Parent Handbook for Science, English Version

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Contents

A Message from the State Superintendent of Public Instruction

Perhaps no area exemplifies humanity's quest for knowledge better or shows more vividly how we use knowledge in attempting to improve life on our planet than does the subject of science. Every day, everywhere in the world, the central place of science in our lives is demonstrated in countless ways.

A laboratory scientist works late into the night to find a cure for a deadly virus afflicting thousands of children. A researcher investigates the mysteries of geothermal heat in the search for more useful and inexpensive forms of energy. A member of Congress reviews a study on ecosystems, gleaning information that will influence the drafting of a new environmental law. Law enforcement officers receive training in the use of a new technology that will help them keep neighborhoods safe. A homemaker studies soils and the weather before planting a first crop of corn in a backyard garden.

The potential examples are endless because science is all around us. Every occupation or vocation either is rooted in science or relies upon it in some way. Knowledge of science is essential for basic human safety, health, and comfort.

Science allows us to understand life, nature, and the universe in which we live. It helps us to improve our quality of life and to make informed decisions that will affect our future. From a child's viewpoint, science is important because it is the source of many thrilling discoveries. Many adults today attest to the fact that science first awakened their love of learning and prompted their enthusiasm to learn more.

California's science curriculum includes the essential skills and knowledge students will need to be scientifically literate citizens in the twenty-first century. The curriculum encompasses expectations for science education at every grade level, and it systematically increases in depth, breadth, and complexity through the grade levels.

In this handbook parents will find an explanation of why science is studied in school as well as some helpful suggestions for supporting children's learning.

In addition to clarification of some commonly used terms, the handbook presents an overview of California's science curriculum, along with information about high school graduation requirements and college and university entrance requirements for this subject area. The handbook also provides parents and teachers with a list of sample resources—literature, magazines, and places worth visiting—that support children's learning of science.

I hope you find this information useful.

JACK O'CONNELL
State Superintendent of Public Instruction

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The Importance of Science

From a blood cell to a star, from the bottom of the sea to the depths of the universe, science is included in every area of our lives. It is the study of everything that exists. Animal life, plant growth, the mineral content of soil, the control of water and dams—everything we eat and breathe, even the dynamics of a golfer's swing—all are a part of science's domain. To think of any human undertaking that does not involve science is impossible.

No wonder we seem to have a natural fascination with science. Even if they are not professional scientists, people of all ages and places are attracted to the things of nature. We watch a bird fly or we gaze at the stars; we observe the physical agility of a cat or study the formation of a rock; we marvel at a seashell and read with astonishment about a new discovery. Science is an extension of this natural curiosity. From the study of science, families can derive a great deal of satisfaction as they see how science is a part of their lives.

As tomorrow's adults, today's students will face many challenges that cannot be predicted. But they will be prepared to meet those new challenges if they have received a sound, basic education. The California science curriculum organizes the body of knowledge that students need to learn during their elementary and secondary school years; it opens up the methods of science that students will use to extend that knowledge during their lifetime and helps develop the analytical and investigative skills students will need to advance scientific knowledge and absorb new discoveries. It is a rich and challenging program of study for all students.

Parents can encourage student achievement in science by engaging in family activities that promote a love of learning and supporting students in their study of science in school. This handbook not only offers some suggestions toward that aim but also provides parents with an overview of California's science curriculum. The final section of the handbook provides examples of resources that help students learn the workings of the natural world.

How You Can Help Your Children Succeed in Science

The involvement of families in their children's education may be the single most important factor for academic success. When families and schools work together to support learning; the children tend to succeed not only in school but also throughout life. Here are some ideas for helping children become interested and successful in science:

A. Enjoy science together as a family.

Children's scientific knowledge begins in early childhood. You are laying a foundation for your children's understanding of how the world works whenever you and your children wonder together about flowers, stars, butterflies, weather, or machines; when you work together to grow a garden or install a bird feeder; or when you share interests in bird watching or rock collecting or enjoy nature in a park. A love of science can be fostered by encouraging your children to:

- Discuss the things they notice in the natural world.
- Read and write about the birds or flowers that they see, for example, and draw pictures of them. Older students may keep a science notebook, using colored pencils or pastels for illustrations. As students learn about the anatomy of plants and animals, they can draw diagrams to show what they are learning.
- Watch nature programs on television or on videos obtained from a public library and afterward discuss the programs together.
- Work with you to find answers to questions in science that you and your children do not understand. Join your children on trips to the public library to seek out reference books that contain the answers.

B. Read and explore with your children.

Use library books to find out about the birds in your vicinity, the kinds of trees in the neighborhood, and the kinds of clouds that appear in the sky or to learn about the rock formations seen on a driving trip. Literature, reference books, magazines, and the Internet offer many opportunities to support home studies in science. Suggestions about books and other resources may be found in Section VI, "Samples of Resources for Parents and Students."

C. Encourage your children to ask questions and pursue answers.

Three basic questions can help lead children to a better understanding of the world:

What's there? What kinds of rocks are found alongside a road or in a park? What kinds of trees grow in the neighborhood? What kinds of birds make their homes in the community? What kinds of clouds appear in the skies overhead?

How does it work? How are rocks formed? How does a fly walk upward on a windowpane? How do leaves stay green? Why do leaves change color in autumn? What causes clouds to form in the sky? Why does a squirrel dart back and forth on a road? Which trees do nesting birds prefer? What causes the ocean's tides? How do airplanes fly?

How did it come to be this way? How did the layers of rock along a road get that way? Why are there more trees on the east slope of the hill than on the west side? What is the reason for the magnificent wildflower displays in the desert? Why is the sky blue? What makes sunsets red?

Together with your children, use what you see, hear, feel, and smell to figure things out. Why does a plant with strong-tasting leaves have an advantage? Here again, books and magazines from the public library can complement and extend the topics and projects in which your children and you are interested.

D. Take an interest in your children's school life.

- Visit their classrooms and meet their teachers.
- Ask the teachers about the science that children will be studying. As the children proceed through the school year, talk with the teachers about your children's progress.
- Examine your children's science textbooks to get an idea of their contents.
- Review your children's individual and group projects.
- Engage children in talking about what they do in class and what they are learning.
- Talk with your children about what homework must be finished for the next day or what needs to be done for an ongoing project.

E. Encourage your children in their homework and show its importance.

Provide a place at home for study and homework—a place that is as free as possible from such distractions as loud conversations or noise from a radio or television. Establish a routine time for children to do their homework. You can help by checking your children's completed assignments before the end of the day. (*Note*: Neatness and correct spelling are important in assignments regardless of what the subject may be.)

You can also help your children find a secure place to store homework supplies so that they are kept neat and clean and can be found readily. Most supplies young students need for homework—pencils, erasers, ruled and plain paper, for example—are ordinarily found at home or can be purchased at various stores. As students grow older, other resources, such as colored pencils, a ruler, or a compass, can be purchased as the need arises.

Many students benefit from having access to a computer and printer. School libraries, public libraries, and some classrooms often make computers available to students. If judiciously used, the Internet can be very useful in researching a topic.

F. Help your children with “hands-on” assignments when necessary.

Your children will probably be assigned hands-on activities to be completed at home. The term *hands-on* refers to projects such as creating posters, displays, and models and doing investigations—any assignments that involve work with three-dimensional objects or the doing of science. The teacher’s directions for these activities usually include a list of materials or equipment that may be required.

Depending on the activity, adult supervision may be needed for hands-on assignments. You can assist by doing the hazardous tasks, such as heating water or cutting wood for a display board. At other times the children may seek an adult’s advice on the best way to approach a creative assignment. Parental assistance of this kind is valuable. However, the actual doing and completing of the project should be performed by the children. Investigation, planning, and presentation are part of the learning process.

G. Encourage science as a hobby.

As children begin to develop a foundation of scientific knowledge and skills, encourage them to conduct experiments as a hobby or as an extension of classroom work. Public libraries often have books that describe *safe* do-it-yourself experiments that illustrate scientific principles and can be conducted at home. Such experiments use simple items, such as baking soda, water, white vinegar, aluminum foil, tissue paper, vegetable dyes, table salt, shoeboxes, and tennis balls. For children who enjoy magic, other books explain how science can be used in presenting effective magic tricks—a potential doorway into science studies and a good opportunity for children to be encouraged and applauded for their accomplishments. If money allows, such items as microscopes and chemistry sets can be wonderful gifts and, if used seriously and responsibly, can expand a child’s knowledge and exposure to science.

H. Teach your children to practice safety.

Safety is always the foremost consideration in performing science projects, whether at the school site or away from school. Safety must be taught. Knowing and following safe practices in science are part of understanding the nature of science and scientific activities.

Safety lessons taught at home prepare preschoolers for safety lessons taught in school. For example, many children are first made aware of safety's importance when families teach them about home fire safety.

Plastic eye goggles or shields, available in hardware stores, are recommended when older students begin to conduct science experiments on their own. Chemistry sets, usually designated by the manufacturer as appropriate for specific age levels, should never be left within the reach of younger children. Whatever the project or experiment, safety must be given first consideration.

I. Encourage older children in science.

As children advance in their study of science, encourage them to participate in local science fairs. Some children find it helpful to attend a science fair before deciding to enter. You or your children can ask a teacher or a school district's curriculum director about science fair opportunities in your area. (For information about science fairs in California, you can check the California State Science Fair Web site at http://www.usc.edu/cssf.)

Older students with a marked interest in science may want to seek opportunities to talk with professional scientists or engineers. Such visits might be arranged through a teacher or by writing the science department of a nearby college or university. In some cases professional laboratories and research facilities accommodate student visitors, usually under adult supervision. When arranging an appointment, let the scientist know the particular project or special area of interest the student would like to discuss. If the scientist is unavailable, he or she may be able recommend someone else who would be a suitable contact.

STANDARDS AND FRAMEWORKS: WHAT THEY ARE AND WHAT ROLE THEY PLAY

The terms *content standards* and *curriculum frameworks* appear prominently in discussions about California's public school curriculum. Standards and frameworks are fundamental to determining what students should learn and teachers teach; therefore, a brief explanation is provided here.

Content standards are written expectations of what all students at a given grade level should know and be able to do. The expectations are high; they are comparable to the academic standards of countries that have high levels of student achievement. Adopted in 1998 by the State Board of Education for California public schools, the content standards for science define the skills and knowledge that students need to become literate, educated citizens and to be admitted to a college or university. Standards constitute the basis of statewide tests that students must take at certain grade levels. District and school administrators, classroom teachers, universities that prepare teachers, and publishers of textbooks and other instructional materials pay close attention to the content standards in their work.

Curriculum frameworks, also adopted by the State Board, describe the content of the course for each grade level, kindergarten through grade twelve, and offer suggestions to teachers on *how* to teach the curriculum. A framework is a kind of blueprint for implementing the content standards. Many teachers and administrators use a framework as a guide to help them coordinate what they will teach. Local school boards sometimes base their own curriculum decisions on the frameworks adopted by the State Board. Many teacher education programs use frameworks as a source for professional learning. Frameworks also inform textbook publishers of the kinds of instructional materials needed in schools.

The State Board's content standards and framework for science outline a rich program of studies for all the children in the state. The standards are based on the premise that all students are capable of learning and using rigorous science skills, concepts, and knowledge. In addition, the standards ensure that students at the same grade level learn similar content regardless of which public school they attend in California.

A summary of the science curriculum appears in the next section of this handbook. Both the *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve* and the *Science Framework for California Public Schools* are available in their entirety online at http://www.cde.ca.gov/ci.

In addition, copies of both publications are available for purchase. For prices and ordering information, e-mail CDE Press at cdepress@cde.ca.gov or call (800) 995-4099.

An Overview of California's Science Standards

Science consists of what we know and what processes are used to discover and extend that knowledge. Modern science includes observation, research, investigation, and experimentation, all of which lead to explanations of how things work. Because so much exists to observe and explain—from subatomic particles to the entire universe—science is divided into many areas of study. So that a complex subject can be simplified, the natural sciences are often categorized as follows:

- *Physical sciences,* the study of the interactions of matter and energy (physics) that do not involve chemical changes and the study of chemical interactions of atoms and molecules (chemistry)
- *Life sciences* (or biology), the study of living things
- *Earth sciences* (also known as earth/space science), the study of the formation of and the changes in our planet and the rest of the universe

The content standards for kindergarten through grade five cover the physical sciences, life sciences, and earth sciences in approximately equal measures and include standards for investigation and experimentation at each grade level. The standards for the later grades deal with the individual disciplines separately and in greater detail.

The following descriptions offer a brief overview of the science curriculum. The complete science content standards and the framework are available at http://www.cde.ca.gov/ci/sc/cf.

A. Kindergarten Through Grade Five

The science standards for children in elementary schools provide the foundational skills and knowledge the children will need in middle school and high school. Introduced to facts, concepts, principles, and theories categorized under the headings of physical, life, and earth sciences, the children learn essential investigation and experimentation skills that will continue to be developed through high school.

Kindergarten

Science study provides children in kindergarten with unique opportunities to explore the world around them. They begin to learn how to be objective observers and to know the difference between an observation and an opinion. As children begin to observe and describe the similarities, differences, and component parts of materials such as clay, cloth, or paper (physical science), they will learn about different types of plants and animals that inhabit Earth (life science) and will study how Earth is composed of land, air, and water (earth science). Activities related to freezing, melting, and

evaporation will prompt classroom discussions, and students will share stories of their personal experiences with these processes.

Through investigation and experimentation children develop their own questions; perform investigations; observe by using the five senses; describe, compare, and sort common objects; and communicate their observations orally, in writing, and through drawings.

Grade One

In grade one the physical science standards build on the study of the properties of matter through an emphasis on solids, liquids, and gases. In life science the standards focus on how plants and animals live in different environments and how some of their external structures function to help the plants and animals meet their needs. Children learn how to use simple weather recording instruments. The earth science standards call for discussing the daily and seasonal changes in weather and the sun's influence on weather. Investigation and experimentation standards continue to help children develop the ability to observe and compare, describe the relative position of objects, and revisit observations when discrepancies occur.

Grade Two

In studying physical science students learn about force and motion, pushes and pulls, gravity, magnetism, and the capacity of vibrating objects to make sounds. The life science standards focus on the predictable life cycles of plants and animals, inherited characteristics, variation within a species, and environmentally induced changes. Students learn about the composition, processes, and materials of Earth's crust. The earth science standards focus on the breakage and weathering of rocks to form soil, geologic time, and fossils and the evidence they provide about Earth's history. Investigation and experimentation standards develop children's ability to make predictions on the basis of observed patterns, measure with appropriate tools, compare and sort objects, describe a sequence of steps or events, use tools to extend their powers of observation, and follow oral directions for an investigation.

Grade Three

In physical science students discuss sources and forms of energy; forms of matter; atoms; symbols displayed on the periodic table of the elements; and the properties of light and the manner in which light affects perception of direction, shadow, and color. In life science children learn about different environments, the types of organisms adapted to live in each environment, the effects of environmental changes on organisms, extinction, and organisms in the fossil record. Earth science standards focus on the regular, predictable patterns of objects in the sky; movements of the sun, moon, and stars; seasonal changes; and the phases of the moon. Investigation and

experimentation help children learn to make predictions on the basis of observations, prior knowledge, and logic; make repeated observations to improve accuracy; differentiate evidence from opinion; and verify their predictions according to the data they have collected.

Grade Four

The physical science standards provide children in grade four with the opportunity to build series and parallel circuits, build and use a compass, build an electromagnet, and observe the behavior of electrically charged objects and the conversion of electrical energy. In life science children expand their knowledge of food chains and food webs, living and nonliving components of ecosystems, and ecological relationships. The earth science standards focus on the properties of rocks and minerals and the processes of weathering and erosion. Through the investigation and experimentation standards, children learn to formulate and justify predictions on the basis of cause-and-effect relationships, differentiate observation from inference, conduct multiple trials to test their predictions, and follow a set of written instructions for a scientific investigation.

Grade Five

In physical science children in grade five learn about chemical reactions and discover the special and shared properties of metallic elements, molecules, atoms, chemical compounds, and mixtures and the organization of atoms on the periodic table of the elements. The life science standards focus on internal structures for blood circulation, respiration, digestion, waste disposal, transport of materials, and photosynthesis in plants. In earth science children study the water cycle, weather, weather maps and weather patterns, the solar system, the composition of the sun, and the relationship between gravity and planetary orbits. Through the investigation and experimentation standards, children develop testable questions, plan and conduct investigations based on the questions, select appropriate tools, draw conclusions from scientific evidence, and write a report of an investigation.

B. Grades Six Through Eight

Unlike the curriculum for kindergarten through grade five, which includes earth, life, and physical sciences in more or less equal measure, the content standards for grades six, seven, and eight emphasize an individual area for each grade level. This approach allows students and teachers to probe specific disciplines in greater depth within a particular grade level. In grade six the standards focus on the earth sciences. Students often become environmentally aware at this grade level, and this focus is meant to stimulate intellectual curiosity in that area. In grade seven the standards focus on life sciences. Students at this grade level typically receive a semester of health education, and this focus is designed to complement that instruction and to

prepare them for the biology/life sciences course work often taken in the early high school years. In grade eight the standards focus on physical sciences, which is intended to prepare students for the physics and chemistry course work often taken in later high school years. As was done for the elementary grade levels, a set of expectations for investigation and experimentation is included at each of the three grade levels.

Grade Six: Focus on Earth Sciences

Children learn Earth's history and the mechanisms that account for the planet's topography, weather phenomena, and interactions of living things. The course is based on learning how two sources of energy (the sun and the radioactive decay inside Earth) drive convection currents that cause weather, the reshaping of Earth's surface, and the continuation of ecosystems. Through the investigation and experimentation standards, students learn to develop hypotheses, use appropriate tools and technology, manipulate data, communicate the steps of an investigation, evaluate evidence, interpret maps and events by sequence and time, and identify changes in natural phenomena.

Grade Seven: Focus on Life Sciences

In the life sciences, cells, body systems, and genetics are studied as the results of the history of life on Earth. The evolution of life through the geologic history learned in grade six receives considerable emphasis. The physical science principles that underlie biological structures and functions (e.g., light, levers, blood pressure) are studied to gain a deeper understanding of living systems. Through the investigation and experimentation standards, students learn how to use appropriate tools and technology and a variety of print and electronic resources, communicate ideas logically, construct scale models and diagrams to communicate knowledge, and communicate the steps and results of investigations.

Grade Eight: Focus on Physical Sciences

Students in grade eight study topics in physical sciences, such as motion, forces, and the structure of matter, through a mathematically based approach similar to the procedures they will use in high school. The study of chemistry centers on the behavior of atoms and molecules and the chemical makeup of living systems. Density and buoyancy are explored as aspects of the behavior of matter, and Earth in the solar system is studied according to the physical interactions of bodies in space. Through the investigation and experimentation standards, students learn how to plan and conduct a scientific investigation, evaluate data, distinguish between variables and controls, construct linear graphs, and manipulate simple mathematical formulas.

C. Grades Nine Through Twelve

For grades nine through twelve, the standards are organized by a particular science discipline rather than by grade level. In addition, one set of standards for investigation and experimentation is given for grades nine through twelve. High schools may offer specific courses (physics, chemistry, biology/life science, earth science) or integrated science courses that include standards from the four science disciplines within a given year.

Physics

Considered the most basic of all sciences, physics includes the study of motion, forces, energy, heat, waves, light, electricity, and magnetism. It focuses on the development of models deeply rooted in scientific inquiry in which mathematics is used to describe and predict natural phenomena and to express principles and theories. Topics in physics requiring little or no mathematics are introduced first. Then students progress to more sophisticated and quantitative treatments as they learn more mathematics.

Chemistry

In studying chemistry, students discover chemistry's tremendous capacity to explain the nature of matter and its transformations. Included in the chemistry standards are atomic and molecular structure, the periodic table, chemical bonds, conservation of matter and stoichiometry, gases, acids and bases, solutions, chemical thermodynamics, reaction rates, chemical equilibrium, organic and biochemistry, and nuclear processes. Because the study of chemistry requires high-level problem-solving skills, such as designing experiments and solving word problems, it requires a firm foundation in algebra.

Biology/Life Sciences

Biology and life sciences approach the study of living things from several directions: cells and cellular functions; systems and organisms, including the genetics of organisms; parts of ecosystems; and the history of life. Included in the standards are the study of cell biology, genetics, ecology, evolution, and physiology. Both laboratory and field experiences are appropriate to meet the investigation and experimentation requirements of the courses.

Earth Sciences

The study of earth sciences involves the physical study of Earth and the rest of the universe. Included are Earth's place in the universe, dynamic Earth processes, energy in the Earth system, biogeochemical cycles, the structure and composition of the atmosphere, and the geology of California. Investigations include exploring the physical, chemical, and biological interactions that explain phenomena and features of our planet and its surroundings.

Investigation and Experimentation

The investigation and experimentation standards for high school require students to learn how to select and use appropriate tools and technology, identify sources of error and inconsistent results, formulate explanations by using logic and evidence, and solve problems by using mathematics. Students also are required to learn scientific terms, such as *hypothesis* and *theory;* recognize the usefulness and limitations of models and theories; interpret maps; and analyze sequences in natural phenomena. Further, they must learn to recognize the need for controlled experiments and the cumulative nature of scientific knowledge, integrate knowledge from more than one area of science, investigate science-based issues, and recognize that science is a human endeavor occasionally flawed by mistakes and even fraud.

D. What Parents May Observe in Instructional Programs

Parents may notice that different teachers use different approaches in teaching the science standards. Some teachers may choose to teach each set of standards in a particular order (for example, a unit on life science, followed by units on earth science and physical science); others may prefer to teach certain sets of standards together, an approach called *integrated science.* Either approach can be effective if the course is based on the science standards and is effective in helping students reach the content standards for their grade level.

Some knowledge of science is best learned by having students read about the subject or hear about it from the teacher. Other knowledge is best learned in the laboratory or on field studies. The first type of instruction (sometimes termed *direct instruction*) and the second type (sometimes called *investigative learning*) need to be coordinated and mutually supportive. In the *Science Framework for California Public Schools, Kindergarten Through Grade Twelve*, the State Board of Education recommends a “sensible balance of direct instruction and investigation and a focus on demonstration of scientific principles” as part of an effective standards-based science program.

Planning for Success: Requirements and Decisions

The following information is provided to assist you and your child in understanding the requirements for high school graduation and university entrance. Careful planning will help ensure your child's success.

A. High School Graduation Requirements

State law specifies that to receive a high school diploma, students must successfully complete at least two courses in science, including biological and physical sciences. Although the law is not explicit, one course generally focuses on biological science; the other, on physical science. Two years of integrated science, which includes the biological and physical sciences, can also fulfill the graduation requirement.

The *Science Framework for California Public Schools, Kindergarten Through Grade Twelve* recommends that "all students take, at a minimum, two years of laboratory science providing fundamental knowledge in at least two of the following content strands: biology/life sciences, chemistry, and physics. Laboratory courses in earth sciences are acceptable if prerequisite courses are required (or provide basic knowledge) in biology, chemistry, or physics."

B. State Testing

California law mandates statewide testing of certain subjects at specified grade levels. The purpose of the legislation is to determine student achievement at state, county, school district, school, and individual student levels. A key testing program, called the Standardized Testing and Reporting (STAR) program, consists of the California Standards Tests (CSTs); the California Achievement Test, Sixth Edition Survey (CAT/6 Survey); the California Alternate Performance Assessment (CAPA); and the Aprenda 3. However, only the CSTs and the CAPA assess student achievement in science.

The CSTs measure students' understanding of California's content standards. The grade-level CSTs in science are given to students in the fifth, eighth, and tenth grades. In addition, high school students in grades nine, ten, and eleven take end-of-course CSTs if they have recently completed or are currently enrolled in a standards-based science course. The fifth-grade CST measures student achievement of the science standards of grades four and five. The eighth-grade CST measures student achievement of the grade eight science standards. The tenth-grade CST in life science measures student achievement of selected middle school life science standards and selected high school biology standards. And high school end-of-course CSTs are given in biology, chemistry, earth sciences, physics, and integrated science.

The CAPA is designed for students with significant cognitive disabilities who are unable to take the CSTs or the CAT/6 Survey even with accommodations or modifications. Participation in the CAPA is specified in the student's individualized education program. Included in the CAPA are science tasks that measure the students' achievement of the science standards selected for those students.

The federal No Child Left Behind (NCLB) law requires that, no later than the 2007-08 school year, states administer science tests based on the state's science standards at least once each year in grade spans three through five, six through nine, and ten through twelve. The grade-level CSTs meet the NCLB mandates for assessing science.

C. University Admission Requirements

The University of California (UC) and the California State University (CSU) specify what course work students must complete to be eligible for university admission. These course requirements are sometimes referred to as the "a–g" requirements because of the order in which the university lists them:

(a) History–social science

(b) English

(c) Mathematics

(d) Laboratory science

(e) Language other than English

(f) Visual and performing arts

(g) College preparatory electives

For science the "d" requirement calls for two units (equivalent to two one-year courses) of laboratory sciences. The "g" requirement pertains to elective courses, for which selected science courses may qualify: specifically, one unit (equivalent to two semester courses) of an additional laboratory science.

The UC and CSU interpret these requirements somewhat differently. In applying the "d" requirement, the UC requires that the two units of laboratory science must come from the three core sciences (biology, chemistry, and physics) *or* a three-year integrated science sequence. Approved courses such as earth science, physical science, and environmental science meet the "g" elective requirement. The UC system strongly recommends students take three science courses.

The CSU also requires two courses of laboratory science (one biological and one physical) and will accept approved courses that meet either the "d" or "g" requirement.

Parents and students are encouraged to confer with high school counselors or to contact the UC or CSU campus of interest for more specific information about admission requirements. General information regarding the “a–g” requirements may be obtained online at http://pathstat1.ucop.edu/ag/a-g/index.html.

Sample Resources for Parents and Students

Whether in school or at home, students can enjoy and understand the world of science by reading good books.

A. Literature and Reference Books

Numerous biographies, stories, narrative nonfiction, plays, and poems touch on science. The fourth grader who reads Diane Siebert's *Mojave*, for example, or the high school junior who reads Rachel Carson's *The Sea Around Us* not only experiences good literature but also builds connections to the study of life sciences and earth sciences.

The reading of scientific literature also can help students to understand the relationship between science and other subject areas. For example, *Mojave* links to the study of California geography and can complement the history–social science content that students learn in grade four. In fact, the entire history of science is inseparable from history itself, for scientists and inventors have changed the ways people live and think about their world. By reading stories about the accomplishments of men and women in science, students enhance their scientific knowledge and gain a better understanding of human history.

Classroom teachers and library/media teachers can advise interested parents and students regarding an array
of appropriate books and stories. Some school districts develop lists of literature that align with subjects studied at different grade levels. In addition, the California Department of Education's *Literature for Science and Mathematics, Kindergarten Through Grade Twelve* provides outstanding examples of literature related to the study of natural sciences and mathematics, including more than 150 selections in Spanish. The titles reflect fiction and nonfiction that accommodate a variety of interests, abilities, and age levels. Many books listed are available through public and school libraries and bookstores. The list is available online at the California Department of Education Web site at http://www.cde.ca.gov/ci/sc/ll/index.asp.

The U.S. Department of Education maintains an online series of parent guides entitled *Helping Your Child*. Each booklet in the series is devoted to a different topic or subject area. Parents with children in kindergarten through grade eight may find *Helping Your Child with Science* a useful resource. The booklet can be found at the Web site http://www.ed.gov/parents/academic/help/hyc.html.

Libraries also make available many useful reference books. Encyclopedias, science dictionaries, nature and wildlife field guides, and science project books can play a valuable part in stimulating enthusiasm for science. By encouraging students to use

reference books, parents help establish the habit of seeking information in a variety of printed materials.

B. Magazines

In addition to books and stories, magazines are another resource that can awaken students' interests in science. For example, magazine articles are frequently illustrated with color photographs, diagrams, and other visual aids. Here again, librarians and teachers can be helpful in locating age-appropriate magazines that support science at particular grade levels. The following titles are provided as examples:

Wild Animal Baby (ages twelve months to six years)

Your Big Backyard (ages three through seven)

Ranger Rick (ages seven through eleven)

Earth Tomorrow (ages eleven through fourteen)

National Geographic (ages twelve through adult)

Popular Mechanics (high school through adult)

Scientific American (high school through adult)

With the growth of the Internet, a number of science-related sites have become available. The publishers of several of the magazines listed previously, for example, maintain Web sites that contain informative articles and activities for students. The National Wildlife Federation's "Kidzone" is one: http://www.nwf.org/kids.

C. Places to Visit

Aquariums, arboretums, aviaries, gardens, museums, planetariums, nature preserves, parks, and zoos help to make science vital for students. California has many such places that appeal to adults and young people alike. Whenever possible, parents and teachers are encouraged to visit some of those places with students.

The listings noted below are only a sampling of the many establishments that advance the public's enjoyment and understanding of science. Parents, teachers, library/media teachers, and students can conduct Internet searches to identify additional resources near them or near a vacation spot that the family intends to visit. (*Note*: Adult supervision is recommended while a student searches for information on the Internet.)

Northern California

California Academy of Sciences, San Francisco (includes the Steinhart Aquarium, the Morrison Planetarium, and other attractions). http://www.calacademy.org

Coyote Point Museum, San Mateo
http://www.coyoteptmuseum.org/education/welcome.htm

The Exploratorium, Palace of Fine Arts, San Francisco. http://www.exploratorium.edu

Lawrence Hall of Science, UC Berkeley (includes the Holt Planetarium and other attractions). http://www.lhs.berkeley.edu

Oakland Museum of California, Oakland.
http://www.museumca.org/global/naturalscience

Redwood Discovery Museum, Eureka. http://www.northcoast.com/~discover

UC Botanical Gardens, Berkeley. http://botanicalgarden.berkeley.edu

Central California

Buena Vista Museum of Natural History, Bakersfield.
http://sharktoothhill.com/index.html

Fresno Metropolitan Museum of Art, History, and Science, Fresno (features the ASK Science Center, which offers hands-on displays geared to children).
http://www.fresnomet.org

Monterey Bay Aquarium, Monterey. http://www.mbayaq.org

Morro Bay Museum of Natural History. http://www.mbspmuseum.org

Sacramento Zoo, Sacramento. http://www.saczoo.com

UC Davis Arboretum, Davis. http://arboretum.ucdavis.edu

Southern California

California Science Center, Exposition Park, Los Angeles. http://www.casciencectr.org

Chula Vista Nature Center, Chula Vista. http://www.chulavistanaturecenter.org

Descanso Gardens, La Cañada. http://www.descanso.com/education.cfm

Living Desert Zoo and Gardens, Palm Desert. http://livingdesert.org

Maturango Museum, Ridgecrest (features natural history of the upper Mojave Desert).
http://www.maturango.org

Natural History Museum of Los Angeles County, Los Angeles. http://www.nhm.org

Page Museum at the La Brea Tar Pits, Los Angeles. http://www.tarpits.org

Rancho Santa Ana Botanic Garden, Claremont. http://www.rsabg.org

Reuben H. Fleet Science Center, Balboa Park, San Diego. http://www.rhfleet.org/index.html

Birch Aquarium at Scripps, La Jolla. http://www.aquarium.ucsd.edu

Other Resources

Many regional, state, national, and theme parks provide tours and resources that extend the study of science. Parents interested in identifying state parks near them may access http://www.parks.ca.gov or call (800) 777-0369. National parks located either within or outside California provide additional opportunities to explore science, geography, and history.

The California Science Fair is the culminating science fair of the academic year for students in grades six through twelve. Hosted by the California Science Center (formerly the California Museum of Science and Industry), the fair provides students with opportunities to excel in science investigation, research, and creative projects. For more information, visit the Web site of the California Science Fair at http://www.usc.edu/CSSF.

Contact Information

For general information regarding content standards and frameworks or the process for the state adoption of instructional materials, please contact the Curriculum Frameworks and Instructional Resources Division, California Department of Education (CDE), at (916) 319-0881.

For information regarding statewide testing in science, please contact the Standards and Assessment Division, CDE, at (916) 445-9441.

For information regarding science curriculum and instruction, including the California Department of Education's publication *Literature for Science and Mathematics, Kindergarten Through Grade Twelve*, please contact the Mathematics and Science Leadership Office, CDE, at (916) 323-5847.

For information on family, parent, and community involvement, please contact the Title I Policy and Partnerships Office, CDE, at (916) 319-0854.