| **Test Content Categories** | **How well do I know the content?  (scale 1–5)** | **What resources do I have/need for this content?** | **Where can I find the resources I need?** | **Dates I will study this content** | **Date completed** |
| --- | --- | --- | --- | --- | --- |
| I . Nature and Impact of Science and Engineering |  |  |  |  |  |
| 1. Nature of Science |  |  |  |  |  |
| 1. Nature of scientific knowledge |  |  |  |  |  |
| 1. Observations and experiments provide evidence |  |  |  |  |  |
| 1. Understanding develops and changes over time in light of new evidence |  |  |  |  |  |
| 1. Science is interdisciplinary in nature (e.g., principles of chemistry and physics and earth science in biology) |  |  |  |  |  |
| 1. Scientific methodologies |  |  |  |  |  |
| 1. Scientific skills include observing, categorizing, comparing, generalizing, inferring, and concluding |  |  |  |  |  |
| 1. Distinguish between scientific laws, and scientific theories, and hypotheses |  |  |  |  |  |
| 1. Models are developed, revised, and applied to explain natural phenomena |  |  |  |  |  |
| 1. Experimental design, data collection, and analysis |  |  |  |  |  |
| 1. Standard units of measurement, dimensional analysis, and unit conversion |  |  |  |  |  |
| 1. Scientific notation and use of significant figures |  |  |  |  |  |
| 1. Experimental design, including hypothesis development, identifying variables, and planning data collection |  |  |  |  |  |
| 1. Processing, organizing, and reporting of quantitative and qualitative data |  |  |  |  |  |
| 1. Error analysis, including identifying the sources and effects of error |  |  |  |  |  |
| 1. Interpreting, extrapolating, and drawing valid conclusions from data |  |  |  |  |  |
| 1. Laboratory procedures |  |  |  |  |  |
| 1. Preparation of materials for classroom or field use |  |  |  |  |  |
| 1. Appropriate and safe use, storage, and disposal of chemicals and biological materials |  |  |  |  |  |
| 1. Appropriate and safe use and care of laboratory equipment |  |  |  |  |  |
| 1. Safety and emergency procedures for science laboratories |  |  |  |  |  |
| 1. Science, Engineering, Technology, Society, and the Environment |  |  |  |  |  |
| 1. Engineering design and the interdependence of science, engineering, and technology |  |  |  |  |  |
| 1. Defining problems, including identifying the success criteria and the constraints |  |  |  |  |  |
| 1. Designing solutions, including proposing and evaluating in terms of criteria, constraints, and limitations |  |  |  |  |  |
| 1. Optimizing the design, including systematic modification and refinement |  |  |  |  |  |
| 1. Engineering advances lead to important discoveries in science |  |  |  |  |  |
| 1. Science and technology drive each other forward |  |  |  |  |  |
| 1. Impacts of science, technology, human activity, and natural phenomena on society and the environment |  |  |  |  |  |
| 1. Sources of air and water pollution |  |  |  |  |  |
| 1. Sources of greenhouse gases and impacts of global climate change |  |  |  |  |  |
| 1. Production, use, disposal, and recycling of consumer products |  |  |  |  |  |
| 1. Consequences of natural disasters, resource extraction, and industrial accidents |  |  |  |  |  |
| 1. Forestry, agriculture, wildlife, and fisheries practices |  |  |  |  |  |
| 1. Ocean, estuary, freshwater, and wetland degradation |  |  |  |  |  |
| 1. Conservation, including species protection and habitat preservation and restoration |  |  |  |  |  |
| 1. Renewable or sustainable use of energy and resource management |  |  |  |  |  |
| 1. Applications of science in public health, medicine, and agriculture |  |  |  |  |  |
| 1. Epidemiology, disease, and medicine (e.g., epidemics/pandemics, H​I​V/AIDS, pathogens, vaccines) |  |  |  |  |  |
| 1. Biotechnology (e.g., genetic engineering, G​M​Os) |  |  |  |  |  |
| 1. Medical technologies for disease diagnosis and treatment (e.g., medical imaging, X-rays, radiation therapy) |  |  |  |  |  |
| 1. Ethical research concerns (e.g., use of stem cells and toxic chemicals) |  |  |  |  |  |
| 1. Ethical use of technology, genetic information, organisms, and cloning |  |  |  |  |  |
| II. Cell Biology: Cell Structure and Function |  |  |  |  |  |
| 1. Basic biochemistry and metabolism of living organisms |  |  |  |  |  |
| 1. Chemical structures and properties of biologically important molecules |  |  |  |  |  |
| 1. Atomic and molecular structures |  |  |  |  |  |
| 1. Chemical bonding |  |  |  |  |  |
| 1. Organic versus inorganic molecules |  |  |  |  |  |
| 1. Properties of water based on structure and bonding characteristics |  |  |  |  |  |
| 1. Major macromolecules, including nucleic acids, proteins, lipids, and carbohydrates |  |  |  |  |  |
| 1. Dependency of biological processes on chemical principles developmental and content domains |  |  |  |  |  |
| 1. Chemical and physical gradients, and factors that influence the gradients |  |  |  |  |  |
| 1. Laws of thermodynamics |  |  |  |  |  |
| 1. Anabolic and catabolic reactions in metabolism |  |  |  |  |  |
| 1. Reduction-oxidation reactions in metabolism |  |  |  |  |  |
| 1. Structure and function of enzymes and the factors that influence their activity |  |  |  |  |  |
| 1. Active site structure and substrate binding |  |  |  |  |  |
| 1. Energy profile of a reaction in the presence or absence of an enzyme |  |  |  |  |  |
| 1. Reaction kinetics, including the effects of temperature, pH, concentrations, and other molecules, including inhibitors |  |  |  |  |  |
| 1. Regulation, including cooperative binding and feedback inhibition |  |  |  |  |  |
| 1. Major biochemical pathways and energy flow within an organism |  |  |  |  |  |
| 1. Cellular locations of biochemical pathways |  |  |  |  |  |
| 1. Structure and function of A​T​P |  |  |  |  |  |
| 1. Photosynthesis, including photosystems, electron transport, Calvin-Benson cycle |  |  |  |  |  |
| 1. Processes associated with aerobic and anaerobic cellular respiration and fermentation, including glycolysis, citric acid cycle, and oxidative phosphorylation |  |  |  |  |  |
| 1. Chemosynthesis as an alternative to photosynthesis |  |  |  |  |  |
| 1. Structure and function of cells and the mechanisms of basic cellular processes |  |  |  |  |  |
| 1. Characteristics of living versus nonliving things |  |  |  |  |  |
| 1. Cell theory |  |  |  |  |  |
| 1. Obtaining and transforming energy |  |  |  |  |  |
| 1. Growth and development |  |  |  |  |  |
| 1. Homeostasis: regulation and responses to the environment |  |  |  |  |  |
| 1. Reproduction |  |  |  |  |  |
| 1. Structure and function of cells and organelles |  |  |  |  |  |
| 1. Prokaryotic versus eukaryotic cells, including organelles, cell walls, and chromosomes |  |  |  |  |  |
| 1. Plant cells versus animal cells |  |  |  |  |  |
| 1. Plasma/cell membranes |  |  |  |  |  |
| 1. Membrane-bound organelles and ribosomes |  |  |  |  |  |
| 1. Cytoskeleton and extracellular matrix |  |  |  |  |  |
| 1. How cells maintain their internal environment and respond to external signals |  |  |  |  |  |
| 1. Selective permeability, including structure and function of phospholipid bilayer |  |  |  |  |  |
| 1. Active and passive transport |  |  |  |  |  |
| 1. Water movement, including osmolarity and water potential |  |  |  |  |  |
| 1. Cell surface proteins, cell communication, signal molecules, and signal transduction |  |  |  |  |  |
| 1. Exocytosis and endocytosis |  |  |  |  |  |
| 1. Negative-feedback and positive-feedback mechanisms |  |  |  |  |  |
| 1. Eukaryotic cell division, the cell cycle, and regulation of the processes |  |  |  |  |  |
| 1. Cell cycle stages and checkpoints |  |  |  |  |  |
| 1. Mitosis, including functions, stages, and results |  |  |  |  |  |
| 1. Cytokinesis, including differences between animals and plants |  |  |  |  |  |
| 1. Cancer (e.g., unregulated checkpoints and cell proliferation) |  |  |  |  |  |
| III. Genetics and Evolution |  |  |  |  |  |
| 1. Mechanisms of molecular biology and genetic transmission |  |  |  |  |  |
| 1. Structure of nucleic acids and chro |  |  |  |  |  |
| 1. Sugar-phosphate backbone and complementary base pairing |  |  |  |  |  |
| 1. D​N​A versus R​N​A |  |  |  |  |  |
| 1. Chromosome structure, including |  |  |  |  |  |
| 1. Transfer of genetic information |  |  |  |  |  |
| 1. Central dogma of molecular biology |  |  |  |  |  |
| 1. Process of D​N​A replication |  |  |  |  |  |
| 1. The process of R​N​A transcription |  |  |  |  |  |
| 1. Pre-m​R​N​A processing in eukaryotes |  |  |  |  |  |
| 1. The process of translation, including the role of m​R​N​A, t​R​N​A,  r​R​N​A and ribosomes |  |  |  |  |  |
| 1. Gene regulation (e.g., promoters, enhancers, transcription factors, and posttranslational regulation) |  |  |  |  |  |
| 1. Utilization of a genetic code chart |  |  |  |  |  |
| 1. Protein synthesis in eukaryotes versus prokaryotes |  |  |  |  |  |
| 1. Nature of mutations |  |  |  |  |  |
| 1. Causes of mutations, including recombination and mutagens |  |  |  |  |  |
| 1. Types of mutations, including substitution, deletion, insertion, inversion, and translocation |  |  |  |  |  |
| 1. Disorders resulting from point mutations, frameshift mutations, changes in chromosome structure, and changes in chromosome numbers |  |  |  |  |  |
| 1. Significance of somatic versus germ-line mutations |  |  |  |  |  |
| 1. Laboratory techniques |  |  |  |  |  |
| 1. Microscopy |  |  |  |  |  |
| 1. Gel electrophoresis |  |  |  |  |  |
| 1. Spectrophotometry |  |  |  |  |  |
| 1. Polymerase chain reaction (P​C​R) |  |  |  |  |  |
| 1. Genome sequencing |  |  |  |  |  |
| 1. Gene therapy |  |  |  |  |  |
| 1. Protein sequence analysis |  |  |  |  |  |
| 1. Genetically engineered cells and transgenic organisms |  |  |  |  |  |
| 1. Chromosome analysis |  |  |  |  |  |
| 1. Mendelian genetics |  |  |  |  |  |
| 1. Dominant and recessive alleles |  |  |  |  |  |
| 1. The law of independent assortment and the role of meiosis |  |  |  |  |  |
| 1. The law of segregation and the role of meiosis |  |  |  |  |  |
| 1. Monohybrid and dihybrid crosses |  |  |  |  |  |
| 1. Pedigree analysis |  |  |  |  |  |
| 1. Non-Mendelian inheritance |  |  |  |  |  |
| 1. Gene linkage and mapping by recombination analysis |  |  |  |  |  |
| 1. Sex-linked inheritance |  |  |  |  |  |
| 1. Multiple alleles, codominance, and incomplete dominance |  |  |  |  |  |
| 1. Polygenic inheritance, epistasis, and pleiotropy |  |  |  |  |  |
| 1. Extranuclear inheritance, including mitochondrial and chloroplast inheritance |  |  |  |  |  |
| 1. Environmental influences, including epigenetics |  |  |  |  |  |
| 1. Pedigree analysis |  |  |  |  |  |
| 1. Mechanisms of evolution as a consequence of genetic variation and factors affecting evolution |  |  |  |  |  |
| 1. Sources of genetic variation |  |  |  |  |  |
| 1. Mutation |  |  |  |  |  |
| 1. Sexual reproduction, including crossing-over, random fertilization, segregation and independent assortment |  |  |  |  |  |
| 1. Horizontal genetic exchange, including conjugation, transformation, and transduction |  |  |  |  |  |
| 1. Mechanisms of evolution |  |  |  |  |  |
| 1. Darwin-Wallace theories of reproductive fitness and natural selection |  |  |  |  |  |
| 1. Hardy-Weinberg equilibrium: calculations and factors that may alter the equilibrium |  |  |  |  |  |
| 1. Effects of mutations, gene flow, genetic drift (including bottleneck and founder effects), and nonrandom mating (including sexual selection) |  |  |  |  |  |
| 1. Artificial selection |  |  |  |  |  |
| 1. Macroevolution versus microevolution |  |  |  |  |  |
| 1. Patterns of evolution: convergent, divergent, coevolution, parallel evolution, adaptive radiation |  |  |  |  |  |
| 1. Gradualism versus punctuated equilibrium |  |  |  |  |  |
| 1. Mechanisms of speciation, including reproductive isolation and allopatric and sympatric speciation |  |  |  |  |  |
| 1. Evidence supporting evolution |  |  |  |  |  |
| 1. Fossil record |  |  |  |  |  |
| 1. Biogeographical similarities |  |  |  |  |  |
| 1. Biodiversity over geological time |  |  |  |  |  |
| 1. Endosymbiosis |  |  |  |  |  |
| 1. Structural and developmental evidence, including homology, embryology and vestigial structures |  |  |  |  |  |
| 1. Molecular evidence, including universal genetic code, D​N​A, R​N​A, and amino acid sequence comparisons |  |  |  |  |  |
| 1. Direct observation of evolution (e.g., antibiotic resistance) |  |  |  |  |  |
| 1. Models of evolution |  |  |  |  |  |
| 1. Molecular clock (mitochondrial  D​N​A) |  |  |  |  |  |
| 1. Phylogenetic relationships, including cladograms and phylogenetic trees |  |  |  |  |  |
| 1. Scientific explanations for the origin and early evolution of life on Earth |  |  |  |  |  |
| 1. Abiotic synthesis of organic compounds (e.g., the Miller-Urey experiment) |  |  |  |  |  |
| 1. Development of self-replicating molecules, including the R​N​A-first hypothesis |  |  |  |  |  |
| 1. Biological influences on atmospheric composition, including the role of photosynthesis |  |  |  |  |  |
| 1. Factors that lead to the extinction of species |  |  |  |  |  |
| 1. Lack of genetic diversity |  |  |  |  |  |
| 1. Interspecific competition |  |  |  |  |  |
| 1. Meteorite impacts and the effects of geological processes, including tectonic plate movement and volcanism |  |  |  |  |  |
| 1. Human-caused environmental pressures, including climate and habitat change |  |  |  |  |  |
| IV. Diversity of Life and Organismal Biology |  |  |  |  |  |
| 1. Diversity of Life |  |  |  |  |  |
| 1. Biological classification of organisms |  |  |  |  |  |
| 1. Taxonomic hierarchy, including domains and kingdoms |  |  |  |  |  |
| 1. Binomial nomenclature |  |  |  |  |  |
| 1. Defining characteristics of viruses, eubacteria, archaea, protists, fungi, plants, and animals |  |  |  |  |  |
| 1. Structural characteristics of viruses, eubacteria, archaea, protists, fungi, plants, and animals |  |  |  |  |  |
| 1. Cellular organization, including unicellular versus multicellular |  |  |  |  |  |
| 1. Modes of nutrition, including autotrophic versus heterotrophic |  |  |  |  |  |
| 1. Organizational hierarchy |  |  |  |  |  |
| 1. Cells |  |  |  |  |  |
| 1. Tissues |  |  |  |  |  |
| 1. Organs |  |  |  |  |  |
| 1. Organ systems |  |  |  |  |  |
| 1. Cell differentiation and specialization |  |  |  |  |  |
| 1. Differential gene expression |  |  |  |  |  |
| 1. Stem cells, including characteristics and sources |  |  |  |  |  |
| 1. Animal Biology |  |  |  |  |  |
| 1. Characteristics of animals |  |  |  |  |  |
| 1. Major evolutionary trends, including body plans, body cavities, cephalization and multicellularity |  |  |  |  |  |
| 1. Modes of reproduction (sexual versus asexual) |  |  |  |  |  |
| 1. Modes of temperature regulation (endotherm versus ectotherm) |  |  |  |  |  |
| 1. Structure and function of major human organ systems |  |  |  |  |  |
| 1. Cardiovascular and respiratory |  |  |  |  |  |
| 1. Digestive and excretory |  |  |  |  |  |
| 1. Immune |  |  |  |  |  |
| 1. Musculoskeletal |  |  |  |  |  |
| 1. Nervous and endocrine |  |  |  |  |  |
| 1. How homeostasis is maintained in organisms |  |  |  |  |  |
| 1. Role of organs or tissues, such as the kidney, adrenals, and hypothalamus, and pituitary |  |  |  |  |  |
| 1. Role of hormones, such as insulin, antidiuretic hormone, and sex hormones |  |  |  |  |  |
| 1. Feedback mechanisms, including negative and positive |  |  |  |  |  |
| 1. Role of behaviors, including diurnal, nocturnal, hibernation, and basking |  |  |  |  |  |
| 1. Reproduction, development, and growth in organisms |  |  |  |  |  |
| 1. Gamete formation, including the stages of meiosis and changes in chromosome number |  |  |  |  |  |
| 1. Fertilization, including internal versus external |  |  |  |  |  |
| 1. Embryonic development |  |  |  |  |  |
| 1. Patterns of growth and development, including metamorphosis |  |  |  |  |  |
| 1. Behavior |  |  |  |  |  |
| 1. Innate versus learned behaviors |  |  |  |  |  |
| 1. Territoriality |  |  |  |  |  |
| 1. Group versus individual |  |  |  |  |  |
| 1. Social behavior (e.g., hunting, flocking, migration, altruism) |  |  |  |  |  |
| 1. Plant Biology |  |  |  |  |  |
| 1. Characteristics of plants |  |  |  |  |  |
| 1. Vascular versus nonvascular plants |  |  |  |  |  |
| 1. Angiosperms versus gymnosperms |  |  |  |  |  |
| 1. Tissues, including dermal, ground, and vascular (xylem and phloem) |  |  |  |  |  |
| 1. Structure of organs, including flowers, stems, leaves, and roots |  |  |  |  |  |
| 1. How plants obtain, transport, and store materials |  |  |  |  |  |
| 1. Roles of roots, stems, and leaves |  |  |  |  |  |
| 1. Water and nutrient transport, including xylem and transpiration through stomata |  |  |  |  |  |
| 1. Production, transport, and storage of products of photosynthesis, including simple and complex carbohydrates, phloem transport, and storage structures |  |  |  |  |  |
| 1. Reproduction, growth and development |  |  |  |  |  |
| 1. Gametogenesis |  |  |  |  |  |
| 1. Alternation of generations, including gametophyte and sporophyte |  |  |  |  |  |
| 1. Pollination/fertilization strategies and seed/spore propagation |  |  |  |  |  |
| 1. Germination and growth |  |  |  |  |  |
| 1. How plants respond to the environment |  |  |  |  |  |
| 1. Plant tropisms |  |  |  |  |  |
| 1. Plant defenses, including physical and chemical |  |  |  |  |  |
| 1. Major plant hormones, including auxin, gibberellins, ethylene, and cytokinins |  |  |  |  |  |
| V. Ecology: Organisms and Environment |  |  |  |  |  |
| 1. Biosphere organization and factors affecting organism interactions and population size |  |  |  |  |  |
| 1. Hierarchical structure of the biosphere |  |  |  |  |  |
| 1. Biomes |  |  |  |  |  |
| 1. Ecosystems |  |  |  |  |  |
| 1. Communities |  |  |  |  |  |
| 1. Populations |  |  |  |  |  |
| 1. Organisms |  |  |  |  |  |
| 1. Relationships within and between species |  |  |  |  |  |
| 1. Symbiotic relationships including mutualism, parasitism, commensalism |  |  |  |  |  |
| 1. Predator – prey relationship, including evolutionary adaptations |  |  |  |  |  |
| 1. Competition |  |  |  |  |  |
| 1. Keystone species |  |  |  |  |  |
| 1. Relationships among reproductive strategies, demographics, and population growth |  |  |  |  |  |
| 1. Sexual versus asexual reproduction |  |  |  |  |  |
| 1. r-strategists versus K-strategists |  |  |  |  |  |
| 1. Exponential growth |  |  |  |  |  |
| 1. Logistic growth and carrying capacity |  |  |  |  |  |
| 1. Population demographics |  |  |  |  |  |
| 1. Influence of biotic and abiotic components on community structure |  |  |  |  |  |
| 1. Limiting factors |  |  |  |  |  |
| 1. Habitat and niche |  |  |  |  |  |
| 1. Competition and predation |  |  |  |  |  |
| 1. Density-dependent versus density-independent factors |  |  |  |  |  |
| 1. Human impacts on ecosystems |  |  |  |  |  |
| 1. Habitat destruction (e.g., deforestation, fragmentation, urbanization and agriculture) |  |  |  |  |  |
| 1. Pollution (e.g., plastics, acid precipitation, ozone layer destruction (C​F​Cs)) |  |  |  |  |  |
| 1. Climate change, including greenhouse gases and ocean acidification |  |  |  |  |  |
| 1. Introduced and reintroduced species and invasive species |  |  |  |  |  |
| 1. Overconsumption of resources |  |  |  |  |  |
| 1. Remediation (e.g., reforestation, movement corridors, captive breeding programs, and biotechnology) |  |  |  |  |  |
| 1. Characteristics of biomes, energy flow in ecosystems, and major biogeochemical cycles |  |  |  |  |  |
| 1. Ecological succession |  |  |  |  |  |
| 1. Primary versus secondary succession |  |  |  |  |  |
| 1. Biomass, diversity, productivity, and habitat changes during succession |  |  |  |  |  |
| 1. Temporal and spatial disturbances (e.g., climate, fire, and disease) |  |  |  |  |  |
| 1. Types of biomes and energy flow in the biomes |  |  |  |  |  |
| 1. Characteristics of aquatic and terrestrial biomes |  |  |  |  |  |
| 1. Trophic levels, including pyramids of numbers, biomass, and energy |  |  |  |  |  |
| 1. Food chains and food webs and trophic cascades |  |  |  |  |  |
| 1. Flow of energy versus cycling of matter, including biomagnification |  |  |  |  |  |
| 1. Biogeochemical cycles, including biotic and abiotic components |  |  |  |  |  |
| 1. Water cycle |  |  |  |  |  |
| 1. Carbon cycle |  |  |  |  |  |
| 1. Nitrogen cycle |  |  |  |  |  |
| 1. Phosphorus cycle |  |  |  |  |  |
| **Science and Engineering Practices** |  |  |  |  |  |
| The SEPs represent eight practices that scientists and engineers—and students and teachers—use to investigate the world and to design and build systems. Many test questions will integrate one or more of these practices.   1. Asking questions (for science) and defining problems (for engineering) |  |  |  |  |  |
| * Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. |  |  |  |  |  |
| * Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships. |  |  |  |  |  |
| * Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. |  |  |  |  |  |
| * Ask questions to clarify and refine a model, an explanation, or an engineering problem. |  |  |  |  |  |
| * Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. |  |  |  |  |  |
| * Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. |  |  |  |  |  |
| * Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. |  |  |  |  |  |
| 1. Developing and using models |  |  |  |  |  |
| * Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. |  |  |  |  |  |
| * Design a test of a model to ascertain its reliability. |  |  |  |  |  |
| * Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. |  |  |  |  |  |
| * Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. |  |  |  |  |  |
| * Develop a complex model that allows for manipulation and testing of a proposed process or system. |  |  |  |  |  |
| * Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. |  |  |  |  |  |
| 1. Planning and carrying out investigations |  |  |  |  |  |
| * Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation’s design to ensure variables are controlled. |  |  |  |  |  |
| * Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. |  |  |  |  |  |
| * Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. |  |  |  |  |  |
| * Select appropriate tools to collect, record, analyze, and evaluate data. |  |  |  |  |  |
| * Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. |  |  |  |  |  |
| * Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables. |  |  |  |  |  |
| 1. Analyzing and interpreting data |  |  |  |  |  |
| * Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. |  |  |  |  |  |
| * Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. |  |  |  |  |  |
| * Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. |  |  |  |  |  |
| * Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. |  |  |  |  |  |
| * Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. |  |  |  |  |  |
| * Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. |  |  |  |  |  |
| 1. Using mathematics and computational thinking |  |  |  |  |  |
| * Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. |  |  |  |  |  |
| * Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. |  |  |  |  |  |
| * Apply techniques of algebra and functions to represent and solve scientific and engineering problems. |  |  |  |  |  |
| * Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world. |  |  |  |  |  |
| * Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as , , acre-feet, etc.). |  |  |  |  |  |
| 1. Constructing explanations (for science) and designing solutions (for engineering) |  |  |  |  |  |
| * Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. |  |  |  |  |  |
| * Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. |  |  |  |  |  |
| * Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. |  |  |  |  |  |
| * Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. |  |  |  |  |  |
| * Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. |  |  |  |  |  |
| 1. Engaging in argument from evidence |  |  |  |  |  |
| * Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. |  |  |  |  |  |
| * Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments. |  |  |  |  |  |
| * Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions. |  |  |  |  |  |
| * Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. |  |  |  |  |  |
| * Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence. |  |  |  |  |  |
| * Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). |  |  |  |  |  |
| 1. Obtaining, evaluating, and communicating information |  |  |  |  |  |
| * Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. |  |  |  |  |  |
| * Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. |  |  |  |  |  |
| * Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. |  |  |  |  |  |
| * Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. |  |  |  |  |  |
| * Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). |  |  |  |  |  |
| Tasks of Teaching Science |  |  |  |  |  |
| This list includes instructional tasks that teachers engage in that are essential for effective General Science teaching. Many test questions will measure content through application to one or more of these tasks. |  |  |  |  |  |
| Scientific Instructional Goals, Big Ideas, and Topics |  |  |  |  |  |
| 1. Selecting or sequencing appropriate instructional goals or big ideas for a topic |  |  |  |  |  |
| 1. Identifying the big idea or instructional goal of an instructional activity |  |  |  |  |  |
| 1. Choosing which science ideas or instructional activities are most closely related to a particular instructional goal |  |  |  |  |  |
| 1. Linking science ideas to one another and to particular activities, models, and representations within and across units |  |  |  |  |  |
| Scientific Investigations and Demonstrations |  |  |  |  |  |
| 1. Selecting investigations or demonstrations, including virtual, that facilitate understanding of disciplinary core ideas, scientific practices, or crosscutting concepts |  |  |  |  |  |
| 1. Evaluating investigation questions for quality (e.g., testable, empirical) |  |  |  |  |  |
| 1. Determining the variables, techniques, or tools that are appropriate for use by students to address a specific investigation question |  |  |  |  |  |
| 1. Critiquing scientific procedures, data, observations, or results for their quality, accuracy, or appropriateness |  |  |  |  |  |
| 1. Supporting students in generating questions for investigation or identifying patterns in data and observations |  |  |  |  |  |
| Scientific Resources (texts, curriculum materials, journals, and other print and media-based resources) |  |  |  |  |  |
| 1. Evaluating instructional materials and other resources for their ability to address scientific concepts; engage students with relevant phenomena; develop and use scientific ideas; promote students’ thinking about phenomena, experiences, and knowledge; take account of students’ ideas and background; and assess student progress |  |  |  |  |  |
| 1. Choosing resources that support the selection of accurate, valid, and appropriate goals for science learning |  |  |  |  |  |
| Student Ideas (including common misconceptions, alternate conceptions, and partial conceptions) |  |  |  |  |  |
| 1. Analyzing student ideas for common misconceptions regarding intended scientific learning |  |  |  |  |  |
| 1. Selecting diagnostic items and eliciting student thinking about scientific ideas and practices to identify common student misconceptions and the basis for those misconceptions |  |  |  |  |  |
| 1. Developing or selecting instructional moves, approaches, or representations that provide evidence about common student misconceptions and help students move toward a better understanding of the idea, concept, or practice |  |  |  |  |  |
| Scientific Language, Discourse, Vocabulary, and Definitions |  |  |  |  |  |
| 1. Selecting scientific language that is precise, accurate, grade-appropriate, and illustrates key scientific concepts |  |  |  |  |  |
| 1. Anticipating scientific language and vocabulary that may be difficult for students |  |  |  |  |  |
| 1. Modeling the use of appropriate verbal and written scientific language in critiquing arguments or explanations, in describing observations, or in using evidence to support a claim, etc. |  |  |  |  |  |
| 1. Supporting and critiquing students’ participation in and use of verbal and written scientific discourse and argumentation |  |  |  |  |  |
| Scientific Explanations (includes claim, evidence, and reasoning) |  |  |  |  |  |
| 1. Critiquing student-generated explanations or descriptions for their generalizability, accuracy, precision, or consistency with scientific evidence |  |  |  |  |  |
| 1. Selecting explanations of natural phenomena that are accurate and accessible to students |  |  |  |  |  |
| Scientific Models and Representations (analogies, metaphors, simulations, illustrations, diagrams, data tables, performances, videos, animations, graphs, and examples) |  |  |  |  |  |
| 1. Evaluating or selecting scientific models and representations that predict or explain scientific phenomena or address instructional goals |  |  |  |  |  |
| 1. Engaging students in using, modifying, creating, and critiquing scientific models and representations that are matched to an instructional goal |  |  |  |  |  |
| 1. Evaluating student models or representations for evidence of scientific understanding |  |  |  |  |  |
| 1. Generating or selecting diagnostic questions to evaluate student understanding of specific models or representations |  |  |  |  |  |
| 1. Evaluating student ideas about what makes for good scientific models and representations |  |  |  |  |  |