**AP Biology: Des Moines Public Schools**

2021 - 2022 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:**• Explain biological concepts, processes, and models presented in written format. • Analyze visual representations of biological concepts and processes.• Determine scientific questions and methods. • Represent and describe data.•Perform statistical tests and mathematical calculations to analyze and interpret data. • Develop and justify scientific arguments using evidence.**AP Biology** **Exam: Format of Assessment – 3 Hours** **Section I: Multiple Choice | 60 Questions | 90 Minutes | 50% of Exam Score** • Multiple Choice: Discrete Questions and Questions in Sets**Section II: Free Response | 6 Questions | 90 Minutes | 50% of Exam Score** • Long Free Response (2 questions, one of which is lab/data-based)• Short Free Response (4 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 1Grading Topics | College Board Curriculum Framework Alignment |
| Chemistry 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.  |
| Cell Structure and Function | Big Idea 1: The process of evolution drives 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 4: Biological systems interact, and these systems and their interactions possess complex properties.  |
| Cell Energetics | Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis. Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.  |
| Cell Communication and Cell Cycle | 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.  |
| Science Practices | Science Practices for AP BiologySP.1, SP.2, SP.3, SP.4, SP.5, SP.6 |

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| Semester 2 Topics | College Board Curriculum Framework Alignment |
| Heredity | Big Idea 1: The process of evolution drives the diversity and unity of life.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. |
| Gene Expression and Regulation | Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes. |
| Evolution and Natural Selection | Big Idea 1: The process of evolution drives the diversity and unity of life.Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties. |
| Ecology | Big Idea 1: The process of evolution drives 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. |
| Science Practices | Science Practices for AP BiologySP.1, SP.2, SP.3, SP.4, SP.5, SP.6 |



**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 knowledge, 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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| Chemistry of Life |

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| **Topic** | **4** | **3** | **2** |
| **Chemistry of Life** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function. (LO 1.1)3B: Use models to explain how the structure and sequence of a monomer determines the properties of the corresponding polymer. (LO 1.2, - 1.4)3C: Explain how a change in subunits of a polymer may lead to changes in structure or function of the macromolecules (LO 1.5).  | 2A.1: Define scientific terms such as: hydrogen bonding, covalent bonding, polarity, adhesion, cohesion, specific heat, surface tension, capillary action, and universal solvent.2A.2: Use a model to describe how covalent and hydrogen bonding affect the properties of water.2A.3: Describe how the chemical properties of water affect its function.2B.1: Define scientific terms such as: amino acid, protein, monosaccharide, disaccharide, polysaccharide, lipid, nucleic acid, nucleotide, monomer, polymer, polar, nonpolar, dehydration, hydrolysis, anabolic, catabolic.2B.2: Identify the connection between the structure of the monomer and the function of the polymer. 2B.3: Identify the four macromolecules and the monomers and polymers of each.2C.1: Use models to predict and justify how changes in the monomers affect the function of the polymer. (LO 1.5) |

# Cell Structure and Function

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| **Topic** | **4** | **3** | **2** |
| **Cell Structure and Function** | *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 bacteria will take up as necessary building blocks and excrete as waste products. LO 2.8 | 3A: Describe the structure and function of subcellular components and organelles and how they contribute to the function of the cell. (LO 2.1, 2.2, 2.10, 2.11)3B: Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell. (LO 2.4, 2.5)3C: Describe the mechanisms that organisms use to maintain solute and water balance. (LO 2.3, 2.6, 2.7,2.8.2.9) |  2A.1: Describe the functions of the following organelles: nucleus, nucleolus, nuclear envelope, cytoplasm, endoplasmic reticulum, Golgi bodies, mitochondria, chloroplast, lysosomes, central vacuoles, microtubules, ribosomes, plasma membrane.2A.2: Use written representations and models to describe similarities and differences between prokaryotic and eukaryotic cells.2A.3: Describe the function of the endomembrane system.2A.4: Describe the importance of compartmentalization and membrane folding to cell function. 2B.1: Define the following terms: phospholipid bilayer, embedded protein, hydrophilic, hydrophobic.2B.2: Construct models that connect the movement of molecules across membranes with membrane structure and function. 2C.1: Define terms: homeostasis, osmosis, diffusion, embedded proteins, passive transport, active transport, exocytosis, endocytosis, phagocytosis, hydrophilic, hydrophobic, water potential.2C.2: Use calculated surface area-to-volume ratios to predict which cells might eliminate wastes or procure nutrients faster by diffusion. 2C.3: Explain how cell size and shape affect the overall rate of nutrient intake and the rate of waste elimination. 2C.4: Predict how cells would respond to various environments to maintain homeostasis (hypertonic, hypotonic etc.).  |

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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: Describe the structure and function of enzymes and how they affect the rate of biological reactions.  3B: Construct a model that demonstrates how energy is captured in the light dependent reactions of photosynthesis and then used to power the production of organic molecules.  C: Construct a model that demonstrates how enzyme catalyzed reactions harvest energy from simple carbohydrates.  | 2A.1: Define terms such as: substrate, active site, allosteric site, denature, inhibition, catalyst2A.2: Explain how changes to the structure of an enzyme may affect its function.2A.3: Explain how the cellular environment affects enzyme activity.2B.1: Define terms such as: photosystem I and II, thylakoid, stroma, NADPH, and Calvin Cycle. electron transport chain, ATP synthase, substrate level phosphorylation, and oxidative phosphorylation2B.2: Discuss how the light dependent and light independent reactions work together to create organic molecules. 2B.3: Explain how cells capture energy from light and transfer it to biological molecules for storage and use2C.1: Define and explain the processes: glycolysis, Krebs Cycle, electron transport chain, NADH, and fermentation, anaerobic respiration, aerobic respiration, lactic acid. 2C.2: Identify the major processes that capture energy from simple carbohydrates.2C.3: Identify various strategies to explain how biological systems use energy to maintain organization, grow, and reproduce.  |

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| Cell Communication and the Cell Cycle |

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| **Topic** | **4** | **3** | **2** |
| **Cell Communication and the Cell Cycle** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Create representations(s) and construct explanations of cell communication through cell-to-cell contact and through chemical signaling. (LO 4.1, 4.2, 4.3, 4.4)3B. Create visual representations of feedback mechanisms and their role in maintaining homeostasis. (LO 4.5)3C. Predict the effects of disruptions to the cell cycle on the cell or organism. (LO 4.6, 4.7) | 2A.1:Define: autocrine, perecrine, juxtacrine, endocrine, ligand, receptor protein, G protein, phosphorylation cascade, secondary messenger2A.2: Describe the ways that cells can communicate with each other.2A.3: Describe the components of a signal transduction pathway and explain how it induces a cellular response.2A.4: Predict the cellular response elicited when given a specific environment condition and justify your prediction.2A.5: Predict how a change in the structure of any signaling molecule affects the activity of the signaling pathway.2B.1: Describe positive and negative feedback systems.2B.2: Differentiate between positive and negative feedback systems.2B.3: Explain how feedback systems affect homeostasis.2C.1: Define: Cytokinesis, apoptosis, chromosome, mitosis, cell cycle, interphase, cyclins, cyclin-dependent kinases, checkpoint.2C2 Describe the events that occur in the cell cycle.2C.3: Explain how mitosis results in the transmission of chromosomes from one generation to the next.2C4: Describe the role of checkpoints in regulating the cell cycle.2C5: Discuss how cancer and apoptosis result from disruptions in the cell cycle. |

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| Heredity |

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| **Topic** | **4** | **3** | **2** |
| **Heredity** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Explain how meiosis results in the transmission of chromosomes from one generation to the next (LO 5.1, 5.2, 5.6)3B: Explain the inheritance of genes and traits as described by Mendel’s laws (LO5.3)3C: Explain deviations from Mendel’s model of the inheritance of traits (LO 5.4) 3D: Explain how the same genotype can result in multiple phenotypes under different environmental conditions. (LO 5.5) | 2A.1: Define the following terms: crossing-over, gametes, zygote, independent assortment, segregation, mutation, allele2A.2: Describe similarities and differences between the phases and outcomes of mitosis and meiosis.2A.3 Explain how chromosomal inheritance, through meiosis, generates genetic variation in sexual reproduction2A.4 Explain the relationship between mutations during meiosis and genetic disorders.2B.1: Define terms such as: Laws of Probability, diploid, genetic variation, monohybrid, dihybrid, phenotype, genotype, complete dominance, and allele. 2B2: Predict the genotypic and phenotypic ratios for the offspring produced by Mendelian crosses. 2B3: Use a pedigree to predict inheritance patterns and genotype and phenotype of individuals. 2C.2: Define terms such as: Sex-Linked Inheritance, carrier, dihybrid, co-dominance, multiple allelles, incomplete dominance, 2C.1: Use a Chi-Square statistical analysis to accept or reject a Null hypothesis.2D1: Define terms such as: epigenetics, histones, methylation, and plasticity.2D2: Identify examples of environmental factors influencing gene expression and leading to phenotypic plasticity. |

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| Scientific Practices |

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| **Topic** | **4** | **3** | **2** |
| **Science Practices** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Explain biological concepts, processes, and models presented in written format.3B. Analyze visual representations of biological concepts and processes. 3C. Develop scientific questions, develop and conduct inquiries to test the question.3D. Represent and describe data.3E. Perform statistical tests and mathematical calculations to analyze and interpret data.3F. Develop and justify scientific arguments using evidence. | 2A.1: Describe biological concepts and processes in applied contexts.2A.2: Explain biological concepts and processes in applied contexts.2B.1: Describe characteristics of a biological concept, process, or model represented visually.2B.2: Explain relationships between different characteristics of biological concepts, processes, or models represented visually.2B.3: Explain how biological concepts or processes represented visually relate to larger biological principles, concepts, princesses, or theories.2B.4: Represent relationships within biological models, including mathematical, diagrams, and flow charts.2C.1: Identify or pose a testable question based on an observation, data, or a model.2C2: State or identify the following: null hypothesis, alternative hypothesis, dependent and independent variables, and controls.2C.3: Collect and organize data.2C.4: Propose a new or next investigation based on evaluation of design and evidence.2D.1: Construct a graph.2D.2: Describe trends and relationships in data.2E.1: Perform mathematical calculations using data.2E.2: Use confidence intervals or error bars to determine statistical significance.2E.3: Perform Chi-square analysis to reject or accept the null hypothesis.2F.1: Make a scientific claim.2F.2: Support a claim with reasoning.2F.3: Provide reasoning to justify a claim by connecting evidence to biological theories.2F.4: Predict the causes and effects of a change in a biological system. |

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| Gene Expression and Regulation |

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| **Topic** | **4** | **3** | **2** |
| **Gene Expression and Regulation** | *In addition to meeting the learning goal, the student demonstrates in-depth inferences and applications that go beyond the goal.* | 3A: Describe the structures involved in passing hereditary information from one generation to the next. (LO 6.1, 6.2)3B: Describe the mechanisms by which genetic information flows from DNA to RNA to protein. (LO 6.3, 6.4)   3C: Describe how Prokaryotes and Eukaryotes regulate gene expression. (LO 6.5, 6.6)3D: Describe how mutations account for some of the phenotypic differences between individuals. (LO6.7)3E: Explain the use of genetic engineering techniques in analyzing or manipulating DNA. (LO 6.8)   | 2A.1: Vocabulary should include, but is not limited to: nucleotide, plasmids, chromosome, purine, pyrimidines. DNA polymerase, ligase, RNA polymerase, helicase, topoisomerase, genome, gene, ribosome 2A.2: Compare and contrast the structure and functions of DNA and RNA.2A.3: Compare and contrast the DNA in prokaryotic and Eukaryotic cells.2A.4: Describe characteristics of DNA that allow it to be used as hereditary material.2A.5: Use a model to describe the process of replication. 2B.1: Vocabulary should include but is not limited to: codon, anticodon, polypeptide chain, retrovirus, transcription, translation, mRNA, tRNA, rRNA.2B.2: Use a model to describe the process of transcription.2B.3: Use a model to describe how the process of translation uses the genotype of an organism to determine the phenotype. 2B.4: Describe how retroviruses use the host genome to assemble new viral progeny.2C.1: Vocabulary should include, but is not limited to: operon, histones, induction, introns, exons, poly-A tail, G3P cap, and gene splicing.2C.2: Use a model to describe how prokaryotes use operons to induce or repress gene expression.2C.3: Describe how eukaryotes regulate gene expression at different points in transcription and translation.2C.4: Explain how epigenetic changes can affect gene expression through reversible modifications of DNA or histones.2C.5: Describe the role of gene expression in cell specialization.2D.1: Vocabulary should include, but is not limited to: deletion, addition, substitution, frameshift, missense, nonsense, and silent. 2D.2: Identify the types of mutations.2D.3: Predict the effect of a given mutation on phenotype.2E.1: Describe how each of these processes manipulates DNA: electrophoresis, polymerase, bacterial transformation, and DNA sequencing.2E.2: Identify uses for each of these techniques.2E.3: Develop an argument for the pros and cons of biotechnology and its impact on society.  |

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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 Describe the scientificevidence that providessupport for models of theorigin of life on Earth.(LO 7.13)3B: Explain the relationshipbetween changes in theenvironment and evolutionarychanges in the population due to natural selection. (LO 7.1, 7.2, 7.3, 7.12) 3C: Describe the conditionsunder which allele andgenotype frequencies willchange in populations.(7.4, 7.5.)3D: Describe the processes of extinction and speciation. (LO 7.10, 7.11)3E: Explain the evidence for evolution and how they can be used to show evolutionary relationships. (LO 7.6. 7.7, 7.8. 7.9)  | 2A.1: Define terms such as: Big bang theory, Miller-Urey experiment, RNA world hypothesis, protocell, cyanobacteria, stromatolites, endosymbiont theory.2A.2: Identify geological and chemical hypotheses for the origin of life on Earth.2A.3: Describe the RNA role hypothesis.2B.1 Describe the causes of natural selection and their effects on populations.2B.2: Describe the importance of phenotypic variation in a population as it relates to its ability to withstand environmental pressures.2B.3: Explain how humans can affect diversity within a population.2C.1: Explain how random occurrences affect the genetic makeup of a population and lead to evolution.2C.2: 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.2D.1: Define terms such as: phylogeny, derived trait, cladogram, clade, sister group2D.2: Describe the conditions under which a new species may arise.2D.3: Explain the processes and mechanisms that drive speciation.2D.3: Explain how the risk of extinction is affected by changes in the environment.2E.1: Define terms such as: biogeography, fossil, comparative morphology, radiometric dating, plate tectonics, homologous structure, analogous structures, convergent evolution, divergent evolution, embryology, molecular clock.2E.2 Describe the fundamental molecular and cellular features shared across all domains of life, which provide evidence of common ancestry.2E.3: Explain how morphological, biochemical, and geological data provide evidence that organisms have changed over time. 2E.4: Describe structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes. 2E.5: Create a model of evolutionary relationships using a phylogenetic tree. |

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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: Describe factors that influence the size, growth and health of a population. (LO 8.1, 8.3, and 8.4)3B: Describe the factors that influence community ecology. (LO 8.5)3C: Predict consequences of human actions on both local and global ecosystems. (LO 8.2, 8.6 and 8.7) | 2A.1: Vocabulary: innate behavior, learned behavior, group behaviors, density dependent, density independent, logistic and exponential growth2A.2: Explain how the behavioral and/or physiological response of an organism is related to changes in internal or external environment.2A.3: Explain how the behavioral responses of organisms affect their overall fitness and may contribute to the success of the population.2A.4: Describe factors that influence growth dynamics of populations.2A.5: Explain how the density of a population affects and is determined by resource availability in the environment.2A.6: Use mathematical models to describe changes in populations. 2B.1: Vocabulary: predation, commensalism, mutualism, parasitism, resource partitioning,2B.2: Calculate Simpson’s Diversity Index to describe the structure of a community. 2B.3: Explain how interactions within and among populations influence community structure.2B.4: Explain how community structure is related to energy availability in the environment.2C.1: Vocabulary may include: biological pyramids, food webs/chains, endotherms, ectotherms, keystone species, 2C.2: Describe the strategies organisms use to acquire and use energy.2C.3: Predict the effects of a change in matter or energy availability on populations and ecosystems. 2C.4: Explain how the activities of autotrophs and heterotrophs enable the flow of energy within an ecosystem.2C.5: Explain how the addition or removal of any component of an ecosystem will affect its overall short-term and long-term structure.2C.6: Explain how invasive species and human activities lead to changes in ecosystem structure and/or dynamics. |

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| **Labs** |
| Unit 1Water labPattern matchingProtein foldingOreo lab - statisticsChi square | Unit 2Cell size labOsmosis / diffusion lab - with water potentialMembrane lab - soap bubblesCase study - osmosis is serious business and/or Cystic Fibrosis | Unit 3Leaf disc labCellular respiration labEnzyme labManipulative modelsToothpickaseEnzyme analogy with screw driversCase Study - Making Sugar Out of This Air | Unit 4Yeast LabMitosis LabTED Talk, Quorum Sensing, Dr. BasslerLearn Genetics - Exploring cell communicationHomeostasis labElisa lab (Biorad) |
| Unit 5Plant lab (Carolina biological - fast plants)Pedigree project (Akim-Chan-Garcia Pedigree) (Geodken Family Pedigree)Fly LabChi Square Lab | Unit 6ElectrophoresisDNA extractionpGLO (bacterial transformation) | Unit 7BLAST labCase study - white striped cloverLizard evolution - HHMIHardware phylogenetic treeExamining the fossil recordHHMI - Creating Phylogenetic Trees from DNA sequencesHHMI - FinchesSex and the Single guppieFishy frequencyallele A1 | Unit 8Transpiration labChildren’s book writing using bookcreator.comEnergy Dynamics Lab - AP lab manualPill bug behavior labFruit fly behavior lab |

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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%** |