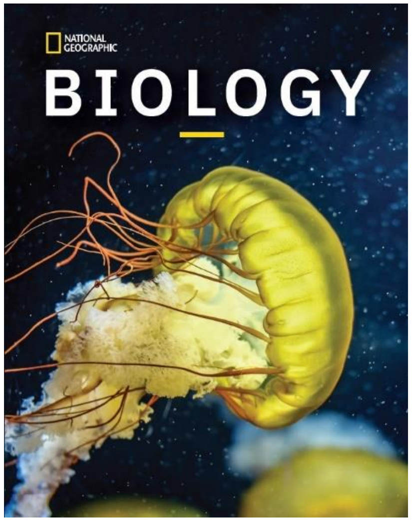

Correlation of

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to

Indiana Academic Science Standards
Biology

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Standards	Where Addressed
High School	
Biology	
HS-LS1-1 From Molecules to Organisms: Structures and Processes	
HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.	316-333
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	13-21, 316-333
Disciplinary Core Ideas	
LS1.A: Structure and Function	
▪ Systems of specialized cells within organisms help them perform the essential functions of life.	133-135
▪ All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)	133-135
Crosscutting Concepts	
CC.6: Structure and Function	
▪ Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	12-21, 112-141

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Standards	Where Addressed
HS-LS1-2 From Molecules to Organisms: Structures and Processes	
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	253-261, 286-295
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	253-261, 286-295
Disciplinary Core Ideas	
LS1.A: Structure and Function	
▪ Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	253-261, 286-295
Crosscutting Concepts	
CC.4: Systems and System Models	
▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	12-21, 42-45, 48-54, 94, 110, 184-190
HS-LS1-3 From Molecules to Organisms: Structures and Processes	
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.	9-14, 256, 276, 292-295,
Science and Engineering Practices	
SEP.3: Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	8-14, 48, 78, 88, 516, Appendix B

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Standards	Where Addressed
Connections to Nature of Science	
Scientific Investigations Use a Variety of Methods	
▪ Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings.	9-15
Disciplinary Core Ideas	
LS1.A: Structure and Function	
▪ Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.	13-14, 260, 292-295
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Feedback (negative or positive) can stabilize or destabilize a system.	292-295
HS-LS1-4 From Molecules to Organisms: Structures and Processes	
HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.	180-199
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Use a model based on evidence to illustrate the relationships between systems or between components of a system.	12-21, 42-45, 94, 110, 184-190

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Standards	Where Addressed
Disciplinary Core Ideas	
LS1.B: Growth and Development of Organisms	
▪ In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.	188-192, 193-197
Crosscutting Concepts	
CC.4: Systems and System Models	
▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy, matter, and information flows — within and between systems at different scales.	12-21, 42-45, 48-54, 94, 110, 184-190
HS-LS1-5 From Molecules to Organisms: Structures and Processes	
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	37-39, 51, 139-140, 169-176
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Use a model based on evidence to illustrate the relationships between systems or between components of a system.	12-21, 42-45, 94, 110
Disciplinary Core Ideas	
LS1.C: Organization for Matter and Energy Flow in Organisms	
▪ The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	37-39, 51, 139-140, 169-176
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	33-53, 139-141, 169-171

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Standards	Where Addressed
HS-LS1-6 From Molecules to Organisms: Structures and Processes	
HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.	128-145
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	9-21, 59, 458-459
Disciplinary Core Ideas	
LS1.C: Organization for Matter and Energy Flow in Organisms	
▪ The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.	128-135
▪ As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	33-57
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.	33-57, 139-144

Standards	Where Addressed
HS-LS1-7 From Molecules to Organisms: Structures and Processes	
HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.	37-39, 51, 139-140, 169-176
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.	
▪ Use a model based on evidence to illustrate the relationships between systems or between components of a system.	12-21, 42-45, 94, 110
Disciplinary Core Ideas	
LS1.C: Organization for Matter and Energy Flow in Organisms	
▪ As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	33-57
▪ As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.	169-176
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.	139-140

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Standards	Where Addressed
HS-LS2-1 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.	95-103, 500
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	95-103, 500
Disciplinary Core Ideas	
LS2.A: Interdependent Relationships in Ecosystems	
▪ 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.	95-103, 500
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	87, 138, 496, 502

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Standards	Where Addressed
HS-LS2-2 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.	60-79, 82-104
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical representations of phenomena or design solutions to support and revise explanations.	70-78, 95-103, 500
Connections to Nature of Science	
Scientific Knowledge is Open to Revision in Light of New Evidence	
▪ Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	9-21, 427, 442
Disciplinary Core Ideas	
LS2.A: Interdependent Relationships in Ecosystems	
▪ 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.	95-103, 500
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	
▪ 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.	60-61, 72-79, 306

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Standards	Where Addressed
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.	16-17, 74, 90-91, 98, 250, 290
HS-LS2-3 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.	38-57
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	13-21, 33-48, 316-333
Connections to Nature of Science	
Scientific Knowledge is Open to Revision in Light of New Evidence	
▪ Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	9-21, 427, 442
Disciplinary Core Ideas	
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	
▪ Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.	34-37, 169-177
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy drives the cycling of matter within and between systems.	32-48

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Standards	Where Addressed
HS-LS2-4 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	38-48
Science and Engineering Practices	
SEP.5: Using Mathematical and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical representations of phenomena or design solutions to support claims.	44-48, 70-78, 95-103, 500
Disciplinary Core Ideas	
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	
▪ Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.	38-48
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.	139-140

Standards	Where Addressed
HS-LS2-5 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.	34-37, 51, 169-177
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or components of a system.	12-21, 34-37, 51, 169-177
Disciplinary Core Ideas	
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	
▪ Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.	34-37, 51, 169-177
PS3.D: Energy in Chemical Processes	
▪ The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary)*	34-37, 169-177
Crosscutting Concepts	
CC.4: Systems and System Models	
▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy, matter, and information flows — within and between systems at different scales.	12-21, 42-45, 48-54, 94, 110, 184-190

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Standards	Where Addressed
HS-LS2-6 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	60-61, 72-79, 306
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
▪ Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	9-15, 78, 79, 105, 27, 339, 427-453, 457-466, 480-483
Connections to Nature of Science	
Scientific Knowledge is Open to Revision in Light of New Evidence	
▪ Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	9-15, 78, 79, 105, 427-453, 457-466
Disciplinary Core Ideas	
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	
▪ 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.	60-61, 72-79, 306
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Much of science deals with constructing explanations of how things change and how they remain stable.	9-15

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Standards	Where Addressed
HS-LS2-7 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	18-21, 68, 103, 177, 415-417, 492-517
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	18-21, 68, 103, 177, 415-417, 492-517
Disciplinary Core Ideas	
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	
▪ 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.	492-517
LS4.D: Biodiversity and Humans	
▪ Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)*	351, 436, 457, 492, 510-516
▪ 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) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*	502-517
ETS1.B: Developing Possible Solutions	
▪ 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)*	502-517

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Standards	Where Addressed
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Much of science deals with constructing explanations of how things change and how they remain stable.	9-15, 78, 79, 105, 27, 339, 427-453, 457-466, 480-483
HS-LS2-8 Ecosystems: Interactions, Energy and Dynamics	
HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	301-309
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
▪ Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.	9-15, 78, 79, 105, 27, 339, 427-453, 457-466, 480-483
Connections to Nature of Science	
Scientific Knowledge is Open to Revision in Light of New Evidence	
▪ Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.	9-15, 78, 79, 105, 427-453, 457-466
Disciplinary Core Ideas	
LS2.D: Social Interactions and Group Behavior	
▪ Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	301-309
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506

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Standards	Where Addressed
HS-LS3-1 Heredity: Inheritance and Variation of Traits	
HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	316-345
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or components of a system.	12-21, 34-37, 51, 169-177
Disciplinary Core Ideas	
LS1.A: Structure and Function	
▪ All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)*	316-324
LS3.A: Inheritance of Traits	
▪ Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	320-324, 335-341
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506
HS-LS3-2 Heredity: Inheritance and Variation of Traits	
HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from:	
(1) new genetic combinations through meiosis,	350-359
(2) viable errors occurring during replication, and/or	182-186, 358-359

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Standards	Where Addressed
(3) mutations caused by environmental factors.	358-361
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
▪ Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.	13-21, 316-333, 484-521
Disciplinary Core Ideas	
LS3.B: Variation of Traits	
▪ In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.	350-359
▪ Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depends on both genetic and environmental factors.	358-359, 374-375
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506

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Standards	Where Addressed
HS-LS3-3 Heredity: Inheritance and Variation of Traits	
HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	88-105, 276, 342, 439, 404-405, 468-475, Appendix B
Science and Engineering Practices	
SEP.4: Analyzing and Interpreting Data Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
▪ Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	276-277, 429, 439, 468-475, Appendix B
Disciplinary Core Ideas	
LS3.B: Variation of Traits	
▪ Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depends on both genetic and environmental factors.	350-359, 374-375
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	88-105, 429, 439, 468-472, Appendix B
Connections to Nature of Science	
Science is a Human Endeavor	
▪ Technological advances have influenced the progress of science and science has influenced advances in technology.	149, 313, 421, 464
▪ Science and engineering are influenced by society and society is influenced by science and engineering.	18-21, 176-177, 201, 379, 382-403, 417

Standards	Where Addressed
HS-LS4-1 Biological Evolution: Unity and Diversity	
HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	426-455
Science and Engineering Practices	
SEP.8: Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
▪ Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	426-455, 457-475
Connections to Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	
▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	9-15, 442, 457-465
Disciplinary Core Ideas	
LS4.A: Evidence of Common Ancestry and Diversity	
▪ 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.	426-455
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	21, 35-36, 72-73, 87, 290, 428-429, 470, 496, 502, 513

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Standards	Where Addressed
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	13-21, 316-333, 458-465
HS-LS4-2 Biological Evolution: Unity and Diversity	
HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors:	
(1) the potential for a species to increase in number,	462-465
(2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction,	462-465
(3) competition for limited resources, and	462-465
(4) the proliferation of those organisms that are better able to survive and reproduce in the environment.	462-465
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	13-21, 316-333, 458-465
Disciplinary Core Ideas	
LS4.B: Natural Selection	
▪ Natural selection occurs only if there is both	
(1) variation in the genetic information between organisms in a population and	462-465
(2) variation in the expression of that genetic information — that is, trait variation — that leads to differences in performance among individuals.	462-465
LS4.C: Adaptation	
▪ Evolution is a consequence of the interaction of four factors:	
(1) the potential for a species to increase in number,	462-465

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Standards	Where Addressed
(2) the genetic variation of individuals in a species due to mutation and sexual reproduction,	462-465
(3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and	462-465
(4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.	462-465
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506
HS-LS4-3 Biological Evolution: Unity and Diversity	
HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.	467-475
Science and Engineering Practices	
SEP.4: Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
▪ Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	276-277, 429, 439, 467-475, Appendix B
Disciplinary Core Ideas	
LS4.B: Natural Selection	
▪ Natural selection occurs only if there is both	
(1) variation in the genetic information between organisms in a population and	467-475
(2) variation in the expression of that genetic information — that is, trait variation — that leads to differences in performance among individuals.	467-475
▪ The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.	467-475

Standards	Where Addressed
LS4.C: Adaptation	
▪ 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.	467-473
▪ Adaptation also means that the distribution of traits in a population can change when conditions change.	467-473
Crosscutting Concepts	
CC.1: Patterns	
▪ Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	21, 35-36, 72-73, 87, 290, 428-429, 470, 496, 502, 513
HS-LS4-4 Biological Evolution: Unity and Diversity	
HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	462-475
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	13-21, 316-333, 458-465

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Standards	Where Addressed
Disciplinary Core Ideas	
LS4.C: Adaptation	
▪ 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.	462-475
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	13-21, 316-333, 458-465
HS-LS4-5 Biological Evolution: Unity and Diversity	
HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in:	
(1) increases in the number of individuals of some species,	485-491
(2) the emergence of new species over time, and	485-491
(3) the extinction of other species.	485-491
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.	
▪ Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	9-15, 78, 79, 105, 27, 339, 427-453, 457-466, 480-483

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Standards	Where Addressed
Disciplinary Core Ideas	
LS4.C: Adaptation	
▪ 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.	485-491
▪ 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.	492-499
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506
HS-LS4-6 Biological Evolution: Unity and Diversity	
HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	500-515, 516, 517
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Create or revise a simulation of a phenomenon, designed device, process, or system.	516, 517
Disciplinary Core Ideas	
LS4.C: Adaptation	
▪ 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.	492-517

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Standards	Where Addressed
LS4.D: Biodiversity and Humans	
▪ 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. *(Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)*	500-517
ETS1.B: Developing Possible Solutions	
▪ 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)*	502-517
▪ 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)*	3, 9-13, 21, 192, 324, 334, 403, 434
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	9-12, 15, 54, 73, 90, 260, 319, 353, 429-433, 479, 506