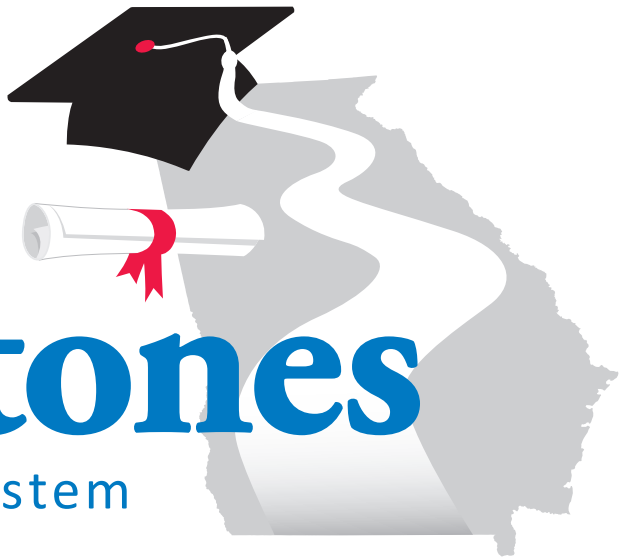
Georgia Milestones Assessment System



Assessment Guide

Biology

Assessment Guide

Table of Contents

THE GEORGIA MILESTONES ASSESSMENT SYSTEM

The purpose of the Georgia Student Assessment Program is to measure student achievement of the state-adopted content standards and inform efforts to improve teaching and learning. Results of the assessment program are utilized to identify students failing to achieve mastery of content, to provide educators with feedback about instructional practice, and to assist school districts in identifying strengths and weaknesses in order to establish priorities in planning educational programs.

The State Board of Education is required by Georgia law (O.C.G.A. §20-2-281) to adopt assessments designed to measure student achievement relative to the knowledge and skills set forth in the state-adopted content standards. The Georgia Milestones Assessment System (Georgia Milestones) fulfills this requirement and, as a key component of Georgia's Student Assessment Program, is a comprehensive summative assessment program spanning Grade 3 through high school. Georgia Milestones measures how well students have learned the knowledge and skills outlined in the state-adopted content standards in English Language Arts, Mathematics, Science, and Social Studies. Students in grades 3 through 8 take an end-of-grade assessment in English Language Arts and Mathematics, while students in grades 5 and 8 also take an end-of-grade assessment in Science and Social Studies. High school students take an end-of-course assessment for each of the ten courses designated by the State Board of Education. In accordance with State Board Rule, Georgia Milestones end-of-course measures serve as the final exams for the specified high school courses.

The main purpose of Georgia Milestones is to inform efforts to improve student achievement by assessing student performance on the standards specific to each course or subject/grade tested. Specifically, Georgia Milestones is designed to provide students and their parents with critical information about the students' achievement and, importantly, their preparedness for the next educational level. The assessment system is a critical informant of the state's accountability measure, the College and Career Ready Performance Index (CCRPI), providing an important gauge about the quality of the educational services and opportunities provided throughout the state.
The ultimate goal of Georgia's assessment and accountability system is to ensure that all students are provided the opportunity to engage with high-quality content standards, receive high-quality instruction predicated upon those standards, and are positioned to meet high academic expectations.

Features of the Georgia Milestones Assessment System include:

- technology-enhanced items (all grades and courses);
- open-ended (constructed-response) items in English Language Arts and Mathematics (all grades and courses);
- a writing component (in response to passages read by students) at every grade level and course within the English Language Arts assessment;
- norm-referenced items in all content areas and courses to complement the criterion-referenced information and to provide a national comparison; and
- a transition to online administration over time, with online administration considered the primary mode of administration and paper/pencil as a backup until the transition is complete.

The primary mode of administration for the Georgia Milestones program is online, with the goal of completing the transition from paper/pencil within five years after the inaugural administration (i.e., the 2014–2015 school year). Paper/pencil test materials (such as Braille) will remain available for students with disabilities who may require them in order to access the assessment.

Georgia Milestones follows guiding principles to help ensure that the assessment system:

- is sufficiently challenging to ensure Georgia students are well positioned to compete with other students across the United States and internationally;
- is intentionally designed across grade levels to send a clear signal of student academic progress and preparedness for the next level, whether it is the next grade level, course, or college or career;
- is accessible to all students, including those with disabilities or limited English proficiency, at all achievement levels;
- supports and informs the state's educator-effectiveness initiatives, ensuring items and forms are appropriately sensitive to quality instructional practices; and
- accelerates the transition to online administration, allowing—over time—for the inclusion of innovative technology-enhanced items.

GEORGIA MILESTONES END-OF-COURSE (EOC) ASSESSMENTS

As previously mentioned, Georgia law (§20-2-281) mandates that the State Board of Education adopt EOC assessments for core courses to be determined by the Board. An EOC assessment serves as a student's final exam in the associated course. With educator input and State Board approval, the Georgia Milestones EOC assessments measure student achievement in the following courses: Ninth Grade Literature and Composition, American Literature and Composition, Algebra I, Geometry, Coordinate Algebra, Analytic Geometry, Physical Science, Biology, United States History, and Economics/Business/Free Enterprise.

Any student enrolled in and/or receiving credit for one of the above-mentioned courses, regardless of grade level, is required to take the Georgia Milestones EOC assessment upon completion of that course. This includes middle school students completing a course associated with a Georgia Milestones EOC assessment, regardless of whether they are receiving high school credit. Students enrolling from non-accredited programs are required to take and pass the Georgia Milestones EOC assessment prior to receiving credit for the course.

A student's final grade in the course will be calculated using the Georgia Milestones EOC assessment as follows (State Board Rule 160-4-2-.13):

- For students enrolled in Grade 9 for the first time before July 1, 2011, the EOC assessment counts as 15% of the final grade.
- For students enrolled in Grade 9 for the first time on or after July 1, 2011, the EOC assessment counts as 20% of the final grade.

Results of the EOC assessments, according to the legislated and identified purposes, must:

- provide a valid measure of student achievement of the state content standards across the full achievement continuum;
- serve as the final exam for each course, contributing 15% or 20% to the student's final course grade;
- provide a clear signal of each student's preparedness for the next course and ultimately post-secondary endeavors (college and career);
- allow for the detection of the academic progress made by each student from one assessed course to the next;
- support and inform educator-effectiveness measures; and
- inform state and federal accountability measures at the school, district, and state levels.

Additional uses of the EOC assessments include: (1) certifying student proficiency prior to the awarding of credit for students enrolling from non-accredited private schools, home study programs, or other non-traditional educational centers and (2) allowing eligible students to demonstrate competency without taking the course and earn course credit (e.g., "test out"). In both cases, students are allotted *one* administration.

ASSESSMENT GUIDE

The Georgia Milestones Biology EOC Assessment Guide is provided to acquaint Georgia educators and other stakeholders with the structure of and content assessed by the test. Importantly, this guide is not intended to inform instructional planning. It is essential to note that there are a small number of content standards that are better suited for classroom or individual assessment than for large-scale summative assessment. While those standards are not included in the tests and therefore are not included in this Assessment Guide, the knowledge, concepts, and skills inherent in those standards are often required for the mastery of the standards that are assessed. Failure to attend to all content standards within a course can limit a student's opportunity to learn and show what he or she knows and can do on the assessment.

The Georgia Milestones Biology EOC Assessment Guide is in *no way* intended to substitute for the state-mandated content standards; it is provided to help educators better understand the structure and content of the assessment, *but it is not all-encompassing of the knowledge, concepts, and skills covered in the course or assessed on the test*. The state-adopted content standards and associated standards-based instructional resources, such as the Content Frameworks, should be used to plan instruction. This Assessment Guide can serve as a *supplement* to those resources, in addition to any locally developed resources, ***but should not be used in isolation***. In principle, the Assessment Guide is intended to be descriptive of the assessment program and should not be considered all-inclusive. The state-adopted content standards are located at www.georgiastandards.org.

TESTING SCHEDULE

The Georgia Milestones Biology EOC assessment is offered during three Main Administrations. Main Administrations are primarily intended to provide an opportunity to assess student achievement at the completion of a course and to serve as the final exam for the associated course as required by State Board Rule. As a result, the EOC assessment should occur as close to the conclusion of the course as possible. Main Administrations can also be utilized to verify credit from a non-accredited school or home schooling. In addition to the Main Administrations, Mid-Month Administrations are provided in order to allow students additional testing opportunities for the various reasons noted below.

Purpose for EOC Assessment	Winter & Spring Main Administrations	Mid-Month Administrations	Summer Main Administration
Completion of Course	Yes	Yes	Yes
Makeup from Previous Administration	Yes	Yes	Yes
Retest	No*	Yes	Yes
Test Out	No	Yes**	Yes
Validation of Credit	Yes	Yes	Yes

*Winter and Spring Main Administrations cannot be used for the purpose of a retest.

**August, September, and March Mid-Month Administrations as well as the Summer Main Administration can be used for the purpose of a test out.

Note: Each district determines a local testing window within the state-designated testing window.

TEST STRUCTURE

DESCRIPTION OF TEST FORMAT AND ORGANIZATION

The Georgia Milestones Biology EOC assessment is primarily a criterion-referenced test designed to provide information about how well a student has mastered the state-adopted content standards within the course. Each student will receive one of four Achievement Level designations, depending on how well the student has mastered the course content standards. The four Achievement Level designations are Beginning Learner, Developing Learner, Proficient Learner, and Distinguished Learner. In addition to criterion-referenced information, the Georgia Milestones measures will also include a limited sample of nationally norm-referenced items to provide a signal of how Georgia students are achieving relative to their peers nationally. The norm-referenced information provided is supplementary to the criterion-referenced Achievement Level designation and will not be utilized in any manner other than to serve as a barometer of national comparison. Only the criterion-referenced scores and Achievement Level designations will be utilized in the accountability metrics associated with the assessment program (such as student course grades, student growth measures, educator-effectiveness measures, and the CCRPI).

The Biology EOC assessment consists of both operational items (contribute to a student's criterion-referenced and/or norm-referenced score) and field test items (newly written items that are being tried out and do not contribute to the student's score). A subset of the norm-referenced operational items have been verified as aligned to the course content standards by Georgia educators and will also contribute to the criterion-referenced score and Achievement Level designation. The other norm-referenced items will contribute only to the national percentile rank, which is provided as supplemental information.

With the inclusion of the norm-referenced items, students may encounter items for which they have not received direct instruction. These items will not contribute to the students' criterion-referenced Achievement Level designation; only items that align to the course content standards will contribute to the criterion-referenced score. Students should be instructed to try their best should they ask about an item that is not aligned to the content they have learned as part of the course.

The table on the following page outlines the number and types of items included on the Biology EOC assessment.

Biology EOC Assessment Design

Description	Number of Items	Points for CR[1] Score	Points for NRT[2] Feedback
CR Selected-Response Items	45	45	0
NRT Selected-Response Items	20[3]	7[4]	20
CR Technology-Enhanced Items	4	8	0
CR Field Test Items	7	0	0
Total Items/Points[5]	**76**	**60**	**20**

[1]CR—Criterion-Referenced: items aligned to state-adopted content standards

[2]NRT—Norm-Referenced Test: items that will yield a national comparison; may or may not be aligned to state-adopted content standards

[3]Of these items, 7 will contribute to both the CR scores and NRT feedback. The other 13 of these items will contribute to NRT feedback only and will not impact the student's Achievement Level designation, scale score, or grade conversion.

[4]Alignment of national NRT items to course content standards was verified by a committee of Georgia educators. Only approved, aligned NRT items will contribute to a student's CR Achievement Level designation, scale score, and grade conversion score.

[5]Of the 76 total items, 56 items contribute to the CR score, for a total of 60 points; 20 total items contribute to NRT feedback, for a total of 20 points.

The test will be given in two sections. Students may have up to 70 minutes per section to complete Sections 1 and 2. The total estimated testing time for the Biology EOC assessment ranges from approximately 90 to 140 minutes. Total testing time describes the amount of time students have to complete the assessment. It does not take into account the time required for the test examiner to complete pre-administration and post-administration activities (such as reading the standardized directions to students). Sections 1 and 2 may be administered on the same day or across two consecutive days based on the district's testing protocols for the EOC measures (in keeping with state guidance).

CONTENT MEASURED

The Biology EOC assessment will measure the Biology standards that are described at www.georgiastandards.org.

The content of the assessment is organized into five groupings, or domains, of standards for the purposes of providing feedback on student performance. A content domain is a reporting category that *broadly* describes and defines the content of the course, as measured by the EOC assessment. The standards for Biology are grouped into five domains: Cells, Genetics, Organisms, Ecology, and Evolution. Each domain was created by organizing standards that share similar content characteristics. The content standards describe the level of expertise that Biology educators should strive to develop in their students. Educators should refer to the content standards for a full understanding of the knowledge, concepts, and skills subject to be assessed on the EOC assessment.

The approximate proportional number of points associated with each domain is shown in the following table. A range of cognitive levels will be represented on the Biology EOC assessment. Educators should always use the content standards when planning instruction.

Biology: Domain Structures and Content Weights

Reporting Category	Standard Assessed	Approximate Percentage of Test	Approximate Number of Points
Cells	SB1 (a, b, c, d, e)	20%	12
Cellular Genetics & Heredity	SB2 (a, b, c) SB3 (a, b, c)	23%	14
Classification & Phylogeny	SB4 (a, b, c)	13%	8
Ecology	SB5 (a, b, c, d, e)	27%	16
Theory of Evolution	SB6 (a, b, c, d, e)	17%	10

ITEM TYPES

Operational items in the Biology EOC assessment consist of selected-response and technology-enhanced items.

A selected-response item, sometimes called a multiple-choice item, is defined as a question, problem, or statement that appears on a test followed by several answer choices, sometimes called options or response choices. The incorrect choices, called distractors, usually reflect common errors. The student's task is to choose, from the alternatives provided, the best answer to the question posed in the stem (the question). The Biology selected-response items will have four answer choices.

A technology-enhanced item is an innovative way to measure student skills and knowledge using scaffolding within a multi-step response. For multiple-select items, the student is asked to pick two correct responses from five or six possible answer options. In multiple-part items, the student responds to a two-part item that combines two multiple-choice items. For these item types, the student selects the responses from the choices provided and receives two points for selecting all correct answers or partial credit for specific combinations of correct responses.

DEPTH OF KNOWLEDGE DESCRIPTORS

Items found on the Georgia Milestones assessments, including the Biology EOC assessment, are developed with a particular emphasis on cognitive complexity or Depth of Knowledge (DOK). DOK is measured on a scale of 1 to 4 and refers to the level of cognitive demand required to complete a task (or in this case, an assessment item). The higher the level, the *more complex* the item; however, higher levels do not necessarily mean *more difficult* items. For instance, a question can have a low DOK but a medium or even high difficulty level. Conversely, a DOK 4 question may have a low difficulty level but still require a great deal of cognitive thinking (e.g., analyzing and synthesizing information instead of just recalling it). The following descriptions and table show the expectations of the four DOK levels in greater detail.

Level 1 (Recall of Information) generally requires students to identify, list, or define, often asking them to recall who, what, when, and where. Consequently, this level usually asks students to recall facts, terms, concepts, and trends and may ask them to identify specific information contained in documents, excerpts, quotations, maps, charts, tables, graphs, or illustrations. Items that require students to "describe" and/or "explain" could be classified at Level 1 or Level 2, depending on what is to be described and/or explained. A Level 1 "describe" and/or "explain" would require students to recall, recite, or reproduce information.

Level 2 (Basic Reasoning) includes the engagement of some mental processing beyond recalling or reproducing a response. A Level 2 "describe" and/or "explain" would require students to go beyond a description or explanation of recalled information to describe and/or explain a result or "how" or "why."

Level 3 (Complex Reasoning) requires reasoning, using evidence, and thinking on a higher and more abstract level than Level 1 and Level 2. Students will go beyond explaining or describing "how and why" to justifying the "how and why" through application and evidence. Level 3 questions often involve making connections across time and place to explain a concept or "big idea."

Level 4 (Extended Reasoning) requires the complex reasoning of Level 3 with the addition of planning, investigating, applying significant conceptual understanding, and/or developing that will most likely require an extended period of time. Students should be required to connect and relate ideas and concepts *within* the content area or *among* content areas in order to be at this highest level. The distinguishing factor for Level 4 would be a show of evidence (through a task, a product, or an extended response) that the cognitive demands have been met.

The following table identifies skills that students will need to demonstrate at each DOK level, along with question cues appropriate for each level.

Level	Skills Demonstrated	Question Cues
Level 1 Recall of Information	• Make observations • Recall information • Recognize properties, patterns, processes • Know vocabulary, definitions • Know basic concepts • Perform one-step processes • Translate from one representation to another • Identify relationships	• Tell what, when, or where • Find • List • Define • Identify; label; name • Choose; select • Compute; estimate • Express • Read from data displays • Order
Level 2 Basic Reasoning	• Apply learned information to abstract and real-life situations • Use methods, concepts, theories in abstract and real-life situations • Perform multi-step processes • Solve problems using required skills or knowledge (requires more than habitual response) • Make a decision about how to proceed • Identify and organize components of a whole • Extend patterns • Identify/describe cause and effect • Recognize unstated assumptions, make inferences • Interpret facts • Compare or contrast simple concepts/ideas	• Apply • Complete • Describe • Explain how; demonstrate • Construct data displays • Construct; draw • Analyze • Extend • Connect • Classify • Arrange • Compare; contrast

Level	Skills Demonstrated	Question Cues
Level 3 Complex Reasoning	• Solve an open-ended problem with more than one correct answer • Create a pattern • Generalize from given facts • Relate knowledge from several sources • Draw conclusions • Make predictions • Translate knowledge into new contexts • Compare and discriminate between ideas • Assess value of methods, concepts, theories, processes, formulas • Make choices based on a reasoned argument • Verify the value of evidence, information, numbers, data	• Plan; prepare • Predict • Create; design • Ask “what if?” questions • Generalize • Justify; explain why; support; convince • Assess • Rank; grade • Test; judge • Recommend • Select • Conclude
Level 4 Extended Reasoning	• Analyze and synthesize information from multiple sources • Examine and explain alternative perspectives across a variety of sources • Combine and synthesize ideas into new concepts	• Design • Connect • Synthesize • Apply concepts • Critique • Analyze • Create • Prove

SCORES

Selected-response and technology-enhanced items are machine scored. The operational items in the Biology EOC assessment consist of selected-response and technology-enhanced items.

Students will receive a scale score and an Achievement Level designation based on total test performance. In addition, students will receive information on how well they performed at the domain level. Students will also receive a norm-referenced score based on a set of norm-referenced items included within the test; this score will allow comparison to a national norming group of students.

EXAMPLE ITEMS

Example items, which are representative of the applicable DOK levels across various Biology content domains, are provided.

All example and sample items contained in this guide are the property of the Georgia Department of Education.

Example Item 1

Selected-Response: 1 point

DOK Level: 1

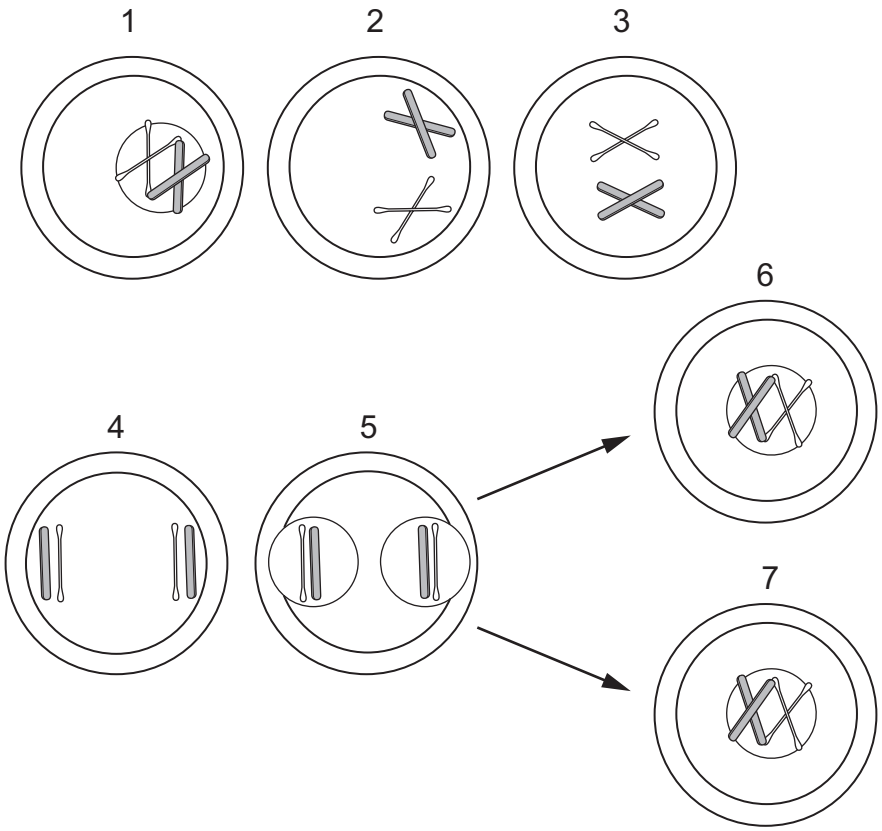
Biology Domain: Cells

Standard: SB1. Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.

b. Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity.

(This item continues on the next page.)

Students modeled the changes in cells during mitosis, using paper plates, flat wooden sticks, cotton swabs, and construction paper.



Which statement correctly uses the model to explain how mitosis maintains genetic continuity?

A. The chromosomes in cell 1 are the same as in cells 6 and 7.
B. Crossing-over occurs in cell 4, which increases the genetic diversity in cells 6 and 7.
C. When the nuclear membrane reforms in cell 5, each nucleus becomes diploid in number.
D. The independent assortment that is represented in cell 2 ensures that cell 3 has the correct number of chromosomes.

Correct Answer: A

Explanation of Correct Answer: The correct answer is choice (A) The chromosomes in cell 1 are the same as in cells 6 and 7. Choice (B) is incorrect because crossing-over does not occur in mitosis. Choice (C) is incorrect because the chromosomes in step 5 are haploid, not diploid as shown in the picture. Choice (D) is incorrect because it is not an independent assortment.

Example Item 2

Selected-Response: 1 point

DOK Level: 2

Biology Domain: Genetics

Standard: SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

c. Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.

Agriculture companies produce plants that have genetic modifications that give the plants desired traits, such as resistance to drought or pests. These companies can also add modifications that cause planted crops to produce seeds that are sterile. The use of these seeds requires farmers to purchase new seeds from the company each year in order to grow the same crops. Which question would gather information about an ethical consideration of genetically modified plants?

A. Will these plants cause pollinators to avoid large areas of land?

B. Can the amount of excess food produced by these plants be calculated?

C. Can the genetic modifications of these plants be acquired by noxious plants?

D. Will these plants require more land to grow than an equal amount of non-genetically modified plants require?

Correct Answer: C

Explanation of Correct Answer: The correct answer is choice (C) Can the genetic modifications of these plants be acquired by noxious plants? Choice (A) is incorrect because genetically modified plants would still attract pollinators. Choice (B) is incorrect because genetically modified crops and non-genetically modified crops would produce the same amount of food. Choice (D) is incorrect because genetically modified crops and non-genetically modified crops would both require the same amount of land.

Example Item 3

Selected-Response: 1 point

DOK Level: 2

Biology Domain: Organisms

Standard: SB6. Obtain, evaluate, and communicate information to assess the theory of evolution.
b. Analyze and interpret data to explain patterns in biodiversity that result from speciation.

Geographic isolation caused the separation of rainforest frog populations into a population in the north and a population in the south. The separated populations later reconnected because the climate got wetter and warmer, causing the rainforest to expand. When males from the north mated with females from the south, the offspring failed to develop past the tadpole stage. When males from the south mated with females from the north, the offspring developed more slowly than the offspring of pairs of northern frogs. These data support which event that occurred while the two populations of frogs were separated?

A. The two populations developed into new species.
B. The two populations mated with other species of frogs.
C. The two populations began a new method of reproduction.
D. The two populations had fewer offspring than before the separation.

Correct Answer: A

Explanation of Correct Answer: The correct answer is choice (A) The two populations developed into new species. Choice (B) is incorrect because hybridization would not have resulted in new species. Choice (C) is incorrect because the frogs reproduced as they always had. Choice (D) is incorrect because there is no indication that population sizes were reduced.

Example Item 4

Selected-Response: 1 point

DOK Level: 3

Biology Domain: Organisms

Standard: SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems. (Clarification statement: Factors include size, carrying capacity, response to limiting factors, and keystone species.)

Students are studying factors that affect population sizes. They plan an investigation to explore the effect of the starting population size on growth rate and on the carrying capacity of the environment. The students select duckweed for the experiment because it has continuous growth. Duckweed is a free-floating aquatic plant that at times clogs waterways. It most commonly reproduces asexually by producing a new leaflike structure that breaks off from the parent plant once the new structure has roots. The students agree on a hypothesis stating that the greater the number of individuals of the starting population, the faster the population will reach carrying capacity. The following procedure is developed by the students for both lab groups.

1. Prepare fertilizer according to the manufacturer's instructions.
2. Fill one petri dish with 50 mL of the fertilizer solution prepared. The solution of each petri dish will be kept constant by refilling.
3. Use the same number of starting populations. The number of starting duckweed populations will be 5, 10, 20, 30, 40, and 50.
4. Place the starting population number of plants into each petri dish.
5. Place a petri dish cover on each petri dish.
6. Expose each petri dish to the same amount of light for the same amount of time.
7. Count the numbers of plants each week for eight weeks and record the numbers in the data table.
8. Share the data with all the groups.

(This item continues on the next page.)

Weekly Plant Count by Group

Group	Week								
	0	1	2	3	4	5	6	7	8
1	5	6	9	12	15	15	16	10	10
2	5	6	8	13	13	15	17	35	43
3	10	12	17	27	33	41	45	55	65
4	10	11	24	26	34	42	47	45	67
5	20	21	33	35	39	44	47	49	51
6	20	20	42	37	47	53	55	57	59
7	30	33	38	40	48	53	68	59	50
8	30	37	39	41	40	44	46	47	50
9	40	52	59	81	67	71	80	74	72
10	40	47	76	78	76	77	81	70	68
11	50	64	78	93	115	124	118	118	110
12	50	67	77	91	118	127	124	117	112

Analyze the data from the investigation. Which statement BEST explains the results?

A. Each population reached the carrying capacity at different weeks.

B. Populations 9 and 10 were unable to reach the carrying capacity before the end of the investigation period.

C. Populations 11 and 12 reached carrying capacity at week 5 because there were fewer plants for the rest of the investigation period.

D. The populations had different starting populations that grew at the same rate and reached their carrying capacities at the same time.

Correct Answer: C

Explanation of Correct Answer: The correct answer is choice (C) Populations 11 and 12 reached carrying capacity at week 5 because there were fewer plants for the rest of the investigation period. Choice (A) is incorrect because some groups did not reach the carrying capacity. Choice (B) is incorrect because group 9 reached carrying capacity in week 3 and group 10 reached it in week 6. Choice (D) is incorrect because the populations actually reached their carrying capacities at different times.

Example Item 5

Multi-Select Technology-Enhanced: 2 points

DOK Level: 3

Biology Domain: Growth and Heredity

Standard: SB3. Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.

c. Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

Today, the common type of banana we buy and eat is a Cavendish banana. They arose from chance mutants that were produced sexually from wild banana plants. The Cavendish banana is infertile and can only be produced by cloning from root shoots. Large commercial growers worldwide now plant only the mutant type. Some information about both types of banana is recorded in the table.

Wild Banana Plants	Mutant Cavendish Banana Plants
Sexual and asexual reproduction occurs to produce new plants.	Only asexual reproduction is used to produce new plants.
New gene combinations and clones are possible.	Only clones are produced.
Cells are diploid with two sets of homologous chromosomes.	Cells are triploid with three sets of homologous chromosomes.
Bananas contain large, hard seeds.	Bananas are seedless.
Very little edible flesh is found around the seeds.	Large amount of sweet, edible flesh is produced.

Part A

Why are scientists warning that exclusively growing this mutant type by asexual reproduction presents a serious disadvantage?

A. The loss of an adequate Cavendish banana seed supply could result in extinction of this variety.

B. The changes in characteristics from a parent plant to a clone will produce inconsistent plants that are less healthy.

C. The lack of genetic variability among clones puts the whole species at increased risk of extinction through a catastrophic disease or pest.

D. The increasing number of homologous sets of chromosomes with each successive generation of clones will eventually result in widespread death of banana plants.

Part B

Growers on large banana farms that supply food commercially have chosen to limit their plantings exclusively to Cavendish banana plants. What advantage is likely cited by the growers for continued planting of these asexually produced crops year after year?

A. Seedless cloned plants are not damaged by disease and pest organisms.
B. Successive generations of clones produce larger bananas and healthier plants.
C. The cloned banana plants rapidly adapt to extreme environmental changes due to their limited genetic variation.
D. The bananas produced maintain consistent characteristics in quality, taste, and appearance from one crop of clones to the next.

Correct Answers: C, D

Explanation of Correct Answers: The correct answer for Part A is choice (C) The lack of genetic variability among clones puts the whole species at increased risk of extinction through a catastrophic disease or pest. Choice (A) is incorrect because Cavendish bananas do not produce seeds. Choice (B) is incorrect because cloned plants are very consistent. Choice (D) is incorrect because cloned organisms do not increase homologous chromosomes.

The correct answer for Part B is choice (D) The bananas produced maintain consistent characteristics in quality, taste, and appearance from one crop of clones to the next. Choice (A) is incorrect because cloned plants can be damaged by disease and pests. Choice (B) is incorrect because cloned organisms are identical to parents. Choice (C) is incorrect because limited genetic variety does not encourage adaptation.

ADDITIONAL SAMPLE ITEMS

This section has two parts. The first part is a set of 10 sample items for Biology. The second part contains a table that shows for each item the standard assessed, the DOK level, the correct answer (key), and a rationale/explanation about the key and distractors. The sample items can be utilized as a mini-test to familiarize students with the item formats found on the assessment.

All example and sample items contained in this guide are the property of the Georgia Department of Education.

Item 1

Multi-Select Technology-Enhanced: 2 points

Bromothymol blue (BTB) is a pH indicator that is also used to detect carbon dioxide (CO_2). BTB is blue when pH is basic and CO_2 is low. BTB is yellow when pH is acidic and CO_2 is high. BTB is green when pH is neutral. A group of students are planning to perform an investigation in which they will place either a stalk of the aquatic plant elodea or a snail in a test tube that contains water with a neutral pH of 7 and BTB. The students will also include a test tube that contains elodea and a snail. Observing color change once the tubes have been placed under a growth light for several hours will allow the students to answer which TWO of the following questions?

A. Do both elodea and snails require oxygen to survive?
B. Does elodea produce oxygen during photosynthesis?
C. Do snails respire faster when placed in a tube with elodea?
D. Do snails use the CO_2 produced by elodea to produce oxygen?
E. Does photosynthesis performed by elodea remove CO_2 from the water?
F. Does cellular respiration occur at a higher rate than photosynthesis in the tube with only elodea?

Item 2

Selected-Response: 1 point

The ribosome of the bacterium *E. coli* includes the ribosomal protein L4 (rpl4). The rpl4 gene carries the instructions for making rpl4 protein. Which of the following arguments provides support for the claim that *E. coli* has a common ancestor with all other organisms?

A. Every organism depends on proteins to carry out essential cellular processes. Ribosomes are needed by all organisms to synthesize proteins such as rpl4.
B. Every organism possesses in its ribosome a protein that is similar to rpl4. This protein has an amino acid sequence that is similar to the sequence of *E. coli's* rpl4.
C. Every organism contains a structure that is similar to a ribosome. This structure helps convert the instructions from the rpl4 gene into amino acids.
D. Every organism has proteins made of amino acids. The code for amino acids is the same in *E. coli* because the instructions for amino acids come from the DNA. DNA contains the same components in all organisms.

Item 3

Multi-Part Technology-Enhanced: 2 points

Part A

The fungus *Candida auris* can cause a dangerous infection. The fungus is often resistant to the antimicrobials used to treat the infection. In recent years, twelve cases have been identified in different regions of the United States. Scientists are working to discover where the fungus originated and how it has spread. Which of the following questions would use biotechnology to provide information about how the fungus is spread?

A. Do age and activity level factor into the risk of infection?
B. How similar are the genomes of each fungus in the 12 cases?
C. Can multiple antimicrobials halt the progress of the infection?
D. How soon can a vaccine be developed that would provide immunity to the fungus?

Part B

Use your answer to the previous question to choose another question that would use biotechnology to understand how the fungal infection spreads.

A. Can a vaccine be mass-produced by genetically altered bacteria?
B. Can patients who recover from the infection be reinfected in the future?
C. Is private information about patients maintained in a secure environment?
D. Are the fungal genomes identical in patients who were treated at the same hospital?

Item 4

Selected-Response: 1 point

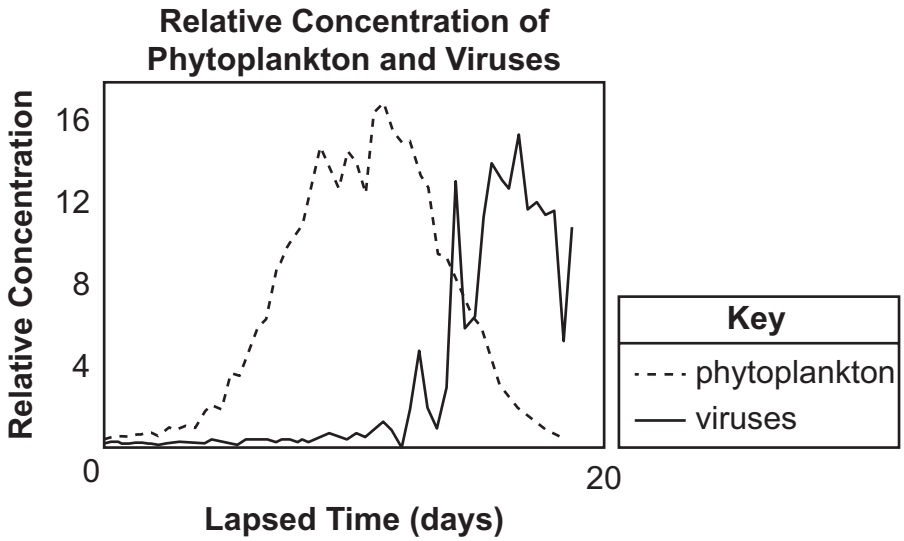
A male and female have a child that has three copies of chromosome 18. Although both parents are unaffected, their doctor claims that the disorder associated with having an extra chromosome 18 is the result of a chromosomal mutation in cells that carry inherited material. Which argument supports this claim?

A. A mutation occurred when crossing-over caused chromosome 18 to be replicated twice during meiosis, allowing one parent to donate two copies of chromosome 18 to the child.
B. A nondisjunction mutation was caused by the improper separation of the genetic material during meiosis, allowing the gamete of one parent to donate two copies of chromosome 18 to the child.
C. A substitution mutation during replication allowed the genetic material of chromosome 18 to replace the genetic material of a nearby chromosome, causing the child to have three copies of chromosome 18.
D. An insertion mutation during replication allowed the genetic material of chromosome 18 to be inserted into the genetic material of another chromosome, causing three copies of chromosome 18 to be made.

Item 5

Multi-Select Technology-Enhanced: 2 points

Scientists have studied a type of phytoplankton species. These phytoplankton are an important part of marine food webs and are major primary producers. As all organisms are regulated by their environment, so are the phytoplankton. The scientists looked at the relationship between the populations of the phytoplankton and viruses found in the same environment. They created three environments in a laboratory setting to collect data on the growth of the phytoplankton population and the viruses for a period of time and graphed the results once they were averaged, as shown below.



The scientists claim that the growth and stability of the population of phytoplankton is affected by the viruses. Using the information given, which TWO arguments support this claim?

A. The phytoplankton population was unable to absorb the light necessary for growth because the viruses cover the surface of the water.

B. The phytoplankton population was affected by the viruses because the viruses were competitors for the food sources in the environment.

C. As the phytoplankton population increased, the number of viruses began to increase because the phytoplankton were consumed by the viruses.

D. As the phytoplankton population increased, the number of viruses increased because the phytoplankton were the hosts to the viruses and replicated the viruses' genome.

E. The phytoplankton population was affected by the increase in the number of viruses in the environment because the viruses used most of the carbon found in the environment.

F. The phytoplankton population decreased as the number of viruses increased because the cells of the phytoplankton were destroyed as the viruses used them to increase the number of viruses in the environment.

Item 6

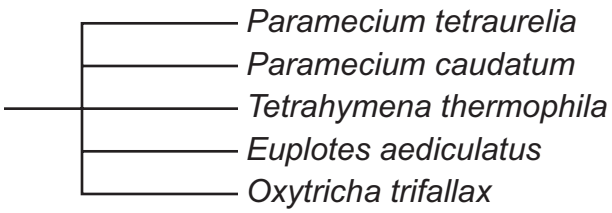
Selected-Response: 1 point

Portions of the sequence alignments for a specific protein in some ciliates are shown below.

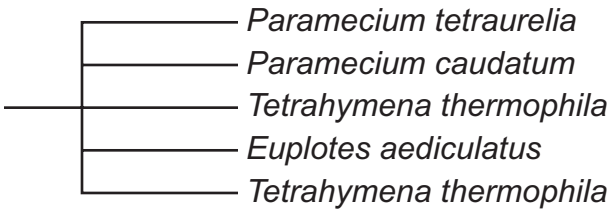
Ciliate	Sequence
Tetrahymena thermophila	NOYTYPEIORSOIFYCNH
Paramecium tetraurelia	KSNNOEKICROOILYCNH
Paramecium caudatum	KOOIAEKIOROOILYCNK
Euplotes aediculatus	NINVPNWNNMKSRTRIFYCH
Oxytricha trifallax	NINKGFWDDOIKRNRLFYCAH

Which of the following cladograms BEST represents these data?

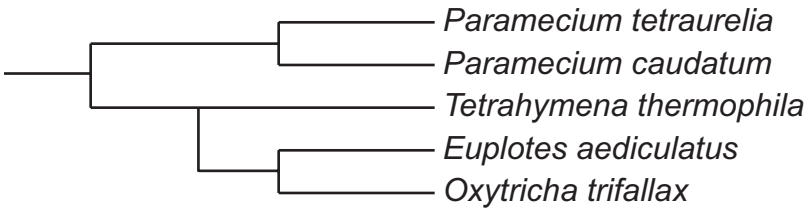
A.



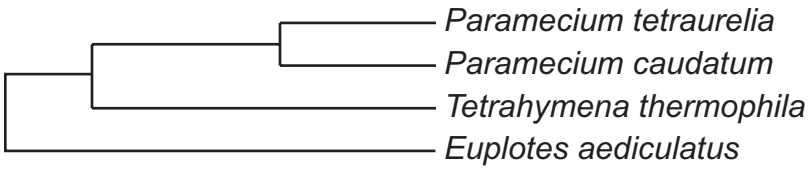
B.



C.



D.



Item 7

Selected-Response: 1 point

Some information about bacteria and viruses is arranged in this table.

Characteristic	Bacteria	Viruses
size	larger (1,000 nm)	smaller (20–400 nm)
benefits	some are beneficial such as decomposers	not beneficial but occasionally useful, as in genetic engineering
enzymes	yes	yes, in some
treatment	antibiotics are used to destroy bacteria; vaccinations are used to prevent their spread	vaccines to prevent spread; antiviral medications to help slow reproduction but cannot stop it completely
reproduction	fission	invades a host cell, uses the host cell to make new viral components, destroys cell when new viruses are released
structure	DNA and RNA float in the cytoplasm; has a cell wall and a cell membrane	DNA or RNA enclosed in a coat of protein
number of cells	unicellular	no cells
nucleus	no	no
ribosomes	yes	no
cell wall	disaccharides and amino acids	no cell wall, but a protein coat is present

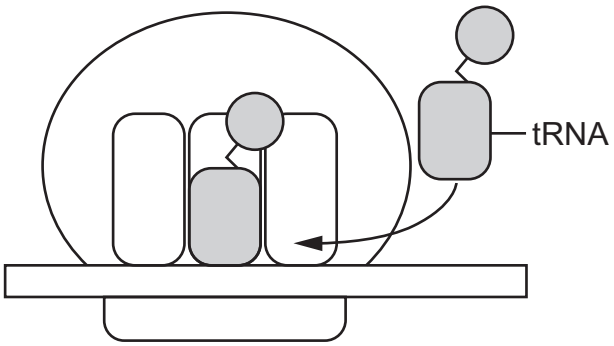
Which argument about bacteria and viruses is supported by this information?

A. Bacteria are larger than viruses but are still small enough to enter cells.
B. Bacterial infections such as diphtheria and tetanus cannot be prevented by vaccines.
C. Only bacteria can acquire new characteristics, which makes them more difficult to treat.
D. Both bacteria and viruses are surrounded by protective coverings, though the composition of each covering may be different.

Item 8

Selected-Response: 1 point

The model shows part of a process that uses tRNA.



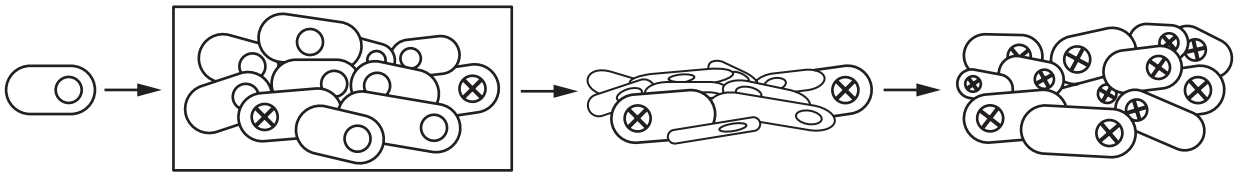
Which description explains the role of the tRNA in the process shown in this model?

A. The model delivers amino acids to the ribosome so that they can be added to the developing peptide.
B. The model recognizes the stop codon of a developing peptide so that no new amino acids are added.
C. The model signals the release of the peptide from the ribosome once all of the amino acids have been added.
D. The model scans the developing peptide to make sure that the sequence of the amino acids matches the mRNA.

Item 9

Selected-Response: 1 point

The diagram represents a model of how bacteria become resistant to an antibiotic, allowing bacteria to survive treatment.



Which BEST explains how the indicated step in the model allows bacteria to develop resistance?

A. Genetic mutations that promote resistance occur.
B. The bacteria are infected by viruses that confer resistance.
C. Alleles for antibiotic resistance become dominant over recessive alleles.
D. A portion of the genetic material is re-replicated, allowing for resistance.

Item 10

Selected-Response: 1 point

Hemoglobin is a protein found in red blood cells of vertebrates and in the plasma of many invertebrates. The function of this protein is to transport oxygen throughout the body and to bring carbon dioxide back to be expelled from the organism. If the amino acid sequence of the protein is altered, the mutated protein is not as efficient at carrying oxygen as is the normal hemoglobin. Which argument is supported by this information?

A. The mutated hemoglobin protein can still carry carbon dioxide to be expelled from the organism.

B. Hemoglobin must be a simple molecule because it is found in both vertebrates and invertebrates.

C. Structural changes of hemoglobin affect its ability to carry oxygen, indicating that the shape of a protein is important to its function.

D. Normal hemoglobin must be a larger molecule than the mutated hemoglobin since it has sufficient space to attach to and carry both oxygen molecules and carbon dioxide molecules.

ADDITIONAL SAMPLE ITEM KEYS

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
1	SB1e	3	E, F	The correct answer choices are choice (E) Does photosynthesis performed by elodea remove CO_2 from the water? and choice (F) Does cellular respiration occur at a higher rate than photosynthesis in the tube with only elodea? Choice (A) is incorrect because the amount of oxygen present or missing from the test tubes cannot be measured with this setup. Choice (B) is incorrect because there is no way to measure oxygen with this setup. Choice (C) is incorrect because there is no way to measure this and because the rate of respiration should not vary. Choice (D) is incorrect because this question cannot be answered using this investigation.
2	SB6c	2	B	The correct answer is choice (B) Every organism possesses in its ribosome a protein that is similar to rpl4. This protein has an amino acid sequence that is similar to the sequence of *E. coli's* rpl4. Choice (A) is incorrect because just the fact that all organisms make proteins does not support a common ancestor. Choice (C) is incorrect because sharing ribosomes does not indicate a common ancestor. Choice (D) is incorrect because having common amino acids is not support for a common ancestor.
3	SB2c	2	B, D	The correct answer for Part A is choice (B) How similar are the genomes of each fungus in the twelve cases? Choice (A) is incorrect because risk factors associated with the victim do not explain the origin of the fungus or how it came to be in its present location. Choice (C) is incorrect because how to halt the disease does not answer the question of where it originated and how it spread. Choice (D) is incorrect because vaccine development does not answer the question. The correct answer for Part B is choice (D) Are the fungal genomes identical in patients who were treated at the same hospital? Choice (A) is incorrect because the answer to the question will not provide information about how the fungus spreads. Choice (B) is incorrect because immunity to the fungus does not explain how it spreads. Choice (C) is incorrect because patient privacy does not explain how the fungus spreads.

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
4	SB2b	2	B	The correct answer is choice (B) A nondisjunction mutation was caused by the improper separation of the genetic material during meiosis, allowing the gamete of one parent to donate two copies of chromosome 18 to the child. Choice (A) is incorrect because crossing over does not cause a chromosome to replicate. Choice (C) is incorrect because an extra chromosome is not the result of a substitution mutation. Choice (D) is incorrect because an insertion mutation does not result in extra chromosomes.
5	SB4c	3	D, F	The correct answers are choice (D) As the phytoplankton population increased, the number of viruses increased because the phytoplankton were the hosts to the viruses and replicated the viruses' genome. and choice (F) The phytoplankton population decreased as the number of viruses increased because the cells of the phytoplankton were destroyed as the viruses used them to increase the number of viruses in the environment. Choice (A) is incorrect because nothing in the graph indicates that the viruses are able to block sunlight. Choice (B) is incorrect because viruses do not require a food source. Choice (C) is incorrect because the viruses do not eat phytoplankton. Choice (E) is incorrect because viruses do not use carbon like living things do.
6	SB5a	1	C	The correct answer is choice (C). Choice (A) is incorrect because the organisms are not equally related. Choice (B) is incorrect because one ciliate is duplicated in the cladogram. Choice (D) is incorrect because one ciliate is omitted.
7	SB4c	3	D	The correct answer is choice (D) Both bacteria and viruses are surrounded by protective coverings, though the composition of each covering may be different. Choice (A) is incorrect because bacteria do not enter cells. Choice (B) is incorrect because many vaccines have been developed against different bacteria. Choice (C) is incorrect because both can acquire new characteristics.
8	SB2a	1	A	The correct answer is choice (A) The model delivers amino acids to the ribosome so that they can be added to the developing peptide. Choice (B) is incorrect because the tRNA does not recognize the stop codon. Choice (C) is incorrect because tRNA is not responsible for releasing the polypeptide. Choice (D) is incorrect because quality control is not a function of tRNA.

Item	Standard/ Element	DOK Level	Correct Answer	Explanation
9	SB6e	2	A	The correct answer is choice (A) Genetic mutations that promote resistance occur. Choice (B) is incorrect because no viruses are present. Choice (C) is incorrect because survival and reproduction of the mutated bacteria is responsible for resistance in a population, not the dominance of the alleles. Choice (D) is incorrect because replication of genetic material on its own is not enough to confer resistance.
10	SB1c	2	C	The correct answer is choice (C) Structural changes of hemoglobin affect its ability to carry oxygen, indicating that the shape of a protein is important to its function. Choice (A) is incorrect because nothing in the information indicates the ability or inability of the altered hemoglobin to carry carbon dioxide. Choice (B) is incorrect because nothing in the information indicates whether the molecule is simple or complex. Choice (D) is incorrect because hemoglobin changes shape not size.

END OF BIOLOGY

EOC ASSESSMENT GUIDE

Assessment Guide
Biology
End-of-Course