SYLLABUS DEVELOPMENT GUIDE

AP® Biology

The guide contains the following information:

Curricular Requirements

The curricular requirements are the core elements of the course. A syllabus must provide explicit evidence of each requirement based on the required evidence statement(s).

The Unit Guides and the "Instructional Approaches" section of the *AP® Biology Course and Exam Description* (CED) may be useful in providing evidence for satisfying these curricular requirements.

Required Evidence

These statements describe the type of evidence and level of detail required in the syllabus to demonstrate how the curricular requirement is met in the course.

Note: Curricular requirements may have more than one required evidence statement. Each statement must be addressed to fulfill the requirement.

Clarifying Terms

These statements define terms in the Syllabus Development Guide that may have multiple meanings.

Samples of Evidence

For each curricular requirement, three separate samples of evidence are provided. These samples provide either verbatim evidence or descriptions of what acceptable evidence could look like in a syllabus.

Curricular Requirements

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.	*See page:* 3
CR2	The course provides opportunities to develop student understanding of the required content outlined in each of the units described in the AP Course and Exam Description (CED).	*See page:* 4
CR3	The course provides opportunities to develop student understanding of the big ideas.	*See page:* 5
CR4	The course provides opportunities for students to develop the skills related to Science Practice 1: Concept Explanation.	*See page:* 7
CR5	The course provides opportunities for students to develop the skills related to Science Practice 2: Visual Representations.	*See page:* 8
CR6	The course provides opportunities for students to develop the skills related to Science Practice 3: Questions and Methods.	*See page:* 9
CR7	The course provides opportunities for students to develop the skills related to Science Practice 4: Representing and Describing Data.	*See page:* 10
CR8	The course provides opportunities for students to develop the skills related to Science Practice 5: Statistical Tests and Data Analysis.	*See page:* 11
CR9	The course provides opportunities for students to develop the skills related to Science Practice 6: Argumentation.	*See page:* 12
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.	*See page:* 13
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.	*See page:* 14
CR12	The course provides opportunities for students to record and present evidence of their laboratory investigations.	*See page:* 16

Curricular Requirement 1

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.

Required Evidence

- ☐ The syllabus must cite the title, author, and publication date of a college-level textbook. The primary course textbook must be published within the last 10 years.

Samples of Evidence

1. The teacher selects a preapproved college-level textbook.

2. The teacher provides the title, author, and publication date (within the last 10 years) of a college-level biology textbook.

Curricular Requirement 2

The course provides opportunities to develop student understanding of the required content outlined in each of the units described in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include an outline of course content by unit title or topic using any organizational approach to demonstrate the inclusion of required course content.

Note: If the syllabus demonstrates a different approach than the units outlined in the *AP Biology Course and Exam Description* (CED), the teacher must indicate where the content of each unit in the CED will be taught.

Samples of Evidence

1. The syllabus includes the required content organized into the following units based on the AP Course and Exam Description:

   Unit 1: Chemistry of Life

   Unit 2: Cells

   Unit 3: Cellular Energetics

   Unit 4: Cell Communication and Cell Cycle

   Unit 5: Heredity

   Unit 6: Gene Expression and Regulation

   Unit 7: Natural Selection

   Unit 8: Ecology

2. The syllabus outline of course content cites specific chapter titles corresponding to the unit outline in the AP Course and Exam Description.

Unit 1 **Chemistry of Life**	**Unit 2** **Cells**	**Unit 3** **Cellular Energetics**	**Unit 4** **Cell Communication and Cell Cycle**
Ch. 1–4	Ch. 6–8	Ch. 8–10	Ch. 11, 12
Unit 5 **Heredity**	**Unit 6** **Gene Expression and Regulation**	**Unit 7** **Natural Selection**	**Unit 8** **Ecology**
Ch. 13–16	Ch. 17, 18, 20 Parts of Ch. 19	Ch. 21–26 Parts of Ch. 27–34	Ch. 8, 52–56

3. The syllabus organizes the required content using a different approach or sequence than that described in the AP Course and Exam Description and specifies where the content from each AP unit is taught in the course.

Curricular Requirement 3

The course provides opportunities to develop student understanding of the big ideas, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include four student activities, one for each big idea, in which students engage with the big ideas outside of laboratory investigations.
- ☐ Each activity must be labeled on the syllabus with the related big idea(s).

Samples of Evidence

1. The syllabus includes at least one specific assignment or activity outside of laboratory investigations for each of the four big ideas.

   Big Idea 1: Evolution

   Students read teacher-selected excerpts from Jonathan Weiner's *The Beak of the Finch* (either aloud in class or as a homework assignment) and highlight evidence that supports evolution by natural selection as an explanation for the observed differences in beak sizes over several seasons.

   Big Idea 2: Energetics

   Students read a teacher-selected article on research that justifies how herbicides block the metabolic pathways that allow a plant to photosynthesize. Students pose scientific questions about the research article and construct explanations (with justification) regarding how mechanisms and structural features of the plant disallow the plant to capture, store, or use free energy.

   Big Idea 3: Information Storage and Transmission

   Students investigate the case study "Shh: Silencing the Hedgehog Pathway." Students identify and explain how molecules are involved in reception, transduction, and response in the hedgehog pathway. They also use a model of the hedgehog pathway to explain the mechanism of gene regulation.

   Big Idea 4: Systems Interactions

   Students complete an activity using a given set of data that focuses on scientific studies of lizard species diversity in central Arizona resulting from urbanization along rivers. They hypothesize, graph data, and make evidence-based claims regarding abundance and diversity of lizards.

2. The syllabus includes classroom activities to demonstrate how each big idea is developed throughout the course during unit instruction.

   Big Idea 1: Evolution

   Students organize evolution-related terms into a concept map which depicts Darwin's view of evolution by natural selection. They then answer questions related to the map (Unit 7). Students must make a prediction (with justification) regarding how environmental changes might cause individuals in a population to show reduced fitness. (Unit 8).

   Big Idea 2: Energetics

   Students use whiteboard drawings to indicate the inputs and outputs of photosynthesis and cellular respiration (Unit 2). Students develop a food web from the class aquarium on a poster, predicting (with justification) the outcome of loss of producers (Unit 8).

Big Idea 3: Information Storage and Transmission

Students use manipulatives to model DNA replication, transcription, and translation. They then model the impact of a mutation on phenotype (Unit 6). Students explain how mutations are related to genetic variations in a population, and they make a prediction (with justification) as to how genetic variation may be subject to natural selection in a certain environment (Unit 8).

Big Idea 4: Systems Interactions

Using molecular model kits, students explain how organic macromolecules are identified. Students make predictions (with justification) pertaining to the behavior of organic molecules based on their structure (Unit 1). Students make models of eukaryotic cells and prokaryotic cells using materials they choose to bring in. In a presentation and class discussion, students explain the structure of organelles and make predictions about the impact of not having a certain organelle (Unit 2).

3. The syllabus includes example activities demonstrating connections across big ideas. Each of the big ideas, collectively, is represented in the example activities included in the syllabus.

   Big Ideas 1, 2: A whole class discussion is used to analyze the endosymbiotic theory, encouraging students to question how prokaryotes can carry on energy transfer processes without true membrane-bound organelles. Students write a conclusion to the discussion on a sticky note for posting at the end of class.

   Big Ideas 2, 4: Students create food webs, labeling in detail three to five interspecies interactions that occur within their food webs such as competition, predation, herbivory, symbiosis, parasitism, mutualism, and/or commensalism. Once their food webs are created, students predict and justify what might happen if a component in the food web changes. For example, what are possible consequences if a disease kills most of the plants, or an invasive- or non-native species is introduced into the ecosystem?

   Big Ideas 1, 3: Students complete a study of sexual and asexual reproduction and write an essay in which they compare reproductive processes and explain how these processes evolved.

   Big Ideas 1, 2, 3: Students view and discuss the PowerPoint presentation "A Deadly Passion: Sexual Cannibalism in the Australian Redback Spider." This case study activity involves explaining how questions about animal behavior are linked in their evolutionary basis and using experimental data to support or reject hypotheses. Students make predictions about the outcomes to behavior scenarios involving the spiders.

Curricular Requirement 4

The course provides opportunities for students to develop the skills related to Science Practice 1: Concept Explanation, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students explain biological concepts, processes, and models presented in written format.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. The syllabus includes a strategy used in activities throughout the year to develop students' content knowledge and skills.

   For example: The syllabus describes a strategy for building academic vocabulary (e.g., photosynthesis)

   - Teacher defines the term or process
   - Students define/describe in their own words
   - Students use a non-linguistic representation to show their understanding
   - Students engage in activities/games that allow them to use descriptions and explanations of the term or process **(Science Practice 1: Concept Explanation)**

2. The syllabus includes a strategy used in activities throughout the year to develop students' content knowledge and skills.

   For example: Students are provided with a list of terms, descriptions and/or processes from a unit or topic. Using sticky notes, students, in small groups, develop concept maps of content with the unit. The teacher facilitates discussion by having students describe and explain how/why they developed the concept map the way they did. **(Science Practice 1)**

3. **Science Practice 1:** The syllabus includes a reference to a free online science research digest as a resource used regularly to delve more deeply into biological concepts and scientific research. The syllabus cites an annotated research paper from the source and describes an activity where students use the document to engage in and explain biology concepts in applied contexts.

Curricular Requirement 5

The course provides opportunities for students to develop the skills related to Science Practice 2: Visual Representations, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students analyze visual representations of biological concepts and processes.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. The syllabus describes how visual representations are utilized in biology instruction.

   For example: Students complete the activity "Great Clade Race." Students are given cards with various symbols and create a "race through the woods" to show how the "runners" take paths and end up at the finish line. They construct a pipe-cleaner model of their hand drawn "tree" to show 3-D components of a phylogenetic tree and how rotation can occur at nodes. Then, given a matrix chart showing organisms and traits they possess, students construct a cladogram showing when the traits appear on the cladogram. **(Science Practice 2: Visual Representations)**

2. **Science Practice 2:** Students use paper chromosomes to model meiosis. Students use the models to develop and demonstrate their understanding of crossing over and how it leads to genetic diversity. They then explain the limits of their model in showing what happens during meiotic division and crossing over, and propose one improvement to the model. In a follow-up activity, students create a new model using their proposed improvement.

3. The syllabus describes an activity in which students analyze a marine food web. They discuss how removing one organism from the food web may impact energy flow. **(Science Practice 2)**

Curricular Requirement 6

The course provides opportunities for students to develop the skills related to Science Practice 3: Questions and Methods, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students determine scientific questions and methods.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. Using a published study, students identify the hypothesis, controls, and methods used in the experiment. **(Science Practice 3: Questions and Methods)**

2. **Science Practice 3:** Students are presented with an experimental design, which tests the effects of pH on photosynthesis, and they are asked to predict the results.

3. Give students a published study and have them propose a new or follow-up experiment based on the data. **(Science Practice 3)**

Curricular Requirement 7

The course provides opportunities for students to develop the skills related to Science Practice 4: Representing and Describing Data, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students represent and describe data.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. Students are given raw data resulting from an experiment conducted by students in the previous school year and are required to make histograms and line graphs describing the results. **(Science Practice 4: Representing and Describing Data)**

2. The syllabus includes activities that allow students opportunities to engage with given data sets presented in a table or graph.

   For example, the teacher leads a discussion in which students analyze the data in a graph, which shows the impact of salt stress on photosynthesis in algae. The teacher facilitates a discussion that allows students to describe the information presented and analyze and interpret trends in the data and relationships between variables. **(Science Practice 4)**

3. **Science Practice 4:** Given a graphical representation of experimental data, students describe the relationship between the independent and dependent variables; given a set of hypothetical data, students identify the dependent and independent variables and the type of graph that should be used and then graph the data; students summarize their quantitative experimental data by constructing the appropriate graph.

Curricular Requirement 8

The course provides opportunities for students to develop the skills related to Science Practice 5: Statistical Tests and Data Analysis, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students perform statistical tests and mathematical calculations to analyze and interpret data.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. The students are given a graph where data has been plotted from an investigation studying the effect of temperature on enzyme activity. Students calculate the rate of reaction for each condition tested. **(Science Practice 5: Statistical Tests and Data Analysis)**

2. **Science Practice 5:** Students are provided data from several trials of an experiment and plot means with error bars. They suggest whether sample means are statistically different.

3. Students are given data from an F_1 Drosophila cross. They then perform a chi-square analysis to test a null hypothesis regarding a proposed pattern of inheritance. **(Science Practice 5)**

Curricular Requirement 9

The course provides opportunities for students to develop the skills related to Science Practice 6: Argumentation, as outlined in the AP Course and Exam Description (CED).

Required Evidence

- ☐ The syllabus must include a description of an instructional approach outside of labs (e.g., assignment or activity) in which students develop and justify scientific arguments using evidence.
- ☐ The instructional approach must be labeled with the relevant science practice(s).

Samples of Evidence

1. Students analyze data from an experiment designed to get an answer to the question: Why do silver-spotted skippers launch their frass? Students make a claim that answers the question using evidence to support their claim. Finally, they use reasoning to explain why the evidence supports the claim.

   In a follow-up activity, students use the data to explain why it is important for caterpillars to avoid detection by predators, and the strategies they use to do so. **(Science Practice 6: Argumentation)**

2. **Science Practice 6:** Students read excerpts from the article "On the Origin of Mitosing Cells" by Lynn Sagan (Margulis), and identify the claims made in the article about endosymbiosis and the evidence to support the claim. Students then learn about the work of Schwartz and Dayhoff, who obtained experimental results to support Margulis's claim, and explain how the results support the theory of endosymbiosis.

3. Students review a research paper related to acid rain and its effect on plants. Students then give an oral presentation in which they use data from the paper to support their claims. **(Science Practice 6)**

   Students are given a sequence of DNA containing a designated mutational change. They then predict the effect of the mutation on the encoded polypeptide and propose a possible resulting phenotype. **(Science Practice 6)**

Curricular Requirement 10

The course provides students with opportunities to apply their knowledge of AP Biology concepts to real-world questions or scenarios to help them become scientifically literate citizens.

Required Evidence

- ☐ The syllabus must label and provide a description of at least one activity requiring students to apply their knowledge of AP Biology concepts to understand real-world questions or scenarios.

Samples of Evidence

1. **Current Event Board**

   The teacher will post newspaper articles on issues impacting the local, regional, national, and/or global community that involve biology. Students write comments or answer teacher-generated questions on sticky notes to engage with and apply biology concepts to real-world issues.

   For example: The teacher posts newspaper articles that follow a real-world situation such as red tides in Florida. The teacher then posts questions related to the articles and asks students to predict what might happen to manatees if they encounter harmful algal blooms. Students write their predictions on sticky notes to generate class discussions on the related stories.

2. **Ecological Issue Role Playing Activity**

   The syllabus describes a role-playing activity in which students must research the ecological effects of clear cutting a forest from the perspective of a lumberjack, an environmentalist seeking to preserve clean water, and someone from congress who might approve or disapprove the action.

3. **Real World Investigation**

   Students complete Part 3 of the AP Biology Investigative Lab 7: Loss of Cell Cycle Control in Cancer. Students engage with Case 1: HeLa Cells. Students listen to the story of Henrietta Lacks and explain what went wrong with her cervical cells that made them cancerous. In small groups, students discuss questions such as: Should tissue be removed from a patient without his or her consent for research?

Curricular Requirement 11

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.

Required Evidence

- ☐ The syllabus must include an explicit statement that at least 25% of instructional time is spent engaged in hands-on, inquiry-based laboratory experiences.

  AND

- ☐ The syllabus must list lab titles and brief descriptions including at least two labs from each big idea and must indicate how the lab experiences, collectively, provide students opportunities to apply all six science practices.

Samples of Evidence

1. Students spend 25% of the instructional time engaged in hands-on, inquiry-based laboratory experiences and complete the following labs from the *AP Biology Investigative Labs: An Inquiry-Based Approach* lab manual:
   - Big Idea 1 (EVOLUTION): Mathematical Modeling—Hardy-Weinberg (students investigate how allele frequencies relate to evolutionary change) (SP 3, 5), Analyzing Genes with BLAST (students learn how to use the tool of bioinformatics in analyzing genetic disease) (SP 2, 3)
   - Big Idea 2 (ENERGETICS): Diffusion and Osmosis (students relate surface area to volume and design experiments in osmosis with artificial cells) (SP 3, 4, 5), Photosynthesis (students use the floating leaf disk procedure to measure oxygen production) (SP 3, 4, 6)
   - Big Idea 3 (INFORMATION STORAGE AND TRANSMISSION): Mitosis and Meiosis (students design experiments with onion cells to test rates of mitosis) (SP 1, 3, 4), Biotechnology I and II—Bacterial Transformation (SP 3, 6) (students use plasmids to transform E. coli and design their own experiments) and Restriction Enzyme Analysis (students use restriction endonucleases and gel electrophoresis to create and analyze genetic fingerprints) (SP 6)
   - Big Idea 4 (SYSTEMS INTERACTIONS): Fruit Fly Behavior (students use Drosophila to design experiments in chemotaxis) (SP 3, 6), Enzyme Activity (a guided inquiry of how peroxidase enzyme is influenced by environmental factors) (SP 3, 5)

2. A statement is included in the syllabus indicating at least 25% of instructional time is spent engaged in hands-on, inquiry-based laboratory experiences.

   A table includes the labs titles and the associated big ideas and science practices for each investigation. For example:

Lab	Big Idea	Science Practice(s)	Brief Description
BLAST	EVOLUTION	1, 2, 3	Students construct a cladogram using BLAST by comparing DNA from several organisms
Hardy Weinberg	EVOLUTION	1, 3, 5	Students build a spreadsheet modeling the change in a hypothetical gene pool

Lab	Big Idea	Science Practice(s)	Brief Description
Photosynthesis	ENERGETICS	1, 3, 4, 5, 6	Students estimate photosynthesis rate by measuring oxygen from floating leaf discs
Enzymes	ENERGETICS	1, 3, 4, 5, 6	Students use peroxidase to design their own experiments on enzyme function
pGlo Transformation	INFORMATION STORAGE AND TRANSMISSION	1, 3, 6	Students use the pGLO plasmid to transform a bacteria
Mitosis/ Meiosis	INFORMATION STORAGE AND TRANSMISSION	1, 3, 4	Students use onion root tips to study effects of environment on mitosis
Transpiration	SYSTEMS INTERACTIONS	1, 3, 4, 5, 6	Students make microscope slides of leaf tissue to study stomata density and use a potometer to design an experiment testing factors affecting transpiration
Fruit Fly Behavior	SYSTEMS INTERACTIONS	1, 3, 5, 6	Students construct a choice chamber to investigate fruit fly responses

3. The syllabus states that “students will spend 30% of class time engaged in inquiry-based activities.” In addition, the syllabus includes lab titles and a brief description along with their associated big ideas and science practices within the relevant units of study in the course outline. At least two labs from each big idea are included in the syllabus.

Curricular Requirement 12

The course provides opportunities for students to record and present evidence of their laboratory investigations.

Required Evidence

- ☐ The syllabus must describe how students will record and present evidence of their investigative work, including elements typically required in lab reporting.

  AND

- ☐ The syllabus must include an explicit statement that students are required to maintain a lab notebook or portfolio (hard-copy or electronic).

Clarifying Terms

Elements: examples could include purpose, methods, data analysis, error analysis, statistics, and conclusions

Lab notebook/portfolio: compilation of recorded evidence throughout the year which could include formal reports, mini-posters, PowerPoint presentations, posters

Samples of Evidence

1. The syllabus describes the components of written lab reports and explicitly states that students are required to maintain a hard-copy or electronic lab notebook.

   Students are given the opportunity to develop a mini-poster for some investigative lab reports. Students share their mini-poster and exchange them for peer review. Peers use sticky notes to respond and ask questions. Oral presentations may be used for mini-posters.

2. The syllabus includes the use of written reports of investigative labs to give students opportunities to write clearly and to reflect on their work. The written reports include the following components and are compiled in a laboratory notebook:
   - Testable question for investigation
   - Background observations and contextual information
   - Hypothesis and rationale for investigations
   - Experimental design: variables, controls, constants
   - Results: data tables, graphs (statistical analyses where appropriate)
   - Conclusions and discussions

3. For each of the eight inquiry labs listed, students will complete a written report including the following sections: **abstract** (100 words or less), **introduction** (including a statement of purpose, a null hypothesis, and one or more alternative hypotheses), **materials and methods** (in paragraph form), **results** (the "what"), **discussion** (the "why"), and **references cited**.

   Students assemble an electronic portfolio containing the final draft for each submitted lab report as a record of their laboratory experience.