**AP Biology: Des Moines Public Schools**

2018-2019 CURRICULUM GUIDE SCI507/508 SCI515/516

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| **AP Biology** |
| AP Biology is an introductory college-level biology course. Students cultivate their understanding of biology through inquiry-based investigations as they explore the following topics: evolution, cellular processes — energy and communication, genetics, information transfer, ecology, and interactions.  **AP Biology** **– Course Content:**  The course is based on four Big Ideas, which encompass core scientific principles, theories, and processes that cut across traditional boundaries and provide a broad way of thinking about living organisms and biological systems.  **Big Idea 1**: The process of evolution explains the diversity and unity of life.  **Big Idea 2**: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  **Big Idea 3**: Living systems store, retrieve, transmit, and respond to information essential to life processes.  **Big Idea 4**: Biological systems interact, and these systems and their interactions possess complex properties.  **AP Biology – Scientific Practices:**  • Use representations and models to communicate scientific phenomena and solve scientific problems  • Use mathematics appropriately  • Engage in scientific questioning to extend thinking or to guide investigations  • Work with scientific explanations and theories  • Plan and implement data collection strategies in relation to a particular scientific question  • Perform data analysis and evaluation of evidence  • Connect and relate knowledge across various scales, concepts, and representations in and across domains.  **AP Biology** **Exam: Format of Assessment – 3 Hours**  **Section I: Multiple Choice | 69 Questions | 90 Minutes | 50% of Exam Score**  • Multiple Choice: Discrete Questions and Questions in Sets  • Grid-In: Discrete Questions and Questions Integrate Biology and Mathematical Skills  **Section II: Free Response | 8 Questions | 90 Minutes | 50% of Exam Score**  • Long Free Response (2 questions, one of which is lab/data-based)  • Short Free Response (6 questions, each requiring a paragraph length argument/response)  **Link to DMPS Grading Resources:** <http://grading.dmschools.org>  **Link to Course Resources**: <http://science.dmschools.org>  **Link to Course Information @ AP Central:** <http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/2117.html> |

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| Semester 1  Grading Topics | College Board Curriculum Framework Alignment |
| Biochemistry | Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  EUs: 4.A, 4.C |
| Cell Processes | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.C  Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  EUs: 4.A, 4.B, 4.C |
| Cell Energetics | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.A |
| DNA/RNA | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.D, 2.E  Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.  EUs: 3.A, 3.B, 3.C  Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  EUs: 4.A, 4.C |
| Science Practices | Science Practices for AP Biology  SP.1, SP.2, SP.3, SP.4, SP.5, SP.6, SP.7 |

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| Semester 2 Topics | College Board Curriculum Framework Alignment |
| Genetics & Biotechnology | Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.  EUs: 3.A, 3.C |
| Evolution & Natural Selection | Big Idea 1: The process of evolution drives the diversity and unity of life.  EUs: 1.A, 1.B, 1.C, 1.D  Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.D, 2.E  Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.  EUs: 3.C  Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  EUs: 4.B, 4.C |
| Cell Communication & Systems | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.C, 2.D  Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.  EUs: 3.D, 3.E |
| Ecology | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis.  EUs: 2.D  Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  EUs: 4.A, 4.B, 4.C |
| Science Practices | Science Practices for AP Biology  SP.1, SP.2, SP.3, SP.4, SP.5, SP.6, SP.7 |

**Standards-Referenced Grading Basics**

The teacher designs instructional activities and assessments that grow and measure a student’s skills in the elements identified on our topic scales. Each scale features many such skills and knowledges, also called learning targets. These are noted on the scale below with letters (A, B, C) and occur at Levels 2 and 3 of the scale. In the grade book, a specific learning activity could be marked as being 3A, meaning that the task measured the A item at Level 3.

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| **The Body of Evidence in a Process-Based Course** |
| **Process-Based SRG** *is defined as an SRG course design where the same scale recurs throughout the course, but the level of complexity of text and intricacy of task increase over time.*  AP Biology cycles students through some topics repeatedly as they progress through the course, with changing content and an increasing complexity of scientific problem-solving, analysis, and expectations throughout.  To account for this, process-based courses like this have their evidence considered in a “Sliding Window” approach. When determining the topic score for any given grading topic, *the most recent evidence* determines the topic score. Teacher discretion remains a vital part of this determination, but it is hard to overlook evidence from the most recent (and therefore rigorous) assessments. |





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| Biochemistry |

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| **Topic** | **4** | **3** | **2** |
| **Biochemistry** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Use models to explain how the structure and sequence of a monomer determines the properties of the corresponding polymer. LO 4.2  3B: Use models to predict and justify how changes in the monomers affect the function of the polymer. LO 4.3  3C: Differentiate between the emergent properties of water through the chemical nature of water. | 2A.1: Define scientific terms such as: amino acid, protein, monosaccharide, disaccharide, polysaccharide, lipid, nucleic acid, nucleotide, monomer, polymer, polar, nonpolar.  2A.2: Identify the connection between the structure of the monomer and the function of the polymer. LO 4.1  2B.1: Define scientific terms such as: dehydration, hydrolysis, anabolic, catabolic.  2B.2: Describe why a variety of molecules provide a wide range of functions to organisms. LO 4.22  2C.1: Define scientific terms such as: hydrogen bonding, adhesion, cohesion, specific heat, and universal solvent.  2C.2: Describe the different emergent properties of water. |

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| Cell Processes |

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| **Topic** | **4** | **3** | **2** |
| **Cell Processes** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.*  4A: Justify the selection of data regarding the types of molecules that an animal, plant or bacterium will take up as necessary building blocks and excrete as waste products. LO 2.8 | 3A: Represent graphically the exchange of molecules between an organism and its environment in order to maintain homeostasis.  3B: Predict how a cell would react to changes in the environment to maintain homeostasis. LO 2.12  3C: Use representations and models to analyze situations qualitatively to describe how interactions of cell structures, which possess specialized functions, provide essential functions. LO 4.6  3D: Make a prediction about the interactions of organelles. LO 4.4 | 2A.1: Define terms: homeostasis, plasma membrane, osmosis, diffusion, phospholipid, embedded proteins, passive transport, active transport, exocytosis, endocytosis, phagocytosis, hydrophilic, hydrophobic, water potential.  2A.2: Construct models that connect the movement of molecules across membranes with membrane structure and function. LO 2.11  2A.3: Use calculated surface area-to-volume ratios to predict which cells might eliminate wastes or procure nutrients faster by diffusion. LO 2.6  2A.4: Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. LO 2.7  2B.1: List various environments that cells react and adjust to, to maintain homeostasis (hypertonic, hypotonic etc.).  2C.1: Define terms: nucleus, nucleolus, nuclear envelope, cytoplasm, endoplasmic reticulum, Golgi bodies, mitochondria, chloroplast, lysosomes, central vacuoles, microtubules, ribosomes, osmosis.  2C.2: Explain how internal membranes and organelles contribute to cell function. LO 2.13  2C.3: Use representations and models to describe differences in prokaryotic and eukaryotic cell. LO 2.14  2D.1: Construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions. LO 4.5 |

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| Cell Energetics |

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| **Topic** | **4** | **3** | **2** |
| **Cell Energetics** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Justify a scientific claim that free energy is required for living systems to maintain organization, to grow or to reproduce, but that multiple strategies exist in different living systems. LO 2.2        3B: Construct a model that demonstrates how free energy is captured in the light dependent reactions of photosynthesis and then subsequently used to power the production of organic molecules.      3C: Construct a model that demonstrates how enzyme catalyzed reactions harvest energy from simple carbohydrates.        3D: Justify a claim based on evidence that the electron chain captures free energy from electrons in a series of reactions that set up an electrochemical gradient. | 2A.1: Define terms such as: free energy, autotroph, heterotroph, photosynthesis, aerobic respiration, and anaerobic respiration.    2A.2: Identify various strategies to explain how biological systems use free energy to maintain organization, to grow, and to reproduce. LO 2.1  2B.1: Define terms such as: photosystem, NADPH, and Calvin Cycle.  2B.2: Discuss how the light dependent and light independent reactions work together to create organic molecules.    2C.1: Define terms such as: glycolysis, Krebs Cycle, electron transport chain, NADH, and fermentation.    2C.2: Identify the major processes that capture energy from simple carbohydrates.    2D.1: Define terms such as: hydrogen ion pump, redox, ATP Synthase. |

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| DNA/RNA |

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| **Topic** | **4** | **3** | **2** |
| **DNA/RNA** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Construct scientific explanations, based on historical investigations, that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, RNA are the primary sources of heritable information. LO 3.1, 3.2  3B: Create representations and models that illustrate how genetic information is replicated and passed to new cells. LO 3.3  3C: Create a visual representation to illustrate how changes in a DNA sequence can result in a **change** in the polypeptide produced. LO 3.25  3D: Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. LO 3.6 | 2A.1: Define terms such as: nucleotide, chromosome, bacteriophage, histone, chromatid, autosome.  2A.2: Describe the structure and function of DNA and RNA.  2A.3: Discuss the main historical investigations that allowed scientists to determine that DNA was the inheritable information.  2B.1: Define terms such as: replication, semiconservative, DNA polymerase, ligase, RNA polymerase, helicase, topoisomerase, G1, S, G2, M phase  2B.2: Describe representations and models that illustrate how genetic information is copied for transmission between generations. LO 3.3  2C.1: Define terms such as: gene, intron, exon, transcription, translation, mRNA, tRNA, rRNA, codon, anticodon, mutation, deletion, substitution, insertion, frameshift, transposable element.  2C.2: Use representations and models illustrating polypeptide synthesis. LO 3.4  2D.1: Describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. LO 3.18  2D.2: Describe the connection between the regulation of gene expression and observed differences betweenindividuals in a population**.** LO 3.19  2D.3: Vocabulary may include: operon, poly A tail, GTP cap, introns, exons, inhibitors, TRP operon, LAC operon |

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| Scientific Practices |
| **Labs and Resources** |
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| **Topic** | **4** | **3** | **2** |
| **Scientific Practices** | *In addition to score 3.0 performance, the student demonstrates in-depth inferences and applications that go beyond the learning goal.*    ❏ Engage in scientific questioning to extend thinking or guide investigations within the context of an AP course (SP.3).  **OR**    ❏ Connect and relate knowledge across various scales, concepts, and representations in and across domains (SP.7). | Apply scientific practices to biology.  ❏ Use representations and models (graphs, diagrams, tables, charts) to communicate scientific phenomena and solve scientific problems (SP.1).    ❏ Use mathematics appropriately (SP.2).    ❏ Implement data collection strategies (SP.4) and perform data analysis and evaluate evidence (SP.5).    ❏ Support conclusions using experimental evidence and scientific reasoning. | A level 2 in scientific practices fails to meet the learning goal in two areas:   * Use representations and models to communicate scientific phenomena and solve scientific problems (SP.1). * Use mathematics appropriately (SP.2.) * Implement data collection strategies (SP.4) and perform data analysis and evaluate evidence (SP.5). * Support conclusions using experimental evidence and scientific reasoning. |

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| Genetics and Biotechnology |

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| **Topic** | **4** | **3** | **2** |
| **Genetics and Biotechnology** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Construct an explanation for how DNA is transmitted via mitosis, binary fission, or meiosis followed by fertilization. (LO 3.9, 3.11)  3B: Compare and contrast how sexually and asexually reproducing organisms increase genetic variation within their population (LO 3.10. 3.27)  3C: Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. (LO 3.14)  3D: Describe representations of an appropriate example of inheritance patterns that cannot be explained by Mendel’s model of the inheritance of traits. LO 3.17  3E: Compare and contrast at least 3 commonly used strategies to manipulate heritable information (LO 3.5) | 2A.1: Explain how meiosis creates haploid cells from diploid cells and how mitosis and binary fission maintain ploidy level  2A.3: Define terms such as: haploid, diploid, gamete, crossing over, homologous chromosomes, random (independent) assortment , mitosis, meiosis, asexual reproduction, cell cycle, telomere, alleles, random fertilization, somatic, zygote.  2B.1: Compare and contrast processes by which genetic variation is produced and maintained in organisms from multiple domains.( LO 3.27)  2B.2: Represent the connection between meiosis and fertilization and increased genetic diversity necessary for evolution (LO 3.10)  2B.3: Define terms such as: conjugation, transformation, transduction, crossing over, independent assortment, and random fertilization  2C.1: Complete basic Punnett squares to show probabilities of different crosses  2C.2: Using the idea of independent assortment, predict the probability of passing on a combination of alleles through meiosis  2C.3: Define terms such as: homozygous, heterozygous, dominant, recessive, genotype, phenotype, wild type, mutant type  2D.1: Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. (LO 3.16)  2D.2: Define terms such as: Multiple alleles, sex-linked genes, codominant, incomplete dominance, linked genes, gene mapping, recombination frequency,  2E.1: Justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies (LO 3.5)  2E.2: Pose questions about ethical, social, or medical issues surrounding human genetic disorders. (LO 3.13) |

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| Evolution and Natural Selection |

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| **Topic** | **4** | **3** | **2** |
| **Evolution and Natural Selection** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Evaluate data to qualitatively and quantitatively to explain the role of natural selection in evolution and how it can lead to speciation. (LO 1.2)  3B: Evaluate evidence that describes evolutionary changes in the genetic makeup (phenotypic or allelic frequencies) of a population over time. (LO 1.4 )  3C: Evaluate, refine and connect scientific evidence from many scientific disciplines to support the modern concept of evolution. Include morphology, biochemistry, and geology. (1.9, 1.10, 1.12)  3D: Justify the scientific claim that organisms share core biological processes and features and how these shared features support the concept of common ancestry. (LO 1.14-1.16)  3E Justify the selection of geological, physical, and chemical data that reveal early Earth conditions that led to the origin of life on Earth. (LO 1.32) | 2A.1: Connect evolutionary changes in a population over time to a change in the environment. (LO 1.5)  2A.2: Predict how a change in genotype, when expressed as phenotype, provides a variation that can be subject to natural selection (LO 3.24)  2A.3: Use theories and models to make predictions about the effects of variation within populations on survival and fitness and what types of changes can occur to the population over time( LO 4.26, LO 1.22)  2A.4: Describe speciation in an isolated population and connect it to reproductive isolation, change in gene frequency, change in environment, natural selection, and/or genetic drift (LO 1.24)  2A.5: Define such terms such as: natural selection, artificial selection, fitness, directional selection, stabilizing selection, disruptive selection, speciation, reproductive isolation, allopatric speciation, sympatric speciation, parapatric speciation, coevolution  2B.1: Use data from models based on the Hardy-Weinberg equilibrium to justify and make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. (LO 1.6, 1.7, 1.8 and 1.13)  2B.2: Use data to describe a model that illustrates evolution as an ongoing process that occurs within populations today. (1.25, 1.26)  2B.3: Define terms such as**:** allele frequency, gene pool, genetic equilibrium, genetic drift, gene flow, founder effect, bottleneck, inbreeding, Hardy-Weinberg postulates    2C.1: Design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry, and geology. (LO 1.11)  2C.2: Define terms such as: biogeography, fossil, comparative morphology, radiometric dating, plate tectonics, homologous structure, analogous structures, convergent evolution, divergent evolution, embryology, molecular clock.    2D.1: Pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data (new information) that could extend or improve the phylogenetic tree. (LO 1.17)  2D.2: Evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. (LO 1.18)  2D.3: Create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation using provided data (LO 1.19)  2D.4: Define terms such as: phylogeny, derived trait, cladogram, clade, sister group  2E.1 Describe scientific hypotheses about the origin of life on Earth. (LO 1.27)  2E.2 Explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past (LO 4.20)  2E.3 Define terms such as: Big bang theory, Miller-Urey experiment, RNA world hypothesis, protocell, cyanobacteria, stromatolites, endosymbiont theory. |

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| Cell Communication & Systems |

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| **Topic** | **4** | **3** | **2** |
| **Cell Communication & Systems** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Create a model that shows how changes(s) in signal transduction can alter cellular response (can include psychoactive drugs, inhibitors, etc.) LO 3.36, 3.37, 3.38, 3.39  3B: Create representations(s) and construct explanations of cell communication through cell-to-cell contact and through chemical signaling LO 3.34, 3.35        3C: Predict the effects of a change in a component(s) of a biological system on the functionality of an organism.    3D: Evaluate data that show the effect(s) of changes in concentrations of key molecules on negative feedback and positive feedback mechanisms. LO 2.17, 2.18 | 2A: Describe the three steps of the cell signaling process (reception, transduction, response (changes in gene expression or activation of an enzyme(s))    2B.1: Describe how cells communicate through direct cell-to-cell contact, local signaling, and long distance signaling    2B.2: Vocabulary words can include: antigen-presenting cells, MHC, neurotransmitters, hormones (such as insulin or glucagon)    2C.1: Compare and contrast the innate and acquired immune responses.  2C.2: Vocabulary words can include: antibodies, antigen, T helper cell, B cell, humoral, cell mediated, cytotoxic T cells, pathogen, mast cells, histamines.  2C.3: Describe how nervous systems detect internal and external signals.  2C.4: Describe how nervous systems transmit information.  2C.5: Explain the role of the vertebrate brain in integrating information to produce a response.  2C.6: Vocabulary can include: neuron, action potential, resting potential, sensory, motor, sodium-potassium pump.  2D.1: Describe positive and negative feedback mechanisms and give an example of each.  2D.2: Describe the role of the endocrine system in feedback mechanisms. |

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| Ecology |

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| **Topic** | **4** | **3** | **2** |
| **Ecology** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems, from cells and organisms to populations, communities and ecosystems. (LO 2.22)  3B: Use data analysis to explain observations and measurements regarding the effect of population interactions on patterns of species distribution and abundance. LO 4.19  3C: Use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environment result in the movement of matter and energy. (LO 4.15)  3D: Predict consequences of human actions on both local and global ecosystems. (4.21) | 2A.1: Predict how changes in free energy availability affect organisms, populations, and ecosystems. LO 2.3  2A.2: Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, and ecosystems). LO 2.24  2B.1: Explain the kind of data needed to answer scientific questions and to make predictions about the interactions of populations within communities. LO 4.11  2B.2: Apply mathematical routines to quantities that describe communities composed of populations of organisms that interact in complex ways. LO 4.12  2B.3: Design a plan for collecting and analyzing data to show that all biological systems (cells, organisms, populations, communities, and ecosystems) are affected by complex biotic and abiotic interactions. (LO 2.23)  2B.4: Explain how organisms use innate and learned behaviors and communicate in response to internal changes and external cues, and which can change behavior. LO 3.40-3.41-3.42  2B.5: Vocabulary may include : primary producer, exponential and logistic growth, density dependent, density independent, competition, predation, commensalism, mutualism, parasitism, innate/learned behaviors  2C.1: Apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. LO 4.14  2C.2: Predict the effects of a change in matter or energy availability on communities. LO 4.16  2C.3: Vocabulary may include: biological pyramids, food webs/chains, keystone species,  2D: Vocabulary may include: logging, monocropping, global climate change, introduced species. |

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| **SRG Scale Score** | **Topic:**  **AP-Style Assessments** | **AP Exam**  **Score Conversion** |
| **4** | In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal. | **90-100%** |
| **3.5** | Student’s performance reflects exceptional facility with **some**, but not all Level 4 learning targets. | **80-89%** |
| **3**  **Learning Goal** | Student’s performance reflects success on **all Level 3** learning targets. | **70-79%** |
| **2.5** | Student’s performance reflects success on **some**, but not all, Level 3 learning targets | **60-69%** |
| **2** | Student’s performance reflects success on **all Level 2** learning targets. | **50-59%** |
| **1.5** | Student’s performance reflects success on **some** but not all Level 2 learning targets | **40-49%** |
| **1** | Student’s performance reflects insufficient progress towards foundational skills and knowledge. | **20-39%** |