



## GACE® Biology Assessment

### *Test at a Glance*

Updated May 2017

See the GACE® Biology Assessment Study Companion for practice questions and preparation resources.

Assessment Name	Biology
Grade Level	6–12
Test Code	Test I: 026 Test II: 027 Combined Test I and Test II: 526
Testing Time	Test I: 2 hours Test II: 2 hours Combined Test I and Test II: 4 hours
Test Duration	Test I: 2.5 hours Test II: 2.5 hours Combined Test I and Test II: 5 hours
Test Format	Computer delivered
Number of Selected-response Questions	Test I: 80 Test II: 80 Combined Test I and Test II: 160
Question Format	The test consists of a variety of short-answer questions such as selected-response questions, where you select one answer choice or multiple answer choices (depending on what the question asks for), questions where you enter your answer in a text box, and other types of questions. You can review the possible question types in the <b><i>Guide to Taking a GACE Computer-delivered Test</i></b> .
Number of Constructed-response Questions	Test I: 0 Test II: 0 Combined Test I and Test II: 0

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## About this Assessment

The GACE Biology assessment is designed to measure the professional knowledge of prospective teachers of secondary school Biology in the state of Georgia.

This assessment includes two tests. You may take either test individually or the full assessment in a single session. The testing time is the amount of time you will have to answer the questions on the test. Test duration includes time for tutorials and directional screens that may be included in the test.

The questions in this assessment assess both basic knowledge across content areas and the ability to apply principles.

The total number of questions that are scored is typically smaller than the total number of questions on the test. Most tests that contain selected-response questions also include embedded pretest questions, which are not used in calculating your score. By including pretest questions in the assessment, ETS is able to analyze actual test-taker performance on proposed new questions and determine whether they should be included in future versions of the test.

## Content Specifications

Each test in this assessment is organized into content **subareas**. Each subarea is further defined by a set of **objectives** and their **knowledge statements**.

- The objectives broadly define what an entry-level educator in this field in Georgia public schools should know and be able to do.
- The knowledge statements describe in greater detail the knowledge and skills eligible for testing.
- Some tests also include content material at the evidence level. This content serves as descriptors of what each knowledge statement encompasses.

See a breakdown of the subareas and objectives for the tests in this assessment on the following pages.

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## Test I Subareas

Subarea	Approx. Percentage of Test
I. Cell Biology: Cell Structure and Function	50%
II. Genetics and Evolution	50%

## Test I Objectives

### Subarea I: Cell Biology: Cell Structure and Function

*Objective 1: Understands the basic biochemistry and metabolism of living organisms*

The beginning Biology teacher:

- A. Understands the chemical structures and properties of biologically important molecules
  - Atomic and molecular structures and chemical bonding
  - Organic versus inorganic molecules
  - Properties of water based on structure and bonding characteristics
  - Major macromolecules, including nucleic acids, proteins, lipids, and carbohydrates
- B. Understands that biological processes are dependent on chemical principles
  - Chemical and physical gradients, and factors that influence the gradients
  - Thermodynamics
  - Anabolic and catabolic reactions
  - Reduction-oxidation reactions
- C. Understands the structure and function of enzymes and the factors that influence their activity
  - Active site structure and substrate binding
  - Energy profile of a reaction in the presence or absence of an enzyme
  - Reaction kinetics, including the effects of temperature, pH, and inhibitors
  - Regulation, including cooperative binding and feedback inhibition
- D. Understands major biochemical pathways and energy flow within an organism
  - Cellular locations of biochemical pathways
  - Photosynthesis, including photosystems, electron transport, Calvin cycle, C3 versus C4, CAM

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- Cellular respiration, including glycolysis, Krebs cycle, electron transport, fermentation
  - Chemosynthesis for photosynthesis and cellular respiration

*Objective 2: Understands the structure and function of cells and the mechanisms of basic cellular processes*

The beginning Biology teacher:

- A. Understands the characteristics of living versus nonliving things
  - Cellular organization
  - Obtaining and using energy
  - Growth and reproduction
  - Regulation and responses to the environment
- B. Understands the defining characteristics of viruses, bacteria, protists, fungi, plants, and animals
  - Structural differences between prokaryotes and eukaryotes, including organelles, cell walls, and chromosomes
  - Structural characteristics of viruses, bacteria, protists, fungi, plants, and animals
  - Cellular organization, including unicellular versus multicellular
  - Modes of nutrition, including autotrophic versus heterotrophic
  - Modes of reproduction/replication
- C. Understands the structure and function of cells and organelles
  - Plant cells versus animal cells
  - Cell membranes
  - Membrane-bound organelles and ribosomes
  - Cytoskeleton
- D. Understands how cells maintain their internal environment and respond to external signals
  - Selective permeability
  - Active and passive transport
  - Water movement, including osmolarity and water potential
  - Cell surface proteins, cell communication, and signal molecules
  - Exocytosis and endocytosis
  - Negative-feedback mechanisms

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- E. Understands eukaryotic cell division, the cell cycle, and regulation of the processes
- Cell cycle stages
  - Mitosis and meiosis, including functions, stages, and results
  - Cytokinesis, including differences between animals and plants
  - Cell cycle checkpoints

## **Subarea II: Genetics and Evolution**

*Objective 1: Understands the mechanisms of molecular biology and the predictions of transmission genetics*

The beginning Biology teacher:

- A. Understands the structure of nucleic acids and chromosomes
- Sugar-phosphate backbone and complementary base pairing
  - DNA versus RNA
  - Chromosome structure, including nucleosomes and telomeres
- B. Understands the transfer of genetic information
- DNA replication
  - Promoters, enhancers, and transcription factors
  - Process of RNA transcription
  - Pre-mRNA processing in eukaryotes
  - Translation and the genetic code
  - Prokaryotic operons
- C. Understands that cells may undergo differentiation and specialization
- Differential gene expression
  - Stem cells, including characteristics and sources
- D. Understands the nature of mutations
- Cause of mutations, including recombination and mutagens
  - Types of mutations, including point mutation, deletion, inversion, and translocation
  - Significance of somatic versus germ-line mutations
  - Disorders resulting from point mutations, frameshift mutations, changes in chromosome structure, and changes in chromosome numbers
- E. Understands basic laboratory techniques and more complex DNA technologies
- Microscopy

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- Gel electrophoresis
  - Spectrophotometry
  - DNA sequencing and polymerase chain reaction (PCR)
  - Genome sequencing projects
  - Gene therapy
  - Transgenic and genetically engineered cells
- F. Understands Mendel's postulates and how to use the postulates to predict probable outcomes of given genetic crosses
- Dominant and recessive alleles
  - Independent assortment
  - Segregation
  - Monohybrid and dihybrid crosses
  - Pedigree analysis
- G. Understands non-Mendelian inheritance
- Gene linkage and mapping by recombination analysis
  - Sex-linked inheritance
  - Multiple alleles, codominance, and incomplete dominance
  - Polygenic inheritance, epistasis, and pleiotropy
  - Extranuclear inheritance, including mitochondrial and chloroplast inheritance
  - Environmental influences, including epigenetics

*Objective 2: Understands mechanisms of evolution as a consequence of genetic variation and factors affecting evolution*

The beginning Biology teacher:

- A. Understands the sources of genetic variation
- Mutation
  - Crossing-over
  - Sexual reproduction, including segregation and independent assortment
  - Horizontal genetic exchange, including conjugation, transformation, and transduction
- B. Understands the mechanisms of evolution
- Hardy-Weinberg equilibrium and factors that may alter the equilibrium
  - Effects of mutations, gene flow, genetic drift (including bottleneck and founder effects), and nonrandom mating (including sexual selection)

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- Natural and artificial selection
  - Coevolution
  - Adaptive radiation
  - Convergent versus divergent evolution (analogous versus homologous structures)
- C. Understands the evidence that supports evolution
- Fossil record
  - Endosymbiosis
  - Structural and developmental evidence, including homology and embryology
  - Molecular evidence, including DNA and RNA sequence comparisons
  - Major evolutionary trends, including cephalization and multicellularity
- D. Understands models of evolutionary rates and the genetic basis of speciation
- Gradualism
  - Punctuated equilibrium
  - Reproductive isolation, including behavioral and postzygotic
  - Mechanisms of speciation, including allopatric and sympatric
- E. Understands scientific explanations for the origin of life on Earth
- Abiotic synthesis of organic compounds and the Miller-Urey experiment
  - Biological influences on atmospheric composition, including the role of photosynthesis
  - Development of self-replication, including the RNA-first hypothesis
- F. Understands factors that lead to the extinction of species
- Lack of genetic diversity
  - Interspecific competition
  - Environmental pressures, including climate and habitat change
  - Human impacts
  - Meteor impacts

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## Test II Subareas

Subarea	Approx. Percentage of Test
I. Scientific Inquiry, Processes, Technology, and Society	30%
II. Organismal Biology	30%
III. Ecology: Organisms and Environments	40%

## Test II Objectives

### Subarea I: Scientific Inquiry, Processes, Technology, and Society

*Objective 1: Understands the nature of scientific inquiry and processes, including the collection and analysis of data*

The beginning Biology teacher:

- A. Understands the processes involved in scientific inquiry and experimental design
  - Identifying problems based on observations
  - Formulating and testing hypotheses
  - Identifying experimental variables and controls
  - Drawing scientific conclusions
  - Formulating theories based on accumulated data
  - Using scientific sources and communicating findings appropriately
- B. Understands the processes involved in scientific data collection and manipulation
  - Common units of measurement (metric and English units), including unit conversions
  - Scientific notation and significant figures in collected data
  - Linear versus logarithmic scales
  - Choosing appropriate types of graphs or charts
  - Interpreting data, including identifying patterns and trends, drawing conclusions, and making predictions
  - Basic data analysis, including determining mean, precision, accuracy, and sources of error
- C. Understands the multidisciplinary nature of biology and the use of scientific models
  - Chemical nature of biology
  - Mathematics in biology



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- Physical laws and principles governing biological systems
  - Selecting appropriate models for a given purpose (e.g., physical, conceptual, mathematical) and knowing the limitations of the models
- D. Understands the major historical developments of biology and the contributions of major historical figures
- Accepted principles and theories change and develop over time
  - Development of germ theory and cell theory
  - Developments in heredity, evolution, and ecology
  - Developments in the understanding of the nature and structure of genetic material
  - Developments in the classification of organisms
- E. Understands the procedures for correct preparation, storage, use, and disposal of laboratory materials
- Preparation for classroom or field use of materials, such as preparing solutions and staining slides
  - Appropriate storage of chemicals, biological specimens, and other materials
  - Appropriate and safe use of materials, including chemicals and laboratory specimens
  - Safe disposal of biological specimens, chemicals, and solutions
- F. Understands the appropriate and safe use and care of laboratory equipment
- Optical equipment, such as microscopes, spectrophotometers, and UV light sources
  - Separation equipment, such as equipment used for gel electrophoresis, chromatography, and centrifugation
  - Measurement, mixing, and heating equipment, such as balances, stirrers, and Bunsen burners
  - Sterilization equipment, such as autoclaves and ovens
- G. Understands safety and emergency procedures for science classrooms and laboratories
- Use of material safety data sheets (MSDS)
  - Use of personal safety equipment; e.g., gloves, goggles, lab coats
  - Use of laboratory safety equipment; e.g., fire extinguishers, eyewash stations, emergency showers

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*Objective 2: Understands the relationship of science and technology to society and the environment*

The beginning Biology teacher:

A. Understands the management of natural resources and the impact of science and technology on the environment

- Agriculture, forestry, wildlife, and fisheries practices
- Renewable and/or sustainable use of resources
- Extraction of mineral and energy resources and resource management, including waste management and recycling
- Conservation, including habitat preservation, habitat restoration, and species protection
- Pollution, including nonpoint sources of pollution and burning of fossil fuels
- Pollution mitigation, including green building and environmental cleanup

B. Understands the impact of human activity and natural phenomena on society

- Economic and social consequences
- Natural disaster management
- Climate change (such as global warming), sea levels, and flooding
- Epidemiology
- Agriculture and soil erosion
- Estuary and wetland degradation
- Water management
- Production, use, and disposal of consumer products

C. Understands the ethical and societal issues arising from the use of science and technology

- Ethical research concerns, including use of stem cells and toxic chemicals
- Ethical use of technology, genetic information, genetically modified organisms, and cloning

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## Subarea II: Organismal Biology

*Objective 1: Understands characteristics contributing to the diversity of life, including classification systems*

The beginning Biology teacher:

- A. Understands the historical and current biological classification systems of organisms
  - Kingdom system
  - Domain system
  - Cladistics
- B. Understands the characteristics of the major animal phyla
  - Body plans, including radial symmetry versus bilateral symmetry
  - Body cavities, including coelomates, pseudocoelomates, and acoelomates
  - Protostomes versus deuterostomes
  - Modes of reproduction (sexual versus asexual)
  - Modes of temperature regulation (endotherm versus ectotherm)
- C. Understands the organizational hierarchy of multicellular organisms
  - Cells
  - Tissues
  - Organs
  - Organ systems

*Objective 2: Understands anatomy and physiology of major animal phyla*

The beginning Biology teacher:

- A. Understands the anatomy and physiology of major organ systems
  - Cardiovascular and respiratory
  - Digestive and excretory
  - Nervous and endocrine
  - Reproductive
  - Immune
- B. Understands how homeostasis is maintained in organisms
  - Role of organs or tissues, such as the kidney, adrenals, and hypothalamus
  - Role of hormones, such as insulin and antidiuretic hormone

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- Feedback mechanisms, including negative and positive
  - Role of behaviors, including diurnal, nocturnal, hibernation, and basking
- C. Understands reproduction, development, and growth
- Gamete formation
  - Fertilization
  - Embryonic development
  - Growth, development, and aging

*Objective 3: Understands anatomy and physiology of major plant phyla*

The beginning Biology teacher:

- A. Understands the characteristics of the major divisions, including life cycles and reproductive strategies
- Vascular versus nonvascular
  - Angiosperms versus gymnosperms
  - Monocot versus eudicot (dicot)
  - Alternation of generations, including gametophyte and sporophyte
  - Seed and spore dispersal and pollination strategies
- B. Growth and development and response to environment
- Tissues, including dermal, parenchyma, cortex, and meristems
  - Vascular, including xylem and phloem
  - Flowers, stems, leaves, and roots
  - Plant tropisms
- C. Understands how plants obtain and transport water and inorganic nutrients
- Roots
  - Xylem transport
  - Control of moisture, including transpiration through stomata
- D. Understands how plants transport and store products of photosynthesis
- Products, including simple and complex carbohydrates
  - Phloem transport
  - Storage and structural molecules, including starch and cellulose, respectively
  - Storage structures, including plastids, vacuoles, and tubers

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### Subarea III: Ecology: Organisms and Environments

*Objective 1: Understands biosphere organization and factors affecting organism interactions and population size*

The beginning Biology teacher:

- A. Understands the hierarchical structure of the biosphere
  - Organisms
  - Populations
  - Communities
  - Ecosystems
  - Biomes
- B. Understands relationships within and between species
  - Forms of symbiosis
  - Predation
  - Competition and territoriality
  - Altruistic behaviors
- C. Understands how biotic and abiotic components of an ecosystem influence population size
  - Resource availability and abiotic factors
  - Habitat and niche
  - Competition and predation
  - Density-dependent versus density-independent selection
- D. Understands the relationship between reproductive strategies, mortality rates, and population growth
  - Sexual versus asexual reproduction
  - *r*-strategists versus K-strategists
  - Exponential growth
  - Logistic growth and carrying capacity

*Objective 2: Understands the characteristics of biomes, energy flow in ecosystems, and major biogeochemical cycles*

The beginning Biology teacher:

- A. Understands the changes that occur during ecological succession
  - Primary versus secondary succession
  - Biomass, diversity, productivity, and habitat changes during succession

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B. Understands the types of biomes and energy flow in the biomes

- Aquatic versus terrestrial biomes
- Trophic levels, including pyramids of biomass and pyramids of energy
- Food chains and food webs
- Keystone species
- Flow of energy versus flow of matter

C. Understands biogeochemical cycles

- Water cycle
- Carbon cycle
- Nitrogen cycle
- Phosphorus cycle

*Objective 3: Understands interactions among ecosystems and effects of their disruption by natural disturbances or humans*

The beginning Biology teacher:

A. Understands the effects of natural disturbances on biodiversity and ecosystems

- Temporal and spatial disturbances, including climate, fire, and disease
- Fragmentation of ecosystems
- Natural ecosystem recovery

B. Understands the connections among ecosystems on a local and a global scale

- Natural flow of material between ecosystems
- Movement of organisms

C. Understands how humans affect ecological systems and biodiversity

- Pollution, including greenhouse gases and acid precipitation
- Habitat destruction
- Introduced and re-introduced species
- Remediation, including reforestation and mine reclamation
- Transport of materials by humans