Evolving TCE Biodegraders Handout Answers

Note to teacher: The questions are meant to guide students in planning their experiments, so expect answers to vary depending on what variables students choose to test. They may change any settings in Avida-ED including the mutation rate, offspring placement, world size, etc. You may wish to limit students to changing only one variable at a time, or leave the question more open-ended and allow students to test protocols that involve changing many variables. Students may choose to evolve organisms in several different environments (by saving the organisms and then placing them in new dishes). Their hypotheses must be testable in Avida-ED and they should use observations and data to explain their results. Check each group's hypothesis before they begin. You may need to guide students in relating their manipulated variables to explanations of the effects on organisms' abilities to efficiently metabolize TCE ("orose"). The best indicator of an organism's ability to metabolize TCE is its fitness value in an environment with only TCE.

Experimental Design

Design the experiment to answer the following question: **What conditions will lead to the evolution of the most efficient TCE degrading bacteria?**

Use the following questions to guide you in designing your experiment. Make sure that you answer each question thoroughly (on paper, word processor, or in your lab notebook) before beginning your investigation.

1. What conditions (settings) might you change in order to increase the likelihood of the "oro" function evolving and maximizing the effectiveness at which the organisms degrade TCE? List as many possibilities as you can (these are potential hypotheses).
2. What conditions do you think have the best potential for solving the problem? Explain your reasoning.
3. A hypothesis is a proposed explanation for an observation. You just wrote your hypothesis in answering the preceding question. Now state it concisely in a sentence or phrase.
4. Hypotheses lead to predictions. Based on your hypothesis about the best conditions for evolving efficient TCE degrading bacteria, your prediction is that the organisms will have a high fitness value in an environment with only the "orose" resource. Now state your hypothesis and your prediction together in an "if… then…" statement in which the "if" refers to the hypothesis and the "then" refers to the results that you predict to observe. Make this a single sentence that concisely links your hypothesis (the "why") to the prediction (the "what") that follows the "if… then…" format.
5. What data do you need to collect in order to test your hypothesis?
6. How many data points (number of replications, variables, etc.) do you need to be able to confidently support or reject your hypothesis? Avida-ED is an instance of evolution in a model environment, which means that every run is unique. To draw any conclusions, you must include at least five runs for each treatment.
7. Describe your experimental design. Make this a concise description of your methods (including settings, replications, data collection, etc.) that is clear enough for another group to replicate.
8. What are the dependent and independent variables and the controls? When determining what variables need to be controlled for, it is often helpful to go back to the alternative possible explanations to your original question and think of how to specifically rule those out in your procedure. Another type of control that is often essential is a point of comparison (a "no treatment" group).
9. How will you organize your data as you collect it? Make a data table to fill in during the investigation.
10. How will you present the data? Usually this is a graph or series of graphs. What type of graph will best display the pattern that you expect to show? What are the x (independent variable) and y (dependent variable) axes of the graph? It may be helpful to sketch a quick version of the graph that you expect to see if your prediction is correct (later, you can compare your actual data to this to see if it is consistent).