

**California STAR Coordinated/Integrated Science Blueprint
Earth Science/Biology/Chemistry (EBC)**

EARTH SCIENCES	ITEMS	PERCENT
Biogeochemical Cycles		
7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept:	6	10%
a. <i>Students know</i> the carbon cycle of photosynthesis and respiration and the nitrogen cycle.		
b. <i>Students know</i> the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.		
c. <i>Students know</i> the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.		
d.* <i>Students know</i> the relative residence times and flow characteristics of carbon in and out of its different reservoirs.		
Total Items in BIOGEOCHEMICAL CYCLES	6	10%
Structure And Composition Of The Atmosphere		
8. Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:	6	10%
a. <i>Students know</i> the thermal structure and chemical composition of the atmosphere.		
b. <i>Students know</i> how the composition of the Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations in carbon dioxide concentration, and the origin of atmospheric oxygen.		
c. <i>Students know</i> the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities.		
Total Items in STRUCTURE AND COMPOSITION OF THE ATMOSPHERE	6	10%
TOTAL IN EARTH SCIENCES	12	20%

BIOLOGY/LIFE SCIENCES	ITEMS	PERCENT
Cell Biology		
1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:	2	3%
a. <i>Students know</i> cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.		
b. <i>Students know</i> enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.		
c. <i>Students know</i> how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.		
d. <i>Students know</i> the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.		
e. <i>Students know</i> the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.		
f. <i>Students know</i> usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.		
g. <i>Students know</i> the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.		
h. <i>Students know</i> most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.		
i.* <i>Students know</i> how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.		
j.* <i>Students know</i> how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.		
Total Items in CELL BIOLOGY	2	3%
Genetics		
2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:	2	3%
a. <i>Students know</i> meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.		
b. <i>Students know</i> only certain cells in a multicellular organism undergo meiosis.		
c. <i>Students know</i> how random chromosome segregation explains the probability that a particular allele will be in a gamete.		

Genetics		
d. <i>Students know</i> new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).		
e. <i>Students know</i> why approximately half of an individual's DNA sequence comes from each parent.		
f. <i>Students know</i> the role of chromosomes in determining an individual's sex.		
g. <i>Students know</i> how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.		
3. A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:	2	3%
a. <i>Students know</i> how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).		
b. <i>Students know</i> the genetic basis for Mendel's laws of segregation and independent assortment.		
c.* <i>Students know</i> how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.		
d.* <i>Students know</i> how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes.		
4. Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:	3	5%
a. <i>Students know</i> the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.		
b. <i>Students know</i> how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.		
c. <i>Students know</i> how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.		
d. <i>Students know</i> specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.		
e. <i>Students know</i> proteins can differ from one another in the number and sequence of amino acids.		
f.* <i>Students know</i> why proteins having different amino acid sequences typically have different shapes and chemical properties.		

Genetics		
5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:	3	5%
a. <i>Students know</i> the general structures and functions of DNA, RNA, and protein.		
b. <i>Students know</i> how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.		
c. <i>Students know</i> how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.		
d.* <i>Students know</i> how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.		
e.* <i>Students know</i> how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.		
Total Items in GENETICS	10	16%
Ecology		
6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:	3	5%
a. <i>Students know</i> biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.		
b. <i>Students know</i> how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.		
c. <i>Students know</i> how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.		
d. <i>Students know</i> how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.		
e. <i>Students know</i> a vital part of an ecosystem is the stability of its producers and decomposers.		
f. <i>Students know</i> at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.		
g.* <i>Students know</i> how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.		
Total Items in ECOLOGY	3	5%

Evolution		
7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:	1	2%
a. <i>Students know</i> why natural selection acts on the phenotype rather than the genotype of an organism.		
b. <i>Students know</i> why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.		
c. <i>Students know</i> new mutations are constantly being generated in a gene pool.		
d. <i>Students know</i> variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.		
e.* <i>Students know</i> the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.		
f.* <i>Students know</i> how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.		
8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:	1	2%
a. <i>Students know</i> how natural selection determines the differential survival of groups of organisms.		
b. <i>Students know</i> a great diversity of species increases the chance that at least some organisms survive major changes in the environment.		
c. <i>Students know</i> the effects of genetic drift on the diversity of organisms in a population.		
d. <i>Students know</i> reproductive or geographic isolation affects speciation.		
e. <i>Students know</i> how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.		
f.* <i>Students know</i> how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.		
g.* <i>Students know</i> how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.		
Total Items in EVOLUTION	2	4%
TOTAL IN BIOLOGY/LIFE SCIENCES	17	28%

CHEMISTRY	ITEMS	PERCENT
Atomic And Molecular Structure		
1. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:	5	8%
a. <i>Students know</i> how to relate the position of an element in the periodic table to its atomic number and atomic mass.		
b. <i>Students know</i> how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.		
c. <i>Students know</i> how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electronegativity, and the relative size of ions and atoms.		
d. <i>Students know</i> how to use the periodic table to determine the number of electrons available for bonding.		
e. <i>Students know</i> the nucleus of the atom is much smaller than the atom yet contains most of its mass.		
f.* <i>Students know</i> how to use the periodic table to identify the lanthanide, actinide, and transactinide elements and know that the transuranium elements were synthesized and identified in laboratory experiments through the use of nuclear accelerators.		
g.* <i>Students know</i> how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.		
h.* <i>Students know</i> the experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.		
i.* <i>Students know</i> the experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.		
j.* <i>Students know</i> that spectral lines are the result of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by using Planck's relationship ($E = h\nu$).		
Total Items in ATOMIC AND MOLECULAR STRUCTURE	5	8%

CHEMISTRY	ITEMS	PERCENT
Chemical Bonds		
2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from on electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:	3	5%
a. <i>Students know</i> atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.		
b. <i>Students know</i> chemical bonds between atoms in molecules such as H ₂ , CH ₄ , NH ₃ , H ₂ CCH ₂ , N ₂ , Cl ₂ , and many large biological molecules are covalent.		
c. <i>Students know</i> salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.		
d. <i>Students know</i> the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.		
e. <i>Students know</i> how to draw Lewis dot structures.		
f.* <i>Students know</i> how to predict the shape of simple molecules and their polarity from Lewis dot structures.		
g.* <i>Students know</i> how electronegativity and ionization energy relate to bond formation.		
h.* <i>Students know</i> how to identify solids and liquids held together by Van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/melting point temperatures.		
Total Items in CHEMICAL BONDS	3	5%
Gases And Their Properties		
4. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:	5	8%
a. <i>Students know</i> the random motion of molecules and their collisions with a surface create the observable pressure on that surface.		
b. <i>Students know</i> the random motion of molecules explains the diffusion of gases.		
c. <i>Students know</i> how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.		
d. <i>Students know</i> the values and meanings of standard temperature and pressure (STP).		
e. <i>Students know</i> how to convert between the Celsius and Kelvin temperature scales.		
f. <i>Students know</i> there is no temperature lower than 0 Kelvin.		

CHEMISTRY	ITEMS	PERCENT
g.* <i>Students know</i> the kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.		
h.* <i>Students know</i> how to solve problems by using the ideal gas law in the form: $PV = nRT$.		
i.* <i>Students know</i> how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict diffusion of gases.		
Total Items in GASES AND THEIR PROPERTIES	5	8%
Acids And Bases		
5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:	2	3%
a. <i>Students know</i> the observable properties of acids, bases, and salt solutions.		
b. <i>Students know</i> acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.		
c. <i>Students know</i> strong acids and bases fully dissociate and weak acids and bases partially dissociate.		
d. <i>Students know</i> how to use the pH scale to characterize acid and base solutions.		
e.* <i>Students know</i> the Arrhenius, Brønsted-Lowry, and Lewis acid-base definitions.		
f.* <i>Students know</i> how to calculate pH from the hydrogen-ion concentration.		
g.* <i>Students know</i> buffers stabilize pH in acid-base reactions.		
Total Items in ACIDS AND BASES	2	3%
Organic Chemistry And Biochemistry		
10. The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept:	1	2%
a. <i>Students know</i> large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.		
b. <i>Students know</i> the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.		
c. <i>Students know</i> amino acids are the building blocks of proteins.		

CHEMISTRY	ITEMS	PERCENT
Organic Chemistry And Biochemistry		
d.* <i>Students know</i> the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.		
e.* <i>Students know</i> how to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.		
f.* <i>Students know</i> the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins.		
Total Items in ORGANIC CHEMISTRY AND BIOCHEMISTRY	1	2%
Nuclear Processes		
11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:	3	5%
a. <i>Students know</i> protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.		
b. <i>Students know</i> the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.		
c. <i>Students know</i> some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.		
d. <i>Students know</i> the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.		
e. <i>Students know</i> alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.		
f.* <i>Students know</i> how to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.		
g.* <i>Students know</i> protons and neutrons have substructures and consist of particles called quarks.		
Total Items in NUCLEAR PROCESSES	3	5%
TOTAL IN CHEMISTRY	19	32%

INVESTIGATION AND EXPERIMENTATION		
1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:	12	20%
a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.		
b. Identify and communicate sources of unavoidable experimental error.		
c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.		
d. Formulate explanations using logic and evidence.		
e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.		
f. Distinguish between hypothesis and theory as scientific terms.		
g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.		
h. Read and interpret topographic and geologic maps.		
i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).		
j. Recognize the issues of statistical variability and the need for controlled tests.		
k. Recognize the cumulative nature of scientific evidence.		
l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.		
m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.		
n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).		
Total Items in INVESTIGATION AND EXPERIMENTATION	12	20%
TOTAL ITEMS FOR INTEGRATED EBC TEST	60	100%