Name:_____ Date: _____

Population Growth Curves Activity –
Population Growth Worksheet

Instructions

Begin by loading the Avida-ED program (available at: http://avida-ed.msu.edu/cgi-bin/download_avida_ed.pl). Once the program has loaded, open a workspace to use for the activity. To do this, find the õFileö tab on the top left of the screen, and select õOpen workspace.ö Choose the default workspace that is contained within the Avida-ED folder.

Begin with a simple Avidian organism as your ancestor (find on the bottom left of the screen in the freezer labeled õ@ancestorö). Click and drag into the õPetri dish,ö the black square in the middle of the screen. You should see a small, white square outline appear.

To speed things up, adjust the environment before you begin. Click on the õFlip to Settingsö arrow just above and to the right of the square Petri dish, and change the size from 60x60 cells to 30x30 cells. A õcellö is a place in the Petri dish for a single Avidian organism; it does not refer to a living cell. Every Avidian must have a cell to live in, and each cell can only have one Avidian in it.

Investigating Questions

1. Once you have adjusted your Petri dish size, how many total cells (spaces for organisms) are available in the Petri dish? _____

The graph on the bottom right of the screen can display several items. Set to display the number of organisms. The graph should now display the number of organisms (on the y-axis/vertical axis) as a function of time (on the x-axis/horizontal axis). Flip back to the Petri dish, and move up to the top to find the õControlö tab. Click on it and select õNext update.ö(repeat this step two or three times). An update occurs when the computer performs a given number of operations (in Avida-ED, an update corresponds to a unit of time).

2. Did the population size change? (look for this number in the top right of the screen) _____

Keep clicking õNext updateö until the population reaches 2.

3. How many updates did it take for the starting organism to reproduce? _____
4. Predict what the population will be at 100 updates. _____
5. Explain how you made your prediction.

Flip over to the settings screen. On the bottom, select the program to pause at 100 updates. Return to the Petri dish, and run until 100 updates (use the triangular play symbol just below the Petri dish).

6. Did the actual results match your prediction? _____

Flip back to the settings screen, and set it to pause at 500 updates.

7. Before reaching 500 updates, predict the population at that time. _____

Allow the program to run. As the organisms grow, you should see them get closer and closer to the edge of the dish. Note the approximate update number when they reach the edge.

8. What was the population at 500 updates? _____

9. Number of updates when population reaches the edge of the dish _____

In most cases, there will be a few empty cells in the Petri dish (should be black in appearance). These are locations where the previous organism has died, and a new organism has yet to take that space. So, even though the environment will support 900 organisms, you will probably have a total of a few less than 900 at any given time.

Look at the graph in the bottom right that shows population growth. Find the spot on the graph that corresponds to the number of updates when the population reached the edge of the dish (see #8 above).

10. What do you notice about the slope of the line at this point? _____

_____

11. Why did the population growth eventually slow down and stop? _____

_____

12. What is the carrying capacity of this Petri dish? _____

13. In the Avida world, organisms are competing for space in which to live. In Avida-ED, however, there are only so many cells for Avidians to live. Other than space, what factors might limit a biological populationøs carrying capacity? _____

14. Based on the simulation results, when (how many updates) did the population reach the carrying capacity of their environment? _____

Now let's lower the carrying capacity. Click on the snowflake symbol and freeze the populated dish, this will allow you to compare the results of this experiment with others you will soon perform.

Go to the control tab and start a new experiment. Drag in the same common ancestor (@ancestor), and this time when you flip to the settings screen, make the Petri dish 20x20 cells to lower the carrying capacity. Set the program to pause at 500 updates. Save the populated dish, and follow the same steps to create another experiment where the Petri dish is adjusted to 40x40 cells. Be sure to save the dish when you reach 500 updates. You don't need to record all your population data by hand, the program does it all for you.

To compare your results from the different runs, you need to switch to analysis mode in the top left panel. Then, drag the frozen dishes you preserved from the freezer onto the graph. You can choose the color for the lines, or use the õXö if you want to delete a data set. Make sure you are showing the number of organisms as the variable displayed (bottom right of the screen), not fitness or other information the program can provide.

15. Just by looking at this graph, how can you determine the carrying capacity for each of your Petri Dishes?

16. Look at the shape of all the lines on your graph, what do they all have in common? Describe the general shape of the line?

17. Just look at the first 250 updates. Why doesn't the population growth take off right away when the experiment begins?

A curve like this is often called a **logistic growth curve**. It has a period of slow growth as the population builds, then a period of rapid expansion (exponential growth). This growth slows as the populations get closer to the limit of organisms the environment can support, eventually stopping once the population reaches the environment's carrying capacity. In biological systems, the organisms often do exceed their carrying capacity, but when the environment can't support the larger population, individuals die and the population comes back down.

18. Compare the results you graphed from your largest and smallest Petri dishes. At 50 updates, what is the population of the dishes? _____ and _____

19. At 200 updates, the line from your smallest dish is flat (no slope, m=0), but the growth curve from the largest dish is still going up (positive slope). Why has population growth stopped in one dish but continuing in another?

20. Look at the line from your largest Petri dish. Between 200 and 300 updates the population growth slows and then stops. Explain what is happening in the Petri dish to cause this result.

Real-World Example: Around the world many people get injections of insulin to control their diabetes. Virtually all the insulin used by diabetics is produced by growing large populations of bacteria that have been genetically modified to produce insulin. Suppose you were the Bio-Engineer in charge of factory that uses a population of bacteria that produce insulin. The containers for these bacteria can hold 10,000 organisms. Your boss needs you to have a population of at least 8,000 organisms to meet the production orders.

21. Using Avida-Ed as a model of population growth of the bacteria in the factory, how much time (how many updates) will it take before the population of bacteria reaches the necessary level?   (Hint: 100x100=10,000)