Formative Assessment Exemplar - BIO.2.2

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Teacher Facing Information

Standard: BIO.2.2

Assessment Format: Printable or Online Format (Does not require students to have online access)

Phenomenon	
Images of different cells look very different from each other.	Proficient Student Explanation of Phenomenon: The shape of cells and the types of organelles in cells is directly related to the function of the cell.
Cluster Task Statement	
In the questions that follow, you will identify appropriate scientific **questions** in order to **plan an investigation** to determine how (a) the structure and function of cells, (b) the proportion and quantity of organelles, and (c) the shape of cells result in cells with specialized functions.	
Supporting Information	
Students in a classroom are asked to investigate cell structure and function. Which of the following questions would best lead to an investigation about the structure and function of the cells pictured above? The investigation could involve one or more of the pictures. Questions: A. Is the structure of muscle cells affected by temperature changes? B. Do muscle cells have mitochondria? C. Does skeletal muscle have a different structure from smooth muscle and does that affect their function? D. How does the number of mitochondria in muscle cells and neurons compare? E. Why do leaf cells have chloroplasts? F. Why are chloroplasts green? G. Are neurons with longer arms able to transmit signals faster than neurons with shorter arms? H. How does the number of chloroplasts in leaf cells and stem compare and is that related to their function? I. Does the amount of light a leaf receives affect the number of chloroplasts present in the cells? J. Why do muscle cells appear in long lines while neurons look like smashed stars?	
Cluster Questions	
Gather: Cluster Question #1 Question Type: Short Answer Addresses: ____ DCI __X__ SEP __x__ CCC	Question 1: Choose one of the questions listed above that would lead to an investigation about the structure of specialized cells.

Answer: The Best options: C, G, H, I The OK Options: A, D, J The Options that should not be chosen: B, E, F	
Reason: Cluster Question #2 Question Type: Short Answer Addresses: ____ DCI __X__ SEP __X__ CCC Answer: response needs to show that there is a cause and effect relationship (a stronger response would show structure AND function)	Question 2: Explain how the question you chose would lead to an investigation of the structure of specialized cells.
Reason: Cluster Question #3 Question Type: Short Answer Addresses: ____ DCI __X__ SEP ____ CCC Answer: Answers will vary depending on the identified question. All questions would need: Microscope, cells under investigation, tools to measure the variables Methods: how the tools will be used and/or how the data would be collected	Question 3: Explain the tools and methods necessary to conduct an investigation that would answer this question.
Reason: Cluster Question #4	Question 4: Provide examples of the types of data that would be gathered to

Question Type: Short Answer Addresses: __X__ DCI __x__ SEP ____ CCC Answer: Answers will vary. The data should center around the structure of the cells and/or types and number of organelles.	support the purpose of the investigation.
Communicate: Cluster Question #5 Question Type: Short Answer Addresses: __x__ DCI ____ SEP ____ CCC Answer: Answers will vary. Answers should include a connection between the structure (cause) and function (effect) of the cells investigated.	Question 5: Explain how the evidence would provide information to answer the investigation question.

Proficiency Scale

Proficient Student Explanation:

Answers will vary. All answers would include the connection between the structure and function of the cells investigated as well as a clear identification of the cause and effect found within the investigation question that was chosen.

Proficient Student Explanation for question I

1. Does the amount of light a leaf receives affect the number of chloroplasts present in the cells?
2. There is a clear cause and effect relationship established in this question–the amount of light affects the number of chloroplasts. The more light, the more chloroplasts.
    a. A level 4 student would also make the connection between structure and function–there would be more chloroplasts when there is more light because the chloroplast is the organelle that captures light energy in order to perform photosynthesis.
3. The tools needed for this investigation would be a microscope, and leaf cells a from various plants with varying amounts of light exposure,
4. The types of data I would gather would include the number of chloroplasts present in each sample of leaf cells. I would also want to know how much light each plant had received as it grew until I collected the leaves to analyze.
5. I would predict that my data would show that plants that are exposed to more light would

have more chloroplasts because they are the organelle where photosynthesis occurs and with more light the plant is able to perform more photosynthesis to grow.

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** **Asking Questions:** Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. **Plan and Carry Out Investigations:** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. Evaluate the accuracy of various methods for collecting data.	**SEP:** **Asking Questions:** Evaluate questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. **Plan and Carry Out Investigations:** Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to	**SEP:** Extends beyond proficient in any way.

		problems. Consider possible variables or effects and evaluate the confounding investigation's design to ensure variables are controlled. Select appropriate tools to collect, record, analyze, and evaluate data.	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** **Structure & Function** Visualizes, models, and uses complex and microscopic structures and systems to describe how their function depends on the shapes, composition, and relationships among its parts. Analyzes complex natural structures/systems to determine how they function.	**CCC:** **Structure & Function** Recognizes that investigating systems or structures requires a detailed examination of the structures of different components and connections of components to reveal its function Infer the functions and properties of natural objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** **LS1.A Structure & Function** All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). Within cells, special structures are responsible for particular	**DCI:** **LS1.A Structure and Function** Systems of specialized cells within organisms help them perform the essential functions of life. Structures within specialized cells are responsible for specific cellular functions.	**DCI:** Extends beyond proficient in any way.

	functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.		

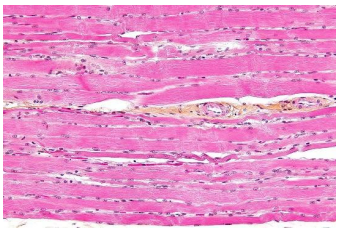
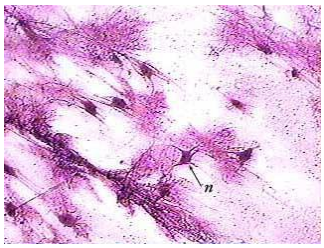
(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

Supporting Information:

The pictures in the table below show the structures of some cells. These pictures were taken with a microscope.

Picture 1:	Picture 2:	Picture 3:
		
Skeletal muscle cells	Nerve cells	Live leaf cells

Picture 1: https://en.wikipedia.org/wiki/Striated_muscle_tissue#/media/File:Skeletal_striated_muscle.jpg
Picture 2: https://www.austincc.edu/histologyhelp/tissues/tx_nerv_tis.html
Picture 3: https://commons.wikimedia.org/w/index.php?search=leaf+cells&title=Special%3ASearch&go=Go&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Bryum_capillare_leaf_cells.jpg

Students in a classroom are asked to investigate cell structure and function. Which of the following questions would best lead to an investigation about the structure and function of the cells pictured above? The investigation could involve one or more of the pictures.

Questions:

A. Is the structure of muscle cells affected by temperature changes?
B. Do muscle cells have mitochondria?
C. Does skeletal muscle have a different structure from smooth muscle and does that affect their function?
D. How does the number of mitochondria in muscle cells and neurons compare?
E. Why do leaf cells have chloroplasts?
F. Why are chloroplasts green?
G. Are neurons with longer arms able to transmit signals faster than neurons with shorter arms?
H. How does the number of chloroplasts in leaf cells and stem compare and is that related to their function?
I. Does the amount of light a leaf receives affect the number of chloroplasts present in the cells?
J. Why do muscle cells appear in long lines while neurons look like smashed stars?

Your Task

In the questions that follow, you will identify appropriate scientific **questions** in order to **plan an investigation** to determine how (a) the structure and function of cells, (b) the proportion and quantity of organelles, and (c) the shape of cells result in cells with specialized functions.

Question 1

Choose one of the questions listed above that would lead to an investigation about the structure of specialized cells.

Chosen Question Letter:_____

Question 2

Explain how the question you chose would lead to an investigation of the structure of specialized cells.

Question 3

Explain the tools and methods necessary to conduct an investigation that would answer this question.

Question 4

Provide examples of the types of data that would be gathered to support the purpose of the investigation.

Question 5

Explain how the evidence would provide information to answer the investigation question.