| Washington state standards | Lesson 1 Case study through critical reading | Lesson 2  Exploration of sources and detection of CO2, carbon cycle | Lesson 3 Consider stakeholders and possible investigation | **Lesson 4**  Plan a cohesive set of experiments | Lesson 5A  Experiments and analysis | Lesson 5B  Analyze online data, simulations or other evidence | Lesson 6  Mock summit, presentation of findings development of network, possible solutions |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SYSA: feedback, output, system disturbance | X | X |  |  | X | X | X |
| SYSB: use systems thinking to analyze | X |  |  |  | X | X | X |
| SYSC: modeling complex systems | X |  |  |  |  |  | X |
| INQA: question |  | X | X | X |  |  |  |
| INQB: investigate |  | X | X | X | X | X |  |
| INQC: explain based on evidence | X | X |  |  | X | X | X |
| INQD: clearly report methods | X | X |  |  | X | X | X |
| INQE: develop model to generate testable predictions | X |  | X |  |  |  | X |
| INQF: testing, revision, reasoning |  | X |  |  | X | X | X |
| INQG: share/evaluate validity of other findings |  |  |  |  |  |  | X |
| INQH: determine reliability before using information and citing others | X |  |  |  |  |  | X |
| APPA: science affects society and cultures; society affects science. |  |  | X |  |  |  | X |
| APPB: technological [design](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Design%27)-define problem in terms of [criteria](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Criteria%27) and [constraint](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Constraint%27)s, conduct research, generate different [solution](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Solution%27)s. | X |  | X |  |  |  | X |
| APPC: choose best solution based on evidence |  |  |  |  |  |  | X |
| APPD: use math and IT |  | X |  |  | X | X |  |
| APPE: technological solutions have trade-offs | X |  | X |  |  |  | X |
| LS1C: cell structures/functions |  | X |  |  | X | X |  |
| LS1D: cell has semi-permeable membrane |  | X |  |  | X | X |  |
| LS1E: central dogma |  |  |  |  |  | X |  |
| LS1F: cell functions based on chemical reactions, enzyme activity |  | X |  |  | X | X |  |
| LS1G: DNA to protein enables cell to respond to environment |  |  |  |  | X |  |  |
| LS2A: energy flows through living/non-living in ecosystems | X | X | X |  | X | X | X |
| LS2B: organisms have capacity to produce large populations |  |  | X |  | X |  |  |
| LS2C: population growth has limits | X |  | X |  | X |  | X |
| LS2D: scientists use mathematical models to represent ecosystems | X | X |  |  |  |  | X |
| LS2E: biodiversity in specific ecosystems |  |  |  |  |  | X | X |
| LS3A: natural selection acts on populations |  |  |  |  | X |  |  |
| LS3C: 3.5 billion years has filled ecosystem niches | X |  |  |  |  | X |  |
| LS3D: fossil record provides evidence of evolution |  | X |  |  |  | X |  |
| LS3E: classification based on relatedness |  |  |  |  | X | X |  |

**EALR 1:**   Big Idea:   Systems (SYS)     Core Content:   *Predictability and Feedback*

Description:   In prior grades students learned how to simplify and analyze complex situations by thinking about them as systems. In grades 9-12 students learn to construct more sophisticated system models, including the concept of feedback. Students are expected to determine whether or not systems analysis will be helpful in a given situation and if so, to describe the system, including subsystems, boundaries, flows, and feedbacks. The next step is to use the system as a dynamic model to predict changes. Students are also expected to recognize that even the most sophisticated models may not accurately predict how the real world functions. This deep understanding of systems and ability to use systems analysis is an essential tool both for scientific inquiry and for technological design.

**SYSA** *Feedback* is a process in which the *output* of a *system* provides information used to regulate the operation of the *system. Positive feedback* increases the disturbance to a *system. Negative feedback* reduces the disturbance to a *system*.

**SYSB** Systems thinking can be especially useful in *analyzing* complex situations. To be useful, a *system* needs to be specified as clearly as possible.

**SYSC** In complex *systems*, entirely new and unpredictable *properties* may emerge. Consequently, modeling a complex *system* in sufficient detail to make *reliable* predictions may not be possible.

**EALR 2:**  Big Idea: Inquiry (INQ),  Core Content:   *Conducting Analyses and Thinking Logically*

Description:   In prior grades students learned to revise questions so they can be answered scientifically. In grades 9-12 students extend and refine their understanding of the nature of inquiry and their ability to formulate questions, propose hypotheses, and design, conduct, and report on investigations. Refinement includes an increased understanding of the kinds of questions that scientists ask and how the results reflect the research methods and the criteria that scientific arguments are judged by. Increased abilities include competence in using mathematics, a closer connection between student-planned investigations and existing knowledge, improvements in communication and collaboration, and participation in a community of learners.

**INQA Question** Scientists *generate* and *evaluate questions* to investigate the *natural world*.

**INQB Investigate** Scientific progress requires the use of various methods appropriate for answering different kinds of research *questions*, a thoughtful plan for gathering data needed to answer the *question*, and care in collecting, analyzing, and displaying the data.

**INQC Explain** *Conclusions* must be logical, based on *evidence*, and consistent with prior *established* knowledge.

**INQD Communicate Clearly** The methods and procedures that scientists use to obtain *evidence* must be clearly reported to enhance opportunities for further *investigation*.

**INQE Model** The essence of scientific *investigation* involves the development of a *theory* or conceptual *model* that can *generate* testable predictions.

**INQF Communicate** [*Science*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Science%27) is a human endeavor that involves logical reasoning and creativity and entails the testing, revision, and occasional discarding of theories as new *evidence* comes to light.

**INQG Intellectual Honesty** Public *communication* among scientists is an essential aspect of research. Scientists *evaluate* the [*validity*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Validity%27) of one another's *investigations*, check the [*reliability*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Reliability%27) of results, and [*explain*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Explain%27) inconsistencies in findings.

**INQH Intellectual Honesty** Scientists carefully *evaluate* sources of information for *reliability* before using that information. When referring to the [*idea*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Idea%27)*s* or findings of others, they cite their sources of information.

**EALR 3:**   Big Idea:   Application (APP)     Core Content:   *Science, Technology, and Society*

Description:   In prior grades students learn to work with other members of a team to apply the full process of technological design and relevant science concepts to solve problems. In grades 9-12 students apply what they have learned to address societal issues and cultural differences. Students learn that science and technology are interdependent, that science and technology influence society, and that society influences science and technology. Students continue to increase their abilities to work with other students and to use mathematics and information technologies (when available) to solve problems. They transfer insights from those increased abilities when considering local, regional, and global issues. These insights and capabilities will help prepare students to solve societal and personal problems in future years.

**APPA** [*Science*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Science%27) affects society and [culture](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Culture%27)s by influencing the way many people think about themselves, others, and the [*environment*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Environment%27). Society also affects *science* by its prevailing views about what is important to study and by deciding what research will be funded.

**APPB** The *technological* [*design*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Design%27) *process* begins by defining a problem in terms of [*criteria*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Criteria%27) and [*constraint*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Constraint%27)*s*, conducting research, and generating several different [*solution*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Solution%27)*s*.

**APPC** Choosing the best solution involves comparing alternatives with respect to *criteria* and *constraints*, then building and testing a [*model*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Model%27) or other representation of the final design.

**APPD** The ability to solve problems is greatly enhanced by use of mathematics and information technologies.

**APPE** Perfect *solutions* do not exist. All technological *solutions* involve *trade-offs* in which decisions to include more of one quality means less of another. All *solutions* involve consequences, some intended, others not.

**EALR 4:**   Big Idea:  Structures and Functions of Living Organisms  Core Content:   *Processes Within Cells*

Description:   In prior grades students learned that all living systems are composed of cells which make up tissues, organs, and organ systems. In grades 9-11 students learn that cells have complex molecules and structures that enable them to carry out life functions such as photosynthesis and respiration and pass on their characteristics to future generations. Information for producing proteins and reproduction is coded in DNA and organized into genes in chromosomes. This elegant yet complex set of processes explains how life forms replicate themselves with slight changes that make adaptations to changing conditions possible over long periods of time. These processes that occur within living cells help students understand the commonalities among the diverse living forms that populate Earth today.

**LS1C** Cells contain specialized parts for determining essential [*function*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Function%27)*s* such as regulation of cellular activities, energy capture and release, formation of proteins, waste disposal, the [*transfer*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Transfer%27) of information, and movement.

**LS1D** The cell is surrounded by a membrane that separates the interior of the cell from the outside world and determines which substances may enter and which may leave the cell.

**LS1E** The [*genetic*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Genetic%27) *information* responsible for inherited [*characteristic*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Characteristic%27)*s* is encoded in the [DNA](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27DNA%27) *molecules* in [*chromosome*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Chromosome%27)*s*. DNA is composed of four subunits (A,T,C,G). The sequence of subunits in a [*gene*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Gene%27) specifies the amino acids needed to make a protein. *Proteins* express inherited traits ([e.g.](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27E.g.%27), eye color, hair texture) and carry out most cell *function*.

**LS1F** All of the *functions* of the cell are based on [*chemical reaction*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Chemical+reaction%27)*s*. Food *molecules* are broken down to provide the energy and the chemical constituents needed to synthesize other *molecules*. Breakdown and synthesis are made possible by proteins called [*enzyme*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Enzyme%27)*s*.

Some of these *enzymes* enable the cell to store energy in special chemicals, such as ATP, that are needed to drive the many other *chemical reactions* in a cell.

**LS1G** Cells use the DNA that forms their *genes* to encode *enzymes* and other proteins that allow a cell to grow and divide to produce more cells, and to respond to the [*environment*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Environment%27).

*Information* during *meiosis* scrambles the *genetic information*, allowing for new *genetic* combinations and *characteristics* in the offspring. [Fertilization](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Fertilization%27) restores the original number of *chromosome* pairs and reshuffles the *genetic information*, allowing for [*variation*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Variation%27) among offspring.

**EALR 4:**  Big Idea:   Ecosystems (LS2)     Core Content:   *Maintenance and Stability of Populations*

Description:   In prior grades students learned to apply key concepts about ecosystems to understand the interactions among organisms and the nonliving environment. In grades 9-11 students learn about the factors that foster or limit growth of populations within ecosystems and that help to maintain the health of the ecosystem overall. Organisms participate in the cycles of matter and flow of energy to survive and reproduce. Given abundant resources, populations can increase at rapid rates. But living and nonliving factors limit growth, resulting in ecosystems that can remain stable for long periods of time. Understanding the factors that affect populations is important for many societal issues, from decisions about protecting endangered species to questions about how to meet the resource needs of civilization while maintaining the health and sustainability of Earth's ecosystems.

**LS2A** [*Matter*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Matter%27) cycles and [*energy*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Energy%27) flows through living and nonliving components in [*ecosystem*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Ecosystem%27)*s*. The [transfer](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Transfer%27) of *matter* and *energy* is important for maintaining the health and sustainability of an *ecosystem*.

**LS2B** Living [*organism*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Organism%27)*s* have the capacity to produce very large *populations. Population* [*density*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Density%27) is the number of individuals of a particular *population* living in a given amount of space.

**LS2C** [*Population growth*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Population+growth%27) is limited by the availability of matter and energy found in resources, the size of the [*environment*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Environment%27), and the presence of competing and/or predatory *organisms*.

**LS2D** Scientists represent *ecosystems* in the [*natural world*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Natural+world%27) using mathematical [*model*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Model%27)*s*.

**LS2E** Interrelationships of *organisms* may [*generate*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Generate%27) *ecosystems* that are stable for hundreds or thousands of years. [*Biodiversity*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Biodiversity%27) refers to the different kinds of *organisms* in specific *ecosystems* or on the planet as a whole.

**EALR 4:**  Big Idea:   Biological Evolution     Core Content:   *Mechanisms of Evolution*

Description:   In prior grades students learned how the traits of organisms are passed on through the transfer of genetic information during reproduction. In grades 9-11 students learn about the factors that underlie biological evolution: variability of offspring, population growth, a finite supply of resources, and natural selection. Both the fossil record and analyses of DNA have made it possible to better understand the causes of variability and to determine how the many species alive today are related. Evolution is the major framework that explains the amazing diversity of life on our planet and guides the work of the life sciences.

**LS3A** Biological [*evolution*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Evolution%27) is due to: (1) [*genetic*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Genetic%27) *variability* of offspring due to [*mutation*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Mutation%27)*s* and [*genetic recombination*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Genetic+recombination%27), (2) the potential for a [*species*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Species%27) to increase its numbers, (3) a finite supply of resources, and (4) [*natural selection*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Natural+selection%27) by the [*environment*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Environment%27) for those offspring better able to survive and produce offspring.

**LS3B** Random changes in the *genetic* makeup of cells and [*organism*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Organism%27)*s (mutations)* can cause changes in their physical [*characteristic*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Characteristic%27)*s* or behaviors. If the genetic *mutations* occur in eggs or sperm cells, the changes will be inherited by offspring. While many of these changes will be harmful, a small minority may allow the offspring to better survive and reproduce.

**LS3C** The great [*diversity*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Diversity%27) of *organisms* is the result of more than 3.5 billion years of *evolution* that has filled available [*ecosystem*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Ecosystem%27)[*niche*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Niche%27)*s* on Earth with life [*form*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Form%27)*s*.

**LS3D** The [*fossil*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Fossil%27) record and anatomical and molecular similarities observed among diverse *species* of living *organisms* provide [*evidence*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Evidence%27) of biological *evolution*.

**LS3E** [*Biological classification*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Biological+classification%27)*s* are based on how *organisms* are related, reflecting their evolutionary history. Scientists [*infer*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Infer%27)[*relationship*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Relationship%27)*s* from physiological traits, [*genetic information*](http://standards.ospi.k12.wa.us/GlossaryPopup.aspx?subject=10&word=%27Genetic+information%27), and the ability of two *organisms* to produce fertile offspring.