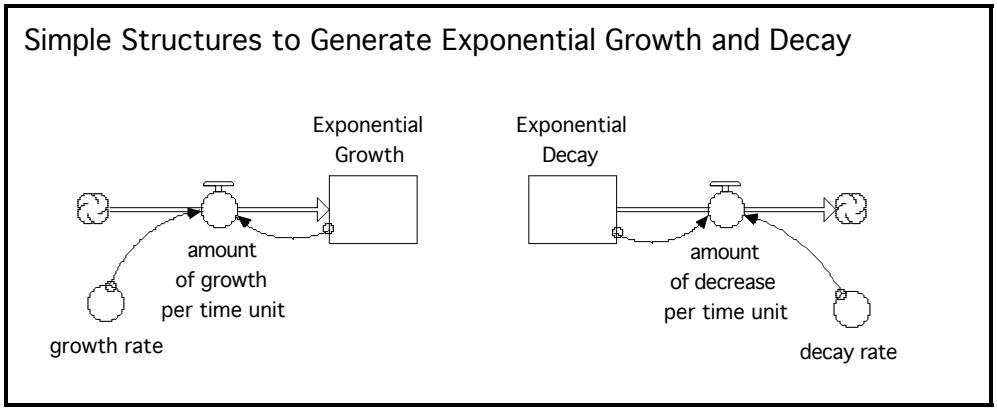
Exponential Models 1



1. Bacteria

Suppose you have been doing an experiment in your biology lab with bacteria. You started the experiment on Wednesday and measured 1000 bacteria per square millimeter. You measure the total number of bacteria each successive day for a week and determine that the exponential growth rate is 30% each day (that is, if you take yesterday's amount of bacteria and multiply it by 30% and add it to yesterday's amount of bacteria, you get today's amount of bacteria.)

In this problem there are three important components to consider: the total amount of bacteria you have on any given day, the growth rate of the bacteria each day, and the amount of new bacteria that are added each day.

1(a) Determine which Stella diagram above to use for this problem. Draw the diagram, label each icon correctly using words that represent the ideas in the bacteria problem, and place the correct value or symbol in each icon so it will model the problem described above.

Notice that, in this diagram (which is very similar to a linear model) there is a connector from the stock (rectangle) back to the flow (growth amount per time unit). This connection didn't happen in the linear model. Why is this connection critical in an exponential model?

1(b) Construct the model you drew above, using the Stella software. Remember to remove the "Non-negative" check mark in the stock. When you double click on the flow icon, to define the value, you will notice that there will be two items listed in the "Required Inputs" box. You MUST use those items in your definition. You should multiply the two "Required Inputs" together for this model. Just click on the name of the first required input, click on *, then click on the second name. Click the ▶ button in the middle of the left side of the panel to close the panel, if desired. Did you remember growth rate must be in decimal form? Double-click on a blank space in the modeling window to open the Model Setting Properties panel. Set the **DT** to **1**, change time units to "days," do not change anything else. Create a graph that includes the Bacteria (stock). Run the simulation.

On which day did the bacteria triple? Remember you can use your cursor to drag across the graph in the graph pad and the software will show you the horizontal (time) and vertical (number of bacteria) values for any point on the graph.

Determine the number of bacteria per square millimeter one week (7 days) after the start of the study.

You may notice that the software has created an automatic format for number of bacteria to thousands, that is, the bacteria value in the graph has a number followed by "k" for thousands. If you do not like this format, double click on the bacteria stock to open its property panel. Click on the # button at the bottom of the panel. Change the precision to 1 and scale by to "none."

How many bacteria per square millimeter are there 12 days after the start of the study?

1(c) If the growth rate is doubled (from 30% to 60%) will there be <u>twice</u> as many bacteria per square millimeter after 12 days? (Yes or No)

Change the growth rater in the model to 60%. Now run the simulation and write down how many bacteria per square millimeter there were after 12 days:

Was your prediction correct? Why or why not?