# Marathon Runner: Unit 1 in HS Biology
# EQuIP Rubric for Science Evaluation

**Developer/Curriculum:** New Visions for Public Schools
**Unit Name:** Marathon Runner: Unit 1 in HS Biology (Life Sciences)
**Grade:** 9, 10
**Date of Review:** June 2019
**Overall Rating (N, R, E/I, E):** E/I
*Category I: NGSS 3D Design Score (0, 1, 2, 3):* 2
*Category II: NGSS Instructional Supports Score (0, 1, 2, 3):* 2
*Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3):* 3
*Total Score (0–9):* 7

*Click here to see scoring guidelines*

This review was conducted by Achieve 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** | Adequate | **A. Monitoring 3D Student Performances** | Extensive |
| **B. Three Dimensions** | Adequate | **B. Student Ideas** | Extensive | **B. Formative** | Adequate |
| **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** | Adequate |
| **E. Multiple Science Domains** | Inadequate | **E. Differentiated Instruction** | Inadequate | **E. Coherence Assessment System** | Extensive |
| **F. Math and ELA** | Extensive | **F. Teacher Support for Unit Coherence** | Adequate | **F. Opportunity to Learn** | Adequate |
| | | **G. Scaffolded Differentiation Over Time** | Adequate | | |

## Summary Comments

Thank you for your commitment to students and their science education. Achieve is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully crafted, and it has many strengths. The unit is strong in several areas, including engaging students with a central phenomenon that is clearly integrated throughout the entire unit. Student learning is aimed at making sense of the collapsed marathon runner and students regularly return to this anchoring phenomenon to develop models and explanations.

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Students routinely engage in elements of the Science and Engineering Practices (SEPs) with emphasis on **Developing and Using Models**, **Planning and Carrying Out Investigations** and **Constructing Explanations**. The unit has multiple examples of three-dimensional learning activities with a wide variety of interconnected lessons in order for students to explain the phenomenon. The lesson sequence creates a coherent learning experience for students and all of the learning is in service to the Disciplinary Core Ideas (DCIs) targeted in the unit.

In addition, there is an effective use of scientifically-accurate articles, data tables, and graphs, which students utilize to make sense of the marathon runner phenomenon. Many opportunities are provided for students to share their thinking and to give and receive feedback, including self-assessment, to reflect on their learning and progress. The unit materials also include a comprehensive teacher guide, which lays out the rationale for the strategies that are embedded within the unit, as well as the full set of student materials and a detailed unit plan with many supports for English Learners (EL) and struggling students.

The unit is a very promising example of a high quality, NGSS-designed unit with a few key revisions. During revisions, the authors should pay close attention to providing better support for the differentiation of learning for high-achieving students who may have already mastered many of the concepts. Incorporating more detailed procedures for providing teacher feedback and how the students will utilize the feedback to make revisions to models and explanations will strengthen the unit.

Consider providing more opportunities for students to directly experience and explain the DCIs by using the Crosscutting Concepts (CCCs). There are multiple lesson experiences in which students are using the concepts within their models, but students can deepen their understanding of the connections if they were clear which CCC elements they are using and why they are using them. There are a few elements of the CCCs that might be a better match than the ones cited in the unit materials.

The formative assessment processes can be enhanced if the unit focuses more attention on issues of student equity and access in some ways that include cultural and linguistically responsive strategies to respond to students' thinking. This might include providing multiple ways for students to demonstrate their thinking and honoring students' backgrounds in order to personalize the learning. Currently, the unit utilizes the same Performance Task Organizer after each learning cycle with no option for student choice.

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 the criterion was not met.

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## Category I. NGSS 3D Design

Score: 2

**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

The reviewers found extensive evidence that learning is driven by students making sense of phenomena and/or designing solutions to a problem because the unit utilizes the health issues of the marathon runner as an anchoring phenomenon. Students regularly return to the problem of the marathon runner throughout the unit in order to add to the explanation of why the runner was ill after the race.

Student sense-making centers around what is happening to the marathon runner and this anchoring phenomenon is revisited frequently throughout the unit. After each series of lessons about gas exchange, muscles and energy, human thermoregulation, and water balance, students make a claim about whether the marathon runner fell ill due to one of these processes within the human body. All of the learning is in service of students making sense of a phenomenon. The following is a list of evidence to support the rating:

- During the Unit Launch, students create initial models of the marathon runner and continue to add to that model throughout the unit.
- Students develop a driving question board based on the medical tent data and their prior experiences with exercise. They frequently revisit the questions to connect what students now know and the ideas that still need to be figured out.
- During the first set of lessons about Gas Exchange and Cellular Respiration, students make connections with the questions they generate in the Unit Launch to the processes in the human body that need to be understood in order to explain the anchoring phenomenon. This helped students drive the learning and remain motivated within this series of lessons.
- The anchoring phenomenon is revisited throughout the unit and the learning in each lesson series is in service to the phenomenon. At the end of each series of lessons (Gas Exchange, Muscles and Energy, Human Thermoregulation, and Water Balance) students use the Performance Task Organizer to add to their models and are asked to make a claim about whether that particular body process caused the runner to collapse.

Suggestions for Improvement

Consider using a more intriguing launch of the marathon phenomenon. The current video with coverage of a marathon might not grab the students' interest. There may be a different video or method to introduce the marathon runner phenomenon that presents the stresses of endurance running, which might be more motivating and relevant to the students.

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

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

## Rating for Criterion I.B. Three Dimensions: Adequate

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because there are multiple examples where students are engaging in the SEPs and the CCCs in order to understand the Disciplinary Core Ideas and apply the DCIs to the anchoring phenomenon.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the SEPs in this unit because there are multiple SEP elements addressed and multiple times during which the students engaged in these practices throughout the unit. The following is a list of evidence to support the reviewers' rationale:

- **Developing and Using Models** – HS Element 3: *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
    - Students develop and revise models in each of the four learning cycles to illustrate body systems in order to explain the marathon runner phenomenon. In the Gas Exchange and Cellular Respiration Explain 1 lesson, students develop a model to explain cellular respiration in yeast cells. Students identify and include the components needed in their model based on their initial models, reading texts, and a whole-class consensus discussion. Students work to modify their models based on the consensus discussion.
    - In the Muscles and Energy Explain 1 lesson, students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to compare the information in

the reading to their models and revise their models as needed. The models include inputs and outputs of cellular respiration within muscle cells during exercise and at rest.

- During each of the series of Evaluate lessons throughout the entire unit, students are modeling using the Performance Task Organizer. Students use evidence from their various investigations and readings to explain the body system(s) involved and address the components of each system represented. Students have multiple opportunities to develop their understanding of modeling as the unit provides specific learning experiences on what models are, how they are used, the limitations of models, and more. For example, in the Thermoregulation Evaluate lesson, "students individually use their models to evaluate a claim about whether or not the runner failed to regulate body temperature, and collapsed because of overheating".

- **Constructing Explanations** – HS Element 2: *Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*
  - The Thermoregulation Explain lesson states, "Confer with students as they develop a scientific explanation in response to the following prompt: Does a human's body temperature change due to temperature changes at the extremities or changes in ambient temperature?" Students are provided with a claim, evidence, reasoning (CER) template to develop their initial explanations. They then provide/receive peer review and complete their final explanations which they share with the class during a consensus discussion. Students develop these explanations by using evidence from the data sets and graphical representations generated in the Explore stage of the Thermoregulation learning cycle. They use peer feedback to construct these explanations as stated in the Teacher Guide, "Students switch papers with a partner and use the CER Rubric to provide peer review. Provide time for students to use peer feedback to draft their explanations". Students are also expected to include their analysis of the Homeostasis and Thermoregulation in Humans diagram in their explanations.
  - Students also develop an explanation during the Evaluation stage of each of the four learning cycles by completing the Performance Task Organizer which prompts students to make a claim whether the cause of the runner's illness is due to the body processes addressed in that particular learning cycle or not. Students are asked to provide an explanation using data generated in the Gas Exchange and Cellular Respiration yeast cell investigation, the Muscles and Energy exercise lab, the Water Balance "osmoregulation in the kidney" online simulation, and the Thermoregulation body temperature investigation. Students also include analysis of text, diagrams, and student models from each learning cycle.
  - During the final learning cycle, students create a final explanatory model and provide a written explanation with evidence about how the "feedback mechanism is being used in

the runner to maintain homeostasis". The Performance Task Completion guide spells out the expectations for constructing the explanation, "Based on the runner's data and the investigations conducted throughout the unit, students create a human body model that depicts what caused the runner to collapse. Students also write an explanation to describe their visual representation of their model…".

- **Planning and Carrying Out Investigations** – HS Element 2: *Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time): refine the design accordingly.*
    - Students are asked to "discuss the limitations of this investigation. How can we learn more about why muscles become tired during exercise" while carrying out the Muscles and Energy Engage investigation.
    - During the Muscles and Energy Explore 1 lesson, the students plan and conduct an investigation involving exercise and cellular respiration. Students first write their initial ideas for using bromothymol blue to test for respiration while exercising. The lesson states, "Students brainstorm with their lab group how they can investigate the relationship between exercise and cellular respiration. Prompt students to use their input-output models and their own experiences with exercise to generate appropriate variables and a procedure." Students develop a research question, a hypothesis, and must also provide the independent and dependent variable(s) and how they will control for the different variables. Students also determine the materials, and how they will collect data. As they are preparing for this investigation, students are asked numerous questions about the accuracy and use of their data: "How accurate is your tool/type of measurement?", "How many trials?", "How does the data you plan to collect provide evidence towards the research question?", "What are some possible sources of error…?", What are the limitations of your data collection plan?, and "How can you address these limitations?".
    - Students design and conduct an investigation during the Thermoregulation Explore lesson to gather evidence about how humans regulate body temperature. Students collaboratively identify their research question, a hypothesis, and develop a possible procedure for the investigation. They identify their independent and dependent variables along with determining materials needed and how they will collect data. As students prepare the investigation, they must address the same questions about accuracy and data collection as listed in the Muscles and Energy Explore 1 lesson. In the Summary section of the lab report, students must address how they will "refine or revise the data collection or procedure to address any limitations that surfaced". Students share their designs with the whole class and they agree on a procedure that all will follow.

      The SEP of **Planning and Conducting an Investigation** is included in the Gas Exchange learning cycle (page 55) as a targeted practice. However, in the Explore 1 lesson, students are provided with a procedure to follow during the Cellular Respiration in Yeast Cells

investigation. Therefore, students do not plan the investigation but only carry out the procedure.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit because the four learning cycles and the final explanatory model all focus on the DCIs identified within the unit. Students develop initial understandings about **LS1.A** and **LS1.C** right from the beginning of the unit and build their understanding with each learning cycle in order to apply the concepts to explain the anchoring phenomenon by the end of the unit.

The unit provides multiple opportunities for students to make sense of several elements of both LS1.A and LS1.C. The following is a list of evidence to support the reviewers' rationale:

- **LS1.A Structure and Function** – HS Element 1: *Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)*
    - The unit begins with students developing an understanding of how gas exchange and cellular respiration assist humans to generate energy for life processes. Students conduct an investigation during the Gas Exchange and Cellular Respiration Explore lesson to identify the inputs and outputs of cellular respiration and how this helps humans survive. They do this by investigating yeast cells and their consumption of sugar. Students are asked "to make a connection between respiration and the work or activities that cells do."
    - The Gas Exchange and Cellular Respiration Explain 2 lesson has students creating "a sequence chart that explains how feedback mechanisms work to maintain homeostasis and regulate gas exchange through the coordinated effort of multiple body systems at the cellular, organ, and body system levels". The cards students are placing in sequence represent the pathways for carbon dioxide and oxygen during exercise and rest, including the role of red blood cells in transporting oxygen throughout the body. As the lesson states, "We are going to use a class consensus discussion, just like we did a few days ago, to learn about all the thinking in the room and come to some decisions about how the human body 'knows' how to have the right amount of different gases at all times." While student groups present their models, the students "pause and reflect on which components are happening at the cell, organ, or body system level".
    - During the Gas Exchange and Cellular Respiration Elaborate lesson, students read the Comparing Gas Exchange Text which provides differences in plant and animal cells – plants have guard cells that regulate gas exchange.
    - The Summary Task for the Gas Exchange and Cellular Respiration Explain 2 lesson, students answer the following prompt: "How is gas exchange regulated at the cell, organ, and body system level? Give one example of each (cellular level, organ level, body system level)".
    - During the Gas Exchange and Cellular Respiration Evaluate lesson, students create a model in the Performance Task Organizer to represent how a human normally regulates

gas exchange. Students are expected to "show how the respiratory and the circulatory systems normally interact."

- Students investigate how muscle cells obtain materials they need and get rid of waste products so they can continue to do their work during exercise in the Muscles and Energy Explore 1 lesson. They are presented with visuals of muscle cells at rest and during exercise and students must show the inputs and outputs that explain energy in muscle cells.
- The Muscles and Energy Explain 1 lesson has students build upon their models by incorporating the parts of cells that are involved in producing energy. Students read the Muscle Fatigue Text which addresses the role of mitochodria in producing ATP.

- **LS1.A Structure and Function** – Element 3: *Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)*
  - The Summary Task for the Gas Exchange and Cellular Respiration Explain 2 lesson, students are asked to answer the following prompt: "How is gas exchange regulated at the cell, organ, and body system level? Give one example of each (cellular level, organ level, body system level)".
  - During the Gas Exchange and Cellular Respiration Evaluate lesson, students create a model in the Performance Task Organizer to represent how a human normally regulates gas exchange. Students are expected to "show how the respiratory and the circulatory systems normally interact."
  - While exploring water balance in the Explain lesson, students provide an explanation about how water and salts are regulated at the cell, organ, and body system levels. They also are expected to provide an example at each level of the system.
  - The Final Explanatory Model lesson expects students to develop a final model to explain why the marathon runner collapsed. "The model should include multiple body systems, and show a zoomed in view of what is happening in an organ or cell." Students construct an explanation to explain how feedback mechanisms are being used to help maintain homeostasis. They are expected to provide evidence for their explanation.
- **LS1.A Structure and Function** – Element 4: *Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)*
  - In the Gas Exchange and Cellular Respiration Explain 2 lesson, students create "a sequence chart that explains how feedback mechanisms work to maintain homeostasis and regulate gas exchange through the coordinated effort of multiple body systems at the cellular, organ, and body system levels". The cards students are placing in sequence represent the pathways for carbon dioxide and oxygen during exercise and rest and demonstrate the feedback mechanism. As the lesson states, "We are going to use a class

consensus discussion, just like we did a few days ago, to learn about all the thinking in the room and come to some decisions about how the human body 'knows' how to have the right amount of different gases at all times."

- During the Muscles and Energy Explore 2 lesson, students examine feedback loops in a simulated investigation that demonstrates how homeostasis maintains body processes by constantly working to keep balance in our cells.
- In the Thermoregulation Explore lesson, students plan and conduct an investigation "designed to help you understand how the body normally responds to changes in our environment…". Students also focus on feedback mechanisms during the Thermoregulation Explain lesson where they are asked to annotate a flow chart representing homeostasis and thermoregulation in humans.
- In the Thermoregulation Explain lesson, students complete the Summary Task by providing explanations about how the human body regulates body temperature and how thermoregulation is a feedback mechanism.
- In the Final Explanatory Model, students are expected to include an explanation about why the runner became ill. "The model should include multiple body systems, and show a zoomed in view of what is happening in an organ or cell. Students construct an explanation to explain feedback mechanisms are being used to help maintain homeostasis."

- **LS1.C Organization for Matter and Energy Flow in Organisms** – Element 3: *As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.* (HS-LS1-6),(HS-LS1-7)
  - During the Gas Exchange and Cellular Respiration Explore lesson, students determine that yeast use sugar for energy and give off carbon dioxide as a byproduct of this process.
  - In the Muscles and Energy Explain 1 lesson, students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to revise their input-output model to include how it represents matter and energy flow starting with glucose.
- **LS1.C Organization for Matter and Energy Flow in Organisms** – Element 4: *As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles.* (HS-LS1-7)
  - During the Gas Exchange and Cellular Respiration Explore lesson, students determine that yeast use sugar for energy and give off carbon dioxide as a byproduct of this process. Students are asked to identify, "the role of oxygen in generating energy through cellular respiration; without oxygen, cellular respiration cannot happen."
  - In the Gas Exchange and Cellular Respiration Explore 2 lesson, students analyze data using the three-level guide about oxygen concentration during exercise and rest. Students explore how oxygen gets to our muscles and how carbon dioxide gets released.

- In the Muscles and Energy Explain 1 lesson, students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to consider their input-output model and how it represents matter and energy flow. The teacher prompts students by asking them to list some types of energy they have heard before. The teacher introduces the term chemical potential energy and asks what is the source of energy that allows living things to use their muscles.
- Although the Muscles and Energy Elaborate lesson asks students to compare and contrast three different energy storage molecules and to identify "where the 'energy' is held and what constitutes the mass of the molecule", it is not clear that this concept is explored with enough detail for students to explain how energy is stored and released. Students are asked to answer these questions but the lesson materials do not provide enough detail on how students learned about these concepts. Additonally, the breaking of bonds and how that process forms new molecules is not addressed in this unit.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit because there are a sufficient number of Crosscutting Concept elements that are addressed and a match between most of the CCCs claimed and the evidence of students using or developing those CCCs at the appropriate element level.

The following is a list of evidence to support the reviewers' rationale:

- **Systems and System Models** – HS Element 3: *Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.*
  - During the Gas Exchange and Cellular Respiration Explain 1 lesson: "Students generate an initial model of respiration in cells, based on the data collected in the lab and the lists of inputs and outputs they created in the Explain 1 phase."
  - The Muscles and Energy Explain 1 lesson has students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to compare the information in the reading to their models and revise their models as needed. The models include inputs and outputs of cellular respiration within muscle cells during exercise and at rest.
  - The Water Balance Explain lesson expects students to provide an explanation about how water and salts are regulated at the cell, organ, and body system levels. They also must provide an example at each level of the system.
- **Stability and Change –** HS Element 3: *Feedback (negative or positive) can stabilize or destabilize a system.*
  - The Gas Exchange and Cellular Respiration Explain 2 lesson has students creating "a sequence chart that explains how feedback mechanisms work to maintain homeostasis and regulate gas exchange through the coordinated effort of multiple body systems at the cellular, organ, and body system levels".

- During the Muscles and Energy Explain 2 lesson, students examine a blood glucose graph and diagram and annotate the graph using terms such as insulin, eating, blood glucose, muscle cells, ATP, and others. After this activity, students participate in a class consensus discussion to "come to some decisions about how the human body regulates blood glucose". Students are then asked to complete a Summary Task including an explanation of feedback mechanisms and providing examples of feedback mechanisms in science and in everyday life.
- In the Thermoregulation Explore lesson, students plan and conduct an investigation "designed to help you understand how the body normally responds to changes in our environment…". Students also focus on feedback mechanisms during the Thermoregulation Explain lesson where they are asked to annotate a flow chart representing homeostasis and thermoregulation in humans.
- In the Thermoregulation Explain lesson, students complete the Summary Task by providing explanations about how the human body regulates body temperature and how thermoregulation is a feedback mechanism.
- The Water Balance Explain lesson asks students to provide an explanation connecting osmoregulation to feedback mechanisms

- **Energy and Matter** HS Element 3: *Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.*
  - Muscles and Energy Explain 1 Summary Task – students have previously modeled the inputs and outputs within muscle cells and use those understandings to answer the following prompt, "How do muscle cells access what they need to keep producing energy?" This is an example where students are progressing towards the CCC of **Energy and Matter**; however, the details of the CCC element claimed in the materials are not clearly spelled out within the unit.

Suggestions for Improvement

SEPs

Consider including additional SEP elements. For a unit of this length, including one or two more SEPs such as **Asking Questions** and **Analyzing and Interpreting Data** would strengthen it and provide more opportunities for students to develop the SEPs. For the SEPs currently cited within the unit, consider addressing more than one element of those practices. For example, students develop models many times throughout the unit but only address one high school-level element of that practice.

Students are currently engaging in more SEPs within this unit than are claimed in the unit materials. It could help reduce confusion to call these out in the unit materials.

DCIs

The concept of bonds breaking within food and oxygen molecules and being recombined needs to be made more evident to students. That portion of the DCI is not fully addressed in the unit.

CCCs

More frequent and direct engagement with the CCCs at the element level could strengthen the unit. For example, **Energy and Matter** could be enhanced by emphasizing more elements not fully addressed as claimed. Element 2 might be a better fit for this unit: *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.* Additionally, the unit materials could be improved if the CCCs were directly listed within the lesson activities and student materials (currently they can be found in the "Tips" boxes). Students are engaging in most of the CCC elements claimed in the unit; however, they may not be aware of the CCC element they are engaging in and why it is an important concept in science, and therefore they might not be able to use it as a thinking tool later.

**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

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 students are expected to figure out the marathon runner phenomenon using grade-appropriate elements of all three dimensions.

The following is a list of evidence to support the reviewers' rationale:

- Gas Exchange and Cellular Respiration Explain 2 lesson:
  SEP: **Constructing Explanations** Element 2; DCI: **LS1.A** Element 3 and 4; CCC: **Stability and Change** Element 3 – In the Gas Exchange and Cellular Respiration Explain 2 lesson, students create "a sequence chart that explains how feedback mechanisms work to maintain homeostasis and regulate gas exchange through the coordinated effort of multiple body systems at the cellular, organ, and body system levels". The cards students are placing in sequence represent the pathways for carbon dioxide and oxygen during exercise and rest and demonstrate the feedback mechanism. As the lesson says, "We are going to use a class consensus discussion, just like we did a few days ago, to learn about all the thinking in the room and come to some decisions about how the human body 'knows' how to have the right amount of different gases at all times." Students provide an explanation in the Summary Task to explain how the body regulates gas exchange and to make connections to feedback mechanisms that maintain homeostasis.
- Gas Exchange and Cellular Respiration Evaluate lesson:
  SEP: **Developing and Using Models** Element 3; DCI: **LS1.A** Element 1 and 3**;** CCC: **Systems and System Models** Element 3 – Students create a model in the Performance Task Organizer to

represent how a human normally regulates gas exchange. Students are expected to "show how the respiratory and the circulatory systems normally interact."

- Muscles and Energy Explain 1 lesson:
  SEP: **Developing and Using Models** Element 3; DCI: **LS1.C** Element 3; CCC: **Systems and System Models** Element 3 – Students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to compare the information in the reading to their models and revise their models as needed. The models include inputs and outputs of cellular respiration within muscle cells during exercise and at rest.
- Thermoregulation Explore lesson:
  SEP: **Planning and Carrying Out Investigations** Element 2, DCI: **LS1.A Element 4**, and CCC: **Stability and Change** Element 3 – Students design and conduct an investigation during the Thermoregulation Explore lesson to gather evidence about how humans regulate body temperature. Students collaboratively identify their research question, a hypothesis, and develop a possible procedure for the investigation. They identify their independent and dependent variables along with determining materials needed and how they will collect data. Students share their designs with the whole class and they agree on a procedure that all will follow. Students participate in a Whole-class Investigation Summary to provide explanations for how our bodies regulate a stable temperature based on feedback mechanisms.
- Thermoregulation Explain lesson:
  SEP: **Constructing Explanations** Element 2; DCI: **LS1.A** Element 4; CCC: **Stability and Change** Element 3 – Students are asked to annotate a flow chart representing homeostasis and thermoregulation in humans. The students complete the Summary Task by providing explanations about how the human body regulates body temperature and how thermoregulation is a feedback mechanism. Students are expected to develop this explanation by stating a claim and providing evidence from the previous investigation to support their claim.
- Water Balance Explore lesson:
  SEP: **Developing and Using Models** Element 3; DCI: **LS1.A** Elements 1 and 4; CCC: **Stability and Change** Element 3 (and **Systems and System Models** Element 3) – Students use a computer model in the Osmoregulation in the Kidneys exploration which focuses on the function of the kidneys and how they help regulate water and filter out wastes. Students participate in a Whole Class Investigation Summary to discuss these ideas.
- Water Balance Explain lesson:
  SEP: **Constructing Explanations** Element 2; DCI: **LS1.A** Elements 1, 3, and 4; CCC: **Stability and Change** Element 3 – Students must provide an explanation about how water and salts are regulated at the cell, organ, and body system levels. They also are expected to provide an example at each level of the system.
- Final Explanatory Model:
  SEP: **Developing and Using Models** Element 3 and **Constructing Explanations** Element 2; DCI: **LS1.A** Elements 1, 3, and 4; CCC: **Stability and Change** Element 3 and **Systems and System Models** Element 3 – Students develop a final model to explain why the marathon runner collapsed. "The

model should include multiple body systems, and show a zoomed in view of what is happening in an organ or cell." Students construct an explanation to explain how feedback mechanisms are being used to help maintain homeostasis. They are expected to provide evidence for their explanation.

Suggestions for Improvement

The lessons that include the **Energy and Matter** CCC have the potential to be three-dimensional; however, the element identified within the unit is not fully addressed. Perhaps Element 2 (*Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system)* would be a better fit as opposed to Element 3 (*Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems).*

Stating which elements of the SEPs, DCIs, and CCCs that are addressed in each lesson could help teachers focus their lessons around them, especially in the area of CCCs and SEPs. Each learning cycle provides a summary of the dimensions addressed; however, it might be helpful for teachers to view the specific elements targeted in each of the 5E lessons. A broader range of CCC and SEP elements could also strengthen the unit.

**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

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations because students figure out a piece of the marathon runner phenomenon in each lesson and their remaining questions are shared and help to motivate students to engage in the next lesson within the unit. In addition, students have adequate opportunities to develop toward proficiency in the targeted set of performance expectations.

The following is a list of evidence to support the reviewers' rationale:

- Students begin the unit by generating a driving question board about the marathon runner phenomenon. After every learning cycle, students revisit the driving question board using the Revisit the Driving Question Board Routine. For example, after modeling about Gas Exchange and Cellular Respiration in the Performance Task Organizer, students are asked to revisit the driving

question board to discuss which questions have been answered and which questions they have not yet figured out. Students share out these questions and document new questions.

- During the Muscles and Energy Explain 1 lesson, students are prompted to use sticky notes to flag areas on their input-output model that require more investigation.
- Each of the four learning cycles progress in a meaningful way by using students' questions and what they have figured out so far. Students gain a piece of the marathon runner explanation, but need to complete all learning cycles to make a final claim about what happened to the runner.

Suggestions for Improvement

None

**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: Inadequate

The reviewers found inadequate evidence that links are made across the science domains when appropriate because the unit focuses on one domain; however, a second domain is needed in order to fully address the phenomenon.

- LS1.A and LS1.C are sufficiently covered within the series of lessons and most of the phenomenon can be addressed using these DCIs.
- Although the Muscles and Energy Elaborate lesson asks students to compare and contrast three different energy storage molecules and to identify "where the 'energy' is held and what constitutes the mass of the molecule", it is not clear that this concept is explored with enough detail for students to explain how energy is stored and released. Students are asked to answer these questions but the lesson materials do not provide enough detail on how students learned about these concepts. Additonally, the breaking of bonds and how that process forms new molecules is not addressed in this unit.

Suggestions for Improvement

If the unit is enhanced to include more investigation and understanding of the conservation of energy, a connection to the Physical Science domain PS3, specifically several elements from PS3.A, PS3.B and PS3.D, will strengthen the unit and make for a meaningful connection for students. Using the CCC of **Energy and Matter** to connect across Physical and Life Science domains will help students see the bigger picture of the role that energy and matter play in the process of cellular respiration and in their lives.

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

## Rating for Criterion I.F. Math and ELA: Adequate

The reviewers found adequate evidence that the materials provide grade-appropriate connections to mathematics, English language arts (ELA), history, social studies, or technical standards because grade-appropriate math and ELA standards are connected within the unit materials and incorporated into the lessons. Teacher support is provided for reading strategies for students struggling to read at grade level or reading complex texts. Students use grade level writing skills to explain and communicate their understanding of scientific concepts.

The following is a list of evidence to support the reviewers' rationale:

- Students use grade level reading and writing skills in order to develop understanding and explanations of homeostasis in body systems. Students read texts about cellular respiration in yeast, gas exchange in fish, muscle fatigue, osmosis in red blood cells, and more.
- Students have multiple opportunities for verbal classroom discourse through numerous whole-class consensus discussions, Domino-Discover protocols, Think-Talk-Open Exchange, among others.
- The ELA Standards RST.9–10.1: *Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions* and RST.9–10.7: *Translate scientific or technical information expressed as written text into visual form (e.g., a table or chart), and translate information expressed visually or mathematically (e.g., in an equation) into words* are addressed in the Muscles and Energy Explain 1 lesson. Students build upon their previous models after reading the Muscle Fatigue Text. Students are asked to compare the information in the reading to their models and revise their models as needed. The models include inputs and outputs of cellular respiration within muscle cells during exercise and at rest based on their investigations and text readings.
- SL.9–10.4: *Present claims, findings, and supporting evidence clearly, concisely, and logically; organization, development, substance, and style are appropriate to task, purpose, and audience* is addressed in multiple lessons. Students frequently participate in class consensus discussions and are asked to present their models and scientific explanations.
- Students are making sense of data and graphs and need to reason quantitatively. They use functions to model relationships between quantities. During the yeast cell investigation, students graph results and are asked to explain their reasoning about whether their hypothesis was supported by the results. Students are then asked to describe the scientific (and mathematical) reasons about taking the class average to make decisions about the results. Standard 8.F.B.5 is an 8th grade expectation.

- *Students summarize, represent, and interpret data on two categorical and quantitative variables* (HSS.ID. B.6). During the yeast cell investigation, students are expected to identify the type of graph that best fits the data collected and to identify the independent and dependent variable on the graph. Students are asked to summarize the blood-oxygen graph within this same learning cycle to interpret data based on the variables provided on the graph.

Suggestions for Improvement

- Consider including these specific standards within the lessons where they are addressed. This can help teachers prepare for the lessons with these specific skills in mind.
- The CCSS-Mathematics 8.F.B.5 is an 8th grade standard. It would therefore be helpful to note to teachers that they are helping students review in this section — not connecting to grade level-appropriate standards.

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

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

## Category II. NGSS Instructional Supports

Score: 2

**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: Adequate

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because the unit materials provide methods to make connections of the phenomena to students' lives. The phenomenon is accessible to students and they can connect their questions about the marathon runner's collapse to their own experiences with exercise.

The following is a list of evidence to support the reviewers' rationale:

- Students' prior experiences with watching marathons or exercising in general are utilized in several places throughout the unit. Students are asked to tap into prior experiences when the phenomenon is first introduced, which helps students connect to the topic and also to raise questions.
- As students explore during the Muscles and Energy lesson, they plan an investigation in which they determine how exercise impacts carbon dioxide production, pulse rate, and breathing rate. The students are seeing how these processes work within their own bodies and are asked to connect the results to the anchoring phenomenon.

Suggestions for Improvement

Are there other possible phenomenon related to this topic that students would have more direct connections with, such as a high school endurance athlete? Finding ways to make the anchoring phenomenon more connected to their prior experiences or allowing them to connect better to the marathon phenomenon in the classroom would be beneficial.

**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

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 student ideas and questions drive the learning throughout the unit. Students frequently collaborate to share ideas and use the ideas to revise models and written explanations. Students reflect on their learning and provide peer-to-peer feedback as well. There are opportunities to apply their learning to other scenarios beyond the marathon runner phenomenon.

The following is a list of evidence to support the reviewers' rationale:

- Classroom discourse focuses on explicitly expressing and clarifying student reasoning. Students have multiple opportunities to share their reasoning during engage lessons when beginning to understand the data or phenomenon they are investigating. Questions and ideas elicited here are then used to drive the learning in the next series of lessons.
- They participate in peer review feedback during every collaborative investigation in each learning cycle. Students complete a peer-to-peer graphing rubric in the Gas Exchange and Cellular Respiration Explore yeast cell investigation to share ideas about how their peers are representing data in graph form.
- Students are required to elaborate and revise their initial thoughts throughout the marathon Performance Task Organizer. Multiple modes of feedback are provided. Questions are provided for the teacher to help elicit student ideas.
- Students participate in multiple group learning routines (Class Consensus Discussions, Domino-Discover, Think-Talk-Open Exchange), which focus on sharing student ideas with one another. Students are provided with multiple modalities for assessment from written feedback from the teacher, from other students, models, and written explanations.
- The unit provides supports to teachers to help elicit student ideas. The unit materials frequently provide supports such as this one to help English Learners: "*Access for English Language Learners: Domino Discover provides receptive language opportunities for students who are entering and emerging language learners. For those who are transitioning and expanding, this routine provides time to rehearse language with peers, so that students are not responsible for on-the-spot responses before they are ready.*"
- Another such example is the support for students who may struggle with graphing for the first time in this course: "Differentiation Point: Additional Support for Experimental Design...After students have collected their data, pause to surface and review experimental design as necessary, using the Same-Different Chart as a scaffold to support students in thinking about the difference between variables. Allow students to revise the portion of the lab that asks them to identify these

variables. When graphing, use the Graphing decision chart before students graph the data, and the Peer-to-Peer graphing rubric after graphing to surface which student may need additional graphing support."

- In the Muscles & Energy Explain 1 Summary Task, students present to the groups and give feedback to each other as well as reflect on their own responses after hearing from their other group members. Students reflect on the discussion and what could be improved upon.
- In the Thermoregulation Explain lesson, the teacher guide instructs the teacher to share some of the student ideas about thermoregulations to the class as a whole and compare their conclusions.
- In the Thermoregulation Explain lesson, students write a claim concerning internal temperature regulation and support their claim using evidence and reasoning.
- During the Water Balance Engage lesson, student ideas and questions about sweat and water/sports drinks drive the learning in that lesson cycle.

Suggestions for Improvement

None

**II.C. Building Progressions:** Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions
ii. Clearly explaining how the prior learning will be built upon.

## Rating for Criterion II.C. Building Progressions: Adequate

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because the unit materials provide guidance on where students should be prior to the unit and the specific concepts students should understand are listed in each lesson. There is a logical progression from the middle school learning to the targeted learning in this unit.

The following is a list of evidence to support the reviewers' rationale:

- Rubrics are included and the expected levels of proficiency are clear within each lesson. The unit materials provide "Look and Listen For" lists which provide the specific concepts teachers can identify to gauge students' learning progression with the three dimensions. These Look and Listen For's are provided for each activity within all learning cycles.
- Each activity also includes a list of important concepts students should glean. They are identified in a section of each lesson called "Take Time for These Key Points".
- The Teacher Guide (page 5) provides an overview of the high school performance expectations (PEs) addressed in the unit. It is expected that students will meet the three listed PEs by the end of the unit.

- An overview of the high school expectations for each of three dimensions are provided in the Teacher Guide (page 6). It also lists the prior learning from the middle school PEs that they are building upon.
- The unit materials include a narrative about the expectations for each learning cycle and an assessment matrix within the Teacher Guide (pages 17–18).

Suggestions for Improvement

While there are instances where students learn about the SEP of modeling throughout the unit and their understanding of this practice is clearly developed by the end of the unit, the materials can be strengthened by adding more details on the progression of student learning based on all three dimensions as they complete each learning cycle. Identifying which elements of all three dimensions students have already developed and which they are still progressing towards would also strengthen the unit. Sharing which elements of CCCs and SEPs (or parts of the elements) that are being developed at each stage in the unit and how these skills will be built upon within the next stage will make the expectations clear to teachers and students.

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

## Rating for Criterion II.D. Scientific Accuracy: Extensive

The reviewers found extensive evidence that the materials use scientifically accurate and grade appropriate scientific information because the science ideas within the unit are accurate and there are teacher supports that provide insight on student ideas and possible misconceptions or gaps in their understanding.

The following is a list of evidence to support the reviewers' rationale:

- The scientific concepts included in the materials are accurate.
- The unit materials provide teacher supports for how to address student thinking that may not be fully developed or accurate. The unit includes suggestions for quick interventions when students are struggling with a concept. There are numerous "Differentiation Points" throughout the unit to provide teachers with additional strategies or scaffolded activities if students need more support. For example, in the Launch phase of the unit, the Differentiation Point states, "If students are struggling to make the connections to hyponatremia, return to the medical tent data as a class, adding in the normal ranges for each. Facilitate discussion around the idea that the sodium plasma levels are below normal for runner #0358 (the one that collapsed), and what that could mean for her water-sodium balance and her cells — especially those in her brain, as she did go into a coma. It is not necessary for students to use the term hyponatremia, but they should be able to demonstrate the concept in the model and written component. Additional articles on

hyponatremia and the results of drinking too much water too fast are listed above, and can be used to further support students, or to extend the discussion based on student interest."

- In the Gas Exchange and Cellular Respiration yeast cell investigation, additional helpful tips about where students should be in their learning progression are provided. "At this point, it is fine if students do not have a completely clear or accurate definition of a scientific model! They will return to this class list throughout the unit."
- Implementation Notes are included at the end of each learning cycle, providing additional helpful supports to teachers. One of the notes for the series of lesson about Gas Exchange and Cellular Respiration addresses student understandings and a support strategy for students: "To break down some barriers it may be useful to provide students with pictures of the body systems for them to see the location of different organs in the body."

Suggestions for Improvement

The Cupples activity in the Explore 2 Stage of Muscles and Energy could be modified to make it more authentic and better integrated with the anchoring phenomenon. Using imaginary organisms seems disconnected with the rest of the unit that is based around human systems and modeling those systems.

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

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

## Rating for Criterion II.E. Differentiated Instruction: Inadequate

The reviewers found inadequate evidence that the materials provide guidance for teachers to support differentiated instruction because although the unit provides extensive differentiation strategies for English Learners and for struggling students, the unit materials do not provide adequate differentiation opportunities for high-interest students and students who have already met the performance expectations.

The following is a list of evidence to support the reviewers' rationale:

- The unit provides many differentiation strategies for reading texts, for scaffolding investigation design, modeling, and more — these strategies are focused on English Learners and for struggling students.

- The Teacher Guide (pages 9 and 12) clearly addresses how the strategies used throughout the unit are designed for equal access for all learners using the Universal Design for Learning (UDL). Specific strategies for students with special needs were intentionally not included in order for teachers to provide these specific accommodations for their students.
- In the Muscles & Energy Elaborate lesson, three different articles are provided and suggestions for differentiating with the resources are given.
- In the Water Balance Explore lesson, teachers are provided with suggestions for students who are struggling with the DCI about diffusion.
- In the Water Balance, Explain Stage, several suggestions are given to support EL students and other students who are struggling to visualize what is happening to the blood cells in different solutions.
- The Water Balance Elaborate lesson provides an enrichment article for students of high interest to challenge what they have learned: "Based on student interest and readiness, provide the additional article, *Goldfish, released in the wild, are somehow surviving in saltwater* in order to spiral in the concepts of adaptation, natural selection, and invasive species."
- The Water Balance Evaluate lesson provides an alternative article for students who are struggling to make the connection between too much water and the runner collapse.
- As the Teacher Guide states, "The performance task is designed as a complex way for students to demonstrate mastery of a set of indicators, with multiple entry points for different learners".
- There is no clear evidence that extensions are provided for high-interest students and students who have already met the performance expectations. There is only one example throughout the entire unit that provides an enrichment article for high-interest students.

Suggestions for Improvement

- There is no clear evidence that extensions are provided for high-interest students and students who have already met the performance expectations. Including differentiation strategies and activities for these high-level students, similar to the numerous strategies and supports included for English Learners and struggling students, throughout each learning cycle will strengthen this unit.
- Adding supports for helping students with learning goals in all three dimensions equally would strengthen the unit.

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

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

## Rating for Criterion II.F. Teacher Support for Unit Coherence: Adequate

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because students have the opportunity to engage in asking questions about the phenomenon that need to be addressed in the next lessons. These student questions drive the learning throughout the unit.

The following is a list of evidence to support the reviewers' rationale:

- Students are engaged with a phenomenon that is meaningful and authentic — the marathon runner/endurance athlete is a topic that students can easily understand.
- Students make progress towards elements of each dimension within each learning cycle and supports are provided for teachers to help identify the learning expectations for each activity. Numerous strategies are provided to teachers to ensure sense-making is connected to all three dimensions throughout the unit.
- Students figure out what the next question is to pursue by utilizing a driving question board and revisiting their questions frequently throughout the unit. Multiple supports are provided to assist teachers with the driving question board routine.

Suggestions for Improvement

Providing supports for teachers in each learning cycle by specifying which strategies are intended to provide students access points to the concepts and activities will help teachers use these strategies more effectively.

**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

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time because the unit materials provide specific guidance targeting diverse learners in order to use the SEPs and make sense of phenomena.

The following is a list of evidence to support the reviewers' rationale:

- Many supports are provided for students with diverse needs. Students have scaffolded documents to help with designing investigations, model body systems and processes, and construct explanations.
- Students develop a deep understanding of the SEP of modeling throughout the unit. Students learn what a model is and then progress through the lessons by adding more model criteria such as identifying limitations of different models by using yeast cells to investigate cellular respiration.
- In the Muscles and Energy Explore lesson, teachers are provided with two versions of a lab — one which students completely design and plan the investigation and one in which students are given the procedure and materials list for the investigation.

Suggestions for Improvement

More direct and explicit support for students building and progressing with elements of the SEPs of **Planning and Carrying Out an Investigations** and **Constructing Explanations** would strengthen the scaffolding. Using a variety of approaches to assist students in developing their understanding of the SEP elements will strengthen the unit.

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

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

## Category III. Monitoring NGSS Student Progress

Score: 3

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

### Rating for Criterion III.A. Monitoring 3D Student Performances: Extensive

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 because tasks are driven by engaging phenomena that are designed to elicit rich, three-dimensional student performances.

The following is a list of evidence to support the reviewers' rationale:

- The lessons involve phenomena and are engaging through varied activities.
- The scenarios require three-dimensional performances to address the learning expectations.
- Each of the three dimensions is routinely used in service of sense-making. For example, all three dimensions are utilized during the Gas Exchange and Cellular Respiration Explain 2 lesson. Students are **Constructing an Explanation** (Element 2) about the DCI: **LS1.A** (Elements 3 and 4) which also asks students to address the CCC: **Stability and Change** (Element 3). This lesson has students creating "a sequence chart that explains how feedback mechanisms work to maintain homeostasis and regulate gas exchange through the coordinated effort of multiple body systems at the cellular, organ, and body system levels". The cards students are placing in sequence represent the pathways for carbon dioxide and oxygen during exercise and rest and demonstrate the feedback mechanism.
- There are multiple opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of the SEPs.
- Students use the CCCs to make sense of the phenomenon and there are multiple opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of these concepts.
- The grade-appropriate DCI elements are required in student sense-making and there are multiple and varied opportunities for students to visibly demonstrate their understanding and ability to use grade-appropriate elements of these core ideas.
- Tasks routinely integrate the three dimensions in varied ways. The Final Performance Task has students showing their learning in all three dimensions as they develop a comprehensive visual system model and a written explanation of the phenomenon.

Suggestions for Improvement

Adding more, and varied, methods of monitoring students' performance in addition to the Performance Task Organizer will strengthen the unit. Students utilize the same modeling activity after each learning cycle and they might benefit from more variety and student choice.

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

## Rating for Criterion III.B. Formative: Adequate

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the unit materials include frequent opportunities for formative assessment in each learning cycle. The materials spell out the concepts students should be able to explain before moving to the next lesson.

The following is a list of evidence to support the reviewers' rationale:

- Assessment Matrices are provided after each of the learning cycles and include multiple formative assessments for each of three dimensions of all four learning cycles.
- Considerations for formative assessment are included throughout the unit. For example, in the Gas Exchange and Cellular Respiration Explore 1 lesson, the unit states, "Use the group learning routine Domino Discover to surface important trends, inferences, and questions from groups' summary sections. Plan forward based on the various understandings that students or student groups have articulated. It is appropriate to go onto the next phase once students have had a chance to make sense of the data, and have had the opportunity to clarify what they have figured out about the phenomenon."
- Students are asked to participate in class consensus discussions, which are identified in the unit as great opportunities to gain insight on student thinking.
- The Summary Task is completed by students after every learning cycle and is cited as an opportunity for the teacher to make decision about students' understanding. For example, Thermoregulation Explain lesson states, "Students individually complete the Summary Task. The results of this task can be used to make determinations about which students need more time to engage in sense-making about how the body regulates body temperature. It's important to get all of this from individual students, so you know these things on a student-by-student basis."
- The Thermoregulation Elaborate lesson states, "In the Explain phase, you were able to assess student learning around how the human body regulates body temperature. This phase of the 5E allows for students who are still unsure of that idea to develop it further through learning why we cool the heart during heart surgery.

- There are no clear examples in which the unit materials provide support for modifying instructional activities to be more culturally responsive. Formative assessment tasks do not clearly address student choice in some way so they can make decisions about how to approach a task.

Suggestions for Improvement

Provide opportunities for students to provide feedback about engagement and learning, such as self-assessment surveys embedded within a lesson about student engagement with the phenomena, sense-making, affect, interests, and experiences. Consider adding a variety of modalities for students to demonstrate their learning at the end of each learning cycle; each cycle currently requires the same exact Performance Task model.

**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

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 are clearly stated and scoring guidelines are provided in rubrics.

The following is a list of evidence to support the reviewers' rationale:

- An assessment matrix for each of the three dimensions is provided in the Teacher Guide in the form of a checklist indicating which SEP, DCI, and CCC elements are addressed in the assessment within each learning cycle.
- Rubrics are provided in many instances, such as the peer-to-peer graphing rubric following the yeast cell investigation during the Gas Exchange and Cellular Respiration lesson. A CER rubric within the Thermoregulation lesson is provided.
- A Final Explanatory Model rubric and exemplar student work are provided for student models for each learning cycle.
- Rubrics clearly include two of the three dimensions but the CCCs are not clearly included in the rubrics. Although the CCCs are embedded in assessment tasks, it is not clear that students are aware they are using the CCCs to help them understand science concepts and make sense of phenomena.
- There are multiple instances where students receive feedback from peers and revise models; however, there are no clear instances where teacher feedback was provided and students then revised models and/or explanations as a result.

Suggestions for Improvement

- Ensure that all three dimensions are included in scoring rubrics.
- Include more scoring guidance details regarding expected student responses. Providing details on when and how teacher feedback is given would strengthen the unit.

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

## Rating for Criterion III.D. Unbiased Task/Items: Adequate

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because the unit assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

The following is a list of evidence to support the reviewers' rationale:

- Appropriate text and vocabulary at grade level are included in the unit materials. Suggestions for when and how terminology is introduced is addressed in each learning cycle. "Conferring Questions" are included in the lessons, providing opportunities for students to use the new vocabulary terms.
- Representations are culturally neutral.
- Tasks/items provide a variety of ways for students to convey their answers through modeling, explanations, summary tasks, graphing, and more. Students graph results during the yeast cell investigation, construct explanations in multiple lessons, and model in various ways by using a sequence chart and body system diagrams.

Suggestions for Improvement

Consider including representations or scenarios that capitalize on the funds of knowledge that students bring with them to the classroom. The unit could also provide materials with clear pathways for students to make connections to their lives beyond the classroom and increase the variety of modalities expected for student responses, including at least one significant task that provides students with a choice of responses across multiple modalities.

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

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

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because the unit provides many opportunities to surface student ideas through models, graphs, and explanations.

- The assessment system provided for this unit carefully matches the three-dimensional goals and all tasks are multi-dimensional. Models and prompts provided by students are expected to include all three dimensions. For example, students are asked to construct an explanation about how cells and body systems maintain homeostasis using feedback mechanisms.
- The assessment system uses a variety of measures and provides multiple assessment opportunities. The unit includes multiple formative assessments integrating the three dimensions in all four learning cycles. The unit materials also include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.
- During the Gas Exchange Explore lesson, students self-assess after this stage using the chart on page 6 as well as assess and give feedback to their partners.
- In the Gas Exchange Explain 2 lesson, students self-assess regarding the class discussions and what they learned from them. The Evaluate lesson has students self-evaluate their models and explanations of gas exchange in humans.
- During the Muscles and Energy Explore 1 lesson, students self-assess their performance on the investigation they planned.
- At the end of every lesson cycle, students develop a visual model that is used as a formative assessment by the teacher or as a summative for that particular part of the unit.
- The Final Performance Task provides a summative assessment of student learning throughout the entire unit.
- In the Engage stage of Gas Exchange and Cell Respiration, students use the "Rumors" protocol to exchange and share initial ideas.
- In the Engage stage of Thermoregulation, the Temperature Extremes writing prompt can serve as pre-assessment of student understanding of Thermoregulation.
- The Unit Launch includes the gathering of students' initial ideas, and questions posted on the driving question board can serve as a pre-assessment for the unit.

Suggestions for Improvement

It might be helpful to clearly identify which activities could serve as pre-assessments.

**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

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 the unit includes multiple, interconnected learning experiences that provide students with several opportunities to demonstrate learning.

The following is a list of evidence to support the reviewers' rationale:

- Students participate in a variety of learning experiences (interpreting complex text/diagrams, conducting investigations, developing and using models, constructing scientific explanations) in which they engage in the SEPs, DCIs and CCCs.
- There are multiple examples of three-dimensional learning as identified in Section I.C. These learning experiences are interconnected throughout the unit. In the Gas Exchange and Cellular Respiration Evaluate lesson, students create a model in the Performance Task Organizer to represent how a human normally regulates gas exchange. Students are expected to "show how the respiratory and the circulatory systems normally interact."
- They participate in peer review feedback during every collaborative investigation in each learning cycle. Students complete a peer-to-peer graphing rubric in the Gas Exchange and Cellular Respiration Explore yeast cell investigation to share ideas about how their peers are representing data in graph form.
- In the Muscles and Energy Lesson, students present their models to the class. The teacher and students give feedback on their models including their use of energy inputs and outputs.
- In the Muscles and Energy Evaluate lesson, students make a model of how the human body regulates blood glucose and energy. Students are engaging in the SEP of **Developing and Using Models**, the DCI of **LS1.C** and the CCC of **Stability and Change**. Guidelines for teacher feedback and "conferring questions" are provided.
- In the Thermoregulation lesson, students conduct an investigation on human regulatory mechanisms and collect data about how changing external temperature impacts internal body temperature to learn humans have a complex system for maintaining body temperature.
- At the end of each series of lessons (Gas Exchange, Muscles and Energy, Human Thermoregulation, and Water Balance) students use the Performance Task Organizer to add to their models and are asked to make a claim about whether that body process caused the runner to collapse. Each learning cycle provides numerous opportunities for students to demonstrate learning through models and explanations which are expected of students during each learning cycle.

- Students complete a Lab Check-in at the end of the Thermoregulation lesson to assess the comprehension, performance, and contributions of their partners and themselves.
- Although students complete a Lab Check-in, it is not revisited nor is there guidance for the teacher to use the Check-in to adjust the instructional plan.
- Opportunities for the teacher to provide specific feedback are not embedded throughout the unit. The unit highlights many formative assessments; however, how and when the teacher should provide feedback is unclear.

Suggestions for Improvement

More formal methods and supports for teachers to provide feedback to students on their progress in all three dimensions would help improve this unit.

Students could be provided with more opportunities to utilize peer and teacher feedback to improve models, written explanations, and other products creating a feedback loop to demonstrate new thinking based on peer and teacher feedback and personal reflection.

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

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

# Marathon Runner: Unit 1 in HS Biology
# EQuIP Rubric for Science Evaluation

## Overall Score

**Category I: NGSS 3D Design Score (0, 1, 2, 3):** 2
**Category II: NGSS Instructional Supports Score (0, 1, 2, 3):** 2
**Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3):** 3
**Total Score:** 7
**Overall Score (E, E/I, R, N): E/I**

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

| Overall Scoring Guide |
|---|
| ***E: Example of high quality NGSS design—****High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)*<br><br>***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)*<br><br>***R: Revision needed—****Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)*<br><br>***N: Not ready to review****—Not designed for the NGSS; does not meet criteria (total 0–2)* |