| **Required Course Numbers** | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Test Content Categories** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Scientific Methodology, Techniques, and History (11%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Methods of Scientific Inquiry and Design** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Identifying problems based on observations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Forming and testing hypotheses |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Development of theories, models, and laws |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Experimental design, including independent and dependent variables, controls, and sources of error |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Process skills including observing, comparing, inferring, categorizing, generalizing, and concluding |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Nature of scientific knowledge |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. subject to change |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. consistent with evidence |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. based on reproducible evidence |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. includes unifying concepts and processes (e.g., systems, models, constancy and change, equilibrium, form and function) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Processes Involved in Scientific Data Collection and Manipulation** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Common units of measurement (metric and English) including unit conversion and prefixes such as *milli* and *kilo* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Scientific notation and significant figures in collected data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Organization and presentation of data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Basic data and error analysis including determining mean, accuracy, precision, and sources of error |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Interpret and Draw Conclusions from Data Presented in Tables, Graphs, Maps, and Charts** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Trends in data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Relationships between variables |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Predictions based on data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Drawing valid conclusions based on the data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Procedures for Correct Preparation, Storage, Use, and Disposal of Laboratory Materials** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Appropriate and safe use of materials (e.g., chemicals, lab specimens) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Safe disposal of materials |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Appropriate storage |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Preparation for classroom or field use (e.g., how to prepare a solution of given concentration, staining slides, labeling samples) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. How to Use Standard Equipment in the Laboratory and the Field** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Appropriate and safe use (e.g., Bunsen burner, glassware, GPS, microscope) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Appropriate storage (e.g., pH probes stored in appropriate buffer solution, dissection equipment, glassware) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Maintenance and calibration (e.g., cleaning microscopes, calibration of balances) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Preparation for classroom or field use (e.g., prelaboratory setup, classroom demonstrations, field research) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Safety and Emergency Procedures in the** **Laboratory** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Location and use of standard safety equipment (e.g., eyewash, shower) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Laboratory safety rules for students |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Appropriate apparel and conduct in the laboratory (e.g., wearing goggles) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Emergency procedures (e.g., fires, chemical spills, handling of injuries) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Major Historical Developments of Science** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Accepted principles and models develop over time |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Major developments in science (e.g., atomic theory, plate tectonics) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Contributions of major historical figures (e.g., Darwin, Newton) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **II. Physical Science (38%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Basic Principles** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Structure of matter |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Elements, compounds, and mixtures |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Atoms, molecules, and ions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Basic properties of solids, liquids, and gases |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Basic structure of the atom |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Atomic models |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Atomic structure including nucleus, electrons, protons, and neutrons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Atomic number, atomic mass, isotopes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Electron arrangements (e.g., valence electrons) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Basic characteristics of radioactive materials |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Radioisotopes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Radioactive decay processes and half-life |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Characteristics of alpha particles, beta particles, and gamma radiation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Fission and fusion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Basic concepts and relationships involving energy and matter |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Conservation of energy (first law of thermodynamics) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Entropy changes (second law of thermodynamics) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Conservation of matter in chemical systems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Kinetic and potential energy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Transformations between different forms of energy (thermal, chemical, radiant, nuclear, mechanical, electrical, electromagnetic) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| f. Differences between chemical and physical properties/changes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| g. Various temperature scales (Celsius, Fahrenheit, Kelvin) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| h. Transfer of thermal energy and its basic measurement |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – conduction, convection, and radiation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – specific heat capacity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – calorimetry (e.g., predict heat transfer in various systems) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| i. Applications of energy and matter relationships |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – trophic level |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – matter cycling (carbon, nitrogen, water) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – energy flow in ecosystems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – convection currents in atmosphere, ocean, and mantle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – conservation of mass in the rock cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – chemical and physical changes in rocks |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – impact of solar radiation on Earth and life |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – energy transformations in living systems (e.g., photosynthesis, cellular respiration) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Chemistry** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Periodicity and states of matter |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Periodic table of the elements |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – elements arranged in groups and periods |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – atomic number, atomic mass, and isotopic abundance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – symbols of the elements |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – trends in physical properties based on position of elements on the periodic table (e.g., atomic radius, ionization energy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – trends in chemical reactivity based on position of elements on the periodic table (e.g., metals, nonmetals, noble gases) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. States of matter and factors that affect phase changes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – basic assumptions of the kinetic theory of matter (e.g., particles in constant motion, average speed of gas particles related to temperature) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – ideal gas laws (e.g., volume is proportional to temperature, pressure is inversely related to volume) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – phase transitions and energy changes (e.g., heat of vaporization, heat of sublimation, phase diagrams, heating curves) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Chemical nomenclature, composition, and bonding |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Name of simple compounds and their chemical formulas |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – interpreting chemical formulas |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – naming compounds based on formula |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – writing formulas based on name |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – structural formulas (e.g., electron dot, Lewis structures) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Types of chemical bonding |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – covalent and ionic |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Mole concept and its applications |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Avogadro’s number |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Molar mass and percent composition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Chemical reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Basic concepts involved in chemical reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – use and balance equations of simple chemical reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| • balance equations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| • simple stoichiometric calculations based on balanced equations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – endothermic and exothermic reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – factors that affect reaction rates (e.g., concentration, temperature, pressure, catalysts/enzymes, activation energy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – factors that affect reaction equilibrium (e.g., Le Châtelier’s principle) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – types of reactions (e.g., combustion, single or double replacement) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – simple oxidation-reduction reactions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Acid-base chemistry |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Simple acid-base chemistry |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – chemical and physical properties of acids and bases |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – pH scale |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – neutralization |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – acid-base indicators (e.g., phenolphthalein, pH paper, litmus paper) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Solutions and solubility |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Different types of solutions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – dilute and concentrated |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – saturated, unsaturated, supersaturated |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – solvent and solute |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – concentration terms (e.g., molarity, parts per million (ppm)) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – preparation of solutions of varying concentrations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Factors affecting the solubility of substances and the dissolving process |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – effect of temperature, pressure, particle size, and agitation on the rate of dissolving |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – effect of temperature and pressure on solubility (e.g., solubility curves) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – polar vs. nonpolar solvents and solutes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – dissociation of ionic compounds such as salts in water (e.g., ionization, electrolytes) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – precipitation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – freezing point depression |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Physics** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Mechanics |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Description of motion in one and two dimensions |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – speed, velocity, acceleration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – displacement |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – linear momentum |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – vector and scalar quantities |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Newton’s three laws of motion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – First law: inertia |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Second law: F = ma (i.e., net force, mass, and acceleration) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Third law: action-reaction forces |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Mass, weight, and gravity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – distinguish between mass and weight |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – gravitational attraction (force of attraction between masses at various distances) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – acceleration due to gravity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Analysis of motion and forces |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – projectile motion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – inclined planes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – friction |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – collisions (e.g., elastic, inelastic) and conservation of linear momentum |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – circular motion (e.g., centripetal acceleration, centripetal force) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – center of mass |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – periodic motion (e.g., pendulums, oscillating springs, planetary orbits, satellites) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – conservation of energy |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – work, energy, and power |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – basic fluid mechanics (e.g., buoyancy, density, pressure) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Simple machines |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – mechanical advantage |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – types of simple machines (e.g., wedge, screw, lever) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – concept of torque |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Electricity and magnetism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Electrical nature of common materials |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – electric charges |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – electrostatic force (attraction and repulsion, Coulomb’s law) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – conductivity, conductors, and insulators |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Basic electrical concepts |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – DC and AC current |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – current, resistance, voltage, and power |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Ohm’s law |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – analyze basic series and parallel circuits |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – voltage sources (e.g., batteries, generators) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Basic properties of magnetic fields and forces |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – magnetic materials |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – magnetic forces and fields (e.g., magnetic poles, attractive and repulsive forces) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – electromagnets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Optics and waves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Electromagnetic spectrum |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – nature of light (e.g., wave properties, photons) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – visible spectrum and color |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – electromagnetic spectrum (e.g., ultraviolet, microwave, gamma) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Basic characteristics and types of waves |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – transverse and longitudinal |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| –wave characteristics and relationships between them (e.g., frequency, amplitude, wavelength, speed, energy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Basic wave phenomena |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – reflection, refraction, diffraction, and dispersion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – absorption and transmission |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – interference, scattering, and polarization |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – total internal reflection |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Doppler effect (e.g., apparent frequency, moving source or observer, red/blue shift) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Basic optics |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – mirrors |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – lenses and their applications (e.g., the human eye, microscope, telescope) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – prisms |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Sound |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – pitch/frequency and loudness/intensity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – sound wave production, air vibrations, and resonance (e.g., tuning forks) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – application of the Doppler effect to sound |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **III. Life Science (20%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Basic Structure and Function of Cells and Their Organelles** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Structure and function of cell membranes (e.g., phospholipid bilayer, passive and active transport) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Structure and function of animal and plant cell organelles |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Levels of organization (cells, tissues, organs, organ systems). Major features of common animal cell types (e.g., blood cells, muscle, nerve, epithelial, gamete) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Major features of common animal cell types (e.g., blood cells, muscle, nerve, epithelial, gamete) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Prokaryotes (bacteria) and eukaryotes (animals, plants, fungi, protists) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Key Aspects of Cell Reproduction and Division** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cell cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Mitosis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Meiosis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Cytokinesis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Basic Biochemistry of Life** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Cellular respiration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Photosynthesis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Biological molecules (e.g., DNA, carbohydrates, proteins, lipids, enzymes) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Basic Genetics** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Structure (double helix, single stranded, and base pairs) and function of DNA and RNA (replication, transcription, and translation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Chromosomes, genes, alleles |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Dominant and recessive traits |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Mendelian inheritance (e.g., genotype, phenotype, use of Punnett squares, pedigrees) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Mutations, chromosomal abnormalities, and common genetic disorders |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Theory and Key Mechanisms of Evolution** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Mechanisms of evolution (e.g., natural selection) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Isolation mechanisms and speciation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Supporting evidence (e.g., fossil record, comparative genetics, homologous structures) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **F. Hierarchical Classification Scheme** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Classification schemes (e.g., domain, class, genus) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Characteristics of bacteria, animals, plants, fungi, and protists |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **G. Major Structures of Plants and Their Functions** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Characteristics of vascular and nonvascular plants |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Structure and function of roots, leaves, and stems (e.g., stomata, xylem, phloem) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Asexual (budding) and sexual reproduction (flowers, fruit, seeds, spores) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Growth (e.g., germination, elongation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Uptake and transport of nutrients and water |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Responses to stimuli (e.g., light, temperature, water, gravity) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **H. Basic Anatomy and Physiology of Animals, including the Human Body** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Response to stimuli and homeostasis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Exchange with the environment (e.g., respiratory, excretory, and digestive systems) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Internal transport and exchange (e.g., heart, arteries, veins, capillaries) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Control systems (e.g., nervous and endocrine systems) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Movement and support (e.g., skeletal and muscular systems) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Reproduction and development |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7. Immune system (e.g., antibodies, autoimmune disorders) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **I. Key Aspects of Ecology** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Population dynamics |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. growth curves and carrying capacity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. behavior (e.g., territoriality) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. intraspecific relationships (e.g., mating systems, social systems, competition) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Community ecology |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. niche |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. species diversity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. interspecific relationships (e.g., predator-prey, parasitism) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Ecosystems |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. biomes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. stability and disturbances (e.g., glaciation, climate change, succession) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. energy flow (e.g., trophic levels, food webs) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. biogeochemical cycles (e.g., water, nitrogen, and carbon cycles, biotic/abiotic interaction) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **IV. Earth and Space Science (20%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Physical Geology** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Types and basic characteristics of rocks and minerals and their formation processes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. The rock cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Characteristics of rocks and their formation processes (i.e., sedimentary, igneous, and metamorphic rock) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Characteristics of minerals and their formation processes (e.g., classes of minerals, crystals, hardness) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Processes involved in erosion, weathering, and deposition of Earth’s surface materials |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| and soil formation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Erosion and deposition (e.g., agents of erosion) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Chemical and physical (mechanical) weathering |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Characteristics of soil (e.g., types, soil profile) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Porosity and permeability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Runoff and infiltration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Earth’s basic structure and internal processes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Earth’s layers (e.g., lithosphere, mantle, core) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Shape and size of Earth |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Geographical features (e.g., mountains, plateaus, mid-ocean ridges) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Earth’s magnetic field |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Plate tectonics theory and evidence |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – folding and faulting (e.g., plate boundaries) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – continental drift, seafloor spreading, magnetic reversals |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – characteristics of volcanoes (e.g., eruptions, lava, gases, hot spots) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – characteristics of earthquakes (e.g., epicenters, faults, tsunamis) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – seismic waves and triangulation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. The water cycle |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Evaporation and condensation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Precipitation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Runoff and infiltration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Transpiration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Historical Geology** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Historical geology |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Principle of uniformitarianism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Basic principles of relative age dating (e.g., superposition, stratigraphic correlation, fossil succession) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Absolute (radiometric) dating |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Geologic time scale (e.g., age of Earth, scope of time) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Fossil record as evidence of the origin and development of life (e.g., fossilization methods, mass extinctions, ice ages, meteor impacts) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Earth’s Bodies of Water** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Characteristics and processes of Earth’s oceans and other bodies of water |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Distribution and location of Earth’s water |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Seawater composition |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Coastline topography and topography of ocean floor |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Tides, waves, currents |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Estuaries and barrier islands |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| f. Islands, reefs, and atolls |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| g. Polar ice, icebergs, and glaciers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| h. Lakes, ponds, and wetlands |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| i. Streams, rivers, and river deltas |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| j. Groundwater, water table, wells, and aquifers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| k. Geysers and springs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| l. Properties of water that affect Earth systems (e.g., density changes on freezing, high heat capacity, polar solvent, hydrogen bonding) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Meteorology and Climate** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Basic structure and composition of Earth’s atmosphere |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Layers (e.g., stratosphere) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Composition of atmosphere (e.g., percent oxygen and nitrogen) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Atmospheric pressure and temperature |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Basic concepts of meteorology |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Relative humidity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Dew point |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Wind (e.g., how it is generated and modified) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Cloud types and formation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Types of precipitation (e.g., hail, rain) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| f. Air masses, fronts, storms, and severe weather (e.g., hurricanes, tornadoes) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| g. Development and movement of weather patterns |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Major factors that affect climate and seasons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Effects of latitude, geographical location, and elevation (e.g., mountains and oceans) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Effects of atmospheric circulation (e.g., trade winds, jet stream) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Effects of ocean circulation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Characteristics and locations of climate zones (e.g., Tropics, Arctic) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Effect of the tilt of Earth’s axis on seasons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| f. Effects of natural phenomena (e.g., volcanic eruptions, solar radiation variations) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| g. El Niño, La Niña |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **E. Astronomy** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Major features of the solar system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Structure of the solar system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Laws of motion (e.g., gravitation, planetary orbits, satellites) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Characteristics of the Sun, Moon, and planets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Theories of origin of the solar system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Interactions of the Earth-Moon-Sun system |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Earth’s rotation and orbital revolution around the Sun |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Effect on seasons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Phases of the Moon |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Effect on tides |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| e. Solar and lunar eclipses |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| f. Time zones |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| g. Effect of solar wind on Earth |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Major features of the universe |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Galaxies (e.g., definition, relative size, Milky Way) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Characteristics of stars and their life cycles |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – life cycle of star, e.g., white dwarf, red giant, supernova, nebulae, black holes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – color, temperature, apparent brightness, absolute brightness, luminosity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| – Hertzsprung-Russell diagrams |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| c. Dark matter |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| d. Theories about the origin of the universe (e.g., Big Bang) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Contributions of space exploration and |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| technology to our understanding of the universe |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| a. Remote sensing devices (e.g., satellites, space probes, telescopes, spectral analysis) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| b. Search for water and life on other planets |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **V. Science, Technology, and Society (11%)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **A. Impact of Science and Technology on the Environment and Society** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Air and water pollution (e.g., acid rain, eutrophication, groundwater pollution) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Climate change and greenhouse gases |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Irrigation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Reservoirs and levees |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Depletion of aquifers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. Ozone layer depletion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7. Loss of biodiversity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8. Space exploration |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9. Waste disposal (e.g., landfills) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. Recycling |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11. Environmentally friendly consumer products |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| (e.g., biodegradable materials) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **B. Major Issues associated with Energy Production and the Management of Natural Resources** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Renewable and nonrenewable energy resources |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Conservation and recycling |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Pros and cons of power generation based on various resources including fossil and nuclear fuel, hydropower, wind power, solar power, geothermal power, and alternative energy sources |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Issues associated with the use and extraction of Earth’s resources (e.g., mining, land reclamation, deforestation) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **C. Applications of Science and Technology in Daily Life** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Chemical properties of household products |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Communication (e.g., wireless devices, GPS, satellites) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Science principles applied in commonly used consumer products (e.g., batteries, lasers, polarized sunglasses, and fiber optic cables) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4. Water purification |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5. Common agricultural practices (e.g., genetically modified crops, use of herbicides and insecticides) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6. DNA evidence in criminal investigations |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7. Nanotechnology |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D. Impact of Science on Public Health Issues** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Nutrition, disease, and medicine (e.g., vitamins, viruses, vaccines) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Biotechnology (e.g., genetic engineering, in vitro fertilization) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3. Medical technologies (e.g., medical imaging, X-rays, radiation therapy) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |