AP Biology Syllabus

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Course Overview

The AP Biology course is a very challenging and time-intensive course designed for students who are interested in pursuing science in college and/or as a career. This course is designed to be the equivalent of a two-semester college level biology course usually taken by biology majors in their freshman year. It provides students with an opportunity to develop a conceptual framework for modern biology, emphasizing applications of biological knowledge and critical thinking to environmental and social concerns. As a college-level course, students will be held to high expectations and mature responsibilities just like a college freshman. The course focuses on science process skills and application of factual information. As such, students should be self-motivated and be able to work both independently and collaboratively to solve science-related problems.

This course is designed to prepare students to be successful on the AP Biology exam. AP exam scores can earn the student college credit for the course. Because the AP Biology exam requires students to hand draw graphs—students are required to use: online graphing tools, spreadsheet graphing tools (i.e. Excel), AND hand drawn graphs to illustrate data.

All instruction is provided for the student either in the course or in the textbook. Instructors provide focused, constructive feedback for each lab or authentic assignment, as well as for each exam. The teacher is available throughout the week, and the student is able to receive one-on-one support and help in whatever capacity they need.

Because this class is presented in an online format, the pace and schedule varies slightly from student to student from within the course, but we have a definitive fall start and definitive spring end date so that students are finished with the course prior to taking their exam.

Curricular Requirements

As stated in the development guide, the curricular requirements are the core elements of the course. Refer to the chart below to locate each of the Curricular Requirements in this syllabus.

Curricular Requirement	Description	Page(s)
CR1	The teacher and students have access to college-level resources including a recently published (within the last 10 years) college-level textbook and reference materials in print or electronic format.	4-5
CR2	The course provides opportunities to develop student understanding of the required content outlined in each	5-14

	of the units described in the AP Course and Exam Description (CED).	
CR3	The course provides opportunities to develop student understanding of the big ideas.	5-14, 14-15
CR4	The course provides opportunities for students to develop the skills related to Science Practice 1: Concept Explanation.	6, 9, 12, 16
CR5	The course provides opportunities for students to develop the skills related to Science Practice 2: Visual Representations.	6-8, 10-12, 17
CR6	The course provides opportunities for students to develop the skills related to Science Practice 3: Questions and Methods.	6-7, -, 11-13, 18
CR7	The course provides opportunities for students to develop the skills related to Science Practice 4: Representing and Describing Data.	6, 8-15, 19
CR8	The course provides opportunities for students to develop the skills related to Science Practice 5: Statistical Tests and Data Analysis.	6, 8-12, 19-20
CR9	The course provides opportunities for students to develop the skills related to Science Practice 6: Argumentation.	6, 8, 10, 12-13, 20-21
CR10	The course provides students with opportunities to apply their knowledge of AP Biology concepts to real-world questions or scenarios (including societal issues or technological innovations) to help them become scientifically literate citizens.	26 and throughout
CR11	Students spend a minimum of 25% of instructional time engaged in a wide range of hands-on, inquiry-based laboratory investigations to support the learning of required content and development of science practice skills throughout the course. Students must conduct a minimum of two labs per big idea.	21-25
CR12	The course provides opportunities for students to record and present evidence of their laboratory investigations.	21-25

Instructional Resources [CR1]

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Course Outline [CR2]

Semester A

Module 1: Biochemistry

CED Topics Covered: 1.1 – 1.7

Big Ideas relevant to this module [CR3]:

Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook Chapters: 1-5

1. Evolution, the Themes of Biology, and Scientific Inquiry
2. The Chemical Context of Life
3. Water and Life
4. Carbon and the Molecular Diversity of Life
5. The Structure and Function of Large Biological Molecules

Module 1 Topics:

- Introduction to Biology
- Basic Chemistry
- Water, Water, Everywhere!
- Introduction to Organic Molecules
- Carbohydrates
- Lipids

- Proteins and Protein Folding
- Nucleic Acids

Science Skills Activities include but are not limited to [CR4, CR7, CR8]:

- Lesson 1.1 - Science Practice (SP) 4B: Interpret a Pair of Bar graphs
- Lesson 1.3 - SP 4B: Interpret a scatter plot
- Lesson 1.3 - SP 1A: Essay about the properties of water with specific examples
- Lesson 1.7- SP 1C: Student essay explaining how a one letter change in DNA can result in sickle cell disease
- Lesson 1.8 - SP 5A: Analyze polypeptide sequence data

Module 2: DNA, Gene Expression, and Biotechnology

CED Topics Covered: 6.1 – 6.7

Big Ideas relevant to this module [CR3]:

Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 16, 17, 18, and 20

16. The Molecular Basis of Inheritance
17. Gene Expression: From Gene to Protein
18. Regulation of Gene Expression
20. DNA Tools and Biotechnology

Module 2 Topics:

- DNA Structure and Replication
- Transcription and Processing
- Translation
- Mutations
- Operons
- Gene Expression in Eukaryotes

Science Skills Activities include but are not limited to [CR4, CR5, CR6, CR8, CR9]:

- Lesson 2.1 - SP 1C and 5A: Work with data in a data table
- Lesson 2.3 and 2.4 - SP 2A, 2B and 2D: Create a diagram of the processes of transcription, processing, and translation
- Lesson 2.4 - SP 6E: Activity – Analyze the effect that mutations have on resulting proteins
- Lesson 2.5 - SP 1A, and 1B: Explain how the parts of an operon work together to regulate gene expression

- Lesson 2.6 - SP 1C, 3C and 3E: Analyze DNA deletion experiments

Module 3: Biotechnology

CED Topics Covered: 6.8

Big Ideas relevant to this module [CR3]:

Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 20 and 21

20. DNA Tools and Biotechnology
21. Genomes and Their Evolution

Module 3 Topics:

- Recombinant DNA Technology and Insulin Production
- Gel Electrophoresis
- PCR and Gene Cloning
- Analyzing Gene Expression
- Determining Gene Function and Editing DNA

Science Skills Activities include but are not limited to [CR5, CR6]:

- Lesson 3.2 - SP 3D: Analyze sample electrophoresis gels to determine possible paternity
- Lesson 3.1 - SP 2D: Use a model to explain how pharmaceutical companies produce human insulin using rDNA technologies

Lab: Biotechnology-Bacterial Transformation

Module 4: Cells and Cell Membranes

CED Topics Covered: 2.1 – 2:10

Big Ideas relevant to this module [CR3]:

Big Idea 1- Evolution: The process of evolution drives the diversity and unity of life.
Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 6 and 7

6. A Tour of the Cell

7. Membrane Structure and Function

Module 4 Topics:

- Cell Structure Overview
- Cell Membrane Structure
- Passive Transport
- Active Transport
- Cell Structure and Function
- Evolution of Eukaryotic Cells
- Cell Structure and Function Part 2

Science Skills Activities include but are not limited to [CR5, CR7, CR8, CR9]:

- Lesson 4.1 - SP 5A: Calculate the surface area to volume ratio (SA : V) for various size model cells
- Lesson 4.1 - SP 4B: Use a chart of SA : V ratios to predict which "cells" have the best survival rate
- Lessons 4.3 and 4,4 - SP 2B: use drawings to explain transport mechanisms and provide examples in living organisms
- Lesson 4.6 - SP 6B: Support the theory of eukaryotic cell evolution by endosymbiosis with evidence
- Lesson 4.6 - SP 6A, 6B, 6C, and 6D: Use evidence and reasoning to support the claim that all cells have a common ancestor

Lab: Diffusion and Osmosis and their Connection to Transpiration in Plants

Module 5: Enzymes and Energy

CED Topics Covered: 3.1 – 3.3, 4.4, 8.2

Big Ideas relevant to this module [CR3]:

Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 8, 40

8. An Introduction to Metabolism
40. Basic Principles of Animal Form and Function

Module 5 Topics:

- Energy and Reactions
- ATP Cycle
- Thermoregulation

- Enzymes
- Enzymes and Environmental Influences

Science Skills Activities include but are not limited to [CR4, CR6, CR7, CR8]:

- Lesson 5.4 - SP 4A and 4B: Make a line graph and calculate a slope
- Lesson 5.4 - SP 5B and 5D: Evaluate sample enzyme experimental data to determine statistical significance
- Lesson 5.5 - SP 1C: Student discussion posts about sample enzyme mediated processes within the human body
- Lesson 5.5 - SP 3A, 3B, 3C, 3D and 3E: Design an experiment to determine how pH, temperature, or substrate concentration will affect enzyme activity

Lab: Enzyme Activity

Module 6: Cell Respiration and Photosynthesis

CED Topics Covered: 3.4 and 3.5

Big Ideas relevant to this module [CR3]:

Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 9 and 10

9. Cellular Respiration and Fermentation
10. Photosynthesis

Module 6 Topics

- Cellular Respiration Part 1
- Cellular Respiration Part 2
- Introduction to Photosynthesis
- The Photosynthetic Process

Science Skills Activities include but are not limited to [CR4, CR6, CR7, CR8]:

- Lesson 6.2 - SP 3C, 4A, and 1C: Making a Bar Graph and Interpreting a Hypothesis
- Lesson 6.3 – SP 3C, 4A, 4B, 5A, and 5D: Making Scatter Plots with Regression Lines Lab: Photosynthesis and Cellular Respiration

Semester B

*Semsters must be taken in order. Semester B cannot be taken until Semester A is completed.

Module 7: Cell Communication, The Cell Cycle, and Cancer

CED Topics Covered; 4.1 – 4.3 and 4.5 – 4.6

Big Ideas relevant to this module [CR3]:

Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.

Textbook chapters: 11, 12, and parts of 18 and 45

11. Cell Communication
12. The Cell Cycle
18. Regulation of Gene Expression
45: Hormones and the Endocrine System

Module 7 Topics:

- Cell Communication Overview
- Signal Transduction Pathways
- Transduction and Response
- The Cell Cycle
- Cell Cycle Regulation
- Cell Cycle Regulation and Cancer

Science Skills Activities include but are not limited to [CR5, CR7, CR8, CR9]:

- Lesson 7.1 - SP 2D: Use a flow chart or series of diagrams to model a signal transduction pathway
- Lesson 7.2 – SP 6E: Predict the result of the disruption to one molecule within a signal transduction pathway
- Lesson 7.4 - SP 5A: Calculate the percent of time a cell spends in each phase of mitosis
- Lesson 7.4 - SP 4A: Construct a pie chart that represents stages of mitotic phases

Module 8: Heredity

CED Topics Covered: 5.1 – 5.5

Big Ideas relevant to this module [CR3]:

Big Idea 1- Evolution: The process of evolution drives the diversity and unity of life.
Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 13, 14, and 15

13. Meiosis and Sexual Life Cycles
14. Mendel and the Gene Idea
15. The Chromosomal Basis of Inheritance

Module 8 Topics:

- Meiosis
- Basic Mendelian Genetics
- Mendelian Genetics Extended
- Sex-linked Inheritance
- Pedigree Analysis
- Genetic Linkage
- Chromosomal Disorders

Science Skills Activities include but are not limited to [CR5, CR6, CR7, CR8]:

- Lesson 8.1 – SP 4A, 4B, and 5A: Making a Line Graph
- Lesson 8.1 – SP 2A, 2B, and 2C: Prepare diagrams of meiosis and illustrate how errors in meiosis can cause genetic diseases
- Lesson 8.2 – SP 3A, 3B, 5C and 5D: Analyze Mendelian genetics experiments using the chi-square test
- Lesson 8.2 – SP 3A: Propose a method of inheritance based on sample genetic data
- Lesson 8.3 – SP 3D, 4A, and 4B: Make a histogram and analyze data

Lab: Cell Division-Mitosis and Meiosis

Module 9: Evolution Part 1: Microevolution

CED Topics Covered: 7.1 – 7.8

Big Ideas relevant to this module [CR3]:

- **Big Idea 1**- Evolution: The process of evolution drives the diversity and unity of life.
- **Big Idea 3**- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
- **Big Idea 4**- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 21, 22, and 23

21. Genomes and Their Evolution
22. Descent with Modification: A Darwinian View of Life
23. The Evolution of Population

Module 9 Topics:

- Natural Selection
- Evidence for Evolution

- Hardy-Weinberg Equilibrium
- Altering Allele Frequency
- The “Modern Synthesis”

Science Skills Activities include but are not limited to [CR4, CR8, CR9]:

- Lesson 9.1 - SP 1C: Explain the theory of natural selection by utilizing an example
- Lesson 9.3 - SP 5A, 6A, 6B, and 6C: Use the Hardy-Weinberg equation to interpret data and make predictions

Lab: Hardy-Weinberg Equilibrium – Modeling Allele Frequencies in Populations

Module 10: Evolution Part 2: Macroevolution

CED Topics Covered: 7.9 – 7.10 and 7.12

Big Ideas relevant to this module [CR3]:

Big Idea 1- Evolution: The process of evolution drives the diversity and unity of life.
Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook chapters: 24, 25, and 26

24. The Origin of Species
25. The History of Life on Earth
26. Phylogeny and the Tree of Life

Module 10 Topics

- Speciation
- Hybrid Zones and Rates of Speciation
- History of Life on Earth
- Major Changes on Earth
- Phylogenetic Trees
- Evidence of Common Ancestry

Science Skills Activities include but are not limited to [CR5, CR6, CR7, CR9]:

- Lesson 10.3 – SP 4B and 6C: Interpret DNA data to predict evolutionary relationships among organisms
- Lesson 10.6 – SP 2C and 3D: Use protein sequence data to test an evolutionary hypothesis
- Lesson 10.5 – SP 2D and 3A, 3B and 3C: Complete a phylogenic tree given DNA sequence data

Lab: Comparing DNA Sequences (BLAST)

Module 11: Ecology

CED Topics Covered: 8.1 – 8.7

Big Ideas relevant to this module [CR3]:

Big Idea 1- Evolution: The process of evolution drives the diversity and unity of life.
Big Idea 2- Energetics: Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis.
Big Idea 3- Information Storage and Transmission: Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4- Systems and Interactions: Biological systems interact, and these systems and their interactions exhibit complex properties.

Textbook Chapters: 53, 54, 55, and 56

53. Population Ecology
54. Community Ecology
55. Ecosystems and Restoration Ecology
56. Conservation Biology and Global Change

Module 11 Topics:

- Population Ecology
- Population Dynamics
- Community Interactions
- Trophic Structure of a Community
- Ecosystems and Restoration Ecology
- Conservation Biology

Science Skills Activities include but are not limited to [CR6, CR7, CR8, CR9]:

- Lesson 11.2 - SP 4A: Construct a graph representing population data
- Lesson 11.2 - SP 4B: Compare logistic and exponential population growth graphs
- Lesson 11.3 – SP 4A, 5D, and 3C: Make a bar graph and a scatter plot
- Lesson 11.6 – SP 4A, 4B and 5D: Graphing cyclic data
- Lesson 11.4 - SP 5B, 6D and 6E: Compare graphs of population density means with and without a keystone species

Lab: Energy Dynamics

Module 12: AP Exam Review

Module 12 Topics:

- AP Exam Overview
- AP Exam Question Types

- Review of Graphs, Error Bars, and Statistical Significance
- Review of Labs and Science Skills
- Preparing for Exam Day

Big Ideas [CR3]

The course is built on the four Big Ideas and the students have multiple opportunities to engage with these big ideas. The following shows sample activities that students will complete to explore the big ideas outside of the laboratory.

Big Idea 1 – Evolution: The process of evolution drives the diversity and unity of life

- In an essay, students describe how gene flow, genetic drift, and natural selection all can influence macroevolution.
- In a class discussion, students discuss how the process of evolution is revealed by the imperfections of living organisms.
- In an essay, students explain the biological basis for assigning all human populations to a single species and describe a scenario by which a second human species could originate in the future.
- In an essay, students explain coevolution as the evolution of reciprocal adaptations in two species, with each species adapting its interaction with the other.

Big Idea 2 – Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis

- In an essay, students explain how the process of irrigation in arid regions leaves salts in the soil. They discuss how this increased salinity would be harmful to crops and suggest ways to minimize the damage and at what cost.
- In an essay, students explain the problems of respiration and gas exchange Mothra (the mutant opponent of Godzilla in the movie) would face. They state why they think truly giant insects are improbable.

- In an essay, students respond to criticisms to the chief scientific advisor regarding the disruption of normal metabolism caused by the foreign genes that are introduced in foods that disturb normal cellular functioning.

Big Idea 3 – Living systems store, retrieve, transmit, and respond to information essential to life processes

- In a class discussion, students debate the advantage/disadvantage of a graded (variable) action potential rather than the on/off nature of action potential signaling.
- In a class discussion, students discuss the use of organophosphate pesticides in food production, taking into consideration the effect on the human nervous system and the need for abundant and affordable food supply.

Big Idea 4 – Biological systems interact, and these systems and their interactions possess complex properties

- In a class discussion, students debate whether the rapid population growth of less industrialized countries is a more serious threat to the environment than the slower population growth of more industrialized countries.
- In an essay, students design a controlled experiment to test the effect of falling leaves on the net primary production of a pond.
- In a multimedia presentation, students select a topic of significant social impact and discuss the problem, the causes, the possible future effects of that problem, what is being done to solve the problem, and how to help as an individual. Topics selected are one of the following:
    - Endangered Species
    - Saving the Rainforests
    - Wildlife Conservation
    - Global Climate Change
    - Energy Conservation
    - Waste Management
    - Human Overpopulation

Science Practices

The science practices are used throughout the course. Students will be introduced to each practice and then continue to utilize the practice throughout the year to obtain mastery. Repetition and practice is embedded into the curriculum. All activities and class work will be connected to at least one learning objective that will be clearly communicated to students so they can see the science practices as the framework around which the learning of the course takes place. The science practices will also be addressed in classroom activities and projects external to the formal lab investigations. Overall, the science practices will give students the opportunity to apply their content knowledge, construct hypotheses, develop claims, and provide evidence and reasoning for their claims.

The following provides examples of where each of the six Science Practices are integrated into the curriculum outside of the formal laboratory activities:

Science Practice 1: Explain biological concepts, processes, and models presented in written format. [CR4]

Science Practice	**Sample Activities in the Curriculum**
1.A: *Describe biological concepts and/or processes.*	Lesson 1.3 - SP 1A: Essay questions about the properties of water with specific examples Lesson 2.5 - SP 1A: Explain how the parts of an operon work together to regulate gene expression
1.B: *Explain biological concepts and/or processes.*	Lesson 2.5 - SP 1B: Explain how the parts of an operon work together to regulate gene expression
1.C: *Explain biological concepts, processes, and/or models in applied contexts.*	Lesson 9.1 - SP 1C: Explain the theory of natural selection by utilizing an example Lesson 1.3 - SP 1C: Essay about the properties of water with specific examples Lesson 1.7 -SP 1C: Student essay explaining how a one letter change in DNA can result in sickle cell disease

Science Practice 2: Analyze visual representations of biological concepts and processes. [CR5]

Science Practice	Sample Activities in the Curriculum
2.A: *Describe characteristics of a biological concept, process, or model represented visually.*	Lesson 2.3 - SP 2A: Create a diagram of the processes of transcription, processing, and translation Lesson 8.1 - SP 2A: Prepare diagrams of meiosis and illustrate how errors in meiosis can cause genetic diseases
2.B: *Explain relationships between characteristics of biological models in both theoretical and applied contexts.*	Lesson 2.3 - SP 2B: Create a diagram of the processes of transcription, processing, and translation Lesson 8.1 - SP 2B: Prepare diagrams of meiosis and illustrate how errors in meiosis can cause genetic diseases
2.C: *Explain how biological concepts or processes represented visually relate to larger biological principles, concepts, processes, or theories.*	Lesson 8,1 - 2C: Prepare diagrams of meiosis and illustrate how errors in meiosis can cause genetic diseases Lesson 10.6 - SP 2C: Use protein sequence data to test an evolutionary hypothesis
2.D: *Represent relationships within biological models, including mathematical models, diagrams, flowcharts, and systems.*	Lesson 2.3 - SP 2D: Create a diagram of the processes of transcription, processing, and translation Lesson 3.1 - SP 2D: Use a model to explain how pharmaceutical companies produce human insulin using rDNA technologies Lesson 10.5 - SP 2D: Complete a phylogenic tree given DNA sequence data

Science Practice 3: Determine scientific questions and methods. [CR6]

Science Practice	Sample Activities in the Curriculum
3.A: *Identify or pose a testable question based on an observation, data, or a model.*	Lesson 8.2 - SP 3A: Propose a method of inheritance based on sample genetic data Lesson 8.2 - SP 3A: Analyze Mendelian genetics experiments using the chi-square test
3.B: *State the null or alternative hypotheses or predict the results of an experiment.*	Lesson 8.2 - SP 3B: Analyze Mendelian genetics experiments using the chi-square test Lesson 10.5 - 3B: Complete a phylogenic tree given DNA sequence data
3.C: *Identify experimental procedures that are aligned to the question, including* *i. Identifying dependent and independent variables.* *ii. Identifying appropriate controls.* *iii. Justifying appropriate controls.*	Lesson 5.5 - 3C: Design an experiment to determine how pH, temperature, or substrate concentration will affect enzyme activity Lesson 10.5 – 3C: Complete a phylogenic tree given DNA sequence data
3.D: *Propose a new investigation based on an evaluation of the experimental design or evidence.*	Lesson 5.5 - SP 3E: Design an experiment to determine how pH, temperature, or substrate concentration will affect enzyme activity Lesson 2.6 - SP 1C, 3C and 3E: Analyze DNA deletion experiments

Science Practice 4: Represent and describe data. [CR7]

Science Practice	Sample Activities in the Curriculum
4.A: *Construct a graph to represent the data, including: x-y graphs (bar, histogram, line, log scale, dual y), scatter plot, box and whisker plot, and pie chart. The graph should include the following components:* *i. type of graph appropriate for the data* *ii. axis labeling, including appropriate units and legend* *iii. scaling* *iv. accurately plotted data (including error bars when appropriate)* *v. trend line (when appropriate)*	Lesson 11.2 - SP 4A: Construct a graph representing population data Lesson 7.4 - SP 4A: Construct a pie chart that represents stages of mitotic phases Lesson 5.4 - SP 4A, Make a line graph and calculate a slope
4.B: *Describe data from a table or graph, including:* *i. identifying specific data points* *ii. describing trends and patterns in the data* *iii. describing relationships between variables*	Lesson 10.3 - SP 4B: Interpret DNA data to predict evolutionary relationships among organisms Lesson 11.2 - SP 4B: Compare logistic and exponential population growth graphs

Science Practice 5: Perform statistical tests and mathematical calculations to analyze and interpret data. [CR8]

Science Practice	Sample Activities in the Curriculum
5.A: *Perform mathematical calculations, including:* *i. mathematical equations in the curriculum* *ii. means* *iii. rates* *iv. ratios* *v. percentages and percent changes*	Lesson 4.1 - SP 5A: Calculate the surface area to volume ratio (SA : V) for various size model cells Lesson 5.4 - SP 5A, Make a line graph and calculate a slope Lesson 7,4 - SP 5A: Calculate the percent of time a cell spends in each phase of mitosis Lesson 9.3 - SP 5A: Use the Hardy-Weinberg Equation to interpret data and make predictions

5.B: *Use confidence intervals and error bars to estimate whether sample means are statistically different.*	Lesson 5.4 - SP 5B: Evaluate sample enzyme experimental data to determine statistical significance Lesson 11.4 - SP 5B: Compare graphs of population density means with and without a keystone species
5.C: *Perform chi-square hypothesis testing.*	Lesson 8.2 - SP 5C Analyze Mendelian genetics experiments using the chi-square test
5.D: *Use data to evaluate a hypothesis or prediction, including rejecting or failing to reject the null hypothesis.*	Lesson 5.4 - 5D: Evaluate sample enzyme experimental data to determine statistical significance Lesson 6.3 –SP 5D: Making scatter plots with regression lines

Science Practice 6: Develop and justify scientific arguments using evidence. [CR9]

Science Practice	Sample Activities in the Curriculum
6.A: *Make a scientific claim.*	Lesson 9.3 - SP 6A: Use the Hardy-Weinberg equation to interpret data and make predictions Lesson 4.6 - SP 6A: Use evidence and reasoning to support the claim that all cells have a common ancestor
6.B: *Support a claim with evidence from biological principles, concepts, processes, and/or data.*	Lesson 9.3 - SP 6B: Use the Hardy-Weinberg equation to interpret data and make predictions Lesson 4.6 - SP 6B: Support the theory of eukaryotic cell evolution by endosymbiosis with evidence

6.C: *Provide reasoning to justify a claim by connecting evidence to biological theories.*	Lesson 10.3 - SP 6C: Interpret DNA data to predict evolutionary relationships among organisms Lesson 9.3 - SP 6C: Use the Hardy-Weinberg equation to interpret data and make predictions
6.D: *Explain the relationship between experimental results and larger biological concepts, processes, or theories.*	Lesson 11.4 - SP 6D: Compare graphs of population density means with and without a keystone species Lesson 4.6 - SP 6D: Use evidence and reasoning to support the claim that all cells have a common ancestor.
6.E: *Predict the causes or effects of a change in, or disruption to, one or more components in a biological system.*	Lesson 2.4 - SP 6E: Activity – Analyze the effect that mutations have on resulting proteins Lesson 7.2 - SP 6E: Predict the result of the disruption to one molecule within a signal transduction pathway Lesson 11.4 - SP 6E: Compare graphs of population density means with and without a keystone species

Lab Components [CR11, CR12]

During this course students will explore scientific methods and processes together and encourage each other to think critically about how science influences our daily lives.

This course requires the use of Quality Science Labs (QSL) Advanced Biology lab manual and kit. The QSL Advanced Biology Lab kit is aligned with and designed to support the first- year college/advanced placement level high school biology curriculum, standards, and science practices.

Labs range from the classics (mitosis, osmosis, photosynthesis) to new techniques in biotechnology (clone a fluorescent jellyfish green gene into a bacteria plasmid); mathematical modeling using genetic databases, and significance analysis of your mitosis data. In the eight student guided inquiries, students will explore and design labs related to environmental effects on enzyme activity, mitotic growth rates, photosynthesis, and cellular respiration; the effect of bacterial transformation on the second generation; and variables to increase biofuel production.

Of the eight main lab investigations (two for each AP® Biology Big Idea), there are a total of 24 labs, including a student-guided inquiry for each. Students can expect to spend at least 25% of their class time engaging in investigative laboratory work.

For each of the eight main lab investigations, there is a discussion assignment that gives students the opportunity to discuss the lab investigation with their classmates. These discussions focus on experimental design, data, and conclusions. The students produce a formal laboratory report for each investigation which are housed electronically in a portfolio for the student. The lab report includes several elements including: Introduction, Methods, Data and Analysis, and Conclusions.

The labs cover the scientific practices outlined in the Science Practices section. Here are the science practices covered in each lab.

Lab Title	**Science Practices**
Diffusion, Osmosis, and Their Connection to Transpiration in Plants	3.C: Identify experimental procedures that are aligned to the question 4.A: Construct a graph, plot, or chart 5.A: Perform mathematical calculations
Hardy-Weinberg Equilibrium: Modeling Allele Frequencies in Populations	5.A: Perform mathematical calculations
Comparing DNA Sequences (BLAST)	2.D: Represent relationships within a biological model
Cell Division: Mitosis and Meiosis	1.B: Explain biological concepts or processes. 4.B: Describe data from a table or graph
Enzyme Activity	6.C: Provide reasoning to justify a claim by connecting evidence to biological theories 6.E: Predict the causes or effects of change in, or disruption to, one or more components in a biological system
Photosynthesis and Cellular Respiration	4.A: Construct a graph, plot, or chart 6.B: Support a claim with evidence from biological principles, concepts, processes, and/or data

Biotechnology: Bacterial Transformation	6.D: Explain the relationship between experimental results and larger biological concepts, processes, or theories
Energy Dynamics	6.C: Provide reasoning to justify a claim by connecting evidence to biological theories 6.D: Explain the relationship between experimental results and larger biological concepts, processes, or theories

Lab Details

Lab 1: Diffusion, Osmosis and Their Connection to Transpiration in Plants (Big Idea 2)

Surface area and cell size, modeling, osmosis in live water plant cells, and student-guided inquiry into water potential of plant tissues and osmosis connections to plant transpiration.

Prelab Questions
Lab 1.1: Surface Area and Cell Size
Lab 1.2: Part 1 - Modeling Diffusion and Osmosis
Part 2 - Observing Osmosis
Part 3 - Student Guided Inquiry, Water Potential in Plant Tissues

Scientific Practices:

2.A: Perform mathematical calculations
3.C: Identify experimental procedures that are aligned to the question
4.A: Construct a graph, plot, or chart

Lab 2: Hardy-Weinberg Equilibrium: Modeling Allele Frequencies in Populations (Big Idea 1)

PTC taste test global analysis, simulations of changes within populations (Equilibrium, Natural Selection, Genetic Drift); mathematical modeling of allele frequencies within a population, and student-guided inquiry.

Pre-lab and Questions: Estimating Allele Frequencies
Lab 2.1: A Micro-Evolution Simulation
Lab 2.2: Part 1 - Estimating Allele Frequencies Tutorial
Part 2 - Student Guided Inquiry

Scientific Practices:

5.A: Perform mathematical calculations

Lab 3: Comparing DNA Sequences (BLAST) (Big Idea 1)

Cladogram construction, biochemical analyses of gene and protein sequence % similarities and differences; BLAST database tutorial and cladogram construction for comparing evolutionary relationships; Entrez Gene database tutorial comparing normal gene sequences to chromosomal aberrations in human diseases; and student guided inquiry.

Pre-lab and Questions: Cladograms
Lab 3.1: Part 1 - BLAST Practice
Part 2 - Student Guided Inquiry

Scientific Practices:
2.D: Represent relationships within a biological model.

Lab 4: Cell Division: Mitosis and Meiosis (Big Idea 3)

Loss of cell cycle control analysis in cancer cells using human karyotypes; environmental abiotic effects on mitotic rates and data analysis for significance; student-guided inquiry on environmental effects on mitosis; and crossing over in meiosis demonstrating increased genetic variability in subsequent generations.

Pre-lab and Questions: Loss of Cell Cycle Control in Cancer
Lab 4.1 Part 1 - Environmental Effects on Mitosis
Part 2 - Student Guided Inquiry
Lab 4.2 Meiosis and Crossing Over in Sordaria

Scientific Practices:
1.B: Explain biological concepts or processes
4.B: Describe data from a table or graph

Lab 5 Enzyme Activity (Big Idea 4)

Catalase enzyme and breakdown of toxins in the liver; enzyme specificity using lactase; enzyme rates of reaction assay and baseline; effects of pH on enzymatic activity; and student guided inquiry for other potential environmental effects on enzyme activity.

Pre-lab Questions
Lab 5.1: Enzyme Specificity
Lab 5.2: Enzyme Rate of Reaction Assay and Baseline
Lab 5.3 Part 1 - Determining the Effect of pH on Enzymatic Activity
Part 2 - Student Guided Inquiry

Scientific Practices:
6.C: Provide reasoning to justify a claim by connecting evidence to biological theories
6.E: Predict the causes or effects of change in, or disruption to, one or more components in a biological system

Lab 6 Photosynthesis and Cellular Respiration (Big Idea 2)

Predictions on effect of different abiotic conditions on photosynthesis and the effect of exercise on cellular respiration waste product production rates; measuring photosynthesis and cellular respiration rates using the Floating Leaf Disk technique; and student-guided inquiry.

Pre-Lab and Questions

Part A Photosynthesis
Part B Cellular Respiration

Lab 6.1 Part 1 - Floating Leaf Disk
Part 2 - Cellular Respiration
Part 3 - Student Guided Inquiry

Scientific Practices:

4.A: Construct a graph, plot, or chart

6.B: Support a claim with evidence from biological principles, concepts, processes, and/or data

Lab 7 Biotechnology: Bacterial Transformation (Big Idea 3)

Biotechnology simulation of transforming the human insulin-making gene into a bacterial plasmid; bacterial transformation of the jellyfish gene for green fluorescence into E.coli; transformation efficiency calculations; and student guided inquiry of the newly transformed bacterial colonies.

Pre-lab and Questions: Genetic Engineering

Lab 7.1: Part 1 - Bacterial Transformation
Part 2 - Student Guided Inquiry

Lab 7.2: Calculating Transformation Efficiency Scientific

Science Practices:

6.D: Explain the relationship between experimental results and larger biological concepts, processes, or theories.

Lab 8 Energy Dynamics (Big Idea 4)

Environmental impact of eating at lower trophic levels; energy transfer and productivity lab using yeast fermentation of corn sugar into ethanol and carbon dioxide; and student-guided inquiry on variables that could potentially increase the rate of fermentation for biofuel production.

Pre-lab Questions

Lab 8.1 Part 1 - Energy Transfer and Productivity
Part 2 - Student Guided Inquiry

Scientific Practices:

6.D: Explain the relationship between experimental results and larger biological concepts, processes, or theories

6.C: Provide reasoning to justify a claim by connecting evidence to biological theories

Real World Questions [CR10]

Throughout this course, students are introduced to real world questions or scenarios, such as in Lab 8 where the student is studying variables that could lead to an increase in biofuel production.

Assessments

Students are assessed through a combination of hands-on laboratory assignments, journals, module tests, discussions, and teacher-student interaction.

- Students submit brief journal entries in many lessons reflecting on the topic of the lesson. These are collected and graded at the end of each module.
- Each module includes at least one discussion prompt; participation in discussions is evaluated based on a rubric that includes these criteria: engagement with the topic, the thoroughness of the response, and the student's attention to elements of discussion etiquette and positive participation.
- At the end of each module, students also take an online exam consisting of randomized multiple choice and essay questions. The multiple-choice sections of these exams provide instant feedback while the essay sections require students to reflect more broadly on what they have learned.
- At the end of each semester, students complete a final exam consisting of several essay prompts that require them to synthesize themes and ideas from the entire semester. The final semester assessments are modeled after the AP exam to provide students practice in answering AP formatted questions.
- Students are required to:
    - engage the teacher in all forms of communication including verbal
    - seek out and receive any help as needed
    - describe the processes they use to arrive their ideas and defend them
    - complete a final exam