**TAMALPAIS UNION HIGH SCHOOL DISTRICT**
**Larkspur, California**

**Course of Study**

*Integrated Science 3, 4*

## I. INTRODUCTION

Integrated Science 3-4 (IS 3-4) is the second year of a two year integrated science core curriculum for 9th and 10th graders. Completion of the program will satisfy the district's graduation requirement in Life and Physical Science. It is designed to give all students the necessary background information and critical thinking skills needed to make informed decisions on scientific issues and prepare students for more advanced study in science. The program is laboratory based, using a thematic approach to organize the content. It stresses data gathering and interpretation, as well as individual research and presentation skills. These skills will be developed/applied within the context of the major concepts in biology and earth science, as well as important introductory concepts from chemistry and physics. The course builds upon the concepts and skills developed in Integrated Science 1-2 by spiraling topics and key themes, extending the student understanding to a higher conceptual level. Content units include: Islands, Vertebrate Evolution, Resources and Populations/Agriculture.

Integrated Science 3-4 has been developed according to the *TUHSD District Mission, Philosophy, and Beliefs*.

The following aspects of the district's mission are especially well–developed within the two-year Integrated Science curriculum:

- Students will acquire, manage and use knowledge and skills.
- Students will think critically and creatively.
- Students will practice self-directed learning, decision-making and problem solving.
- Students will develop skills needed for effective teamwork.

The following aspects of the district's Philosophy are especially well–developed within the two-year Integrated Science curriculum:

- Integrated Science will maintain high academic standards.
- Integrated Science will encourage student creativity.
- Integrated Science will provide equity of opportunity for all students.
- Integrated Science will provide programs for high achieving students.
- Integrated Science will extend learning beyond the classroom.
- Integrated Science teachers will monitor and assess student achievement for instructional planning and decision-making.
- Integrated Science teachers will monitor and assess the educational program for

relevance and the need for change.

The following aspects of the district's Beliefs are especially well–represented within the two-year Integrated Science curriculum:

- ❖ Education is a shared responsibility requiring the partnership of staff, students, parents and community.
- ❖ There's a body of knowledge and skills that our students should and can master.
- ❖ Creativity should be encouraged and nurtured throughout the curriculum.
- ❖ Environmental awareness is an essential component of student learning.
- ❖ Students need to master essential skills to succeed in our global community.
- ❖ Everyone benefits from high attainable expectations, varied opportunities and encouragement to grow and excel.
- ❖ Flexibility and choice enhance learning, as do structure, stability and self-discipline.

*District Student Learning Outcomes:*

1. Communicate articulately, effectively, and persuasively when speaking and writing.
2. Read and analyze material in a variety of disciplines.
3. Use technology as a tool to access information, analyze and solve problems, and communicate ideas.
4. Demonstrate knowledge of the rights and responsibilities of the individual in a democratic society.
5. Apply mathematical knowledge and skills to analyze and solve problems.
6. Demonstrate scientific literacy.
7. Demonstrate knowledge of the global environment and its resources.
10. Analyze and propose solutions to contemporary issues using a variety of perspectives.

**Integrated Science 3-4 is designed to help students attain California Content Standards for *Biology/Life Science and Earth Science.***

## II. STUDENT LEARNING OUTCOMES

A. Course Outcomes

The Integrated Science 3-4 course outcomes that follow are organized by content unit.

*Experimental Design:*

1. Students will conduct scientific research using proper source citation.
2. Students will design and outline an experiment identifying the variables, constants, etc.
3. Students will create and use a proper data table.
4. Students will define, convert, and use tools to metrically measure mass, length, and volume.
5. Students will use skills of data analysis to determine central tendency and variation.

6. Students will use the basic rules of graphing to create a proper graph.
7. Students will use the complete scientific method in the context of a lab write-up.
8. Students will determine an appropriate topic for and complete an individual Science Fair Project.

*Populations and Agriculture:*

9. Students will understand population dynamics in various systems by defining carrying capacity and identify several parameters that affect the carrying capacity and size of a population; analyzing population data to interpret past and future trends in population growth; and using population data to calculate and graph trends of population values.
10. Students will gain an understanding of how light is captured from sunlight and stored through synthesis of sugar from carbon dioxide and the role of mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide by comparing and contrasting the biochemical similarities and difference between photosynthesis and cellular respiration; looking at a cross section of a leaf, identify structures and organelles used in photosynthesis and cellular respiration; comparing and contrasting aerobic and anaerobic respiration and identify organisms and cells that perform these processes.
11. Students will consider the influence of irrigation, fertilization, pest control and mechanizations in agricultural ecosystems in terms of feeding the world by comparing the nutritional and energy demands of plants to the demands of humans; analyzing the mineral and nutritional content of soils and describe how nitrogen cycles through the environment; evaluating different agricultural strategies and practices for growing food.

*Resources:*

12. Students will investigate what resources are, how they are used and their impact on society by defining resource types, then diagramming and describing a resource from exploration to manufacturing (including exploration, location, mining, milling, refining, & production); comparing and contrasting the environmental impact of different types of resource extraction, use, and byproducts.
13. Students will understand different forms of energy and how alternative forms of the earth's energy resources are used by defining energy and its forms (kinetic, potential, thermal, radiant, electrical, chemical, nuclear) and distinguish between renewable, potentially/perpetually renewable, and nonrenewable resources; evaluating the feasibility of various forms of energy and describe how they are harvested to produce electricity.
14. Students will understand the structure of stable and unstable atoms, and their impact on the human body by defining isotope and describing how its instability leads to radioactive decay; distinguishing between fission and fusion reactions; comparing the properties of alpha, beta, and gamma radiation, and describing how radiation affects living organisms and their

cells; using the Periodic Table to write and balance a nuclear equation to express transmutation of an element using the radioactive decay series; comparing the properties of alpha, beta, and gamma radiation.

*Vertebrate Evolution:*

15. Students will gain an understanding of vertebrate evolution, classification, anatomy, physiology, and phylogeny by describing major evolutionary trends in anatomy and physiology for different vertebrate phyla (focus is on circulatory, respiratory, nervous systems, skeletal, and reproductive strategies); defining and giving examples of ectothermy and endothermy.
16. Students will predict the probable outcome of phenotypes in a genetic cross for different modes of inheritance by diagramming the levels of biological organization (cell organism); using Mendelian genetics to predict dihybrid and sex-linked crosses, and analyze pedigrees; completing dihybrid and sex linked crosses.
17. Students will understand the process and outcome of protein synthesis by describing how protein form influences its function (primary quaternary); defining protein synthesis and discussing its role in a functioning organism; demonstrating how transcription and translation determines the amino acid sequence of a protein; describing the difference between point and chromosomal mutations; identifying the locations and distinguishing between the processes of transcription and translation; decoding a series of codons to determine the amino acid sequence of a protein; explaining the potential consequences on incorrect "reading" of a gene.
18. Students will understand how some tools and techniques are used in biotechnology to further our understanding of vertebrate evolution and discuss some applications of genetic engineering by explaining how gel electrophoresis works; interpreting the results of a gel electrophoresis; discussing the societal impacts (pros and cons) of biotechnology.

*Islands:*

19. Students will gain an understanding of earth's geological processes involved in island formation observing evidence of plate tectonics, and rock samples; by investigating and interpreting multiple lines of evidence related to plate tectonics; discussing various island formation processes at an introductory level; describing the internal structure of the earth and explain its relationship to plate tectonics; identifying major tectonic plates and surface features related to plate tectonics; identifying igneous rock types based on chemical composition and crystal size; identifying the mode of formation for various igneous rock specimens.
20. Students will connect the unique biological evolution of organisms on an isolated island system to the island's geology by describing examples of unique biological adaptations due to differing island geology; describing the succession of new ecosystems on an isolated island; listing and explaining the limiting factors of closed ecosystems and how human impact can constrain it; describing how human impact can influence

biological evolution on an island.

21. Students will understand the process of biological evolution on isolated island systems by identifying some unique examples of biological evolution on islands; discussing the difference between deterministic and random evolutionary factors; distinguishing between genetic equilibrium and disequilibrium.
22. Students will observe the results of biological evolution and describe the specific mechanisms that drive it by defining the concepts of gene flow and genetic drift and their relationship to Hardy-Weinberg equilibrium; defining and providing examples of adaptive radiation as a speciation mechanism.

B. California Content Standards

Integrated Science 3-4 students will be taught the following California Content Standards for Biological/Life Sciences and Earth Sciences. The letters in parentheses following each standard corresponds to the Integrated Science 3-4 unit where that standard is most commonly taught: **(Is)** = Islands; **(VE)** = Vertebrate Evolution; **(Re)** = Resources; **(P+A)** = Populations and Agriculture. Standards that are taught as part of Integrated Science 1-2 are indicated with a **(1-2).**

*Biology/Life Science*

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:
    a. Students know cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings. **(1-2)**
    b. Students know 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. **(VE)**
    c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure. **(1-2)**
    d. Students know 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. **(VE)**
    e. Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins. **(1-2)**
    f. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide. **(P+A)**

g. Students know the role of the mitochondria in making stored chemical bond energy available to cells by completing the breakdown of glucose to carbon dioxide. **(1-2)**

h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors. **(VE)**

i. ***Students know how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production. **(P+A)**

j. *Students know how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both. **(1-2)**

Genetics

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:

   a. Students know 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. **(VE) + (1-2)**

   b. Students know only certain cells in a multicellular organism undergo meiosis. **(1-2)**

   c. Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete. **(VE) + (1-2)**

   d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization). **(1-2)**

   e. Students know why approximately half of an individual's DNA sequence comes from each parent. **(1-2)**

   f. Students know the role of chromosomes in determining an individual's sex. **(1-2)**

   g. Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents. **(VE) + (1-2)**

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:

   a. Students know 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). **(VE) + (1-2)**

   b. Students know the genetic basis for Mendel's laws of segregation and independent assortment. **(VE)**

   c. *Students know how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes. **(1-2)**

   d. ***Students knowhow 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:
    a. Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA. **(VE)**
    b. Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA. **(VE)**
    c. Students know 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. **(VE)**
    d. Students know specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves. **(VE)**
    e. Students know proteins can differ from one another in the number and sequence of amino acids. **(VE)**
    f. * Students know why proteins having different amino acid sequences typically have different shapes and chemical properties. **(VE)**

5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:
    a. Students know the general structures and functions of DNA, RNA, and protein. **(VE) + (1-2)**
    b. Students know how to apply base-pairing rules to explain precise copying of DNA during semi-conservative replication and transcription of information from DNA into mRNA. **(VE)**
    c. Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products. **(VE) + (P+A)**
    d. * Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules. **(VE)**
    e. * Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products. **(VE)**

Ecology

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
    a. Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats. **(1-2)**
    b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size. **(1-2)**
    c. Students know how fluctuations in population size in an ecosystem

are determined by the relative rates of birth, immigration, emigration, and death. **(P+A)**

d. Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration. **(1-2)**

e. Students know a vital part of an ecosystem is the stability of its producers and decomposers. **(1-2)**

f. Students know 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. **(1-2)**

g. *Students know 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. **(1-2)**

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:

   a. Students know why natural selection acts on the phenotype rather than the genotype of an organism. **(Is)**

   b. Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool. **(VE)**

   c. Students know new mutations are constantly being generated in a gene pool. **(VE)**

   d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions. **(Is) + (1-2)**

   e. * Students know the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature. **(Is)**

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:

   a. Students know how natural selection determines the differential survival of groups of organisms. **(Is) + (1-2)**

   b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment. **(Is) + (1-2)**

   c. Students know the effects of genetic drift on the diversity of organisms in a population. **(Is)**

   d. Students know reproductive or geographic isolation affects speciation. **(Is)**

   e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation and mass extinction. **(VE)**

**+ (1-2)**

f. *Students know 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. **(VE)**

g. *Students know 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. **(VE) + (1-2)**

Physiology

9. As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:

   a. Students know the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide. **(1-2)**

   b. Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment. **(1-2)**

   c. Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.

   d. Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses. **(1-2)**

   e. Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response. **(1-2)**

   f. *Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.

   g. *Students know the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance

   h. *Students know the cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca+2, and ATP

   i. *Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:

   a. Students know the role of the skin in providing nonspecific defenses against infection. **(1-2)**

   b. Students know the role of antibodies in the body's response to infection. **(1-2)**

   c. Students know how vaccination protects an individual from

infectious diseases. **(1-2)**

d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections. **(1-2)**

e. Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign. **(1-2)**

f. *Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.

*Earth Science*

Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept**:**

   a. Students know how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system. **(1-2)**

   b. Students know the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago. **(1-2)**

   c. Students know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today. **(1-2)**

   d. Students know the evidence indicating that the planets are much closer to Earth than the stars are. **(1-2)**

   e. Students know the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium. **(1-2)**

   f. Students know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth. **(1-2)**

   g. *Students know the evidence for the existence of planets orbiting other stars.

2. Earth-based and space-based astronomy reveal the structure, scale and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept**:**

   a. Students know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years. **(1-2)**

   b. Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe. **(1-2)**

   c. Students know the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars. **(1-2)**

d. Students know that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data that reveal those differences. **(1-2)**

e. *Students know accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed

f. *Students know the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.

g. *Students know how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years. **(1-2)**

Dynamic Earth Processes

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:

   a. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics. **(Is)**

   b. Students know the principal structures that form at the three different kinds of plate boundaries. **(Is)**

   c. Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes. **(Is)**

   d. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.

   e. Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes. **(Is)**

   f. *Students know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction. **(Is)**

Energy in the Earth System

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:

   a. Students know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society. **(Re) + (1-2)**

   b. Students know the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis. **(P+A) + (1-2)**

   c. Students know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect. **(1-2)**

   d. *Students know the differing greenhouse conditions on Earth,

Mars and Venus; the origins of those conditions; and the climatic consequences of each. **(1-2)**

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:
   a. Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat. **(1-2)**
   b. Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers. **(1-2)**
   c. Students know the origin and effects of temperature inversions. **(1-2)**
   d. Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms. **(1-2)**
   e. Students know rain forests and deserts on Earth are distributed in bands at specific latitudes. **(1-2)**
   f. * Students know the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts. **(1-2)**
   g. Students know features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.

6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:
   a. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere. **(1-2)**
   b. Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents. **(1-2)**
   c. Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement. **(1-2)**
   d. * Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions. **(1-2)**

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:

a. Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle. **(1-2)**
b. Students know 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. **(1-2)**
c. Students know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy. **(1-2)**
d. *Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs. **(1-2)**

Structure and Composition of the Atmosphere

8. 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:
   a. Students know the thermal structure and chemical composition of the atmosphere. **(1-2)**
   b. Students know how the compositions of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen. **(1-2)**
   c. Students know 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. **(1-2)**

California Geology

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology. **(R)**
   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water and the relationship between supply and need. **(1-2)**
   d. *Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

*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:

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 by using logic and evidence.
e. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
f. Recognize the issues of statistical variability and the need for controlled tests.
g. Recognize the cumulative nature of scientific evidence.
h. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
i. 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.

***The state standards for Investigation and Experimentation are imbedded throughout the laboratory work that is the central organizing feature of the Integrated Science program.***

## III. ASSESSMENT

A. Student Assessment

Integrated Science 3-4 assesses students through tests, quizzes and exams, oral presentations, multi-media presentations, laboratory reports, research projects, homework and activities. Teacher specific grading criteria and course expectations are provided to the students in writing at the beginning of the course.

B. Course Assessment

Students taking Integrated Science 1-2 are given the California Standards Test in Earth Science, while those taking Integrated Science 3-4 are given the California Standards Test in Biological Science. As the California Content Standards in those subject areas are taught over the entire two-year curriculum, student performance on those tests provide a means for course evaluation. Student performance on these statewide assessments provides one means for course evaluation. Because these tests do not provide a perfect match with our integrated curriculum, we are working to develop a content exam for each year, linked specifically to our curriculum and student outcomes. These tests, one for Integrated Science 1-2 and one for Integrated Science 3-4, will provide a more

specific analysis of our program. We expect to have them operational by the 2008-09 school year. The number of D's and F's in each level of Integrated Science provides a qualitative measure for evaluation.

## IV. METHODS AND MATERIALS

A. Methods

Integrated Science 3-4 is a laboratory and project based science course. Instruction will include but not be limited to lecture/discussion, demonstration, subject matter reading, inquiry, laboratory experimentation, research, investigation and multi-media presentation.

B. Materials

Integrated Science 3-4 utilizes staff-generated curriculum supplemented by the Board-approved textbooks. The textbook for this course is Integrated Science 3-4, Custom Edition (2009).

C. Technology

Integrated Science 3-4 utilizes computer-based data analysis and presentation software, online resources, scientific calculators, and digital probes for measuring specific parameters. In addition, a wide array of scientific equipment is employed in laboratory activities.

D. School to Career Goals

Implicit in the presented instruction will be connections with career opportunities and skills in the areas of science and technology. This will include background in the following sectors identified in the California Career Technical Education Model Curriculum Standards (relevant units noted in *italics*):

- Agriculture and Natural Resources – *Populations and Agriculture, Resources, Islands*
- Energy and Utilities Industry - *Populations and Agriculture, Resources*
- Engineering and Design Industry – *Resources, Islands*
- Health Science and Medical Technology Industry – *Vertebrate Evolution*

For example, biotechnology careers will be presented through the curricular use of technology and student research/presentation. Further connections include guest speakers, job shadowing, internship, adult mentors, field studies, and/or other activities that engage students with the world of work.

E. Suggested Instructional Time Allocation

Integrated Science 3-4 is a yearlong, two semester course. The course is designed to have two units taught per semester (eight to ten weeks per unit). As a laboratory science course, lab activities will make up approximately 40% of instructional time. The remainder of instructional time will be distributed amongst individual research, lecture and discussion, video presentations,

computer analysis, and group projects and presentations. Team and individual teacher planning need will determine the relative allocation of time.

## V. GENERAL INFORMATION

Integrated Science 3-4 is a ten-credit course open to students that have successfully completed the prerequisite Integrated Science 1-2. Students must pass Integrated Science 3 to continue on to Integrated Science 4. It satisfies ten credits of TUHSD science graduation requirements.

This course is accepted towards the “d” requirement for UC and CSU admissions.

Adopted: 10/3/94
Revised: 7/26/99
Revised: 8/8/02
Revised: 11/03
Revised: 6/30/04
Revised: 5/07
Updated: 12/10

Appendix. California Content Standards and Course Content

Table A. Correlation of California Biological/Life Science Standard by Unit

| State Standard | Integrated Science 1-2 | | | | Integrated Science 3-4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Origin | Climate | Disease | SF Bay | Islands | Resource | Vert Evol | Pop+Ag |
| **Cell Biology** | | | | | | | | |
| 1a | | | ✓ | | | | | |
| 1b | | | | | | | ✓ | |
| 1c | | | ✓ | | | | | |
| 1d | | | | | | | ✓ | |
| 1e | | | ✓ | | | | | |
| 1f | | | | | | | | ✓ |
| 1g | | | ✓ | | | | ✓ | |
| 1h | | | | | | | ✓ | |
| 1i** | | | | | | | | ✓ |
| 1j** | | | ✓ | | | | | |
| **Genetics** | | | | | | | | |
| 2a | | | ✓ | | | | ✓ | |
| 2b | | | ✓ | | | | | |
| 2c | | | ✓ | | | | ✓ | |
| 2d | | | ✓ | | | | | |
| 2e | | | ✓ | | | | | |
| 2f | | | ✓ | | | | | |
| 2g | | | ✓ | | | | ✓ | |
| 3a | | | ✓ | | | | ✓ | |
| 3b | | | | | | | ✓ | |
| 3c** | | | ✓ | | | | | |
| 3d** | | | | | | | | |
| 4a | | | | | | | ✓ | |
| 4b | | | | | | | ✓ | |
| 4c | | | | | | | ✓ | |
| 4d | | | | | | | ✓ | |
| 4e | | | | | | | ✓ | |
| 4f** | | | | | | | ✓ | |
| 5a | | | ✓ | | | | ✓ | |
| 5b | | | | | | | ✓ | |
| 5c | | | | | | | ✓ | ✓ |
| 5d** | | | | | | | ✓ | |
| 5e** | | | | | | | ✓ | |
| **Ecology** | | | | | | | | |
| 6a | | | | ✓ | ✓ | | | |
| 6b | | | | ✓ | | | | ✓ |
| 6c | | | | | | | | ✓ |
| 6d | | | | ✓ | | | | |
| 6e | | | | ✓ | | | | |
| 6f | | | | ✓ | | | | |
| 6g** | ✓ | | | | | | | |

Table A. Correlation of California Biological/Life Science Standard by Unit, continued

| State Standard | Integrated Science 1-2 | | | | Integrated Science 3-4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Origin | Climate | Disease | SF Bay | Islands | Resource | Vert Evol | Pop+Ag |
| **Evolution** | | | | | | | | |
| **7a** | | | | | ✓ | | | |
| **7b** | | | ✓ | | | | ✓ | |
| **7c** | | | | | ✓ | | ✓ | |
| **7d** | ✓ | | | | ✓ | | | |
| **7e**** | | | | | ✓ | | | |
| **8a** | ✓ | | | | ✓ | | | |
| **8b** | ✓ | | | | ✓ | | | |
| **8c** | | | | | ✓ | | | |
| **8d** | | | | | ✓ | | | |
| **8e** | ✓ | | | | | | ✓ | |
| **8f**** | ✓ | | | | | | ✓ | |
| **8g**** | ✓ | | | | | | ✓ | |
| **Physiology** | | | | | | | | |
| **9a** | | | ✓ | | | | | |
| **9b** | | | ✓ | | | | | |
| **9c** | | | ✓ | | | | | |
| **9d** | | | ✓ | | | | | |
| **9e** | | | ✓ | | | | | |
| **9f**** | | | | | | | | |
| **9g**** | | | | | | | | |
| **9h**** | | | | | | | | |
| **9i**** | | | | | | | | |
| **10a** | | | ✓ | | | | | |
| **10b** | | | ✓ | | | | | |
| **10c** | | | ✓ | | | | | |
| **10d** | | | ✓ | | | | | |
| **10e** | | | ✓ | | | | | |
| **10f**** | | | | | | | | |

Table B. Correlation of California Earth Science Standard by Unit

| State Standard | Integrated Science 1-2 | | | | Integrated Science 3-4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Origin | Climate | Disease | SF Bay | Islands | Resource | Vert Evol | Pop+Ag |
| **Earth's Place in Universe** | | | | | | | | |
| 1a | ✓ | | | | | | | |
| 1b | ✓ | | | | | | | |
| 1c | ✓ | | | | | | | |
| 1d | ✓ | | | | | | | |
| 1e | ✓ | | | | | | | |
| 1f | ✓ | | | | | | | |
| 1g** | | | | | | | | |
| 2a | ✓ | | | | | | | |
| 2b | ✓ | | | | | | | |
| 2c | | | | | | ✓ | | |
| 2d | ✓ | | | | | | | |
| 2e** | | | | | | | | |
| 2f** | | | | | | | | |
| 2g** | ✓ | | | | | | | |
| **Dynamic Earth Process** | | | | | | | | |
| 3a | | | | | ✓ | | | |
| 3b | | | | | ✓ | | | |
| 3c | | | | | | | | |
| 3d | | | | | ✓ | | | |
| 3e | | | | | ✓ | | | |
| 3f** | | | | | ✓ | | | |
| **Energy in Earth System** | | | | | | | | |
| 4a | | ✓ | | | | ✓ | | |
| 4b | | ✓ | | | | | | ✓ |
| 4c | | ✓ | | | | | | |
| 4d** | | ✓ | | | | | | |
| 5a | | ✓ | | | | | | |
| 5b | | ✓ | | | | | | |
| 5c | | | | | | | | |
| 5d | | | | ✓ | | | | |
| 5e | | ✓ | | | | | | |
| 5f** | | ✓ | | | | | | |
| 5g** | | ✓ | | | | | | |
| 6a | | ✓ | | | | | | |
| 6b | | ✓ | | | | | | |
| 6c | ✓ | ✓ | | | | | | |
| 6d** | | ✓ | | | | | | |
| **Biogeochem Cycles** | | | | | | | | |
| 7a | | | | ✓ | | | | ✓ |
| 7b | | ✓ | | ✓ | | | | |
| 7c | | ✓ | | ✓ | | | | |
| 7d** | | | | | | | | |

Table B. Correlation of California Earth Science Standard by Unit, continued

| State Standard | Integrated Science 1-2 | | | | Integrated Science 3-4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Origin | Climate | Disease | SF Bay | Islands | Resource | Vert Evol | Pop+Ag |
| **Atmosphere** | | | | | | | | |
| **8a** | | ✓ | | | | | | |
| **8b** | ✓ | | | | | | | |
| **8c** | | ✓ | | | | | | |
| **California Geology** | | | | | | | | |
| **9a** | | | | | | ✓ | | |
| **9b** | | | | | | | | |
| **9c** | | | | ✓ | | | | |
| **9d**** | | | | | | | | |