Minnesota Department of Education

High School Science MCA-III Item Sampler Teacher Guide

Updated September 2, 2016

Purpose of the Item Samplers

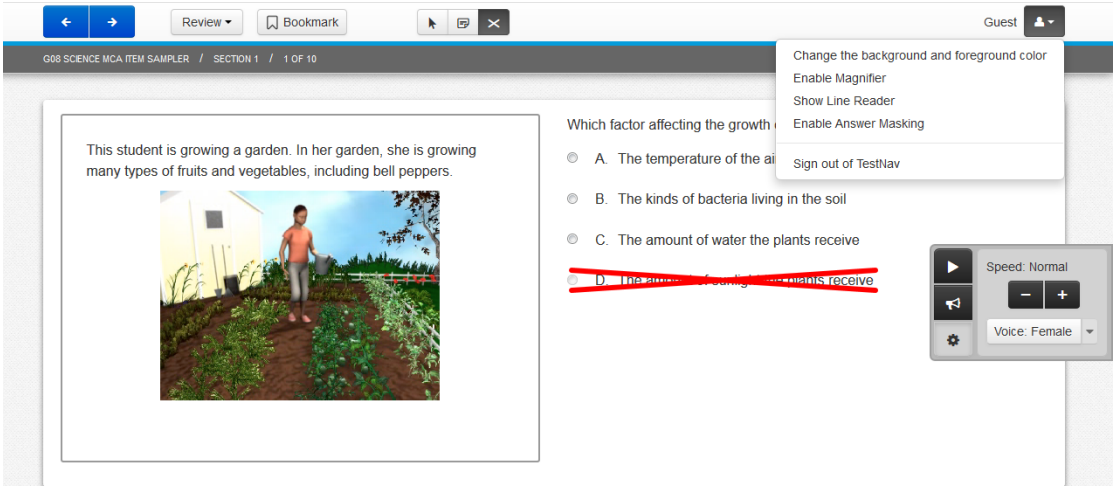
Item Samplers are provided to help teachers and students become familiar with the format and type of content included in the MCAs. Item Samplers contain fewer items than an actual full-length test and are aligned to the Minnesota Academic Standards. They are not suitable for predicting how students will perform on the MCAs.

For more information on the proportions of items aligned to each standard and clarifications on how each standard will be assessed, see the MCA-III Test Specifications for Science (MDE > Districts, Schools and Educators > Statewide Testing > Test Specifications).

The Item Samplers and other testing resources, like the Online MCA Tutorials, can be found on the Pearson Access Next site (http://minnesota.pearsonaccessnext.com).

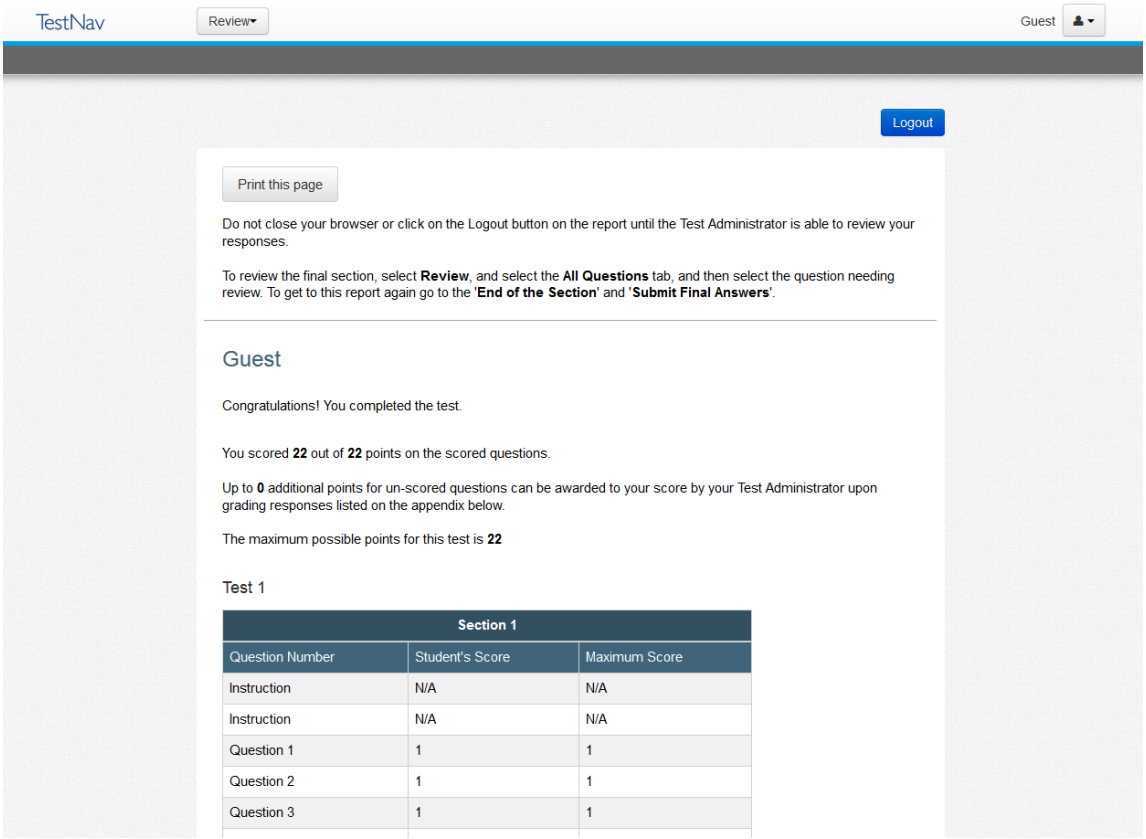
Test Design and Navigation

- The screen is split vertically, with the scene on the left and questions on the right.
- Students are required to answer all questions in a section before they can proceed to the next section.
- A review screen at the end of a section reminds students about unanswered questions and questions they marked for review, and it provides an opportunity to review any questions in that section.
- Text-to-speech (TTS) is available on all items. Accommodated text is available for graphics and tables but needs to be part of the student's IEP or EL designation.
- Online tools include a highlighter, eliminate choice options, line reader, answer option masking, magnifier, notepad, screen contrast, and a calculator if needed.
- All items in the Item Samplers are worth one point.



Score Report

Upon completion of the Item Samplers, a Score Report is displayed. This report can be printed.



Section 1		
Question Number	Student's Score	Maximum Score
Instruction	N/A	N/A
Instruction	N/A	N/A
Question 1	1	1
Question 2	1	1
Question 3	1	1

Teacher Guide

This guide includes the answer keys for all items in the sampler, along with rationales for the answer options. When student performance data is available for an item, the percentages of students answering correctly and incorrectly are shown. Item benchmark alignment and Depth of Knowledge (DOK) level are also provided for each item.

DOK refers to the cognitive demand associated with an item. The level of cognitive demand focuses on the type and level of thinking and reasoning required of the student on a particular item. MCA-III levels of cognitive complexity are based on Norman L. Webb's Depth of Knowledge[1] levels. Although certain verbs, such as "recall," "classify" or "reason," are commonly associated with specific cognitive levels, Webb's DOK levels are not determined by the verbs that describe them, but rather the contexts in which the verbs are used and the depth of thinking required.

[1] Webb, N. L. Alignment of science and mathematics standards and assessments in four states (Research Monograph No. 18). Madison: University of Wisconsin – Madison, National Institute for Science Education, 1999.

DOK 1 (recall) items require the recall of information such as a fact, definition, term or simple science process or procedure.

DOK 2 (skill/concept) items call for the engagement of some mental processing beyond a habitual response, with students required to make some decisions as to how to approach a problem or activity.

DOK 3 (strategic thinking) items require students to reason, plan or use evidence to solve a problem.

The MCA-III Science Test Specifications give a more detailed explanation of DOK levels used in the MCA-III assessments.

If you have further questions concerning the MCA Science Assessments please contact the following MDE staff:

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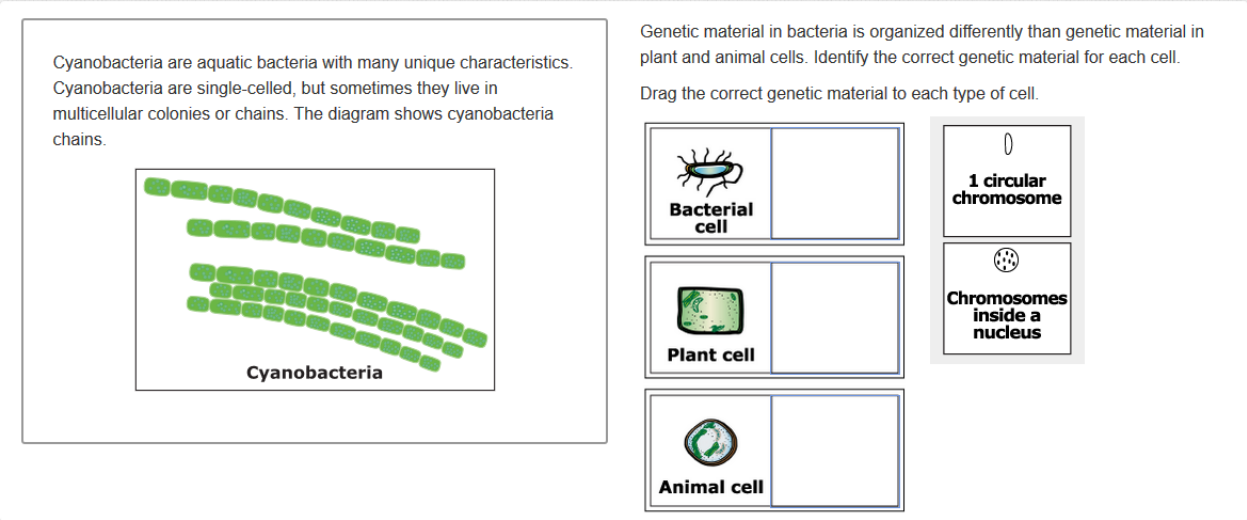
Section 1

Scenario: Cyanobacteria

Question 1



Benchmark: 9.4.1.2.3

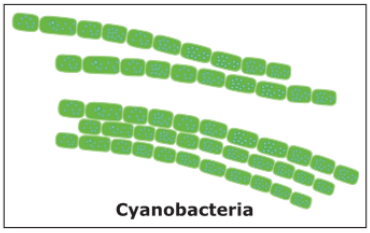
> Describe how viruses, prokaryotic cells and eukaryotic cells differ in relative size, complexity and general structure.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: Bacterial cell: *1 circular chromosome*; Plant cell: *Chromosomes inside a nucleus*; Animal cell: *Chromosomes inside a nucleus*.	The student understands that bacterial cells have a circular chromosome while animal and plant cells have a chromosome inside a nucleus.	73%
Incorrect: All other answer combinations	The student does not understand how prokaryotic and eukaryotic cells differ in terms of their chromosome structure.	27%

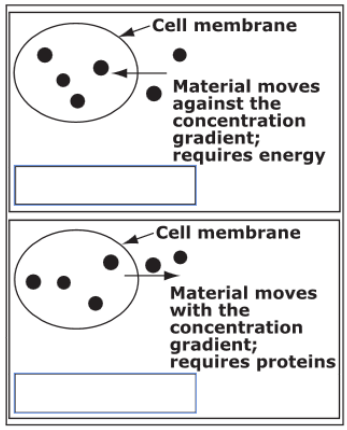
Question 2

Cyanobacteria are aquatic bacteria with many unique characteristics. Cyanobacteria are single-celled, but sometimes they live in multicellular colonies or chains. The diagram shows cyanobacteria chains.



Cyanobacteria cell membranes are selectively permeable. Cells use many methods of transport to move materials into and out of the cells. Label each method of material transport in the diagram.

Drag a label into each box.



Labels

- osmosis
- active transport
- facilitated transport

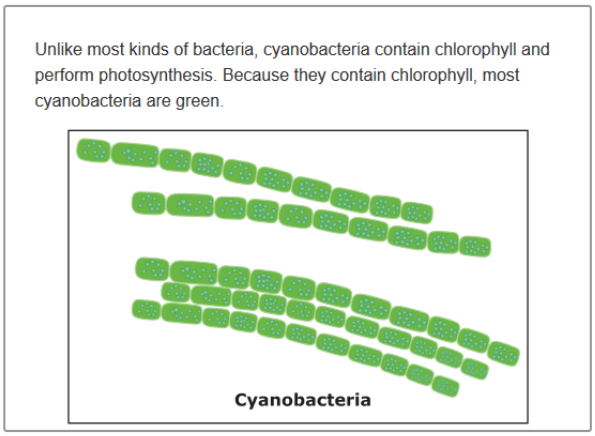
Benchmark: 9.4.1.2.5

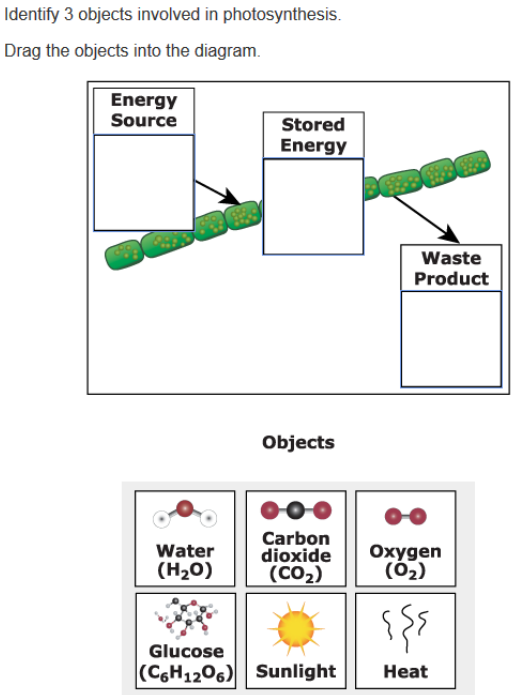
Compare and contrast passive transport (including osmosis and facilitated transport) with active transport, such as endocytosis and exocytosis.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: Material moves against the concentration gradient: *active transport;* Material moves with the concentration gradient: *facilitated transport*	The student understands the differences in concentration gradients and requirements between active and facilitated transport and that neither diagram describes osmosis.	51%
Incorrect: All other responses	The student does not understand one or more modes of transport.	49%

Question 3





Benchmark: 9.4.2.2.2

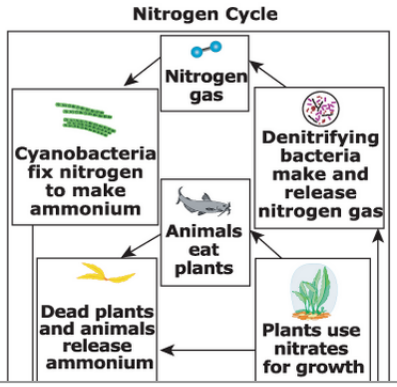
Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: Energy Source: *Sunlight*; Stored Energy: *Glucose*; Waste Product: *Oxygen*.	The student understands the components of photosynthesis in terms of the energy source, stored form of energy and one of the products of the process.	32%
Incorrect: All other responses	The student does not understand one or more components of photosynthesis.	68%

Question 4

Some cyanobacteria change nitrogen gas in the air to a usable form. These cyanobacteria are nitrogen fixers and important components of the nitrogen cycle. The diagram shows part of the nitrogen cycle in an aquatic environment.



How are cyanobacteria important to aquatic plants in the nitrogen cycle?

- A. Aquatic plants use cyanobacteria for food.
- B. Aquatic plants absorb cyanobacteria for nitrogen.
- C. Aquatic plants depend on cyanobacteria to fix nitrogen gas.
- D. Aquatic plants use the form of nitrogen made by cyanobacteria.

Benchmark: 9.4.2.2.2

Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.

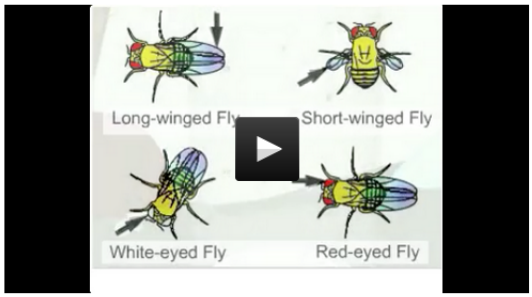
DOK: 2

Answer option	Rationale	Percent of student responses
A	Aquatic plants make their own food.	10%
B	Aquatic plants do not absorb cyanobacteria. The nitrogen is converted into usable forms for plants.	14%
Correct: C	Without atmospheric nitrogen fixation, no nitrogen would be available to plants.	52%
D	Aquatic plants need a form of nitrogen produced by other intermediates.	24%

Scenario: Fruit Fly Genetics

Question 5

Biology students can use fruit flies in experiments. Fruit flies have short life cycles and easily observable traits. Genetics studies involving wing length and eye color are common.



Students observe fruit flies with different eye colors and wing lengths. Which type of molecule carries the instructions for characteristics in fruit flies?

- A. ATP
- B. Glucose
- C. Fatty acids
- D. Nucleic acids

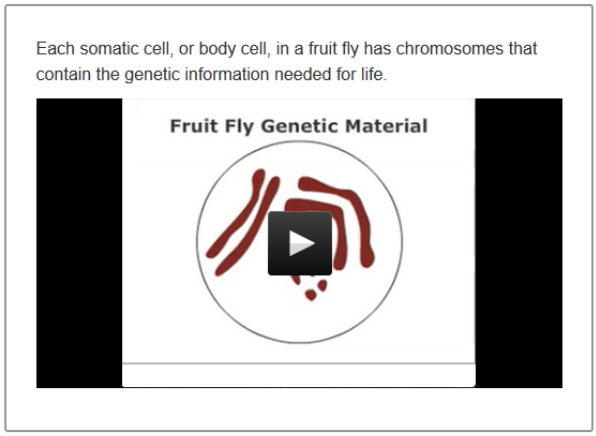
Benchmark: 9.4.1.2.1

Recognize that cells are composed primarily of a few elements (carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur), and describe the basic molecular structures and the primary functions of carbohydrates, lipids, proteins and nucleic acids.

DOK: 1

Answer option	Rationale	Percent of student responses
A	ATP is an energy source for cellular processes, but it does not determine genetic differences.	30%
B	Glucose is a form of stored energy for the cell, but it does not determine genetic differences.	8%
C	Fatty acids are structures that make up different types of cells, but they do not determine genetic differences.	4%
Correct: D	Nucleic acids determine genetic differences in organisms.	58%

Question 6



Which statement best describes the composition of genetic material in fruit flies and other animals?

A. Genes and chromosomes are composed of DNA.

B. Genes and chromosomes are composed of RNA.

C. Genes are composed of DNA; chromosomes are composed of RNA.

D. Genes are composed of RNA; chromosomes are composed of DNA.

Benchmark: 9.4.3.1.1

Explain the relationships among DNA, genes and chromosomes.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: A	Both genes and chromosomes are composed of DNA.	55%
B	The student thinks that genes and chromosomes are composed of RNA instead of DNA.	4%
C	The student thinks there is a difference in the composition of genes and chromosomes.	33%
D	The student thinks there is a difference in the composition of genes and chromosomes.	8%

Question 7

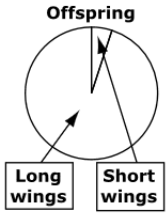
Biology students examine wing length inheritance in fruit flies by doing a cross and observing the offspring. In biology, a cross is defined as 2 organisms bred to produce offspring.

Results of a Fruit Fly Cross

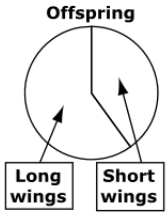
Cross	Offspring
 **Long-winged fly** **X**  **Long-winged fly**	75% long wings 25% short wings

The students count the offspring from the cross and show the results in a circle graph. Which graph best represents the results of the cross?

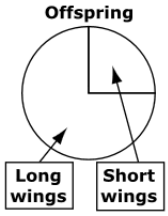
A.



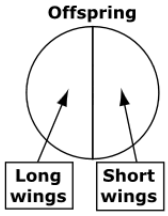
B.



C.



D.



Benchmark: 9.1.3.3.2

Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.

DOK: 1

Answer option	Rationale	Percent of student responses
A	This circle graph represents more long wings and fewer short wings than shown in the data table.	6%
B	This circle graph represents fewer long wings and more short wings than shown in the data table.	3%
Correct: C	This circle graph shows the correct percentage of long and short wings shown in the data table.	89%
D	The number of long and short wings are not equal in the data table.	2%

Question 8

Biology students examine wing length inheritance in fruit flies by doing a cross and observing the offspring. In biology, a cross is defined as 2 organisms bred to produce offspring.

Results of a Fruit Fly Cross

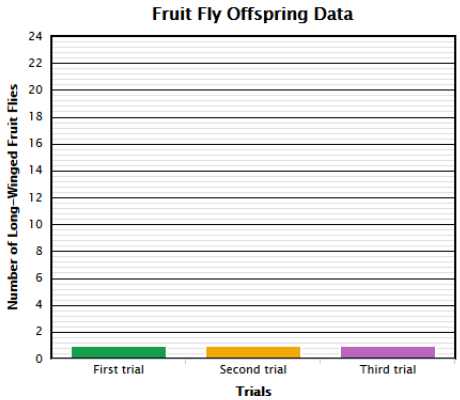
Cross	Offspring
 **Long-winged fly** **X**  **Long-winged fly**	75% long wings 25% short wings

The students perform 3 trials of the cross. In the first trial, the students count 8 offspring. In the second trial, the students count 16 offspring. In the third trial, the students count 24 offspring.

Calculate the number of long-winged fruit flies counted in each of the 3 trials. Make a graph of this data.

You can use the calculator to help you answer this question.

Drag the top of each bar to the correct height.



Benchmark: 9.1.3.4.3

Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

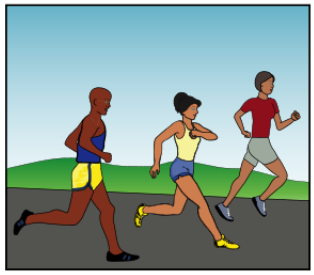
DOK: 2

Answer option	Rationale	Percent of student responses
Correct: First trial: 6; Second trial: 12; Third trial: 18.	The student is able to calculate 75% of the offspring for each trial in order to know what the expected number of long-winged organisms will be and graphs the appropriate data.	44%
Incorrect: All other responses	The student does not calculate the percent of long-winged offspring and/or does not graph the data correctly.	56%

Scenario: Altitude Training

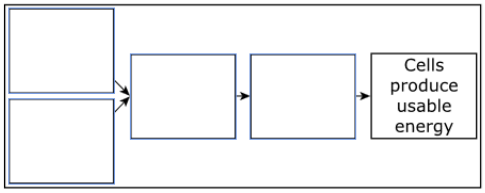
Question 9

When athletes train and compete, their cells require large amounts of energy. For cells to get the energy they need, many organ systems must work together.



Put the activities into the diagram to show how organ systems work together to help the cells transform energy.

Drag the activities into the diagram.



Activities

Cells get raw materials	Circulatory system transports	Digestive system breaks down food	Respiratory system gets oxygen

Benchmark: 9.4.1.1.2

Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism.

DOK: 2

Answer option	Rationale	Percent of student responses
Correct: *Digestive system breaks down food* and *Respiratory system gets oxygen* in either of the boxes on the left. *Circulatory system transports* in middle box. *Cells get raw materials* in box on the right.	The student understands the order and function of how body systems work together to produce energy that is usable for the cell.	26%
Incorrect: All other responses	The student does not show how the functions of one or more organ systems interact to provide energy to the cell.	74%

Question 10

Some athletes train in locations that have high altitudes. Training in these locations may result in the body being able to get more oxygen to the muscles during exercise. More oxygen available to the muscles can help athletes perform better during competition.

What is 1 way more oxygen helps athletes' muscle cells when they exercise?
Athletes' muscle cells

- A. require less food.
- B. produce less waste.
- C. use more carbon dioxide.
- D. convert more glucose to energy.

Benchmark: 9.4.2.2.1

Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products.

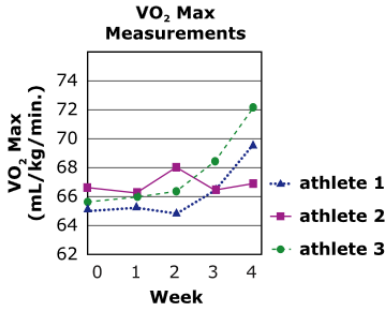
DOK: 2

Answer option	**Rationale**	**Percent of student responses**
A	Athletes' muscle cells will require more food as cellular respiration increases.	4%
B	Athletes' muscle cells will produce more waste as cellular respiration increases.	6%
C	Athletes' muscle cells do not use carbon dioxide, they produce it as waste.	13%
Correct: D	Athletes' muscle cells will be able to convert more glucose to energy due to increased oxygen.	77%

Question 11

To determine if athletes are benefiting from training in high altitudes, scientists measure the volume of oxygen that athletes use during exercise. This measurement is called VO_2 max. Athletes benefit when they increase their VO_2 max.

The graph shows the VO_2 max for 3 athletes who trained in high altitudes for 4 weeks.



Identify the time period during which each athlete showed the greatest increase in VO_2 measurements.

Drag the time period into each box.

Greatest Increase in VO_2 Measurements

Athlete 1	Athlete 2	Athlete 3
Week 0–1	Week 0–1	Week 0–1
Week 1–2	Week 1–2	Week 1–2
Week 2–3	Week 2–3	Week 2–3
Week 3–4	Week 3–4	Week 3–4

Benchmark: 9.1.1.2.1

Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations and draw conclusions supported by evidence from the investigation.

DOK: 2

Answer option	Rationale	Percent of student responses
Correct: Athlete 1: *Week 3–4*; Athlete 2: *Week 1–2*; Athlete 3: *Week 3–4*.	The student analyzes the graph and identifies the weeks that each athlete has an increase in their VO_2 max.	74%
Incorrect: All other responses	The student analyzes the data incorrectly.	26%

Question 12

Athletes who increase their VO_2 max may also improve their performance during competition.

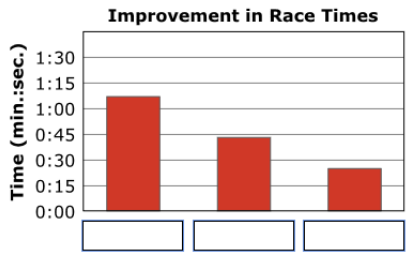
The table shows the race times for the 3 athletes before and after they trained in high altitudes.

Athletes' Race Times

	Before Training (min.:sec.)	After Training (min.:sec.)
Athlete 1	17:46	17:02
Athlete 2	16:58	16:32
Athlete 3	17:24	16:12
Average	17:23	16:35

The graph shows the improvement in race times (min.:sec.) for each of the 3 athletes. Complete the graph by putting labels on the x-axis.

Drag the labels into the graph.



Labels

Athlete 1 | Athlete 2 | Athlete 3

Benchmark: 9.1.3.4.3

Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

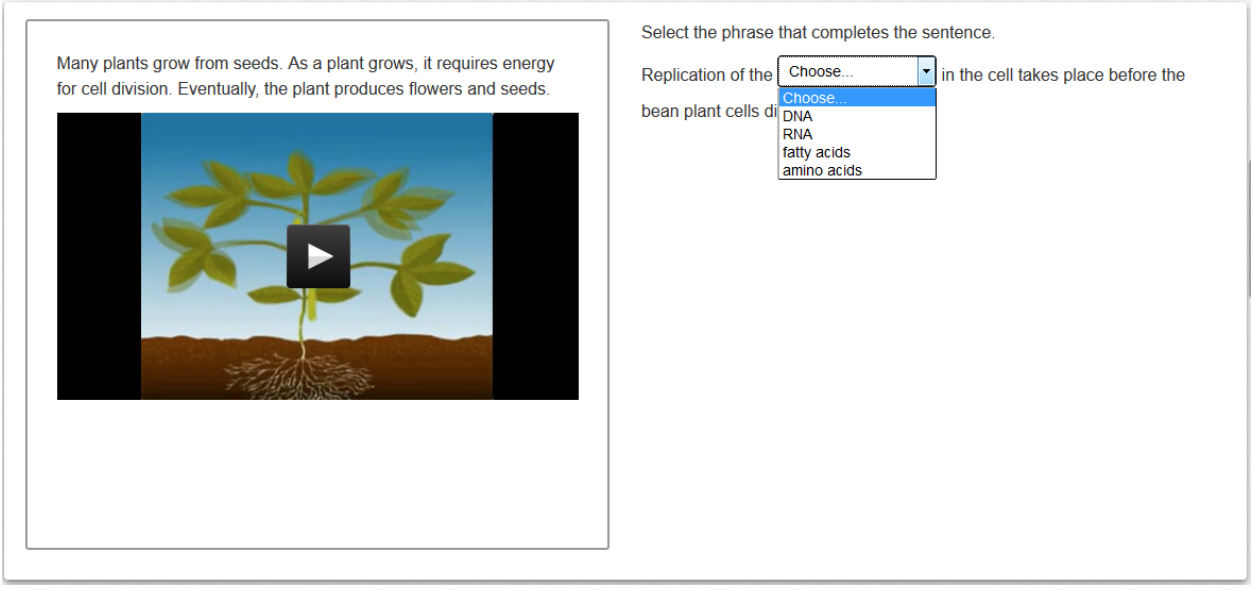
DOK: 2

Answer option	Rationale	Percent of student responses
Correct: From left to right on the x-axis: *Athlete 3, Athlete 1, Athlete 2.*	The student calculates the improvement in race times for each athlete and correctly places the athlete labels on the x-axis of the graph.	71%
Incorrect: All other responses	The student does not calculate the improvement for each athlete from the data table and does not label the graph correctly.	29%

Section 2

Scenario: Plant Growth

Question 13



Benchmark: 9.4.3.1.3

Describe the process of DNA replication and the role of DNA and RNA in assembling protein molecules.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: *DNA*	DNA is replicated at the beginning of mitosis.	No data available
Incorrect: All other responses	The student shows a misunderstanding that RNA, fatty acids and amino acids are replicated instead of transcribed, modified or manufactured.	No data available

Question 14

Many plants grow from seeds. As a plant grows, it requires energy for cell division. Eventually, the plant produces flowers and seeds.

Identify each plant system response that must occur for the bean plant to maintain homeostasis when it is growing.

Select each system response you want to choose.

- [ ] Increased xylem conduction
- [ ] Increased gas exchange
- [ ] Decreased root absorption
- [ ] Decreased phloem conduction

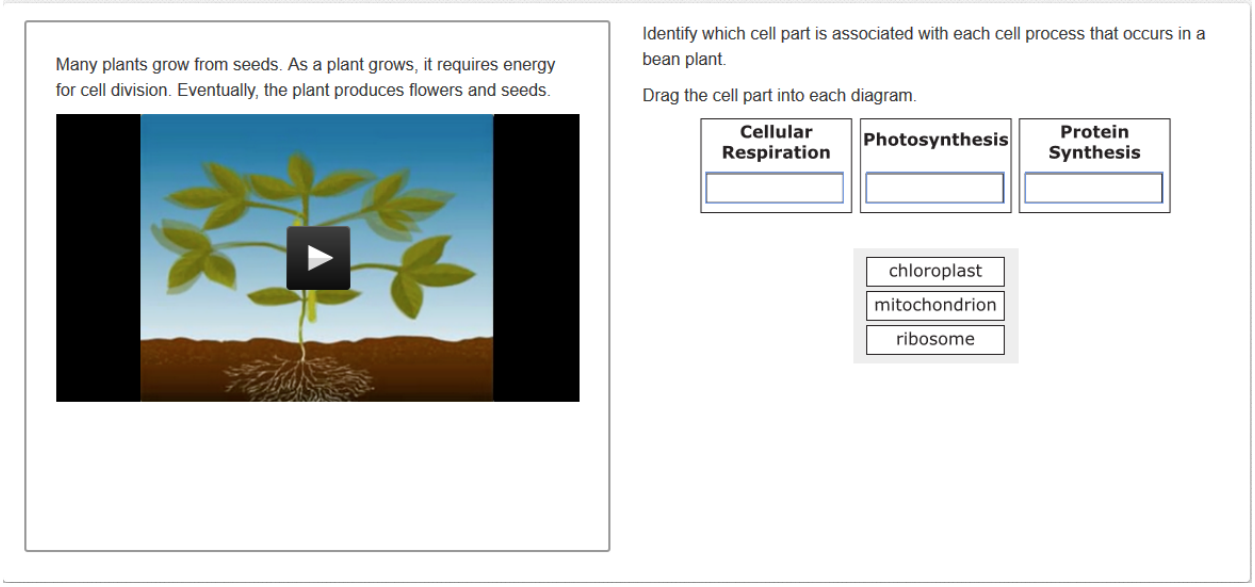
Benchmark: 9.4.1.1.2

Describe how the functions of individual organ systems are integrated to maintain homeostasis in an organism.

DOK: 2

Answer option	Rationale	Percent of student responses
Correct: *Increased xylem conduction, Increased gas exchange*	The student understands that in order to maintain homeostasis during plant growth there is an increase in gas exchange and an increase in fluid transportation upward from the root through the xylem.	No data available
Incorrect: All other responses	The student does not understand the function and roles of vascular tissue and plant structures in maintaining homeostasis during plant growth.	No data available

Question 15



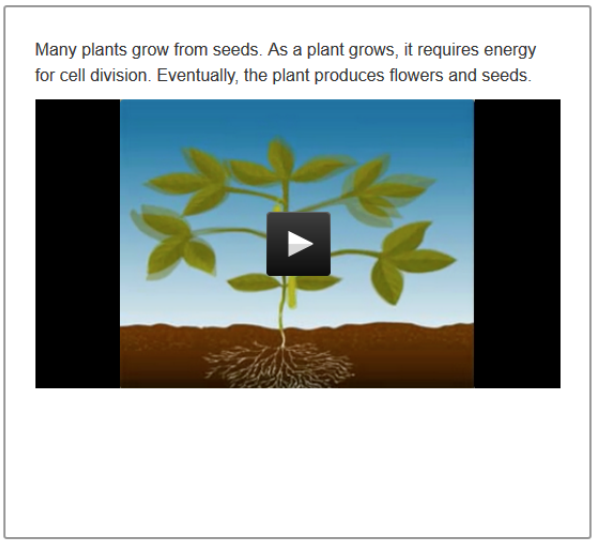
Benchmark: 9.4.1.2.4

Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: From left to right: *mitochondrion, chloroplast, ribosome.*	The student understands that cellular respiration occurs in the mitochondrion, photosynthesis occurs in chloroplasts, and protein synthesis occurs in the ribosomes.	No data available
Incorrect: All other responses	The student does not understand where cellular processes occur inside a plant cell.	No data available

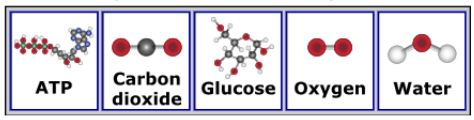
Question 16



From the compounds, identify each reactant of cellular respiration in the cells of this growing bean plant.

Select each reactant you want to choose.

Compounds of Cellular Respiration



Benchmark: 9.4.2.2.1

Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: *Glucose, Oxygen*	The student understands that both glucose and oxygen are the reactants needed for cellular respiration to occur. Water, carbon dioxide and ATP are products.	No data available
Incorrect: All other responses	The student does not correctly identify the reactants of cellular respiration.	No data available

Question 17

Many plants grow from seeds. As a plant grows, it requires energy for cell division. Eventually, the plant produces flowers and seeds.

What role does a bean plant play in the food web of an ecosystem?

- A. Producer
- B. Decomposer
- C. Primary consumer
- D. Secondary consumer

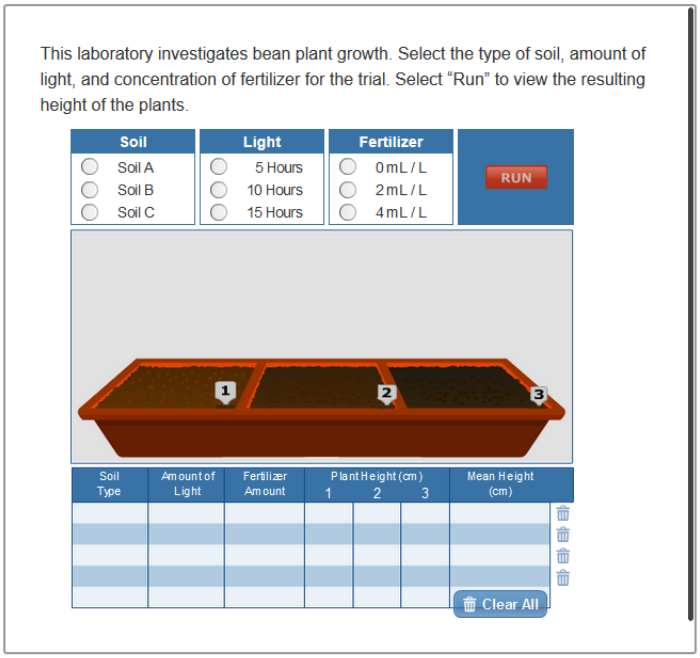
Benchmark: 9.4.2.2.2

Explain how matter and energy is transformed and transferred among organisms in an ecosystem, and how energy is dissipated as heat into the environment.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: A	Bean plants are producers because they undergo photosynthesis.	No data available
B	Decomposers are organisms like bacteria and fungi that recycle nutrients back into the ecosystem.	No data available
C	Primary consumers are organisms that use plants as a food source.	No data available
D	Secondary consumers are organisms that use primary consumers as a food source.	No data available

Question 18



Which statement can be defended because of the results of the investigation?

A. The type of soil affects plant height.

B. The amount of light has no effect on plant height.

C. The amount of water affects the heights of the plants.

D. The plants grow the tallest after receiving 8 mL/L of fertilizer.

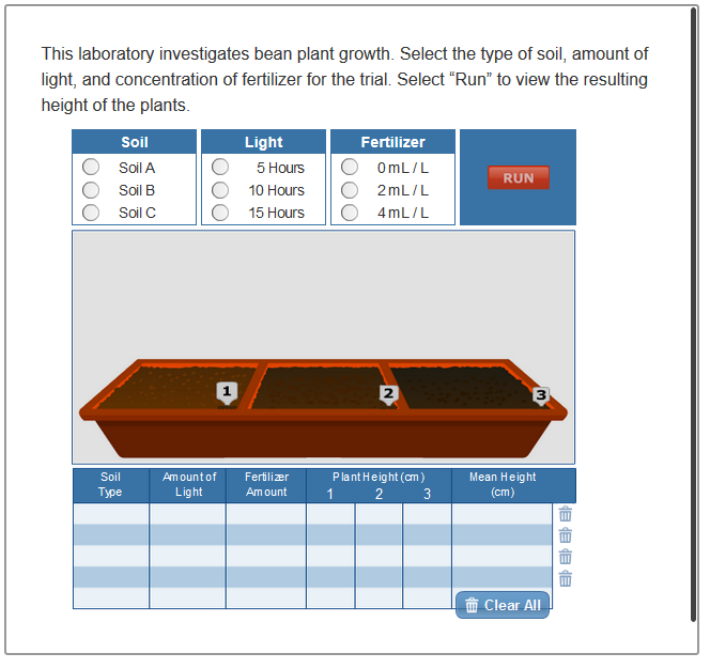
Benchmark: 9.1.3.3.2

Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.

DOK: 2

Answer option	Rationale	Percent of student responses
Correct: A	The simulation data shows that soil type affects the height of the bean plants.	No data available
B	The simulation data indicates that the amount of light does affect plant height.	No data available
C	This claim cannot be supported with the variables and design of the current simulation because water was not tested.	No data available
D	This claim cannot be supported because 8 mL/L of fertilizer is not one of the amounts of fertilizer that could be tested in this simulation.	No data available

Question 19



Proper safety precautions should be followed when conducting scientific investigations. Identify 2 safety procedures to use in this plant growth investigation in a laboratory.

Select the 2 safety precautions you want to choose.

- ☐ Use protective eyewear when handling chemical fertilizer.
- ☐ Use caution when calculating mean plant heights.
- ☐ Use gloves when applying fertilizer to the plants.
- ☐ Use caution to avoid mixing different soil types.

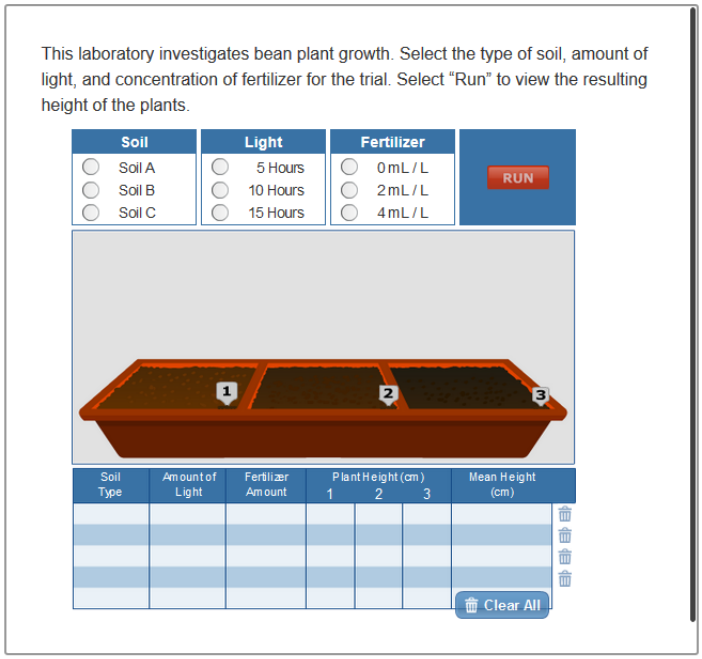
Benchmark: 9.1.3.4.2

Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts. For example: Consideration of chemical and biological hazards in the lab.

DOK: 1

Answer option	Rationale	Percent of student responses
Correct: *Use protective eyewear when handling chemical fertilizer* and *Use gloves when applying fertilizer to the plants.*	The student understands that in order to protect both eyes and skin from chemical fertilizer exposure, protective eyewear and gloves should be worn.	No data available
Incorrect: All other responses	Calculating mean plant heights and mixing soil types does not require safety protocol.	No data available

Question 20



An investigation is designed to test the effect of the amount of light on bean plant growth. Which part of this design would add a source of error to the investigation?

A. Growing all plants in different types of soil

B. Giving all plants the same amount of water

C. Providing all plants with different amounts of light

D. Supplying all plants with the same amount of fertilizer

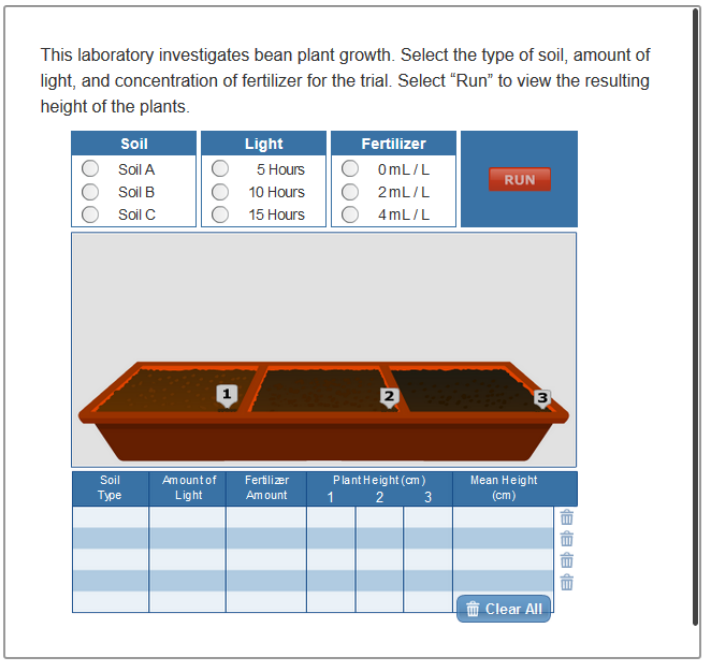
Benchmark: 9.1.3.4.4

Relate the reliability of data to consistency of results, identify sources of error, and suggest ways to improve the data collection and analysis. For example: Use statistical analysis or error analysis to make judgments about the validity of results.

DOK: 2

Answer option	Rationale	Percent of student responses
Correct: A	Growing all plants in different types of soil would be a source of error because it adds to the design another changed variable in addition to the amount of light.	No data available
B	Growing all plants in the same amount of water would not be a source of error because it ensures another changed variable is not added to the design.	No data available
C	This variable is appropriate and would not be a source of error because to test the length of light, the length of light should be varied for each trial.	No data available
D	Using the same amount of fertilizer would not be a source of error because it ensures another changed variable is not added to the design.	No data available

Question 21



Bean plants are grown in soil C and receive 5 hours of light. Calculate the expected mean height of the plants if they receive fertilizer at a concentration of 1 mL/L.

You can use the calculator to help you answer this question.

Enter your answer in the box.

_____ cm

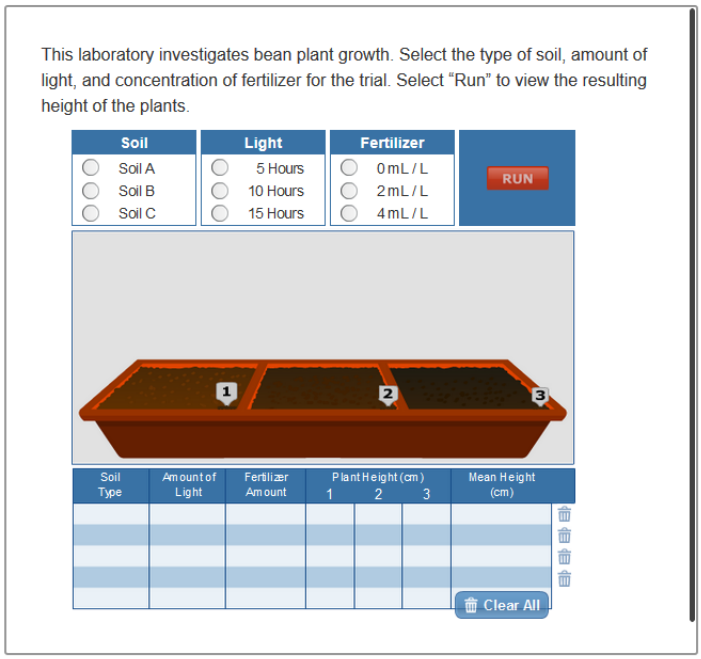
Benchmark: 9.1.1.2.1

Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations and draw conclusions supported by evidence from the investigation.

DOK: 3

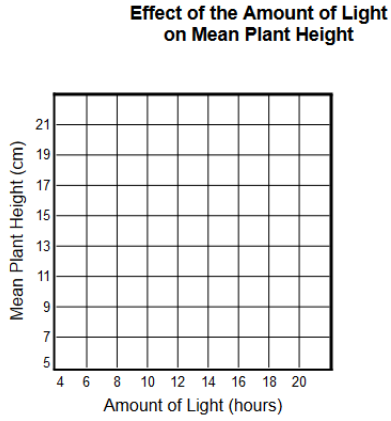
Answer option	Rationale	Percent of student responses
Correct: Answers between 13.5 and 15.5.	The student correctly runs the simulation using the variables given. Then they predict that the average height of plants when given 1 mL/L of fertilizer will be the mean of the results for 0 mL/L and 2 mL/L. This would be 14.5 cm. Since this is a prediction, a variance of +/- 1 is given in the scoring.	No data available
Incorrect: All other responses	The student does not run the simulation with the variables given or does not correctly calculate the expected mean.	No data available

Question 22



Use soil B and a fertilizer concentration of 4 mL/L to run the simulation for 5, 10, and 15 hours of light. Predict the mean plant height if plants were given 20 hours of light. Graph the data for 5, 10, 15, and 20 hours of light.

Select the location on the graph to plot each point.



Benchmark: 9.1.3.3.2

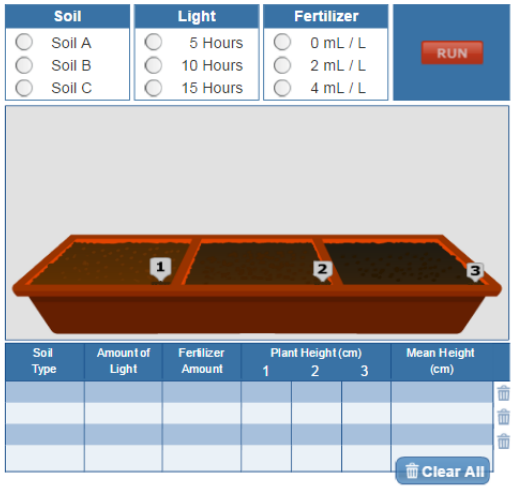
Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.

DOK: 3

Answer option	Rationale	Percent of student responses
Correct: The student plots the points 5,7; 10,17; 15,19; 20,(19, 20, or 21).	The student correctly runs the simulation with the variables given and plots the results for 5, 10 and 15 hours of light. Then, based on the relationship between the amount of light and mean plant height, the student calculates the plants' average growth if given 20 hours of light.	No data available
Incorrect: All other responses	The student does not plot the data correctly and/or understand the relationship between the amount of light and plant growth in the simulation.	No data available

Question 23

This laboratory investigates bean plant growth. Select the type of soil, amount of light, and concentration of fertilizer for the trial. Select "Run" to view the resulting height of the plants.



Conduct an investigation to test the hypothesis that bean plant growth is affected by the amount of light.

After you conduct the investigation, go on to the next question.

Benchmark: 9.1.1.2.1

Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.

DOK: 3

Answer option	Rationale	Percent of student responses
Correct: Student performs at least 3 trials varying only the amount of light. Soil type and amount of fertilizer remain the same.	The student understands that in a controlled experiment, only 1 variable should be changed. In this simulation, the student can select any amount of fertilizer and soil type as long as only the amount of light for each trial is varied.	No data available
Incorrect: All other responses	The student does not set up a controlled experiment correctly, changing only the amount of light or running 3 trials.	No data available