

101 Dalmatians, or Any Other Critter

Concepts

- Simulating chance that occurs during gamete formation and fertilization

Materials

- TI-84 Plus
- *Probability Simulation APP*

Overview

Fundamental genetics is based on probability. Whether in agriculture, dog breeding, or human sex determination, the traits an individual organism has are the result of statistical “odds.” In this activity, you will simulate genetic outcomes using the *Probability Simulation Application* on the TI-84 Plus.

Procedure

1. Press **[APPS]**, scroll to the *ProbSim* Application, and press **[ENTER]**.
2. Press any key on the TI-84 Plus to start the Probability Simulation.
3. Choose “Toss Coins” by pressing either **[1]** or **[ENTER]**.
 - While you are working with an Application, the top row of keys are called softkeys.
 - Look on the TI-84 Plus screen just above the top row of keys, and you will see what each of these keys does during an APP.
4. Press **[ZOOM]**, which corresponds to Set on the calculator screen, and make the following selections:
 - Coins: 1
 - Graph: Freq
 - StoTbl: All
 - Update: 1
 - Press “OK” (**[GRAPH]**).
5. Press Toss (**[WINDOW]**).
 - The simulator will toss one coin, one time.
 - A graph should appear that shows the result of this first toss (gamete).
 - Since you are simulating genetic probability, you do not want to stop at only one toss, which would represent only one gamete.
6. Press **[TRACE]** to perform “+50” more tosses.

- After the TI-84 Plus has run through 50 more tosses, the graph will look different from how it looked after only one toss.
 - You will work with about 100 tosses.
7. Press **TRACE** again, and watch your graph.
 - You now have asked the TI-84 Plus to generate 101 gametes.
 - When you were setting up the criteria for data collection, you asked the handheld to store all of the tosses, so all 101 of them are being stored in memory.
 - Let's find where they are stored and move them into a list on the TI-84 Plus.
 8. Press the softkey **ESC**, and **DATA**.
 - Take a look at the Save data to: screen. The data you are interested in is the C1 Data.
 9. Press **OK**, **ESC**, and then **YES**.
 10. Now press **QUIT** and then **YES**.

Working with the Data

1. To find where the unit has stored the data from the first set of tosses, press **STAT** **ENTER**, and scroll to the top of L1 so that L1 is highlighted.
 - If there are data in L1, make sure that L1 is highlighted, and press **CLEAR** **ENTER**.
2. Move the cursor back up to highlight L1, and press **2nd** **STAT** and scroll down to C1, then press **ENTER**.
 - This will paste the list called C1, which was generated while in the probability APP, into L1 when you press **ENTER**.

Now L1 should have 101 numbers in it, with all numbers being either a 0 or 1. Since you are simulating genetic probability, zeros represent recessive genes (a) and ones represent dominant genes (A).

You started with a coin that had both, so the coin would represent an individual who is heterozygous (Aa). The numbers in L1 represent 101 gametes (sperm or eggs) produced by an individual who is heterozygous.

During the formation of the gametes, the gene pair (Aa in this case) gets separated so that each gamete contains only one gene from the pair, either A (1) or a (0).

Generate Another Parent's Data

So far, you only have in your lists the gametes from one parent. Now you need to generate another 101 gametes using the Probability Simulation Application and paste them into L2 of your TI-84 Plus.

- Go back to the beginning of the instructions, and start the APP again.
- Follow the same procedure as you did before, but this time, place the data in the C1 list into L2 when you finish.
 - Scroll to the bottom of L1 and L2 and make sure you have the same number of data entries in each list.

Combining Data

Now that you have gametes from one parent in L1 and from the other parent in L2, add the two lists to one another to simulate the joining of the gametes at conception.

- To do this, scroll to the top of L3 so that L3 is highlighted.
- Press $\boxed{2nd} \boxed{1} \boxed{+} \boxed{2nd} \boxed{2}$ (L1 and L2 are above the 1 and 2 buttons).
 - Your screen should look like the screen in Figure 1.
- Press \boxed{ENTER} .

In L3, you now have the probability results of the cross between the individual in L1 and the individual in L2. Congratulations! You now have 101 TI-84 Plus grandchildren!

L1	L2	$\boxed{=}$	L3
1	1		-----
1	1		
1	1		
1	0		
0	0		
1	1		
0	1		
0	1		
$L3 = L1 + L2$			

Figure 1

Graphing

To see how your actual results compare to the theoretical results you expected, it is helpful to produce a graph of the data.

- Press **2nd** **Y=** **ENTER**, and make your settings reflect Figure 2.
 - You will be looking at a histogram of the data in L3, but first you need to set your window so you can view the graph.
- After you press **WINDOW**, the settings that appear in Figure 3 should be fine.
- Now press **GRAPH**, and draw your graph in the box provided in Figure 4.
- Press **TRACE** and then use **◀** and **▶** to move from place to place on the graph.
 - The first bar represents the number of homozygous recessive individuals (the 0s) from your cross.
 - The second bar represents the number of heterozygous individuals (the 1s).
 - The third bar represents the number of homozygous dominants (the 2s).
- On top of each bar in your graph above, write the number of individuals in that bar, which represent the number of individuals of that genotype.

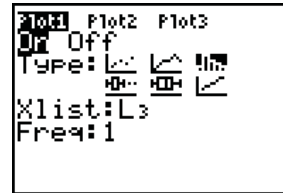


Figure 2

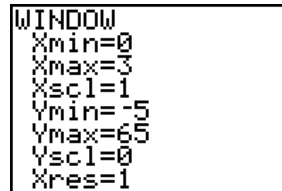


Figure 3



Figure 4

Questions

- The expected ratio of genotypes (AA, Aa, aa) from a monohybrid cross (Aa x Aa) is 1 AA: 2 Aa: 1 aa, or 25%: 50%: 25%. If your results matched this ratio, how many of each genotype would you have had?
AA _____ Aa _____ aa _____.
- How many of each genotype did you actually have?
AA _____ Aa _____ aa _____.
- What percent of your offspring had each genotype?
AA _____ Aa _____ aa _____.
- Did your results exactly match the expected results? Explain.
- Discuss how this activity simulates meiosis.
- Discuss how this activity simulates sexual reproduction.

Extension of Original Activity

This time, you will simulate the flipping of two coins simultaneously and make an analogy to reproduction with only one simulation round, rather than two as in the first part of the activity.

1. Press **[APPS]**, scroll to the *ProbSim* APP, and press **[ENTER]**.
2. Press any key on the TI-84 Plus to start the Probability Simulation.
3. Choose “Toss Coins” by pressing either **[1]** or **[ENTER]**.
4. Press **[ZOOM]**, which corresponds to “Set” on the calculator screen, and make the following selections:
 - Coins: 2
 - Graph: Freq
 - StoTbl: All
 - Update: 1
5. Press OK and TOSS.
 - The result of the toss of two coins will be displayed graphically and on the two coins that were tossed.
6. Press ‘+50’ to simulate 50 more tosses.
7. Watch the graph change as the results accumulate.
8. Repeat the previous step so that you have 101 total tosses.
9. Press ESC and DATA.
10. On the Save data to: screen, make note of where in the TI-83 Plus the lists of data will be stored.
11. Press OK, ESC, and YES.
12. Now press QUIT and YES.
13. To find where the calculator has stored the data from the first set of tosses, press **[STAT]** **[ENTER]**, and scroll to the top of L1 so that L1 is highlighted.
 - If there is data in L1, make sure that L1 is highlighted, and press **[CLEAR]** **[ENTER]**.
14. Once L1 is cleared, place the cursor at the top of L1 again so that L1 is highlighted.
15. Press **[2nd]** **[STAT]**, and scroll to the list named TOTH, which stands for Total Heads.
16. Highlight TOTH, and press **[ENTER]**.

- Your screen should look like the screen that appears in Figure 5.
- Press **[ENTER]**, and you should see L1 filled in with data—zeros, ones, and twos.
 - The zeros represent homozygous recessives (aa), the ones represent heterozygotes (Aa) and the twos represent homozygous dominants (AA).
 - To see a graphical representation of these data, press **[2nd] [Y=] [ENTER]**. Enter the settings as shown in Figure 6.
 - Now set the window so that you can view the graph of the data. Press the **[WINDOW]** key, and enter the settings shown in Figure 7.
 - Press **[GRAPH]**. Draw your graph in Figure 8.
 - Press **[TRACE]**, and use **[▶]** and **[◀]** to move from place to place on the graph.
 - The first bar represents the number of homozygous recessive individuals from your cross.
 - The second bar represents the number of heterozygous individuals.
 - The third bar represents the number of homozygous dominants.
 - On top of each bar in your graph above, write the number of individuals in that bar, which represent the number of individuals of that genotype.

Questions

- If your results matched the expected ratio, how many of each genotype would you have had?
AA _____ Aa _____ aa _____.
- How many of each genotype did you actually have?
AA _____ Aa _____ aa _____.
- What percent of your offspring had each genotype?
AA _____ Aa _____ aa _____.
- Calculate the percent of error for each genotype. To do this, subtract the actual number of a particular genotype from the expected number of that genotype. Divide this difference by the expected number, then multiply that dividend by 100 to get a percentage.
Percent errors: AA _____ Aa _____ aa _____
- Explain the difference between this method of generating offspring and the first method.

L1	L2	L3	1
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L1 = LTOTH			

Figure 5

Plot1	Plot2	Plot3
Off	Off	Off
Type: L1	Line	Bar
Xlist: L1		
Freq: 1		

Figure 6

WINDOW
Xmin=0
Xmax=3
Xscl=1
Ymin=-5
Ymax=70
Yscl=0
Xres=1

Figure 7



Figure 8