EEI Lesson Plan Worksheet

Date: TBD	Class/Period: **AP Biology (3 class periods)**
Standard and objectives	Following a simple photosynthesis lab, students will develop hypotheses and design their own experiments to compare photosynthesis in native plants. **STRAND 1 - INQUIRY PROCESS** **CONCEPT 1: OBSERVATIONS, QUESTIONS, AND HYPOTHESES** - FORMULATE PREDICTIONS, QUESTIONS, OR HYPOTHESES BASED ON OBSERVATIONS. EVALUATE APPROPRIATE RESOURCES. PO 2. DEVELOP QUESTIONS FROM OBSERVATIONS THAT TRANSITION INTO TESTABLE HYPOTHESES. PO 3. FORMULATE A TESTABLE HYPOTHESIS. PO 4. PREDICT THE OUTCOME OF AN INVESTIGATION BASED ON PRIOR EVIDENCE, PROBABILITY, AND/OR MODELING (NOT GUESSING OR INFERRING). **CONCEPT 2: SCIENTIFIC TESTING (INVESTIGATING AND MODELING)** - DESIGN AND CONDUCT CONTROLLED INVESTIGATIONS. PO 2. IDENTIFY THE RESOURCES NEEDED TO CONDUCT AN INVESTIGATION. PO 3. DESIGN AN APPROPRIATE PROTOCOL (WRITTEN PLAN OF ACTION) FOR TESTING A HYPOTHESIS. PO 4. CONDUCT A SCIENTIFIC INVESTIGATION THAT IS BASED ON A RESEARCH DESIGN. PO 5. RECORD OBSERVATIONS, NOTES, SKETCHES, QUESTIONS, AND IDEAS USING TOOLS SUCH AS JOURNALS, CHARTS, GRAPHS, AND COMPUTERS. **CONCEPT 3: ANALYSIS, CONCLUSIONS, AND REFINEMENTS** - EVALUATE EXPERIMENTAL DESIGN, ANALYZE DATA TO EXPLAIN RESULTS AND PROPOSE FURTHER INVESTIGATIONS. DESIGN MODELS. PO 1. INTERPRET DATA THAT SHOW A VARIETY OF POSSIBLE RELATIONSHIPS BETWEEN VARIABLES. PO 2. EVALUATE WHETHER INVESTIGATIONAL DATA SUPPORT OR DO NOT SUPPORT THE PROPOSED HYPOTHESIS. PO 3. CRITIQUE REPORTS OF SCIENTIFIC STUDIES (E.G., PUBLISHED PAPERS, STUDENT REPORTS). PO 4. EVALUATE THE DESIGN OF AN INVESTIGATION TO IDENTIFY POSSIBLE SOURCES OF PROCEDURAL ERROR. PO 7. PROPOSE FURTHER INVESTIGATIONS BASED ON THE FINDINGS OF A CONDUCTED INVESTIGATION. **CONCEPT 4: COMMUNICATION** - COMMUNICATE RESULTS OF INVESTIGATIONS. PO 1. FOR A SPECIFIC INVESTIGATION, CHOOSE AN APPROPRIATE METHOD FOR COMMUNICATING THE RESULTS. PO 2. PRODUCE GRAPHS THAT COMMUNICATE DATA. PO 3. COMMUNICATE RESULTS CLEARLY AND LOGICALLY. PO 4. SUPPORT CONCLUSIONS WITH LOGICAL SCIENTIFIC ARGUMENTS.

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	STRAND 4: LIFE SCIENCE **CONCEPT 5: MATTER, ENERGY, AND ORGANIZATION IN LIVING SYSTEMS (INCLUDING HUMAN SYSTEMS) -** UNDERSTAND THE ORGANIZATION OF LIVING SYSTEMS, AND THE ROLE OF ENERGY WITHIN THOSE SYSTEMS. PO 1. COMPARE THE PROCESSES OF PHOTOSYNTHESIS AND CELLULAR RESPIRATION IN TERMS OF ENERGY FLOW, REACTANTS, AND PRODUCTS.
Set • **Active Participation** • **Past Experience** • **Relevancy**	Bellwork (on screen; Day One): Get together with your lab partners and discuss the photosynthesis experiments you carried out. How can you improve the techniques you used? How do you think your results might be different if you repeated your experiments with chloroplasts from different plants? (Day Two): Review with your group and be prepared to share your hypothesis. (Day Three): What kind of graph(s) do you plan to use to present your results? What will the x-axis and y-axis labels be? What units of measurement did you use?
Lesson Overview • **Four Teacher Actions (Direct Instruction)** ▪ **Information** ▪ **Response** ▪ **Activities** ▪ **Questions** • **Guided Practice** • **Independent Practice** • **Active Participation**	*1.* Students (3-4 students per lab group) brainstorm ideas for comparing photosynthesis activity of native plants to that measured in the previous experiment. *Plant tissue samples will be obtained primarily from plants on the school grounds or nearby. Possibilities include both native and non-native desert-adapted plants of several functional types. For some, chloroplast isolation will be straightforward, but others will present some challenges, increasing the realism of the research.* *2.* Each student group develops a prediction/hypothesis about differences in photosynthesis between spinach chloroplasts and those from desert plants. *Desert adaptations have not yet been discussed in AP Biology, but many students will have some prior knowledge of general desert plant adaptations and biochemistry (C_3 vs. C_4 vs. CAM plants, etc.).* 3. Student groups write up an experimental procedure and list of materials needed. *Students have standard lab report format, and previous experimental design experience. It is expected they will carry out variations of the spinach chloroplast experiment, but they have the freedom to go in different directions.* 4. Each group carries out their experiment and evaluates their hypothesis including a discussion of problems that occurred and possible improvements to their chosen method. 5. Each group presents their results to the class using the electronic medium of their choice. Teacher introduces the activity and monitors and guides discussion and progress when needed.
Closure • **Active Participation** • **Student Summary** • **Relevancy**	Day One: "Stop for a moment and think about where you are in the planning process today. Write up a quick outline of what you need to accomplish before carrying out your experiment. Is there anything you can do outside of class to do this? Do you have all the supplies you

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	need to carry out your experiment?" Day Two: "How did your results compare to the measurements we obtained from spinach? How did your results relate to your predictions? What challenges did you run in to? What can you do to test your ideas further?" Day Three: "Think about the experiments you just carried out. What do you think would change if we could test photosynthesis in whole leaves or whole plants instead of isolated chloroplasts?"
Assessment	Monitor discussions for level of understanding. Research plans evaluated before experiments begin. Formal lab report of resulting experiment will be submitted.