

Why Are Living Things Different From One Another?

DEVELOPER: OpenSciEd

GRADE: 8 | DATE OF REVIEW: November 2021



Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E
TOTAL SCORE: 9

CATEGORY I: <u>NGSS 3D Design Score</u>	CATEGORY II: <u>NGSS Instructional Supports Score</u>	CATEGORY III: <u>Monitoring NGSS Student Progress Score</u>
3	3	3

[Click here to see the scoring guidelines.](#)

This review was conducted by the [Science Peer Review Panel](#) using the [EQuIP Rubric for Science](#).

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

Why Are Living Things Different From One Another?

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. It is obvious that this unit was thoughtfully crafted, and it is strong in several areas, including the integration of the three dimensions throughout the unit, the incorporation of Common Core State Standards (CCSS) for English Language Arts (ELA) and mathematics, and teacher support for ensuring scientific accuracy.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Building Progressions.** The development of SEPs and CCCs in the unit could be strengthened by explicitly stating student prior knowledge of specific elements of SEPs and CCCs, along with a clear progression of how students will move from prior proficiency toward use of targeted elements rather than the SEP or CCC.
- **Scoring Guidance.** The provided scoring guidance provides sample responses and rubrics which describe performance of targeted elements of all three dimensions. The materials would be strengthened by providing a range of student responses showing examples of multiple proficiency levels of targeted DCI, CCC, and SEP elements.
- **Feedback.** The materials provide opportunities for students to be provided with a variety of feedback from teachers and peers. Adding additional support for teachers to provide feedback to individual students would strengthen these opportunities and opportunities for students to improve their work based on that feedback.

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 definitely WAS met; the purple text is simply not part of the argument for that Extensive rating.

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

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

Why Are Living Things Different From One Another?

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

Extensive
(None, Inadequate, Adequate,
Extensive)

The reviewers found extensive Extensive evidence that learning is driven by students making sense of phenomena and/or designing solutions to a problem because student learning is driven by an anchoring and multiple lesson-level phenomena that students make sense of throughout the unit and students' learning is driven by their questions and investigations that they want to partake in.

Student sense-making centers around how organisms look different from each other, specifically, the authentic example of heavily muscled cattle. In addition to revisiting the anchoring phenomenon often throughout the unit, students engage with lesson-level phenomena to work towards lesson-level objectives. Related evidence includes:

- Lesson 1: Students view pictures of cattle with different amounts of muscle. They record their observations and the questions they have about the cattle.
- Lesson 2: The lesson begins with a lesson-level phenomenon. Students are instructed to feel their own muscles in their arms and necks and make observations.
- Lesson 3: The lesson begins with a lesson-level phenomenon. The students look at pictures of athletes working out and are asked what they notice about their muscles. This prompts the question "How do you think these wheelchair athletes got such large muscles in their arms?" (Teacher Edition, page 71).
- Lesson 4: Students update the classroom consensus model to explain how an animal gets extra-big muscles.
- Lesson 7: Students are asked to analyze a family tree of cattle and students write down what they notice and wonder about the variation of siblings and parents: "Say, Hmmm... Our model predicted that siblings would look the same, but in our experience that is not the case. Let's stick with cattle for now — I have some photos of siblings of a heavily muscled cow — what data could we gather from those? Sample student response: We could see if the siblings of that heavily muscled cow are also all heavily muscled. Analyze photos of siblings. Display slide O. Say, Here is a cow named Fiona, and below her are her siblings. Take a moment to individually and silently observe the phenotypes of these cattle." (Teacher Edition, page 165).
- Lesson 11: Students are presented with pictures of other organisms which show variation. "Introduce other organisms and variations to explore. Display slide E. Say, I have some other

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

example organisms for us to consider — they’re not exactly the same as what we have listed on our DQB and Related Phenomena list, but let’s spend some time today exploring their variations to see if we think parts of our model could explain them too.” (Teacher Edition, page 221). Investigations of these organisms’ traits drive learning in subsequent lessons.

- Lesson 13: “Revisit the tulip varieties we saw in the anchor lesson. Display slide O. Remind students about the varieties of tulip petals they saw in the anchor lesson. Have students turn and talk for a minute about how we could have gotten all these tulip variations, then share some of their ideas with the class.” (Teacher Edition, page 254). Students are then prompted to discuss what they are wondering about the tulip variations.
- Lesson 15: Planaria, flamingos, and apples are used as lesson-level phenomena to investigate the relationships between environmental factors and coloration. Students are provided with pictures of the organisms.
- Lesson 16: Students revisit the musculature of cattle. “Connect what we learned to our existing explanation for musculature in cattle. Show slide Q and facilitate a discussion to surface the idea that there is more variation in general cattle musculature than we could really explain with only one gene.” (Teacher Edition, page 299).
- Students use a Progress Tracker which is updated frequently throughout the unit to show where they have made progress toward explaining the phenomena.

Throughout the unit, students have opportunities to generate their own questions and investigations related to the phenomenon. Related evidence includes:

- Lesson 1: The class creates a Driving Question Board (DQB) based on the questions students generate to guide investigations about the unit phenomenon: “Begin constructing the DQB. Display slide X. Say, We have a lot of really good questions about these phenomena. It is important that we hear everybody’s questions, and we might find that we have questions similar to some of our classmates’ questions. We are going to create a Driving Question Board to help us group and organize our questions so they can help guide our investigations into what is going on with these extra-big muscles and other differences in living things. The Driving Question Board will help us keep track of what we want to figure out.” (Teacher Edition, page 47).
- Lesson 1: Students create a chart indicating possible future investigations and data they will need. The following teacher guidance is provided. “This list of ideas for investigations will be revisited throughout the unit just like the DQB. When a future lesson involves an investigation like one the class suggested, take time to point that out. For example, in Lesson 3, students will investigate what these cattle (and typical cattle) eat and do for exercise. If your students suggest ideas that are not planned in the unit but that you feel would be productive to pursue, use your discretion and your knowledge of the storyline to decide where these additional investigations would best fit so the unit’s punchlines continue to build on one another.” (Teacher Edition, page 49).
- Lesson 4: “Display slide H. Say, OK, so it seems like the cattle are born like this. But there doesn’t appear to be anything specific in our model yet indicating what could happen before birth to cause this. What questions do we have on our DQB related to how these cattle might be born like this? Refer to the DQB to help decide what to investigate next. After pointing out related DQB questions, summarize these ideas by asking, So how could this be? Why are some baby cattle born with big muscles and others aren’t? What could be causing differences in what they are born with? Turn and talk with your partner for a moment about the slide questions.” (Teacher Edition, page 94).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 5: “Most classes will also have a question (or multiple) on the DQB about getting trait variations from parents, so refer to that as part of this discussion, too. Similarly, your class may have listed something like ‘look at family trees’ on the list of Ideas for Investigation and Data We Need from Lesson 1; if so, acknowledge that, as well.” (Teacher Edition, page 99).
- Lesson 8: Students revisit the DQB. “Briefly revisit our DQB. Display slide AZ. Say, We had some questions about mutations on our DQB. Since we now know that when mutations happen, a new allele can be created, can we rephrase these as questions about alleles? Read a couple of questions from the DQB that students had regarding mutations, or mutated traits, and challenge students to rephrase them using the language of genes and alleles.” (Teacher Edition, page 194).
- Lesson 11: Students revisit the DQB. Students first work individually to identify questions that have answered, partially answered, or not yet answered, as well as generate new questions. Students then discuss the questions they can answer with a partner. “Share answers with a partner. Display slide C. Pair students up with a partner and have them spend about 3 minutes taking turns sharing answers to the questions they think we can answer now, using evidence from their work in the unit so far. Again, if new questions arise, students can record them in their notebooks for now, so we can use them soon.” (Teacher Edition, page 221). Students then identify questions they have answered as a class and add any new questions to the board. This is used to motivate the next step for student learning: “Students will realize that we have answered a lot of questions about cattle and muscles specifically, and many of our questions about genetic material. However, we still have questions about organisms other than cattle and trait variations other than musculature.” (Teacher Edition, page 221).
- Lesson 13: At the end of the lesson, students are provided with an opportunity to add additional questions to the DQB.

Throughout the unit, teacher guidance is provided to connect upcoming learning to student wonderings about the phenomenon. Related evidence includes:

- Lesson 4: “Display slide H. Say, OK, so it seems like the cattle are born like this. But there doesn’t appear to be anything specific in our model yet indicating what could happen before birth to cause this. What questions do we have on our DQB related to how these cattle might be born like this? Refer to the DQB to help decide what to investigate next. After pointing out related DQB questions, summarize these ideas by asking, So how could this be? Why are some baby cattle born with big muscles and others aren’t? What could be causing differences in what they are born with? Turn and talk with your partner for a moment about the slide questions.” (Teacher Edition, page 94).
- Lesson 8: This lesson builds on what students have figured out about the anchoring phenomenon and extends it further. Students analyze patterns in pedigrees and calculate genotype proportions in herds. Students then discuss their initial ideas about why some farmers have whole herds of heavily muscled cattle when the occurrence of that trait in the general population is so low. “Describe the patterns found during the pedigree analysis using proportions. Show slide T to remind students what they should discuss when they finish sharing calculations. Have them review the calculations they did for all the different types of crosses. After they have had a few minutes to review, say, So what did your groups figure out about the proportion of offspring that resulted from these different crosses?” (Teacher Edition, page 182). This leads to information about how humans use selective breeding to control traits.
- Lesson 11: “Navigate into next time’s work. Display slide Y. Refer to the chart you just created to support a decision about what organism to investigate first in order to expand our model. Say, If we start with investigating an organism that is the most different from cattle or the most confusing to explain, then maybe explaining other organisms and variations we’re curious about

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

will be easier from there. Which of these organisms do you think is most different from cattle? Which would be the best choice to really push on our model and help us expand it? Why?” (Teacher Edition, page 226).

- Lesson 13: “Summarize what we learned in this lesson. Display slide U. Say, We figured out that plants reproduce sexually using the structures in flowers — sometimes with the help of different kinds of pollinators. And we figured out that plants can also reproduce asexually without sperm or egg involved at all. Can cattle reproduce asexually? (No.) What about the other organisms we looked at in Lesson 11? Ask new questions. Allow students to share their thinking and wondering about the way other organisms might reproduce, or what the offspring of asexual reproduction might be like. Do they always have the exact same phenotype as their parents? Have them add any burning questions to the Driving Question Board.” (Teacher Edition, page 259).

Suggestions for Improvement

Consider additional ways to motivate student learning using students’ prior experiences.

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.

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

Rating for Criterion I.B. Three Dimensions

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because students regularly engage in developing and using elements of all three dimensions to make sense of phenomena.

Science and Engineering Practices (SEPs) | Rating: Extensive

The reviewers found extensive evidence that students can use or develop the SEPs in this unit because students engaged in several grade-appropriate elements of multiple SEPs throughout the unit. There are sufficient SEP elements for the length of the unit and a strong match between SEPs that are claimed and the evidence of SEPs in which students are engaged.

Asking Questions and Defining Problems

- Ask questions that arise from careful observation of phenomena, models, or unexpected results to clarify and/or seek additional information.
 - Lesson 1: Students record what they wonder about their observations of the images of musculature of different animals: “Independently record noticings and wonderings about the bull photos. Say, The photos I’m going to show you are of actual animals.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

These photos have not been altered to make them look like this. Take a couple of minutes to look at them carefully and record what you notice and wonder” (Teacher Edition, page 36). Students are also encouraged to ask and record questions during the sharing of their initial models: “Students should record similarities and differences in their T-charts while they are talking with different partners. If other questions come up during their conversations, students should record those questions in their science notebooks, too” (Teacher Edition, page 40). Students generate questions about all the differences of the living things they have observed. These questions are used to create a DQB in Step 11. Students categorize questions into groups of questions that are related: “Generate questions about living things having differences even though they also seem the same. Direct students to consider all these related phenomena we just listed along with all the work we did on our initial models and with our Notice and Wonder chart (be sure these are within view). Remind students that they’ve been jotting ideas in their notebook these past few days, too” (Teacher Edition, page 46).

- Lesson 5: Students observe components of egg and sperm and complete a Notice and Wonder chart: “Display slide R. Ask students to turn in their science notebook to the next blank page and create a Notice/Wonder chart for this activity. They should write the question we’re trying to answer (or what we’re trying to figure out) at the top of the page in their own words. Facilitate a conversation to share noticings and wonderings. Allow students some time to observe the information on the slide” (Teacher Edition, page 111). Students are asked what new questions they have about chromosomes after creating a karyotype: “Do you have any new questions about these chromosomes or about how they might help us figure out about our heavily muscled cattle?” (Teacher Edition, page 116).
- *Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.*
 - Lesson 11: Students work in groups to generate additional questions as they try to apply the classroom consensus model to the range of phenotypes seen in the new organisms they have been presented with. The following teacher prompt is provided: “Refer back to our model to generate questions. Display slide W. Say something like, We are trying to figure out answers to these DQB questions that we still have. Let’s think through what we would need to know about these organisms and these traits to see if our model works to explain them. While we talk, let’s record questions on sticky notes right on our model, to show where our areas of uncertainty are. What would we have to know in order to decide if our model could explain these other variations? Turn and talk with your partner/trio before we share as a class.” (Teacher Edition, page 224).
 - Lesson 17: After discussing questions they have answered on the DQB, students are encouraged to add additional questions: “Encourage students to ask questions to help clarify the models the class has built so far. Work through these questions together to clear up the partial understandings” (Teacher Edition, page 314).

Developing and Using Models

- This SEP is identified as a focus SEP in the materials.
- *Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*
 - Lesson 7: Students revise their models to show the cause-effect relationship between genotype, the protein it influences, and the phenotype of the animal: “Arrange these components to support developing our model. Display slide E. Say, How might we organize these ideas we collected to help us best explain how musculature can be

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

influenced by genotype?” (Teacher Edition, page 154). “Which of these scales or components can we see (or not)? Sample student responses: Obviously we can see organisms, organs, and tissues with our own eyes. We can see cells and their nuclei with a microscope, and we’ve seen chromosomes in microscope photos and videos, too. But we cannot see the atoms that make up the chromosome molecule; we can’t see the different gene regions/alleles. And proteins were smaller than the chromosomes, too — we can’t see those, either!” “Review the model in terms of cause and effect. Say, Who can, in your own words, walk us through the chain of cause and effect relationships that result in each phenotype?” (Teacher Edition, page 161). “Predict the phenotype of a sibling. Display slide L. Refer to the classroom consensus model as you give these directions. Say, Let’s give ourselves a little more practice with this model. Since we worked backwards from phenotype to genotype together last time, let’s start from the genotype this time and use that to predict the phenotype we expect to see. We can practice by predicting the phenotypes of siblings from the same parents we were just using in our model” (Teacher Edition, page 164).

- Lesson 16: Students revise their model of the heavily muscled cattle. They consider the new information they have gained about traits in different organisms: “Revise classroom consensus model to include environmental factors and multiple genes. Turn and talk about how we should revise our classroom consensus model. Display slide AA. Say, Now that we’ve done some figuring out about the impact of genotype and environment on the muscles of cattle, we need to revise our model to show that. How do you think we should represent the idea of different amounts of impact from genes or environment on different places along this continuum of variation, for these different phenotypes? Turn and talk with a neighbor about how we could show these ideas in our model” (Teacher Edition, page 304). “When suggesting revisions to the model, students should point out the need to show multiple causes of both the heavily muscled and typical phenotype in cattle. These causes do not carry the same ‘weight’ of influence on the different phenotypes, so students should suggest a way (such as larger or smaller arrows) to represent these different causes” (Teacher Edition, page 306).
- *Develop and/or use a model to predict and/or describe phenomena.*
 - Lesson 1: Students develop an initial model to explain the question: “What do you think caused this animal to get such big muscles?” They are provided with a handout which provides them with a place and guidance to draw their initial model. The student handout provides the following guidance for students: “1. Choose a type of animal we have seen that had an individual with extra-big muscles. Sketch that animal in the top of each box, with typical muscles on the left and with extra-big muscles on the right. 2. If you could view the muscle cells in the muscle tissue from both animals with a microscope, how would they compare? Draw and/or write in the ovals what you would expect to see. 3. On the lines below, explain how you think the animal on the right got those extra-big muscles and the other one did not” (L8.5 Lesson Handout 1 Initial Model, page 1).
 - Lesson 4: The class revises the model, adding new information. “Say, Let’s revise our model to reflect the new ideas we have figured out. Since we’ve clarified some of the ideas we were not certain about, let’s start with a new chart to give us more room. Title a new chart paper ‘How does an animal get extra-big muscles or not?’ and, like before, have two headings — ‘Typical Animals’ on the left side and ‘Extra-Big Muscled Animals’ on the right. Draw two representative animals below the headings” (Teacher Edition, page 85). After a class discussion, more information is added to the consensus model. A

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

strategy for developing competence in making models is used. “Choose another color marker to add to the model the ideas about how exercise impacts muscle size” (Teacher Edition, page 87).

- Lesson 5: Students create a pedigree to show the phenotypes of different cattle: “Organize groups and materials for pedigree activity. Give all students a copy of Family Phenotype Graphic Organizer and ask them to open their notebooks to the next blank two-page spread...Tell students, This graphic organizer is similar to the way scientists organize and keep track of the biological relationships of parents and offspring. Scientists call this a pedigree” (Teacher Edition, page 103). Students then look for patterns in the first karyotype and use these patterns to predict the number of chromosomes in other cells. They then update their family tree with the number of chromosomes in other cells.
- Lesson 6: Students develop initial models and use them to predict how the variables are related: “Develop and use a model to describe correlational relationships among chromosome pairs containing two variants, specific proteins, and the trait of musculature. What to look/listen for: Students should identify these relationships as correlational: the partial (or holey) myostatin protein, the blue star chromosome symbol, and the heavily muscled phenotype are related; the full myostatin protein, the blue circle chromosome symbol, and the typical muscled phenotype are related; one of each version of the myostatin protein and one of each blue chromosome symbol (circle and star) are related to the medium-muscled phenotype” (Teacher Edition, page 133).
- Lesson 7: “Predict the phenotype of a sibling. Display slide L. Refer to the classroom consensus model as you give these directions. Say, Let’s give ourselves a little more practice with this model. Since we worked backwards from phenotype to genotype together last time, let’s start from the genotype this time and use that to predict the phenotype we expect to see. We can practice by predicting the phenotypes of siblings from the same parents we were just using in our model. By sibling, we mean an animal who had the same male and female parents. You’ll work with a partner to predict what phenotype a sibling of these individuals will have. Use your notebook to record the model ideas that support your thinking.” (Teacher Edition, page 164).
- Lesson 10: The following question is provided on the assessment which students take individually. The assessment involves students exploring the phenomenon of goldfish breeding. “1b. Using the information, you obtained from the reading, visually represent each mating in Dr. Chen’s scientific paper by creating 4 pedigrees, one of each mating he did in his experiment. Make four offspring for each mating. Be sure to include a key for phenotype and genotype in your pedigree” (Goldfish Assessment page 3).
- *Develop a model to describe unobservable mechanisms.*
 - Lesson 5: Students develop an understanding of the inheritance of the heavily muscled trait using pedigrees which leads them to wonder about how chromosomes are inherited from parents. Students then use a karyotype to look for patterns in the inheritance of chromosomes. Students then use this information to update their pedigree to show how chromosomes are inherited. “Update the pedigree to include the number of chromosomes in the other cells. Say, OK use this new information to update the pedigrees in your science notebook one more time. Display slide AD to confirm student predictions while they add the chromosome numbers to their science notebooks” (Teacher Edition, page 119). *While developing a model is identified as a focus practice for the unit, this is the only instance of this practice being used by students.*

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Planning and Carrying Out Investigations

- *Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.*
 - Lesson 12: At the beginning of the lesson students engage in the discussion which leads them to wonder if plants have genetic material. Students brainstorm ideas for how to get at the genetic material from plants and then conduct an investigation to attempt to extract genetic material from a strawberry, which they compare to a control group which contains everything used for the extraction except for the strawberry in order to gather evidence to answer their question.
- *Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.*
 - Lesson 8: Students look at “herd books” and count the number of times certain kinds of offspring result from each cross using data tables which are provided to them. This data is collected to help them explain why the cattle do not always look like their siblings.
 - Lesson 8: Students undergo a simulation to see if random combination explains the patterns they saw in their pedigrees. Students engage in a discussion (with teacher prompts) to help with the design of how they could collect this data. The simulation involves the flipping of coins. Students are asked to collect data in their own notebooks (with a sample of how to set up recording of the data found on the slides), and then are provided with a place to record class data.

Analyzing and Interpreting Data

- *Analyze and interpret data to provide evidence for a phenomenon.*
 - Lesson: 16: Students analyze data of colors of wheat seeds to determine the reason for variation in color. The following teacher guidance is provided: “Universal Design for Learning: Using the I sense-making strategy will help all students comprehend this relatively complex set of data. This strategy helps students identify and interpret important features of each graph and will allow students to see and make sense of the patterns in the data. Consider modeling one observation (WIS — What I See) and one interpretation (WIM — What It Means) with your students before they begin to work on their own” (Teacher Edition, page 295).

Using Mathematics and Computational Thinking

- This SEP category is identified as a focus SEP in the materials.
- *Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.*
 - Lesson 16: Class data on the arm spans of the students is collected and organized by using an online histogram creator. **However, the data set is not very large and the digital tool is used only to graph the data and not to analyze the data.**
- *Create algorithms (a series of ordered steps) to solve a problem.*
 - Lesson 8: Students engage in a class discussion to lead them to the conclusion that there are mathematical tools they could use to figure out the probability that an offspring will have a specified genotype or phenotype. The teacher then uses slides to walk students through the series of steps which could be followed to determine the probability. At the conclusion of this, the following teacher prompt is provided: “Turn and talk about the steps we’re using. Display slide AL. Say, An algorithm is a series of ordered steps used to solve a problem. What are the steps we can use each time we want to determine the probability of the possible genotypes of the offspring of two parents? Turn and talk with

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

a neighbor to review the steps we just took” (Teacher Edition, page 190). While this is identified as a focus SEP, this is the only instance this element is developed in the lesson.

- *Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.*
 - Lesson 8: “Compare the numbers in different categories. Have some students share the numbers they found for particular crosses with the class. Be sure to ask them how many they saw with which phenotype/genotype out of how many total. Note that the total numbers aren’t the same and ask how we might compare across different categories. Say, We seem to keep saying so many with a particular phenotype out of so many total offspring. Is there a single number we can use to describe that so we can compare them more easily? If no one suggests using a proportion, ratio, or percentage, raise the possibility yourself. Say, In order to determine if some of these breeding pairs result in more muscled phenotypes, let’s calculate the proportion or percent of offspring with certain traits. Use the suggested prompts below to encourage students to explain these concepts to their classmates” (Teacher Edition, page 181).
 - Lesson 8: “Calculate proportions from the crosses. Display slide S. Have students add a column labeled ‘Proportion’ to the right of each table in Using Pedigrees to Make Predictions and fill in the proportion of each offspring phenotype as both a ratio (or fraction) and a percent value. Say, OK, we’re going to work as a group so we can get our calculations finished quickly. Divide the work between your group members and then share your calculations with each other. As you are sharing results, discuss whether you noticed any cases where offspring didn’t look like their parents, and if you have thought of any new questions” (Teacher Edition, page 182).
 - Lesson 9: Students collect data from a simulation of selective breeding in birds. Students are asked to calculate the percentage of birds that have each selected trait. The following teacher prompt is provided: “Then tell students that they will need to tally up these values at the start and at the end of their selective breeding, and use a calculator to determine the percentages for each category, which should add up to 100% for that column. Point out that there is an additional data table to record number of matings, number of offspring, and number removed at the end of their selective breeding investigation, as well as some additional making sense questions to respond to. Tell students that they will have 10 minutes to conduct their simulation, at which time you will give a signal to record the results for the current simulation and answer the questions on their handout in the last 5 minutes” (Teacher Edition, page 208).
 - Lesson 10: The following question is found on the assessment: “2a. Speckled goldfish are popular fish because of their beautiful colors. If a goldfish breeder wanted to breed speckled fish, should the breeder mate a speckled female with a speckled male or a brown female with a transparent male? Which breeding combination would you recommend and why? Use Punnett squares or probability rules showing the potential outcomes of each mating to support your answer” (Goldfish Assessment, page 2).
 - Lesson 13: Students work either individually or in groups to complete calculations to determine the probability of specific phenotypes when tulips are crossed.

Constructing Explanations and Designing Solutions

- *Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.*

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 17: In the final assessment, students use the scientific knowledge gained in the unit to develop an explanation for the differences in height of redwood trees. *However, there is no evidence of this element being developed prior to its use on the assessment.*
- *Construct an explanation using models or representations.*
 - Lesson 10: The following question is found on the assessment: “1c. In 1928, when Dr. Chen did research on goldfish, scientists did not yet know about genetic material, proteins, and phenotypes. Write or draw a model that explains how the transparent fish’s phenotype is influenced by its genotype, starting with how that fish got its genotype and including a protein. Also Include an example of the brown fish for comparison. Be sure to indicate cause-effect relationships in your model and/or explanation” (Goldfish Assessment, page 2). *However, there is no evidence of this element being developed prior to its use on the assessment.*
 - Lesson 13: Students complete an Exit Ticket with the following question: “Using labels you add to the pictures, drawings of your own, and/or writing, explain how the lily plant is likely to reproduce and make seeds” (Lesson 13 Handout Exit Ticket, page 1).
 - Lesson 15: Students work with a partner to develop a model to explain the causes of color variation in apples and flamingos.
 - Lesson 16: “Give students instructions for their independent explanations using models. Say, Next, you’ll work by yourself to read a bit and obtain information about what is known about this trait. Then you’ll create a model with different-sized arrows (like we have in our consensus model) to show the impact of those factors on this trait. You each will be responsible for sharing your model (and explaining why you designed it that way) with your small group (and they will share their models and information with you). We will read, draw models, and share all during today’s class” (Teacher Edition, page 301).

Obtaining, Evaluating, and Communicating Information

- This SEP category is identified as a focus SEP in the materials.
- *Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).*
 - Lesson 3: Students read two articles about diet and exercise and develop evidence for conflicting claims. “I have summaries of two studies done about the effects of diet and exercise on muscle growth. Distribute Study 1 v1: The Effect of Diet and Exercise on Human Muscle Growth to half the students in class and Study 2 v1: The Effect of Diet and Exercise on Human Muscle Growth to the other half... Discuss science ideas learned from credible sources. Say, So we have two credible articles sharing information about human muscle growth... Based on the articles we just read, what are the cause-effect relationships among protein in food, exercise, and muscle growth? Let’s work together and use this table to articulate this relationship.” (Teacher Edition, page 74). “Read about the roles of diet and exercise (separately) in muscle growth. Obtain and evaluate information about the role of diet and the role of exercise in muscle growth... Say, Half of you have an article on how diet, specifically protein, influences muscle growth. This is Team Protein. The other half of you are on Team Exercise and have an article on how exercise influences muscle growth. After you read, we’ll share what you found out and discuss how much each factor influences muscle growth. Remember to mark your text to help you track your thinking about ideas related to the checklist” (Teacher Edition, page 75).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 6: Students read articles to help determine the cause/effect relationship between proteins and size of muscles. Students are provided with a list of what they should pay attention to while they read (this is either a pre-existing list or one that was constructed by the students in a previous lesson). The following teacher prompt is also provided: “Remind students that they may want to mark up the text to help them obtain and evaluate information” (Teacher Edition, page 137).
- Lesson 9: Before engaging in readings about selective breeding in cattle, the following teacher prompt is provided: “Identify goals for reading about selective breeding in cattle. Say, I have three readings about selective breeding in cattle. One is from the interview with our farmer from earlier lessons, another is an interview with another farmer that raises heavily muscled cattle, and the final reading is from another source. Before we dive in, let’s think about what our goals are as readers, how we can compare the three readings, and how we can identify and evaluate the claims made by each reading” (Teacher Edition, page 201). Question prompts are then provided to lead a class discussion about the purpose of the materials and how we can tell they are reliable.
- Lesson 10: As part of the assessment, students read a summary of a study regarding traits of goldfish. Students are provided with a Checklist for Obtaining and Evaluating Information from Scientific Text handout which guides them through the process of reading the text and asks the following questions: “What is the central idea or claim?”, and “What is the goal of the text — to share information, to convince someone of something, to distract people from a larger issue, something else?” (Checklist for Obtaining and Evaluating Information from Scientific Text, page 1). Students use information from this text to answer questions to further explain how these traits are inherited and bred in goldfish.
- Lesson 13: “Read about tulip breeding. Distribute Reading: How Do We Get New Tulip Variations? Have students set a purpose for reading the article (to answer their question about whether and how farmers breed plants/tulips) and write it at the top of the handout. Then allow them time to read, and have them turn and talk with a partner to communicate the information they obtained from the reading” (Teacher Edition, page 255). In addition, the following is provided: “SUPPORTING STUDENTS IN ENGAGING IN OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION Students should obtain information from the text that is relevant to answering their questions using whatever reading strategies work best for them. Refer them to the checklist your class made in Lesson 3 or optional slide P only if needed. Once they have obtained the information from the text, sharing what they learned verbally with a partner will allow them to practice communicating information they have obtained. Even though this is done informally here, the practice of articulating their understanding is an important part of this practice” (Teacher Edition, page 255).
- Lesson 14: “This lesson begins there is a gradual release of responsibility as students obtain, evaluate, and communicate information. As the complexity of the task increases it is important to scaffold other aspects of the task to allow for student success. Here the teacher directly leads the students to their purpose for reading scientific text, while they need to identify and evaluate sources that would be appropriate so they can communicate these ideas back to the class. In Lesson 15, the class will work on a different aspect of this practice by co-construct its purpose for reading. The organisms selected for research in this lesson were chosen in an attempt to include a variety of types of asexual reproduction without getting too complicated” (Teacher Edition, page 264).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 15: Students individually engage in a gallery walk to gather information about the reasons for different colors in Planaria. The following teacher guidance is provided: “SUPPORTING STUDENTS IN ENGAGING IN OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION At this point in the unit and year, students should be independent in critically reading scientific texts adapted for classroom use to determine the central ideas and obtaining scientific information, as well as integrating qualitative scientific information in written text with that contained in visual displays to clarify findings. If your students need more support with this practice, you might choose to have them do the gallery walk in partnerships, or work with the Planaria Study Data as a whole class shared activity” (Teacher Edition, page 282).
- Lesson 16: Students engage in a discussion about obtaining, evaluating, and communicating information as a reminder of the skills they have developed throughout the unit. Students then independently engage in reading a text and develop a model explaining how much of the trait is influenced by genes and how much is supported by the environment. Students are provided with a handout to support this work.
- While the texts read by students throughout the unit come from scientifically accurate sources, they are not scientific texts adapted for classroom use.
- *Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.*
 - Lesson 2: Students compile information from images of muscle tissue, pictures of muscle cells, an article about muscles with diagrams, a video of muscle movement, and graphs of muscle cell data to explain similarities and differences of typical animals and heavily muscled animals: “Watch a video of muscle animations. Say, Let’s zoom in even further to find out what is happening when muscles contract. I have a video of animations and an article that I think can help us figure out what’s inside any muscles that allows them to move. Let’s watch the video with the animations first and record what we figure out” (Teacher Edition, page 57). “Synthesize information from videos, images, and text. Say, It seems like we need to understand more about the structures of these muscle parts and how they work. So I also have an article that includes still images and captions about this same topic. Work through it, and then we’ll take some time to connect the ideas we watched in the video to the ideas we read in the article” (Teacher Edition, page 58). “I do have some photos taken through a microscope of cross sections of muscle fibers from animals that have extra-big muscles, and we can compare them to images of muscles in typical animals. But while I was looking at the images, I saw that the scientists also shared some other cool data: they used box plots and a bar graph to summarize measurements they took from these samples. So we can also use these data sources to compare the muscles. We have four different sources of information — images and graphs — around the room for you to go investigate” (Teacher Edition, page 63). Students synthesize this information and communicate it in a “building understandings discussion.”
 - Lesson 15: Students combine information from reading a text with visual data to create an explanatory model. “Gallery walk through planaria data. If you haven’t already posted the pages from Planaria Study Data around the room, have students help do that as they move to various locations around the room. Instruct students to move through the data at their own pace. Give students about 10 minutes to explore the data and record key ideas in their notebooks” (Teacher Edition, page 282). “Distribute Two Examples of Environmental Influences on Trait Variation and give students time to read. Display slide F. Say, Let’s read to find out what’s causing the ranges of variation we see

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

in flamingo and apple colors. Do what you need to do to make sense of the text and find key ideas while you read... Assign partnerships and give directions for modeling the influence(s) on apples and flamingos like we did earlier for planaria. Work together to construct explanations using models” (Teacher Edition, page 285).

- *Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.*
 - Lesson 3: Students co-construct a checklist as a class for what to look for to determine if a source is credible. This checklist is then used as they engage in a reading to determine the credibility of the course. After students stop reading the article, teacher prompts are provided to engage students in a discussion regarding the credibility of the article.
 - Lesson 9: Before engaging in readings about selective breeding in cattle, the following teacher prompt is provided: “Identify goals for reading about selective breeding in cattle. Say, I have three readings about selective breeding in cattle. One is from the interview with our farmer from earlier lessons, another is an interview with another farmer that raises heavily muscled cattle, and the final reading is from another source. Before we dive in, let’s think about what our goals are as readers, how we can compare the three readings, and how we can identify and evaluate the claims made by each reading” (Teacher Edition, page 201). Question prompts are then provided to lead a class discussion about the purpose of the materials and how we can tell they are reliable.
 - Lesson 14: “Give specific directions for today’s mini-research project. Display slide B (or refer to the slide or chart you created in Lesson 3 and used in Lesson 6) about strategies for making meaning from text and evaluating the text. Say, We have already had practice during this unit reading and gathering information from scientific text. You have also practiced evaluating sources to consider how reliable they are. For today’s research, your group will have a specific organism to research, and you will have to find information online about how that organism reproduces. You will need to ask yourself questions to consider whether the sources you find are reliable. If so, you will need to read the information in a way that helps you make sense of it. Usually we mark up the text to help us focus on our purpose for reading; how will you read closely and carefully on a screen? What tools or strategies can you use? Elicit suggestions such as attending to text features (headings, image captions, and so forth), highlighting the text on the screen to call attention to key details, taking notes on paper to remember main ideas, and so on” (Teacher Edition, page 265).
- *Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.*
 - Lesson 9: Students read three articles about selective breeding in cattle. The following teacher prompt is provided: “Use a checklist to compare the readings. Remind students of the checklist they used in Lesson 3 to evaluate two articles. Instruct students to use the checklist they developed in Lesson 3 to record information about these three readings as they read them” (Teacher Edition, page 203). **While the students do compare the claims of the three articles, the articles do not contain competing information or accounts.**
- *Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or oral presentations.*
 - Lesson 14: Students engage in a discussion about how to share the scientific information they gather from their research on asexual organisms and what they should consider.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Questions on the associated slide include: “Who is our audience? What is your purpose? What are the constraints for your communication?” (GE.L14 Slides, slide C). The discussion ends with the teacher showing a sample slide and modeling a presentation.

- Lesson 16: Students engage in a discussion about obtaining, evaluating, and communicating information as a reminder of the skills they have developed throughout the unit. Students then independently engage in reading a text and develop a model explaining how much of the trait is influenced by genes and how much is supported by the environment. Students are provided with a handout to support his work. Students share this presentation with a partner.

Disciplinary Core Ideas (DCIs) | Rating: Extensive

The reviewers found extensive evidence that students can use or develop the DCIs in this unit because there are multiple DCI elements at the middle school level and all the DCIs targeted in the unit are addressed. Students develop and use DCIs within this unit as they continually incorporate new information in revised models.

LS1.A Structure and Function

- *Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.*
 - Lesson 2: Students look at how the structure of a muscle cell (specifically actin and myosin) results in the ability of a muscle to expand and contract.
 - Lesson 5: Students observe sperm and egg cells at the microscopic level and recognize some of the cell parts based on previous experiences. “Examine pictures of sperm and egg cells at a microscopic scale. Show slide S. Explain that these are the basic parts of sperm and egg cells that can be seen with a microscope. Ask, What structures do they have in common? Students should identify the nucleus, cytoplasm, and cell membrane that they are familiar with from OpenSciEd Unit 6.6: How do living things heal?” (Teacher Edition, page 111). *However, students only identify the structures and do not identify their functions.*

LS1.B Growth and Development of Organisms

- *Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.*
 - Lesson 5: While observing karyotypes, students notice patterns to determine how chromosomes are passed from parent to offspring. “Discuss what students discovered about these chromosomes in a Building Understandings Discussion. Chromosomes are passed from parents to offspring when the sperm and egg fuse during fertilization. Egg and sperm have half the number of chromosomes as the muscle cells” (Teacher Edition, page 115).
 - Lesson 13: Students dissect a flower and relate the parts of the flower to reproductive structures of animals. “Purpose of this discussion: Discuss flower structures and their functions, identify plant reproduction using flowers as sexual reproduction. Listen for these ideas: Pollen (sperm equivalent) needs to get to the ovules (egg equivalent) in order for them to combine. This process in flowers is sexual reproduction” (Teacher Edition, page 251).
 - Lesson 14: Students research organisms which produce asexually and provide a presentation on the process. The lesson is introduced to students as an extension of the previous lesson’s exploration of plant reproduction. “Say, In the previous lesson we

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

observed that plants have similar structures as animals that function as sperm and eggs. We also noticed that plants sometimes don't need these structures and can produce new plants through a process called asexual reproduction. We know that organisms like strawberries that can reproduce asexually have genetic information. But that left us wondering how asexual organisms pass on genetic information if they don't have sperm and eggs! So today, you're going to work in small groups to do a miniature research project about organisms that reproduce asexually. Your group will be responsible for obtaining information about how a certain asexual organism reproduces, and then you will communicate back to the whole class what you've figured out. We have just today's class to do research, and each group will have only about 2 minutes to share, so it's going to be quick, but we'll learn a lot" (Teacher Edition, page 265).

- *Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.*
 - Lesson 13: During a dissection of a flower, students identify structures in the flower responsible for reproduction. Students use their understanding to write an explanation of how plants reproduce. "Students formulate an explanation. Display slide S. Have students refer to the prompts on the slide, which are also listed below. Allow them to think quietly to themselves for a couple of minutes to come up with responses to the prompts. They can use their responses to construct a verbal explanation of the process of how plants reproduce. They can record notes in their science notebook if they like. 1. What reproductive structures in plants have similar functions to structures in cattle (or humans)? 2. What is similar about their functions in plant reproduction and cattle reproduction? 3. What is similar about the process of reproduction in plants and cattle? 4. What is different about the process of reproduction in plants and cattle?" (Teacher Edition, page 258).
- *Genetic factors as well as local conditions affect the growth of the adult plant.*
 - Lesson 15: Students investigate how light exposure affects the coloration of planaria, and how the color of flamingos and apples is also due to environmental factors. "While students work on Explaining Environmental Effects and share their explanations with their partners, listen for the following ideas: Flamingo color is influenced by the environmental factor of the foods they eat: eating more algae results in deeper pink-orange color, eating more shrimp results in lighter pink-orange color. Apple color is influenced by genetic and environmental factors: temperature and sun exposure to a greater extent, and stressors such as lack of water or nutrients and insect activity to a lesser extent. As you review the models students use along with their written explanations, look for arrows of varying size and/or words that indicate how much effect some factors have relative to others" (Teacher Edition, page 286).
 - Lesson 17: Students construct explanations about environmental and genetic factors on redwoods: "Using the data from this study and what you have figured out in the unit about how genetic and environmental traits affect organisms to explain: How does this study mapping the heights of redwood trees help us understand what factors might affect how the redwood trees grow so tall? Respond to the prompts below to construct your explanation. a. Explain how environmental factors could influence the height of the redwood trees. In your explanation, include rationale for why you think environmental factors do or do not influence height of the trees. b. Explain how genetic factors could also influence the height of the redwood trees. In your

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

explanation, include rationale for why you think genetics factors do or do not influence height of the trees” (Redwoods Assessment).

LS3.A Inheritance of Traits

- *Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.*
 - Lesson 6: In a reading selection, students relate chromosomes and a specific protein. “Explain that you have two articles about work scientists did to figure out the cause/effect relationships between chromosomes, musculature, and the myostatin protein” (Teacher Edition, page 138). During a class discussion, teachers are advised to look for the following: “Listen for these ideas: Specific regions of the chromosomes are called genes, and a gene controls how a specific protein is made. Different versions of a gene are called alleles. An animal’s genotype is the combination of alleles that it has. The genotype determines the protein(s) that get produced, which leads to the phenotype we see” (Teacher Edition, page 139).
 - Lesson 7: The following teacher prompt is provided: “Help students make connections between chromosomes, genes, alleles, and genotype by discussing questions such as the following. During the discussion, invite students to the whiteboard or extra chart paper and have them draw the relationships they’re describing.” The following suggested prompts are provided: “How are chromosomes and genes related”, “How are genes and proteins related?” (Teacher Edition, page 152). Students go on to generate a cause-and-effect chain to demonstrate these relationships.
 - Lesson 8: “If a mutation changes a gene, what do you think it does to the protein that gene makes? Sample student response: It probably changes the protein so it’s different, like the two different myostatin proteins. Use the model to trace the historical story of mutations. Point out that all cattle used to have two copies of just the circle or “E” allele, but when this mutation occurred, it was the first time any organism had the “e” allele. That individual continued to pass that “e” allele on to its offspring... Briefly revisit our DQB. Display slide AZ. Say, We had some questions about mutations on our DQB. Since we now know that when mutations happen, a new allele can be created, can we rephrase these as questions about alleles? Read a couple of questions from the DQB that students had regarding mutations, or mutated traits, and challenge students to rephrase them using the language of genes and alleles” (Teacher Edition, page 194).
- *Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.*
 - Lesson 5: Students look at pedigrees, microscopic representations of egg and sperm cells, and karyotypes, and determine that parents transfer one copy of a chromosome to their offspring.
 - Lesson 6: Student groups develop a model that shows the patterns noticed between the cattle phenotype, proteins, and chromosomes. “What to look/listen for: Students should identify these relationships as correlational: *the partial (or holey) myostatin protein, the blue star chromosome symbol, and the heavily muscled phenotype are related *the full myostatin protein, the blue circle chromosome symbol, and *the typical-muscled phenotype are related one of each version of the myostatin protein and one of

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

each blue chromosome symbol (circle and star) are related to the medium-muscled phenotype” (Teacher Edition, page 133).

LS3.B Variation of Traits

- *In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.*
 - Lesson 5: Students create pedigrees from images of cattle families. The class discusses how traits can be passed on from parents to their offspring. “Purpose of this discussion: To help students make their reasoning with evidence public so that other students can connect with the ideas about the inheritance of phenotype, critique these ideas, and build on them by motivating students to need to zoom in to look at the egg and sperm cells under a microscope so we can figure out what is getting passed on to the offspring. Students also have an opportunity to use their shared understanding to make predictions about expected phenotypes” (Teacher Edition, page 108).
 - Lesson 8: Students analyze patterns in pedigrees. “The general patterns (that homozygous x homozygous crosses result in all one genotype/phenotype of offspring; while crosses involving a heterozygous parent or parents result in a distribution of different genotypes/phenotypes of offspring) are the critical ones for students to notice at this point” (Teacher Edition, page 180).
 - Lesson 10: In an assessment, students make models to show how the different colors of fish are inherited. “2b. Use words and/or drawings to show how the offspring’s genotype results from the parents’ chromosomes” (Goldfish Assessment, Teacher Edition, page 579).
- *In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.*
 - Lesson 8: Students model how heavily muscled cattle get their large musculature. The model includes parents, their offspring, the alleles of each parent, and what the offspring would look like if it was a typical animal or a heavily muscled cow. Students add the concept of mutation to the model and learn about historical data that provides evidence that this allele is a mutation: “If a mutation changes a gene, what do you think it does to the protein that gene makes? Sample student response: It probably changes the protein so it’s different, like the two different myostatin proteins. Use the model to trace the historical story of mutations. Point out that all cattle used to have two copies of just the circle or “E” allele, but when this mutation occurred, it was the first time any organism had the “e” allele. That individual continued to pass that “e” allele on to its offspring... Briefly revisit our DQB. Display slide AZ. Say, We had some questions about mutations on our DQB. Since we now know that when mutations happen, a new allele can be created, can we rephrase these as questions about alleles? Read a couple of questions from the DQB that students had regarding mutations, or mutated traits, and challenge students to rephrase them using the language of genes and alleles” (Teacher Edition, page 194).
 - Lesson 9: “What do you mean by ‘drawbacks’ or ‘beneficial’ – do you think what is beneficial for the farmer or breeder is always also beneficial for the animal? Who else might have a stake in deciding what is beneficial or harmful? It might not be a beneficial

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

trait for an animal to have really big muscles if it makes them hard to be born – even if the farmer sees it as beneficial. The farmers or breeders don't really want that either though so they try to breed cattle to have trait variations that go better together. Other people on earth can also have an opinion on what is beneficial or harmful with regard to the environmental impact" (Teacher Edition, page 204). "Are the conclusions in both articles valid based on the information we already know? Sample student responses: Both articles helped support the idea that while the heavily muscled trait is useful/helpful, there are some negative effects of the trait, like big babies that require C-sections... Purpose of this discussion: Synthesize the main ideas about how farmers select for trait variations when breeding cattle, based on the evidence we have read in the articles. Listen for these ideas: Many different trait variations are taken into consideration when breeding cattle. Different farmers look for different trait variations depending on what the requirements of the cattle are. While there are benefits to having heavily muscled cattle, like increased yield of meat, there are some harmful effects too, like complicated births and mobility issues. Farmers can use different techniques like selective breeding and monitoring what a female cow eats while pregnant to help reduce negative effects of the trait" (Teacher Edition, page 205).

LS4.B Natural Selection

- *In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto offspring.*
 - Lesson 9: Students read articles describing selective breeding in cattle. They synthesize the information in a discussion. "Listen for these ideas: Many different trait variations are taken into consideration when breeding cattle. Different farmers look for different trait variations depending on what the requirements of the cattle are" (Teacher Edition, page 205). Students run a computer simulation on selective breeding in birds and discuss the results with the class. "Listen for these ideas: People can control trait variations in organisms by choosing to mate individuals with the trait or traits they are selecting for. The parents pass their alleles to their offspring, which sometimes leads to the selected-for phenotype or not, based on the inheritance pattern" (Teacher Edition, page 205).
 - Lesson 13: Students read about artificial selection in tulips and watch a video.

Throughout the unit, the idea that traits of organisms are influenced by both genes and the environment is explored. *This concept is addressed by the DCI LS3.B Variation of Traits at the high school level. (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).* The teacher materials, however, provide a rationale for this inclusion in the "How can we work toward a more powerful and equitable genetics education?" section of the Teacher Edition.

Crosscutting Concepts (CCCs) | Rating: extensive

The reviewers found extensive evidence that students can use or develop the CCCs in this unit because students engaged in several grade-appropriate elements of multiple CCCs. There are sufficient CCC elements for the length of the unit and a strong match between those that are claimed and the evidence of the CCCs for which students are engaged. The CCCs of **Cause and Effect** and **Structure and Function** are developed and used frequently within the unit.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Patterns

- *Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.*
 - Lesson 8: Students describe patterns found in the offspring of crosses of parents with different genotypes. “Suggested Prompts: Did you notice any patterns in the proportions? What were the patterns you saw? Do these patterns match the patterns we saw with our families?” (Teacher Edition, page 182).
- *Graphs, charts, and images can be used to identify patterns in data.*
 - Lesson 5: Students use the pedigree they have constructed to identify patterns. The following teacher guidance is provided: “Supporting Students In Developing and Using Patterns. Circulate as they work in small groups to listen for students using patterns to make their decisions. If students are struggling with labeling the phenotypes, suggest a strategy of labeling the extremes first (typical or extra-big) and passing over any images they are not sure of. Sometimes in looking for patterns, it’s easier to see a pattern when the contrast is more extreme. Then suggest that once those are labeled, students go back to assign a phenotype to the images they were unsure of during the first pass. If they are not explicitly using evidence from the pictures and the cattles’ appearance to discuss patterns that are surfacing as a reason for assigning symbols, try using some of the following prompts: What are you noticing that determines if you are labeling it extra-big (black) or medium (gray)? Is it always easy to decide if it should be extra-big or medium (black or gray)? What specific characteristics did you use to decide which phenotypes these are? How are these patterns similar to or different from the other cattle in this family?” (Teacher Edition, page 103).
 - Lesson 5: After looking for patterns in the pedigree they constructed in small groups, students discuss the patterns they noticed as a whole class. Teacher question prompts are provided to elicit responses from students regarding patterns between parents and offspring.
 - Lesson 5: “Describe patterns in the karyotype. Display slide X. Have students talk briefly with an elbow partner about what patterns they see in how chromosomes are organized in karyotypes. Circulate among students as they talk to listen for whether they are distinguishing the following patterns. Ask probing questions to direct their attention to patterns they might miss. It is not necessary that students notice all these patterns, only that they focus on discerning what patterns exist. They will share and consolidate the important patterns in the Building Understandings Discussion that follows. There are 30 different pairs of chromosomes. There are 60 chromosomes in total. They are in order from largest to smallest. The pairs are numbered in order. A lot of the patterns of the stripes on the pairs look pretty similar to each other. There’s an X and a Y that don’t seem to match” (Teacher Edition, page 114).
 - Lesson 6: Students organize cattle cards to find patterns about how chromosomes connect to an individual having extra-big muscles. Suggested teacher prompts are provided to engage students in a discussion about how these cards could be organized to find these patterns and students are provided with a Guiding Questions for Chromosome/Protein Data Handout to guide their thinking.
 - Lesson 17: On the summative assessment, students use graphs and images to find a pattern. Before the assessment is given, the class participates in a discussion. One of the discussion questions is “What do you notice about the height of trees in these two areas?” (Teacher Edition, page 634).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Cause and Effect

- *Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.*
 - Lesson 6: Students work in small groups to develop an initial model that shows the relationships between chromosome information, proteins, and the cattle's muscle phenotype. Students develop an understanding that these three factors are correlated. The following teacher guidance is provided: "Supporting Students In Developing and Using Cause and Effect. At this point, the allele, protein, and phenotype are correlated but we do not yet see causation. If students aren't identifying correlation, help them realize that we do not know what causes what... but we do see a pattern linking them (correlation)." (Teacher Edition, page 133).
 - Lesson Six: While engaging in the discussion to generate the classroom consensus model, the following teacher prompt is provided: "We've seen there is a pattern here: the heavily muscled phenotype is correlated to the chromosome's shape in that blue region and the partial, differently shaped myostatin protein. If we want to figure out causes (rather than just correlations), can we at least decide which comes first? Which of these components is the starting point?" (Teacher Edition, page 135).
- *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
 - Lesson 1: Students model what they believe to be the cause of the difference in organisms' musculatures: "Develop an initial model to explain this question: What do you think caused this animal to get such big muscles compared to typical animals? 1. Choose a type of animal we have seen that had an individual with extra-big muscles. Sketch that animal in the top of each box, with typical muscles on the left and with extra-big muscles on the right. 2. If you could view the muscle cells in the muscle tissue from both animals with a microscope, how would they compare? Draw and/or write in the ovals what you would expect to see. 3. On the lines below, explain how you think the animal on the right got those extra-big muscles and the other one did not" (Initial Models Handout, page 1).
 - Lesson 3: Students are provided with a table which helps them explain the cause-and-effect relationship between food, exercise, and muscle growth. Students use the prompts on the chart to explain the relationships. The following teacher guidance is provided: "Establish a cause-and-effect relationship. Display slide G. Say, In the Magnets Unit, we traced cause-effect relationships within the system of the speaker. Now we get to apply the same idea to living systems! Based on the articles we just read, what are the cause-effect relationships among protein in food, exercise, and muscle growth? Let's work together and use this table to articulate this relationship. As students suggest the responses below, you may choose to type them into the table on slide G. When we: eat more protein and exercise more we observe: muscle growth because: _____ (We're not sure yet.)" (Teacher Edition, page 74).
 - Lesson 9: "Update Progress Trackers in science notebooks. Direct students to add to their Progress Tracker, slide I, in their science notebooks. Explain that we need to record our new understandings on how people can use selective breeding to change trait variations in organisms... Students should identify that selective breeding is a way that farmers can control trait variations in their livestock, or system. The act of selective breeding leads to different effects in the population, such as having more individuals with selected-for trait variations. If students struggle to identify the cause-and-effect

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- relationship, ask probing questions about how what they were doing caused different effects in the offspring that were produced.” (Teacher Edition, page 209).
- Lesson 10: The following question is found on the assessment: “1c. In 1928, when Dr. Chen did research on goldfish, scientists did not yet know about genetic material, proteins, and phenotypes. Write or draw a model that explains how the transparent fish’s phenotype is influenced by its genotype, starting with how that fish got its genotype and including a protein. Also Include an example of the brown fish for comparison. Be sure to indicate cause-effect relationships in your model and/or explanation” (Goldfish Assessment, page 4).
 - Lesson 14: The following teacher prompt is provided: “Throughout this unit we have discussed different cause and effect relationships. How might thinking about cause and effect relationships help us make strong predictions about planaria reproducing asexually?” (Teacher Edition, page 273). In addition, this additional guidance is provided: “SUPPORTING STUDENTS IN DEVELOPING AND USING CAUSE AND EFFECT This prompt foregrounds thinking students have done numerous times in this unit as they have used cause and effect framing to discuss these relationships. This is an opportunity to help students predict, using their knowledge of cause and effect relationships, about what they might see when planaria regenerate after being divided into multiple pieces. Having students think through the different potential outcomes helps them consider the mechanistic how or why explanations for this relationship. At this point in the unit students should be able to use causal framing themselves. Look for students saying When a planarian is divided into multiple pieces we will observe _____ then proceed to explain why we should observe their predicted outcome” (Teacher Edition, page 273).
 - *Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.*
 - Lesson 4: Students read and listen to interviews from farmers about the diet and exercise of the cattle to determine what influence those factors play in heavily-muscled cattle: “How can we represent on the consensus model what we just learned? Sample student response: We can add arrows to represent that they were born that way. Based on how we were using the arrows before, with the thicker lines meaning the factor has more of an effect, how should we draw the “born this way” arrows? The arrow to the heavily muscled animals should be thick — it has more of an effect than either diet or exercise” (Teacher Edition, page 93).
 - Lesson 7: “We’ve been modeling several cause-and-effect relationships today, and we already had others on our classroom consensus model. In the Magnets Unit when you had multiple cause-effect relationships that happened in a sequence (from turning on the music player to getting the music we hear), you represented them in a chain like this. This graphic can help us visualize the cause-effect relationships that influence an animal’s phenotype, also. But, the final result of an animal’s phenotype isn’t quite as simple as this graphic... How can we change this graphic so we cause it to explain the cause and effect relationships that lead to the phenotype we see? Sample student response: We need more boxes for and arrows for causes — there are more steps in how the genotype influences the phenotype” (Teacher Edition, page 160). This lesson does not yet address probability: “At this point in the unit students are not yet describing cause/effect relationships with probability (they will do that in the following lesson), but they do explain that the phenomenon of varying musculature, including

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- extra-big muscles, has more than one cause” (5.0 Muscles Rationale for SEP and CCC Elements, page 6).
- Lesson 8: “If a male is heterozygous for the myostatin allele (Ee) and a female is homozygous for the allele that leads to typical muscles (ee), what are the probabilities of each genotype their offspring might have? You may choose to use either the probability calculations algorithm or a Punnett square to figure this out, but be sure to show all of your work... Use mathematics and computational thinking to find patterns about genotypic and phenotypic outcomes resulting from crossing individuals with specific genotypes. What to look and listen for: At this point, students should be comfortable with the idea that the proportion of offspring with different genotypes, and hence phenotypes, can be predicted using a simple mathematical model when we know the genotypes of the parents. In their science notebooks, students should have recorded their work using the probability calculations or the Punnett squares to determine that: If one parent is EE and the other is ee , 100% of the offspring have medium muscles. If both parents are heterozygous, we see about 50% of the offspring with medium muscles, and 25% of offspring with typical muscles. The other 25% have extra-big muscles. In the work they show on the exit ticket, they should use either algorithm to determine that: If one parent is EE and the other is Ee , 50% of offspring have extra-big muscles and the other half have medium muscles” (Teacher Edition, page 191).
 - Lesson 14: “Use a Punnett square to show that genetic information of offspring from asexual reproduction is identical to the parent’s. Draw a Punnett square on chart paper or the white board. Lead a discussion about how this model could apply to asexual reproduction, and record the students’ thinking on the chart paper or whiteboard as you talk... What is the purpose of a Punnett square? It helps us figure out what the possible genotypes (variations of alleles) are that offspring could have” (Teacher Edition, page 271). “If students do not see the value in applying a model to a situation where it doesn’t really work, explain that working through this model in a new situation (asexual reproduction) helps us understand and articulate how it does work (for sexual reproduction). Also, it is important to discover the limitations of our models (and we don’t figure those out until we try applying the model to different situations)” (Teacher Edition, page 272).
 - Lesson 15: “Bring the class back together for a Building Understandings Discussion. Display slide C. Use prompts such as those that follow to facilitate a discussion about the planaria data. Capture the class’s thinking in a model with different-sized arrows showing the influences of the planaria’s color variation” (Teacher Edition, page 282). “Purpose of this discussion: (1) to share take-aways from the planaria data gallery walk, establishing that light exposure can cause variation in planaria color, (2) co-construct a model to explain the influences on planaria color variation, and (3) motivate investigating other organisms’ variations that could be caused by environmental factors” (Teacher Edition, page 283). “You were able to explain that the ranges of variation in apple color and flamingo color were caused by environmental factors. What do you predict is causing the variation we see in wheat kernel color and human arm span length? Why do you think that? Sample student responses: Since those are ranges of variation — we couldn’t put them into specific groups or categories — we think they’re caused by environmental factors, too. Maybe the wheat is influenced by the temperature or sunlight or rain like other plants. People definitely have different arm spans depending on how old they are, and I bet like with muscles if you didn’t have enough healthy food you wouldn’t be able to grow as much. But there are patterns in

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

people’s families about how big or small they are, too, so I don’t think it’s just environment that causes that variation” (Teacher Edition, page 286).

- Lesson 16: “Do you think we could use what we learned about how to predict an offspring phenotype with cattle musculature to make a prediction about some other parental crosses in wheat? For example, can we use what we learned to make a claim about what alleles might be present in the plants that make medium red wheat kernels?... Great, how does this help us make some predictions about the offspring? We could use a Punnett square to see how they would combine during fertilization. We could also use the probability rules to see the probability of each kernel color variation” (Teacher Edition, page 296). “What did you learn about how the color of wheat is determined? Sample student responses: Wheat plants have three different chromosomes with genes that contribute to the red coloration in wheat kernels. There are two forms of the allele for each of the genes, one that will lead to making a pigment and the other that doesn’t. Plants have six total alleles that help determine the red color” (Teacher Edition, page 297).

Scale, Proportion, and Quantity

- *Phenomena that can be observed at one scale may not be observable at another scale.*
 - Lesson 7: The class model contains components of different sizes; some are microscopic and some macroscopic. “Acknowledging the different scales in this model helps students make sense of the process of how genes affect an organism’s visible phenotype through the production of molecules they cannot see directly” (Teacher Edition, page 152).

Structure and Function

- *Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.*
 - Lesson 2: Students view photographs and video to see the action of muscle cells. “Using multiple sources, the video animations as well as the reading with labeled diagrams, provides multiple representations of the proteins actin and myosin during muscle contraction. Looking at the commonalities between these representations should help students focus on the actual properties of these proteins rather than the creative differences between individual models. This way students can accurately describe and discuss how the proteins’ function is related to their structure. As students discuss the structure-function relationship, encourage the students to use gestures or objects to help them visualize and explain the structures that work to make our muscles move” (Teacher Edition, page 58).
 - Lesson 6: Students engage in a consensus discussion. The following teacher prompt is provided. “That’s interesting, because I’m remembering other proteins we know about in muscles: myosin and actin. They had different shapes than myostatin has. Why would this be?” (Teacher Edition, page 140). In addition, the following support is provided. “It may be helpful to display the molecular models of myostatin from Protein and Chromosome Data or slide J and the diagrams from the article Version 1: Function of the Myostatin Protein while the class is discussing the structure and function of this protein. You might also ask students to point out exactly how the partial myostatin protein’s

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- structure is different from the typical one, and have them consider how that different structure could impact its function (or lack thereof)” (Teacher Edition, page 139).
- Lesson 13: Students look at parts of a flower. The following teacher prompts are provided: “How would you describe the structures you see? What do you think is the function of those structures? Which of the structures do you think have to do with reproduction? What questions do you have?” (Teacher Edition, page 249). Students go onto dissect a flower and compare the parts of the flower to parts with equivalent functions in animals.

Suggestions for Improvement

Science and Engineering Practices

Consider having student engage in scientific texts adapted for classroom use that include key components of scientific texts, such as the methods and results.

Disciplinary Core Ideas

- Consider providing additional teacher guidance indicating when specific lessons are above grade level expectations.
- Consider adding DCI elements addressed to the “DCI and CCC elements addressed by lesson” document.
- Consider including on the Performance Expectation and DCI elements addressed in the lesson on the first page of each lesson rather than all PEs for the unit.

Crosscutting Concepts

N/A

I.C. INTEGRATING THE THREE DIMENSIONS

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and/or designing solutions to problems because there are multiple events where all students are expected to figure something out in a way that requires grade-appropriate elements of all three dimensions of the standards.

Three-dimensional learning outcomes are specified for each unit. Related evidence includes:

- Lesson 2: “Obtain, evaluate, and communicate information about muscles in various media and visual displays, including models of complex protein structures, to describe (1) how the function

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

of those proteins depends on their shape and (2) how the muscle cells of extra-big muscled animals compare with those of typical animals” (Teacher Edition, page 51).

- Lesson 12: “Plan and carry out an investigation to produce data to serve as the basis for evidence that plants have genetic information inside their cells that can be visualized (scale)” (Teacher Edition, page 229).

Throughout the unit, there are numerous instances of students engaging in all three dimensions to figure something out related to the phenomenon. Related evidence includes:

- Lesson 1: Students develop an initial model to explain the question “What do you think caused this animal to get such big muscles?” (L8.5 Lesson Handout 1 Initial Model, page 1). This task incorporates grade level elements of the following three dimensions:
 - CCC: **Cause and Effect**
 - SEP: **Developing Using Models**
 - DCI: **LS3.A**
- Lesson 2: Students watch a video and engage in a reading, including diagrams, which explains how muscle cells cause movement. In this activity, students integrate the following three dimensions:
 - SEP: **Obtaining, Evaluating, and Communicating Information**
 - CCC: **Structure and Function**
 - DCI: **LS1.A**
- Lesson 3: Students read articles and summaries of scientific studies to determine the cause-and-effect relationships between diet and exercise and muscle growth. In this lesson, students integrate the following three dimensions:
 - SEP: **Obtaining, Evaluating, and Communicating Information**
 - CCC: **Cause and Effect**
 - DCI: **LS1.A**
- Lesson 6: Students organize cattle cards to find patterns about how chromosomes connect to an individual having extra-big muscles. Suggested teacher prompts are provided to engage students in a discussion about how these cards could be organized to find these patterns, and students are provided with a Guiding Questions for Chromosome/Protein Data Handout to guide their thinking. In this activity, students integrate the following three dimensions:
 - SEP: **Developing and Using Models**
 - CCC: **Patterns**
 - DCI: **LS3.A**
- Lesson 11: Students ask questions to assist them with using the classroom consensus model to explain the causes of the variability of phenotypes in different organisms. In this lesson, students integrate the following three dimensions:
 - SEP: **Asking Questions and Defining Problems**
 - DCI: **LS3.B**
 - CCC: **Cause and Effect**
- Lesson 15: Students gather information from texts and data about planaria, apples, and flamingos to determine the cause of color variation. In this activity, students integrate the following three dimensions:
 - SEP: **Obtaining, Evaluating, and Communicating Information**
 - DCI: **LS1.B**
 - CCC: **Cause and Effect**

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Suggestions for Improvement

N/A

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

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

Rating for Criterion I.D. Unit Coherence

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations because there is a clear connection between what has been figured out in previous lessons to the concepts that students will explore in the next lesson. Throughout the unit, students consistently take stock of what they have figured out about the phenomenon and revisit their original questions and generate new questions along the way.

Throughout the unit, there are numerous opportunities presented for teachers to connect lessons to previous learning as well as the anchoring phenomenon. Related evidence includes:

- Lesson 2: The end of the lesson includes a transition to the upcoming lessons: “What question(s) are you still wondering about? Where do you think the matter could be coming from to build these extra-big muscles? What should we investigate next to keep figuring out why the cattle got these extra-big muscles? Do certain kinds of food help them build extra-big muscles? I think that exercise makes muscles bigger, too, so we should see if these animals have been working out” (Teacher Edition, page 65).
- Lesson 5: The lesson begins by looking back at what students wondered last time. “Look back to what we wondered about last time. Display slide A. Say, So last time our classroom consensus model predicted that in order for the cattle to get really big muscles, the cattle would have to be working out a lot. But the farmer said that the cattle just lay around most of the day. Also, we saw some baby pictures of cattle and they are born with these big muscles. That led us to start brainstorming some possible explanations for these two questions” (Teacher Edition, page 99). After discussing these questions, the following teacher guidance is provided “Summarize for the class. Say, So it sounds like we have a variety of ideas of where these babies might get their big muscles from. One idea we’re hearing is that maybe these baby cattle got their muscles from their parents. Most classes will also have a question (or multiple) on the DQB about getting trait variations from parents, so refer to that as part of this discussion, too. Similarly, your class may

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

have listed something like ‘look at family trees’ on the list of Ideas for Investigation and Data We Need from Lesson 1; if so, acknowledge that, as well” (Teacher Edition, page 99).

Guidance is provided to the teacher for connecting the previous lesson to the next at the beginning of each lesson so that part of what students figure out is used as the next question to pursue. Related evidence includes:

- Lesson 7: Students use their model to predict that siblings should look the same. After gathering evidence that this is not really the case, the teacher is prompted to engage students in a discussion about why that might be the case. The teacher is then provided with a series of prompts to lead students to the question “What are we wondering?” (Teacher Edition, page 165). The following teacher guidance is provided: “Purpose of this discussion: To problematize the next lesson question. We want kids to start wondering, If we have this model for how offspring get traits from their parents via these alleles, then why don’t all of the offspring of those same parents look the same?” (Teacher Edition, page 145).
- Lesson 8: “Connect to how we could use the information we figured out. Show slide BA. Say, So this is cool, we know where the two different alleles came from, and we can predict the patterns of muscularity in cattle now that we know how this inheritance pattern works. I bet ranchers are all over this information to make sure they have the most muscular cattle. What genotype cattle do you think the farmers are mating together to get the phenotype they want? We think they mate EE with EE cattle, because then you get the most muscles guaranteed every time. So if that’s true, how do they do that? How do they make sure they mate the right bulls with the right cows? Not totally sure... Reassure students that we will investigate this in our next lesson” (Teacher Edition, page 195).
- Lesson 12: “Turn and talk to recall the conversation about sexual vs. asexual reproduction from last class. Display slide A. Say, At the end of last class we were thinking about whether we thought plants had genetic material like we saw in animals. Turn and talk with a partner about what we decided we should investigate and why?” (Teacher Edition, page 234). After talking with a partner, students engage in a whole class discussion. After a series of questions designed to guide student thinking, the following teacher prompt is provided: “OK so we’re not really sure if plants have genetic material. If we did want to look for it, where would we even look? Where is the genetic material stored? What are the structures called?” (Teacher Edition, page 234).

On many occasions in the unit, students are provided with opportunities to generate questions to assist with navigating to the next lesson.

- Lesson 1: After viewing photographs of cattle, students record their initial questions and then organize a DQB.
- Lesson 3: At the end of the lesson, students are provided with an Exit Ticket. One of the questions on the exit ticket asks students: “What questions do you still have about protein, exercise, and our cattle with extra-big muscles?” (Teacher Edition, page 79). In addition, the following teacher guidance is provided regarding use of these questions: “Read the students’ exit tickets so you are ready to refer to them during next time’s class, referencing the questions students wrote” (Teacher Edition, page 79). **However, no additional guidance is provided in Lesson 4 regarding use of these questions.**
- Lesson 4: The end of the lesson includes a transition to the upcoming lessons: “Refer to the DQB to help decide what to investigate next. After pointing out related DQB questions, summarize these ideas by asking, So how could this be? Why are some baby cattle born with big muscles and others aren’t? What could be causing differences in what they are born with? Turn and talk with your partner for a moment about the slide questions” (Teacher Edition, page 94).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 11: Students revisit the DQB. Students first work individually to identify questions that have been fully answered, partially answered, or not yet answered, as well as generate new questions. Students then discuss the questions they can answer with a partner. “Share answers with a partner. Display slide C. Pair students up with a partner and have them spend about 3 minutes taking turns sharing answers to the questions they think we can answer now, using evidence from their work in the unit so far. Again, if new questions arise, students can record them in their notebooks for now, so we can use them soon” (Teacher Edition, page 221). Students then identify questions they have answered as a class and add any new questions to the board. This is used to motivate the next step for student learning: “Students will realize that we have answered a lot of questions about cattle and muscles specifically, and many of our questions about genetic material. However, we still have questions about organisms other than cattle and trait variations other than musculature” (Teacher Edition, page 221).

Students use a Progress Tracker to document the increasing understanding of the phenomenon. Related evidence includes:

- Lesson 2: Students set up a Progress Tracker in their notebooks. Students record questions and then an explanation, using words and pictures. Examples of expected student responses are provided. “Begin Progress Trackers in science notebooks. Direct students to draw directly in their science notebook a T-chart as indicated on slide J. Explain that as we investigate what is going on with these cattle and their muscles, we are going to keep track of our new ideas and how our model changes and develops over time. To do this, we are going to use a Progress Tracker” (Teacher Edition, page 61).
- Lesson 4: Progress Trackers are updated with new information. “Update Progress Tracker. Display slide B. Say, By rebuilding our classroom consensus model for muscles we now have a deeper understanding about each idea and component we included. We added these ideas and components to our model because we have evidence to support their role in musculature. Let's add what we figured out so far to the Progress Tracker in our science notebooks” (Teacher Edition, page 88).
- Lesson 6: Students update the Progress Tracker with a prompt from the teacher about possible concepts to include and how this entry in the tracker will be used in the next lesson. “Update Progress Trackers in science notebooks. Using slide Y, direct students to add to their Progress Tracker in their science notebooks. Say, Let's record our new understandings about the relationships among chromosomes, genes, alleles, proteins, and phenotypes. Also, the thinking we do here and now will give us a starting point for our next lesson, so we can update our classroom consensus model and determine what we need to figure out next. The example two-column Progress Tracker below has been completed with possible student ideas” (Teacher Edition, page 142).
- Lesson 7: An additional category, Sources of Evidence is added to the Progress Tracker (Teacher Edition, page 162).

The lessons work together to build proficiency in all three dimensions for a targeted set of performance expectations. Related evidence includes:

- **MS-LS1-5:** *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*
 - Lesson 1: Students look at pictures of cattle with extra-big muscles and develop an initial model to explain why some cattle have extra-big muscles and some do not.
 - Lesson 3: Students evaluate and use information in articles, graphs, and pictures and determine that exercise and diet play a role in building muscles.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 5: Students look at pedigrees in muscle cells to determine that chromosomes are passed from parent to offspring and that these chromosomes contain information which determine whether organisms have extra-big muscles.
- Lesson 15: Students investigate why planaria which reproduce asexually do not produce identical offspring. Students gather and use information from various sources in a gallery walk to determine that light (an environmental factor) affects this trait.
- Lesson 16: Students utilize the information they have gathered in the unit to explain the variability of height of redwood trees.
- **MS-LS3-1:** *Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.*
 - Lesson 5: Students look at pedigrees in muscle cells to determine that chromosomes are passed from parent to offspring and that these chromosomes contain information which determine whether organisms have extra-big muscles. One of these chromosomes come from each parent.
 - Lesson 6: Students read articles to determine the relationships between alleles, proteins, and phenotype. Students update the class consensus model with this new information.
- **MS-LS3-2:** *Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.*
 - Lesson 5: Students look at pedigrees in muscle cells to determine that chromosomes are passed from parent to offspring and that these chromosomes contain information which determine whether organisms have extra-big muscles. One of these chromosomes come from each parent.
 - Lesson 8: Students investigate the inheritance patterns of the protein which causes extra-big muscles and use mathematical models to predict the outcome of crosses.
 - Lesson 14: Students conduct research on organisms which reproduce asexually. Students use a model as a class to conclude that organisms which reproduce asexually produce identical offspring.

The lesson themes and content are sequenced coherently from a student’s perspective. Related evidence includes:

- Prior to transitioning into students learning more about the structure of muscle cells, the following guidance is provided. Lesson 2: “Briefly navigate into today’s work. Display slide A. Say, In the previous class we came up with great questions and ideas to investigate! We worked on connecting our questions together, and we thought we might start by trying to figure out how those animals got such big muscles. We already have some ideas about muscles, but we were uncertain about what we would see if we zoomed in on the muscles of extra-big versus the more-typical individuals. Refer to the classroom consensus model” (Teacher Edition, page 55). This is used to transition into studying the structure of muscle cells.
- Lesson 7: Students use their model to predict that siblings should look the same. After gathering evidence that this is not really the case, the teacher is prompted to engage students in a discussion about why that might be the case. The teacher is then provided with a series of prompts to lead students to the question “What are we wondering?” (Teacher Edition, page 165). The following teacher guidance is provided: “Purpose of this discussion: To problematize the next lesson question. We want kids to start wondering, If we have this model for how offspring get traits from their parents via these alleles, then why don’t all of the offspring of

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

those same parents look the same?” (Teacher Edition, page 145). This motivates new learning about how alleles are inherited from parents in lesson 8.

- After identifying questions on the DQB students have answered as well as those that remained unanswered, the teacher is provided with guidance to motivate learning about other phenomena, specifically leading to investigating more about plants in the next lesson. Lesson 11: “Navigate into next time’s work. Display slide Y. Refer to the chart you just created to support a decision about what organism to investigate first in order to expand our model. Say, If we start with investigating an organism that is the most different from cattle or the most confusing to explain, then maybe explaining other organisms and variations we’re curious about will be easier from there. Which of these organisms do you think is most different from cattle? Which would be the best choice to really push on our model and help us expand it? Why? Sample student responses: The plants are the most different. We should investigate strawberry size or wheat kernels or apple colors first. We’re not sure if plants even have genetic material like we saw in animals. Some of those plants could grow wild, and wouldn’t be so influenced by humans. Plants don’t even have muscles! They’re way different! Say something like, It sounds like we need to investigate a plant next. Before we can dive into a specific one it seems like we should figure out if they even have genetic material to be influencing the trait variations we see. That can be our work for next time!” (Teacher Edition, page 226).
- Lesson 12: “Navigate to the next lesson. Project slide S. Summarize what the class just figured out, then ask the question on the slide. Say, We just figured out plants have genetic material in their cells just like animals do. Do you think they also pass on the genetic material to their offspring the same way that animals do? What could we do to find out?” (Teacher Edition, page 242). This motivates learning of plant parts to further investigate how they reproduce.

Suggestions for Improvement

N/A

I.E. MULTIPLE SCIENCE DOMAINS

When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

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

Rating for Criterion I.E. Multiple Science Domains

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that links are made across the science domains when appropriate because the unit can be fully addressed with the targeted life science DCIs. In addition, connections across previously learned domains are made using the CCC of **Cause and Effect**.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Students can make sense of the anchoring phenomenon using only the Life Science domain. Related evidence includes:

- Teacher Background Knowledge: “This unit is guided by the key idea that both environmental and genetic factors influence the variation we see in living things. In this unit, students will develop, refine, and apply models to first explain what could be causing some cattle to have such big muscles, and then explain what is causing other variations we’ve noticed around us. As students obtain and evaluate information from farmers, breeders, and research scientists, they see the role that humans often have in selecting for certain trait variations. Students work toward explaining how environmental and genetic factors affect organisms’ growth to varying degrees depending on the trait, and apply what they have learned to explain variations in many organisms other than cattle” (Teacher Edition, page 18).

The CCC of **Cause and Effect** is used to make connections to science domains addressed in previous units. Related evidence includes:

- Lesson 3: “Establish a cause-and-effect relationship. Display slide G. Say, In the Magnets Unit, we traced cause-effect relationships within the system of the speaker. Now we get to apply the same idea to living systems! Based on the articles we just read, what are the cause-effect relationships among protein in food, exercise, and muscle growth? Let’s work together and use this table to articulate this relationship” (Teacher Edition, page 74).
- Lesson 6: “Once again (as in Lesson 3), we are applying the cause/effect scaffold students used in OpenSciEd Unit 8.3: How can a magnet move another object without touching it? (Magnets Unit). In that unit, students used this tool to plan investigations they could carry out to test their hypotheses about forces and motion. In this lesson, this familiar tool is supporting students in planning biological investigations, even hypothetical ones they won’t be able to carry out in their own classroom” (Teacher Edition, page 136).
- Lesson 7: “Build a cause-effect chain. Display slide H. Say, We’ve been modeling several cause-and-effect relationships today, and we already had others on our classroom consensus model. In the Magnets Unit when you had multiple cause-effect relationships that happened in a sequence (from turning on the music player to getting the music we hear), you represented them in a chain like this. This graphic can help us visualize the cause-effect relationships that influence an animal’s phenotype, also. But, the final result of an animal’s phenotype isn’t quite as simple as this graphic” (Teacher Edition, page 170).

Suggestions for Improvement

Consider providing additional opportunities to connect learning to other science domains using CCCs, such as **Cause and Effect**, that do not only rely on knowledge of previous units for students who may not have engaged in previous OpenSciEd units.

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.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

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, English language arts (ELA), history, social studies, or technical standards because grade-appropriate mathematics and ELA CCSS are purposely incorporated into lessons with teacher support to help students make these connections. Reading materials go beyond textbooks and include journal articles, infographics, and scientific websites.

Connections to appropriate mathematics CCSS are found within the materials. Related evidence includes:

- **Teacher Background Knowledge:** The unit introduction includes a note about the importance of a certain learning sequence for middle school science courses based on the specific understandings of mathematics CCSS skills students should have prior to this science unit: “Also note that an important math consideration was made when placing this unit in the 8th grade scope and sequence. The understanding of essential CCSS math probability standards does not occur until 7th grade. Specifically, the standards CCSS.MATH.CONTENT.7.SP.C.5, CCSS.MATH.CONTENT.7.SP.C.6, and CCSS.MATH.CONTENT.7.SP.C.7 would need to be taught before starting this unit.” This section also provides the prerequisite Mathematics CCSS concepts that are necessary for this unit: “In Lesson 3, students analyze and interpret data from graphs and charts about the effects of dietary protein and exercise on muscle growth. This work draws upon multiple Common Core Mathematics Standards from elementary grades 1–5 within the domain of Measurement and Data, under the category of Represent and Interpret Data. For example: CCSS.MATH.CONTENT.3.MD.B.3: Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step ‘how many more’ and ‘how many less’ problems using information presented in scaled bar graphs... In Lesson 16, students co-construct and analyze a histogram from arm span length data. Prerequisite math concepts that may be helpful include the following: CCSS.MATH.CONTENT.6.SP.B.4: ‘Display numerical data in plots on a number line, including dot plots, histograms, and box plots’” (Teacher Edition, page 26).
- *CCSS.MATH.CONTENT.7.SP.C.7: Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.*
- *CCSS.MATH.CONTENT.7.SP.C.7.B: Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.*
 - Lesson 8: “Students engage in a class discussion to lead them to the conclusion that there are mathematical tools they could use to figure out the probability that an offspring will have a specified genotype or phenotype. The teacher then uses slides to walk students through the series of steps which could be followed to determine the probability. At the conclusion of this, the following teacher prompt is provided: “Turn and talk about the steps we’re using. Display slide AL. Say, An algorithm is a series of ordered steps used to solve a problem. What are the steps we can use each time we want to determine the probability of the possible genotypes of the offspring of two parents? Turn and talk with a neighbor to review the steps we just took” (Teacher Edition, page 190).
 - Lesson 9: Students collect data from a simulation of selective breeding in birds. Students are asked to calculate the percentage of birds that have each selected trait.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

The following teacher prompt is provided: “Then tell students that they will need to tally up these values at the start and at the end of their selective breeding, and use a calculator to determine the percentages for each category, which should add up to 100% for that column. Point out that there is an additional data table to record number of matings, number of offspring, and number removed at the end of their selective breeding investigation, as well as some additional making sense questions to respond to. Tell students that they will have 10 minutes to conduct their simulation, at which time you will give a signal to record the results for the current simulation and answer the questions on their handout in the last 5 minutes” (Teacher Edition, page 208).

- *CCSS.MATH.CONTENT.6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots.*
 - Lesson 16: Students use an online tool to create a histogram of the arm span dataset. “Use the histogram creator to co-construct a histogram using the data collected by the class... After the class has settled on a good representation, you may want to capture a screenshot and add it to slide U to use as you facilitate a discussion that highlights the ideas that are important to consider when creating the histogram using the class data.” (Teacher Edition, page 301).

Connections to appropriate ELA CCSS are found within the materials. Related evidence includes:

- *CCSS.ELA-Literacy.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.*
 - Lesson 1: Students engage in a turn and talk about the bull photos presented. “After students have had some time to work on their own, display slide C and direct them to share their thinking with a neighbor. Remind them to refer to specific details in the photos to support their ideas” (Teacher Edition, page 36).
 - Lesson 2: Students are provided with an opportunity to discuss what they notice about the structure of muscle cells with a partner. “Let’s take a look at these microscope images of muscle cells again to help connect to the ideas we had as we felt our muscles. Turn to a neighbor and describe what you notice about the structure of these muscle cells and how that might connect to what we observed when we felt our muscles moving” (Teacher Edition, page 56). Students then share their thoughts in a whole group discussion.
 - Lesson 8: “Discuss patterns and how these connect to what we know and the questions we are trying to answer. Display slide N and Say, Turn to your elbow partner and take 30 seconds each to share one pattern or key idea you noticed, and one question that came up for you while you were looking for patterns between parents and offspring.” (Teacher Edition, page 179).
- *CCSS.ELA-LITERACY.RI.8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound, and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.*
 - Lesson 3: Students co-construct a checklist as a class for what to look for to determine if a source is credible. This checklist is then used as they engage in a reading to determine the credibility of the course. After students stop reading the article, teacher prompts are provided to engage students in a discussion regarding the credibility of the article.
 - Lesson 9: Before engaging in readings about selective breeding in cattle, the following teacher prompt is provided: “Identify goals for reading about selective breeding in cattle. Say, I have three readings about selective breeding in cattle. One is from the

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

interview with our farmer from earlier lessons, another is an interview with another farmer that raises heavily muscled cattle, and the final reading is from another source. Before we dive in, let's think about what our goals are as readers, how we can compare the three readings, and how we can identify and evaluate the claims made by each reading" (Teacher Edition, page 201). Question prompts are then provided to lead a class discussion about the purpose of the materials and how we can tell they are reliable.

Throughout the lesson, students have an opportunity to read a variety of texts. These include:

- Lesson 4: A transcript of an interview titled Ask a Farmer: Diet
- Lesson 4: A blog post titled How to Build Muscles
- Lesson 6: An adaptation of scientific research articles regarding the relationship of the Myostatin Protein to the heavily muscled phenotype
- Lesson 16: A research paper from a journal.

There are multiple writing opportunities found throughout the unit. Related evidence includes:

- Students use a Progress Tracker throughout the unit, which allows them opportunities to individually write what they have figured out so far.
- Lesson 7: Students have the option of writing their explanation to explain how an animal's genotype can influence its musculature.
- Lesson 13: Students complete an exit ticket in which they write an answer to the following question: "2. If a gardener liked a particular lily flower that grew in their garden, and wanted to make more plants with the same kind of flower, how would you recommend that they do that? Explain why you recommend that way of doing it" (Lesson 13 Handout Exit Ticket, page 2).
- Lesson 17: An optional activity asks students to write a reflection regarding their experiences in the unit.

Suggestions for Improvement

N/A

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL CATEGORY I SCORE: 3 (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

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

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 because the anchoring phenomenon and lesson-level inquiries are actual scenarios from the natural world. Students can experience the phenomena as directly as possible and the unit connects students' questions to the targeted learning.

Students are presented with relevant and engaging phenomena which are relatable to students and presented in a way which allows students to experience them as firsthand as possible. Related evidence includes:

- Lesson 1: Students look at pictures of cattle directly to make observations and record questions: "Independently record noticings and wonderings about the bull photos. Say, The photos I'm going to show you are of actual animals. These photos have not been altered to make them look like this. Take a couple of minutes to look at them carefully and record what you notice and wonder" (Teacher Edition, page 36).
- Lesson 1: Students look at pictures of other animals with large musculature. "The goal is to broaden out to more examples of animals that have really large muscles. The large musculature isn't just a one-time thing that happened in one animal" (Teacher Edition, page 38).
- Lesson 1: When creating their initial model to explain the phenomenon, students are asked to develop their model around an animal they have seen that had extra-big muscles which allows them to focus on an animal with which they are more familiar.
- Lesson 2: Students investigate their own muscles to begin learning about how muscles work. The following teacher guidance is provided: "Say, Let's start with considering the muscles we have on our own bodies since they're right here with us! After that, we can zoom into other animals that have those extra-big muscles. What are our muscles like? Feel our own muscles in our lower arms and necks. Say, Use one hand to feel along your other arm between your wrist and elbow. Demonstrate on your own arm" (Teacher Edition, page 59).
- Lesson 5: Students use images of cattle when constructing family trees to investigate patterns of inheritance: "Work in small groups to build the pedigrees. Show slide I and review the directions listed there. 1. Make room on your workspace so each person in your group can easily see all the cattle in the family. Work together to figure out which of the three

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

musculature phenotypes your first individual (Eva, Jacki, Arias, Elkie, Name 5–7, or Name 6–7) has. Then agree on what symbols from your key for sex (circle or square) and for phenotype (shading) should be entered for your first individual at the bottom of the pedigree and record those in the organizer” (Teacher Edition, page 103). “Say, Scientists organize the chromosomes like this so they are able to see patterns. This is the karyotype of Lorenc’s muscle cells. However, if we were to look at the chromosomes in any of his other body cells, they would have the same number of chromosomes and could be organized the exact same way” (Teacher Edition, page 114).

- Lesson 11: Students are provided with motivation to begin investigating plant-based phenomenon after noticing they had not yet answered questions on their DQB related to other organisms. After working through a process as a class to determine which organisms to investigate next, the following teacher prompt is provided: “Navigate into next time’s work. Display slide Y. Refer to the chart you just created to support a decision about what organism to investigate first in order to expand our model. Say, If we start with investigating an organism that is the most different from cattle or the most confusing to explain, then maybe explaining other organisms and variations we’re curious about will be easier from there. Which of these organisms do you think is most different from cattle? Which would be the best choice to really push on our model and help us expand it? Why?” (Teacher Edition, page 226).
- Lesson 13: Students are shown red peppers, apples, pea pods and strawberries to see where the seeds are located followed by watching a video which shows a pepper plant growing from seed through flowering and make observations about how plants make seeds.
- Lesson 15: Planaria, flamingos, and apples are used as lesson-level phenomena to investigate the relationships between environmental factors and coloration. Students are provided with pictures of the organisms.

Students are provided with multiple opportunities to connect the phenomena in the unit to their own experiences. Related evidence includes:

- Lesson 1: Students are provided with an opportunity to brainstorm related phenomena. The following teacher guidance is provided: “Say, Like the cattle or tulips were generally the same but had differences or variations in some characteristics or traits, what other examples of living things have you seen that are basically similar but have different variations in a feature or trait? Give students 3 minutes to create their lists, working silently and independently” (Teacher Edition, page 45). Guidance is provided for the teacher to elicit these ideas for students who may struggle. “If students are struggling to come up with ideas, prompt them to think about their own pets compared to a friend’s pet, plants they see on the walk to school, or even the foods they eat that are living things, such as apples or bananas” (Teacher Edition, page 45).
- Lesson 1: An optional home learning assignment is provided in which students are asked to identify variations in organisms in their community. “Help support students and trusted members of their community in observing variations in living things. Encourage students to bring their observations and ideas back to class to inform and enrich the work of this unit. Inviting students to bring their family and/or community knowledge, experiences, and practices into school not only supports students in coordinating the learning they do outside school with what they do in school, but it can also help you as a teacher to expand your understanding of the strengths of the families and communities you work with” (Teacher Edition, page 46).
- Lesson 3: “Motivate the desire to investigate human muscle growth. Display slide B. Direct students to briefly turn and talk with a neighbor about their own experiences with building bigger muscles. After about 30 seconds, share ideas as a class. Ask, Do you have any personal

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

experiences with increasing your own muscle mass? What are some ways you or other people have built bigger muscles?” (Teacher Edition, page 71).

- Lesson 9: “Besides animals, what are some other types of organisms that you think people may have tried to selectively breed? Draw on your experiences from the grocery store to brainstorm some possibilities” (Teacher Edition, page 206).
- Lesson 13: If you have a student who has experience, or knowledge, about ways some plants may reproduce asexually, you might choose to have them share their experience rather than using the media described in the step above. Hearing about the experiences of their peers generally has a positive impact on students’ learning. If you can cue students a couple of days ahead of time that they will be sharing information about this with the class, they may even want to bring in cuttings or parts of plants from home to share” (Teacher Edition, page 257).

Throughout the lesson, students are provided with opportunities to generate and use their own questions they have about the phenomenon and ways to investigate those questions related to their own experiences. *While there’s teacher support to cultivate student questions from their experience, there isn’t explicit support to cultivate students’ questions related to their community and culture.*

Related evidence includes:

- Lesson 1: Students generate their own questions which are then used to create a DQB.
- Lesson 1: Students create a chart indicating possible future investigations and data they will need. The following teacher guidance is provided: “This list of ideas for investigations will be revisited throughout the unit just like the DQB. When a future lesson involves an investigation like one the class suggested, take time to point that out. For example, in Lesson 3, students will investigate what these cattle (and typical cattle) eat and do for exercise. If your students suggest ideas that are not planned in the unit but that you feel would be productive to pursue, use your discretion and your knowledge of the storyline to decide where these additional investigations would best fit so the unit’s punchlines continue to build on one another” (Teacher Edition, page 49).
- Lesson 2: Students are provided with an opportunity to document which questions they are still wondering about and then share these questions out as a class.
- Lesson 4: “Display slide H. Say, OK, so it seems like the cattle are born like this. But there doesn’t appear to be anything specific in our model yet indicating what could happen before birth to cause this. What questions do we have on our DQB related to how these cattle might be born like this? Refer to the DQB to help decide what to investigate next. After pointing out related DQB questions, summarize these ideas by asking, So how could this be? Why are some baby cattle born with big muscles and others aren’t? What could be causing differences in what they are born with? Turn and talk with your partner for a moment about the slide questions” (Teacher Edition, page 94).

The materials provide teacher support for anticipating and dealing with issues that may arise when engaging in discussion. Related evidence includes:

- Lesson 1: “At some point during this unit, your students may bring up the idea that they may (or may not) share traits with members of their families. Recall that not all your students may be living with or in touch with their biological family members and therefore would not be able to compare themselves with their parents, grandparents, siblings, and so on. In order to be sensitive to these situations, you should not direct students to explore inheritance with their families. The home learning in this lesson should be focused on nonhuman examples of trait variation, although if students bring in human examples on their own, that is OK” (Teacher Edition, page 45).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 2: “Students might bring up the fact that the meat people eat is muscle from animals. Leverage students’ connection to meat by asking them to consider how that could help us in today’s work. Does a description of meat line up with the other descriptions we’re making of muscles? Be mindful of the fact that some of your students may be vegetarian, vegan, or otherwise sensitive about animal rights, and as such, discussions about this topic may be difficult for them. Remind the class to be respectful of one another’s ideas, and be sure the discussion continues to focus on moving our science thinking forward” (Teacher Edition, page 55).
- Lesson 5: “It is important to remember that while biological sex is genetically determined, gender is not. Gender is a social construct that refers to how individuals position themselves and are positioned by others in relation to roles as female or male. There are more gender identities than just male or female. Gender definitions, expectations, and roles vary in different cultures, with some cultures embracing multiple gender definitions. In this unit, it is more scientifically accurate to refer to biological sex rather than gender. As such, refrain from using terms like ‘girl’ and ‘boy’ to refer to animals; use ‘male’ and ‘female’ instead” (Teacher Edition, page 100).
- Lesson 9: “Please note that we intentionally choose to say ‘selected for’ instead of “desirable” when describing the trait variations that breeders select for. While consumers, farmers, and others may desire certain trait variations, the development team did not want to promote thinking about desirable or undesirable trait variations that could carry over into thinking about humans” (Teacher Edition, page 200).
- Lesson 16: “Body size and stature can be a sensitive topic for people of any age, but especially for middle schoolers. We have added more data for two reasons, first so that there are more measurements and we will be more likely to see the shape of the curve we are looking for (especially if there is a small class); and two by having more data students will not be as likely to feel like the rest of the class is noticing their ‘outlier’ measurements. As you collect measurements throughout the day in more classes, keep adding to your data set to have an even larger number of measurements. You may even keep this data year to year and later explain to students that these are measurements that you have collected over the years from people at their school. However, if you have concerns about collecting arm span data from your class, you may continue the activity with only the data provided in the table” (Teacher Edition, page 301).

Suggestions for Improvement

Consider providing additional alternate activities like the one on page 257 to encourage students with a special interest to share their experiences with the class.

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)

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

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 because students are provided with numerous opportunities to engage in classroom discourse and show changes in their thinking as they receive feedback.

Students have multiple opportunities to articulate their ideas with peers. This happens in a variety of ways, which includes small group discussions and whole class discussions. Teacher guidance is provided to elicit these ideas. Related evidence includes:

- Throughout the unit, students gather in Scientists Circles and engage in other types of classroom discussions. For each of these discussions, suggested teacher prompts and sample student responses are provided to provide teacher guidance to guide the discussion.
- A section in the Teacher Handbook (Teacher Edition, pages 38–45) gives ideas for supporting different kinds of discussions in the classroom.
- Lesson 1: Students work in small groups where they can safely try out their thinking about how to sort tulips by their traits. “Work in small groups to observe photos of tulips and identify traits and variations. Display slide R. Say, I have some images of a type of flower called a tulip. Work with your group to observe the images and identify some traits of tulips. Choose one trait and then organize the images by variations in that trait, grouping them or lining them up to show the variations. Form 8 small groups of students and distribute a set of 24 tulip photos to each group. Give students 5–7 minutes to examine their photos and sort them based on a trait of their choice. If they have time to spare, encourage groups to reorganize their tulip photos based on a different trait” (Teacher Edition, page 44).
- Lesson 1: Students engage in an initial ideas discussion as a whole class. The following teacher guidance is provided: “Purpose of this discussion: (1) to engage students in thinking very carefully about these photos, (2) to generate a range of ideas to cultivate curiosity and uncertainty, and (3) to build student agency in science discussions. A diverse range of ideas is something to celebrate here!” (Teacher Edition, page 36).
- Lesson 6: “Small groups develop initial models for relationships they’ve found. Display slide O. As groups finish recording their patterns on Guiding Questions for Chromosome/Protein Data, call everyone’s attention back for the next direction. Within each group of same-phenotype cattle, arrange smaller groups of about 3 students. Distribute a piece of chart paper to each group. Direct these groups to develop a model that captures the patterns they found between their cattle phenotype, proteins, and chromosomes” (Teacher Edition, page 133).
- Lesson 11: Students revisit the DQB. Students first work individually to identify questions that have answered, partially answered, or not yet answered, as well as generate new questions. Students then discuss the questions they can answer with a partner. “Share answers with a partner. Display slide C. Pair students up with a partner and have them spend about 3 minutes taking turns sharing answers to the questions they think we can answer now, using evidence from their work in the unit so far. Again, if new questions arise, students can record them in their notebooks for now, so we can use them soon” (Teacher Edition, page 221). Students then identify questions they have answered as a class and add any new questions to the board. This is used to motivate the next step for student learning: “Students will realize that we have answered a lot of questions about cattle and muscles specifically, and many of our questions about genetic material. However, we still have questions about organisms other than cattle and trait variations other than musculature” (Teacher Edition, page 221).
- Lesson 14: Students work in small groups to research and share information about an organism that reproduces asexually (Teacher Edition, page 267).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

The unit provides opportunities for students to show how their thinking has changed over time.

- The students develop a classroom consensus model which is discussed, revisited, and revised as a whole class throughout the unit as students engage in new learning.
- Throughout the unit, students use and update a Progress Tracker that includes their new learning.
- In Lesson 1, students individually create an initial model which explains why there are differences in the size of muscle in cattle. Students revise these models in Lessons 2 and 7.

Throughout the unit, students can receive feedback and use that feedback to respond and revise thinking when appropriate, **however explicit opportunities for students to respond to feedback directly from the teacher are not found.** Related evidence includes:

- Lesson 12: Students give and receive feedback from a partner about their explanation of plant reproduction. Then they express their individual ideas on an exit ticket assignment. “Students share, provide and receive feedback on their explanation. Display slide T. Each student should have an opportunity to share their explanation and receive feedback from one partner, and then listen to and provide feedback on a different partner’s explanation. Have students turn to an elbow partner and share their explanation verbally. The elbow partner should listen carefully, then provide feedback as directed on the slide. Peer Feedback Guidelines is available to support students if that would be helpful to your students. Have students turn to a different elbow partner and listen carefully to their explanation. They should then provide feedback to this second partner” (Teacher Edition, page 258).
- Lesson 16: Students share models in small groups and provide feedback to others to improve and clarify the ideas represented in the models. “Students meet with their small group to share and compare the models and explanations they created. Direct students to circle up in their small groups. Display slide X and instruct students to share their models and explanations with other students and then create a list of similarities and differences in their models. Students exchange models to provide peer feedback. Ask students to provide feedback that might help their partner’s models clearly show the cause and effect relationships that result in the phenotype” (Teacher Edition, page 303).

Suggestions for Improvement

Consider providing additional opportunities for students to receive feedback from their peers and teacher. While the Teacher Handbook suggests adding more opportunities for peer feedback, it would be beneficial for these opportunities to be explicitly incorporated into specific lessons in the unit.

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.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Rating for Criterion II.C. Building Progressions

Adequate
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because the materials clearly state the expected level of proficiency for all three dimensions as well as how this proficiency will be built upon, **however, the materials do not clearly provide this information at the element level for targeted SEPs or CCCs.**

The teacher background materials provide information about the expected level of prior proficiency students should have with individual elements of all three dimensions. In addition, guidance is provided for how and where specific DCI elements will be used and developed, **however this guidance is not provided at the element level for all focus SEP and CCC elements.** Related evidence includes:

- The materials provide a table for the DCIs, focal SEPs, and focal CCCs (Teacher Edition, pages 19–20) that clearly state how each of these dimensions are developed throughout the unit. While specific element level information is provided for the DCIs, **information for the element level is not found for the SEPS or CCCs in this table.**
- Specific information is provided regarding how the CCC of **Cause and Effect** and the SEP of **Obtaining, Evaluating, and Communicating Information** are built from a previous unit: "Additionally, this unit uses and builds on Cause and Effect supports that were established in OpenSciEd Unit 8.3: How can a magnet move another object without touching it? (Magnets Unit), and the checklist for Obtaining, Evaluating, and Communicating information that can support students' work in this unit was previously used in OpenSciEd Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit) and Healing Unit" (Teacher Edition, page 23).
- In the teacher materials, a table is provided which clearly outlines previous learning of DCI elements from other units which will be built upon (Teacher Edition, pages 21–22), **however no such table is provided for SEPs or CCCs.**

Further information regarding the expected proficiency of all three dimensions and how they are developed further using a logical sequence is found within specific lessons. Related evidence includes:

- Lesson 1: Where We Are Going and NOT Going Section: "Students may come into this unit with different ideas about how animals get such big muscles. They most likely will know that diet and exercise play a large role in how big an animal's muscles get. What they might not know is that the extra-big muscles they see in the anchoring phenomenon are the result of having an allele for the MSTN gene that makes a different shape of a protein called myostatin. Figuring out the genetic and environmental factors that can influence musculature is the focus of the first lesson set of the unit; in the second lesson set, students will explore how genetic and environmental factors influence the variation we see in other traits in other organisms" (Teacher Edition, page 35).
- Lesson 3: "SUPPORTING STUDENTS IN ENGAGING IN OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION This unit is one of the last units taught in 8th grade. At this point in the scope and sequence, students should be able to utilize the practice of 'obtaining, evaluating, and communicating information' almost or completely independently. If this unit is taught out of sequence and/or you have students who are struggling with this practice, scaffolding may be appropriate here. Instead of co-constructing a checklist with students to guide their reading, you may want to distribute Organizer for Obtaining and Evaluating

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Information and have students fill it out as they read. If you choose this option, slide E — alternate is available to support your students, as well” (Teacher Edition, page 72).

- Lesson 3: “SUPPORTING STUDENTS IN DEVELOPING AND USING CAUSE AND EFFECT The teacher instructions here assume that students have experienced OpenSciEd Unit 8.3: How can a magnet move another object without touching it? (Magnets Unit) prior to completing this unit. In the Magnets Unit, students used this framing to establish several cause-and-effect relationships about how a speaker makes sound. If your students have not considered cause-and-effect relationships in this way, you may need to provide more support as they complete the table on slide G” (Teacher Edition, page 73).
- Lesson 5: “Work students do in this lesson to reason through how a single fertilized cell develops into a calf relies heavily on prior knowledge from OpenSciEd Unit 6.6: How do living things heal? (Healing Unit). If your students have not yet experienced the Healing Unit, you will need to spend more time supporting their sense-making about how cells grow and split in order to heal injuries and/or increase the organism’s size (as during embryonic development)” (Teacher Edition, page 98).
- Lesson 13: Lesson 10 includes prior knowledge about pollination in plants from grade 2 and connects it to the current learning about inherited traits. The Additional Guidance section includes what students should already know from a prior performance expectation. “If students struggle to identify pollinators as being necessary for plant reproduction, refer them to experiences with plants from earlier grades. The identification of animals as pollinators and seed dispersers is a second grade standard. What we are adding here is the middle school DCI element that some of the ways plants reproduce depend on animal behavior and specialized features” (Teacher Edition, page 253).
- Lesson 14: “This prompt foregrounds thinking students have done numerous times in this unit as they have used cause and effect framing to discuss these relationships. This is an opportunity to help students predict, using their knowledge of cause and effect relationships, about what they might see when planaria regenerate after being divided into multiple pieces. Having students think through the different potential outcomes helps them consider the mechanistic how or why explanations for this relationship. At this point in the unit students should be able to use causal framing themselves. Look for students saying When a planarian is divided into multiple pieces we will observe _____ then proceed to explain why we should observe their predicted outcome” (Teacher Edition, page 273).

Suggestions for Improvement

- Consider providing guidance in the Teacher Background Knowledge section on the expected prior knowledge and learning progression for all targeted SEPs and CCCs at the element level.

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students’ three-dimensional learning.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

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 because all the science ideas in the unit are accurate and the unit provides teacher support for clarifying students' ideas when needed.

The unit provides guidance to ensure scientific accuracy and address any potential misconceptions. Related evidence includes:

- Teacher Background Knowledge: “Teachers may notice some important differences in how this OpenSciEd unit treats the topic of genetics from what they have seen in prior curriculum materials. There are two important reasons for these shifts. First, the Framework for K–12 Science and the NGSS call for changes in what we should teach. Second, research shows that conventional ways of teaching genetics can lead to problematic views about race and ethnicity. (1) Shifts in standards about genetics: Historically, Mendelian genetics and the associated terminology (dominant, recessive, etc.), have been the major focus of much teaching about genetics. The Framework for K–12 Science Education and the NGSS de-emphasize these topics and the ability to use them to compute the likelihood of traits resulting from combinations of genetic information. In their place, the Framework and the NGSS emphasize three key ideas at the middle school level: (a) almost all traits show great variation, (b) this variation is due to both environmental and genetic factors, and (c) the genetic information influences the trait that appears through cellular and molecular mechanisms. Therefore, we have anchored the OpenSciEd genetics unit in a phenomenon in which both genetics and environmental factors contribute to variation in a trait, and where students can see how changes to the structure of genes alters the structure and function of proteins that influence the trait. We selected the trait of muscle mass, which we can see in familiar animals, including humans. (2) Reducing likelihood of problematic views about race: The choice to focus on more complex genetics rather than only simple dominant/recessive relationships was also driven by research that shows there is a potential for social harm associated with teaching overly simplified models of inheritance... Research has shown that teaching only traits determined by a single gene can cause harm by leading students to believe in genetic determinism and genetic essentialism. Genetic determinism is the belief that genes alone determine all of an organism’s traits. Genetic essentialism is the belief that racial or gender groups have widely different genes that cause them to differ in physical, cognitive, and behavioral traits. At their extreme, these views can result in blatant prejudice, racism, and the belief that racial and/or social disparities are natural and need not be eliminated through policy interventions (Lynch, Morandini, Dar-Nimrod, & Griffiths, 2018)... Therefore, we have chosen to provide students a first encounter with genetic inheritance that uses more complex, multifactorial genetics in order to reduce the risk of developing or reinforcing deterministic and essentialist mindsets in our students” (Teacher Edition, page 28).
- Lesson 1: Where We Are Going and NOT Going section: “This unit intentionally brings out the effects of environmental factors on trait variation because this is an important scientific concept to understand that will be further built upon in high school. The trait variation we see among living things is almost never due to genetics alone. By the end of the unit, students will grasp that genes and environment are always at play in the variation we see among living things. (There is a gene and environment interaction, but this is beyond the middle school grade-band understanding)” (Teacher Edition, page 35).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 1: “Students may refer to the pictures of the bulls as “cows” or “cattle” or some other word. Whatever name they use in their initial ideas is fine. For your background knowledge, the following are definitions of the specific terms: Cattle is the plural for males and/or females. A bull is a fertile male. A steer is a sterile male. A cow is a female who has had a calf. A heifer is a female who has not had a calf” (Teacher Edition, page 38).
- Lesson 2: Where We Are Going and NOT Going section: “The video, handout, and discussion of muscle structure and function, even at the protein level, have deliberately simplified the sliding filament theory of muscle contraction. Many specific terms (e.g., sarcomeres, t-tubules) have been left out, as well as the chemical processes involved (e.g., the roles of calcium or ATP). We want the students to learn enough about muscles that they can explain our anchoring phenomenon and understand the structure-function relationship of proteins but not spend so much time on muscle anatomy and movement that it detracts from the unit’s focus on genetics” (Teacher Edition, page 54).
- Lesson 5: “Students will likely notice the X and Y chromosomes on the cattle karyotype. In cattle and humans, biological sex is determined by an XX/XY system. Keep in mind the difference between biological sex and gender. This unit does not address gender but deals only with biological sex. Here is some additional information about XY chromosomes for your teacher background knowledge: A functional SRY gene on the Y chromosome, once activated, creates testosterone and anti-mullerian hormone, which typically causes the development of a male reproductive system. Without a Y chromosome and functional SRY, an XX embryo develops into a female. While SRY is central, there are many other genes involved in influencing maleness. When SRY is mutated and produces a nonfunctional protein, the individual presents externally as female (and is usually raised as a female, that is, has a female gender identity) but has XY chromosomes and underdeveloped ovaries (therefore, the individual cannot bear children). There are several other systems for determining sex, some genetic (like XX/XY) and some environmental, like the effect of temperature on sex of reptiles” (Teacher Edition, page 114).
- Lesson 6: “If/when your students ask about genetically-modified organisms (GMOs), you can respond by saying something like, To modify something means to change it. So yes, when scientists alter or change the shape of a specific region on an organism’s chromosome, that’s genetic modification” (Teacher Edition, page 141).
- Lesson 16: “It may be tempting to think that one can actually separate environmental and genetic influences on traits. But it is too simple to try to say that a certain percentage of a trait is influenced by the environment and a certain percentage is influenced by genetics. Rather, all traits are mutually influenced by genes and environment in an integrated way. It isn’t correct to think that there are two influences that are independent of each other. Instead, it is genes interacting with the environment that determines our traits. The notion of heritability as a measure of how much genes versus environment influence a trait is therefore misleading. Our takeaway in this lesson is that both genes and environment are always at play — we are not getting into how they interact. More information about ‘environment’ can be found in the Genetics FAQ document located in the handout folder. Also, do not confuse the way we approach the role of environmental factors (local conditions such as diet) in the growth of organisms with epigenetics. Gene expression is beyond the scope of this unit and beyond the target DCIs for middle school” (Teacher Edition, page 293).
- Lesson 16: “Also note that if you are considering exposing students to other examples of human traits, many that were previously thought to have simple dominant/recessive inheritance patterns are, in fact, more complex. There is more information about these

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

examples traditionally used in classrooms that you may want to consider at this link: <http://udel.edu/~mcdonald/mythinintro.html>" (Teacher Edition, page 293).

- Lesson 16: "If your state assessment will expect students to recognize the terms 'dominant' and 'recessive' and name the patterns of inheritance tied to these words, you may choose to introduce them during this lesson in the context of wheat kernel color. You can discuss why the allele that leads to red pigment would be considered 'dominant' to the allele that does not lead to production of that pigment, and how that relationship results in a classical dominant/recessive pattern. However, resist the urge to equate 'makes a product or protein' with 'dominant,' because this is not always the case (such as with Huntington's disease, for example)" (Teacher Edition, page 298).

Suggestions for Improvement

N/A

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

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide guidance for teachers to support differentiated instruction because the unit provides multiple differentiation strategies that support a variety of students, including multilingual learners, struggling readers, and students with high interest or who have already met the performance expectations.

Materials explicitly clarify how teachers can anticipate and support the needs of students who might struggle. Related evidence includes:

- Lesson 1: "Initial Model asks, If you could view the muscle cells in the muscle tissue from both animals with a microscope, how would they compare? If your students did not participate in OpenSciEd Unit 6.6: How do living things heal? (Healing Unit) and/or you know they have not had experience with microscopes, you may need to dissect the word microscope (micro

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

meaning “small” and scope meaning “see”) and/or rephrase this direction to something like, If you could zoom in really closely. ...” (Teacher Edition, page 39).

- Lesson 2: A strategy for integrating information from a variety of sources is provided to help students who struggle with this task. “If students are struggling to integrate information from different media, guide them to highlight using different colors their summary statement (in part 2) about how muscles contract. Highlight one color for ideas that came only from watching the video. Highlight with another color for ideas that came only from the article, then highlight in a third color ideas that were found in both. Students should see all three colors in their summary, showing them how they had to integrate multiple sources to deepen their understanding” (Teacher Edition, page 59).
- Lesson 4: Students record what they notice and wonder as they listen to the audio of the interview with a farmer. The following teacher guidance is provided: “The action of marking two key points on the list of ideas they have written down allows all students to manage the information. Taking the time to do this gives students a moment to focus on their ideas and allows them to be better prepared and more confident to share their ideas with the class” (Teacher Edition, page 90).
- Lesson 6: “What to do: In order to support students who are struggling to make sense of the text, you might provide an annotated version of the text(s) and ask students to explain why those annotations are helpful to obtaining information and evaluating the text. To support students who are struggling with supporting cause/effect relationships, you might provide a print-out of slide U so students can complete the cause/effect table on paper” (Teacher Edition, page 138).
- Lesson 7: “If you think your class would benefit from additional practice with these terms and ideas, take another round through them as you’re organizing the sticky notes in the next step. As you review each word or phrase on a sticky notes, ask students to recall their meanings in various ways. Mix it up! Call volunteers up to describe the images on slide D. For some terms you might ask a volunteer to read the Word Wall definition and then restate that in their own words. For others you might ask students to turn and tell a neighbor what that word means. If time and space allow, have students add illustrations to the sticky notes and explain why they drew what they did” (Teacher Edition, page 154).
- Lesson 8: “Universal Design for Learning Crosses of two homozygous parents will be the quickest and easiest for students to conduct and record, and some students’ sustained effort will be enhanced by engaging with a quicker and easier analysis. However, these homozygous crosses will not give students an opportunity to notice any proportions or think about probability patterns. Many students may realize quickly that crosses with two homozygous parents will always result in the same offspring genotype. It is important to vary demands on students’ skills to optimize the challenge for all students. Consider your students’ skill level and processing/learning needs when assigning groups to particular breeding pairs. Regardless of student skill levels, have at least some pairs work with homozygous crosses so the data is available and the pattern of probabilities is obvious when the class data is tabulated” (Teacher Edition, page 185–186).
- Lesson 8: “Providing students with another form of representation of these methods will give them an opportunity to reread and interact with the text and diagrams at their own pace, differently from when the class was working through the slides orally. In addition, students can consider the different ways of working out this problem and identify what type of representation works best for them. Offering, and honoring students’ individual choices of, the multiple ways to solve for probability reinforces the actual meaning behind finding the

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

probability of possible offspring genotypes (the separation of alleles when sperm and egg are formed and their combining randomly during fertilization)” (Teacher Edition, page 188).

- Lesson 12: “Universal Design for Learning: Students have been using sentence starters to help them express their ability to use Cause and Effect to explain how data they collect serves as evidence to support a claim. There are two versions of this handout. If there are students with diverse levels of development with regard to using Cause and Effect you may choose to give some students version A and others version B (which includes more scaffolding). In this case, you may not choose to show slide P to give students who are using version A a chance to express their ability to use Cause and Effect without the extra scaffolds” (Teacher Edition, page 239).
- Lesson 14: “Universal Design for Learning: Students may benefit from careful planning of groups for today’s work rather than numbering off randomly or keeping the same groups they usually have. You might consider grouping students heterogeneously by reading skill or willingness to speak in front of the group to create effective cooperative learning groups. This can set groups up for success by providing one on one peer support and better differentiation. Or, if you have a couple of students who require extra support, you may want to group them together (to make teacher assistance easier) and assign them one of the simpler organisms to research, such as hydra or planaria” (Teacher Edition, page 267).

Differentiation strategies are provided for multilingual Learners. Related evidence includes:

- Teacher Background Knowledge: “It is best for students if you create cards for the Word Wall in the moment, using definitions and pictorial representations that the class develops together as they discuss their experiences in the lesson. When they co-create the posted meaning of the word, students ‘own’ the word — it honors their use of language and connects their specific experiences to the vocabulary of science beyond their classroom. It is especially important for emergent multilingual students to have a reference for this important vocabulary, which includes an accessible definition and visual support.” (Teacher Edition, page 29).
- Lesson 1: Supporting emergent multilinguals: Asking questions in everyday language allows students to share their thinking or experiences even if they do not have the appropriate scientific vocabulary yet. This is helpful for emergent multilingual students because by not requiring scientific words at the onset you do not limit their participation in classroom discourse” (Teacher Edition, page 46).
- Lesson 5: “Supporting emergent multilinguals: When new scientific words, like phenotype, are introduced, it can be helpful for emergent multilingual students to see a reference to these words added to a Word Wall. Add these words to the Word Wall as they emerge in the discussion, rather than before” (Teacher Edition, pages 100–101).
- Lesson 8: “Supporting emergent multilinguals: The common ‘fall back’ language many teachers use to convey information about the alleles an individual has involves describing a letter of the alphabet in terms of its ‘case.’ This creates several points of confusion for students because we are moving from a concrete to symbolic description of genotype. However, this could be especially problematic for emerging multilingual students who may lack familiarity with the details of our alphabet structure” (Teacher Edition, page 179).

Differentiation strategies are provided for learners with disabilities: Related evidence includes:

- Lesson 1: “As a reminder about supporting students with visual disabilities: This unit in general and this lesson specifically use images as data. So, you will need to make accommodations so that students with visual disabilities can access these data. Depending on your students’ needs, suggested modifications include enlarging and/or brightening the provided digital versions of

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

these photos or using alternate text descriptions. Your students' IEP or 504 case leaders should also be able to provide you with specific resources and possible modifications to use. If you have students who are color blind, the conversations in this lesson around color variations in a group of organisms may pose a unique challenge. If you haven't already done so, take some time to talk with your student(s), familiarizing yourself with their way(s) of seeing the world, and ask how you can best support them as they investigate differences among organisms, including but not limited to their color patterns" (Teacher Edition, page 34).

Differentiation support is provided for students who read below grade level. Related evidence includes:

- Lesson 3: The materials provide two versions of reading selections, and the teacher has the choice to use either or both. "If you think that any of your students would benefit from simplified versions of the readings used in today's lesson, use the materials with 'v2' in the titles, which have a lower text complexity (but the same content)" (Teacher Edition, page 72).
- Lesson 5: The following teacher guidance is provided with respect to the two different articles students are provided to read: "Consider intentionally assigning certain students different versions of these articles based on what you know about them as readers. Version 1: New protein linked to the heavily muscled phenotype summarizes a very complicated scientific study, and as such even this text adapted for classroom use is relatively complex. Version 1: Function of the Myostatin Protein is a bit longer, but less complex and supported by diagrams (still fitting for readers at the end of 8th grade). Version 2: New protein linked to the heavily muscled phenotype and Version 2: Function of the Myostatin Protein are also available, which have both been further modified to make the text less complex. If you anticipate that your students will struggle to understand these texts when reading independently, it is perfectly acceptable for you to have students work with a partner to complete that task and then create a group of four for sharing the ideas from both articles" (Teacher Edition, page 124).
- Lesson 6: Another strategy for struggling readers offers students an annotated version of the reading. "In order to support students who are struggling to make sense of the text, you might provide an annotated version of the text(s) and ask students to explain why those annotations are helpful to obtaining information and evaluating the text. To support students who are struggling with supporting cause/effect relationships, you might provide a print-out of slide U so students can complete the cause/effect table on paper" (Teacher Edition, page 138).
- Lesson 9: Strategies for teacher's support of students who may not read at grade level are provided. "Struggling readers may have more success engaging with the readings by implementing strategies such as: reading with a partner, reading aloud, chunking the text, highlighting unknown words, or looking for key ideas" (Teacher Edition, page 201).
- Lesson 15: "Universal Design for Learning: If you anticipate that some students would benefit from an alternate representation of this text, consider pairing students to have one person read aloud and one person listen. The listener could begin to sketch ideas for a model or jot notes. You could also assign different parts of the article to different students to read to themselves or aloud. The flamingo section is a less complex text than the apple section" (Teacher Edition, pages 284–285).

Differentiation strategies are provided for students who have high interest in the subject matter.

Related evidence includes:

- Lesson 12: "If you have time in your classroom you may choose to have students do this negative control portion of the investigation. As an extension for high-interest students they may work to develop their own protocol for this investigation based on the description in the video they just watched" (Teacher Edition, page 238).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 17: “Extension opportunity: Climate change is affecting redwood trees. Your students might be interested in obtaining and evaluating more information about how these amazing trees sometimes can but cannot always contend with changes to their environment. Students may also be able to connect to their knowledge from OpenSciEd Unit 7.6: How do changes in Earth’s system impact our communities and what can we do about it? (Droughts and Floods Unit). Then, they can communicate with others about steps we can take to protect redwood trees and their environment. Students could choose to communicate with policy makers about largescale changes and/or communicate with peers and other community members about actions individuals can take to reduce the effects of climate change and ensure that redwoods are around for the future. Optional slide O is provided to support students in thinking about this extension opportunity” (Teacher Edition, page 318)
- “To extend or enhance the unit, consider the following: Lesson 14: Students could spend more time researching details about organisms that reproduce asexually, and/or communicate the information they’ve learned in a different format than the suggested slide or to a different audience than just their peers. Lesson 17: Provide time for students to work on the alternate activity described in the teacher guide where students obtain and evaluate information about how climate change is affecting redwood trees, and then communicate that information to an audience of their choice in a format appropriate for that audience. After Lesson 16 or 17: Students can return to the specific examples of trait variations they brought in during Lesson 1 and apply the model they’ve developed in this unit to explain those. As additional practice with Obtaining, Evaluating, and Communicating information, students could do additional research to find details about those trait variations, such as the function of specific protein(s), the number of genes, and/or the specific environmental factors that influence that trait variation” (Teacher Edition, page 26).

Suggestions for Improvement

- Many of the differentiation strategies can be used with a variety of learners. Consider labeling the strategies with all student groups who would benefit from them to provide guidance for the teacher on which student groups they’re supporting.
- Consider providing additional differentiation strategies to meet the needs of students who have already met the lesson-level expectations.
- Consider adding suggestions for adaptations if students begin the lesson with significantly higher or lower levels of proficiency in any of the three dimensions.

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.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

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 teachers to support linking student engagement across lessons to ensure that students see their learning in all three dimensions linked to the progress they are making toward explaining the phenomena.

Throughout the lesson, teacher support is provided to ensure that each lesson is connected to both the driving phenomenon and each other. Related evidence includes:

- Lesson 1: After creating a DQB and brainstorming a list of investigations, the following teacher guidance is provided as Lesson 1 ends: “Say, We have so many great ideas to investigate! We’re curious about variations in a lot of living things, but we seem especially interested in how animals like those cattle got their extra-big muscles, so let’s start there and see if what we figure out about that can help us make progress on understanding other variations, too” (Teacher Edition, page 49).
- Lesson 2: “Briefly navigate into today’s work. Display slide A. Say, In the previous class we came up with great questions and ideas to investigate! We worked on connecting our questions together, and we thought we might start by trying to figure out how those animals got such big muscles. We already have some ideas about muscles, but we were uncertain about what we would see if we zoomed in on the muscles of extra-big versus the more-typical individuals. Refer to the classroom consensus model” (Teacher Edition, page 55).
- Lesson 4: “There is a good chance students have asked questions on the Driving Question Board related to this (such as ‘Are those animals working out?’). If that is the case, refer to the DQB and the specific questions about whether the cattle with extra-big muscles were getting exercise” (Teacher Edition, page 90). The end of the lesson includes a transition to the upcoming lessons: “Refer to the DQB to help decide what to investigate next. After pointing out related DQB questions, summarize these ideas by asking, So how could this be? Why are some baby cattle born with big muscles and others aren’t? What could be causing differences in what they are born with? Turn and talk with your partner for a moment about the slide questions” (Teacher Edition, page 94).
- Lesson 8: Students begin the lesson by reviewing what they wondered about at the end of that lesson. As a result of that discussion, the following teacher prompt is provided: “Show slide B. Say, We have a lot of questions on our DQB about alleles, and how they get passed on, and we also talked last class about how siblings don’t always look the same as each other, or as their parents. How might we investigate how siblings from the same family look different from one another?” (Teacher Edition, page 174).
- Lesson 9: “Navigate to our next steps. Ask kids to compare and share Progress Tracker notes. Have them look for similarities and differences and give them a chance to add any good ideas to their own trackers that they see on their partner’s tracker. Then say we’ve learned so much! Let’s pop out and revisit our original question and see how much progress we’ve made. Direct students to the DQB. Ask them to jot down any questions they would like to discuss next time. These may be questions they feel like they completely answered, partially answered, or have not answered yet. Let them know we will discuss these next time we meet” (Teacher Edition, page 210).
- Lesson 11: “Navigate into next time’s work. Display slide Y. Refer to the chart you just created to support a decision about what organism to investigate first in order to expand our model.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Say, if we start with investigating an organism that is the most different from cattle or the most confusing to explain, then maybe explaining other organisms and variations we're curious about will be easier from there. Which of these organisms do you think is most different from cattle? Which would be the best choice to really push on our model and help us expand it? Why? Sample student responses: The plants are the most different. We should investigate strawberry size or wheat kernels or apple colors first. We're not sure if plants even have genetic material like we saw in animals. Some of those plants could grow wild, and wouldn't be so influenced by humans. Plants don't even have muscles! They're way different! Say something like, it sounds like we need to investigate a plant next. Before we can dive into a specific one it seems like we should figure out if they even have genetic material to be influencing the trait variations we see. That can be our work for next time!" (Teacher Edition, page 226).

- Lesson 12: "Navigate to the next lesson. Project slide S. Summarize what the class just figured out, then ask the question on the slide. Say, We just figured out plants have genetic material in their cells just like animals do. Do you think they also pass on the genetic material to their offspring the same way that animals do? What could we do to find out?" (Teacher Edition, page 242).

In some lessons, guidance or strategies are provided to help ensure that students see their learning related to CCCs and SEPs as linked to the progress they make toward explaining the unit phenomenon.

Related evidence includes:

- Lesson 7: Students use their model to predict that siblings should look the same. After gathering evidence that this is not really the case, the teacher is prompted to engage students in a discussion about why that might be the case. The teacher is then provided with a series of prompts to lead students to the question "What are we wondering?" (Teacher Edition, page 165). The following teacher guidance is provided: "Purpose of this discussion: To problematize the next lesson question. We want kids to start wondering, If we have this model for how offspring get traits from their parents via these alleles, then why don't all of the offspring of those same parents look the same?" (Teacher Edition, page 145).
- Lesson 10: "Navigate to today's assessment. Say, So we've figured out how a farmer could have a whole herd of heavily-muscled cattle, and we got a chance to try selective breeding ourselves with birds. I think we're ready to use our model for predicting how genotype influences phenotype to explain another trait variation example, and give you an opportunity to demonstrate everything you've figured out so far" (Teacher Edition, page 215).
- Lesson 14: "Say, In the previous lesson we observed that plants have similar structures as animals that function as sperm and eggs. We also noticed that plants sometimes don't need these structures and can produce new plants through a process called asexual reproduction. We know that organisms like strawberries that can reproduce asexually have genetic information. But that left us wondering how asexual organisms pass on genetic information if they don't have sperm and eggs! So today, you're going to work in small groups to do a miniature research project about organisms that reproduce asexually. Your group will be responsible for obtaining information about how a certain asexual organism reproduces, and then you will communicate back to the whole class what you've figured out. We have just today's class to do research, and each group will have only about 2 minutes to share, so it's going to be quick, but we'll learn a lot!" (Teacher Edition, page 265).
- Lesson 14: "Throughout this unit we have discussed different cause and effect relationships. How might thinking about cause and effect relationships help us make strong predictions about planaria reproducing asexually? This prompt foregrounds thinking students have done

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

numerous times in this unit as they have used cause and effect framing to discuss these relationships. This is an opportunity to help students predict, using their knowledge of cause and effect relationships, about what they might see when planaria regenerate after being divided into multiple pieces. Having students think through the different potential outcomes helps them consider the mechanistic how or why explanations for this relationship. At this point in the unit students should be able to use causal framing themselves. Look for students saying: When a planarian is divided into multiple pieces we will observe ___ then proceed to explain why we should observe their predicted outcome” (Teacher Edition, page 273).

Suggestions for Improvement

Consider explicitly incorporating language of CCCs and SEPs into navigation routines so that it is clear to students how learning in these dimensions will help them make sense of the phenomena.

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 because teachers are supported throughout the unit with ideas for providing scaffolding for elements of practices and removing the scaffolds over the course of the unit. *However, specific teacher guidance related to scaffolding at the element level is not clear.*

The materials clearly state where 11 targeted SEP elements are used or developed throughout specific lessons in the unit (Teacher Edition, pages 19–20). *However, these are not outlined for specific elements.* Related evidence includes:

- **“Obtaining, Evaluating, and Communicating Information:** Throughout the unit students obtain and evaluate information from a variety of sources including articles, audio interviews, videos, charts, graphs, and images. They have formal and informal opportunities to communicate information orally and in writing. This practice is integral to the sense-making students do in this unit and it is intentionally developed as students work with a new element (evaluating competing accounts in Lesson 9) and gradually become more independent in their use of all the other elements of this practice. To support their use of this practice, in Lesson 3, students construct a version of the checklist tool they’ve used in prior units and use it in Lessons 6, 10, 13, 14, and 15 with opportunities to obtain and evaluate, and communicate increasingly complex information. Students are formally assessed on this practice in Lesson 10 and then they reflect on their use of this practice in a self-assessment in Lesson 14.” (Teacher Edition, page 20).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- **“Using Mathematics and Computational Thinking:** While using mathematics and computational thinking is not required in every lesson of the unit, it is integral to understanding and predicting inheritance patterns. Students calculate the probability of offspring phenotypes from various parental crosses in Lessons 8, 10, 14, and 16. In Lesson 8, students take note that the series of ordered steps they’re using is an algorithm (an element of this practice they have not used previously). In addition, students use digital tools to analyze very large data sets for patterns and trends in Lesson 16” (Teacher Edition, page 19).

Teacher-provided scaffolding is reduced over time for use of nearly all targeted SEP elements. Related evidence includes:

- **Obtaining, Evaluating, and Communicating Information:** *Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).*
 - Lesson 3: Before reading a selection on muscle growth, the class creates a list of ideas they should look for as they read the text. For students who have less experience with this process, an alternative is given. “Instead of co-constructing a checklist with students to guide their reading, you may want to distribute Organizer for Obtaining and Evaluating Information and have students fill it out as they read” (Teacher Edition, page 72). A discussion follows, where students evaluate the reading and realize that it is not from a credible source. Students then read from a credible source and give several reasons why it is credible. “After 5 minutes, ask students if they found these articles to be more credible than the blog post and why. Listen for ideas such as these: The article I read appears to be a scientific study. It had a controlled test. Data are clearly represented (e.g. tables, charts) so the reader can make sense of them. The authors are not trying to sell any products. The evidence from the study supports the article’s claims” (Teacher Edition, page 74).
 - Lesson 6: Students use the list generated in Lesson 3 to guide reading of another text. “Your class may have generated their own checklist in Lesson 3 of what to pay attention to when obtaining and evaluating information from a text. If so, refer students to that list or copy/paste those ideas from slide E of Lesson 3 onto slide S for their reference in this lesson.” (Teacher Edition, page 137).
 - Lesson 9: Students use the checklist to read three more selections. “Students should use their checklist to determine the claims and conclusions of each of the readings. While this checklist is similar to the one they used in Lesson 3, this time the readings are in agreement around the main claims they are making: that farmers are able to change the frequency of trait variations in their herd through selective breeding. The readings differ in the types of data used to support the claims, and in some of the techniques used to achieve the selected-for results. If students struggle, remind them to think about what information we decided as a class to look for as we read.” (Teacher Edition, page 202).
 - Lesson 10: The reading skills learned in previous lessons are used in the Goldfish Assessment. Students complete the “Checklist for Obtaining and Evaluating Information from Scientific Text” as part of the assessment which involves tasks like “What question was the author asking? What evidence did they collect? What is the goal of the text? Are research methods used appropriate for the purpose of the study?” (Checklist for Obtaining and Evaluating Information from Scientific Text, page 1).
 - Lesson 13: Students read a text about tulips. They individually determine an appropriate strategy to use. “Read about tulip breeding. Distribute Reading: How Do We Get New Tulip Variations?. Have students set a purpose for reading the article (to answer their

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

question about whether and how farmers breed plants/tulips) and write it at the top of the handout. Then allow them time to read, and have them turn and talk with a partner to communicate the information they obtained from the reading” (Teacher Edition, page 255). Guidance for teachers to support this is given. “Students should obtain information from the text that is relevant to answering their questions using whatever reading strategies work best for them. Refer them to the checklist your class made in Lesson 3 or optional slide P only if needed. Once they have obtained the information from the text, sharing what they learned verbally with a partner will allow them to practice communicating information they have obtained. Even though this is done informally here, the practice of articulating their understanding is an important part of this practice” (Teacher Edition, page 255).

- While scaffolding is removed over time for this element, *the texts students read are not scientific texts adapted for classroom use.*
- **Obtaining, Evaluating, and Communicating Information:** *Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.*
 - Lesson 3: Students co-construct a checklist as a class for what to look for to determine if a source is credible. This checklist is then used as they engage in a reading to determine the credibility of the course. After students stop reading the article, teacher prompts are provided to engage students in a discussion regarding the credibility of the article.
 - Lesson 9: Before engaging in readings about selective breeding in cattle, the following teacher prompt is provided: “Identify goals for reading about selective breeding in cattle. Say, I have three readings about selective breeding in cattle. One is from the interview with our farmer from earlier lessons, another is an interview with another farmer that raises heavily muscled cattle, and the final reading is from another source. Before we dive in, let’s think about what our goals are as readers, how we can compare the three readings, and how we can identify and evaluate the claims made by each reading” (Teacher Edition, page 201). Question prompts are then provided to lead a class discussion about the purpose of the materials and how we can tell they are reliable.
 - Lesson 14: “Give specific directions for today’s mini-research project. Display slide B (or refer to the slide or chart you created in Lesson 3 and used in Lesson 6) about strategies for making meaning from text and evaluating the text. Say, We have already had practice during this unit reading and gathering information from scientific text. You have also practiced evaluating sources to consider how reliable they are. For today’s research, your group will have a specific organism to research, and you will have to find information online about how that organism reproduces. You will need to ask yourself questions to consider whether the sources you find are reliable. If so, you will need to read the information in a way that helps you make sense of it. Usually we mark up the text to help us focus on our purpose for reading; how will you read closely and carefully on a screen? What tools or strategies can you use? Elicit suggestions such as attending to text features (headings, image captions, and so forth), highlighting the text on the screen to call attention to key details, taking notes on paper to remember main ideas, and so on” (Teacher Edition, page 265).

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- **Using Mathematics and Computational Thinking:** *Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.*
 - Lesson 8: The teacher walks students through the series of steps which are needed to calculate the probability of specific phenotypes. Students then use these steps to make probability calculations.
 - Lesson 10: Students are asked to calculate probabilities individually on an assessment. The following question is found on the assessment: “2a. Speckled goldfish are popular fish because of their beautiful colors. If a goldfish breeder wanted to breed speckled fish, should the breeder mate a speckled female with a speckled male or a brown female with a transparent male? Which breeding combination would you recommend and why? Use Punnett squares or probability rules showing the potential outcomes of each mating to support your answer” (Goldfish Assessment, page 2). *However, there is limited scaffolding provided prior to students doing this task independently.*
 - Lesson 13: Students work either individually or in groups to complete probability calculations to determine the probability of specific phenotypes when tulips are crossed.
- **Developing and Using Models**
 - While this is identified as a focus of the SEP, *explicit scaffolding of elements of this SEP is not found. However, the teacher materials indicate that while this is a focus SEP, no new elements are introduced or developed in this unit:* “Although no new elements of this practice are introduced, students use models to make sense of and explain almost every aspect of what they figure out in this unit” (Teacher Edition, page 19).

Guidance is provided for how to support students with diverse needs and abilities in developing the SEPs. Related evidence includes:

- Lesson 5: The following teacher guidance is provided with respect to the two different articles students are provided to read: “Consider intentionally assigning certain students different versions of these articles based on what you know about them as readers. Version 1: New protein linked to the heavily muscled phenotype summarizes a very complicated scientific study, and as such even this text adapted for classroom use is relatively complex. Version 1: Function of the Myostatin Protein is a bit longer, but less complex and supported by diagrams (still fitting for readers at the end of 8th grade). Version 2: New protein linked to the heavily muscled phenotype and Version 2: Function of the Myostatin Protein are also available, which have both been further modified to make the text less complex. If you anticipate that your students will struggle to understand these texts when reading independently, it is perfectly acceptable for you to have students work with a partner to complete that task and then create a group of four for sharing the ideas from both articles” (Teacher Edition, page 124).
- Lesson 8: “Universal Design for Learning Crosses of two homozygous parents will be the quickest and easiest for students to conduct and record, and some students’ sustained efforts will be enhanced by engaging with a quicker and easier analysis. However, these homozygous crosses will not give students an opportunity to notice any proportions or think about probability patterns. Many students may realize quickly that crosses with two homozygous parents will always result in the same offspring genotype. It is important to vary demands on students’ skills to optimize the challenge for all students. Consider your students’ skill levels and processing/learning needs when assigning groups to particular breeding pairs. Regardless of student skill levels, have at least some pairs work with homozygous crosses so the data is

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

available and the pattern of probabilities is obvious when the class data is tabulated” (Teacher Edition, pages 185–186).

- Lesson 8: “Providing students with another form of representation of these methods will give them an opportunity to reread and interact with the text and diagrams at their own pace, differently from when the class was working through the slides orally. In addition, students can consider the different ways of working out this problem and identify what type of representation works best for them. Offering, and honoring students' individual choices of the multiple ways to solve for probability reinforces the actual meaning behind finding the probability of possible offspring genotypes (the separation of alleles when sperm and egg are formed and their combining randomly during fertilization)” (Teacher Edition, page 188).
- Lesson 8: “SUPPORTING STUDENTS IN ENGAGING IN USING MATHEMATICS AND COMPUTATIONAL THINKING Students have likely learned multiple algorithms for solving problems in math class, even in elementary school, but they may not have called them algorithms. If you'd like to explore the idea of algorithms a bit more with your students, you might ask them how they learned to divide multi-digit numbers. Students might mention, for example, using repeated subtraction, the partial quotients method, the area method, and traditional long division (though there are more, and different students may call any of these examples by different names). Explain that these ‘ways’ or methods are both algorithms — series of ordered steps used to solve problems” (Teacher Edition, page 188).
- Lesson 9: “SUPPORTING STUDENTS IN ENGAGING IN USING MATHEMATICS AND COMPUTATIONAL THINKING If students struggle to use mathematical and computational thinking to analyze their data, support them by helping them visualize the data numerically. Have students use various groupings, like different colored highlighters, to identify individuals with the same genotypes. Once students have grouped individuals by genotypes, they can then count them and determine the percentage of each in the population” (Teacher Edition, page 207).
- Lesson 9: “Universal Design for Learning: Struggling readers may have more success engaging with the readings by implementing strategies such as: reading with a partner, reading aloud, chunking the text, highlighting unknown words, or looking for key ideas” (Teacher Edition, page 203).
- Lesson 14: The following support is provided for students who may struggle with putting together their presentation: “If needed, slide O is provided as a template that could be shared with students (all or a select few) to support them in including all the expected components” (Teacher Edition, page 265).
- Lesson 15: SUPPORTING STUDENTS IN ENGAGING IN OBTAINING, EVALUATING, AND COMMUNICATING INFORMATION At this point in the unit and year, students should be independent in critically reading scientific texts adapted for classroom use to determine the central ideas and obtaining scientific information, as well as integrating qualitative scientific information in written text with that contained in visual displays to clarify findings. If your students need more support with this practice, you might choose to have them do the gallery walk in partnerships, or work with the Planaria Study Data as a whole class shared activity” (Teacher Edition, page 282).
- Lesson 15: “Universal Design for Learning: If you anticipate that some students would benefit from an alternate representation of this text, consider pairing students to have one person read aloud and one person listen. The listener could begin to sketch ideas for a model or jot notes. You could also assign different parts of the article to different students to read to themselves or aloud. The flamingo section is a less complex text than the apple section” (Teacher Edition, page 284–285).

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

Suggestions for Improvement

- Consider providing explicit teacher guidance for how each focus SEP element is scaffolded and where and when supports should be provided and reduced to move students towards independence in using the practices.
- Consider providing additional scaffolding of for students to develop elements of **Using Mathematics and Computational Thinking** prior to asking students to use them individually.

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

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena and/or design solutions because the assessments throughout the unit have the overall goal of addressing a phenomenon and student products are focused on real-world scenarios which require three-dimensional performances. Materials routinely elicit direct, observable evidence that students are using all three dimensions in service of making sense of phenomenon. Related evidence includes:

- The Assessment System Overview document includes a section called Lesson-by-Lesson Assessment Opportunities which lists the three-dimensional lesson-level performance expectations, the targeted SEPs, CCCs, and the DCI understandings students should be able to demonstrate. For example: “Lesson 3: 3A. Obtain, evaluate, and communicate information to determine the effects of exercise and diet in the development of muscle tissue. Obtaining, Evaluating, and Communicating Information; Cause and Effect When to check for understanding: At the end of the lesson, in students’ responses to the exit ticket What to look for: Look to see if students synthesize information presented in the lesson via images, readings, and data to identify the role of diet and exercise in building muscles. Look to see if students use specific pieces of information to support the claim that protein consumption can positively influence muscle growth but that exercise is key in building larger muscles. Look for questions that ask about the diet of the cattle with extra-big muscles and how they exercise” (Teacher Edition, page 325).
- Lesson 1: Students develop an initial model to explain the question “What do you think caused this animal to get such big muscles?” (L8.5 Lesson Handout 1 Initial Model, page 1). Students utilize grade-level elements of the following three dimensions:
 - SEP: **Developing and Using Models**
 - CCC: **Cause and Effect**
 - DCI: **LS2.A** and **LS2.B**
- Lesson 6: Students work in small groups to develop an initial model that shows the relationships between chromosome information, proteins, and the cattle’s muscle phenotype. Students utilize grade-level elements of the following three dimensions:
 - SEP: **Developing and Using Models**
 - CCC: **Cause and Effect**
 - DCI: **LS3.A**
- Lesson 7: Students individually revise their initial model to explain how their organism gets extra-big muscles. Students utilize grade-level elements of the following three dimensions:
 - SEP: **Developing and Using Models**
 - CCC: **Cause and Effect**
 - DCI: **LS2.A** and **LS2.B**

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 8: Students are provided an exit ticket to answer the following question independently: “If a male is heterozygous for the myostatin allele (Ee) and a female is homozygous for the allele that leads to typical muscles (ee), what are the probabilities of each genotype their offspring might have? You may choose to use either the probability calculations algorithm or a Punnett square to figure this out, but be sure to show all of your work” (Teacher Edition, page 191). Students utilize grade-level elements of the following three dimensions:
 - SEP: **Using Mathematics and Computational Thinking**
 - CCC: **Cause and Effect**
 - DCI: **LS2.B**
- Lesson 10: Students take an assessment centered around the breeding of goldfish. The following questions are found on the assessment which demonstrate use of all three dimensions: “1c. In 1928, when Dr. Chen did research on goldfish, scientists did not yet know about genetic material, proteins, and phenotypes. Write or draw a model that explains how the transparent fish’s phenotype is influenced by its genotype, starting with how that fish got its genotype and including a protein. Also Include an example of the brown fish for comparison. Be sure to indicate cause-effect relationships in your model and/or explanation” (Goldfish Assessment, page 2). “2a. Speckled goldfish are popular fish because of their beautiful colors. If a goldfish breeder wanted to breed speckled fish, should the breeder mate a speckled female with a speckled male or a brown female with a transparent male? Which breeding combination would you recommend and why? Use Punnett squares or probability rules showing the potential outcomes of each mating to support your answer” (Goldfish Assessment, page 4).
 - SEP: **Constructing Explanations and Using Mathematics and Computational Thinking**
 - CCC: **Cause and Effect**
 - DCI: **LS3.A and LS3.B**
- Lesson 13: Students are asked to explain how plants reproduce (given prompts provided on a slide). Students then share their response with other students and receive feedback. Once provided with the feedback, students fill out an Exit Ticket. Questions include: “1. Using labels you add to the pictures, drawings of your own, and/or writing, explain how the lily plant is likely to reproduce and make seeds. Be sure you include the most important structures, the functions of those structures...” (GE.L13 Slides, Slide U). Students use grade level elements of the following three dimensions:
 - SEP: **Construction Explanations**
 - CCC: **Structure and Function**
 - DCI: **LS1.A and LS1.B**
- **Lesson 17:** The final summative assessment for the unit contains the following questions: “Using the data from this study and what you have figured out in the unit about how genetic and environmental traits affect organisms to explain: How does this study mapping the heights of redwood trees help us understand what factors might affect how the redwood trees grow so tall? Respond to the prompts below to construct your explanation. a. Explain how environmental factors could influence the height of the redwood trees. In your explanation, include rationale for why you think environmental factors do or do not influence height of the trees. b. Explain how genetic factors could also influence the height of the redwood trees. In your explanation, include rationale for why you think genetics factors do or do not influence height of the trees. c. Consider the histogram above that shows total tree height data from both areas. Develop a model in the space below to explain how both genetic and environmental factors in differing amounts could cause the range of height variation among all the redwoods in this area. d. In the Bull Creek area, the tallest redwood trees are clustered together. Also, the histogram shows there are more taller trees there than in the creek valley

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

area. Explain how the ways that coast redwood trees reproduce could cause these patterns in the data” (Redwoods Assessment, page 4).

- SEP: **Developing and Using Models, and Constructing Explanations**
- CCC: **Patterns and Cause and Effect**
- DCI: **LS1.B**

Suggestions for Improvement

N/A

III.B. FORMATIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative

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 because although opportunities are presented for formative assessment, [support for the teacher on how to adjust instruction for individual students based on varied responses and proficiencies is not provided.](#)

The materials include opportunities for formative assessment of all three dimensions that are called out explicitly throughout the lessons.

- A Progress Tracker is used throughout the unit. The following guidance is provided for its use as a formative assessment: “The Progress Tracker can be a valuable tool for formative assessment, giving you a clear picture of students’ thinking and allowing you to direct your instruction accordingly. However, Progress Tracker entries should not be scored or graded because doing so would invalidate their purpose — to be a safe space for students to process and record their thoughts honestly and without worry about evaluation” (Teacher Edition, page 62).
- Lesson 1: Students engage in a “Sand UP, Hand UP, Pair Up” activity in which they compare and contrast their initial models. The following teacher guidance is provided to use this as a formative assessment opportunity: ‘While students are sharing their models, circulate the room and listen in so you can gauge the range and diversity of student ideas and be ready to surface these ideas in the Consensus Discussion on day 2. You may also choose to collect Initial Model so you can look more closely at students’ models after class’” (Teacher Edition, page 40).
- Lesson 6: Students work in small groups to develop an initial model that shows the relationships between chromosome information, proteins, and the cattle’s muscle phenotype. The following teacher guidance is provided for use of this as a formative assessment opportunity. “While groups work on their initial models, circulate through the classroom and look for representations of key ideas that you want included in the consensus model.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Specifically, look for indications of a correlational relationship between gene and protein, gene and phenotype, and phenotype and protein. These relationships may be indicated with double arrows or lines with question marks as students are confident about the pattern, but don't have evidence for a causal relationship (which would likely be represented as a single directional arrow). Make note of the examples you see, and consider asking the members of that group if they would be willing to explain that part of their model to the class during discussion" (Teacher Edition, page 133).

- Lesson 8: Students are provided an exit ticket to answer the following question independently: "If a male is heterozygous for the myostatin allele (Ee) and a female is homozygous for the allele that leads to typical muscles (ee), what are the probabilities of each genotype their offspring might have? You may choose to use either the probability calculations algorithm or a Punnett square to figure this out, but be sure to show all of your work" (Teacher Edition, page 191).
- Lesson 13: Students dissect a flower and label the different parts with the names of the equivalent parts in animals. The following teacher prompt is provided: "As they work, circulate among them to help with identifications in the dissection and probe their thinking about the reproductive process in plants" (Teacher Edition, page 251).

Formative assessment opportunities are accompanied by clear guidance for the teacher of how to modify instruction based on varied student responses. Teacher materials include supports for informing instruction. However, assessments do not provide guidance on assessing multiple possible levels of student responses or student proficiency.

- An "Assessment System Overview" is provided. In this document, guidance is provided on the embedded opportunities for Formative Assessment including guidance on what to look/listen for and what to do with responses. One example of this can be found below (Assessment System Overview, page 4).
 - 2A Obtaining, Evaluating, and Communicating Information; Structure and Function
When to check for understanding
 1. During students' work on Muscle Protein Questions
 2. In students' Progress Tracker entries
 3. During the Building Understandings Discussion after the gallery walkWhat to look and listen for
 1. See Key for Muscle Protein Questions for sample student responses. In general, look for responses that articulate how students' understanding improved from initially watching the video animations to watching the video animations a second time after reading printed text with labeled diagrams, specifically regarding how integrating these different sources of information helped them understand the structure and function of the muscle cells and proteins.
 2. A quick glance at students' Progress Tracker entries will give you insight into their understanding of myosin and actin's structure-and-function relationship.
 3. After the gallery walk, look for students who can integrate information to describe differences between the extra-big and typical muscle tissue photos or graphs. Listen for comments that synthesize the information from the various media in this lesson to explain the structure and function of muscle cells and proteins.
- Assessment Opportunity Call Out Boxes are found in each lesson. These lessons provide "What to look for" and "What to do" information for teachers, however, these typically only provide

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

one sample student response rather than a range of responses. For example: Lesson 3 (Teacher Edition, page 79).

Building towards: 3A. Obtain, evaluate, and communicate information to determine the effects of exercise and diet in the development of muscle tissue. What to look for: Look to see if students synthesize information presented in the lesson via images, readings, and data to identify the role of diet and exercise in building muscles. Look to see if students use specific pieces of information to support the claim that protein consumption can positively influence muscle growth, but that exercise is key in building larger muscles. Look for questions that ask about the diet of the cattle with extra-big muscles and how they exercise.

What to do If students need support in organizing their thoughts, recommend that they look back at the credible sources from which they obtained information today. Consider showing the images of the tennis players again to highlight the different roles of protein and exercise.

If it would be helpful to their questioning, allow students to review the questions on the DQB that are about the diet and exercise of cattle with extra-big muscles.

Read the students' exit tickets so you are ready to refer to them during next time's class, referencing the questions students wrote.

Suggestions for Improvement

Consider adding examples of specific levels of performance and how students could be further supported based upon those responses.

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

Adequate
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because assessment targets for all dimensions being assessed are clearly stated. However, there is insufficient evidence for scoring guidance that provides a range of student responses to guide teacher feedback for all students.

Assessment targets for grade-appropriate elements of all dimensions being assessed together are clearly stated in assessment call out boxes found in each lesson. Related evidence includes:

- Lesson 4: "Building towards: 4.A Develop and use a model to construct and predict a scientific explanation based on evidence for how different environmental factors (cause) influence variation in a trait (effect)" (Teacher Edition, page 89).

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

- Lesson 6: “Building towards: 6.B Obtain, evaluate, and communicate information by synthesizing different adapted scientific text in order to obtain evidence to support that a distinct gene is the cause for the production of a specific protein related to the trait of musculature” (Teacher Edition, page 138).

Provided rubrics provide information to interpret student response for grade-appropriate elements.

Related evidence includes:

- Lesson 10: A rubric is provided for the Goldfish Assessment which clearly outlines how specific elements for each dimension are assessed. In addition, the rubric outlines how students would show evidence for these dimensions.
- Lesson 17: A rubric is provided for the Redwoods Assessment. The rubric specifies elements of SEPs, DCIs, and CCCs which are assessed as well as evidence that indicates they are utilized successfully.
- The provided rubrics include a space for teachers to write in any evidence of development or extension. **However, no further teacher guidance is provided which outlines how to interpret a wider range of responses beyond proficient.**
- The Appendix of the Teacher Handbook includes a sample modeling rubric and a sample argument rubric. This section also provides a general classroom discourse student self-evaluation, and a peer feedback self-assessment (Teacher Handbook, page 63). These rubrics are samples and do not include criteria specific to the Muscles Unit.

“Assessment Opportunity” call out boxes are provided for all major formative and summative assessment opportunities and give the teacher enough information to enable modification of instruction. **However, the modification guidance provided is not based on a variety of responses and typically relates primarily to student completion of the task rather than what can be done after the students complete the task to modify instruction.** Related evidence includes:

- Lesson 3: “Building towards: 3A. Obtain, evaluate, and communicate information to determine the effects of exercise and diet in the development of muscle tissue. What to look for: Look to see if students synthesize information presented in the lesson via images, readings, and data to identify the role of diet and exercise in building muscles. Look to see if students use specific pieces of information to support the claim that protein consumption can positively influence muscle growth, but that exercise is key in building larger muscles. Look for questions that ask about the diet of the cattle with extra-big muscles and how they exercise. What to do If students need support in organizing their thoughts, recommend that they look back at the credible sources from which they obtained information today. Consider showing the images of the tennis players again to highlight the different roles of protein and exercise. If it would be helpful to their questioning, allow students to review the questions on the DQB that are about the diet and exercise of cattle with extra-big muscles. Read the students’ exit tickets so you are ready to refer to them during next time’s class, referencing the questions students wrote” (Teacher Edition, page 79).
- Lesson 5: “Building towards: 5.A.2 Use a model to describe and predict the patterns in variations in traits between parents and offspring in a pedigree. What to look and listen for: Listen for students using evidence from the images to support the assignment of phenotypes. Also listen for students to articulate the patterns that offspring who are heavily muscled have two parents that have either extra-big or medium muscles and offspring that are typically muscled have both parents that are typically muscled. They should use those patterns in reasoning to support their prediction of what offspring of a given cross may look like. What to do If students struggle to articulate their reasoning, pause and ask them to clearly name the patterns that they observed

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

and to note what those patterns have in common. Noticing that the same general patterns appear in all the pedigrees should help them identify those patterns as the ones they would predict they would see in the unknown offspring” (Teacher Edition, page 106).

Tools are provided for students to evaluate their responses for some assessments. Related evidence includes:

- Lesson 7: Students work with a partner to develop a “Gotta-Have-It Checklist” to guide the model they are constructing to answer the question “How can an animal’s musculature be influenced by its phenotype?”
- Lesson 17: “In order to prepare for the end-of-unit assessment on Day 2 of this lesson, and to support your students while they work on it, you may take time before the assessment to co-create a student-facing rubric with the class. (The provided Rubric for Redwoods Assessment is teacher-facing and not intended for student use during the assessment.) To develop a rubric with the class, create a chart or document with the three dimensions students will use on the assessment listed across the top, such as is shown on optional slide G: Constructing explanations Science ideas around variation / why living things are different Cause and effect Have students discuss and work together as a class to list what they expect to do and words or ideas they expect to use when constructing an explanation about what causes variation in living things. You could then choose to have students use the rubric they create as a tool during the assessment” (Teacher Edition, page 315).

Suggestions for Improvement

- Consider providing additional guidance and processes for how the teacher can provide feedback to students on assessments based on a range of responses.
- Consider providing additional information in the “What to Do” section in the Assessment Callout boxes related to ways the teacher can modify instruction after students have taken the assessment.
- Consider providing additional guidance for students to utilize the Progress Tracker as a tool to track their own learning across all three dimensions.

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 because the vocabulary and reading used in the unit are appropriate for middle school, students are provided with a variety of ways to convey their thinking, and students have a choice in modalities on multiple key assessments.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Tasks are presented in an accessible way for all students. Related evidence includes:

- Grade appropriate vocabulary is used throughout the unit, including on the formal assessments provided.
- When appropriate, pictures are provided to accompany texts on key assessments. For example, on the Goldfish Assessment in Lesson 10, pictures of the different types of goldfish are provided in addition to descriptions.
- Phenomenon used to drive key tasks are ones easily accessed by students.
 - Lesson 10: Assessment uses goldfish which are organisms with which students are likely to be familiar. Additional information about them and pictures are provided for students who may not have experience with the organism.
 - Lesson 17: The assessment uses variability in height of redwood trees as a phenomenon. In addition to descriptions, pictures are provided on the assessment to increase familiarity.
- Lesson 6: Multiple versions of the text are provided to meet varying reading levels: “Assessment Opportunity: Building towards: 6.B Obtain, evaluate, and communicate information by synthesizing different adapted scientific text in order to obtain evidence to support that a distinct gene is the cause for the production of a specific protein related to the trait of musculature. Consider intentionally assigning certain students’ different versions of these articles based on what you know about them as readers. Version 1: New protein linked to the heavily muscled phenotype summarizes a very complicated scientific study, and as such even this adapted text is relatively complex. Version 1: Function of the Myostatin Protein is a bit longer, but less complex and supported by diagrams (still fitting for readers at the end of 8th grade). Version 2: New protein linked to the heavily muscled phenotype and Version 2: Function of the Myostatin Protein are also available, which have been further modified to make the text less complex. If you anticipate that your students will struggle to understand these texts when reading independently, it is perfectly acceptable for you to have students work with a partner to complete that task and then create a group of four for sharing the ideas from both articles” (Teacher Edition, page 138).

Students are provided with a variety of modalities to collect student thinking. These include some opportunities for student choice. Related evidence includes:

- Classroom Consensus discussions are used throughout the unit which allow students to express their thinking verbally.
- Lesson 1: Students use a handout to construct initial models. Students are provided with a handout which asks them to both write and draw as part of their model: “Develop an initial model to explain this question: What do you think caused this animal to get such big muscles compared to typical animals? 1. Choose a type of animal we have seen that had an individual with extra-big muscles. Sketch that animal in the top of each box, with typical muscles on the left and with extra-big muscles on the right. 2. If you could view the muscle cells in the muscle tissue from both animals with a microscope, how would they compare? Draw and/or write in the ovals what you would expect to see. 3. On the lines below, explain how you think the animal on the right got those extra-big muscles and the other one did not” (Initial Model, page 1).
- Lesson 7: Students are provided choice in modality for their response to this assessment task: “Directions: Choose one of the following ways to explain how an animal’s genotype can influence its phenotype of musculature. Choice 1: Develop a model in the space below to explain how an animal’s genotype can influence its phenotype of musculature. Choose an animal other than cattle that we’ve seen with extra-big muscles, such as sheep, dogs, pigs, or

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

fish. Label the components of your model in the column on the left. Be sure to indicate cause and effect relationships. Show how these components influence the phenotype we see for both a typical and heavily muscled animal. You may choose to use words from the following list to make your ideas clear, but you may not need to use all of them: genotype, phenotype, sperm, egg, allele, protein, myostatin, receptor, gene, food, chromosomes, offspring. Choice 2: Explain in writing how an animal's genotype can influence its musculature. Include explanations for both a typical and heavily muscled animal. Be sure to describe cause and effect relationships. You may choose to use words from the following list to make your ideas clear, but you may not need to use all of them: genotype, phenotype, sperm, egg, sex cells, allele, protein, gene, food, chromosomes, parents, offspring, myostatin, receptor" (Lesson 7 Assessment Revise Your Model).

- Lesson 8: "You may choose to use either the probability calculations algorithm or a Punnett square to figure this out, but be sure to show all of your work... Use mathematics and computational thinking to find patterns about genotypic and phenotypic outcomes resulting from crossing individuals with specific genotypes" (Teacher Edition, page 191).
- Lesson 10: This assessment includes a variety of tasks and provides a choice in how students can respond to several tasks within the assessment: "Students will obtain and evaluate the information from the text in the assessment. Checklist for Obtaining and Evaluating Information from Scientific Text is provided to support students' work in this practice and give your insight into their development of this practice" (Teacher Edition, page 215). "1a. Synthesize the data using the Checklist for Obtaining and Evaluating Information from Scientific Text to make sense of and evaluate the information in the reading above. 1b. Using the information, you obtained from the reading, visually represent each mating in Dr. Chen's scientific paper by creating 4 pedigrees, one of each mating he did in his experiment. Make four offspring for each mating. Be sure to include a key for phenotype and genotype in your pedigree... 1c. In 1928, when Dr. Chen did research on goldfish, scientists did not yet know about genetic material, proteins, and phenotypes. Write or draw a model that explains how the transparent fish's phenotype is influenced by its genotype, starting with how that fish got its genotype and including a protein. Also include an example of the brown fish for comparison. Be sure to indicate cause-effect relationships in your model and/or explanation" (Goldfish Assessment, page 3). "Which breeding combination would you recommend and why? Use Punnett squares or probability rules showing the potential outcomes of each mating to support your answer" (Goldfish Assessment, page 4).

Suggestions for Improvement

Consider providing additional opportunities for student choice throughout the assessments in the unit in a way that goes beyond having students work with the same information in two different formats.

III.E. COHERENT ASSESSMENT SYSTEM

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Rating for Criterion III.E. Coherent Assessment System

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because the unit materials include assessments that are consistently designed to connect to learning goals and require students to apply elements of the three dimensions to make sense of the phenomenon. All tasks are multi-dimensional and measurement of the three dimensions matches up with the elements of the learning goals. There are multiple assessment opportunities, and the assessment system includes pre-, formative, summative, and self-assessments.

The materials contain pre-, formative, summative, and self-assessment that measure three-dimensional learning.

- “The student self-assessment discussion rubric found in the Teacher Handbook can be used anytime after a discussion to help students reflect on their participation in the class that day. Choose to use this as least once a week on once every other week. Initially, you might give students ideas for what they can try next time to improve such as sentence starters for discussions. As students gain practice and proficiency with discussions, ask for their ideas about how the classroom and small group discussions can be more productive” (Teacher Edition, page 3).
- Lesson 1: Students develop an initial model to answer the question “What do you think caused this animal to get such big muscles?” (L8.5 Lesson Handout 1 Initial Model, page 1). This is pointed out as an opportunity for a pre-assessment.
- Lesson 2: The Progress Tracker is introduced as a method of formative assessment. The following teacher guidance is provided: “The Progress Tracker can be a valuable tool for formative assessment, giving you a clear picture of students’ thinking and allowing you to direct your instruction accordingly. However, Progress Tracker entries should not be scored or graded because doing so would invalidate their purpose — to be a safe space for students to process and record their thoughts honestly and without worry about evaluation” (Teacher Edition, page 62).
- Lesson 7: Students individually revise their initial model to explain how their organism gets extra-big muscles. Students are encouraged to use their Progress Tracker and Gotta-Have-It Checklist for this task. Students are instructed to use an organism other than cattle. A key with a sample response is provided. Students are provided with a Revise Your Model Handout to guide their assessment. This can be used as both formative and summative assessment.
- Lesson 10: “Students use a checklist to critically read and evaluate a research study adapted for classroom use to determine how the brown, speckled, and transparent trait variations of goldfish scales are inherited. They use this information to develop models explaining the inheritance patterns of this trait variation and to give a recommendation for selective breeding of the speckled phenotype. They also apply mathematical concepts of probability and use basic operations to calculate the chances of various goldfish phenotypes resulting from certain matings” (Assessment System Overview, page 2).
- Lesson 14: Students complete an **Obtaining, Evaluating, and Communicating Information** self-assessment. “Complete the Obtaining, Evaluating, and Communicating Information Self-Assessment individually. Display slide H. Distribute Self-assessment for Obtaining, Evaluating, and Communicating Information to every student. Students should take the next few minutes

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

to individually reflect on their research and presentation and independently complete the self-assessment. After students finish filling it out, have them tape it in their science notebook to refer back to later in the unit. This assessment is intended as a space for student reflection, but if you are interested in responding to their thoughts, you might ask students to leave their notebooks open to this page at the end of class today so that you can see it” (Teacher Edition, page 269).

- Lesson 17: “Summative: This lesson includes a transfer task to give students an opportunity to use the 3 dimensions to make sense of a different phenomenon. In the context of redwood tree heights, students construct an explanation about how environmental and genetic factors influence the growth of organisms and how organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. This summative assessment ends the unit and will allow you to provide feedback to your students about their work with several key ideas and practices from the second lesson set. Key for Redwoods Assessment and Rubric for Redwoods Assessment are available to support you in providing this feedback.” (Teacher Edition, page 323).

The assessment system components present are generally coherent, working together to provide information about student learning. Teachers are provided with a purpose and rationale for how, when, and why student learning is measured across the materials.

- The assessment system overview describes how assessments are aligned to targeted three-dimensional learning outcomes.
- The assessment system overview describes alignment to specific SEPs and CCCs. *However, specific elements of SEPs and CCCs are not specified in this document.*

Suggestions for Improvement

Consider adding specific SEP and CCC element information to the Assessment System Overview.

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 core ideas and crosscutting concepts because students are provided with multiple linked opportunities to display their thinking and are provided with multiple feedback opportunities. *However, opportunities for students to receive individual feedback from the teacher (specifically in written form) are limited.*

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

For key claimed learning in the unit, there are multiple student performances that provide students with opportunities to demonstrate their growth. Related evidence includes:

- **MS-LS1-5:** *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*
 - Lesson 1: Students develop an initial model to explain the question “What do you think caused this animal to get such big muscles?” (L8.5 Lesson Handout 1 Initial Model, page 1).
 - Lesson 2: Students are provided with a new handout to revise their models based upon the learning from this lesson.
 - Lesson 3: Students are provided with an Exit Ticket at the end of the lesson which asks them to explain how diet and exercise affect muscle size.
 - Lesson 6: Students work in small groups to develop an initial model that shows the relationships between chromosome information, proteins, and the cattle’s muscle phenotype.
 - Lesson 7: Students individually revise their initial model to explain how their organism gets extra-big muscles. Students are encouraged to use their Progress Tracker and Gotta-Have-It Checklist for this task. Students are instructed to use an organism other than cattle.
- **Obtaining, Evaluating, and Communicating Information:** *Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).*
 - Lesson 3: Students read articles related to either the effect of diet or exercise on muscle growth. After reading, students engage in a discussion to determine the central claims of the article and what information it provides about muscle growth.
 - Lesson 10: As part of the assessment, students read a summary of a study regarding traits of goldfish. Students are provided with a Checklist for **Obtaining and Evaluating Information** from Scientific Text handout which guides them through the process of reading the text and asks the following questions: “What is the central idea or claim?” and “What is the goal of the text — to share information, to convince someone of something, to distract people from a larger issue, something else?” (Checklist for Obtaining and Evaluating Information from Scientific Text, page 1). Students use information from this text to answer questions to further explain how these traits are inherited and bred in goldfish.
 - Lesson 13: “Read about tulip breeding. Distribute Reading: How Do We Get New Tulip Variations? Have students set a purpose for reading the article (to answer their question about whether and how farmers breed plants/tulips) and write it at the top of the handout. Then allow them time to read, and have them turn and talk with a partner to communicate the information they obtained from the reading” (Teacher Edition, page 255).
 - Lesson 16: “Give students the reading to explain how wheat color is determined. Pass out Arm span existing data and table to record additional classroom data that gives an explanation that three genes, with three pairs of alleles that lead to the production of a red pigment or not contribute additively to red coloration in wheat kernels. Instruct students to highlight important ideas so they are prepared to share them with the rest of the class” (Teacher Edition, page 297).
 - Lesson 17: Students are provided with scientific text about redwood trees and use this information to construct an explanation explaining the variation in redwood trees.

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

Students receive feedback which they can apply to claimed learning. However, much of the teacher feedback to students is provided during discussions and **individual written teacher feedback is limited**.

Related evidence includes:

- Students use a Progress Tracker to show the development of their thinking as the unit progresses. Although there is a mention that teachers can use this as a formative assessment tool, **there is no mention of how this can help students revise their work if some of their ideas are incomplete or missing**.
- Through the coherent set of lessons in this unit students are frequently revisiting classroom consensus models. The consensus models are updated in Lessons 2, 4, 7, 15, and 16. Building Understandings Discussions are also part of this feedback loop as students and the teacher participate in multiple discussions to synthesize their learning to build on their prior understandings. These discussions help inform their next model or explanation, **but there is no mention of how the teacher can evaluate the thinking of individual students who do not participate or have alternate thinking on the discussion topics**.
- Opportunities for feedback are found in the Assessment Opportunity call out boxes found in every lesson. For example:
 - Lesson 4: “Building towards: 4.A Develop and use a model to construct and predict a scientific explanation based on evidence for how different environmental factors (cause) influence variation in a trait (effect). What to look and listen for: Look to see if students are able to make connections between the updates the class made to the classroom consensus model and how these updates can change or influence musculature. What to do: If students are struggling, recommend that they first create a list of the ideas and components that were added to the model. Suggest that they use that list to decide what to include in their representation” (Teacher Edition, page 89).
 - Lesson 6: “Building towards: 6.A Develop and use a model to describe correlational relationships among chromosome pairs containing two variants, specific proteins, and the trait of musculature. What to look/listen for: Students should identify these relationships as correlational:
 - The partial (or holey) myostatin protein, the blue star chromosome symbol, and the heavily muscled phenotype are related.
 - Phenotype are related the full myostatin protein, the blue circle chromosome symbol, and the typical muscled phenotype are related
 - One of each version of the myostatin protein and one of each blue chromosome symbol (circle and star) are related to the medium-muscled phenotype.

In all of these cases, just because they appear together we do not know if one of these components is causing the other(s). Students’ models may predict which component in the pattern is ‘first,’ ‘next,’ or ‘last,’ but question marks or other indicators should show that this thinking has not been supported. What to do: If students propose a causal relationship, refer back to the cause/effect framing that we recalled from OpenSciEd Unit 8.3: How can a magnet move another object without touching it? (Magnets Unit) and used in Lesson 3 of this unit: When we ___ [change to the system] ___, we observe ___ [effect] ___ because ___ [how/why] ___. Ask if they can fill in those blanks for this situation yet. Have we seen evidence of a cause/effect relationship yet? Not yet? If students respond with something like, ‘because the heavily muscled cattle always have that,’ offer them another situation to consider: I’ve noticed here at school that many of the teachers have cars. Are they teachers because they have cars? Do they have cars because they are teachers? Just because two things happen together doesn’t mean I can

Why Are Living Things Different From One Another?

EQUIP RUBRIC FOR SCIENCE EVALUATION

assume one is the reason for the other. Note which group(s) or student(s) have struggled to identify correlation or causation here so you can be sure to support them during the upcoming discussion” (Teacher Edition, page 133).

- Lesson 16: Students engage in a discussion about obtaining, evaluating, and communicating information as a reminder of the skills they have developed throughout the unit. Students then independently engage in reading a text and develop a model explaining how much of the trait is influenced by genes and how much is supported by the environment. Students are provided with a handout to support his work. Students share this presentation with a partner. “Students exchange models to provide peer feedback. Ask students to provide feedback that might help their partner’s models clearly show the cause and effect relationships that result in the phenotype. Show slide Y and encourage students to use the sentence frames provided to think about the type of feedback they might give” (Teacher Edition, page 303).

Suggestions for Improvement

Consider providing frequent and direct feedback from the teacher to individual students, especially after discussions.

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL CATEGORY III SCORE: 3 (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

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

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

Why Are Living Things Different From One Another?

EQuIP RUBRIC FOR SCIENCE EVALUATION

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

Why Are Living Things Different From One Another?

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)