**High School Integrated Science Course 3**

The 11th grade high school science course, based on an integrated grouping of Next Generation Science Standards will introduce students to the following concepts (arranged topically)

**Physical Science**

### [Nuclear Processes](http://www.nap.edu/openbook.php?record_id=13165&page=111)

* [Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)](http://www.nap.edu/openbook.php?record_id=13165&page=111)

**Life Science**

### [Interdependent Relationships in Ecosystems](http://www.nap.edu/openbook.php?record_id=13165&page=150)

* [Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)](http://www.nap.edu/openbook.php?record_id=13165&page=150)

### [Ecosystem Dynamics, Functioning, and Resilience](http://www.nap.edu/openbook.php?record_id=13165&page=154)

* [A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)](http://www.nap.edu/openbook.php?record_id=13165&page=154)
* [Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)](http://www.nap.edu/openbook.php?record_id=13165&page=154)

[**Social Interactions and Group Behavior**](http://www.nap.edu/openbook.php?record_id=13165&page=156)

* [Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)](http://www.nap.edu/openbook.php?record_id=13165&page=156)

### [Adaptation](http://www.nap.edu/openbook.php?record_id=13165&page=164)

* [Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-6)](http://www.nap.edu/openbook.php?record_id=13165&page=164)

### [Biodiversity and Humans](http://www.nap.edu/openbook.php?record_id=13165&page=166)

* [Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)](http://www.nap.edu/openbook.php?record_id=13165&page=166)
* [Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7),(HS-LS4-6.)](http://www.nap.edu/openbook.php?record_id=13165&page=166)

### [Developing Possible Solutions](http://www.nap.edu/openbook.php?record_id=13165&page=206)

* [When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7),(secondary to HS-LS4-6)](http://www.nap.edu/openbook.php?record_id=13165&page=206)
* [Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6)](http://www.nap.edu/openbook.php?record_id=13165&page=206)

### [Evidence of Common Ancestry and Diversity](http://www.nap.edu/openbook.php?record_id=13165&page=162)

* [Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)](http://www.nap.edu/openbook.php?record_id=13165&page=162)

### [Natural Selection](http://www.nap.edu/openbook.php?record_id=13165&page=163)

* [Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2),(HS-LS4-3)](http://www.nap.edu/openbook.php?record_id=13165&page=163)
* [The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)](http://www.nap.edu/openbook.php?record_id=13165&page=163)

### [Adaptation](http://www.nap.edu/openbook.php?record_id=13165&page=164)

* [Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)](http://www.nap.edu/openbook.php?record_id=13165&page=164)
* [Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4)](http://www.nap.edu/openbook.php?record_id=13165&page=164)
* [Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)](http://www.nap.edu/openbook.php?record_id=13165&page=164)
* [Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5)](http://www.nap.edu/openbook.php?record_id=13165&page=164)
* [Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (HS-LS4-5)](http://www.nap.edu/openbook.php?record_id=13165&page=164)

**Earth Science**

### [The History of Planet Earth](http://www.nap.edu/openbook.php?record_id=13165&page=177)

* [Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)](http://www.nap.edu/openbook.php?record_id=13165&page=177)
* [Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history. (HS-ESS1-6)](http://www.nap.edu/openbook.php?record_id=13165&page=177)

### [Nuclear Processes](http://www.nap.edu/openbook.php?record_id=13165&page=111)

* [Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6)](http://www.nap.edu/openbook.php?record_id=13165&page=111)

### [Weather and Climate](http://www.nap.edu/openbook.php?record_id=13165&page=186)

* [Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7)](http://www.nap.edu/openbook.php?record_id=13165&page=186)
* [Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)](http://www.nap.edu/openbook.php?record_id=13165&page=186) (HS-ESS2-4)
* [The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-4)](http://www.nap.edu/openbook.php?record_id=13165&page=186)
* [Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6)](http://www.nap.edu/openbook.php?record_id=13165&page=186)

### [Biogeology](http://www.nap.edu/openbook.php?record_id=13165&page=189)

* [The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7)](http://www.nap.edu/openbook.php?record_id=13165&page=189)

### [Earth and the Solar System](http://www.nap.edu/openbook.php?record_id=13165&page=175)

* [Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)](http://www.nap.edu/openbook.php?record_id=13165&page=175)

[**Earth Materials and Systems**](http://www.nap.edu/openbook.php?record_id=13165&page=179)

* [The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)](http://www.nap.edu/openbook.php?record_id=13165&page=179)

### [Global Climate Change](http://www.nap.edu/openbook.php?record_id=13165&page=196)

* [Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)](http://www.nap.edu/openbook.php?record_id=13165&page=196)
* [Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)](http://www.nap.edu/openbook.php?record_id=13165&page=196)

### [Natural Resources](http://www.nap.edu/openbook.php?record_id=13165&page=191)

* [Resource availability has guided the development of human society. (HS-ESS3-1)](http://www.nap.edu/openbook.php?record_id=13165&page=191)

### [Natural Hazards](http://www.nap.edu/openbook.php?record_id=13165&page=192)

* [Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)](http://www.nap.edu/openbook.php?record_id=13165&page=192)

### [Human Impacts on Earth Systems](http://www.nap.edu/openbook.php?record_id=13165&page=194)

* [The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)](http://www.nap.edu/openbook.php?record_id=13165&page=194)
* [Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)](http://www.nap.edu/openbook.php?record_id=13165&page=194)

### [Developing Possible Solutions](http://www.nap.edu/openbook.php?record_id=13165&page=175)

* [When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-ESS3-2),(secondary HS-ESS3-4)](http://www.nap.edu/openbook.php?record_id=13165&page=206)

**Engineering and Design**

### [Defining and Delimiting Engineering Problems](http://www.nap.edu/openbook.php?record_id=13165&page=204)

* [Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1,](http://www.nap.edu/openbook.php?record_id=13165&page=204) secondary to HS-PS3-3)
* [When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)](http://www.nap.edu/openbook.php?record_id=13165&page=206)
* [Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)](http://www.nap.edu/openbook.php?record_id=13165&page=206)

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| [**HS.SPM** Structure, Properties of Matter](http://www.nextgenscience.org/hsps-spm-structure-properties-matter) [HS-PS1-1, 3 and HS-PS2-6 🡪 Course 1] [🡨 Note: This is a ‘[Topic Arrangement’](http://www.nextgenscience.org/sites/ngss/files/NGSS%20Combined%20Topics%2011.8.13.pdf) term] |
| DUM | [HS-PS1-8](http://www.nextgenscience.org/hs-ps1-8-matter-and-its-interactions) | Matter and its Interactions [Composition of the atom and the energy released during the processes of fission, fusion, and radioactive decay] \* Also part of the HS.HE History of Earth ‘topical arrangement’ |

**Physical Science Components**

**Life Science Component(s)**

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| [**HS.IRE** Interdependent Relationships in Ecosystems](http://www.nextgenscience.org/hsls-ire-interdependent-relationships-ecosystems) **[**HS-LS2-1, 2 🡪 Course 1] |
| UMCT | [HS-LS2-2](http://www.nextgenscience.org/hs-ls2-2-ecosystems-interactions-energy-and-dynamics) | Ecosystems: Interactions, Energy, and Dynamics [factors affecting biodiversity and populations] |
| EAE | [HS-LS2-6](http://www.nextgenscience.org/hs-ls2-6-ecosystems-interactions-energy-and-dynamics) | Ecosystems: Interactions, Energy, and Dynamics [Complex interactions in ecosystems maintain relatively consistent numbers and types of organisms when in stable conditions] |
| CEDS | [HS-LS2-7](http://www.nextgenscience.org/hs-ls2-7-ecosystems-interactions-energy-and-dynamics) | Ecosystems: Interactions, Energy, and Dynamics [Reducing the impacts of human activities on the environment and biodiversity] |
| EAE | [HS-LS2-8](http://www.nextgenscience.org/hs-ls2-8-ecosystems-interactions-energy-and-dynamics) | Ecosystems: Interactions, Energy, and Dynamics [The role of group behavior on individual and species’ chances to survive and reproduce.] |
| UMCT | [HS-LS4-6](http://www.nextgenscience.org/hs-ls4-6-biological-evolution-unity-and-diversity) |  Biological Evolution: Unity and Diversity [Mitigate adverse impacts of human activity on biodiversity] |

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| [**HS.NSE** Natural Selection and Evolution](http://www.nextgenscience.org/hsls-nse-natural-selection-evolution) |
| OECI | [HS-LS4-1](http://www.nextgenscience.org/hs-ls4-1-biological-evolution-unity-and-diversity) | Biological Evolution: Unity and Diversity [Common ancestry and biological evolution are supported by multiple lines of empirical evidence] |
| CEDS | [HS-LS4-2](http://www.nextgenscience.org/hs-ls4-2-biological-evolution-unity-and-diversity) | Biological Evolution: Unity and Diversity [Evolution primarily results from four factors] |
| AID | [HS-LS4-3](http://www.nextgenscience.org/hs-ls4-3-biological-evolution-unity-and-diversity) | Biological Evolution: Unity and Diversity [Organisms with an advantageous heritable trait tend to increase in proportion] |
| CEDS | [HS-LS4-4](http://www.nextgenscience.org/hs-ls4-4-biological-evolution-unity-and-diversity) | Biological Evolution: Unity and Diversity [Natural selection leads to adaptation of populations] |
| EAE | [HS-LS4-5](http://www.nextgenscience.org/hs-ls4-5-biological-evolution-unity-and-diversity) | Biological Evolution: Unity and Diversity [∆ in environmental conditions may result in: (1) population ∆, (2) emergence (3) the extinction]. |

**Earth and Space Science Component(s)**

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| [**HS.HE** History of Earth](http://www.nextgenscience.org/hsess-he-history-earth) **[**HS-ESS1-1 Course 1 & 2] |
| EAE | [HS-ESS1-5](http://www.nextgenscience.org/hs-ess1-5-earths-place-universe) | Earth's Place in the Universe [oceanic crust and the theory of plate tectonics, rock age] |
| CEDS | [HS-ESS1-6](http://www.nextgenscience.org/hs-ess1-6-earths-place-universe) | Earth's Place in the Universe [Ancient Earth materials, meteorites, and other planetary surfaces used to construct an account of Earth’s formation and early history] |
| DUM | [HS-PS1-8](http://www.nextgenscience.org/hs-ps1-8-matter-and-its-interactions) | Matter and its Interactions [Composition of the atom and the energy released during the processes of fission, fusion, and radioactive decay] |

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| [HS.ES Earth’s Systems](http://www.nextgenscience.org/hsess-es-earth-systems) [HS-ESS2-3,5. 🡪 Course 1 and HS-ESS2-2. 🡪 Course 2] |
| DUM | [HS-ESS2-6](http://www.nextgenscience.org/hs-ess2-6-earths-systems) | Earth's Systems [Cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.] |
| EAE | [HS-ESS2-7](http://www.nextgenscience.org/hs-ess2-7-earths-systems) | Earth's Systems [Simultaneous coevolution of Earth’s systems and life on Earth] |

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| [**HS.WC** Weather and Climate](http://www.nextgenscience.org/hsess-wc-weather-climate) |
| DUM | [HS-ESS2-4](http://www.nextgenscience.org/hs-ess2-4-earths-systems) | Earth's Systems [Flow of energy into and out of Earth’s systems result in changes in climate.] |
| AID | [HS-ESS3-5](http://www.nextgenscience.org/hs-ess3-5-earth-and-human-activity) |  Earth and Human Activity [Current rate of global or regional climate change and associated future impacts to Earth systems] |

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| [**HS.HS** Human Sustainability](http://www.nextgenscience.org/hsess-hs-human-sustainability) **[** HS-ESS3-2 🡪 Course 1] |
| CEDS | [HS-ESS3-1](http://www.nextgenscience.org/hs-ess3-2-earth-and-human-activity) | Earth and Human Activity [Developing, managing, and utilizing energy and mineral resources] |
| UMCT | [HS-ESS3-3](http://www.nextgenscience.org/hs-ess3-3-earth-and-human-activity) | Earth and Human Activity [Management of natural resources, the sustainability of human populations, and biodiversity. ] |
| CEDS | [HS-ESS3-4](http://www.nextgenscience.org/hs-ess3-4-earth-and-human-activity) | Earth and Human Activity [Technological solution that reduces impacts of human activities on natural systems.] |
| UMCT | [HS-ESS3-6](http://www.nextgenscience.org/hs-ess3-6-earth-and-human-activity) | Earth and Human Activity [Earth systems and how those relationships are being modified due to human activity] |

**Engineering Design Component(s)**

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| [**HS.ED** Engineering Design](http://www.nextgenscience.org/hsets-ed-engineering-design) |
| AQDP | [HS-ETS1-1](http://www.nextgenscience.org/hs-ets1-1-engineering-design) | Engineering Design [Analyze major global challenge, find solution, account for societal needs and wants]  |
| CEDS | [HS-ETS1-2](http://www.nextgenscience.org/hs-ets1-2-engineering-design) | Engineering Design [Design a solution to a complex real-world problem] |
| CEDS | [HS-ETS1-3](http://www.nextgenscience.org/hs-ets1-3-engineering-design) | Engineering Design [Evaluate a complex real-world (trade-offs, cost, safety, reliability, and aesthetics social, cultural, and environmental impacts] |
| UMCT | [HS-ETS1-4](http://www.nextgenscience.org/hs-ets1-4-engineering-design) | Engineering Design [Use computer simulation to model the impact of proposed solutions] |