| **Required Course Numbers** | | | | | | | | | | | | | | | |
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| **Test Content Categories** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Nature of Science: Scientific Inquiry, Methodology, Techniques, and History (14%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Processes involved in scientific inquiry** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Making observations (e.g., quantitative versus qualitative) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Formulating and testing hypotheses |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Identifying experimental variables and controls |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Drawing scientific conclusions (e.g., proof versus support) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Using scientific sources and communicating findings appropriately |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Science involves many disciplines** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Chemical nature of biology |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Mathematics in biology (e.g., statistics, proportions) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Physical laws and principles governing biological systems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Differences among facts, hypotheses, theories, and laws** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Testable nature of hypotheses |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Formulation of theories based on accumulated data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Durability of laws |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D. **Scientific ideas change over time; contributions made by major historical figures** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cell theory and germ theory (e.g., Hooke, Pasteur) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Heredity, evolution, and ecology (e.g., Mendel, Darwin) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Structure and nature of genetic material (e.g., Hershey and Chase, Franklin, Watson and Crick) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Classification of organisms (e.g., Linnaeus, Woese) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Appropriate use of scientific measurement and notation systems** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 .Precision versus accuracy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Metric and SI units |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Unit conversions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Scientific notation and significant figures |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Linear versus logarithmic scales (e.g., pH) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Read and interpret data represented in tables, graphs, and charts** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Identify patterns and trends in data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Choose appropriate types of graphs or charts |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Error analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Draw conclusions and make predictions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Construct and use scientific models to explain complex phenomena** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Limitations of models |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Select models for a given purpose |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Physical (e.g., anatomical models), conceptual (e.g., fluid mosaic model), graphical and/or mathematical models (e.g., population growth models, global climate change) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Procedures involved in the safe preparation, storage, use, and disposal of laboratory and field materials** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Molarity and percent solutions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Acid and base solutions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Flammable and/or caustic chemicals |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Biological specimens and waste |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Appropriate and safe use and care of laboratory equipment** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Optical equipment (e.g., microscopes, spectrophotometers, UV light sources) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Separation equipment (e.g., gel electrophoresis, chromatography, centrifuges) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Measurement, mixing, and heating equipment (e.g., balances, stirrers, burners) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Sterilization equipment (e.g., autoclave, ovens) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **J. Safety and emergency procedures for science classrooms and laboratories** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Use of material safety data sheets (MSDS) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Use of personal safety equipment: (e.g., gloves, goggles, labcoats) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Use of laboratory safety equipment (e.g., fire extinguishers, eye wash stations, emergency showers) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **II. Molecular and Cellular Biology (20%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Chemical structures and properties of biologically important molecules** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Atomic structure |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Organic versus inorganic molecules |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Chemical bonding (e.g., hydrogen, covalent) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Molecular structure (e.g., carbon dioxide, ATP) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Water properties (e.g., cohesion, high specific heat) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Macromolecules (e.g., carbohydrates, nucleic acids, proteins, lipids) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Biological processes are dependent on chemical principles** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Chemical and physical gradients (e.g., osmosis, diffusion, temperature) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Thermodynamics |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Anabolic and catabolic reactions (e.g., hydrolysis) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Reduction-oxidation reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Structure and function of enzymes and factors influencing their activity** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Active site structure and substrate binding (e.g., induced fit, lock and key) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Reaction kinetics (e.g., effects of temperature, pH, and inhibitors) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Regulation (e.g., cooperative binding, feedback inhibition) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Biochemical pathways and energy flow within an organism** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cellular locations of biochemical pathways |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Photosynthesis (e.g., photosystems, electron transport, C3 and C4) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Cellular respiration (e.g., fermentation, Krebs cycle, electron transport) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Chemosynthesis (e.g., deep sea vent microorganisms) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Major differences between prokaryotes and eukaryotes** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cell size |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Membrane bound organelles |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Cell walls (e.g., peptidoglycan, cellulose) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Chromosome structure (e.g., circular versus linear |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Structure and function of cells and organelles** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Plant cells versus animal cells |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Cell membranes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Membrane-bound organelles (e.g., nucleus, chloroplast) and ribosomes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Cytoskeleton |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Cells maintain their internal environment and respond to external signals** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Selective permeability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Active and passive transport |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Water movement (e.g., osmolarity, water potential) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Cell surface proteins and cell communication |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Exocytosis and endocytosis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Hormone action and feedback |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Cellular division, the cell cycle, and how they are regulated** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cell cycle stages (G1, S, G2, M) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Mitosis and meiosis (e.g., stages, functions, results) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Cytokinesis (e.g., cleavage furrow, cell plate) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Cell cycle checkpoints |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Structure and function of nucleic acids** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Sugar-phosphate backbone |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. DNA versus RNA |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Complementary base pairing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Chromosome structure (e.g., nucleosome, telomeres, linear versus circular) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. DNA replication |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **J. Processes involved in protein synthesis** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. RNA transcription |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. mRNA processing (e.g., poly A tail, splicing) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Translation (e.g., ribosome structure, tRNA) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **K. Regulation of gene expression** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Promoters |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Enhancers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Transcription factors |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Operons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Environmental influences (e.g., epigenetics) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **L. Cells may undergo differentiation and specialization** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Differential gene expression |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Stem cells (e.g., sources, developmental potential) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **M. Nature of mutations** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cause of mutations (e.g., recombination, translocation, mutagens) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Types of mutations (e.g., point mutations, deletions, inversion) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Somatic versus germ-line mutations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **N. Use of basic laboratory techniques to study biological processes** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Gel electrophoresis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Microscopy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Spectrophotometry |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **O. Use and applications of DNA technologies and genetic engineering** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. DNA sequencing and polymerase chain reaction (PCR) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Genome sequencing projects |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Gene therapy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Cloning |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Transgenic and genetically engineered cells |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **III. Genetics and Evolution (20%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Mendel’s laws and predicting the probable** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Independent assortment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Law of segregation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Monohybrid and dihybrid crosses |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Pedigree analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Non-Mendelian inheritance** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Linkage (e.g., recombination mapping) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Sex-linked inheritance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Multiple alleles, codominance, and incomplete dominance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Polygenic inheritance, epistasis, and pleiotropy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Organelle inheritance (e.g., mitochondrial inheritance) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Chromosomal and genetic changes that lead to common human genetic disorders** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Changes in chromosome numbers (e.g., Down syndrome) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Changes in chromosome structure (e.g., deletions, inversion, duplications) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Common genetic disorders (e.g., Sickle-cell anemia, Tay-Sachs) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Sources of genetic variation** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Mutation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Crossing-over |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Genetic exchange (e.g., transduction, transformation, conjugation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Sexual reproduction (e.g., independent assortment) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Mutations, gene flow, genetic drift, and nonrandom mating affect the gene pool of a population** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Distribution and movement of alleles within populations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Distribution and movement of alleles between populations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Principles and applications of Hardy-Weinberg equilibrium** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Conditions of HW equilibrium |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Calculating allele frequencies using the HW equation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Mechanisms of evolution** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Natural and artificial selection |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Sexual selection |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Genetic drift (e.g., bottleneck, founder effect) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Coevolution |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Adaptive radiation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Evidence that supports evolution** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Molecular evidence (e.g., DNA sequence comparisons) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Structural and developmental evidence (e.g., homology, embryology) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Fossil record |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Endosymbiosis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Convergent versus divergent evolution |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Major evolutionary trends (e.g., cephalization, multicellularity) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Genetic basis of speciation** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Reproductive isolation (e.g., behavioral, postzygotic) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Types of speciation (e.g., allopatric, sympatric) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| J. **Models of evolutionary rates** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Gradualism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Punctuated equilibrium |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **K. Scientific explanations for origin of life on Earth** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.Panspermia (e.g., asteroid seeding) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2.Abiotic synthesis of organic compounds (e.g., Urey-Miller experiment) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3.Biological influences on atmospheric composition (e.g., photosynthesis) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4.Development of self-replication (e.g., RNA world) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **L. Factors that lead to extinction of species** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Lack of genetic diversity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Environmental pressures (e.g., climate and habitat change) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Human impacts |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Interspecific competition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **IV. Diversity of Life and Organismal Biology (20%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Characteristics of living versus nonliving things** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cellular organization |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Growth and reproduction |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Regulation and responses to the environment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Obtain and use energy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Historical and current biological classification systems of organisms** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Kingdom system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Domain system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Defining characteristics of viruses, bacteria, protists, fungi, plants, and animals** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Structure (e.g., capsid, cell wall, organelles) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Organization (e.g., prokaryote, multicellular) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Modes of nutrition (e.g., heterotroph, autotroph) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Reproduction/replication (e.g., viral replication, binary fission, budding) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Characteristics of the major animal phyla** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Body plans (e.g., radial versus bilateral symmetry) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Body cavities (e.g., coelomates, pseudocoelomates, acoelomates) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Modes of reproduction |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Modes of temperature regulation (e.g., endotherm, ectotherm) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Organizational hierarchy of multicellular organisms** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cells |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Tissues |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Organs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Organ systems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Anatomy and physiology of major organ systems in animals** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cardiovascular and respiratory |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Reproductive |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Digestive and excretory |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Nervous and endocrine |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Immune |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Maintenance of homeostasis in organisms** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Role of structural components (e.g., kidney, hypothalamus) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Feedback mechanisms |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Role of hormones (e.g., antidiuretic hormone (ADH), insulin) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Role of behaviors (e.g., diurnal, nocturnal, basking) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Reproduction, development, and growth in animals** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Gamete formation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Fertilization |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Embryonic development |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Growth, development, and aging |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Characteristics of major plant divisions** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Vascular versus nonvascular plants |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Flowering versus nonflowering plants |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Monocot versus dicot |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **J. Structure and function of major plant tissues and organs** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Dermal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Vascular (xylem, phloem) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Ground (e.g., parenchyma, cortex) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Meristems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Flowers, stems, leaves, and roots |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **K. Plant life cycles and reproductive strategies** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Alternation of generations (i.e., gametophyte, sporophyte) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Pollination strategies (e.g., wind, insect) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Seed dispersal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **L. Plants obtain and transport water and inorganic nutrients** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Roots |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Xylem transport |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Control (e.g., stomata) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **M. Plants transport and store products of photosynthesis** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Products (e.g., simple and complex carbohydrates) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Phloem transport |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Storage molecules (e.g., starch, cellulose) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Storage structures (e.g., plastids, vacuoles, tuber) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **V. Ecology: Organisms and Environments (16%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Hierarchical structure of the biosphere** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Populations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Communities |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Ecosystems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Biomes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Biotic and abiotic components of an ecosystem influence population size** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Resource availability and abiotic factors (e.g., nutrients and temperature) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Habitat and niche |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Competition and predation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Models of population growth** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Exponential growth |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Logistic growth (e.g., carrying capacity) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Relationship between reproductive strategies and mortality rates** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Sexual versus asexual reproduction |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Parental investment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Numbers of offspring produced versus numbers that survive |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Relationships within and between species** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Symbiosis (e.g., parasitism, commensalism, mutualism) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Predation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Competition and territoriality |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Altruistic behaviors |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Changes occur during ecological succession** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Primary versus secondary succession |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Biomass, diversity, productivity, and habitat changes during succession |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Types and characteristics of biomes** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Aquatic (e.g., stream, estuary, coral reef) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Terrestrial (e.g., desert, grassland, tropical rain forest) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Energy flow in the environment** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Trophic levels (e.g., pyramids of biomass, pyramids of energy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Food webs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Biogeochemical cycles** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Water cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Carbon cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Nitrogen cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Phosphorus cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **J. Effects of natural disturbances on biodiversity and ecosystems** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Temporal and spatial disturbances (e.g., climate, fire, disease) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Fragmentation of ecosystems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Natural ecosystem recovery |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **K. Humans affect ecological systems and biodiversity** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Pollution (e.g., greenhouse gases, acid precipitation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Habitat destruction (e.g., deforestation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Introduced species (e.g., non-native, reintroduced) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Remediation (e.g., reforestation, mine reclamation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **L. Connections among ecosystems on a local and global scale** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Natural flow of material between ecosystems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Transport of materials by humans |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Movement of organisms (e.g., migration) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **VI. Science, Technology, and Social Perspectives (10%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Impact of science and technology on the environment** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Pollution and pollution mitigation (e.g., burning fossil fuels, green building, environmental cleanup) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Resource management (e.g., waste management, recycling) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Conservation (e.g., habitat protection, habitat restoration, species protection) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Non-point sources |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Impact of human activity and natural phenomena on society** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Consequences (e.g., economic, social) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Disaster management (e.g., hurricane relief and cleanup) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Global warming, sea levels, flooding |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Epidemiology (e.g., malaria, influenza |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Agriculture and soil erosion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Estuary and wetland degradation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7. Water management |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8. Production, use, and disposal of consumer products (e.g., plastics) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Societal impacts associated with the management of natural resources** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Habitat preservation (e.g., Endangered Species Act, National Parks) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Extraction of mineral and energy resources (e.g., mining, drilling) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Agriculture, forestry, wildlife, and fisheries practices |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Renewable and/or sustainable use of resources |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Ethical and societal issues arising from the use of science and technology** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Ethical research concerns (e.g., stem cells, toxic chemicals) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Ethical use of technology (e.g., genetically modified organisms, cloning) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Societal concerns (e.g., security of genetic information, equal access to medical treatment) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |