

TABLE OF CONTENTS

PG #

SUBAREA I—FOUNDATIONS OF SCIENTIFIC INQUIRY

Competency 0001 - Understand common themes among the sciences and the relationships that connect mathematics, technology, and science..... 1

Skill 1.1 Similarities among systems in math, science, and technology 1

Skill 1.2 Apply concepts and theories from mathematics and other sciences to a biological system 1

Skill 1.3 Analyze the use of biology and other sciences in the design of a technological solution to a given problem..... 2

Skill 1.4 Use a variety of software and information technologies (e.g., spreadsheets, graphing utilities, statistical packages, simulations, on-line resources) to model and solve problems in mathematics, science, and technology 3

Competency 0002 - Understand the historical and contemporary contexts of biological study and the applications of biology and biotechnology to everyday life4

Skill 2.1 Analyze the significance of key events in the history of biological study 4

Skill 2.2 Assess the societal implications of recent developments in biology and biotechnology 5

Competency 0003 - Understand the process of scientific inquiry and the role of observation, experimentation, and communication in explaining natural phenomena 7

Skill 3.1Processes by which scientific knowledge and hypotheses are generated and revised 7

Skill 3.2Analyze ethical practices related to the process of scientific research and reporting 7

Skill 3.3Evaluate the appropriateness of a specified experimental design to test a hypothesis 9

Skill 3.4Analyze the use of models in explaining and investigating natural phenomena 9

TEACHER CERTIFICATION STUDY GUIDE

Competency 0004 - Understand principles of measurement and the processes of gathering, interpreting, and communicating scientific data 11

Skill 4.1 Evaluate the appropriateness of a given method or procedure for collecting data for a specified purpose 11

Skill 4.2 Evaluate the appropriateness and limitations of units of measurement, measuring devices, or methods of measurement..... 11

Skill 4.3 Knowledge of appropriate and effective graphic representation of Data 11

Skill 4.4 Select an effective graphic representation (e.g., graph, table, diagram) for organizing, reporting, and analyzing given experimental data 12

Competency 0005 - Understand the use of equipment, materials, chemicals, and organisms used in biological studies and the application of procedures for their proper, safe, and legal use 14

Skill 5.1 Demonstrate knowledge of the appropriate use of laboratory instruments and equipment 14

Skill 5.2 Storing, identifying, and disposing of chemicals and biological materials..... 15

Skill 5.3 Use of live specimens 16

Skill 5.4 Dissection and alternatives to dissection 17

Skill 5.5 Laboratory Safety Procedures 17

SUBAREA II—CELL STRUCTURE AND FUNCTION

Competency 0006 - Understand the functions and interrelatedness of cell structures, and identify the structural features of different types of cells 19

Skill 6.1 Compare prokaryotes and eukaryotes 19

Skill 6.2 Understand the importance of active and passive transport 22

Competency 0007 - Understand basic chemistry and biochemistry, and use this understanding to analyze the role of biologically important elements and compounds in living organisms 26

Skill 7.1 Compare and contrast hydrogen, ionic, and covalent bonds 26

TEACHER CERTIFICATION STUDY GUIDE

Skill 7.2 Analyze the structure and function of carbohydrates, lipids, proteins, and nucleic acids	27
Skill 7.3 Analyze the properties of water and its significance to living organisms.....	30
Skill 7.4 Analyze the structure and function of enzymes and factors.....	31
Competency 0008 - Understand the processes of photosynthesis and cellular respiration and their relationships to cell structure and function	33
Skill 8.1 Analyze limiting factors that affect the yield of energy from the breakdown of organic molecules in a cell.....	33
Skill 8.2 Understand the significance of photosynthesis and respiration to living organisms	34
Skill 8.3 Evaluate the significance of chloroplast structure and mitochondrion structure in the processes of photosynthesis and respiration	38
Skill 8.4 Compare C3 and C4 photosynthesis	39
Competency 0009 - Understand the structure and function of DNA and RNA	40
Skill 9.1 DNA replication, potential errors, and implications of these errors.....	40
Skill 9.2 Protein Synthesis	42
Skill 9.3 Mutations in DNA molecules and their effect on protein structure and function.....	43
Skill 9.4 Control of gene expression in cells	44
SUBAREA III—HEREDITY AND BIOLOGICAL ADAPTATION	
Competency 0010 - Understand the procedures involved in the isolation, manipulation, and expression of genetic material and the application of genetic engineering in basic and applied research.....	46
Skill 10.1 Understand the role of genetic engineering in the medical field	46
Skill 10.2 Knowledge of genetic engineering techniques	47

TEACHER CERTIFICATION STUDY GUIDE

Competency 0011 - Understand the cell cycle, the stages and end products of meiosis and mitosis, and the role of cell division in unicellular and multicellular organisms	48
Skill 11.1 Knowledge of cell division	48
Skill 11.2 Understand genetic diversity	52
Skill 11.3 Understand the relationship between an unrestricted cell cycle and cancer	52
Competency 0012 - Understand concepts, principles, and applications of classical and molecular genetics.....	53
Skill 12.1 Understand the basic principle of heredity	53
Skill 12.2 Analyze genetic inheritance problems.....	55
Skill 12.3 Analyze the techniques used to screen for genetic disorders	56
Skill 12.4 Understand the role of nonnuclear inheritance	57
Competency 0013 - Understand the principles of population genetics and the interaction between heredity and the environment, and apply this knowledge to problems involving populations	58
Skill 13.1 Analyze the conditions that affect the gene pool.....	58
Skill 13.2 Recognize the relationship between phenotype and its selective advantage in the environment.....	59
Competency 0014 - Understand the processes of natural selection and adaptation and evolutionary theory	60
Skill 14.1 Analyze the role of natural selection on evolution	60
Skill 14.2 Compare alternative mechanisms of evolution	60
Skill 14.3 Recognize the factors that lead to speciation.....	61
Skill 14.4 Evaluate observations made in various areas of biology (e.g., embryology, biochemistry, anatomy) in terms of evolutionary theory.....	62

TEACHER CERTIFICATION STUDY GUIDE

SUBAREA IV—MATTER, ENERGY, AND ORGANIZATION IN ORGANISMS

Competency 0015 - Understand the principles of taxonomy	64
Skill 15.1 Knowledge of the classification of organisms.....	64
Skill 15.2 Analyzing a phylogenetic tree or cladogram of related species ...	65
Skill 15.3 Analyzing the impact of evolution and modern genetics in the classification system	65
Skill 15.4 Recognize the functions of specialized structures at all levels of complexity (e.g., leaves on trees, wings on birds).....	65
Competency 0016 - Understand the unity and diversity of life, including common structures and functions	66
Skill 16.1 Knowledge of the properties of life	66
Skill 16.2 Recognize the level of organization	66
Skill 16.3 Comparing and analyzing the basic life functions carried out by living organisms (e.g., obtaining nutrients, excretion, reproduction).....	66
Skill 16.4 Recognize the importance of maintaining biological diversity (e.g., pharmacological products, stability of ecosystems)	68
Skill 16.5 Analyze the processes involved in homeostasis	69
Competency 0017 - Understand the characteristics, functions, and adaptations of viruses, archaebacteria, monerans, protocists (protists), and fungi	70
Skill 17.1 Analyze the structure and processes of prions and viruses	70
Skill 17.2 Compare archaebacteria and eubacteria	70
Skill 17.3 Chromosome and plasmid replication in bacteria	71
Skill 17.4 Structure and function of protists.....	72
Skill 17.5 Knowledge of the significance of fungi, bacteria, and viruses	72
Skill 17.6 Analyze the process of gene transfer in monerans	73

TEACHER CERTIFICATION STUDY GUIDE

Competency 0018 - Understand the characteristics, functions, and adaptations of plants	74
Skill 18.1 Features of plants	74
Skill 18.2 Reproduction and development of plants.....	75
Skill 18.3 Knowledge of transport in plants	76
Skill 18.4 Evaluate the adaptive significance of plant structures (e.g., sporangia, microphylls, modified leaves, colorful flowers).....	76
Competency 0019 - Understand the characteristics, functions, and adaptations of animals	78
Skill 19.1 Identify the general characteristics of vertebrate and invertebrate development.....	78
Skill 19.2 Knowledge of physiological processes of animals	79
Skill 19.3 Predict relative metabolic rates of animals (e.g., endotherms, ectotherms, animals of different sizes).....	89
Skill 19.4 Analyze the importance of animal behaviors.....	80

SUBAREA V—INTERDEPENDENCE OF ORGANISMS

Competency 0020 - Understand the structures and functions of the human skeletal, muscular, and integumentary systems; common malfunctions of these systems; and their homeostatic relationships within the body.....	81
Skill 20.1 Structures, locations, and functions of the three types of muscular tissue	81
Skill 20.2 Understand the mechanism of skeletal muscular contraction	81
Skill 20.3 Analyze the movements of body joints.....	81
Skill 20.4 Knowledge of the structure and function of skin.....	82
Skill 20.5 Demonstrate an understanding of possible causes and effects of malfunctions of the skeletal, muscular, and integumentary systems (e.g., arthritis, skin cancer).....	82

TEACHER CERTIFICATION STUDY GUIDE

Competency 0021 - Understand the structures and functions of the human respiratory and excretory systems, common malfunctions of these systems, and their homeostatic relationships within the body.....	85
Skill 21.1 Surface area, volume, and function of the respiratory and excretory systems	85
Skill 21.2 Knowledge of process of breathing and gas exchange.....	85
Skill 21.3 Analyze factors that influence the characteristics of the major types of biomes Knowledge of osmoregulation and waste removal	86
Skill 21.4 Recognize the effect of biome degradation and destruction on biosphere stability (e.g., climate changes, deforestation, reduction of species diversity)Malfunctions of the respiratory and excretory systems	87
Competency 0022 - Understand the structures and functions of the human circulatory and immune systems, common malfunctions of these systems, and their homeostatic relationships within the body.....	88
Skill 22.1 Analyze the structure, function, and regulation of the heart	88
Skill 22.2 Malfunctions of the circulatory system	89
Skill 22.3 Structure, function, and regulation of the immune system	89
Skill 22.4 Malfunctions of the immune system	91
Competency 0023 - Understand human nutrition and the structures and functions of the human digestive system and accessory organs, common malfunctions of the digestive system, and its homeostatic relationships within the body	92
Skill 23.1 Understand the roles of basic nutrients found in foods	92
Skill 23.2 Understand the mechanisms of digestion and indigestion	92
Skill 23.3 Malfunctions of the digestive system.....	93
Competency 0024 - Understand the structures and functions of the human nervous and endocrine systems, common malfunctions of these systems, and their homeostatic relationships within the body.....	94
Skill 24.1 Knowledge of the central and peripheral nervous systems	94

TEACHER CERTIFICATION STUDY GUIDE

Skill 24.2 Analyze the role of nerve impulses and neurons	94
Skill 24.3 Discuss the influence of drugs and other chemicals on nerve transmission	95
Skill 24.4 Understand the feedback mechanisms in homeostasis	96
Skill 24.5 Malfunctions of the nervous and endocrine systems	96
Competency 0025 - Understand the structures and functions of the human reproductive systems, their homeostatic relationships within the body, processes of embryonic development, common malfunctions of the reproductive systems, and sexually transmitted diseases	97
Skill 25.1 Understand the major endocrine glands and the function of their hormones.....	97
Skill 25.2 Understand hormone control and development and function of male and female reproductive systems.....	97
Skill 25.3 Gametogenesis, fertilization, and birth control.....	98
Skill 25.4 Embryonic and fetal development.....	99
Skill 25.5 Potential effects of drugs, alcohol, and nutrition on fetal development.....	99
Skill 25.6 Malfunctions of the reproductive systems (e.g., infertility, birth defects)	100
Skill 25.7 Demonstrate an understanding of sexually transmitted diseases	101
Competency 0026 - Understand the characteristics of populations and communities, and use this knowledge to analyze population growth and community interactions	103
Skill 26.1 Factors that affect population size and growth rate.....	103
Skill 26.2 Population growth curves	103
Skill 26.3 Relationships among organisms in a community.....	104

TEACHER CERTIFICATION STUDY GUIDE

Competency 0027 - Understand the development and structure of ecosystems and the characteristics of major biomes.....	106
Skill 27.1 Flow of energy through trophic levels of an ecosystem	106
Skill 27.2 Pyramid models	107
Skill 27.3 Ecological succession and biotic and abiotic factors.....	107
Competency 0028 - Understand the connections within and among the biogeochemical cycles, and analyze their implications for living things	109
Skill 28.1 Recognize the importance of the processes involved in the water cycle	109
Skill 28.2 Role of decomposers in nutrient cycling.....	109
Skill 28.3 Analyze the role of respiration and photosynthesis in biogeochemical cycling	109
Skill 28.4 Evaluate the effects of limiting factors on ecosystem productivity (e.g., light intensity, gas concentrations, mineral availability).....	111
Competency 0029 - Understand concepts of human ecology and the impact of human decisions and activities on the abiotic and biotic environments	112
Skill 29.1 Recognize the importance and implications of influencing factors (e.g., nutrition, public health) on human population dynamics	112
Skill 29.2 Predict the impact of human use of natural resources (e.g., forests, rivers) on organisms.....	112
Skill 29.3 Analyze types of resource misuse and their long- and short-term effects	113
Skill 29.4 Evaluate methods and technologies that reduce or mitigate environmental degradation	113
Sample Test	115
Answer Key	136
Rationales for Sample Questions	137