

505-3-.28 SCIENCE EDUCATION PROGRAM

(1) Purpose. This rule states field-specific content standards for approving programs that prepare individuals to teach broad field science and/or the science specialties of biology, chemistry, earth/space science and physics in grades 6-12 and supplements requirements in Rule 505-3-.01, Requirements and Standards for Approving Professional Education Units and Educator Preparation Programs.

(2) Requirements.

(a) Programs may be offered in broad field science and/or the specialty fields of biology, chemistry, earth/space science and physics.

(b) A state-approved professional education unit shall offer a preparation program described in program planning forms, catalogs, and syllabi addressing the following standards:

1. Science Core. All science education programs (broad field and specialty field) shall conform to the following standards published by the National Science Teachers' Association:

(i) Science teacher candidates shall understand and can articulate the knowledge and practices of contemporary science. They shall interrelate and interpret important concepts, ideas, and applications in their fields of licensure; and can conduct scientific investigations. All science teacher candidates shall:

(I) Explain multiple ways we organize our perceptions of the world and how systems organize the studies and knowledge of science.

(II) Understand the nature of scientific evidence and the use of models for explanation.

(III) Explain measurement as a way of knowing and organizing observations of constancy and change.

(IV) Explain evolution of natural systems and factors that result in evolution or equilibration.

(V) Describe the interrelationships of form, function, and behaviors in living and nonliving systems.

(ii) Science teacher candidates shall engage students effectively in studies of the history, philosophy, and practice of science. They shall enable students to distinguish science from non-science, understand the evolution and practice of science as a human endeavor, and critically analyze assertions made in the name of science.

(iii) Science teacher candidates shall engage students both in studies of various methods of scientific inquiry and in active learning through scientific inquiry. They shall encourage students, individually and collaboratively, to observe, ask questions, design inquiries, and collect and interpret data in order to develop concepts and relationships from empirical experiences.

(iv) Science teacher candidates shall recognize that informed citizens must be prepared to make decisions and take action on contemporary science- and technology-related issues of interest to the general society. They shall require students to conduct inquiries into the factual basis of such issues and to assess possible actions and outcomes based upon their goals and values.

(v) Science teacher candidates shall create a community of diverse learners who construct meaning from their science experiences and possess a disposition for further exploration and learning. They shall use, and justify, a variety of classroom arrangements, groupings, actions, strategies, and methodologies. Science teacher candidates shall create a community of diverse learners who construct meaning from their science experiences and possess a disposition for further exploration and learning. They shall use, and justify, a variety of classroom arrangements, groupings, actions, strategies, and methodologies.

(vi) Science teacher candidates shall plan and implement an active, coherent, and effective curriculum that is consistent with the goals and recommendations of the National Science Education Standards. They shall begin with the end in mind and effectively incorporate contemporary practices and resources into their planning and teaching.

(vii) Science teacher candidates shall relate their discipline to their local and regional communities, involving stakeholders and using the individual, institutional, and natural resources of the community in their teaching. They shall actively engage students in science-related studies or activities related to locally important issues.

(viii) Science teacher candidates shall construct and use effective assessment strategies to determine the backgrounds and achievements of learners and facilitate their intellectual, social, and personal development. They shall assess students fairly and equitably, and require that students engage in ongoing self-assessment.

(ix) Science teacher candidates shall organize safe and effective learning environments that promote the success of students and the welfare of all living things. They shall require and promote knowledge and respect for safety, and oversee the welfare of all living things used in the classroom or found in the field.

(x) Science teacher candidates shall strive continuously to grow and change, personally and professionally, to meet the diverse needs of their students, school, community, and profession. They shall have a desire and disposition for growth and betterment.

2. Specialty Fields. The program shall require a major or equivalent in one of the science specialty areas listed in (a) that meets the appropriate specialty area standards listed below:

(i) Biology

(I) Biology teacher candidates shall understand life processes in living systems including organization of matter and energy.*

(II) Biology teacher candidates shall describe similarities and differences among animals, plants, fungi, microorganisms, and viruses.*

(III) Biology teacher candidates shall understand and apply principles and practices of biological classification.*

(IV) Biology teacher candidates shall understand scientific theory and principles of biological evolution.*

(V) Biology teacher candidates shall understand ecological systems including the interrelationships and dependencies of organisms with each other and their environments.*

(VI) Biology teacher candidates shall understand population dynamics and the impact of population on its environment.*

(VII) Biology teacher candidates shall understand general concepts of genetics and heredity.*

(VIII) Biology teacher candidates shall explain the organization and functions of cells and multi-cellular systems.*

(IX) Biology teacher candidates shall explain the behavior of organisms and their relationships to social systems.*

(X) Biology teacher candidates shall explain the regulation of biological systems including homeostatic mechanisms.*

(XI) Biology teacher candidates shall understand the fundamental processes of modeling and investigating in the biological sciences.*

(XII) Biology teacher candidates shall explain applications of biology in environmental quality and in personal and community health.*

(XIII) Biology teacher candidates shall understand bioenergetics including major biochemical pathways.

(XIV) Biology teacher candidates shall explain biochemical interactions of organisms with their environments.

(XV) Biology teacher candidates shall explain molecular genetics and heredity and mechanisms of genetic modification.

(XVI) Biology teacher candidates shall explain the molecular basis for evolutionary theory and classification.

(XVII) Biology teacher candidates shall explain the causes, characteristics, and avoidance of viral, bacterial, and parasitic diseases.

(XVIII) Biology teacher candidates shall understand issues related to living systems such as genetic modification, uses of biotechnology, cloning, and pollution from farming.

(XIX) Biology teacher candidates shall explain the historical development and perspectives in biology including contributions of significant figures and under-represented groups, and the evolution of theories in biology.

(XX) Biology teacher candidates shall understand how to design, conduct, and report research in biology.

(XXI) Biology teacher candidates shall be familiar with applications of biology and biotechnology in society, business, industry, and health fields.

(XXII) Biology teacher candidates shall understand and apply concepts from other sciences and mathematics to the teaching of biology, including

- I. Chemistry, including general chemistry and biochemistry with basic laboratory techniques,
 - II. Physics, including light, sound, optics, electricity, energy and order, magnetism, and thermodynamics,
 - III. Earth and space sciences, including energy and geochemical cycles, climate, oceans, weather, natural resources, and changes in the Earth, and
 - IV. Mathematics, including probability and statistics.
- (ii) Chemistry.
- (I) Chemistry teacher candidates shall understand fundamental structures and atoms and molecules.*
 - (II) Chemistry teacher candidates shall understand basic principles of ionic, covalent, and metallic bonding.*
 - (III) Chemistry teacher candidates shall understand physical and chemical properties and classification of elements including periodicity.*
 - (IV) Chemistry teacher candidates shall understand chemical kinetics and thermodynamics.*
 - (V) Chemistry teacher candidates shall understand principles of electrochemistry.*
 - (VI) Chemistry teacher candidates shall understand the mole concept, stoichiometry, and laws of composition.*
 - (VII) Chemistry teacher candidates shall understand transition elements and coordination compounds.*
 - (VIII) Chemistry teacher candidates shall understand acids and bases, oxidation-reduction chemistry, and solutions.*
 - (IX) Chemistry teacher candidates shall understand fundamental biochemistry.*
 - (X) Chemistry teacher candidates shall understand functional and polyfunctional group chemistry.*
 - (XI) Chemistry teacher candidates shall understand environmental and atmospheric chemistry.
 - (XII) Chemistry teacher candidates shall understand fundamental processes of investigating in chemistry.*
 - (XIII) Chemistry teacher candidates shall understand applications of chemistry in personal and community health and environmental quality.*
 - (XIV) Chemistry teacher candidates shall understand molecular orbital theory, aromaticity, metallic and ionic structures, and correlation to properties of matter.

- (XV) Chemistry teacher candidates shall understand superconductors and principles of metallurgy.
- (XVI) Chemistry teacher candidates shall understand advanced concepts of chemical kinetics and thermodynamics.
- (XVII) Chemistry teacher candidates shall understand Lewis adducts and coordination compounds.
- (XVIII) Chemistry teacher candidates shall understand solutions, colloids, and colligative properties.
- (XIX) Chemistry teacher candidates shall understand major biological compounds and natural products.
- (XX) Chemistry teacher candidates shall understand solvent system concepts including non-aqueous solvents.
- (XXI) Chemistry teacher candidates shall understand chemical reactivity and molecular structure including electronic and steric effects.
- (XXII) Chemistry teacher candidates shall understand organic synthesis and organic reaction mechanisms.
- (XXIII) Chemistry teacher candidates shall understand energy flow through chemical systems.
- (XXIV) Chemistry teacher candidates shall understand issues related to chemistry, including ground water pollutions, disposal of plastics, and development of alternative fuels.
- (XXV) Chemistry teacher candidates shall understand the historical development and perspectives of chemistry including contributions of significant figures and under-represented groups, and the evolution of theories in chemistry.
- (XXVI) Chemistry teacher candidates shall understand how to design, conduct, and report research in chemistry.
- (XXVII) Chemistry teacher candidates shall understand applications of chemistry and chemical technology in society, business, industry, and health fields.
- (XXVIII) Chemistry teacher candidates shall understand and apply concepts from other sciences and mathematics to the teaching of chemistry, including:
- I. Biology, including molecular biology, bioenergetics, and ecology,
 - II. Earth Science, including geochemistry, cycles of matter, and energetics of Earth systems,
 - III. Physics, including energy, stellar evolution, properties and functions of waves, motions and forces, electricity, and magnetism.

IV. Mathematical and statistical concepts and skills including statistics and the use of differential equations and calculus.

(iii) Earth and Space Sciences.

(I) Earth and space science teacher candidates shall understand characteristics of land, atmosphere, and ocean systems on Earth.*

(II) Earth and space science teacher candidates shall understand properties, measurement, and classification of Earth materials.*

(III) Earth and space science teacher candidates shall understand changes in the Earth including land formation and erosion.*

(IV) Earth and space science teacher candidates shall understand geochemical cycles including biotic and abiotic systems.*

(V) Earth and space science teacher candidates shall understand energy flow and transformation in Earth systems.*

(VI) Earth and space science teacher candidates shall understand hydrological features of the Earth.*

(VII) Earth and space science teacher candidates shall understand patterns and changes in the atmosphere, weather, and climate.*

(VIII) Earth and space science teacher candidates shall understand origin, evolution, and planetary behaviors of Earth.*

(IX) Earth and space science teacher candidates shall understand origin, evolution, and properties of the universe.*

(X) Earth and space science teacher candidates shall understand fundamental processes of investigating in the Earth and space sciences.*

(XI) Earth and space science teacher candidates shall understand sources and limits of natural resources.*

(XII) Earth and space science teacher candidates shall understand applications of Earth and space sciences to environmental quality and to personal and community health and welfare.*

(XIII) Earth and space science teacher candidates shall understand gradual and catastrophic changes in the Earth.

(XIV) Earth and space science teacher candidates shall understand oceans and their relationship to changes in atmosphere and climate.

(XV) Earth and space science teacher candidates shall understand hydrological cycles and problems of distribution and use of water.

(XVI) Earth and space science teacher candidates shall understand dating of the Earth and other objects in the universe.

(XVII) Earth and space science teacher candidates shall understand structures and interactions of energy and matter in the universe.

(XVIII) Earth and space science teacher candidates shall understand impact of changes in the Earth on the evolution and distribution of living things.

(XIX) Earth and space science teacher candidates shall understand issues related to changes in Earth systems such as global climate change, mine subsidence, and channeling of waterways.

(XX) Earth and space science teacher candidates shall understand historical development and perspectives in the Earth and space sciences, including contributions of significant figures and under-represented groups, and the evolution of theories in these fields.

(XXI) Earth and space science teacher candidates shall understand how to design, conduct, and report research in the Earth and space sciences.

(XXII) Earth and space science teacher candidates shall understand Applications of the Earth and space sciences and related technologies in society, business, industry, and health fields.

(XXIII) Earth and space science teacher candidates shall understand and apply concepts from other sciences and mathematics to the teaching of Earth and space science, including:

I. Biology, including evolution, ecology, population dynamics, and the flow of energy and materials through Earth systems,

II. Chemistry, including broad concepts and basic laboratory techniques of inorganic and organic chemistry, physical chemistry, and biochemistry,

III. Physics, including electricity, forces and motion, energy, magnetism, thermodynamics, optics, and sound, as well as basic quantum theory, and

IV. Mathematics, including statistics and probability.

(iv) Physics.

(I) Physics teacher candidates shall understand energy, work, and power.*

(II) Physics teacher candidates shall understand motion, major forces, and momentum.*

(III) Physics teacher candidates shall understand Newtonian principles and laws including engineering applications.*

(IV) Physics teacher candidates shall understand conservation of mass, momentum, energy, and charge.*

(V) Physics teacher candidates shall understand physical properties of matter.*

- (VI) Physics teacher candidates shall understand kinetic-molecular motion and atomic models.*
- (VII) Physics teacher candidates shall understand radioactivity, nuclear reactors, fission and fusion.*
- (VIII) Physics teacher candidates shall understand wave theory, sound, light, the electromagnetic spectrum, and optics.*
- (IX) Physics teacher candidates shall understand electricity and magnetism.*
- (X) Physics teacher candidates shall understand fundamental processes of investigating in physics.*
- (XI) Physics teacher candidates shall understand applications of physics in environmental quality and to personal and community health.*
- (XII) Physics teacher candidates shall understand thermodynamics and relationships between energy and matter.
- (XIII) Physics teacher candidates shall understand nuclear physics including matter-energy duality and reactivity.
- (XIV) Physics teacher candidates shall understand angular momentum, centripetal forces, and vector analysis.
- (XV) Physics teacher candidates shall understand quantum mechanics, space-time relationships, and special relativity.
- (XVI) Physics teacher candidates shall understand models of nuclear and subatomic structures and behavior.
- (XVII) Physics teacher candidates shall understand light behavior, including wave-particle duality and models.
- (XVIII) Physics teacher candidates shall understand electrical phenomena including electric fields, vector analysis, energy, potential, capacitance, and inductance.
- (XIX) Physics teacher candidates shall understand issues related to physics such as disposal of nuclear waste, light pollution, shielding communication systems and weapons development.
- (XX) Physics teacher candidates shall understand historical development and cosmological perspectives in physics including contributions of significant figures and under-represented groups, and evolution of theories in physics.
- (XXI) Physics teacher candidates shall understand how to design, conduct, and report research in physics.
- (XXII) Physics teacher candidates shall understand applications of physics and engineering in society, business, industry, and health fields.

(XXIII) Physics teacher candidates shall understand and apply concepts from other sciences and mathematics to the teaching of physics, including:

- I. Biology, including organization of life, bioenergetics, biomechanics, and cycles of matter,
- II. Chemistry, including organization of matter and energy, electrochemistry, thermodynamics, and bonding.
- III. Earth sciences or astronomy related to structure of the universe, energy, and interactions of matter, and
- IV. Mathematical and statistical concepts and skills including statistics and the use of differential equations and calculus.

3. Broad Field.

I. The program shall require a major or equivalent in one of the science specialty areas listed in 2., which meets the appropriate specialty area standards, and at least two additional areas of concentration selected from the science specialties listed in paragraph (a)(i).

II. An area of concentration shall be defined as a minimum of fifteen semester hours of content that address the appropriate specialty area standards indicated by an (*) in section 2.

(c) The program shall meet all requirements specified in Rule 505-3-.01 (4.f.), Special Georgia Requirements.

Authority O.C.G.A. § 20-2-200