Scientific Practices (SP) for AP Biology:

1. **The students can use representations and models to communicate scientific phenomena and solve scientific problems.**
   - **A.** **1.1** The students can **create** representations and models of natural or man-made phenomena and systems in the domain.
     - **I.** verbal, written, visual, manipulative
     - **II.** Illustrative examples include **a) the relationship between photosynthesis and cellular respiration, b) structure and functional relationship of membranes, or c) chromosomal movement in meiosis and mitosis.**
   - **B.** **1.2** The students can **describe** representations and models of natural or man-made phenomena and systems in the domain.
   - **C.** **1.3** The students can **refine** representations and models of natural or man-made phenomena and systems in the domain.
     - **I.** Revise or refine examples such as **a) energy flow through an ecosystem, b) movement of molecules in and out of cells, or c) traits in a population**
   - **D.** **1.4** The student can **use** representations and models to analyze situations or solve problems qualitatively and quantitatively.
   - E. **1.5** The students can **reexpress** key elements of natural phenomena across multiple representations in the domain.

2. **The student can use mathematics appropriately.**
   - **F.** **2.1** The student can **justify** the selection of mathematical routine to solve problems.
     - **I.** Justify the use of mathematics, including **a) use of chi-square to analyze observed and predicted inherited patterns, b) Hardy-Weinberg equation to predict changes in gene frequency over time, c) concentration gradients and osmotic potential, d) rates of chemical reactions, processes, and solute concentration.**
     - II. Measure and collect experimental data with respect to **volume, size, mass, temperature, pH, and more.**
   - **G.** **2.2** The student can **apply** mathematical routine to quantitates that describe natural phenomena.
   - **H.** **2.3** The student can **estimate** numerically quantitates that describe natural phenomena.

3. **<u>The students can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.</u>**
   - **A.** **3.1** The students can **pose** scientific questions.
     - **I.** Two guiding questions in scientific experiments must be "**how do we know what we know**" and **"This is why we know what we know**."
     - **II.** Must be able to **pose, refine, and evaluate scientific questions**
     - **III.** Use questions for **research, experimentation, informational analysis, and synthesis.**
   - **B.** **3.2** The students can **refine** scientific questions.
   - **C.** **3.3** The students can **evaluate** scientific questions.
     - **I.** **Pose and rationally discuss questions** which address ethical and civil issues that surrounds the development and application of scientific knowledge.
     - **II.** Controversial issues include **stem cells, cloning, genetically modified organisms, and other forms of biological research.**

4. **<u>The student can plan and implement data collection strategies appropriate to a particular scientific question.</u>**
   - **A.** **4.1** The students can **justify** the selection of the kind of data needed to answer a particular scientific question.
     - **I.** Data can be utilized within **an experimental investigation, scientific observation, the findings of others, or reconstruction of events.**
   - **B.** **4.2** The students can **design** a plan for collecting data to answer a particular scientific question.
     - **I.** Must investigate and arrive at **answers, and justify** a specific type of data and methodology for data collection.
     - **II.** Must **control for other variables and influences within** the experiment.
   - **C.** **4.3** The student can **collect** data to answer a particular scientific question.
     - **I.** Identify needed controls, supplies and resources from a given list, **develop and/or follow an experimental procedure.**
   - **D.** **4.4** The student can **evaluate** the source of data to answer a particular scientific question.
     - **I.** Must **analyze data and draw conclusions, as well as limitations of data/ conclusions.**

II. Draw conclusions from other experiments and scientists, such as Griffith, Calvin and Krebs, Hershey and Chase, Watson and Crick.

5. **<u>The student can preform data analysis and evaluation of evidence.</u>**
   A. **5.1** The student can **analyze** data to identify patterns or relationships.
      I. Conducts experimental design and procedure, and collected data can be utilized to determine and formulate **statements, conclusions, and even hypothesis.**
      II. **Draw conclusions from provided data or charts.**
   B. **5.2** The students can **refine** observations and measurements based on data.
      I. Develop new methodology and data collection after conducting experiments.
   C. **5.3.** The student can **evaluate the evidence** provided by data sets in relation to a particular scientific question.
      I. Can not only evaluate the **accuracy and precision of data collection**, but use found results to analyze the validity of the experiments with **similar/identical aims and procedures.**

6. **<u>The student can work with scientific explanations and theories.</u>**
   A. **6.1** The student can **justify** claims with evidence
      I. Using evidence from results in experiments to answer "**How do we know what we know?"**
   B. **6.2** The student can **construct** explanations of phenomena based on evidence produced through scientific practices
      I. **Cite, utilize, and synthesize** results and conclusions from experiments, such as **natural selection** via antibiotic resistant bacteria, herbicide-resistance in plants, and more.
   C. **6.3** The student can **articulate** the reasons that scientific explanations and theories are refined or replaced.
      I. Understand the role of **improved, advanced technologies, continuous experimental design replication**, and **new scientific concepts.**
   D. **6.4** The student can **make claims and predictions** about natural phenomena based on scientific theories and models.
      I. Use scientific laws, data, and theories **to predict the effect or consequences** of a specific scenario or scientific experiment.

E. **6.5** The student can **evaluate alternative scientific** explanations.

7. **<u>The student is able to connect and relate knowledge acrid various scales, concepts, and representations in and across domains.</u>**
   A. **7.1** The student can **connect phenomena** and models across spatial and temporal scales.
      I. Biological processes are connected and intertwined across **the scales of time, space, and complexity**.
         I. DNA sequences, morphological structures, and metabolic pathways **connect and diverge the tree of life**.
         II. Photosynthesis and the global carbon cycle.
         III. Genotype and phenotype
         IV. Competition and cooperation from molecules to populations.
   B. **7.2**. the student can **connect concepts in and across domains** to generalize or extrapolate in and/or across enduring understandings and big ideas.
      I. Describe how **enduring understandings are connected** to the big ideas in biology.
      II. Describe how big ideas are connected to one another, and how they connect to other **scientific disciplines**.