

**SCIENCE STANDARDS AND BENCHMARKS**

The standards are adapted from the National Science Education Standards (U.S.A.) and AAAS Project 2061. The benchmarks used are taken from the current Project 2061.

<http://www.nap.edu/openbook.php?record_id=4962&page=104>

<http://www.project2061.org/publications/bsl/online/index.php?home=true>

**STANDARD 1: THE NATURE OF SCIENCE**

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**STANDARD 3: THE PHYSICAL SETTING**

**STANDARD 4: THE LIVING ENVIRONMENT**

**STANDARD 5: SCIENCE AND SOCIETY**

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES K-2**

1. When a science investigation is done the way it was done before, we expect to get a very similar result.
2. When a science investigation is done again in a different place, we expect to get a very similar result.
3. People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.
4. Tools such as thermometers, magnifiers, rulers, or balances often give more information about things than can be obtained by just observing things unaided.
5. Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.
6. When people give different descriptions of the same thing, it is usually a good idea to make some fresh observations instead of just arguing about who is right.
7. Everybody can do science and invent things and ideas.
8. In doing science, it is often helpful to work with a team and to share findings with others. All team members should reach their own individual conclusions, however, about what the findings mean.
9. A lot can be learned about plants and animals by observing them closely, but care must be taken to know the needs of living things and how to provide for them in the classroom.
10. Use whole numbers in ordering, counting, identifying, measuring, and describing
11. Assemble, take apart, and reassemble constructions using interlocking blocks or other interconnecting pieces.
12. Make something out of paper, cardboard, cloth, wood, plastic, metal, or existing objects that can actually be used to perform a task.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES K-2**

1. Measure the length in whole units of objects using rulers and tape measures.
2. Weigh objects using a scale.
3. Give the sums and differences of single-digit numbers.
4. Explain to other students how they go about solving numerical problems.
5. Make quantitative estimates of time intervals and the lengths and weights of familiar objects.
6. Describe and compare real-world objects in terms of number, shape, texture, size, weight, color, and motion.
7. Draw pictures that portray some features of the thing being described.
8. Interpret pictures, drawings, and videos of real-world objects and events.
9. Interpret oral descriptions of real-world objects and events.
10. Ask "How do you know?" in appropriate situations and attempt reasonable answers when others ask the same question.
11. Most things are made of parts.
12. Something may not work if some of its parts are missing.
13. When parts are put together, they can do things that they couldn't do by themselves.
14. A model of something is different from the real thing but can be used to learn something about the real thing.
15. One way to describe something is to say how it is and isn't like something else.
16. An object can change in various ways, such as in size, weight, color, or temperature.
17. Small changes can sometimes be detected by comparing counts or measurements at different times.
18. Some things change so slowly or so quickly that the changes are hard to notice while they are taking place.
19. Things in nature and things people make have very different sizes, weights, ages, and speeds.
20. Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES 3-5**

1. Sometimes similar investigations give different results because of differences in the things being investigated, the methods used, or the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observations. It is not always easy to tell which.
2. Science is a process of trying to figure out how the world works by making careful observations and trying to make sense of those observations.
3. Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.
4. Because we expect science investigations that are done the same way to produce the same results, when they do not, it is important to try to figure out why.
5. One reason for following directions carefully and for keeping records of one's work is to provide information on what might have caused differences in investigations.
6. Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think.
7. Sometimes scientists have different explanations for the same set of observations. That usually leads to their making more observations to resolve the differences.
8. Science is an adventure that people everywhere can take part in, as they have for many centuries.
9. Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.
10. Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.
11. Add or subtract any two whole numbers between 1 and 100.
12. Multiply any two whole numbers between 1 and 10 and multiply or divide any number by 2, 10, or 100.
13. Use appropriate units when describing quantities.
14. Add and subtract fractions with common denominators.
15. Give written and oral instructions that others can follow to carry out a procedure.
16. Make sketches or diagrams to aid in explaining procedures or ideas.
17. Use numerical data in describing and comparing objects and events.
18. Read simple tables and graphs produced by others and describe what the tables and graphs show.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES 3-5**

1. Find locations on maps and globes, interpret information displayed on maps, and use maps to navigate.
2. Interpret written descriptions of real-world objects and events.
3. Write a clear and accurate description of a real-world object or event.
4. Locate information in print and electronic resources.
5. Make rough estimates of numerical calculations and use them to judge whether the results of a calculation done on a calculator are reasonable.
6. Measure out a prescribed amount of a liquid or dry powder using a measuring cup, measuring spoon, or scale.
7. Keep written or electronic records of information so that the records are understandable weeks or months later.
8. Use audio and video recording devices for capturing information.
9. Buttress their statements with facts found in books, articles, and databases, and identify the sources used and expect others to do the same.
10. Recognize when comparisons might not be fair because some conditions are not kept the same.
11. Seek reasons for believing something rather than just claiming "Everybody knows that…" or "I just know" and discount such claims when made by others.
12. Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and oral and written descriptions can be used to represent objects, events, and processes in the real world.
13. A model of something is similar to, but not exactly like, the thing being modeled. Some models are physically similar to what they are representing, but others are not.
14. Models are very useful for communicating ideas about objects, events, and processes. When using a model to communicate about something, it is important to keep in mind how it is different from the thing being modeled.
15. Some features of things may stay the same even when other features change.
16. Things change in steady, repetitive, or erratic ways—or sometimes in more than one way at the same time.
17. Often the best way to tell which kinds of change are happening is to make a table or graph of measurements.
18. Some things, such as a person's age, change in only one direction.
19. Some things in nature have a repeating pattern, such as the day-night cycle, the phases of the moon, and seasons.
20. Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES 6-12**

1. Science is based on the assumption that the universe is a system in which the basic rules are everywhere and always the same and that events in the universe occur in consistent patterns that are comprehensible through systematic study.
2. Continuity and change are persistent features of science.
3. No matter how well one theory fits observations, a new theory might fit them just as well or better, or might fit a wider range of observations. This ongoing process leads to a better understanding of how things work in the world but not to absolute truth.
4. Hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of the data (both new and previously available).
5. Scientists value evidence that can be verified, hypotheses that can be tested, and theories that can be used to make predictions.
6. In the long run, theories are judged by the range of observations they explain, how well they explain observations, and how useful they are in making accurate predictions.
7. Bias attributable to the investigator, the sample, the method, or the instrument may not be completely avoidable in every instance, but scientists want to know the possible sources of bias and how bias is likely to influence evidence.
8. Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.
9. Important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.
10. Progress in science and invention depends heavily on what else is happening in society.
11. Scientists differ greatly in what phenomena they study but they share a common purpose and philosophy, and all are part of the same scientific enterprise.
12. Models are often used to think about processes that happen too slowly, too quickly, or on too small a scale to observe directly. They are also used for processes that are too vast, too complex, or too dangerous to study.
13. The usefulness of a model depends on how closely its behavior matches key aspects of what is being modeled. The only way to determine the usefulness of a model is to compare its behavior to the behavior of the real-world object, event, or process being modeled.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES 6-12**

1. The behavior of a physical model cannot ever be expected to represent the full-scale phenomenon with complete accuracy, not even in the limited set of characteristics being studied.
2. A system may stay the same because nothing is influencing it or the influences on it are balanced.
3. Many systems contain feedback mechanisms that serve to keep changes within certain limits.
4. Symbolic equations can be used to summarize how the quantity of something changes over time or in response to other changes.
5. Graphs and equations are useful (and often equivalent) ways for depicting and analyzing patterns of change.
6. If a system in equilibrium is disturbed, it may return to a very similar state of equilibrium, or it may undergo a radical change until the system achieves a new state of equilibrium with very different conditions, or it may fail to achieve any type of equilibrium.
7. Representing very large or very small numbers in terms of powers of ten makes it easier to perform calculations using those numbers.
8. Because different properties are not affected to the same degree by changes in size, large changes in size typically change the way that things work in physical, biological, or social systems.
9. Natural phenomena often involve sizes, durations, and speeds that are extremely small or extremely large. These phenomena may be difficult to appreciate because they involve magnitudes far outside human experience.
10. Use the units of the inputs to a calculation to determine what units (such as seconds, square inches, or dollars per tankful) should be used in expressing an answer.
11. Convert quantities expressed in one unit of measurement into another unit of measurement when necessary to solve a real-world problem.
12. Decide what degree of precision is adequate and round off the result of calculator operations to enough significant figures to reasonably reflect those of the inputs.
13. Use appropriate ratios and proportions, including constant rates, when needed to make calculations for solving real-world problems.
14. Find answers to real-world problems by substituting numerical values in simple algebraic formulas and check the answer by reviewing the steps of the calculation and by judging whether the answer is reasonable.
15. Use computer spreadsheet, graphing, and database programs to assist in quantitative analysis of real-world objects and events.
16. Consider the possible effects of measurement errors on calculations.
17. Keep written or electronic records of information so that the records are understandable weeks or months later.

**STANDARD 1: THE NATURE OF SCIENCE**

**Benchmarks**

**GRADES 6-12**

1. Select the proper tool for completing a particular task.
2. Give written and oral instructions that others can follow to carry out a procedure.
3. Locate information in print and electronic resources.
4. Organize information in simple tables and graphs and identify relationships they reveal.
5. Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
6. Make sketches or diagrams, including scale drawings, to aid in explaining procedures or ideas.
7. Use tables, charts, and graphs in making arguments and claims in oral, written, and visual presentations.
8. Notice and criticize claims based on the faulty, incomplete, or misleading use of numbers, such as in instances when (1) average results are reported but not the amount of variation around the average, (2) a percentage or fraction is given but not the total sample size, (3) absolute and proportional quantities are mixed, or (4) results are reported with overstated precision.
9. Check graphs to see that they do not misrepresent results by using inappropriate scales or by failing to specify the axes clearly.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES K-2**

1. People, alone or in groups, are always inventing new ways to solve problems and get work done. The tools and ways of doing things that people have invented affect all aspects of life.
2. Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure, and make things.
3. Some kinds of materials are better than others for making any particular thing. Materials that are better in some ways, such as stronger or cheaper, may be worse in other ways, such as heavier or harder to cut.
4. People burn fuels such as wood, oil, coal, or natural gas, or use electricity, to cook their food and warm their houses.
5. Information can be sent and received in many different ways. Some allow answering back and some do not. Each way has advantages and disadvantages.
6. People have always tried to communicate with one another. Signed and spoken language was one of the first inventions.
7. Vaccinations and other scientific treatments are used to protect people from getting certain diseases.
8. Tools such as thermometers and X-ray machines are used to help figure out whether a person is healthy.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 3-5**

1. Throughout all of history, people everywhere have invented and used tools. Most tools of today are different from those of the past but many are modifications of very ancient tools.
2. Technology enables scientists and others to observe things that are too small or too far away to be seen otherwise and to study the motion of objects that are moving very rapidly or are hardly moving at all.
3. Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.
4. Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds. The changes may be for survival needs such as food, shelter, and defense; for communication and transportation; or to gain knowledge and express ideas.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 3-5**

1. There is no perfect design. Designs that are best in one respect (safety or ease of use, for example) may be inferior in other ways (cost or appearance). Usually some features must be sacrificed to get others.
2. The solution to one problem may create other problems.
3. Like language, ritual, commerce, and the arts, technology is an intrinsic part of human culture, and it both shapes society and is shaped by it.
4. Any invention is likely to lead to other inventions. Once an invention exists, people are likely to think up ways of using it that were never imagined at first.
5. Transportation, communications, nutrition, sanitation, health care, entertainment, and other technologies give large numbers of people today the goods and services that once were luxuries enjoyed only by the wealthy. These benefits are not equally available to everyone.
6. Factors such as cost, safety, appearance, environmental impact, and what will happen if the solution fails must be considered in technological design.
7. Technologies often have drawbacks as well as benefits. A technology that helps some people or organisms may hurt others—either deliberately (as weapons can) or inadvertently (as pesticides can).
8. Humans have produced a wide variety of materials, such as steel, plastic, and nylon, that do not appear in nature.
9. Sometimes it is possible to use the materials from discarded products to make new products, but materials differ widely in the ease with which they can be recycled.
10. Although many things are still made by hand in some parts of the world, almost everything in the most technologically developed countries is now produced using machines that are automated. By using machinery, the time required to make a product and its cost can be greatly reduced.
11. Moving air and water can be used to run machines.
12. Sunlight is used to run many devices.
13. Some people try to reduce the amount of fuels they use in order to conserve resources, reduce pollution, or save money.
14. People have invented devices such as paper and ink, engraved plastic disks, and magnetic tapes for recording information. These devices enable great amounts of information to be stored, retrieved, and sent to other people or places.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 6-8**

1. Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.
2. Design usually requires taking into account not only physical and biological constraints, but also economic, political, social, ethical, and aesthetic ones.
3. Rarely are technology issues simple and one-sided. Relevant facts alone, even when known and available, usually do not settle matters. That is because contending groups may have different values and priorities. They may stand to gain or lose in different degrees, or may make very different predictions about what the future consequences of the proposed action will be.
4. Societies influence what aspects of technology are developed and how these are used. People control technology (as well as science) and are responsible for its effects.
5. Scientific laws, engineering principles, properties of materials, and construction techniques must be taken into account in designing engineering solutions to problems.
6. In all technologies, there are always trade-offs to be made.
7. Throughout history, people have carried out impressive technological feats, some of which would be hard to duplicate today even with modern tools. The purposes served by these achievements have sometimes been practical, sometimes ceremonial.
8. People control some characteristics of plants and animals they raise by selective breeding and by preserving varieties of seeds (old and new) to use if growing conditions change.
9. Automation, including the use of robots, has changed the nature of work in most fields, including manufacturing. As a result, the demand for workers with some knowledge and skills has decreased while the demand for workers with other knowledge and skills has increased. Furthermore, as the pace of innovation has increased, workers have needed to learn new skills throughout their careers.
10. Efforts to find replacements for existing materials are driven by an interest in finding materials that are cheaper to obtain or produce or that have more desirable properties.
11. Some materials, such as plastics, are synthesized in chemical reactions that link atoms together in long chains. Plastics can be designed to have a variety of different properties for a variety of uses.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 6-8**

1. Transformations and transfers of energy within a system usually result in some energy escaping into its surrounding environment. Some systems transfer less energy to their environment than others during these transformations and transfers.
2. Different ways of obtaining, transforming, and distributing energy have different environmental consequences.
3. In many instances, manufacturing and other technological activities are performed at a site close to an energy resource. Some forms of energy are transported easily, others are not.
4. Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of energy. Electric circuits are used to distribute energy quickly and conveniently to distant locations. 8C/M4\*
5. Energy from the sun (and the wind and water energy derived from it) is available indefinitely. Because the transfer of energy from these resources is weak and variable, systems are needed to collect and concentrate the energy.
6. Industry, transportation, urban development, agriculture, and most other human activities are closely tied to the amount and kind of energy available. People in different parts of the world have different amounts and kinds of energy resources to use and use them for different purposes.
7. Energy is required for technological processes such as taking apart, putting together, moving around, and communicating.
8. People have invented ingenious ways of deliberately bringing about energy transformations that are useful to them.
9. Energy resources are more useful if they are concentrated and easy to transport.
10. Some resources are not renewable or renew very slowly. Fuels already accumulated in the earth, for instance, will become more difficult to obtain as the most readily available resources run out. How long the resources will last, however, is difficult to predict. The ultimate limit may be the prohibitive cost of obtaining them.
11. By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy which spreads throughout the environment.
12. It is possible to manufacture complex chemical substances such as insulin and hormones that are normally found in the body. They can be used by individuals whose own bodies do not produce the amounts required for good health.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 6-8**

1. As the knowledge of how cells in the body detect and fight invaders has grown, the transplantation of tissue or whole organs has become increasingly common. New materials that are durable and less likely to be rejected by the immune system now make it possible to replace some body parts and to implant devices for electrically pacing the heart, sensing internal conditions, or slowly dispensing drugs at optimal times.
2. Many diseases are caused by bacteria or viruses.
3. If the body's immune system cannot suppress a bacterial infection, an antibacterial drug may be effective—at least against the types of bacteria it was designed to combat. Less is known about the treatment of viral infections, especially the common cold. However, more recently, useful antiviral drugs have been developed for several major kinds of viral infections, including drugs to fight HIV, the virus that causes AIDS.
4. Increased knowledge about nutrition has led to the development of diets containing the variety of foods that can help people live longer and healthier lives.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**GRADES 9-12**

1. Mathematics, creativity, logic, and originality are all needed to improve technology.
2. *Technology usually affects society more directly than science does because technology solves practical problems and serves human needs (and also creates new problems and needs).*
3. Scientific knowledge provides a means of estimating what the behavior of things will be even before they are made. Moreover, science often suggests new kinds of behavior that had not even been imagined before, and so leads to new technologies.
4. Engineers use knowledge of science and technology, together with strategies of design, to solve practical problems.
5. The value of any given technology may be different for different groups of people and at different points in time.
6. Risk analysis is used to minimize the likelihood of unwanted side effects of a new technology. The public perception of risk may depend, however, on psychological factors as well as scientific ones.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**Grades 9-12**

1. The human species has a major impact on other species in many ways: reducing the amount of the earth's surface available to those other species, interfering with their food sources, changing the temperature and chemical composition of their habitats, introducing foreign species into their ecosystems, and altering organisms directly through selective breeding and genetic engineering.
2. Human inventiveness has brought new risks as well as improvements to human existence.
3. The human ability to influence the course of history comes from its capacity for generating knowledge and developing new technologies—and for communicating ideas to others.
4. New varieties of farm plants and animals have been engineered by manipulating their genetic instructions to produce new characteristics.
5. Government sometimes intervenes in matching agricultural supply to demand to ensure a stable, high-quality, and inexpensive food supply. Regulations are often also designed to protect farmers from abrupt changes in farming conditions and from competition from other countries.
6. Agricultural technology requires trade-offs between increased production and environmental harm and between efficient production and social values.
7. In the 1900s, agricultural technology led to a huge shift of population from farms to cities and to a great change in how people live and work.
8. Manufacturing processes have been changed by improved tools and techniques based on more thorough scientific understanding, increases in the forces that can be applied and the temperatures that can be reached, and the availability of electronic controls that make operations occur more rapidly and consistently.
9. Waste management includes considerations of quantity, safety, degradability, and cost. It requires social and technological innovations, because waste-disposal problems are political and economic as well as technical.
10. Increased knowledge of the properties of particular molecular structures helps in the design and synthesis of new materials for special purposes.
11. Objects made up of a small number of atoms may exhibit different properties than macroscopic objects made up of the same kinds of atoms.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**Grades 9-12**

1. Groups of atoms and molecules can form structures that can be measured in billionths of a meter. The properties of structures at this scale (known as the nanoscale) and materials composed of such structures, can be very different than the properties at the macroscopic scale because of the increase in the ratio of surface area to volume and changes in the relative strengths of different forces at different scales. Increased knowledge of the properties of materials at the nanoscale provides a basis for the development of new materials and new uses of existing materials.
2. The development of new materials and the increased use of existing materials by a growing human population have led to the removal of resources from the environment much more rapidly than they can be replaced by natural processes. Disposal of waste materials has also become a problem. Solving these problems requires systematic efforts involving both social and technological innovations.
3. A central factor in technological change has been how hot a fire could be made. The discovery of new fuels, the design of better ovens and furnaces, and the forced delivery of air or pure oxygen have progressively increased the maximum possible temperature.
4. Lasers are a new tool for focusing radiation energy with great intensity and control.
5. When selecting fuels, it is important to consider the relative advantages and disadvantages of each fuel.
6. Nuclear reactions release energy without the combustion products of burning fuels, but the radioactivity of fuels and their by-products poses other risks.
7. Industrialization brings an increased demand for and use of energy. Such usage contributes to having many more goods and services in the industrially developing nations but also leads to more rapid depletion of the earth's energy resources and to environmental risks associated with some energy resources.
8. Decisions to slow the depletion of energy resources can be made at many levels, from personal to national, and they always involve trade-offs involving economic costs and social values.
9. The useful energy output of a device—that is, what energy is available for further change—is always less than the energy input, with the difference usually appearing as thermal energy. One goal in the design of such devices is to make them as efficient as possible—that is, to maximize the useful output for a given input.
10. During any transformation of energy, there is inevitably some dissipation of energy into the environment. In this practical sense, energy gets "used up," even though it is still around somewhere.

**STANDARD 2: SCIENCE AND TECHNOLOGY**

**Benchmarks**

**Grades 9-12**

1. Sunlight is the ultimate source of most of the energy we use. The energy in fossil fuels such as oil and coal comes from energy that plants captured from the sun long ago.
2. Almost all body substances and functions have daily or longer cycles. These cycles often need to be taken into account in interpreting normal ranges for body measurements, detecting disease, and planning treatment of illness. Computers aid in detecting, analyzing, and monitoring these cycles.
3. Knowledge of genetics is opening whole new fields of health care. In diagnosis, mapping of genetic instructions in cells makes it possible to detect defective genes that may lead to poor health. In treatment, substances from genetically engineered organisms may reduce the cost and side effects of replacing missing body chemicals.
4. Inoculations use weakened germs (or parts of them) to stimulate the body's immune system to react. This reaction prepares the body to fight subsequent invasions by actual germs of that type. Some inoculations last for life.
5. Knowledge of molecular structure and interactions aids in synthesizing new drugs and predicting their effects.
6. Techniques for detecting and diagnosing mental disorders include observation of behavior, in-depth interviews, and measurements of brain activity. Treatments for mental disorders range from conversation with the patient to treating the brain with chemicals, electric shock, or surgery.
7. Biotechnology has contributed to health improvement in many ways, but its cost and application have led to a variety of controversial social and ethical issues.
8. The incorrect use of any given antibacterial drug can lead, by means of natural selection, to the spread of bacteria that are not affected by it.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades K-2**

1. There are more stars in the sky than anyone can easily count, but they are not scattered evenly, and they are not all the same in brightness or color.
2. The sun can be seen only in the daytime, but the moon can be seen sometimes at night and sometimes during the day. The sun, moon, and stars all appear to move slowly across the sky.
3. The moon looks a little different every day but looks the same again about every four weeks.
4. The temperature and amount of rain (or snow) tend to be high, low, or medium in the same months every year.
5. Water can be a liquid or a solid and can go back and forth from one form to the other. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.
6. Water left in an open container disappears, but water in a closed container does not disappear.
7. Animals and plants sometimes cause changes in their surroundings.
8. Objects can be described in terms of their properties. Some properties, such as hardness and flexibility, depend upon what material the object is made of, and some properties, such as size and shape, do not.
9. Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.
10. The sun warms the land, air, and water.
11. Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow.
12. The way to change how something is moving is to give it a push or a pull.
13. Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow.
14. The way to change how something is moving is to give it a push or a pull.
15. Things that make sound vibrate.
16. Chunks of rocks come in many sizes and shapes, from boulders to grains of sand and even smaller.
17. Magnets can be used to make some things move without being touched.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 3-5**

1. The patterns of stars in the sky stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons.
2. Telescopes magnify the appearance of some distant objects in the sky, including the moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than can be seen by the unaided eye.
3. Planets change their positions against the background of stars.
4. The earth is one of several planets that orbit the sun, and the moon orbits around the earth.
5. Stars are like the sun, some being smaller and some larger, but so far away that they look like points of light.
6. A large light source at a great distance looks like a small light source that is much closer.
7. The earth is approximately spherical in shape. Like the earth, the sun and planets are spheres.
8. The rotation of the earth on its axis every 24 hours produces the night-and-day cycle. To people on earth, this turning of the planet makes it seem as though the sun, moon, planets, and stars are orbiting the earth once a day.
9. When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets or frozen crystals of water.
10. Air is a material that surrounds us and takes up space and whose movement we feel as wind.
11. The weather is always changing and can be described by measurable quantities such as temperature, wind direction and speed, and precipitation. Large masses of air with certain properties move across the surface of the earth. The movement and interaction of these air masses is used to forecast the weather.
12. Heating and cooling can cause changes in the properties of materials, but not all materials respond the same way to being heated and cooled.
13. Many kinds of changes occur faster under hotter conditions.
14. No matter how parts of an object are assembled, the weight of the whole object is always the same as the sum of the parts; and when an object is broken into parts, the parts have the same total weight as the original object.
15. Materials may be composed of parts that are too small to be seen without magnification.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 3-5**

1. When a new material is made by combining two or more materials, it has properties that are different from the original materials.
2. A lot of different materials can be made from a small number of basic kinds of materials.
3. Substances may move from place to place, but they never appear out of nowhere and never just disappear.
4. All materials have certain physical properties, such as strength, hardness, flexibility, durability, resistance to water and fire, and ease of conducting heat.
5. Collections of pieces (powders, marbles, sugar cubes, or wooden blocks) may have properties that the individual pieces do not.
6. Light travels and tends to maintain its direction of motion until it interacts with an object or material. Light can be absorbed, redirected, bounced back, or allowed to pass through.
7. Without touching them, an object that has been electrically charged pulls on all other uncharged objects and may either push or pull other charged objects.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. The sun is a medium-sized star located near the edge of a disc-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night.
2. The universe contains many billions of galaxies, and each galaxy contains many billions of stars. To the naked eye, even the closest of these galaxies is no more than a dim, fuzzy spot.
3. The sun is many thousands of times closer to the earth than any other star. Light from the sun takes a few minutes to reach the earth, but light from the next nearest star takes a few years to arrive. The trip to that star would take the fastest rocket thousands of years.
4. Many chunks of rock orbit the sun. Those that meet the earth glow and disintegrate from friction as they plunge through the atmosphere—and sometimes impact the ground. Other chunks of rock mixed with ice have long, off-center orbits that carry them close to the sun, where the sun's radiation (of light and particles) boils off frozen materials from their surfaces and pushes it into a long, illuminated tail.
5. Earth is the only body in the solar system that appears able to support life. The other planets have compositions and conditions very different from the earth's.
6. Everything on or anywhere near the earth is pulled toward the earth's center by gravitational force.
7. The moon's orbit around the earth once in about 28 days changes what part of the moon is lighted by the sun and how much of that part can be seen from the earth- the phases of the moon.
8. Climates have sometimes changed abruptly in the past as a result of volcanic eruptions or impacts of huge rocks from space.
9. Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. The water falling on land collects in rivers and lakes, soil, and porous layers of rock, and much of it flows back into the oceans. The cycling of water in and out of the atmosphere is a significant aspect of the weather patterns on Earth.
10. Fresh water, limited in supply, is essential for some organisms and industrial processes. Water in rivers, lakes, and underground can be depleted or polluted, making it unavailable or unsuitable for life.
11. Thermal energy carried by ocean currents has a strong influence on climates around the world. Areas near oceans tend to have more moderate temperatures than they would if they were farther inland but at the same latitude because water in the oceans can hold a large amount of thermal energy.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. Some material resources are very rare and some exist in great quantities. The ability to obtain and process resources depends on where they are located and the form they are in. As resources are depleted, they may become more difficult to obtain.
2. Recycling materials and the development of substitutes for those materials can reduce the rate of depletion of resources but may also be costly. Some materials are not easily recycled.
3. The benefits of Earth's resources—such as fresh water, air, soil, and trees—can be reduced by deliberately or inadvertently polluting them. The atmosphere, the oceans, and the land have a limited capacity to absorb and recycle waste materials. In addition, some materials take a long time to degrade. Therefore, cleaning up polluted air, water, or soil can be difficult and costly.
4. The atmosphere is a mixture of nitrogen, oxygen, and trace amounts of water vapor, carbon dioxide, and other gases.
5. The interior of the earth is hot. Heat flow and movement of material within the earth cause earthquakes and volcanic eruptions and create mountains and ocean basins. Gas and dust from large volcanoes can change the atmosphere.
6. Some changes in the earth's surface are abrupt (such as earthquakes and volcanic eruptions) while other changes happen very slowly (such as uplift and wearing down of mountains).
7. Sediments of sand and smaller particles (sometimes containing the remains of organisms) are gradually buried and are cemented together by dissolved minerals to form solid rock again.
8. Sedimentary rock buried deep enough may be re-formed by pressure and heat, perhaps melting and recrystallizing into different kinds of rock. These re-formed rock layers may be forced up again to become land surface and even mountains. Subsequently, this new rock too will erode. Rock bears evidence of the minerals, temperatures, and forces that created it.
9. Thousands of layers of sedimentary rock confirm the long history of the changing surface of the earth and the changing life forms whose remains are found in successive layers. The youngest layers are not always found on top, because of folding, breaking, and uplift of layers.
10. There are a variety of different land forms on the earth's surface (such as coastlines, rivers, mountains, deltas, and canyons).
11. Matching coastlines and similarities in rock types and life forms suggest that today's continents are separated parts of what was long ago a single continent.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. The earth first formed in a molten state and then the surface cooled into solid rock.
2. The outer layer of the earth—including both the continents and the ocean basins—consists of separate plates.
3. The earth's plates sit on a dense, hot, somewhat melted layer of the earth. The plates move very slowly, pressing against one another in some places and pulling apart in other places, sometimes scraping alongside each other as they do. Mountains form as two continental plates, or an ocean plate and a continental plate, press together.
4. There are worldwide patterns to major geological events (such as earthquakes, volcanic eruptions, and mountain building) that coincide with plate boundaries.
5. All matter is made up of atoms, which are far too small to see directly through a microscope.
6. The atoms of any element are like other atoms of the same element, but are different from the atoms of other elements.
7. Atoms may link together in well-defined molecules, or may be packed together in crystal patterns. Different arrangements of atoms into groups compose all substances and determine the characteristic properties of substances.
8. Equal volumes of different materials usually have different masses.
9. Atoms and molecules are perpetually in motion. Increased temperature means greater average energy of motion, so most substances expand when heated.
10. In solids, the atoms or molecules are closely locked in position and can only vibrate. In liquids, they have higher energy, are more loosely connected, and can slide past one another; some molecules may get enough energy to escape into a gas. In gases, the atoms or molecules have still more energy and are free of one another except during occasional collisions.
11. The temperature of a solution influences reaction rates. Many substances dissolve in water, which may greatly facilitate reactions between them.
12. Chemical elements are those substances that do not break down during normal laboratory reactions involving such treatments as heating, exposure to electric current, or reaction with acids. All substances from living and nonliving things can be broken down to a set of about 100 elements, but since most elements tend to combine with others, few elements are found in their pure form.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. There are groups of elements that have similar properties, including highly reactive metals, less-reactive metals, highly reactive nonmetals (such as chlorine, fluorine, and oxygen), and some almost completely nonreactive gases (such as helium and neon).
2. An important kind of reaction between substances involves the combination of oxygen with something else—as in burning or rusting.
3. Carbon and hydrogen are common elements of living matter.
4. No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same.
5. The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how the same atoms are rearranged, then their total mass stays the same.
6. Materials vary in how they respond to electric currents, magnetic forces, and visible light or other electromagnetic waves.
7. A substance has characteristic properties such as density, a boiling point, and solubility, all of which are independent of the amount of the substance and can be used to identify it.
8. Substances react chemically in characteristic ways with other substances to form new substances with different characteristic properties.
9. If samples of both the original substances and the final substances involved in a chemical reaction are broken down, they are found to be made up of the same set of elements.
10. The idea of atoms explains chemical reactions: When substances interact to form new substances, the atoms that make up the molecules of the original substances combine in new ways.
11. Energy can be transferred from one system to another (or from a system to its environment) in different ways: 1) thermally, when a warmer object is in contact with a cooler one; 2) mechanically, when two objects push or pull on each other over a distance; 3) electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device; or 4) by electromagnetic waves.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. Thermal energy is transferred through a material by the collisions of atoms within the material. Over time, the thermal energy tends to spread out through a material and from one material to another if they are in contact. Thermal energy can also be transferred by means of currents in air, water, or other fluids. In addition, some thermal energy in all materials is transformed into light energy and radiated into the environment by electromagnetic waves; that light energy can be transformed back into thermal energy when the electromagnetic waves strike another material. As a result, a material tends to cool down unless some other form of energy is converted to thermal energy in the material.
2. Energy appears in different forms and can be transformed within a system. Motion energy is associated with the speed of an object. Thermal energy is associated with the temperature of an object. Gravitational energy is associated with the height of an object above a reference point. Elastic energy is associated with the stretching or compressing of an elastic object. Chemical energy is associated with the composition of a substance. Electrical energy is associated with an electric current in a circuit. Light energy is associated with the frequency of electromagnetic waves.
3. Light and other electromagnetic waves can warm objects. How much an object's temperature increases depends on how intense the light striking its surface is, how long the light shines on the object, and how much of the light is absorbed.
4. Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors.
5. Something can be "seen" when light waves emitted or reflected by it enter the eye—just as something can be "heard" when sound waves from it enter the ear.
6. An unbalanced force acting on an object changes its speed or direction of motion, or both.
7. If a force acts towards a single center, the object's path may curve into an orbit around the center.
8. Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials.
9. Human eyes respond to only a narrow range of wavelengths of electromagnetic waves-visible light. Differences of wavelength within that range are perceived as differences of color.
10. Light acts like a wave in many ways. And waves can explain how light behaves.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 6-8**

1. There are a great variety of electromagnetic waves: radio waves, microwaves, infrared waves, visible light, ultraviolet rays, X-rays, and gamma rays. These wavelengths vary from radio waves, the longest, to gamma rays, the shortest.
2. Every object exerts gravitational force on every other object. The force depends on how much mass the objects have and on how far apart they are. The force is hard to detect unless at least one of the objects has a lot of mass.
3. The sun's gravitational pull holds the earth and other planets in their orbits, just as the planets' gravitational pull keeps their moons in orbit around them.
4. Electric currents and magnets can exert a force on each other.
5. Electrical circuits require a complete loop through which an electrical current can pass.
6. A charged object can be charged in one of two ways, which we call either positively charged or negatively charged. Two objects that are charged in the same manner exert a force of repulsion on each other, while oppositely charged objects exert a force of attraction on each other.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

1. On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass.
2. Mathematical models and computer simulations are used in studying evidence from many sources in order to form a scientific account of the universe.
3. Life is adapted to conditions on the earth, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of electromagnetic waves from the sun that allows water to be present in the liquid state.
4. Transfer of thermal energy between the atmosphere and the land or oceans produces temperature gradients in the atmosphere and the oceans. Regions at different temperatures rise or sink or mix, resulting in winds and ocean currents. These winds and ocean currents, which are also affected by the earth's rotation and the shape of the land, carry thermal energy from warm to cool areas.
5. Because the earth turns daily on an axis that is tilted relative to the plane of the earth's yearly orbit around the sun, sunlight falls more intensely on different parts of the earth during the year. The difference in intensity of sunlight and the resulting warming of the earth's surface produces the seasonal variations in temperature.
6. Greenhouse gases in the atmosphere, such as carbon dioxide and water vapor, are transparent to much of the incoming sunlight but not to the infrared light from the warmed surface of the earth. When greenhouse gases increase, more thermal energy is trapped in the atmosphere, and the temperature of the earth increases the light energy radiated into space until it again equals the light energy absorbed from the sun.
7. Climatic conditions result from latitude, altitude, and from the position of mountain ranges, oceans, and lakes. Dynamic processes such as cloud formation, ocean currents, and atmospheric circulation patterns influence climates as well.
8. The earth's climates have changed in the past, are currently changing, and are expected to change in the future, primarily due to changes in the amount of light reaching places on the earth and the composition of the atmosphere. The burning of fossil fuels in the last century has increased the amount of greenhouse gases in the atmosphere, which has contributed to Earth's warming.
9. The earth has many natural resources of great importance to human life. Some are readily renewable, some are renewable only at great cost, and some are not renewable at all.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

1. Although the earth has a great capacity to absorb and recycle materials naturally, ecosystems have only a finite capacity to withstand change without experiencing major ecological alterations that may also have adverse effects on human activities.
2. Plants on land and under water alter the earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.
3. The formation, weathering, sedimentation, and reformation of rock constitute a continuing "rock cycle" in which the total amount of material stays the same as its forms change.
4. The outward transfer of the earth's internal heat causes regions of different temperatures and densities. The action of a gravitational force on regions of different densities causes the rise and fall of material between the earth's surface and interior, which is responsible for the movement of plates.
5. Earthquakes often occur along the boundaries between colliding plates, and molten rock from below creates pressure that is released by volcanic eruptions, helping to build up mountains. Under the ocean basins, molten rock may well up between separating plates to create new ocean floor. Volcanic activity along the ocean floor may form undersea mountains, which can thrust above the ocean's surface to become islands.
6. Scientific evidence indicates that some rock layers are several billion years old.
7. Atoms are made of a positively charged nucleus surrounded by negatively charged electrons. The nucleus is a tiny fraction of the volume of an atom but makes up almost all of its mass. The nucleus is composed of protons and neutrons which have roughly the same mass but differ in that protons are positively charged while neutrons have no electric charge.
8. The number of protons in the nucleus determines what an atom's electron configuration can be and so defines the element. An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons.
9. Although neutrons have little effect on how an atom interacts with other atoms, the number of neutrons does affect the mass and stability of the nucleus. Isotopes of the same element have the same number of protons (and therefore of electrons) but differ in the number of neutrons.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

1. The nucleus of radioactive isotopes is unstable and spontaneously decays, emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. This predictability of decay rate allows radioactivity to be used for estimating the age of materials that contain radioactive substances.
2. Scientists continue to investigate atoms and have discovered even smaller constituents of which neutrons and protons are made.
3. When elements are listed in order by the masses of their atoms, the same sequence of properties appears over and over again in the list.
4. Atoms often join with one another in various combinations in distinct molecules or in repeating three-dimensional crystal patterns.
5. An enormous variety of biological, chemical, and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.
6. The configuration of atoms in a molecule determines the molecule's properties. Shapes are particularly important in how large molecules interact with others.
7. The rate of reactions among atoms and molecules depends on how often they encounter one another, which is affected by the concentration, pressure, and temperature of the reacting materials.
8. Some atoms and molecules are highly effective in encouraging the interaction of others.
9. The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.
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**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

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9. The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.
10. The change in motion (direction or speed) of an object is proportional to the applied force and inversely proportional to the mass.
11. All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion.
12. When electrically charged objects undergo a change in motion, they produce electromagnetic waves around them.
13. In empty space, all electromagnetic waves move at the same speed—the "speed of light."
14. Whenever one thing exerts a force on another, an equal amount of force is exerted back on it.
15. The observed wavelength of a wave depends upon the relative motion of the source and the observer. If either is moving toward the other, the observed wavelength is shorter; if either is moving away, the wavelength is longer.

**STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

1. Because the light seen from almost all distant galaxies has longer wavelengths than comparable light here on Earth, astronomers believe that the whole universe is expanding.
2. Waves can superpose on one another, bend around corners, reflect off surfaces, be absorbed by materials they enter, and change direction when entering a new material. All these effects vary with wavelength.
3. The energy of waves (like any form of energy) can be changed into other forms of energy.
4. Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it.
5. Gravitational force is an attraction between masses. The strength of the force is proportional to the masses and weakens rapidly with increasing distance between them.
6. Electric forces acting within and between atoms are vastly stronger than the gravitational forces acting between the atoms. At larger scales, gravitational forces accumulate to produce a large and noticeable effect, whereas electric forces tend to cancel each other out.
7. At the atomic level, electric forces between electrons and protons in atoms hold molecules together and thus are involved in all chemical reactions.
8. Electric forces hold solid and liquid materials together and act between objects when they are in contact—as in sticking or sliding friction.
9. Most materials have equal numbers of protons and electrons and are therefore electrically neutral. In most cases, a material acquires a negative charge by gaining electrons and acquires a positive charge by losing electrons. Even a tiny imbalance in the number of protons and electrons in an object can produce noticeable electric forces on other objects.
10. In many conducting materials, such as metals, some of the electrons are not firmly held by the nuclei of the atoms that make up the material. In these materials, applied electric forces can cause the electrons to move through the material, producing an electric current. In insulating materials, such as glass, the electrons are held more firmly, making it nearly impossible to produce an electric current in those materials.
11. At very low temperatures, some materials become superconductors and offer no resistance to the flow of electrons.
12. Semiconducting materials differ greatly in how well they conduct electrons, depending on the exact composition of the material.
13. Magnetic forces are very closely related to electric forces and are thought of as different aspects of a single electromagnetic force. Moving electrically charged objects produces magnetic forces and moving magnets produces electric forces.

**SCIENCE STANDARD 3: THE PHYSICAL SETTING**

**Benchmarks**

**Grades 9-12**

1. The interplay of electric and magnetic forces is the basis for many modern technologies, including electric motors, generators, and devices that produce or receive electromagnetic waves.
2. The nuclear forces that hold the protons and neutrons in the nucleus of an atom together are much stronger than the electric forces between the protons and electrons of the atom. That is why much greater amounts of energy are released from nuclear reactions than from chemical reactions.
3. Electric currents in the earth's interior give the earth an extensive magnetic field, which we detect from the orientation of compass needles.
4. The motion of electrons is far more affected by electrical forces than protons are because electrons are much less massive and are outside of the nucleus.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades K-2**

1. Some animals and plants are alike in the way they look and in the things they do, and others are very different from one another.
2. There is variation among individuals of one kind within a population.
3. Offspring are very much, but not exactly, like their parents and like one another.
4. Magnifiers help people see things they could not see without them.
5. Most living things need water, food, and air.
6. Animals eat plants or other animals for food and may also use plants (or even other animals) for shelter and nesting.
7. Living things are found almost everywhere in the world. There are somewhat different kinds in different places.
8. Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in.
9. Microscopes make it possible to see that living things are made mostly of cells.
10. Some organisms are made of a collection of similar cells that benefit from cooperating. Some organisms' cells vary greatly in appearance and perform very different roles in the organism.
11. Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light.
12. Many materials can be recycled and used again, sometimes in different forms.
13. Different plants and animals have external features that help them thrive in different kinds of places.
14. Some kinds of organisms that once lived on Earth have completely disappeared, although they were something like others that are alive today.
15. People have different external features, such as the size, shape, and color of hair, skin, and eyes, but they are more like one another than like other animals.
16. People need water, food, air, waste removal, and a particular range of temperatures in their environment, just as other animals do.
17. People tend to live in families and communities in which individuals have different roles.
18. All kinds of animals have offspring, usually with two parents involved.
19. A human baby grows inside its mother until its birth. Even after birth, a human baby is unable to care for itself, and its survival depends on the care it receives from adults.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades K-2**

1. The human body has parts that help it seek, find, and take in food when it feels hunger—eyes and a nose for detecting food, legs to get to it, arms to carry it away, and a mouth to eat it.
2. Senses can warn individuals about danger; People use their senses to find out about their surroundings and themselves. Different senses give different information.
3. Eating a variety of healthful foods and getting enough exercise and rest help people to stay healthy.
4. Some things people take into their bodies from the environment can hurt them.
5. Some diseases are caused by germs, some are not. Diseases caused by germs may be spread by people who have them. Washing one's hands with soap and water reduces the number of germs that can get into the body or that can be passed on to other people.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 3-5**

1. A great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group.
2. There are millions of different kinds of individual organisms that inhabit the earth at any one time—some very similar to each other, some very different.
3. Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in.
4. Microscopes make it possible to see that living things are made mostly of cells.
5. Some organisms are made of a collection of similar cells that benefit from cooperating. Some organisms' cells vary greatly in appearance and perform very different roles in the organism.
6. For any particular environment, some kinds of plants and animals thrive, some do not live as well, and some do not survive at all.
7. Insects and various other organisms depend on dead plant and animal material for food.
8. Organisms interact with one another in various ways besides providing food.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 3-5**

1. Many plants depend on animals for carrying their pollen to other plants or for dispersing their seeds.
2. Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.
3. Most microorganisms do not cause disease, and many are beneficial.
4. Almost all kinds of animals' food can be traced back to plants.
5. Some source of "energy" is needed for all organisms to stay alive and grow.
6. Over the whole earth, organisms are growing, dying, decaying, and new organisms are being produced by the old ones.
7. It takes about nine months for a human to develop inside its mother. The developing baby is nourished by the mother, so substances she takes in will affect how well or poorly the baby develops.
8. Human beings live longer than most other animals, but all living things die.
9. In the first few years after birth, most children make remarkable gains in their physical and mental abilities that allow them to interact with others and with their environment.
10. From food, people obtain fuel and materials for body repair and growth.
11. The indigestible parts of food are eliminated.
12. By breathing, people take in the oxygen they need to live.
13. Tobacco, alcohol, other drugs, and certain poisons in the environment—such as pesticides and lead—can harm human beings and other living things.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 6-8**

1. One of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms, many of them microscopic, cannot be neatly classified as either plants or animals.
2. Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce.
3. Similarities among organisms are found in internal anatomical features, which can be used to infer the degree of relatedness among organisms.
4. In classifying organisms, scientists consider details of both internal and external structures.
5. Traditionally, a species has been defined as all organisms that can mate with one another to produce fertile offspring.
6. In some kinds of organisms, all the genes come from a single parent.
7. In organisms that have two sexes, typically half of the genes come from each parent.
8. In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male.
9. The same genetic information is copied in each cell of the new organism.
10. New varieties of cultivated plants and domestic animals have resulted from selective breeding for particular traits.
11. All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope.
12. Different body tissues and organs are made up of different kinds of cells.
13. The cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants.
14. Cells repeatedly divide to make more cells for growth and repair.
15. Various organs and tissues function to serve the needs of all cells for food, air, and waste removal.
16. Within cells, many of the basic functions of organisms—such as extracting energy from food and getting rid of waste—are carried out.
17. The way in which cells function is similar in all living organisms.
18. About two thirds of the weight of cells is accounted for by water, which gives cells many of their properties.
19. In all environments, organisms with similar needs may compete with one another for limited resources, including food, space, water, air, and shelter.
20. Interactions between organisms may be for nourishment, reproduction, or protection and may benefit one of the organisms or both of them. Some species have become so dependent on each other that neither could survive without the other.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 6-8**

1. One organism may scavenge or decompose another.
2. Given adequate resources and an absence of disease or predators, populations of organisms in ecosystems increase at rapid rates. Finite resources and other factors limit their growth.
3. All organisms, both land-based and aquatic, are interconnected by their need for food. This network of interconnections is referred to as a food web. The entire earth can be considered a single global food web, and food webs can also be described for a particular environment. At the base of any food web are organisms that make their own food, followed by the animals that eat them, then the animals that eat those animals, and so forth.
4. Food provides molecules that serve as fuel and building material for all organisms.
5. Plants use the energy from light to make sugars from carbon dioxide and water.
6. Plants can use the food they make immediately or store it for later use.
7. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.
8. Energy can change from one form to another in living things.
9. Organisms get energy from oxidizing their food, releasing some of its energy as thermal energy.
10. Almost all food energy comes originally from sunlight.
11. Small differences between parents and offspring can accumulate (through selective breeding) in successive generations so that descendants are very different from their ancestors.
12. Individual organisms with certain traits are more likely than others to survive and have offspring.
13. Changes in environmental conditions can affect the survival of individual organisms and entire species.
14. Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks.
15. More recently deposited rock layers are more likely to contain fossils resembling existing species.
16. Most species that have lived on the earth are now extinct. Extinction of species occurs when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment.
17. Reproduction is necessary for the survival of any species.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 6-8**

1. Organs and organ systems are composed of cells and help to provide all cells with basic needs.
2. For the body to use food for energy and building materials, the food must first be digested into molecules that are absorbed and transported to cells.
3. To burn food for the release of energy stored in it, oxygen must be supplied to cells, and carbon dioxide removed. Lungs take in oxygen for the combustion of food and eliminate the carbon dioxide produced. The urinary system disposes of dissolved waste molecules, the intestinal tract removes solid wastes, and the skin and lungs aid in the transfer of thermal energy from the body. The circulatory system moves all these substances to or from cells where they are needed or produced, responding to changing demands.
4. Specialized cells and the molecules they produce identify and destroy microbes that get inside the body.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. The variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions.
2. A great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.
3. The degree of relatedness between organisms or species can be estimated from the similarity of their DNA sequences, which often closely match their classification based on anatomical similarities.
4. Similar patterns of development and internal anatomy suggest relatedness among organisms.
5. Most complex molecules of living organisms are built up from smaller molecules. The various kinds of small molecules are much the same in all life forms, but the specific sequences of components that make up the very complex molecules are characteristic of a given species.
6. A classification system is a framework created by scientists for describing the vast diversity of organisms, indicating the degree of relatedness between organisms, and framing research questions.
7. Some new gene combinations make little difference, some can produce organisms with new and perhaps enhanced capabilities, and some can be deleterious.
8. The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations in the offspring of any two parents.
9. The information passed from parents to offspring is coded in DNA molecules, long chains linking just four kinds of smaller molecules, whose precise sequence encodes genetic information.
10. Genes are segments of DNA molecules. Inserting, deleting, or substituting segments of DNA molecules can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment.
11. Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, they can be passed on to offspring; if they occur in other cells, they can be passed on to descendant cells only. The experiences an organism has during its lifetime can affect its offspring only if the genes in its own sex cells are changed by the experience.
12. The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions.
13. Different parts of the genetic instructions are used in different types of cells, influenced by the cell's environment and past history.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. Heritable characteristics can include details of biochemistry and anatomical features that are ultimately produced in the development of the organism. By biochemical or anatomical means, heritable characteristics may also influence behavior.
2. Every cell is covered by a membrane that controls what can enter and leave the cell.
3. In all but quite primitive cells, a complex network of proteins provides organization and shape and, for animal cells, movement.
4. Within the cells are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, passing information, and even movement.
5. In addition to the basic cellular functions common to all cells, most cells in multicellular organisms perform some special functions that others do not.
6. The work of the cell is carried out by the many different types of molecules it assembles, mostly proteins. Protein molecules are long, usually folded chains made from 20 different kinds of amino acid molecules. The function of each protein molecule depends on its specific sequence of amino acids and its shape. The shape of the chain is a consequence of attractions between its parts.
7. The genetic information encoded in DNA molecules provides instructions for assembling protein molecules.
8. The genetic information encoded in DNA molecules is virtually the same for all life forms.
9. Before a cell divides, the instructions are duplicated so that each of the two new cells gets all the necessary information for carrying on.
10. Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Cell behavior can also be affected by molecules from other parts of the organism or even other organisms.
11. Gene mutation in a cell can result in uncontrolled division called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus the chance of cancer.
12. Most cells function best within a narrow range of temperature and acidity. At very low temperatures, reaction rates are too slow. High temperatures and/or extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. A living cell is composed of a small number of chemical elements mainly carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules.
2. Ecosystems can be reasonably stable over hundreds or thousands of years. As any population grows, its size is limited by one or more environmental factors: availability of food, availability of nesting sites, or number of predators.
3. If a disturbance such as flood, fire, or the addition or loss of species occurs, the affected ecosystem may return to a system similar to the original one, or it may take a new direction, leading to a very different type of ecosystem. Changes in climate can produce very large changes in ecosystems.
4. Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.
5. At times, environmental conditions are such that land and marine organisms reproduce and grow faster than they die and decompose to simple carbon containing molecules that are returned to the environment. Over time, layers of energy-rich organic material inside the earth have been chemically changed into great coal beds and oil pools.
6. The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment. Continual input of energy from sunlight keeps the process going.
7. The basic idea of biological evolution is that the earth's present-day species are descended from earlier, distinctly different species.
8. Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched off from one another.
9. Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species; some of these characteristics give individuals an advantage over others in surviving and reproducing; and the advantaged offspring, in turn, are more likely than others to survive and reproduce. As a result, the proportion of individuals that have advantageous characteristics will increase.
10. Heritable characteristics can be observed at molecular and whole-organism levels—in structure, chemistry, or behavior.
11. Heritable characteristics influence how likely an organism is to survive and reproduce.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. New heritable characteristics can result from new combinations of existing genes or from mutations of genes in reproductive cells. Changes in other cells of an organism cannot be passed on to the next generation.
2. Natural selection leads to organisms that are well-suited for survival in particular environments.
3. Chance alone can result in the persistence of some heritable characteristics having no survival or reproductive advantage or disadvantage for the organism.
4. When an environment, including other organisms that inhabit it changes, the survival value of inherited characteristics may change.
5. Modern ideas about evolution and heredity provide a scientific explanation for the history of life on Earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms.
6. Life on earth is thought to have begun as simple, one-celled organisms about four billion years ago. Once cells with nuclei developed about a billion years ago, increasingly complex multi-cellular organisms evolved.
7. Evolution builds on what already exists, so the more variety there is, the more there can be in the future. But evolution does not necessitate long-term progress in some set direction. Evolutionary change appears to be like the growth of a bush: Some branches survive from the beginning with little or no change; many die out altogether; and others branch repeatedly, sometimes giving rise to more complex organisms.
8. The continuing operation of natural selection on new characteristics and in diverse and changing environments, over and over again for millions of years, has produced a succession of diverse new species.
9. The similarity of humans in their cell chemistry and DNA sequences reinforces the idea that all humans are part of a single species.
10. Fossil and molecular evidence supports the idea that human beings evolved from earlier species.
11. As successive generations of an embryo's cells form by division, small differences in their immediate environments cause them to develop slightly differently, by activating or inactivating different parts of the DNA information.
12. The availability of artificial means to prevent or facilitate pregnancy raises social, moral, ethical, and legal issues.
13. The complexity of the human brain allows humans to create technological, literary, and artistic works on a vast scale, and to develop a scientific understanding of the world.
14. The development and use of technologies to sustain, prolong, or terminate life raise social, moral, ethical, and legal issues.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. Both genes and environmental factors influence the rate and extent of development.
2. Following fertilization, cell division produces a small cluster of cells that embeds itself in the wall of the uterus. As the embryo develops, it receives nourishment and eliminates wastes by the transfer of substances between its blood and the blood of its mother.
3. Patterns of human development are similar to those of other vertebrates.
4. The immune system functions to protect against microscopic organisms and foreign substances that enter from outside the body and against some cancer cells that arise within.
5. Communication between cells is required to coordinate their diverse activities. Cells may secrete molecules that spread locally to nearby cells or that are carried in the bloodstream to cells throughout the body. Nerve cells transmit electrochemical signals that carry information much more rapidly than is possible by diffusion or blood flow.
6. Some drugs mimic or block the molecules involved in communication between cells and therefore affect operations of the brain and body.
7. The human body is a complex system of cells, most of which are grouped into organ systems that have specialized functions. These systems can best be understood in terms of the essential functions they serve for the organism: deriving energy from food, protection against injury, internal coordination, and reproduction.
8. Even instinctive behavior may not develop well if the individual is exposed to abnormal conditions.
9. The expectations, moods, and prior experiences of human beings can affect how they interpret new perceptions or ideas. People tend to ignore evidence that challenges their beliefs and to accept evidence that supports them.
10. The context in which something is learned may limit the contexts in which the learning can be used.
11. Human thinking involves the interaction of ideas, and ideas about ideas. People can produce many associations internally without receiving information from their senses.
12. Some allergic reactions are caused by the body's immune responses to usually harmless environmental substances. Sometimes the immune system may attack some of the body's own cells.
13. Faulty genes can cause body parts or systems to work poorly. Some genetic diseases appear only when an individual has inherited a certain faulty gene from both parents.

**STANDARD 4: THE LIVING ENVIRONMENT**

**Benchmarks**

**Grades 9-12**

1. New medical techniques, efficient health care delivery systems, improved diet and sanitation, and a fuller understanding of the nature of health and disease give today's human beings a better chance of staying healthy than their ancestors had.
2. Conditions now are very different from the conditions in which the species evolved. But some of the differences may not be good for human health.
3. Some viral diseases, such as AIDS, destroy critical cells of the immune system, leaving the body unable to deal with multiple infection agents and cancerous cells.

**STANDARD 5: SCIENCE AND SOCIETY**

**Benchmarks**

**Grades K-2**

1. People are alike in many ways and different in many ways.
2. Changes happen in everyone's life, sometimes suddenly, more often slowly. People cannot control some changes, but they can usually learn to cope with them.
3. Different people may make different choices for different reasons.
4. Choices have consequences, some more serious than others.

**STANDARD 5: SCIENCE AND SOCIETY**

**Benchmarks**

**Grades 3-5**

1. People can learn about others from direct experience, from the mass communications media, and from listening to other people talk about their work and their lives.
2. In making decisions, it helps to take time to consider benefits and drawbacks of alternatives.
3. In making decisions, benefits and drawbacks of alternatives can be taken into account more effectively if the people who will be affected are involved.
4. Sometimes social decisions have unexpected consequences, no matter how carefully the decisions are made.
5. For many things they need, people rely on others who are not part of their family and may not even be part of their local community.

**STANDARD 5: SCIENCE AND SOCIETY**

**Benchmarks**

**Grades 6-12**

1. Cultural beliefs strongly influence the values and behavior of the people who grow up in the culture, often without their being fully aware of it. Responses to these influences varies among individuals.
2. Differences in the behavior of individuals arise from the interaction of heredity, culture, and experience—the effect of each depends on the other.
3. Organizations usually have explicitly stated social, business, or political purposes, but they also often have purposes beyond those for which they officially exist.
4. The size and rate of growth of the human population in any location are affected by economic, political, religious, technological and environmental factors. Some of these factors, in turn, are influenced by the size and rate of growth of the population.
5. The decisions of one generation both provide and limit the range of the possibilities open to the next generation.
6. Mass media, migration, and conquest affect social change by exposing one culture to another. Extensive borrowing among cultures has led to the virtual disappearance of some cultures but only modest changes in others.
7. To various degrees, governments try to bring about social change or impede it through policies, laws, incentives, or direct coercion. Sometimes such efforts achieve their intended results and sometimes they do not.
8. Benefits and costs of proposed choices include consequences that are long-term as well as short-term, and indirect as well as direct. The more remote the consequences of a personal or social decision, the harder it usually is to take them into account in considering alternatives. But benefits and costs may be difficult to estimate.
9. The wealth of a country depends on the balance between how much its resources and products are sought by other nations and how much of other nations' resources and products it seeks. Even if a country could produce everything it needs for itself, it may still benefit from trade with other countries.
10. The migration of workers between nations—temporary and permanent, legal and illegal—plays a major role in the quality and availability of the workforce in many nations. It can bring both economic benefits and political problems.
11. The growing worldwide interdependence of social, economic, and ecological systems means that changes in one place in the world may have effects in any other place.

**STANDARD 5: SCIENCE AND SOCIETY**

**Benchmarks**

**Grades 6-12**

1. Communication and transportation technologies, coupled with political and economic policies, now allow people to interact with people in different countries almost as easily as they interact with people in their own country. This has allowed for the spread of political, economic, and cultural influences across the planet much more rapidly than had been the case in the past. Like any social change, there are trade-offs in the globalization of the planet, and it benefits some people more than others.