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Biology Standards **Total Standards: 11**				
Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
BIO.1 Cells as a System	Biologists have determined that organisms share unique characteristics that differentiate them from non-living things. Organisms range from very simple to extremely complex.	BIO.1A Students will demonstrate an understanding of the characteristics of life and biological organization.	BIO.1A.1 Develop criteria to differentiate between living and non-living things.	NA
			BIO.1A.2 Describe the tenets of cell theory and the contributions of Schwann, Hooke, Schleiden, and Virchow.	Chapter 4: A Tour of the Cell 4.0 Microscopes reveal a startling new view of life Introduction to the Cell Page 60 4.1 Microscopes reveal the world of the cell Page 61
			BIO.1A.3 Using specific examples, explain how cells can be organized into complex tissues, organs, and organ systems in multicellular organisms.	Chapter 1: Biology: Exploring Life 1.3 VISUALIZING THE CONCEPT In life's hierarchy of organization, new properties emerge at each level Page 4

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Chapter 20: Unifying Concepts of Animal Structure and Function 20.2 Structure fits function at all levels of organization in the animal body Topic Overview Video: Anatomy and Physiology Page 426 20.3 Tissues are groups of cells with a common structure and function Page 427
			BIO.1A.4 Use evidence from current scientific literature to support whether a virus is living or non-living.	Chapter 10: Molecular Biology of the Gene The Genetics of Viruses and Bacteria 10.17 Viral DNA may become part of the host chromosome Page 217 10.18 Many viruses cause disease in animals and plants Page 218

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				10.19 Emerging viruses threaten human health Page 219
	Organisms are composed of four primary macromolecules: carbohydrates, lipids, proteins, and nucleic acids. Metabolism is the sum of all chemical reactions between molecules within cells. Cells continuously utilize materials obtained from the environment and the breakdown of other macromolecules to synthesize their own large macromolecules for cellular structures and functions. These metabolic reactions	BIO.1B Students will analyze the structure and function of the macromolecules that make up cells.	BIO.1B.1 Develop and use models to compare and contrast the structure and function of carbohydrates, lipids, proteins, and nucleic acids (DNA and RNA) in organisms.	Chapter 3: The Molecules of Cells 3.2 A few chemical groups are key to the functioning of biological molecules Page 42 3.3 Cells make large molecules from a limited set of small molecules Page 43 Carbohydrates 3.4 Monosaccharides are the simplest carbohydrates Page 44 3.5 Two monosaccharides are linked to form a disaccharide Page 45

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
	require enzymes for catalysis.			3.7 Polysaccharides are long chains of sugar units Page 47 3.8 Fats are lipids that are mostly energy-storage molecules Page 48 3.10 Phospholipids and steroids are important lipids with a variety of functions Page 50 3.12 Proteins have a wide range of functions and structures Page 52 3.13 Proteins are made from amino acids linked by peptide bonds Page 52

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				3.14 VISUALIZING THE CONCEPT A protein's functional shape results from four levels of structure Page 54 Nucleic Acids 3.15 The nucleic acids DNA and RNA are information-rich polymers of nucleotides Page 55
			BIO.1B.2 Design and conduct an experiment to determine how enzymes react given various environmental conditions (i.e., pH, temperature, and concentration). Analyze, interpret, graph, and present data to explain how those changing conditions affect the enzyme activity and the rate of the reactions that take place in biological organisms.	Chapter 5: The Working Cell How Enzymes Function 5.13 Enzymes speed up the cell's chemical reactions by lowering energy barriers 3.16 Lactose tolerance is a recent event in human evolution 3.16 Lactose tolerance is a recent event in human evolution

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				Page 56
	Cells are the basic units of all organisms, both prokaryotes and eukaryotes. Prokaryotic and eukaryotic cells differ in key structural features, but both can perform all functions necessary for life.	BIO.1C Students will relate the diversity of organelles to a variety of specialized cellular functions.	BIO.1C.1 Develop and use models to explore how specialized structures within cells (e.g., nucleus, cytoskeleton, endoplasmic reticulum, ribosomes, Golgi apparatus, lysosomes, mitochondria, chloroplast, centrosomes, and vacuoles) interact to carry out the functions necessary for organism survival.	Chapter 4: A Tour of the Cell 4.5 The nucleus contains the cell's genetic instructions Page 65 to 4.21 Cell walls enclose and support plant cells Page 81 4.22 Review: Eukaryotic cell structures can be grouped on the basis of four main functions Page 82
			BIO.1C.2 Investigate to compare and contrast prokaryotic cells and eukaryotic cells, and plant, animal, and fungal cells.	Chapter 4: A Tour of the Cell 4.3 Prokaryotic cells are structurally simpler than eukaryotic cells Page 63 4.4 Eukaryotic cells are partitioned into functional compartments Page 64

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				4.19 The extracellular matrix of animal cells functions in support and regulation Page 79 4.20 Three types of cell junctions are found in animal tissues Page 80 4.21 Cell walls enclose and support plant cells Page 81 Chapter 16: Microbial Life: Prokaryotes and Protists Prokaryotes 16.1 Prokaryotes are diverse and widespread Page 337 16.12 Protists are an extremely diverse assortment of eukaryotes

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 348 Chapter 17: The Evolution of Plant and Fungal Diversity Figure 17.12A Mycelium on fallen conifer needles Page 371 Figure 17.12B Fungal reproductive and feeding structures Page 371
			BIO.1C.3 Contrast the structure of viruses with that of cells, and explain why viruses must use living cells to reproduce.	Chapter 10: Molecular Biology of the Gene The Genetics of Viruses and Bacteria 10.17 Viral DNA may become part of the host chromosome Page 217 10.18 Many viruses cause disease in animals and plants Page 218

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				10.19 Emerging viruses threaten human health Page 219 Chapter 24: The Immune System 24.14 HIV destroys helper T cells, compromising the body's defenses Page 517
	The structure of the cell membrane allows it to be a selectively permeable barrier and maintain homeostasis. Substances that enter or exit the cell must do so via the cell membrane. This transport across the membrane may occur through a variety of mechanisms, including simple diffusion,	BIO.1D Students will describe the structure of the cell membrane and analyze how the structure is related to its primary function of regulating transport in and out of cells to maintain homeostasis.	BIO.1D.1 Plan and conduct investigations to prove that the cell membrane is a semi-permeable, allowing it to maintain homeostasis with its environment through active and passive transport processes.	Chapter 5: The Working Cell 5.1 VISUALIZING THE CONCEPT Membranes are fluid mosaics of lipids and proteins with many functions Page 87 5.3 Passive transport is diffusion across a membrane with no energy investment Page 89

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
	facilitated diffusion, osmosis, and active transport.			5.4 Osmosis is the diffusion of water across a membrane Page 90 5.5 Water balance between cells and their surroundings is crucial to organisms Page 91 5.6 Transport proteins can facilitate diffusion across membranes Page 92 5.8 Cells expend energy in the active transport of a solute Page 94 5.9 Exocytosis and endocytosis transport large molecules across membranes Page 95
			BIO.1D.2 Develop and use models to explain how the cell deals with imbalances of solute concentration	Chapter 5: The Working Cell 5.5 Water balance between cells and their surroundings is crucial to organisms

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
			across the cell membrane (i.e., hypertonic, hypotonic, and isotonic conditions, sodium/potassium pump).	Page 91 Figure 5.5 How animal and plant cells react to changes in tonicity (deeping shades of blue reflect increasing concentrations of solutes in the surrounding solutions) Page 91 Checkpoint 5.5 Explain the function of the contractile vacuoles in a freshwater Paramecium (shown in Figure 4.11A) in terms of what you have just learned about water balance in cells. Page 91 5.8 Cells expend energy in the active transport of a solute Page 94

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	Cells grow and reproduce through a regulated cell cycle. Within multicellular organisms, cells repeatedly divide for repair, replacement, and growth. Likewise, an embryo begins as a single cell that reproduces to form a complex, multicellular organism through the processes of cell division and differentiation.	BIO.1E Students will develop and use models to explain the role of the cell cycle during growth, development, and maintenance in multicellular organisms.	BIO.1E.1 Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.1 Cell division plays many important roles in the lives of organisms Page 147 Checkpoint 8.1 What function does cell division play in an amoeba (a single-celled protist)? What functions does it play in your body? Page 147 Figure 8.2A Binary fission of a prokaryotic cell Page 147 8.4 The cell cycle includes growth and division phases Page 150 8.5 Cell division is a continuum of dynamic changes

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 151 Figure 8.5 The stages of cell division by mitosis Page 151 BioFlix: Mitosis Page 151 8.13 Meiosis reduces the chromosome number from diploid to haploid Page 159 Chapter 27: Reproduction and Embryonic Development 27.1 Asexual reproduction results in the generation of genetically identical offspring Page 555 27.2 Sexual reproduction results in the generation of genetically unique offspring Page 556

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				27.5 The formation of sperm and egg cells requires meiosis Page 559 27.9 Fertilization results in a zygote and triggers embryonic development Page 563 27.12 Organs start to form after gastrulation Page 566 27.13 Multiple processes give form to the developing animal Page 567
			BIO.1E.2 Identify and describe the changes that occur in a cell during replication. Explore problems that might occur if the cell does not progress through the cycle correctly (cancer).	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.3 The large, complex chromosomes of eukaryotes duplicate with each cell division Page 149

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				8.9 Growing out of control, cancer cells produce malignant tumors Page 155 8.18 Accidents during meiosis can alter chromosome number Page 164 Checkpoint 8.18 Explain how nondisjunction could result in a diploid gamete. Page 164 8.20 An extra copy of chromosome 21 causes Down syndrome Page 166
			BIO.1E.3 Relate the processes of cellular reproduction to asexual reproduction in simple organisms (i.e., budding, vegetative propagation, regeneration, binary fission). Explain why the DNA of the	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.1 Cell division plays many important roles in the lives of organisms

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
			daughter cells is the same as the parent cell.	Page 147 Checkpoint 8.1 What function does cell division play in an amoeba (a single-celled protist)? What functions does it play in your body? Page 147 Figure 8.2A Binary fission of a prokaryotic cell Page 147 Chapter 27: Reproduction and Embryonic Development 27.1 Asexual reproduction results in the generation of genetically identical offspring Page 555
			BIO.1E.4 Enrichment: Use an engineering design process to investigate the role of stem cells in regeneration and asexual reproduction, then develop	Chapter 27: Reproduction and Embryonic Development 27.10 Cleavage produces a blastula from the zygote Page 564

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
			applications of stem cell research to solve human medical conditions.*	Chapter 11: How Genes Are Controlled 11.14 Therapeutic cloning can produce stem cells with great medical potential Page 241 Figure 11.14 Therapeutic cloning using stem cells Page 241
BIO.2 Energy Transfer	Organisms require energy to perform life functions. Cells are transformers of energy, continuously utilizing a complex sequence of reactions in which energy is transferred from one form to another, for example, from light energy to chemical energy to kinetic energy. Emphasis is on	BIO.2 Students will explain that cells transform energy through the processes of photosynthesis and cellular respiration to drive cellular functions.	BIO.2.1 Use models to demonstrate that ATP and ADP are cycled within a cell as a means to transfer energy.	Chapter 5: The Working Cell 5.10 Cells transform energy and matter as they perform work Page 96 Figure 5.10 An illustration of the two laws of thermodynamics: transformation of energy and increase in entropy Page 96

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	illustrating the inputs and outputs of matter and the transfer and transformation of energy in photosynthesis and cellular respiration. Assessment is limited to identification of the phases (i.e., glycolysis, citric acid cycle, and electron transport chain) in cellular respiration as well as light and light-independent reactions of photosynthesis and does not include specific biochemical reactions within the phases.			5.12 ATP drives cellular work by coupling exergonic and endergonic reactions Page 98 Figure 5.12A The hydrolysis of ATP yielding ADP, a phosphate group, and energy Page 98 Figure 5.12B How ATP powers cellular work Page 98 Figure 5.12C The ATP cycle Page 98 Chapter 6: How Cells Harvest Chemical Energy 6.3 Cellular respiration banks energy in ATP molecules Page 109 Figure 6.3 Summary equation for cellular respiration

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 109
			BIO.2.2 Develop models of the major reactants and products of photosynthesis to demonstrate the transformation of light energy into stored chemical energy in cells. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored.	Chapter 7: Photosynthesis: Using Light to Make Food 7.4 Photosynthesis is a redox process Page 131 Figure 7.4 The redox reactions of photosynthesis Page 131 7.5 Photosynthesis occurs in two stages, which are linked by ATP and NADPH Page 132 Figure 7.5A The summary equation of photosynthesis Page 132 Figure 7.5B An overview of the two stages of photosynthesis in a chloroplast Page 132 BioFlix: Photosynthesis

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 132 7.7 Photosystems capture solar energy Page 134 Figure 7.7B A photosystem harvesting light energy and an excited electron being passed to the primary electron acceptor Page 134 7.8 Two photosystems connected by an electron transport chain convert light energy to the chemical energy of ATP and NADPH Page 135 Figure 7.8 A mechanical analogy of the light reactions Page 135

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				7.9 VISUALIZING THE CONCEPT The light reactions take place within the thylakoid membranes Page 136 The Calvin Cycle: Reducing CO_2 to Sugar 7.10 ATP and NADPH power sugar synthesis in the Calvin cycle Page 137 Figure 7.10 Details of the Calvin cycle, which takes place in the stroma of a chloroplast Page 137
			BIO.2.3 Develop models of the major reactants and products of cellular respiration (aerobic and anaerobic) to demonstrate the transformation of the chemical energy stored in food to the available	Chapter 6: How Cells Harvest Chemical Energy Cellular Respiration: Aerobic Harvesting of Energy Page 107

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
			energy of ATP. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored.	6.2 Breathing supplies O2 for use in cellular respiration and removes CO2 Page 108 6.3 Cellular respiration banks energy in ATP molecules Page 109 Figure 6.3 Summary equation for cellular respiration Page 109 6.4 The human body uses energy from ATP for all its activities Page 110 6.6 Overview: Cellular respiration occurs in three main stages Page 112 to 6.11 VISUALIZING THE CONCEPT Stage 3: Most ATP production occurs by oxidative phosphorylation

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 117 6.14 Fermentation enables cells to produce ATP without oxygen Page 120
			BIO.2.4 Conduct scientific investigations or computer simulations to compare aerobic and anaerobic cellular respiration in plants and animals, using real world examples.	Chapter 6: How Cells Harvest Chemical Energy 6.13 Review: Each molecule of glucose yields many molecules of ATP Page 119 Figure 6.13 An estimated tally of the ATP produced per molecule of glucose by substrate-level and oxidative phosphorylation in cellular respiration Page 119 6.14 Fermentation enables cells to produce ATP without oxygen Page 120

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Figure 6.14A Lactic acid fermentation. NAD+ is regenerated as pyruvate is reduced to lactate. Page 120
			BIO.2.5 Enrichment: Investigate variables (e.g., nutrient availability, temperature) that affect anaerobic respiration and current real-world applications of fermentation.	Chapter 6: How Cells Harvest Chemical Energy 6.14 Fermentation enables cells to produce ATP without oxygen Page 120 Figure 6.14A Lactic acid fermentation. NAD+ is regenerated as pyruvate is reduced to lactate. Page 120 Alcohol Fermentation Page 120 Types of Anaerobes Page 120

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			BIO.2.6 Enrichment: Use an engineering design process to manipulate factors involved in fermentation to optimize energy production.*	Chapter 6: How Cells Harvest Chemical Energy 6.14 Fermentation enables cells to produce ATP without oxygen Page 120 Figure 6.14A Lactic acid fermentation. NAD+ is regenerated as pyruvate is reduced to lactate. Page 120 Alcohol Fermentation Page 120 Types of Anaerobes Page 120 Checkpoint 6.14 A glucose-fed yeast cell is moved from an aerobic environment to an anaerobic one. For the cell to continue generating ATP at the same rate, how would its

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				rate of glucose consumption need to change? Page 120
BIO.3 Reproduction and Heredity	Somatic cells contain homologous pairs of chromosomes, one member of each pair obtained from each parent, that form a diploid set of chromosomes in each cell. These chromosomes are similar in genetic information but may contain different alleles of these genes. For sexual reproduction, an offspring must inherit a haploid set from each parent. Haploid gametes are formed by meiosis, a specialized cell division in which the chromosome number is reduced by half.	BIO.3A Students will develop and use models to explain the role of meiosis in the production of haploid gametes required for sexual reproduction.	BIO.3A.1 Model sex cell formation (meiosis) and combination (fertilization) to demonstrate the maintenance of chromosome number through each generation in sexually reproducing populations. Explain why the DNA of the daughter cells is different from the DNA of the parent cell.	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.13 Meiosis reduces the chromosome number from diploid to haploid Page 159 Figure 8.13 The stages of meiosis Page 159 BioFlix: Meiosis Page 159 8.15 Independent orientation of chromosomes in meiosis and random fertilization lead to varied offspring Page 161

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	During meiosis, members of a homologous pair may exchange information and then are randomly sorted into gametes resulting in genetic variation in sex cells.		BIO.3A.2 Compare and contrast mitosis and meiosis in terms of reproduction.	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.1 Cell division plays many important roles in the lives of organisms Page 147 8.2 Prokaryotes reproduce by binary fission Page 148 Checkpoint 8.2 Why is binary fission classified as asexual reproduction? Page 148 8.14 VISUALIZING THE CONCEPT Mitosis and meiosis have important similarities and differences Page 160 8.15 Independent orientation of chromosomes in meiosis

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				and random fertilization lead to varied offspring Page 161
			BIO.3A.3 Investigate chromosomal abnormalities (e.g., Down syndrome, Turner's syndrome, and Klinefelter syndrome) that might arise from errors in meiosis (nondisjunction) and how these abnormalities are identified (karyotypes).	Chapter 8: The Cellular Basis of Reproduction and Inheritance 8.18 Accidents during meiosis can alter chromosome number Page 164 Figure 8.18 Nondisjunction in meiosis I and meiosis II Page 164 8.19 A karyotype is a photographic inventory of an individual's chromosomes Page 165 8.20 An extra copy of chromosome 21 causes Down syndrome Page 166

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				8.23 Alterations of chromosome structure can cause birth defects and cancer Page 169
	Offspring inherit DNA from their parents. The genes contained in the DNA (genotype) determine the traits expressed in the offspring's phenotype. Alleles of a gene may demonstrate various patterns of inheritance. These patterns of inheritance may be followed through multiple generations within families.	BIO.3B Students will analyze and interpret data collected from probability calculations to explain the variation of expressed traits within a population.	BIO.3B.1 Demonstrate Mendel's law of dominance and segregation using mathematics to predict phenotypic and genotypic ratios by constructing Punnett squares with both homozygous and heterozygous allele pairs.	Chapter 9: Patterns of Inheritance 9.3 Mendel's law of segregation describes the inheritance of a single character Page 176 Figure 9.3A A cross that tracks one character (flower color) Page 176 Figure 9.3B An explanation of the crosses in Figure 9.3A Page 176 9.4 Homologous chromosomes bear the alleles for each character Page 177

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				Figure 9.4 Three gene loci on homologous chromosomes Page 177 9.6 Geneticists can use a testcross to determine unknown genotypes Page 179 9.7 Mendel's laws reflect the rules of probability Page 180 9.9 Many inherited traits in humans are controlled by a single gene Page 182 Figure 9.9A Examples of single-gene inherited traits in humans Page 182 Figure 9.9B Offspring produced by parents who are

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				both carriers for albinism, a recessive disorder Page 182
			BIO.3B.2 Illustrate Mendel's law of independent assortment using Punnett squares and/or the product rule of probability to analyze monohybrid crosses.	Chapter 9: Patterns of Inheritance 9.5 The law of independent assortment is revealed by tracking two characters at once Page 178 Figure 9.5ATwo hypotheses for segregation in a dihybrid cross Page 178 Figure 9.5B Independent assortment of two genes in Labrador retrievers Page 178 9.7 Mendel's laws reflect the rules of probability Page 180

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				Figure 9.7 Segregation and fertilization as chance events Page 180
			BIO.3B.3 Investigate traits that follow non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, multiple alleles in human blood types, and sex-linkage).	Chapter 9: Patterns of Inheritance 9.11 Incomplete dominance results in intermediate phenotypes Page 184 9.12 Many genes have more than two alleles that may be codominant Page 185 Figure 9.12 Multiple alleles for the ABO blood groups Page 185 9.21 Sex-linked genes exhibit a unique pattern of inheritance Page 194 Figure 9.21A Fruit fly eye color determined by sex-linked gene Page 194

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				Figure 9.21C A heterozygous female crossed with a red-eyed male Page 194
			BIO.3B.4 Analyze and interpret data (e.g., pedigrees, family, and population studies) regarding Mendelian and complex genetic traits (e.g., sickle-cell anemia, cystic fibrosis, muscular dystrophy, color-blindness, and hemophilia) to determine patterns of inheritance and disease risk.	Chapter 9: Patterns of Inheritance 9.8 VISUALIZING THE CONCEPT Page 181 9.9 Many inherited traits in humans are controlled by a single gene Page 182 9.9 Many inherited traits in humans are controlled by a single gene Page 182 Table 9.9 Some Autosomal Disorders in Humans Page 182

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Recessive Disorders Page 182 Dominant Disorders Page 182 9.10 New technologies can provide insight into one's genetic legacy Page 183 9.13 A single gene may affect many phenotypic characters Page 186 Figure 9.13B Sickle-cell disease, an example of pleiotropy Page 186
	Gene expression results in the production of proteins and thus determines the phenotypes of the organism. Changes in the DNA occur throughout an	BIO.3C Students will construct an explanation based on evidence to describe how the structure and nucleotide base sequence of DNA	BIO.3C.1 Develop and use models to explain the relationship between DNA, genes, and chromosomes in coding the instructions for the traits transferred from parent to offspring.	Chapter 3: The Molecules of Cells Nucleic Acids 3.13 Proteins are made from amino acids linked by peptide bonds

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	organism's life. Mutations are a source of genetic variation that may have a positive, negative, or no effect on the organism.	determines the structure of proteins or RNA that carry out essential functions of life.		Page 53 3.15 The nucleic acids DNA and RNA are information-rich polymers of nucleotides Page 55 Figure 3.15A A nucleotide Page 55 Figure 3.15D The flow of genetic information in the building of a protein Page 55 Chapter 4: A Tour of the Cell The Nucleus and Ribosomes 4.5 The nucleus contains the cell's genetic instructions Page 65 4.6 Ribosomes make proteins for use in the cell and for export

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				4.6 The locations and structure of ribosomes Page 66 Chapter 8: The Cellular Basis of Reproduction and Inheritance Cell Division and Reproduction 8.1 Cell division plays many important roles in the lives of organisms Page 147 Figure 8.3B Chromosome duplication and distribution Page 149 8.16 Homologous chromosomes may carry different versions of genes Page 162 Figure 8.16A Differing genetic information (coat color and

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				eye color) on homologous chromosomes Page 162 Chapter 9: Patterns of Inheritance 9.17 Genes on the same chromosome tend to be inherited together Page 190 Chapter 10: Molecular Biology of the Gene 10.1 Experiments showed that DNA is the genetic material Page 201 The Flow of Genetic Information from DNA to RNA to Protein 10.6 Genes control phenotypic traits through the expression of proteins Page 206

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				10.7 Genetic information written in codons is translated into amino acid sequences Page 207
			BIO.3C.2 Evaluate the mechanisms of transcription and translation in protein synthesis.	Chapter 10: Molecular Biology of the Gene 10.6 Genes control phenotypic traits through the expression of proteins Page 206 10.7 Genetic information written in codons is translated into amino acid sequences Page 207 10.8 The genetic code dictates how codons are translated into amino acids Page 208 10.9 VISUALIZING THE CONCEPT

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				Transcription produces genetic messages in the form of RNA Visualizing the Concept: Transcription produces genetic messages in the form of RNA Page 209 10.10 Eukaryotic RNA is processed before leaving the nucleus as mRNA Page 210 10.11 Transfer RNA molecules serve as interpreters during translation Page 211 10.12 Ribosomes build polypeptides Page 212 to 10.15 Review: The flow of genetic information in the cell is DNA → RNA → protein

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				Page 215 Figure 10.15 A summary of transcription and translation Page 215
			BIO.3C.3 Use models to predict how various changes in the nucleotide sequence (e.g., point mutations, deletions, and additions) will affect the resulting protein product and the subsequent inherited trait.	Chapter 10: Molecular Biology of the Gene 10.16 Mutations can affect genes Page 216 Figure 10.16A The molecular basis of sickle-cell disease Page 216
			BIO.3C.4 Research and identify how DNA technology benefits society. Engage in scientific argument from evidence over the ethical issues surrounding the use of DNA technology (e.g., cloning, transgenic organisms, stem cell research, and the Human Genome Project, gel electrophoresis).	Chapter 10: Molecular Biology of the Gene 10.23 Bacterial plasmids can serve as carriers for gene transfer Page 223 Chapter 12: DNA Technology and Genomics

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				Gene Cloning and Editing (12.1–12.5) Pages 250-254 Genetically Modified Organisms (12.6–12.10) Pages 255-259 12.13 Gel electrophoresis sorts DNA molecules by size Page 262 12.15 DNA profiling has provided evidence in many forensic investigations Page 264 12.18 The Human Genome Project revealed that most of the human genome does not consist of genes Page 267 Chapter 31: Plant Structure, Growth, and Reproduction

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				31.15 Plant cloning is an important agricultural tool Page 650
			BIO.3C.5 Enrichment: Investigate current biotechnological applications in the study of the genome (e.g., transcriptome, proteome, individualized sequencing, and individualized gene therapy).	Chapter 12: DNA Technology and Genomics 12.10 Gene therapy may someday help treat a variety of diseases Page 259 12.11 The analysis of genetic markers can produce a DNA profile Page 260 12.15 DNA profiling has provided evidence in many forensic investigations Page 264 Table 12.15 STR Analysis Data that Exonerated Earl Washington Page 264

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				12.20 The field of bioinformatics is expanding our understanding of genomes Page 269
BIO.4 Adaptations and Evolution	Evolution is a key unifying principle in biology. Differentiating between organic and chemical evolution and the analysis of the gradual changes in populations over time, helps students understand common features and differences between species and thus the relatedness between species. There are several factors that affect how natural selection acts on populations within their environments leading to speciation, extinction, and	BIO.4 Students will analyze and interpret evidence to explain the unity and diversity of life.	BIO.4.1 Use models to differentiate between organic and chemical evolution, illustrating the steps leading to aerobic heterotrophs and photosynthetic autotrophs.	Chapter 13: How Populations Evolve Darwin's Theory of Evolution (13.1–13.7) Pages 276 -282 Chapter 15: Tracing Evolutionary History 15.2 Experiments show that the abiotic synthesis of organic molecules is possible Page 314 Figure 15.2 Diagram showing the synthesis of organic compounds in Miller's 1953 experiment Page 314

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	the current diversity of life on earth.			15.3 Stages in the origin of the first cells probably included the formation of polymers, protocells, and self-replicating RNA Page 315 Figure 15.3B A hypothesis for the origin of the first genes Page 315 15.4 The origins of single-celled and multicellular organisms and the colonization of land were key events in life's history Page 316 Chapter 17: The Evolution of Plant and Fungal Diversity Plant Evolution and Diversity (17.1–17.2) Pages 360-361

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				Chapter 18: The Evolution of Invertebrate Diversity Animal Evolution and Diversity (18.1–18.4) Pages 383-386
			BIO.4.2 Evaluate empirical evidence of common ancestry and biological evolution, including comparative anatomy (e.g., homologous structures and embryological similarities), fossil record, molecular/biochemical similarities (e.g., gene and protein homology), and biogeographic distribution.	Chapter 13: How Populations Evolve 13.2 The study of fossils provides strong evidence for evolution Page 277 Checkpoint 13.2 What types of animals do you think would be most represented in the fossil record? Explain your answer. Page 277 13.4 Homologies provide strong evidence for evolution Page 279 13.5 Homologies indicate patterns of descent that can

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				be shown on an evolutionary tree Page 280 Figure 13.5 An evolutionary tree for tetrapods and their closest living relatives, the lungfishes Page 280 Checkpoint 13.5 Refer to the evolutionary tree in Figure 13.5. Are crocodiles more closely related to lizards or birds? Page 280 Chapter 15: Tracing Evolutionary History 15.15 Phylogenies based on homologies reflect evolutionary history Page 327

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				Figure 15.15A Relating classification to phylogeny Page 327 15.16 Shared characters are used to construct phylogenetic trees Page 328 15.17 An organism's evolutionary history is documented in its genome Page 329 Figure 15.17 A phylogenetic tree of the bear family (Ursidae) based on mitochondrial DNA Page 329 15.19 Constructing the tree of life is a work in progress Page 331

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Figure 15.19B Two major episodes of horizontal gene transfer in the history of life (dates are uncertain) Page 331
			BIO.4.3 Construct cladograms/phylogenetic trees to illustrate relatedness between species.	Chapter 15: Tracing Evolutionary History 15.15 Phylogenies based on homologies reflect evolutionary history Page 327 15.16 Shared characters are used to construct phylogenetic trees Page 328 Cladistics Page 328 Figure 15.16A Constructing a phylogenetic tree using cladistics Page 328

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				Figure 15.16B A phylogenetic tree of reptiles (* indicates extinct lineages) Page 328
			BIO.4.4 Design models and use simulations to investigate the interaction between changing environments and genetic variation in natural selection leading to adaptations in populations and differential success of populations.	Chapter 13: How Populations Evolve 13.6 Darwin proposed natural selection as the mechanism of evolution Page 281 13.7 Scientists can observe natural selection in action Page 282 The Evolution of Populations 13.8 Mutation and sexual reproduction produce the genetic variation that makes evolution possible Page 283 Genetic Variation Page 283

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				Figure 13.8 Variation in a population of brown-lipped snails Page 283 13.9 Evolution occurs within populations Page 284 13.10 The Hardy-Weinberg equation can test whether a population is evolving Page 285 Mechanisms of Microevolution 13.12 Natural selection, genetic drift, and gene flow can cause microevolution Page 287 13.13 Natural selection is the only mechanism that consistently leads to adaptive evolution

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 288 13.17 Diploidy and balancing selection preserve genetic variation Page 292 13.18 Natural selection cannot fashion perfect organisms Page 293
			BIO.4.5 Use Darwin's Theory to explain how genetic variation, competition, overproduction, and unequal reproductive success acts as driving forces of natural selection and evolution.	Chapter 13: How Populations Evolve 13.6 Darwin proposed natural selection as the mechanism of evolution Page 281 13.8 Mutation and sexual reproduction produce the genetic variation that makes evolution possible Page 283 Genetic Variation Page 283

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				13.13 Natural selection is the only mechanism that consistently leads to adaptive evolution Page 288 13.14 VISUALIZING THE CONCEPT Natural selection can alter variation in a population in three ways Page 289 13.15 Sexual selection may lead to phenotypic differences between males and females Page 290 13.17 Diploidy and balancing selection preserve genetic variation Page 292 Checkpoint 13.17 Why would natural selection tend to

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				reduce genetic variation more in populations of haploid organisms than in populations of diploid organisms? Page 292
			BIO.4.6 Construct explanations for the mechanisms of speciation (e.g., geographic and reproductive isolation).	Chapter 14: The Origin of Species 14.3 VISUALIZING THE CONCEPT Reproductive barriers keep species separate Page 300 Mechanisms of Speciation 14.4 In allopatric speciation, geographic isolation leads to speciation Page 301 14.5 Reproductive barriers can evolve as populations diverge Page 302 Figure 14.5A Evolution of reproductive barriers in laboratory populations of fruit

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				flies adapted to different food sources Page 302 14.6 Sympatric speciation takes place without geographic isolation Page 303
			BIO.4.7 Enrichment: Construct explanations for how various disease agents (bacteria, viruses, chemicals) can influence natural selection.	Chapter 9: Patterns of Inheritance 9.13 A single gene may affect many phenotypic characters Page 186 Chapter 13: How Populations Evolve 13.16 The evolution of drug-resistant microorganisms is a serious public health concern Page 291 Chapter 37: Communities and Ecosystems

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				37.7 Parasites and pathogens can affect community composition Page 763
BIO.5 Interdependence of Organisms and Their Environments	Complex interactions within an ecosystem affect the numbers and types of organisms that survive. Fluctuations in conditions can affect the ecosystem's function, resources, and habitat availability. Ecosystems are subject to carrying capacities and can only support a limited number of organisms and populations. Factors that can affect the carrying capacities of populations are both biotic and abiotic.	BIO.5 Students will Investigate and evaluate the interdependence of living organisms and their environment.	BIO.5.1 Illustrate levels of ecological hierarchy, including organism, population, community, ecosystem, biome, and biosphere.	Chapter 34: The Biosphere: An Introduction to Earth's Diverse Environments 34.1 Ecologists study how organisms interact with their environment at several levels Page 693 Topic Overview Video: Ecological Organization Page 693 Figure 34.1A An organism Figure 34.1B A population Figure 34.1C A community Figure 34.1D An ecosystem Page 693

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				34.3 Physical and chemical factors influence life in the biosphere Page 695 Checkpoint 34.3 Why are birds and mammals found in Himalayan alpine meadows, but non-bird reptiles and amphibians are not? Page 695
			BIO.5.2 Analyze models of the cycling of matter (e.g., carbon, nitrogen, phosphorus, and water) between abiotic and biotic factors in an ecosystem and evaluate the ability of these cycles to maintain the health and sustainability of the ecosystem.	Chapter 34: The Biosphere: An Introduction to Earth's Diverse Environments 34.18 VISUALIZING THE CONCEPT The global water cycle connects aquatic and terrestrial biomes Page 710 Video: Visualizing the Concept: The global water cycle connects aquatic and terrestrial biomes

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Page 710 Checkpoint 34.18 What is the main way that living organisms contribute to the water cycle? Page 710 Chapter 37: Communities and Ecosystems Ecosystem Structure and Dynamics 37.14 Ecosystem ecology emphasizes energy flow and chemical cycling Page 770 37.15 Primary production sets the energy budget for ecosystems Page 771 37.19 The carbon cycle depends on photosynthesis and respiration

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				Page 775 Figure 37.19 The carbon cycle Page 775 37.20 The phosphorus cycle depends on the weathering of rock Page 776 Figure 37.20 The phosphorus cycle Page 776 37.21 The nitrogen cycle depends on bacteria Page 777 Figure 37.21 The nitrogen cycle Page 777 37.22 A rapid inflow of nutrients degrades aquatic ecosystems

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				Checkpoint 37.22 How would excessive addition of mineral nutrients to a lake eventually lead to the loss of many fish species? Page 778
			BIO.5.3 Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases on the carbon dioxide cycle and global climate.	Chapter 38: Conservation Biology 38.3 Rapid warming is changing the global climate Page 786 Figure 38.3A VISUALIZING THE DATA Differences in average annual global temperatures compared with 20th-century average Page 786 38.4 Human activities are responsible for rising concentrations of greenhouse gases Page 787

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				Figure 38.4A Atmospheric concentrations of CO2, N2O (y axis, left), and CH4 (y axis, right), as of 2014 Page 787 38.5 Climate change affects biomes, ecosystems, communities, and populations Page 788
			BIO.5.4 Develop and use models to describe the flow of energy and amount of biomass through food chains, food webs, and food pyramids.	Chapter 37: Communities and Ecosystems 37.8 Trophic structure is a key factor in community dynamics Figure 37.8 Two food chains Page 764 Checkpoint 37.8 I'm eating a cheese pizza. At which trophic level(s) am I feeding? Page 764 37.9 VISUALIZING THE CONCEPT

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Food chains interconnect, forming food webs Page 765 Checkpoint 37.9 In addition to grasshoppers, the collared lizard shown in the middle of the figure may also eat smaller lizards, which in turn feed on grasshoppers and ants. What trophic levels does the collared lizard occupy when its diet includes smaller lizards as well as grasshoppers? Page 765 37.16 Energy supply limits the length of food chains Page 772 Figure 37.16A The fate of the energy in leaf biomass consumed by a caterpillar Page 772

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				Figure 37.16B An idealized energy pyramid Page 772
			BIO.5.5 Evaluate symbiotic relationships (e.g., mutualism, parasitism, and commensalism) and other co-evolutionary (e.g., predator-prey, cooperation, competition, and mimicry) relationships within specific environments.	Chapter 37: Communities and Ecosystems 37.2 Interspecific interactions are fundamental to community structure Page 758 37.3 Competition may occur when a shared resource is limited Page 759 Checkpoint 37.3 Which do you think has more severe effects, intraspecific competition or interspecific competition? Explain why. Page 759 37.4 Mutualism benefits both partners Page 760

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				Checkpoint 37.4 When corals are stressed by environmental conditions, they expel their dinoflagellates in a process called bleaching. How is widespread bleaching likely to affect coral reefs? Page 760 37.5 Predation leads to diverse adaptations in prey species Page 761 Checkpoint 37.5 Explain why predation is a powerful factor in the adaptive evolution of prey species. Page761 37.7 Parasites and pathogens can affect community composition Page 763

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				Checkpoint 37.7 Use your knowledge of interspecific interactions to explain why tree diversity increased after all the chestnuts died. Page 763
			BIO.5.6 Analyze and interpret population data, both density-dependent and density-independent, to define limiting factors. Use graphical representations (growth curves) to illustrate the carrying capacity within ecosystems.	Chapter 36: Population Ecology 36.2 Density and dispersion patterns are important population variables Page 743 36.3 Life tables track survivorship in populations Page 744 Table 36.3 Life Table for the U.S. Population in 2015 Page 744 Figure 36.3 Three types of survivorship curves Page 744

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				36.4 Idealized models predict patterns of population growth Page 744 Table 36.4A Exponential Growth of Rabbits, r = 0.3 Page 745 Figure 36.4A Exponential growth of rabbits Page 745 36.5 Multiple factors may limit population growth Page 746 Figure 36.5B Increasing mortality of kelp perch (Brachyistius frenatus, inset) with increasing density Page 746 Figure 36.5C Weather change as a density-independent

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				factor limiting aphid population growth Page 746 36.6 Some populations have "boom-and-bust" cycles Page 747 Figure 36.6 Population cycles of the snowshoe hare and the lynx Page 747
			BIO.5.7 Investigate and evaluate factors involved in primary and secondary ecological succession using local, real world examples.	Chapter 37: Communities and Ecosystems 37.12 Disturbance is a prominent feature of most communities Page 768 Figure 37.12A Primary succession on a lava flow Page 768 Figure 37.12B Secondary succession: Yellowstone

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				National Park in November 1988, after a fire (top), and in July 1989 Page 768
			BIO.5.8 Enrichment: Use an engineering design process to create a solution that addresses changing ecological conditions (e.g., climate change, invasive species, loss of biodiversity, human population growth, habitat destruction, biomagnification, or natural phenomena).*	Chapter 37: Communities and Ecosystems 37.17 An energy pyramid explains the ecological cost of meat Page 773 Figure 37.17 Food energy available to people eating at different trophic levels Page 773 Chapter 38: Conservation Biology Conservation Biology and Restoration Ecology 38.7 Protecting endangered populations is one goal of conservation biology Page 790

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Disciplinary Core Idea	**Conceptual Understanding**	**Content Standard**	**Breakout**	**Citations**
				Checkpoint 38.7 What do you think is the first priority for conservation biologists when they select a site for ferret reintroduction? Page 790 38.8 Sustaining ecosystems and landscapes is a conservation priority Page 791 38.9 Establishing protected areas slows the loss of biodiversity Page 792 38.10 Zoned reserves are an attempt to reverse ecosystem disruption Page 793 38.11 The Yellowstone to Yukon Conservation Initiative seeks to preserve biodiversity

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				by connecting protected areas Page 794 38.12 The study of how to restore degraded habitats is a developing science Page 795 Checkpoint 38.12 How will the Kissimmee River Restoration Project improve water quality in the Everglades ecosystem? Page 795 38.13 Sustainable development is an ultimate goal Page 796 Checkpoint 38.13 Why is a concern for the well-being of future generations essential for progress toward sustainable development? Page 796

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			BIO.5.9 Enrichment: Use an engineering design process to investigate and model current technological uses of biomimicry to address solutions to real-world problems.*	Chapter 35: Behavioral Adaptations to the Environment 35.6 Imprinting poses problems and opportunities for conservation programs Figure 35.6A A whooping crane chick interacting with a puppet "parent" Page 720

Objectives identified by "Enrichment:" are considered enrichment material that may be expanded upon as time permits. Engineering standards are represented in some performance objectives with specific wording that will prompt students to approach learning and exploration using the engineering process. These performance objectives are marked with an * at the end of the statement.