students to think about other types of foods or activities that only some people (not everyone) have difficulty with or do not partake in because it is not a usual part of their culture. Students may discuss allergies to foods, or cultural/religious/environmental differences or preferences between different countries or geographic locations" (page 25).

- Circadian Rhythm 5E: "Use the group learning routine Idea Carousel to surface the thinking in the room. Prompt triads to generate a poster that best represents their ideas on the guiding question, using the CCC of Cause and Effect as a lens to explain their ideas. Students have a choice of how they visually represent their ideas but the following could be appropriate formats: cause & effect chart, flow chart, graphs, and annotated diagrams" (page 97).
- Performance Task: "In the performance task, students have the choice to use one of those crosscutting concepts in their response. Therefore, tailor assessment to the crosscutting concept that students use to better understand and respond to the task" (page 76).
- Students have the following modalities with which to learn and express their learning during the unit: watching animations, interpretating maps, watching videos, interpreting diagrams, individual work, group work, making charts, making sketches, discussions, reflections, using simulations, filling out handouts, reading articles, writing answers to guiding questions, and using self-evaluations (rubrics).

Suggestions for Improvement

- It could be helpful to provide guidance to teachers who may not know what different forms of bias look like. Consider giving teachers examples of bias to help them guard against modality bias, pacing bias, expectation bias, etc.
- Some of the vocabulary related to instructional moves (not content) used in the teacher guide might not be familiar to all teachers or students. Consider simplifying vocabulary in prompts to ensure that teachers and students do not need to understand jargon in order to support student learning effectively. For example, consider the following phrasing replacements, especially in instructions that teachers are meant to give students verbatim:
    - brainstorm: come up with ideas without worrying if they are correct or incorrect.
    - prompt: get students to begin thinking in a particular direction or begin leading their thinking.
    - identify: make explicit reference to.
    - consider: think how the "thing" we're talking about does or does not make sense in this moment.
    - revisit: thinking about something for a second or third time, but based on new information.
    - clarify: say, write, or sketch what you think well enough for a classmate to repeat the intended idea.
    - explore: do things that help you find out more.
    - engage: get started experiencing the thing you're supposed to learn about.
    - generate: come up with something own your own, but from the "stuff" you just covered.

- surface: turn your thoughts into something concrete like a sketch, written sentence, or sentence that you speak.
- emerge: find the new "thing" you are supposed to find and get ready to speak it, write it, or draw it.

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	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include a coherent assessment system that assesses three-dimensional learning because some supports are provided for self-, formative, and summative assessment, but pre-assessment is not explicitly included. Although element-level assessment targets are not listed, assessments generally require students to use at least two high school-level elements to make sense of phenomena or solve a problem.

Teachers are provided with information about the assessment system in the unit. For example:

- "The Teacher Materials for each 5E instructional sequence includes a matrix that lists which student artifacts can provide evidence of student learning for each of three-dimensional learning goals from that sequence. Each 5E addresses the integration of the three dimensions across the activities. Please keep in mind that Explore/Explain phases in the matrix should be looked at together as a continuous experience to assess the foregrounded three-dimensional learning goals across the two phases" (page 14).
- The unit introduction Assessment section (pages 14–15) includes a table in which SEP, DCI, and CCC categories are listed with indications for in which section of the unit they are assessed. Individual elements of these categories are not listed.
- "To support assessment throughout the unit, rubrics have been included in the Student Materials to support the Evaluate phase in every 5E instructional sequence. Teachers should customize these rubrics to support their schools' grading systems" (page 15).

Self-assessment opportunities are included in the unit. For example:

- Students have several opportunities for self-assessment of their overall learning and contributions. For example, in the Lactase Persistence 5E: "Provide students with the Dairy Investigation Rubric. Ask students to use the investigation rubric to self and peer assess their

progress on engaging with the investigation individually and as a group" (page 36). The self-assessment rubric includes the following prompts: "I know how this investigation connects to our current unit" and "I was able to contribute to the See-Think-Wonder and respond to the evaluation questions." There is also a prompt that provides useful feedback for the teacher: "What other resources could you have used to get more out of this investigation? More time More resources…." (Student Materials, page 31). However, many of these rubrics do not provide self-assessment opportunities on specific learning goals. An exception is the Engineering Mini-Rubric, which includes DCI- and SEP-specific information (as well as calls for inclusion of CCCs without CCC rubric details): "After completing their response, use the Leptin Resistance Engineering Mini-Rubric as self, peer, or teacher feedback on their initial design ideas" (page 77).

- Unit Closing: "Provide students with the Argument Evaluation to complete individually" (page 123). However, this document was not found in the unit materials.

Formative assessment opportunities are included in the unit. See evidence under EQuIP Criterion III.B for more details.

Summative assessment opportunities are included in the unit. For example, the teacher is told "The Unit 3 Performance Task also includes a rubric, and the task can be considered a final summative assessment for the unit. We have not included a traditional 'unit test' in our materials. Teachers may opt to create their final exam using their states' previous exam questions, however we believe that the formative assessment tasks embedded in the materials (such as the Looks and Listen For notes, the Explore phase summaries, and the modeling done in the Evaluate phases), along with the Performance Task can serve as sufficient evidence of what students know and can do" (page 15). Teachers are told "In the performance task, students have the choice to use one of those crosscutting concepts in their response. Therefore, tailor assessment to the crosscutting concept that students use to better understand and respond to the task" (page 76). However, guidance related to specific high school-level elements of the CCC that students might use (and what those might look like in a performance) is not provided, so there isn't evidence that students will be assessed on grade-appropriate CCCs in the task.

Suggestions for Improvement

- Consider providing element-level assessment targets for the major assessments in the unit.
- Consider providing guidance related to possible pre-assessments that could provide teachers with understanding of where students are starting from.

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	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCCs. Students have opportunities to receive both written and oral feedback from the teacher and peers on their performance of both DCIs and SEPs. However, students do not have explicit opportunities to receive and react to feedback related to CCCs, and the rubrics students use for self-assessment are not written in student-friendly language (see related evidence under EQuIP Criterion III.C).

Related evidence includes:

- Lactase Persistence 5E: "Once students have completed an initial draft of their scientific explanation, have students use the CER Rubric to peer or self-assess their work. After students assess their models, provide time for them to revise their work" (page 42).
- Leptin Resistance 5E: "After completing their response, use the Leptin Resistance Engineering Mini-Rubric as self, peer, or teacher feedback on their initial design ideas" (page 77). This rubric includes details of DCI and SEP learning goals.
- Circadian Rhythm 5E: "After students complete their responses, use the Circadian Rhythms Engineering Mini-Rubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 101). This rubric includes details of DCI and SEP learning goals.
- Common Ancestry 5E: "After completing their responses, have students use the Common Ancestry Engineering Mini-Rubric as a tool for self, peer, or teacher feedback on their initial design ideas" (page 115). This rubric includes details of DCI and SEP learning goals.
- Unit Closing: "Use the Final Design Rubric to provide feedback as students are working" (page 123).

Suggestions for Improvement

Consider supporting students to receive and apply feedback on their performance of all targeted learning goals in the unit, including the targeted CCC elements.

EQuIP Report Template for Units

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL CATEGORY III SCORE: **2** (0, 1, 2, 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

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

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)

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

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

EQuIP Report Template for Units

EQuIP RUBRIC FOR SCIENCE EVALUATION

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)