**Freezer Full of Fossils v.2**

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Faculty Notes:

Freezer Full of Fossils was initially developed as a Data Nugget then extended to include additional data. The exercise allows students to practice working in excel, graphing, and estimating means and confidence intervals. If interested to original data set was obtained from DRYAD, and additional analyses can be performed using the original data set published with Wiser, M. J., N. Ribeck, and R. E. Lenski. 2013. Long-term dynamics of adaptation in asexual populations. *Science* 342:1364-1367.

A key to the questions included follows.

Questions:

1. **What observations can you make from Figure 1?**

Mean fitness increases over time; there is a linear relationship between fitness and time; there is a great deal of variation within any one time unit.

1. **Why is the mean fitness 1.0 at the intercept, meaning when time = 0 generations?**

Because the ancestor should always have a fitness of 1 relative to itself

1. **What does the graph represent biologically?**

The graph shows the average fitness as measured between two populations of *E. coli*, at different time points. In each case the descendant is compared to its ancestor*.*

1. **What type of mathematical relationship or model do you think best describes the observed changes in fitness? Refer to specific elements of Figure 1 to support your claim.**

Linear

1. **What do you conclude from these findings? Be specific and provide evidence to support your claim.**

A stepwise model of increasing fitness provides a better fit to the data, suggesting that mutational change happens, if beneficial, increases in frequency, and then the fitness of the population levels off for a bit until a new mutation conferring an increase in fitness occurs.

**6. What is your prediction as to the expected outcome of mean fitness change over this period of time? Graph and explain your prediction.**

Answers will vary but should be similar to 2000 or show average fitness leveling off

**7. Describe the results of your graphs, explaining specifically the evolutionary trajectory of each of the 12 different populations over the 10,000 generations.**

*Must describe general trend in all 12 populations*

**8. What do you predict the evolutionary trajectory will be for each of the populations if Dr. Lenski continues the experiment?**

*Answers will vary. Continue to follow the trends from the previous 10,000 generations*

**9. Describe your initial observations.**

*Any acceptable answer describing general trends*

**10. From the additional readings for this unit, what changes in *E. coli* might help explain these observations (i.e. At 33,000 generations Ara-3 evolves Cit+ and maintains two types of *E. coli* therefore it is no longer possible to measure fitness compared to the ancestor).**

Students should brainstorm possible explanations. Answers will vary.

**11. Calculate the Grand Mean (average across all populations at each time point) and then calculate 95% confidence intervals. [NOTE: BE SURE TO ACCOUNT FOR THE DIFFERENT SAMPLE SIZES WHEN ESTIMATING THE MEAN AND CI].**

**12. Based on the data you analyzed, what do you think will happen if the experiment is continued for another 50,000 generations? [Be sure to explain the observed trend from 2000 to 10,000 to 50,000 and provide a graph for what you predict fitness will look like in another 50,000 generations].**

*Fitness starts to level off, must include graph showing this.*