Minnesota Comprehensive Assessment-Series IV (MCA-IV)

Guide to Science MCA-IV Released Items

High School Life Science

Purpose of the Guide to Released Items

The purpose of this guide is to give Minnesota education professionals some examples of phenomenon-based, multidimensional items aligned to the 2019 Minnesota Science Standards. These items can be used for professional development to prepare for the Science MCA-IV, which will be administered beginning in Spring 2025. Until that time, students will be assessed using the Science MCA-III. Resources for students to prepare for testing can be found on the Minnesota Assessments-Student Tutorials page.

This group of items is an example of one phenomenon with its associated items. There are some unique features specific to the MCA-IV:

- Phenomenon-based item sets. The context for each phenomenon is focused around observable events occurring in the universe that can be explained or predicted with scientific reasoning (Achieve, Next Generation Science Storylines and STEM Teaching Tools).
- Multi-dimensional items. Each item assesses the Practice and Core Idea of the benchmark. Most items also assess the Crosscutting Concept of the benchmark.
- Tabs. The information explaining the phenomenon may be contained in multiple tabs, which are all simultaneously available for each item.
- Constructed Response. In order to better assess student learning of several of the practices, MDE is investigating the use of short-answer constructed response items. An example is contained in this set of items.

The data included in this document are actual student responses from the 2021 field test results. Items in this guide are not interactive. Visit High School Life Science MCA-IV Released Items to see this High School Life Science phenomenon as it will appear in the testing platform.

For more information, see Minnesota Comprehensive Assessment-Series IV (MCA-IV) Draft Test Specifications for Science.

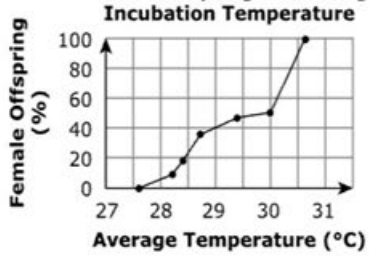
Phenomenon Title: Sex Determination in Sea Turtles

Tab A

Tab A | Tab B | Tab C

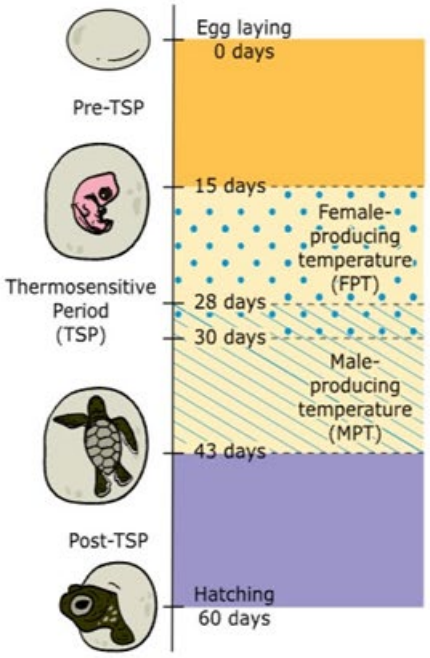
There are animals whose sex is determined by the temperature at which the eggs incubate, or develop. Sea turtles are one of those animals. Graph 1 shows the percentage of female sea turtle offspring for different average incubation temperatures.

Graph 1. Percentage of Female Offspring vs. Average Incubation Temperature



The period when sex is determined is known as the thermosensitive period (TSP). TSP in sea turtles occurs in 2 phases that overlap slightly. During the first phase (days 15–30), genes that control female development are turned on or off, depending on average incubation temperature. During the second phase (days 28–43), genes that control male development are turned on or off, depending on average incubation temperature. Figure 1 shows the effect of incubation temperature on sea turtle development.

Figure 1. Sea Turtle Development

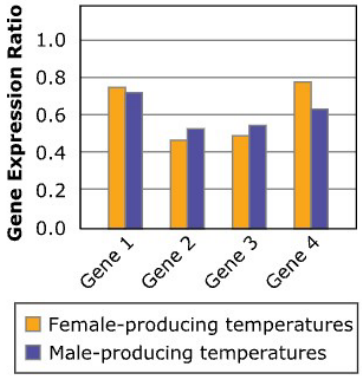


Tab B

Tab A | Tab B | Tab C

Scientists studied 4 genes that control the development of male and female turtles. They measured the gene expression ratio of those 4 genes during the thermosensitive period. Graph 2 shows their results.

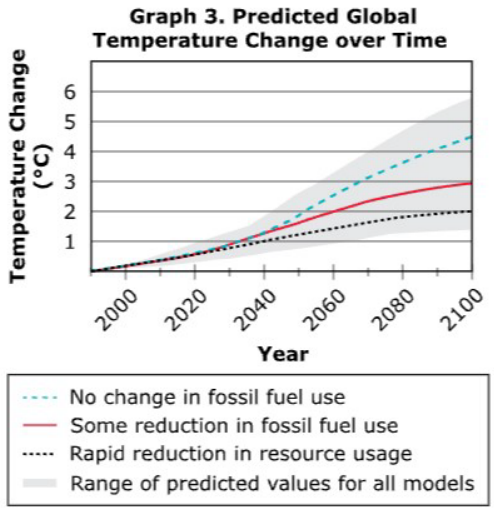
Graph 2. Gene Expression Ratio during the Thermosensitive Period



Tab C

Tab A | Tab B | Tab C

Graph 3 shows the predicted global temperature change, in degrees Celsius (°C), under 3 conditions: no change in fossil fuel use, some reduction in fossil fuel use, and rapid reduction in resource usage.



Item 1

Item 1 Information

Item Characteristic	Description
Item Number	1
Associated Tab	Tab A
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.2.1.1.1 Apply concepts of probability to explain and predict the variation and distribution of expressed traits in a population.** (P: 4, CC: 3, CI: LS3) Examples of traits in human groups may include lactose intolerance, or high altitude adaptation.
Practice	4 Analyzing and interpreting data
Cross-cutting Concept	3 Scale, proportion and quantity
Core Idea	LS3 Heredity: Inheritance and variation of traits
Points	1

Illustration Reference for Item 1

Based on the data in Graph 1 (Tab A), what is the average incubation temperature at which 50% of sea turtle offspring are female?

A. 28°C
B. 29°C
C. 30°C
D. 31°C

Item 1 Scoring Information

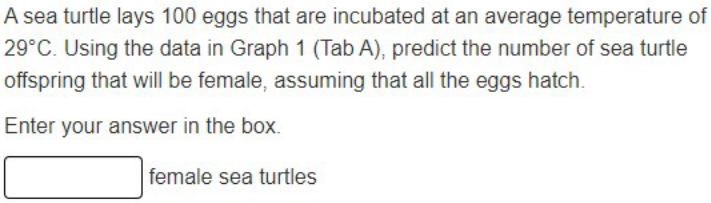
Score	Description	Percent of Student Responses
0	A. At 28°C, less than 20% of offspring can be expected to be female.	3.0%
0	B. At 29°C, about 40% of offspring are female.	15.8%
1	C. **Correct.** Half the offspring incubated at 30°C will likely be female.	77.3%
0	D. At 31°C, all offspring will likely be female.	3.9%

Item 2

Item 2 Information

Item Characteristic	Description
Item Number	2
Associated Tab	Tab A
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.2.1.1.1 Apply concepts of probability to explain and predict the variation and distribution of expressed traits in a population.** (P: 4, CC: 3, CI: LS3) Examples of traits in human groups may include lactose intolerance, or high altitude adaptation.
Practice	4 Analyzing and interpreting data
Cross-cutting Concept	3 Scale, proportion and quantity
Core Idea	LS3 Heredity: Inheritance and variation of traits
Points	1

Illustration Reference for Item 2



Item 2 Scoring Information

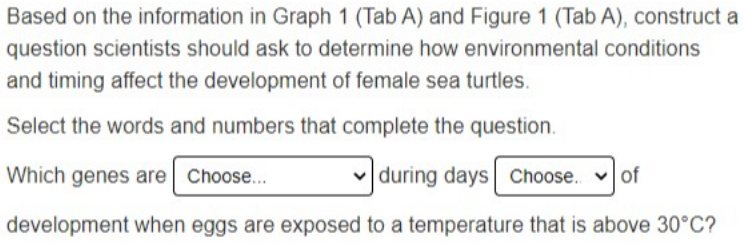
Score	Description	Percent of Student Responses
1	The student enters 40.	68.7%
0	The response is incorrect or irrelevant.	31.3%

Item 3

Item 3 Information

Item Characteristic	Description
Item Number	3
Associated Tab	Tab A
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.1.1.1.1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** (P: 1, CC: 2, CI: LS3) Examples of relationships may include relationships between mutated DNA sequences or chromosomal deletions and their effect on traits.
Practice	1 Asking questions (for science) and defining problems (for engineering)
Cross-cutting Concept	2 Cause and effect: Mechanism and explanation
Core Idea	LS3 Heredity: Inheritance and variation of traits
Points	1

Illustration Reference for Item 3



Response Number	First Answer Option	Second Answer Option	Third Answer Option	Fourth Answer Option
Response 1	turned on	inherited	N/A	N/A
Response 2	0-15	15-30	28-43	43-60

Item 3 Scoring Information

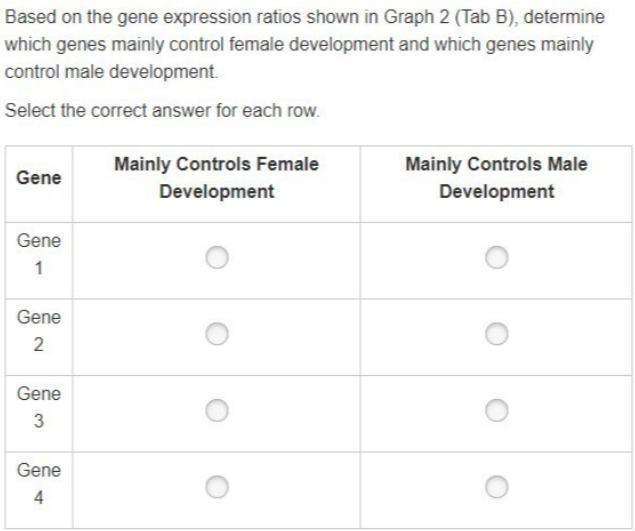
Score	Description	Percent of Student Responses
1	The student selects the following words or numbers to complete the sentences: Which genes are **turned on** during days **15—30** of development when eggs are exposed to a temperature that is above 30°C?	44.1%
0	The response is incorrect or irrelevant.	55.9%

Item 4

Item 4 Information

Item Characteristic	Description
Item Number	4
Associated Tab	Tab B
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.1.1.1.1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** (P: 1, CC: 2, CI: LS3) Examples of relationships may include relationships between mutated DNA sequences or chromosomal deletions and their effect on traits.
Practice	1 Asking questions (for science) and defining problems (for engineering)
Cross-cutting Concept	2 Cause and effect: Mechanism and explanation
Core Idea	LS3 Heredity: Inheritance and variation of traits
Points	1

Illustration Reference for Item 4



Based on the gene expression ratios shown in Graph 2 (Tab B), determine which genes mainly control female development and which genes mainly control male development.

Select the correct answer for each row.

Gene	Mainly Controls Female Development	Mainly Controls Male Development
Gene 1	○	○
Gene 2	○	○
Gene 3	○	○
Gene 4	○	○

Item 4 Scoring Information

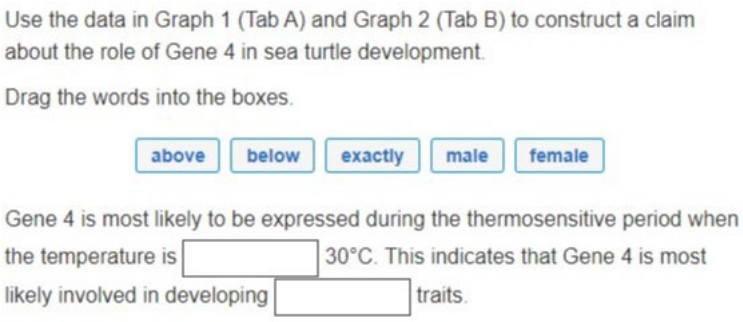
Score	Description	Percent of Student Responses
1	The student selects the following in each row: For Gene 1, Mainly Controls Female Development For Gene 2, Mainly Controls Male Development For Gene 3, Mainly Controls Male Development For Gene 4, Mainly Controls Female Development	86.6%
0	The response is incorrect or irrelevant.	13.4%

Item 5

Item 5 Information

Item Characteristic	Description
Item Number	5
Associated Tab	Tab B
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.2.1.1.1 Apply concepts of probability to explain and predict the variation and distribution of expressed traits in a population.** (P: 4, CC: 3, CI: LS3) Examples of traits in human groups may include lactose intolerance, or high altitude adaptation.
Practice	4 Analyzing and interpreting data
Cross-cutting Concept	3 Scale, proportion and quantity
Core Idea	LS3 Heredity: Inheritance and variation of traits
Points	1

Illustration Reference for Item 5



Item 5 Scoring Information

Score	Description	Percent of Student Responses
1	The student drags the following words into the boxes: Gene 4 is most likely to be expressed during the thermosensitive period when the temperature is **above** 30°C. This indicates that gene 4 is most likely involved in developing **female** traits. OR Gene 4 is most likely to be expressed during the thermosensitive period when the temperature is **below** 30°C. This indicates that gene 4 is most likely involved in developing **male** traits.	64.6%
0	The response is incorrect or irrelevant.	35.4%

Item 6

Item 6 Information

Item Characteristic	Description
Item Number	5
Associated Tab	Tab C
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.4.1.1.3 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species** (P: 7, CC: 2, CI: LS4). Emphasis is on determining cause and effect relationships for (1) how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and (2) the rate of change of the environment affect distribution or disappearance of traits in species.
Practice	7 Engaging in argument from evidence.
Cross-cutting Concept	2 Cause and effect: Mechanism and explanation
Core Idea	LS4 Biological evolution: Unity and diversity
Points	1

Illustration Reference for Item 6

Which claim about the effect of the predicted temperature change in Graph 3 (Tab C) is supported by the data in Graph 1 (Tab A) and Figure 1 (Tab A)?

A. The number of sea turtle eggs laid will increase.
B. The percentage of male sea turtles will increase.
C. The percentage of female sea turtles will increase.
D. The number of sea turtle eggs that hatch will increase.

Item 6 Scoring Information

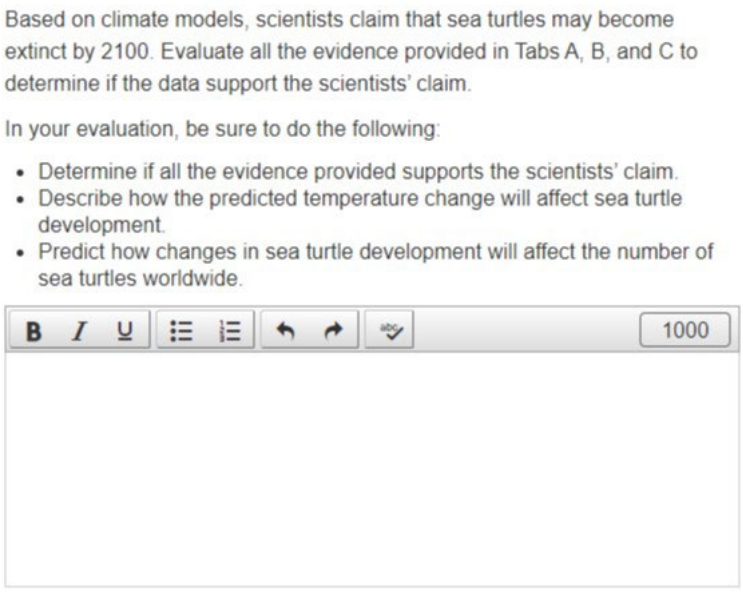
Score	Description	Percent of Student Responses
0	A. None of the data relate to egg laying rates.	12.9%
0	B. Male sea turtles develop when incubated at lower temperatures, and the global temperature is expected to rise.	12.8%
1	C. **Correct.** As global temperatures increase, the number of female turtles is also expected to increase.	57.3%
0	D. No data related to temperature and hatching rates are provided.	17.1%

Item 7

Item 7 Information

Item Characteristic	Description
Item Number	7
Associated Tab	Tab C
Phenomenon	Sex Determination in Sea Turtles
Benchmark	**9L.4.1.1.3 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species**. P: 7, CC: 2, CI: LS4) Emphasis is on determining cause and effect relationships for (1) how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and (2) the rate of change of the environment affect distribution or disappearance of traits in species.
Practice	7 Engaging in argument from evidence
Cross-cutting Concept	2 Cause and effect: Mechanism and explanation
Core Idea	LS4 Biological evolution: Unity and diversity
Points	3

Illustration Reference for Item 7



Item 7 Scoring Information

Score	Description	Percent of student Responses
3	The response demonstrates a complete understanding of the question. The response thoroughly: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response is fully cohesive and developed. • The response is solidly based on core ideas. • The response clearly and definitively connects ideas/concepts to the question. • The response is solidly based on evidence.	4.5%
2	The response demonstrates a partial understanding of the question. The response somewhat: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response is somewhat cohesive and developed. • The response is based on core ideas. • The response connects ideas/concepts to the question.	19.6%
1	The response demonstrates a minimal understanding of the question. The response minimally: explores phenomena/problems; utilizes evidence; develops explanations/solutions; and/or communicates information. • The response lacks cohesion and development. • The response may be based on core ideas. • The response lacks connections between ideas/concepts and the question.	21.1%
0	The response demonstrates no understanding of the question. • The response may contain correct information, but overall the response lacks enough correct information that is connected to the question.	54.8%

3-point Actual Student Response from 2021

Turtles are likely to be extinct by 2100 if the temperature does increase. The more the temperature increases, the less male sea turtles there will be. Sea turtles rely on sexual reproduction and require a mate to create offspring. This means that if there are less males to mate with females there will be less sea turtles made. As less and less turtles are born, the species nears or reaches extinction.