ILLINOIS LICENSURE TESTING SYSTEM

FIELD 105 SCIENCE: BIOLOGY

TEST FRAMEWORK

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Science and Technology
Life Science
Physical Science
Earth Systems and the Universe
Cell Biology, Heredity, and Evolution
Organismal Biology and Ecology

SUBAREA I—SCIENCE AND TECHNOLOGY

0001 Understand and apply knowledge of science as inquiry.

- Recognize the assumptions, processes, purposes, requirements, and tools of scientific inquiry.
- Use evidence and logic in developing proposed explanations that address scientific questions and hypotheses.
- Identify various approaches to conducting scientific investigations and their applications.
- Use tools and mathematical and statistical methods for collecting, managing, analyzing (e.g., average, curve fit, error determination), and communicating results of investigations.
- Demonstrate knowledge of ways to report, display, and defend the results of an investigation.

0002 Understand and apply knowledge of the concepts, principles, and processes of technological design.

- Recognize the capabilities, limitations, and implications of technology and technological design and redesign.
- Identify real-world problems or needs to be solved through technological design.
- Apply a technological design process to a given problem situation.
- Identify a design problem and propose possible solutions, considering such constraints as tools, materials, time, costs, and laws of nature.
- Evaluate various solutions to a design problem.

0003 Understand and apply knowledge of accepted practices of science.

- Demonstrate an understanding of the nature of science (e.g., tentative, replicable, historical, empirical) and recognize how scientific knowledge and explanations change over time.
- Compare scientific hypotheses, predictions, laws, theories, and principles and recognize how they are developed and tested.
- Recognize examples of valid and biased thinking in reporting of scientific research.
- Recognize the basis for and application of safety practices and regulations in the study of science.

0004 Understand and apply knowledge of the interactions among science, technology, and society.

- Recognize the historical and contemporary development of major scientific ideas and technological innovations.
- Demonstrate an understanding of the ways that science and technology affect people's everyday lives, societal values and systems, the environment, and new knowledge.
- Analyze the processes of scientific and technological breakthroughs and their effects on other fields of study, careers, and job markets.
- Analyze issues related to science and technology at the local, state, national, and global levels (e.g., environmental policies, genetic research).
- Evaluate the credibility of scientific claims made in various forums (e.g., the media, public debates, advertising).

0005 Understand and apply knowledge of the major unifying concepts of all sciences and how these concepts relate to other disciplines.

- Identify the major unifying concepts of the sciences (e.g., systems, order, and organization; constancy, change, and measurement) and their applications in real-life situations.
- Recognize connections within and among the traditional scientific disciplines.
- Apply fundamental mathematical language, knowledge, and skills at the level of algebra and statistics in scientific contexts.
- Recognize the fundamental relationships among the natural sciences and the social sciences.

SUBAREA II—LIFE SCIENCE

0006 Understand and apply knowledge of cell structure and function.

- Compare and contrast the structures of viruses and prokaryotic and eukaryotic cells.
- Identify the structures and functions of cellular organelles.
- Describe the processes of the cell cycle.
- Explain the functions and applications of the instruments and technologies used to study the life sciences at the molecular and cellular level.

0007 Understand and apply knowledge of the principles of heredity and biological evolution.

- Recognize the nature and function of the gene, with emphasis on the molecular basis of inheritance and gene expression.
- Analyze the transmission of genetic information (e.g., Punnett squares, sex-linked traits, pedigree analysis).
- Analyze the processes of change at the microscopic and macroscopic levels.
- Identify scientific evidence from various sources, such as the fossil record, comparative anatomy, and biochemical similarities, to demonstrate knowledge of theories about processes of biological evolution.

0008 Understand and apply knowledge of the characteristics and life functions of organisms.

- Identify the levels of organization of various types of organisms and the structures and functions of cells, tissues, organs, and organ systems.
- Analyze the strategies and adaptations used by organisms to obtain the basic requirements of life.
- Analyze factors (e.g., physiological, behavioral) that influence homeostasis within an organism.
- Demonstrate an understanding of the human as a living organism with life functions comparable to those of other life forms.

0009 Understand and apply knowledge of how organisms interact with each other and with their environment.

- Identify living and nonliving components of the environment and how they interact with one another.
- Recognize the concepts of populations, communities, ecosystems, and ecoregions and the role of biodiversity in living systems.
- Analyze factors (e.g., ecological, behavioral) that influence interrelationships among organisms.
- Develop a model or explanation that shows the relationships among organisms in the environment (e.g., food web, food chain, ecological pyramid).
- Recognize the dynamic nature of the environment, including how communities, ecosystems, and ecoregions change over time.
- Analyze interactions of humans with their environment.
- Explain the functions and applications of the instruments and technologies used to study the life sciences at the organism and ecosystem level.

SUBAREA III—PHYSICAL SCIENCE

0010 Understand and apply knowledge of the nature and properties of energy in its various forms.

- Describe the characteristics of and relationships among thermal, acoustical, radiant, electrical, chemical, mechanical, and nuclear energies through conceptual questions.
- Analyze the processes by which energy is exchanged or transformed through conceptual questions.
- Apply the three laws of thermodynamics to explain energy transformations, including basic algebraic problem solving.
- Apply the principle of conservation as it applies to energy through conceptual questions and solving basic algebraic problems.

0011 Understand and apply knowledge of the structure and properties of matter.

- Describe the nuclear and atomic structure of matter, including the three basic parts of the atom.
- Analyze the properties of materials in relation to their chemical or physical structures (e.g., periodic table trends, relationships, and properties) and evaluate uses of the materials based on their properties.
- Apply the principle of conservation as it applies to mass and charge through conceptual questions.
- Analyze bonding and chemical, atomic, and nuclear reactions (including endothermic and exothermic reactions) in natural and man-made systems and apply basic stoichiometric principles.
- Apply kinetic theory to explain interactions of energy with matter, including conceptual questions on changes in state.
- Explain the functions and applications of the instruments and technologies used to study matter and energy.

0012 Understand and apply knowledge of forces and motion.

- Demonstrate an understanding of the concepts and interrelationships of position, time, velocity, and acceleration through conceptual questions, algebra-based kinematics, and graphical analysis.
- Demonstrate an understanding of the concepts and interrelationships of force (including gravity and friction), inertia, work, power, energy, and momentum.
- Describe and predict the motions of bodies in one and two dimensions in inertial and accelerated frames of reference in a physical system, including projectile motion but excluding circular motion.
- Analyze and predict motions and interactions of bodies involving forces within the context of conservation of energy and/or momentum through conceptual questions and algebra-based problem solving.
- Describe the effects of gravitational and nuclear forces in real-life situations through conceptual questions.
- Explain the functions and applications of the instruments and technologies used to study force and motion in everyday life.

0013 Understand and apply knowledge of electricity, magnetism, and waves.

- Recognize the nature and properties of electricity and magnetism, including static charge, moving charge, basic RC circuits, fields, conductors, and insulators.
- Recognize the nature and properties of mechanical and electromagnetic waves (e.g., frequency, source, medium, spectrum, wave-particle duality).
- Describe the effects and applications of electromagnetic forces in real-life situations, including electric power generation, circuit breakers, and brownouts.
- Analyze and predict the behavior of mechanical and electromagnetic waves under varying physical conditions, including basic optics, color, ray diagrams, and shadows.

SUBAREA IV—EARTH SYSTEMS AND THE UNIVERSE

0014 Understand and apply knowledge of Earth's land, water, and atmospheric systems and the history of Earth.

- Identify the structure and composition of Earth's land, water, and atmospheric systems and how they affect weather, erosion, fresh water, and soil.
- Recognize the scope of geologic time and the continuing physical changes of Earth through time.
- Evaluate scientific theories about Earth's origin and history and how these theories explain contemporary living systems.
- Recognize the interrelationships between living organisms and Earth's resources and evaluate the uses of Earth's resources.

0015 Understand and apply knowledge of the dynamic nature of Earth.

- Analyze and explain large-scale dynamic forces, events, and processes that affect Earth's land, water, and atmospheric systems, including conceptual questions about plate tectonics, El Niño, drought, and climatic shifts.
- Identify and explain Earth processes and cycles and cite examples in real-life situations, including conceptual questions on rock cycles, volcanism, and plate tectonics.
- Analyze the transfer of energy within and among Earth's land, water, and atmospheric systems, including the identification of energy sources of volcanoes, hurricanes, thunderstorms, and tornadoes.
- Explain the functions and applications of the instruments and technologies used to study the earth sciences, including seismographs, barometers, and satellite systems.

0016 Understand and apply knowledge of objects in the universe and their dynamic interactions.

- Describe and explain the relative and apparent motions of the sun, the moon, stars, and planets in the sky.
- Recognize properties of objects (e.g., comets, asteroids) within the solar system and their dynamic interactions.
- Recognize the types, properties, and dynamics of objects external to the solar system (e.g., black holes, supernovas, galaxies).

0017 Understand and apply knowledge of the origins of and changes in the universe.

- Identify scientific theories dealing with the origin of the universe (e.g., big bang).
- Analyze evidence relating to the origin and physical evolution of the universe (e.g., microwave background radiation, expansion).
- Compare the physical and chemical processes involved in the life cycles of objects within galaxies.
- Explain the functions and applications of the instruments, technologies, and tools used in the study of the space sciences, including the relative advantages and disadvantages of earth-based versus space-based instruments and optical versus non-optical instruments.

SUBAREA V—CELL BIOLOGY, HEREDITY, AND EVOLUTION

0018 Understand and apply knowledge of the concepts of cell biology.

- Demonstrate an understanding of the structural and functional aspects of nucleic acids, proteins (including enzyme activity), carbohydrates, and lipids.
- Analyze, at the cellular level, the chemical processes by which organic materials are synthesized and used and relate these processes to energy production and utilization in living systems (e.g., photosynthesis, respiration).
- Demonstrate knowledge of the mechanisms and genetics of cellular differentiation in forming specialized tissues, organs, and complete organisms.

0019 Understand and apply knowledge of the molecular basis of heredity and the associated mathematical probabilities.

- Explain the structure and function of genes.
- Analyze the molecular basis of DNA replication, transcription, translation, and gene expression.
- Analyze the mechanisms and impacts of mutations.
- Demonstrate an understanding of genetic and mathematical explanations associated with probabilities of the transmission of traits and heritable defects in organisms (e.g., pedigrees, Punnett squares).
- Demonstrate knowledge of the concepts and consequences associated with recombinant DNA applications.

0020 Understand and apply knowledge of the historical progression of cellular biology and genetics and the basic research methods and technologies used in these areas.

- Analyze the historical progression of cellular biology and biotechnology, including the changes in knowledge due to advances in technology and the resulting societal implications.
- Demonstrate knowledge of the basic methods, processes, and tools used in cellular and molecular biology research (e.g., electrophoresis, transformation, polymerase chain reaction).

0021 Understand and apply knowledge of biological evolution and diversity.

- Demonstrate an understanding of biological diversity, with an emphasis on the evolutionary relationships among the major groups of organisms.
- Demonstrate an understanding of the processes of natural selection and speciation.
- Describe evidence (e.g., comparative anatomy, paleontology, genetics) supporting the theory of evolution and evolutionary relationships.
- Evaluate recent findings or research that are associated with the testing of the theory of evolution and its mechanisms.
- Analyze the historical progression of the study of biological evolution, including the changes in knowledge due to advances in technology and the resulting societal implications.

SUBAREA VI—ORGANISMAL BIOLOGY AND ECOLOGY

0022 Understand and apply knowledge of organismal biology, using examples from each kingdom.

- Recognize the basic physiological needs and requirements (e.g., energy, nutrients, oxygen) of organisms.
- Demonstrate knowledge of the biochemical and molecular biology of processes fundamental to metabolic function of various systems of living organisms.
- Analyze interrelationships of the functions of various organismal systems.
- Analyze how organisms recognize and localize various internal and external signals to maintain homeostasis.
- Demonstrate knowledge of various instruments and technologies that enhance the study of organisms on the microscopic and macroscopic levels.

0023 Understand and apply knowledge of biological diversity in terms of the structure, function, and nomenclature of the major groups of organisms.

- Analyze the relationships between structure and function in various organisms.
- Distinguish among organisms from different major taxonomic groups based on their characteristics.
- Demonstrate knowledge of the historical development of biological classification systems.
- Apply methods of biological classification and nomenclature.

0024 Understand and apply knowledge of ecological concepts.

- Explain the interactions and interdependence of organisms in various ecosystems, including the environmental influences and limiting factors that affect them.
- Demonstrate an understanding of the concepts of population dynamics and the effects of population dynamics on environments and communities.
- Analyze ways in which humans influence and are influenced by the environment.
- Explain the functions and applications of the methods, instruments, and technologies used in the research of ecology.
- Analyze the risk/cost/benefit factors in environmental impact studies.

0025 Understand and apply knowledge of matter, energy, and organization in living systems.

- Analyze energy flow between biological systems and the physical environment.
- Analyze the effects of limited availability of resources on the distribution and abundance of organisms and populations.
- Demonstrate an understanding of the transfer and transformation of energy in various biological reactions.
- Analyze food webs, including the roles of and relationships among producers, consumers, and decomposers.
- Relate the varying complexity and organization of organisms to the means by which they obtain, transform, transport, and release matter and energy.