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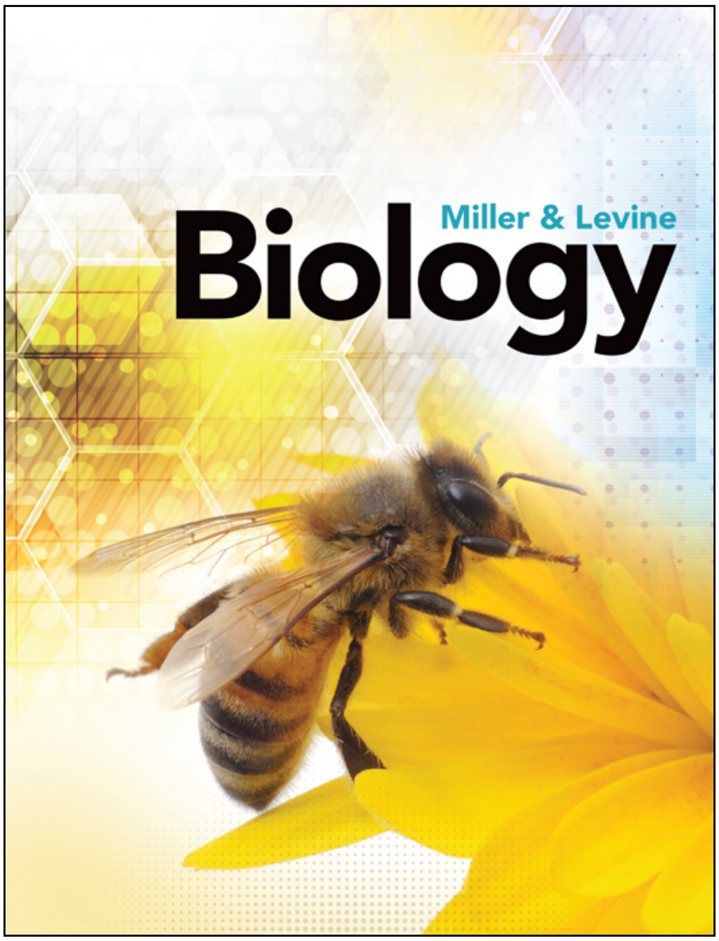

To the

New York State Student Learning Standards for Science (2016)
High School Life Science

Prepared by Savvas Learning Company, formerly Pearson K12 Learning

Introduction

The following document demonstrates how the ***Miller & Levine Biology ©2019*** program supports the New York State 2016 Student Learning Standards for High School Life Science. Correlation references include the Student Edition, Teacher Edition, and online Realize™ digital resources.

Renowned Author Team Ken Miller and Joe Levine have created a comprehensive on-level program to inspire students to interact with trusted and up-to-date biology content. The authors' unique storytelling style engages students in biology, with a greater focus on written and visual analogies. This innovative and fresh new program was developed for modern biology classrooms with a focus on STEM integration and 21st century education.

Problem-Based Learning The Problem-Based Learning Strand introduced in each unit opener immerses students in an active learning environment with lab investigations, STEM projects, virtual activities, and authentic readings. When students each the end of the unit, they use their newly acquired scientific knowledge and data to design, test, and evaluate a solution to the presented problem.

Performance-Based Assessment Authentic assessments of STEM learning allow students to demonstrate mastery of the chapter concepts and new standards. All Performance-Based Assessments feature real-world problems and focus on science inquiry, engineering, and STEM practices.

Case Studies Students directly interact with science phenomena in every chapter as they learn about a real-world science problem. Throughout the lessons, students find case study connections in data analysis activities, labs, diagrams, illustrations, and interactivities.

Interactive Learning Students interact with digital art, videos, and animations through interactive prompts or questions, making ***Miller & Levine Biology*** relevant to their lives.

Reading and Study Support *Biology Foundations: Reading and Study Guide Workbook* includes lesson summaries, vocabulary help, and reading tools. Practice focuses on key concepts and science literacy to improve students' understanding of scientific text.

SavvasRealize.com is your online destination for the complete Miller & Levine Biology digital curriculum. A single sign-on provides access to biology content, assessments, resources, management tools, and real-time student data. Realize directly syncs with providers such as Google® and OpenEd to provide a seamless digital experience.

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New York State 2016 Student Learning Standards for Science
High School Life Science

New York State 2016 Student Learning Standards for High School Life Science	**Miller & Levine Biology ©2019**
HS. Structure and Function	
Performance Expectation	
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.	**SE/TE:** The Nucleus, 249 Organelles That Build Proteins, 250-251 The Role of DNA, 416 The Components of DNA, 418-419 The Double-Helix Model, 422-423 Comparing RNA and DNA, 440-441 Reading Check: Summarize, 441 Transcription, 443 Lesson 14.1 Review, #3, 444 Translation, 447-449 Performance-Based Assessment: A New Kind of Drug: mRNA, #4, 466-467 Chapter 14 Assessment, #27, #32, #34, 469-470 **Realize™ Digital Resources:** **Chapter 14: RNA and Protein Synthesis** >Lesson 1: RNA>Quick Lab: How Can You Model DNA and RNA?
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**SE/TE:** Lesson 14.1 Review, #3, 444
Disciplinary Core Ideas: LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life.	**SE/TE:** Cell Specialization, 267 The Role of DNA, 416 Three Main Types of RNA, 442
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.	**SE/TE:** The Nucleus, 249 Organelles That Build Proteins, 250 The Role of RNA, 440

SE = Student Edition **TE = Teacher Edition**

Digital Resources: The symbol > indicates a click to reach each digital asset on the Realize platform.

New York State 2016 Student Learning Standards for High School Life Science	Miller & Levine Biology ©2019
Crosscutting Concepts: 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.	**SE/TE:** Figure 14-1: Comparing RNA and DNA, 441 Performance-Based Assessment: A New Kind of Drug: mRNA, #3, #4, 466-467 **Realize™ Digital Resources:** **Chapter 14: RNA and Protein Synthesis** >Lesson 1: RNA>Quick Lab: How Can You Model DNA and RNA?
Performance Expectation	
HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	**SE/TE:** Multicellular Life, 267-268 Lesson 23.1 Review, #8, 775 Lesson 25.4 Review, #5, 857 Responding, 871 Muscles and Movements, 878-879 Lesson 26.2 Review, #5, 879 Interrelationship of Body Systems, 888-889 Performance-Based Assessment: Design a model of interacting systems, 896-897 Organization of the Body, 904-905 Figure 27-2: Human Body Systems, 906 Figure 27-5: The Digestive System, 911 Figure 27-8: Structure and Function of the Kidneys, 914 Figure 27-10: Circulation, 916 Figure 27-13: The Lymphatic System, 919 Figure 27-15: The Respiratory Systems, 921 Figure 27-20: The Skeleton, 926 Figure 27-25: The Endocrine System and Its Organs, 930 Chapter 27 Assessment, #38, 952 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 1: Organization of the Human Body>Quick Lab: How Do You Respond to an External Stimulus?

New York State 2016 Student Learning Standards for High School Life Science	Miller & Levine Biology ©2019
Scientific and Engineering Practices: Developing and Using Models	
Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	**SE/TE:** Lesson 25.4 Review, #5, 857 Performance-Based Assessment: Design a model of interacting systems, 896-897 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 1: Organization of the Human Body>Quick Lab: How Do You Respond to an External Stimulus?
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.	**SE/TE:** Multicellular Life, 267-268 Interrelationship of Body Systems, 888-889 Organization of the Body, 904-905 **Realize™ Digital Resources:** **Chapter 8: Cell Structure and Function** >Lesson 4: Homeostasis and Cells>Interactivity: Multicellular Life
(NYSED) Disease is a failure of homeostasis. Organisms have a variety of mechanisms to prevent and combat disease. Technological advances including vaccinations and antibiotics have contributed to the prevention and treatment of disease.	**SE/TE:** Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Homeostasis, 907-909 Nonspecific Defenses, 938-939 Specific Defenses: The Immune System, 939-940 Performance-Based Assessment: A Tale of Two Diseases, 948-949
Crosscutting Concepts: 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.	**SE/TE:** Structure and Function of Roots, 766 Performance-Based Assessment: Design a model of interacting systems, 896-897 Figure 27-8: Structure and Function of the Kidneys, 914 Figure 27-21: Structure of a Bone, 927 Chapter 27 Assessment, #38, 952 **Realize™ Digital Resources:** **Chapter 23: Plant Structure and Function** >Lesson 1: Roots, Stems, and Leaves>Interactivity: Plant Structure and Function

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Performance Expectation	
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis	**SE/TE:** Passive Transport, 260 The Cell as an Organism, 266 Multicellular Life, 267 Tropisms and Rapid Movements, 780-781 Response to Seasons, 782-783 What Animals Do to Survive, 801-802 Interrelationship of Body Systems, 888-889 Body Temperature Control, 890-891 Lesson 26.4 Review, #1, #4, 891 Homeostasis, 907-909 Lesson 27.1 Review, #4, 909 The Endocrine System, 930-932 Reading Check: Summarize, 932 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 2: Human Systems I>Exploration Lab: Exercise and Heart Rate
Scientific and Engineering Practices: Planning and Carrying Out Investigations	
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.	**Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 2: Human Systems I>Exploration Lab: Exercise and Heart Rate
Scientific and Engineering Practices: 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.	**SE/TE:** Scientific Attitudes, 16 Avoiding Bias, 20 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 2: Human Systems I>Exploration Lab: Exercise and Heart Rate

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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.	**SE/TE:** Maintaining Homeostasis, 801 Feedback Inhibition, 907-908 Control of the Endocrine System, 932 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 2: Human Systems I>Exploration Lab: Exercise and Heart Rate
(NYSED) Disease is a failure of homeostasis. Organisms have a variety of mechanisms to prevent and combat disease. Technological advances including vaccinations and antibiotics have contributed to the prevention and treatment of disease.	**SE/TE:** Homeostasis, 907-909 Nonspecific Defenses, 938-939 Specific Defenses: The Immune System, 939-940
Crosscutting Concepts: Stability and Change	
Feedback (negative or positive) can stabilize or destabilize a system.	**SE/TE:** Maintaining Homeostasis, 801 Figure 27-3: Feedback Inhibition, 907 Feedback Inhibition, 907-908 Figure 27-4: Body Temperature Control, 908 Lesson 27.1 Review, #4, 909 Control of the Endocrine System, 932 **Realize™ Digital Resources:** **Chapter 27: The Human Body** >Lesson 2: Human Systems I>Exploration Lab: Exercise and Heart Rate

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HS. Matter and Energy in Organisms and Ecosystems	
Performance Expectation	
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	**SE/TE:** An Overview of Photosynthesis, 289-290 Figure 9-6: Stages of Photosynthesis, 290 Lesson 9.2 Review, #4, #6, 290 Figure 9-8: The Light-Dependent Reactions, 293 Figure 9-9: The Light-Independent Reactions, 295 Lesson 9.3 Review, #4, 297 Chapter 9 Assessment, #23, #34, 305-306 **Realize™ Digital Resources:** **Chapter 9: Photosynthesis** >Lesson 2: Photosynthesis: An Overview>Interactivity: A Model of Photosynthesis;>Develop a Solution Lab: Plant Pigments and Photosynthesis
Scientific and Engineering Practices: Developing and Using Models	
Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**SE/TE:** Lesson 9.2 Review, #4, #6, 290 Figure 9-9: The Light-Independent Reactions: Interpret Visuals, 295 Lesson 9.4 Review, #4, 297 Chapter 9 Assessment, #23, 305 **Realize™ Digital Resources:** **Chapter 9: Photosynthesis** >Lesson 2: Photosynthesis: An Overview>Interactivity: A Model of Photosynthesis;>Develop a Solution Lab: Plant Pigments and Photosynthesis
Disciplinary Core Idea: 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.	**SE/TE:** An Overview of Photosynthesis, 289-290 Lesson 9.2 Review, #3, #6, 290 The Light-Dependent Reactions: Generating ATP and NADPH, 291-294 The Light-Independent Reactions: Producing Sugars, 294-295 **Realize™ Digital Resources:** **Chapter 9: Photosynthesis** >Lesson 2: Photosynthesis: An Overview>Interactivity: A Model of Photosynthesis >Lesson 3: The Process of Photosynthesis>Interactivity: The Details of Photosynthesis

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Crosscutting Concepts: 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.	**SE/TE:** Chapter 9 Assessment, #34, 306
Performance Expectation	
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 such as nitrogen, sulfur, and phosphorus to form amino acids and other carbon-based molecules.	**SE/TE:** The Chemistry of Carbon, 52 Carbohydrates, 53 Lipids, 54-55 Nucleic Acids, 55 Proteins, 55 Lesson 2.3 Review, #2, #3, 57 Chemical Reactions, 58 The Light-Independent Reactions: Producing Sugars, 294-295 **Realize™ Digital Resources:** **Chapter 2: The Chemistry of Life** >Lesson 3: Carbon Compounds>Interactivity: Understanding Macromolecules
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**Realize™ Digital Resources:** **Chapter 2: The Chemistry of Life** >Lesson 3: Carbon Compounds>Interactivity: Understanding Macromolecules
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. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.	**SE/TE:** Chemical Reactions, 58 Energy in Reactions, 58-59 The Light-Dependent Reactions: Generating ATP and NADPH, 291 The Light-Independent Reactions: Producing Sugars, 294 The End Results, 295

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(NYSED) Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones combine with other elements to make amino acids and other carbon-based molecules that can be assembled into larger molecules, such as proteins or DNA.	**SE/TE:** Carbohydrates, 53-54 Lipids, 54-55 Nucleic Acids, 55 Proteins, 55-57 Lesson 2.3 Review, #2, #3, #5, 57 **Realize™ Digital Resources:** **Chapter 2: The Chemistry of Life** >Lesson 3: Carbon Compounds>Interactivity: Understanding Macromolecules
Crosscutting Concepts: 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.	**SE/TE:** Energy in Reactions, 58-59 Reading Check: Interpret Graphs, 59
Performance Expectation	
HS-LS1-7. Use a model to illustrate that aerobic 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.	**SE/TE:** Overview of Cellular Respiration, 311-312 Figure 10-3: Glycolysis, 315 Figure 10-4: The Krebs Cycle, 317 Figure 10-5: The Electron Transport Chain and ATP Synthesis, 319 Figure 10-6: Energy Totals, 320 Lesson 10.2 Review, #7, 320 Chapter 10 Assessment, #37, 334 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 2: The Process of Cellular Respiration>Interactivity: The Mechanics of Cellular Respiration;>Modeling Lab: Making a Model of Cellular Respiration
Scientific and Engineering Practices: Developing and Using Models	
Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**SE/TE:** Lesson 10.2 Review, #7, 320 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 2: The Process of Cellular Respiration>Interactivity: The Mechanics of Cellular Respiration;>Modeling Lab: Making a Model of Cellular Respiration

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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. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.	**SE/TE:** Chemical Energy and Food, 310-311 Overview of Cellular Respiration, 311 Comparing Photosynthesis and Cellular Respiration, 313 Glycolysis, 314 The Krebs Cycle, 316 Electron Transport and ATP Synthesis, 318 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 2: The Process of Cellular Respiration>Interactivity: The Mechanics of Cellular Respiration
(NYSED) Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed. In this process ATP is produced, which is used to carry out life processes.	**SE/TE:** Overview of Cellular Respiration, 311-312 Comparing Photosynthesis and Cellular Respiration, 313 Glycolysis, 314-315 The Krebs Cycle, 316 Electron Transport and ATP Synthesis, 318 The Totals, 320
Crosscutting Concepts: Energy and Matter	
Energy can be transferred between one place and another place, between objects and/or fields, or between systems.	**SE/TE:** Chapter 10 Assessment, #37, 334
Performance Expectation	
HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in ecosystems.	**SE/TE:** Consumers, 116 Lesson 4.1 Review, #3, #4, 117 Biological Processes, 124 Nutrient Cycles, 126 Biological Processes, 126 Lesson 4.3 Review, #7, 131 Comparing Photosynthesis and Cellular Respiration, 313 Lesson 10.1 Review, #5, 313 Fermentation, 321-322 Lesson 10.3 Review, #4, 325 Chapter 10 Assessment, #21, 333 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 3: Fermentation>Interactivity: Comparing Cellular Respiration and Fermentation

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Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**SE/TE:** Lesson 4.1 Review, #4, 117 Lesson 10.1 Review, #5, 313 Lesson 10.3 Review, #4, 325 Chapter 10 Assessment, #21, 333 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 3: Fermentation>Interactivity: Comparing Cellular Respiration and Fermentation
Scientific and Engineering Practice: 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.	**SE/TE:** Case Study: What's to blame for the bloom? 113, 132 Figure 4-8: Global Processes and Global Systems, 124 Food Webs and Disturbance, 120 Human Activity, 128 Human Activities, 130 Technology on the Case, 133 Performance-Based Assessment: Can Algal Blooms Be Useful? 136
Disciplinary Core Idea: 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.	**SE/TE:** Energy From the Sun, 114 Lesson 4.1 Review, #1, 117 Biological Processes, 124 Biological Processes, 126 Comparing Photosynthesis and Cellular Respiration, 313 Fermentation, 321-322 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 3: Fermentation>Interactivity: Comparing Cellular Respiration and Fermentation

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Crosscutting Concepts: Energy and Matter	
Energy drives the cycling of matter within and between systems.	**SE/TE:** Energy From the Sun, 114 Lesson 4.1 Review, #3, 117 Biological Processes, 126 Chapter 4 Assessment, #32, 140 **Realize™ Digital Resources:** **Chapter 10: Cellular Respiration** >Lesson 3: Fermentation>Interactivity: Comparing Cellular Respiration and Fermentation
Performance Expectation	
HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	**SE/TE:** Food Chains and Food Webs, 118 Decomposers and Detritivores in Food Webs, 120 Ecological Pyramids, 121-122 Lesson 4.2 Review, #4, 122 Nutrient Cycles, 126-130 Lesson 4.3 Review, #5, 131 Performance-Based Assessment: Data From the Corn Field, #2, 302-303 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 2: Energy Flow in Ecosystems>Quick Lab: How Can You Model Energy Flow in Ecosystems?
Scientific and Engineering Practices: Using Mathematics and Computational Thinking	
Use mathematical representations of phenomena or design solutions to support claims.	**SE/TE:** Lesson 4.2 Review, #4, 122 Lesson 4.3 Review, #5, 131 Performance-Based Assessment: Data From the Corn Field, #2, 302-303 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 2: Energy Flow in Ecosystems>Quick Lab: How Can You Model Energy Flow in Ecosystem

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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. 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.	**SE/TE:** Figure 4-3: Food Web, 119 Pyramids of Energy, 121 Pyramids of Biomass and Numbers, 122 Recycling in Nature, 123-124 Nutrient Cycles, 126-130 Lesson 4.3 Review, #1, 131 Performance-Based Assessment: Data From the Corn Field, #1, 302-303 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 2: Energy Flow in Ecosystems>Quick Lab: How Can You Model Energy Flow in Ecosystems? >Lesson 3: Cycles of Matter>Exploration Lab: The Effect of Fertilizer on Algae
When matter is cycled through organisms and ecosystems, some of the matter reacts to release energy for life functions, some is stored in newly made structures, and some is eliminated as waste.	**SE/TE:** Case Study: What's to blame for the bloom? 113, 132 Recycling in Nature, 123-124 The Water Cycle, 125-126 Figure 4.8, Global Processes and Global Systems, 124 Nutrient Cycles, 126-130 Lesson 4.3 Review, 131
Crosscutting Concepts: Energy and Matter	
Energy can be transferred between one place and another place, between objects and/or fields, or between systems.	**SE/TE:** Food Chains and Food Webs, 118 Pyramids of Energy, 121 Lesson 4.2 Review, #1, 122 Chapter 4 Assessment, #32, 140 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 2: Energy Flow in Ecosystems>Quick Lab: How Can You Model Energy Flow in Ecosystems?

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Performance Expectation	
HS-LS2-5. Develop a model to illustrate the role of various processes in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.	**SE/TE:** Figure 4-11: The Carbon Cycle, 127 Lesson 4.3 Review, #7, 131 Performance-Based Assessment: Can Algal Blooms Be Useful?, #1, 136-137 An Overview of Photosynthesis, 289 Lesson 9.2 Review, #4, 290 Carbon Dioxide Enters the Cycle, 294 Summary of the Calvin Cycle, 295 Figure 9-9: The Light-Independent Reactions, 295 Lesson 9.3 Review, #7, 297 Comparing Photosynthesis and Cellular Respiration, 313 Lesson 10.1 Review, #5, 313 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Interactivity: Biogeochemical Cycles
Scientific and Engineering Practices: Developing and Using Models	
Develop a model based on evidence to illustrate the relationships between systems or components of a system.	**SE/TE:** Lesson 4.3 Review, #7, 131 Performance-Based Assessment: Can Algal Blooms Be Useful?, #1, 136-137 Chapter 4 Assessment, #21, 139 Lesson 9.1 Review, #4, 285 Lesson 9.2 Review, #4, 290 Lesson 9.3 Review, #4, #7, 297 Chapter 9 Assessment, #22, 305 Chapter 10 Assessment, #29, #30, 333

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Disciplinary Core Ideas: LS2.B Cycles of Matter and Energy Transfer in Ecosystems	
(NYSED) Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, hydrosphere, and geosphere through chemical, physical, geological, and biological processes.	**SE/TE:** The Carbon Cycle, 126-128 Performance-Based Assessment: Can Algal Blooms Be Useful?, #1, 136-137 Light-Independent Reactions, 290 Lesson 9.2 Review, #4, 290 The Light-Independent Reactions: Producing Sugars, 294-295 Lesson 9.3 Review, #7, 297 Performance-Based Assessment: Data From the Corn Field, #1, 302-303 Comparing Photosynthesis and Cellular Respiration, 313 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Interactivity: Biogeochemical Cycles
Disciplinary Core Ideas: 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.	**SE/TE:** Heterotrophs and Autotrophs, 285 An Overview of Photosynthesis, 289 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Interactivity: Biogeochemical Cycles
Crosscutting Concepts: 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.	**SE/TE:** Figure 4-11: The Carbon Cycle, 127 Performance-Based Assessment: Can Algal Blooms Be Useful?, #1, 136-137 Chapter 4 Assessment, #33, 140 Figure 9-6: Stages of Photosynthesis, 290 Figure 9-9: The Light-Independent Reactions, 295 Chapter 9 Assessment, #33, 306 Figure 10-2: A Global Balance, 313 Chapter 10 Assessment, #38, 334 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Interactivity: Biogeochemical Cycles

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HS. Interdependent Relationships in Ecosystems	
Performance Expectation	
HS-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.	**SE/TE:** Figure 5-5: Logistic Growth, 150 Carrying Capacity, 151 Limiting Factors, 152 Reading Check: Stability and Change, 152 Density-Dependent Limiting Factors, 153-155 Figure 5-9: Moose-Wolf Populations on Isle Royale: Interpret Graphs, 154 Density-Independent Limiting Factors, 156-157 Limiting Factors and Extinction, 157 Lesson 5.2 Review, #2, #5, 157 Historical Overview, 158 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 1: How Populations Grow>Modeling Lab: Estimating Population Size >Lesson 2: Limits to Growth>Interactivity: Limiting Factors
Scientific and Engineering Practices: Using Mathematics and Computational Thinking	
Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	**SE/TE:** Lesson 5.1 Review, #5, 151 Figure 5-9: Moose-Wolf Populations on Isle Royale: Interpret Graphs, 154 Chapter 5 Assessment, #26, 169 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 1: How Populations Grow>Modeling Lab: Estimating Population Size

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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. 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.	**SE/TE:** Carrying Capacity, 151 Limiting Factors, 152 Reading Check: Stability and Change, 152 Density-Dependent Limiting Factors, 153-155 Density-Independent Limiting Factors, 156-157 Lesson 5.2 Review, #2, #5, 157 Historical Overview, 158 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 1: How Populations Grow>Modeling Lab: Estimating Population Size >Lesson 2: Limits to Growth>Interactivity: Limiting Factors
(NYSED) Carrying capacity results from the availability of biotic and abiotic factors and from challenges such as predation, competition, and disease.	**SE/TE:** Carrying Capacity, 151 Limiting Factors, 152 Density-Dependent Limiting Factors, 153-155 Lesson 5.2 Review, 157
Crosscutting Concepts: Scale, Proportion, and Quantity	
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	**SE/TE:** Population Growth, 147-148 Exponential Growth, 148 Logistic Growth, 150 Figure 5-9: Moose-Wolf Populations on Isle Royale, 154 Predator-Prey Relationships, 154-155 Exponential Human Population Growth, 158-159

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Performance Expectation	
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.	**SE/TE:** Limiting Factors, 152 Reading Check: Stability and Change, 152 Competition, 153 Figure 5-9: Moose-Wolf Populations on Isle Royale: Interpret Graphs, 154 Predation and Herbivory, 154-155 Reading Check: Describe, 155 Density-Independent Limiting Factors, 156 Lesson 5.2 Review, #3, 157 Patterns of Human Population Growth, 160-161 Lesson 5.3 Review, #2, #4, 161 Performance-Based Assessment: A Tale of Two Countries, China and India, #2, #3, 166-167 Chapter 5 Assessment, #35, 170 Predation and Herbivory, 179 Lesson 6.1 Review, #3, 181 Performance-Based Assessment: The Populations of Yellowstone, #2, #3, 194-195 Ecological Impacts, 220-221 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 2: Limits to Growth>Analyzing Data: Monarchs in Decline >Lesson 3: Human Population Growth>Quick Lab: Modeling Population Changes **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 1: Habitats, Niches, and Species Interactions>Analyzing Data: Predator-Prey Dynamics: Case Study;>Science Skills Worksheet: Life on the Reef

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Scientific and Engineering Practices: Using Mathematics and Computational Thinking	
Use mathematical representations of phenomena or design solutions to support and revise explanations.	**SE/TE:** Figure 5-9: Moose-Wolf Populations on Isle Royale: Interpret Graphs, 154 Lesson 5.3 Review, #4, 161 Case Study Wrap-Up: What can we learn from China?, #2, 162 Performance-Based Assessment: A Tale of Two Countries, China and India, #1, #3, 166-167 Performance-Based Assessment: The Populations of Yellowstone, #1, #2, 194-195 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 2: Limits to Growth>Analyzing Data: Monarchs in Decline >Lesson 3: Human Population Growth>Quick Lab: Modeling Population Changes **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 1: Habitats, Niches, and Species Interactions>Analyzing Data: Predator-Prey Dynamics: Case Study;>Science Skills Worksheet: Life on the Reef
Scientific and Engineering Practices: 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.	**SE/TE:** Density-Independent Limiting Factors, 156 Ecosystem Services and Biodiversity, 188-189 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 2: Limits to Growth>Analyzing Data: Monarchs in Decline >Lesson 3: Human Population Growth>Quick Lab: Modeling Population Changes **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 1: Habitats, Niches, and Species Interactions>Analyzing Data: Predator-Prey Dynamics: Case Study

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Disciplinary Core Ideas: LS.2.A: Interdependent Relationships in Ecosystems	
Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. 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.	**SE/TE:** Competition, 153 Parasitism and Disease, 153 Predation and Herbivory, 154-155 Historical Overview, 158 Predation and Herbivory, 179 Performance-Based Assessment: The Populations of Yellowstone, #2, #3, 194-195 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 1: Habitats, Niches, and Species Interactions>Analyzing Data: Predator-Prey Dynamics: Case Study
(NYSED) Carrying capacity results from the availability of biotic and abiotic factors and from challenges such as predation, competition, and disease.	**SE/TE:** Competition, 153 Density -Dependent Limiting Factors, 153-155 Ecological Impacts, 220-221
Disciplinary Core Ideas: LS.2.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.	**SE/TE:** Limiting Factors, 152 Figure 5-9: Moose-Wolf Populations on Isle Royale: Interpret Graphs, 154 Predator-Prey Relationships, 154 Predation and Herbivory, 179 Keystone Species, 180 Symbioses, 181 Succession After Natural Disturbances, 184 Performance-Based Assessment: The Populations of Yellowstone, #1, #2, 194-195 Ecological Impacts, 220-221 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 1: Habitats, Niches, and Species Interactions>Analyzing Data: Predator-Prey Dynamics: Case Study

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Crosscutting Concepts: 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. (HS-LS2-2)	**SE/TE:** Figure 5-15: Population Age Structure, 161 Performance-Based Assessment: A Tale of Two Countries, China and India, #3, 166-167 Lesson 6.1 Review, #6, 181 Figure 6-8: Primary and Secondary Succession, 183 Performance-Based Assessment: The Populations of Yellowstone, #1, #2, 194-195 Chapter 6 Assessment, #32, 198 Figure 7-5: Understanding Global Change, 207 Figure 7-16: Biological Magnification, 216 Lesson 7.2 Review, #5, 217 **Realize™ Digital Resources:** **Chapter 5: Populations** >Lesson 2: Limits to Growth>Analyzing Data: Monarchs in Decline >Lesson 3: Human Population Growth>Interactivity: Human Population Growth

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Performance Expectations	
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.	**SE/TE:** Primary and Secondary Succession, 182-184 Succession After Natural Disturbances, 184 Succession After Human-Caused Disturbances, 185 Lesson 6.2 Review, #4, #5, 185 Biodiversity and Ecosystem Resilience, 187 Lesson 6.3 Review, #4, 189 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 2: Succession>Quick Lab: How Does Succession Occur? >Lesson 3: Biodiversity, Ecosystems, and Resilience>In Your Neighborhood Lab: Biodiversity on the Forest Floor
Scientific and Engineering Practice: Engaging in Argument from Evidence	
Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**SE/TE:** Lesson 6.2 Review, #3, #4, 185 Lesson 6.3 Review, #5, 189 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 2: Succession>Quick Lab: How Does Succession Occur? >Lesson 3: Biodiversity, Ecosystems, and Resilience>In Your Neighborhood Lab: Biodiversity on the Forest Floor
Scientific and Engineering Practice: 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.	**SE/TE:** Lesson 6.2 Review, #3, #4, 185 Lesson 6.3 Review, #5, 189 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 2: Succession>Quick Lab: How Does Succession Occur? >Lesson 3: Biodiversity, Ecosystems, and Resilience>In Your Neighborhood Lab: Biodiversity on the Forest Floor

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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.	**SE/TE:** Secondary Succession, 183 Succession After Natural Disturbances, 184 Succession After Human-Caused Disturbances, 185 Biodiversity and Ecosystem Resilience, 187 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 3: Biodiversity, Ecosystems, and Resilience>In Your Neighborhood Lab: Biodiversity on the Forest Floor
Crosscutting Concepts: Stability and Change	
Much of science deals with constructing explanations of how things change and how they remain stable.	**SE/TE:** Lesson 6.2 Review, #3, #5, 185 Chapter 6 Assessment, #33, 198 **Realize™ Digital Resources:** **Chapter 6: Communities and Ecosystem Dynamics** >Lesson 3: Biodiversity, Ecosystems, and Resilience>In Your Neighborhood Lab: Biodiversity on the Forest Floor

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Performance Expectation	
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	**SE/TE:** Lesson 6.3 Review, #5, 189 Lesson 7.1 Review, #5, 205 Reforestation, 211 Habitat Restoration, 213 Lesson 7.2 Review, #6, 217 Designing Solutions, 222 Sustainable Development, 223-225 Case Study Wrap-Up: How can a rising tide be stopped?, #2, 226 Performance-Based Assessment: Biodiversity in the Everglades, #3, #4, #5, 230-231 Case Study Wrap-Up: How do animal processes and human activity affect the environment?, #2, 858 Performance-Based Assessment: Design a Zoo Exhibit, #5, #6, 862-863 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint >Lesson 3: Measuring and Responding to Change>Science Skills Worksheet: Plan an Urban Tree Planting >Lesson 4: Sustainability>Science Skills Worksheet: Biogas Farming
Scientific and Engineering Practices: Using Mathematics and Computational Thinking	
Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS2-7)	**SE/TE:** Designing Solutions, 222 Case Study Wrap-Up: How can a rising tide be stopped?, #2, 226 Performance-Based Assessment: Design a Rooftop Garden, #3, 792-793 Case Study Wrap-Up: How do animal processes and human activity affect the environment?, #2, 858 Performance-Based Assessment: Design a Zoo Exhibit, #5, #6, 862-863

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Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**SE/TE:** Lesson 6.3 Review, #5, 189 Lesson 7.1 Review, #5, 205 Lesson 7.2 Review, #6, 217 Designing Solutions, 222 Case Study Wrap-Up: How can a rising tide be stopped?, #2, 226-227 Performance-Based Assessment: Biodiversity in the Everglades, #3, #4, #5, 230-231 Chapter 7 Assessment, #33, #39, 233-234 Performance-Based Assessment: Design a Rooftop Garden, #3, 792-793 Case Study Wrap-Up: How do animal processes and human activity affect the environment?, #2, 858 Performance-Based Assessment: Design a Zoo Exhibit, #5, #6, 862-863 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint >Lesson 3: Measuring and Responding to Change>Science Skills Worksheet: Plan an Urban Tree Planting >Lesson 4: Sustainability>Science Skills Worksheet: Biogas Farming
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.	**SE/TE:** Succession After Human-Caused Disturbances, 185 Lesson 6.2 Review, #5, 185 Lesson 6.3 Review, #5, 189 Human Causes of Global Change, 206 Fossil Fuels and the Atmosphere, 208-209 Habitat Fragmentation, 213 Invasive Species, 214 Industrial and Agricultural Pollution, 216 Ecological Impacts, 220-221 Lesson 7.3 Review, #2, 222 Performance-Based Assessment: Biodiversity in the Everglades, #2, 230-231 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 2: Causes and Effects of Global Change>Interactivity: Human Impact on Ecosystems

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Disciplinary Core Ideas: LS4.D: Biodiversity and Humans	
Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).	**SE/TE:** Climate Change, 208 Habitat Fragmentation, 213 Invasive Species, 214 Ecological Impacts, 220-221
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.	**SE/TE:** The Anthropocene, 204-205 Human Causes of Global Change, 206 Climate Change, 208 Habitat Loss, Fragmentation, and Restoration, 213 Invasive Species, 214 Pollution, 214 Ecological Impacts, 220-221 Impacts on Human Systems, 221 Sustainable Development, 223 Performance-Based Assessment: Biodiversity in the Everglades, #2, 230-231 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 2: Causes and Effects of Global Change>Interactivity: Human Impact on Ecosystems
Disciplinary Core Ideas: 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.	**SE/TE:** Designing Solutions, 222 Case Study Wrap-Up: How can a rising tide be stopped?, #2, 226 Performance-Based Assessment: Biodiversity in the Everglades, #4, 230-231 Performance-Based Assessment: Design a Rooftop Garden, #3, #4, 792-793 Case Study Wrap-Up: How do animal processes and human activity affect the environment?, #2, 858 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 3: Measuring and Responding to Change>Science Skills Worksheet: Plan an Urban Tree Planting

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Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Case Study Wrap-Up: How do animal processes and human activity affect the environment?, 858
Crosscutting Concepts: Stability and Change	
Much of science deals with constructing explanations of how things change and how they remain stable.	**SE/TE:** Performance-Based Assessment: A Tale of Two Countries, China and India, #4, #5, 166-167 Lesson 6.2 Review, #5, 185 Lesson 6.3 Review, #4, 189 Lesson 7.1 Review, #3, 205 Lesson 7.2 Review, #5, 217 Lesson 7.3 Review, #6, 222 Performance-Based Assessment: Biodiversity in the Everglades, #5, 230-231 Chapter 7 Assessment, #36, 234 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint

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Performance Expectation	
HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	**SE/TE:** Behavior and Evolution, 822 Social Behavior, 825-826 Communication, 827 Lesson 24.4 Review, #4, #6, 827 Case Study: How are Reef's Affected by Global Change?, 799, 828 **Realize™ Digital Resources:** **Chapter 24: Animal Evolution, Diversity, and Behavior** >Lesson 4: Social Interactions and Group Behavior>Modeling Lab: The Role of Group Behavior
Scientific and Engineering Practices: Engaging in Argument from Evidence	
Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**SE/TE:** Lesson 24.4 Review, #6, 827 **Realize™ Digital Resources:** **Chapter 24: Animal Evolution, Diversity, and Behavior** >Lesson 4: Social Interactions and Group Behavior>Modeling Lab: The Role of Group Behavior
Scientific and Engineering Practice: 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.	For Supporting Content, please see: **SE/TE:** Case Study: How are Reef's Affected by Global Change?, 799, 828 **Realize™ Digital Resources:** **Chapter 24: Animal Evolution, Diversity, and Behavior** >Lesson 4: Social Interactions and Group Behavior>Modeling Lab: The Role of Group Behavior
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.	**SE/TE:** Social Behavior, 825-826 Lesson 2.4 Review, #4, #6, 827 **Realize™ Digital Resources:** **Chapter 24: Animal Evolution, Diversity, and Behavior** >Lesson 4: Social Interactions and Group Behavior>Modeling Lab: The Role of Group Behavior

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Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Lesson 2.4 Review, #1, #6, 827 **Realize™ Digital Resources:** **Chapter 24: Animal Evolution, Diversity, and Behavior** >Lesson 4: Social Interactions and Group Behavior>Modeling Lab: The Role of Group Behavior
HS. Inheritance and Variation of Traits	
Performance Expectation	
HS-LS1-4. Use a model to illustrate cellular division (mitosis) and differentiation	**SE/TE:** Cell Division, 340 The Cell Cycle, 345-346 Mitosis, 346-347 Cytokinesis, 348 Lesson 11.2 Review, #5, 348 Figure 11-10: Mitosis, 349 From One Cell to Many, 355-356 Figure 11-16: Differentiation in *C. elegans*, 356 Human Development, 357 Lesson 11.4, #4, 361 **Realize™ Digital Resources:** **Chapter 11: Cell Growth and Division** >Lesson 2: The Process of Cell Division>Quick Lab: Make a Model of Mitosis >Lesson 4: Cell Differentiation>Exploration Lab: Regeneration in Planaria
Scientific and Engineering Practices: Developing and Using Models	
Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**SE/TE:** Figure 11-10: Mitosis, 349 Figure 11-16: Differentiation in *C. elegans*, 356 Chapter 11 Assessment, #28, 369 **Realize™ Digital Resources:** **Chapter 11: Cell Growth and Division** >Lesson 2: The Process of Cell Division>Quick Lab: Make a Model of Mitosis >Lesson 4: Cell Differentiation>Exploration Lab: Regeneration in Planaria

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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.	**SE/TE:** Mitosis, 346-347 From One Cell to Many, 355-356 Lesson 11.4, #4, 361 **Realize™ Digital Resources:** **Chapter 11: Cell Growth and Division** >Lesson 2: The Process of Cell Division>Interactivity: Exploring Mitosis
Crosscutting Concepts: 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.	**SE/TE:** Chapter 11 Assessment, #28, #32, 369-370 **Realize™ Digital Resources:** **Chapter 11: Cell Growth and Division** >Lesson 2: The Process of Cell Division>Quick Lab: Make a Model of Mitosis

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Performance Expectation	
(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.	**SE/TE:** Eukaryotic Chromosomes, 344 Chromosome Number, 393-394 Phases of Meiosis, 394-395 Comparing Meiosis and Mitosis, 396 Gene Linkage, 398 The Role of DNA, 416 Comparing RNA and DNA, 440-441 Molecular Genetics, 450 Lesson 14.2 Review, #6, 450 Eukaryotic Gene Regulation, 453 Chromosomal Mutations, 459 Transmission of Human Traits, 476-477 From Molecule to Phenotype, 481 Case Study Wrap-Up: DNA – to test or not to test?, #1, 494 Performance-Based Assessment: Tracking Royal Blood, #4, 498-499 Lesson 16.3 Review, #5, 523 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 4: Meiosis>Modeling Lab: Make a Model of Meiosis Chapter **13: DNA** >Lesson 1: Identifying the Substance of Genes>Forensics Lab: Using DNA to Identify Species
Scientific and Engineering Practices: Asking Questions and Defining Problems	
Ask questions that arise from examining models or a theory to clarify relationships.	**SE/TE:** Chapter 13 Assessment, #28, 435 Case Study Wrap-Up: DNA – to test or not to test?, #1, 494 Chapter 15 Assessment, #30, 501 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 4: Meiosis>Modeling Lab: Make a Model of Meiosis **Chapter 13: DNA** >Lesson 1: Identifying the Substance of Genes>Forensics Lab: Using DNA to Identify Species

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Disciplinary Core Ideas: 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.	**SE/TE:** Chromosomes, 343-344 The Role of RNA, 440 The Genetic Code, 445 Translation, 447 Prokaryotic Gene Regulation, 451 Eukaryotic Gene Regulation, 453 Homeotic Genes, 454-455 Figure 15-16: Functions of Human Genes, 489 The Large and Small of It, 491
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.	**SE/TE:** The Role of DNA, 416 The Role of RNA, 440 Comparing RNA and DNA, 440-441 The Genetic Code, 445 Translation, 447 Chapter 14 Assessment, #34, 470
Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Chapter 15 Assessment, #36, 502

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Performance Expectation	
(HS-LS3-2) Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, (3) mutations caused by environmental factors and/or (4) genetic engineering.	**SE/TE:** Replication and Separation of Genetic Material, 396 Lesson 12.4 Review, #7, 399 Eukaryotic DNA Replication, 427 Types of Mutations, 457-459 Effects of Mutations, 459-461 Case Study: What will the future hold for genetically modified crops?, 505, 528 Sources of Genetic Variation, 582-583 Hox Genes and Evolution, 597 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 4: Meiosis>Modeling Lab: A Model of Meiosis **Chapter 13: DNA** >Lesson 3: DNA Replication>Quick Lab: Modeling DNA Replication **Chapter 14: RNA and Protein Synthesis** >Lesson 4: Mutations>Modeling Lab: The Effect of Mutations
Scientific and Engineering Practices: Engaging in Argument from Evidence	
Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.	**SE/TE:** Lesson 14.4 Review, #4, 461 **Realize™ Digital Resources:** **Chapter 13: DNA** >Lesson 3: DNA Replication>Quick Lab: Modeling DNA Replication Chapter **14: RNA and Protein Synthesis** >Lesson 4: Mutations>Modeling Lab: The Effect of Mutations
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.	**SE/TE:** Phases of Meiosis, 394-395 Replication and Separation of Genetic Material, 396 Eukaryotic DNA Replication, 427 Types of Mutations, 457-459 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 4: Meiosis>Modeling Lab: A Model of Meiosis

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(NYSED) Environmental factors can cause mutations in genes. Only mutations in sex cells can be inherited.	**SE/TE:** Types of Mutations, 457-459 Sources of Genetic Variation, 582-583 **Realize™ Digital Resources:** **Chapter 14: RNA and Protein Synthesis** >Lesson 4: Mutations>Modeling Lab: The Effect of Mutations
(NYSED) Advances in biotechnology have allowed organisms to be modified genetically.	**SE/TE:** Rewriting the Genome, 511-513 Transgenic Organisms and Cloning, 514-515 Agriculture and Industry, 516-517 Heath and Medicine, 517-519 Case Study: What will the future hold for genetically modified crops?, 505, 505,528
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.	**SE/TE:** Types of Mutations, 457-459 Mutagens, 460
Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Reading Tool, 458 Lesson 14.4 Review, #1, 461 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 4: Meiosis>Modeling Lab: A Model of Meiosis **Chapter 13: DNA** >Lesson 3: DNA Replication>Quick Lab: Modeling DNA Replication **Chapter 14: RNA and Protein Synthesis** >Lesson 4: Mutations>Modeling Lab: The Effect of Mutations
Crosscutting Concepts: 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.	**SE/TE:** Analyzing DNA, 509 Rewriting the Genome, 511-513 Transgenic Organisms and Cloning, 514-515 Agriculture and Industry, 516-517 Heath and Medicine, 517-519 Case Study: What will the future hold for genetically modified crops?, 505, 505,528

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Science and engineering are influenced by society and society is influenced by science and engineering.	**SE/TE:** Agriculture and Industry, 516-517 Heath and Medicine, 517-519 Arguments for GM Foods, 525 Arguments Against GM Foods, 525 Case Study: What will the future hold for genetically modified crops?, 505, 505,528
Performance Expectation	
(HS-LS3-3) Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	**SE/TE:** Genes and Alleles, 380 Dominant and Recessive Alleles, 380 Segregation, 381-382 Probability and Heredity, 383-385 Independent Assortment, 387 Lesson 12.2 Review, #4, 388 Beyond Dominant and Recessive Alleles, 389-391 Case Study Wrap-Up: Genetic disorders: understanding the odds, #1, #2, 400 Performance-Based Assessment: Growing More and Better Corn, #2, #3, #6, 404-405 Populations and Gene Pools, 581 Single-Gene and Polygenic Traits, 583-584 Figure 18-5: Selection on a Single-Gene Trait, 586 The Hardy-Weinberg Principle, 590 Performance-Based Assessment: When Weeds Fight Back!, #2, 604-605 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 2: Applying Mendel's Principles>Interactivity: Using Punnett Squares Chapter **18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Quick Lab: Modeling Genetic Drift >Lesson 4: Molecular Evolution>Analyzing Data: Variation of Expressed Traits

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Scientific and Engineering Practices: Analyzing and Interpreting 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.	**SE/TE:** Figure 12-5: Segregation and Probability: Reason Quantitatively, 384 Lesson 12.2 Review, #4, 388 Case Study Wrap-Up: Genetic disorders: understanding the odds, #1, #2, 400 Performance-Based Assessment: Growing More and Better Corn, #3, 404-405 The Hardy-Weinberg Principle, 590 Performance-Based Assessment: When Weeds Fight Back!, #2, 604-605 **Realize™ Digital Resources:** **Chapter 12: Introduction to Genetics** >Lesson 2: Applying Mendel’s Principles>Interactivity: Using Punnett Squares **Chapter 18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Quick Lab: Modeling Genetic Drift >Lesson 4: Molecular Evolution>Analyzing Data: Variation of Expressed Traits
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.	**SE/TE:** Genes and Alleles, 380 A Summary of Mendel’s Principles, 388 Genes and the Environment, 392 Case Study Wrap-Up: Genetic disorders: understanding the odds, #1, #2, 400 Performance-Based Assessment: Growing More and Better Corn, #1, 404-405 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 4: Molecular Evolution>Analyzing Data: Variation of Expressed Traits

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Crosscutting Concepts: 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).	**SE/TE:** Using Segregation to Predict Outcomes, 384 Probabilities Predict Averages, 385 Case Study Wrap-Up: Genetic disorders: understanding the odds, #1, #2, 400 Performance-Based Assessment: Growing More and Better Corn, #3, 404-405 Chapter 12 Assessment, #32, 408 The Hardy-Weinberg Principle, 590 Performance-Based Assessment: When Weeds Fight Back!, #2, 604-605 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 4: Molecular Evolution>Analyzing Data: Variation of Expressed Traits
Crosscutting Concepts: 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.	**SE/TE:** Case Study Wrap-Up: Genetic disorders: understanding the odds, 400 Performance-Based Assessment: Growing More and Better Corn, 404-405 Performance-Based Assessment: When Weeds Fight Back!, 604-605 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Quick Lab: Modeling Genetic Drift
Science and engineering are influenced by society and society is influenced by science and engineering.	**SE/TE:** Case Study: What will the future hold for genetically modified crops?, 505, 505,528 Performance-Based Assessment: Gene Therapy, 532-533

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Performance Expectation	
HS-LS1-8. Use models to illustrate how human reproduction and development maintains continuity of life.	**SE/TE:** The Male Reproductive System, 933 The Female Reproductive System, 934-935 Later Development, 936 Lesson 27.3 Review: Questions #6 & #9
Scientific and Engineering Practices: Developing and Using Models	
Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**SE/TE:** The Male Reproductive System, 933 The Female Reproductive System, 934
Disciplinary Core Idea: LS1.A: Structure and Function	
(NYSED) The structures and functions of the human female reproductive system produce gametes in ovaries, allow for internal fertilization, support the internal development of the embryo and fetus in the uterus, and provide essential materials through the placenta, and nutrition through milk for the newborn. The structures and functions of the human male reproductive system produce gametes in testes and make possible the delivery of these gametes for fertilization.	**SE/TE:** The Male Reproductive System, 933 The Female Reproductive System, 934 Fertilization and Early Development, 935 Later Development, 936 Lesson 27.3 Review: Questions #6 and 9
Disciplinary Core Idea: LS1.B: Growth and Development of Organisms	
(NYSED) The continuity of life is sustained through reproduction and development. Human development, birth, and aging should be viewed as a predictable pattern of events influenced by factors such as gene expression, hormones, and the environment.	**SE/TE:** Fertilization and Early Development, 935 Later Development, 936
Crosscutting Concepts: 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.	For supporting content, please see: **SE/TE:** The Male Reproductive System, 933 The Female Reproductive System, 934
Crosscutting Concepts: Connections to Nature of Science **Science Is a Human Endeavor**	
Science and engineering are influenced by society and society is influenced by science and engineering.	**SE/TE:** Analyzing DNA, 509-511 Rewriting the Genome, 511-513 Transgenic Organisms and Cloning, 514-515

New York State 2016 Student Learning Standards for High School Life Science	Miller & Levine Biology ©2019
HS. Natural Selection and Evolution	
Performance Expectation	
(HS-LS4-1) Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	**SE/TE:** Observations from the Voyage, 546-548 Biogeography, 560-561 The Age of Earth and Fossils, 561 Comparing Anatomy and Development, 562-564 Reading Check: Summarize, 564 Genetics and Molecular Biology, 564-565 Lesson 17.4 Review, #3, #6, 567 Evolutionary Classification, 619 Cladograms, 620 DNA in Classification, 624-625 Figure 19-12: Tree of Life, 626-627 Case Study Wrap-Up: It's a duck! No, it's a beaver! No, it's a platypus!, #2, 630 Performance-Based Assessment: Build a Cladogram, #5, 634-635 Case Study Wrap-Up: How did fossil hunters find Tiktaalik?, #2, 666 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 1: The Voyage of Discovery>Analyzing Data: Darwin's Voyage >Lesson 4: Evidence of Evolution>Exploration Lab: Evidence of Evolution **Chapter 19: Biodiversity and Classification** >Lesson 2: Modern Evolutionary Classification>Argument-Based Inquiry Lab: Construct a Cladogram
Scientific and Engineering Practices: Obtaining, Evaluating, and Communicating Information	
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).	**SE/TE:** Reading Check: Summarize, 564 Chapter 17 Assessment, #40, 576 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 4: Evidence of Evolution>Exploration Lab: Evidence of Evolution **Chapter 19: Biodiversity and Classification** >Lesson 2: Modern Evolutionary Classification>Argument-Based Inquiry Lab: Construct a Cladogram

New York State 2016 Student Learning Standards for High School Life Science	**Miller & Levine Biology ©2019**
Scientific and Engineering Practices: 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.	**SE/TE:** Darwin's Epic Journey, 544-545 Lesson 17.1 Review, #1, 548 Testing Natural Selection, 565-567 New Techniques Suggest New Trees, 625 The Tree of All Life, 626 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 4: Evidence of Evolution>Exploration Lab: Evidence of Evolution
Disciplinary Core Ideas: LS4.A: Evidence of Common Ancestry and Diversity	
Genetic information 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.	**SE/TE:** Species Vary Over Time, 547 Comparing Anatomy and Development, 562-564 Genetics and Molecular Biology, 564-565 Genes as Derived Characters, 624 Performance-Based Assessment: Build a Cladogram, #5, 634-635 Case Study Wrap-Up: How did fossil hunters find Tiktaalik?, #2, 666 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 4: Evidence of Evolution>Exploration Lab: Evidence of Evolution
Crosscutting Concepts: 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.	**SE/TE:** Observations from the Voyage, 546-547 Lesson 17.1 Review, #3, 548 Chapter 17 Assessment, #33, 576 Figure 19-8: Interpreting a Cladogram, 622 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 1: The Voyage of Discovery>Analyzing Data: Darwin's Voyage Chapter **19: Biodiversity and Classification** >Lesson 2: Modern Evolutionary Classification>Science Skills Worksheet: Shark Classification;>Argument-Based Inquiry Lab: Construct a Cladogram

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Crosscutting Concepts: 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.	**SE/TE:** An Ancient, Changing Earth, 549-550
Performance Expectation	
(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, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.	**SE/TE:** Evolution by Natural Selection, 555-557 Lesson 17.3 Review, #3, 559 Natural Selection, 567 Performance-Based Assessment: Evolution in Action: Beak Size Among Darwin's Finches, #3, 572-573
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**SE/TE:** Performance-Based Assessment: Evolution in Action: Beak Size Among Darwin's Finches, #3, 572-573
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 (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.	**SE/TE:** Variation and Adaptation, 556 Survival of the Fittest, 556 Natural Selection, 557 Lesson 17.3 Review, #1, 559 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 3: Darwin's Theory: Natural Selection>Interactivity: Discovering Natural Selection
Disciplinary Core Ideas: LS4.C: Adaptation	
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.	**SE/TE:** Evolution by Natural Selection, 555-557 Performance-Based Assessment: Evolution in Action: Beak Size Among Darwin's Finches, #3, 572-573

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Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Case Study Wrap-Up: Lizards, Legs, and the Diversity of Life, #1, 568 Performance-Based Assessment: Evolution in Action: Beak Size Among Darwin's Finches, #3, 572-573 Chapter 17 Assessment, #34, 576
Performance Expectation	
(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.	**SE/TE:** Natural Selection, 557 How Natural Selection Works, 585-587 Case Study: How can antibiotics keep up with drug-resistant bacteria?, #2, 579, 600 Performance-Based Assessment, #2, 604-605 Chapter 18 Assessment, #33, 607 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Interactivity: Genetic Change
Scientific and Engineering Practices: Analyzing and Interpreting 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.	**SE/TE:** Performance-Based Assessment, #2, 604-605
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 (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.	**SE/TE:** Variation and Adaptation, 556 Survival of the Fittest, 556 Natural Selection, 557 Lesson 17.3 Review, #1, 559 How Natural Selection Works, 585-587 Lesson 18.2 Review, #6, 591
The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.	**SE/TE:** Natural Selection, 557 How Natural Selection Works, 585 Case Study Wrap-Up: How can antibiotics keep up with drug-resistant bacteria?, #2, 600 Chapter 18 Assessment, #33, 607 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Interactivity: Genetic Change

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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.	**SE/TE:** Evolution by Natural Selection, 555-557 How Natural Selection Works, 585-587 Lesson 18.2 Review, #6, 591
Adaptation also means that the distribution of traits in a population can change when conditions change.	**SE/TE:** Variation and Adaptation, 557 Performance-Based Assessment: Evolution in Action: Beak Size in Darwin's Finches, 572-573 Case Study: How can antibiotics keep up with drug-resistant bacteria?, #2, 579, 600 How Natural Selection Works, 585-587 Genetic Drift, 588
Crosscutting Concepts: 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.	**SE/TE:** Figure 18-5: Selection of a Single-Gene Trait: Apply Concepts, 586 Case Study Wrap-Up: How can antibiotics keep up with drug-resistant bacteria?, #2, 600 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 2: Evolution as Genetic Change>Interactivity: Genetic Change

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Performance Expectation	
(HS-LS4-4) Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	**SE/TE:** Evolution by Natural Selection, 555-557 Common Ancestry, 558 Lesson 17.3 Review, #4, 559 Speciation in Darwin's Finches, 594-595 Lesson 18.3 Review, #3, 595 Case Study Wrap-Up: How can antibiotics keep up with drug-resistant bacteria?, #2, 600 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 3: The Process of Speciation>Modeling Lab: Competing for Resources
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
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.	**SE/TE:** Case Study Wrap-Up: How can antibiotics keep up with drug-resistant bacteria?, #2, 600 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 3: The Process of Speciation>Modeling Lab: Competing for Resources
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.	**SE/TE:** Variation and Adaptation, 556 Survival of the Fittest, 556 Natural Selection, 557 Common Ancestry, 558 Geographic Isolation, 594 Changes in Gene Pools, 594 **Realize™ Digital Resources:** **Chapter 17: Darwin's Theory of Evolution** >Lesson 3: Darwin's Theory: Natural Selection>Simulation: Bird Beaks Chapter **18: Evolution of Populations** >Lesson 3: The Process of Speciation>Modeling Lab: Competing for Resources

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Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Lesson 18.3 Review, #3, 595 **Realize™ Digital Resources:** **Chapter 18: Evolution of Populations** >Lesson 3: The Process of Speciation>Modeling Lab: Competing for Resources
Crosscutting Concepts: 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.	**SE/TE:** Darwin's Epic Journey, 544-545 Common Ancestry, 558 Competition and Continued Evolution, 595
Performance Expectation	
(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, (2) the emergence of new species over time, and (3) the extinction of other species.	**SE/TE:** Speciation and Extinction, 652-654 Macroevolutionary Patterns, 657 Lesson 20.2 Review, #5, 658 Performance-Based Assessment: Evaluating Evidence from the K-T Boundary, #3, 670-671 **Realize™ Digital Resources:** **Chapter 20: History of Life** >Lesson 2: Evolutionary Patterns and Processes>Analyzing Data: Extinctions Through Time
Scientific and Engineering Practices: Engaging in Argument from Evidence	
Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**SE/TE:** Performance-Based Assessment: Evaluating Evidence from the K-T Boundary, #3, 670-671
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.	**SE/TE:** Adaptation and Extinction, 653 Patterns of Extinction, 654 Adaptive Radiation, 657 Lesson 20.2 Review, #5, 658 **Realize™ Digital Resources:** **Chapter 20: History of Life** >Lesson 2: Evolutionary Patterns and Processes>Analyzing Data: Extinctions Through Time

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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.	**SE/TE:** Adaptation and Extinction, 653 Patterns of Extinction, 654
Crosscutting Concepts: Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Performance-Based Assessment: Evaluating Evidence from the K-T Boundary, #4, 670-671 Chapter 20 Assessment, #32, 674 **Realize™ Digital Resources:** **Chapter 20: History of Life** >Lesson 2: Evolutionary Patterns and Processes>Analyzing Data: Extinctions Through Time

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HS. Engineering Design	
Performance Expectation	
(HS-ETS1-1) Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	**SE/TE:** Case Study: Something is missing. But what?, 41, 62 Performance-Based Assessment: Meet the Anthromes, p. 106-107 Case Study: How can a rising tide be stopped?, 201, 226 Performance-Based Assessment: Biodiversity in the Everglades, 230-231 Case Study: What would it take to make an artificial leaf?, 281, 298 Case Study: How does a plant remember winter?, 439, 462 Case Study: What will the future hold for genetically modified crops?, 505, 528 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 Case Study: What's wrong with the water?, 903, 944 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint
Scientific and Engineering Practices: Asking Questions and Defining Problems	
Analyze complex real-world problems by specifying criteria and constraints for successful solutions.	**SE/TE:** Case Study: How can a rising tide be stopped?, 201, 226 Case Study: What would it take to make an artificial leaf?, 281, 298 Case Study: What will the future hold for genetically modified crops?, 505, 528 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 Case Stud: What's wrong with the water?, 903, 944 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint

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Disciplinary Core Ideas: ETS1.A: Defining and Delimiting Engineering Problems	
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.	**SE/TE:** Case Study: Something is missing. But what?, 41, 62 Case Study: How can a rising tide be stopped?, 201, 226 Performance-Based Assessment: Biodiversity in the Everglades, 230-231 Case Study: What would it take to make an artificial leaf?, 281, 298 Case Study: What will the future hold for genetically modified crops?, 505, 528 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 Case Study: What's wrong with the water?, 903, 944
Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.	**SE/TE:** Case Study: How can a rising tide be stopped?, 201, 226 Performance-Based Assessment: Biodiversity in the Everglades, 230-231 Case Study: What will the future hold for genetically modified crops?, 505, 528 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Case Study: What's wrong with the water?, 903, 944 **Realize™ Digital Resources:** **Chapter 7: Humans and Global Change** >Lesson 1: Ecological Footprints>Argument-Based Inquiry: Calculating Ecological Footprint
Crosscutting Concepts: Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	**SE/TE:** Case Study: What will the future hold for genetically modified crops?, 505, 528

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Performance Expectation	
(HS-ETS1-2) Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	**SE/TE:** Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Something is missing. But what?, 41, 62 Case Study: Can we make a working model of our living planet?, 77, 102 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Exploration Lab: The Effect of Fertilizer on Algae
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**SE/TE:** Case Study: Can we make a working model of our living planet?, 77, 102 Case Study: Preventing the next epidemic, 681, 710- Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Exploration Lab: The Effect of Fertilizer on Algae
Disciplinary Core Ideas: ETS1.C: Optimizing the Design Solution	
Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.	Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Something is missing. But what?, 41, 62 Case Study: Can we make a working model of our living planet?, 77, 102 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design a Zoo Exhibit, 862-863 **Realize™ Digital Resources:** **Chapter 4: Ecosystems** >Lesson 3: Cycles of Matter>Exploration Lab: The Effect of Fertilizer on Algae

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Performance Expectation	
(HS-ETS1-3) Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	**SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Something is missing. But what?, 41, 62 Case Study: Can we make a working model of our living planet?, 77, 102 Performance-Based Assessment: Can Algal Blooms be Useful?, 136-137 Performance-Based Assessment: Using Cells to Clean up Pollution, 274-275 Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design A Model of Interacting Systems, 896-897 Case Study: What's wrong with the water?, 903, 944
Scientific and Engineering Practices: Constructing Explanations and Designing Solutions	
Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Can we make a working model of our living planet?, 77, 102 Performance-Based Assessment: Can Algal Blooms be Useful?, 136-137 Performance-Based Assessment: Using Cells to Clean up Pollution, 274-275 Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Case Study: What's wrong with the water?, 903, 944

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Disciplinary Core Ideas: 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.	**SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Something is missing. But what?, 41, 62 Case Study: Can we make a working model of our living planet?, 77, 102 Performance-Based Assessment: Can Algal Blooms be Useful?, 136-137 Performance-Based Assessment: Using Cells to Clean up Pollution, 274-275 Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design A Model of Interacting Systems, 896-897 Case Study: What's wrong with the water?, 903, 944
Crosscutting Concepts: Connections to Engineering, Technology, and Applications of Science **Influence of Science, Engineering, and Technology on Society and the Natural World**	
New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	**SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Can we make a working model of our living planet?, 77, 102 Performance-Based Assessment: Can Algal Blooms be Useful?, 136-137 Performance-Based Assessment: Using Cells to Clean up Pollution, 274-275 Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design A Model of Interacting Systems, 896-897 Case Study: What's wrong with the water?, 903, 944

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Performance Expectation	
(HS-ETS1-4) Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	For supporting content, please see: **SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Investigating Hydroponics, 34-35 Case Study: Can we make a working model of our living planet?, 77, 102 Performance-Based Assessment: Can Algal Blooms be Useful?, 136-137 Performance-Based Assessment: Using Cells to Clean up Pollution, 274-275 Performance-Based Assessment: A New Kind of Drug: mRNA, 466-467 Case Study: Preventing the next epidemic, 681, 710 Performance-Based Assessment: Cholera in Haiti, 714-715 Performance-Based Assessment: Design A Model of Interacting Systems, 896-897 Case Study: What's wrong with the water?, 903, 944
Scientific and Engineering Practices: Using Mathematics and Computational Thinking	
Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.	**SE/TE:** Performance-Based Assessment: Design A Model of Interacting Systems, 896-897
Disciplinary Core Ideas: ETS1.B: Developing Possible Solutions	
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.	**SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Analyzing DNA, 509-510 CRISPR and DNA Editing, 512-513
Crosscutting Concepts: 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.	For supporting content, please see: **SE/TE:** Case Study: Biology and Technology Solve Problems, 7, 31 Performance-Based Assessment: Design A Model of Interacting Systems, 896-897