Who Started It All?

It is generally accepted that diseases are spread by viruses and bacteria. In fact many diseases spread by bacteria have been "controlled" by antibiotics The following diseases and their bacteria are just a few; *Hemophilus influenzae* causes Meningitis, *Clostridium botulinum* causes Botulism, *Yersinia pestis* causes The Plague, *Treponema pallidum* causes Syphilis, *Clostridium tetani* causes Tetanus, *Neisseria meningitidis* causes Spinal Meningitis, *Rickettsia prowazekii* causes Epidemic Typhus, *Rickettsia rickettsii* causes Rocky Mountain Spotted Fever, *Streptococcus (group A)* causes Rheumatic Fever, *Bacillus anthracis* causes Anthrax, *Mycobacterium lepraeleprosy* causes Leprosy, and *Vibrio cholerae* causes Cholera. Many of these you may not even recognize today as they have been eradicated by the medical professions. But while virulent they killed hundreds of thousands.

Viruses posed a different problem. Some viruses like chicken pox caused by *varicella-zoster* or the common cold seem fairly safe. However an epidemic of the flu swept the world in 1918 and killed over 20 million people. Other viruses seem to have been eradicated, at least in the United States, but once were deadly include smallpox caused by *Variola minor*, measles, diphtheria, and the plague. Society now has viruses which are emerging as well like AIDS, avian flu, Encephalitis and certain types of cancer.

Diseases are also caused by other types of agents. Though less often considered, these agents include ; fungi, protozoans, worms and prions.

Diseases are generally thought of to be "natural" and the spread of disease to be "just what happens". Those statements were true when diseases, typically caused by bacteria and viruses causes spread, spread through the air or contact with animals. The idea of a sneeze in a crowed room contaminating lots of people or an insect bite is easy to understand and even allows us to forgive. Sometimes diseases spread differently, causing "blame" can be contributed. Such is the case with the exchange of bodily fluids. It is this spread of disease mode that we will be modeling in this activity.

Scenario

A college campus has just been hit with a bomb, a medical bomb that is. The infirmary is inundated with cases of a rare disease which only spreads by direct contact of bodily fluids. It could be sharing needles or cups or other such fluids. You must treat and identify those infected. You also wish to find the person who brought it to campus.

In this activity you will

- explore the spread of disease through an exchange of fluids
- explore the spread of disease through a limited population
- graph and model the spread of the disease
- determine the person who started it all

Equipment

TI-83 or TI-84 calculator for each participant
Cups for each participant
Beral pipettes for each participant
6 graphing calculators and data collection devices
3 pH probes
3 conductivity probes
6 Distilled water in beakers for rinsing stations
6 Wash bottles at stations

Pre-lab Discussion

Assume you have 90 students in this class and we begin with one infected student. If you randomly exchange fluids with one other person, how many persons will be infected after each encounter?

Data Table 1

Encounter	
1	
2	
3	
4	
5	
6	
7	

Sketch the graph of the above data. What is its function?

How many encounters would it take to infect your entire grade of 400 students?

Procedure for Test Station

1. Each student group should set up one of the testing stations. Connect the probe to channel 1 of the CBL-2 or to the Easylink. If you are setting up the Conductivity probe select the 0 – 2000 range. Place all the probes in distilled water.
2. Turn the calculator on and start up Easy Data.
   a. Select File from the Main screen, and then select **New** to reset the application.
   b. Select Setup from the Main screen, and then select **Single Point**.
3. Be ready to test each participant.
   a. Test each person's cup. RINSE completely between samples. BE SURE TO RINSE the probe before and after you test.
   b. Select Start to begin data collection, you will get a single averaged point.
   c. Test both pH or Conductivity and record their values.
   d. Rinse the probe again.
4. Record each person's conductivity or pH by their number on the Class Data Sheet.

Procedure for Student Participants

2. Obtain a cup of body fluids from the front desk and record its number. You must also get a pipette to exchange fluid during your encounters.
3. When instructed to do so randomly select one other person to exchange fluids with by giving them a pipette full of your fluid and taking a pipette full of yours. Stir your solution with your pipette several times. Write down who you "encountered" you will need to choose a different person each time.
4. Bring your solution to both testing sites to be tested.
5. Repeat steps 1 - 3 again until you have had 6 encounters.
6. After the 6 encounters ask your instructor for the magic solution to test.

Data Manipulation

Data Table 2
Class Summary Data

Encounter	Number with High Conductivity	Number with High pH
0		
1		
2		
3		
4		
5		
6		

1. Collect the class data into table 2.
2. Enter the predicted data into you calculator in list 1 and 2. Add actual data to list
    a. Turn the calculator on.
    b. Press the [STAT] then [ENTER] to select **edit**
    c. Type the encounter number into L1, the expected infected into L2 and the actual encountered into L3.
3. Graph the data.
    a. Clear L1, L2, L3 by placing the curser in L1 first pressing [CLEAR] and then [ENTER]. Repeat for L2 and L3.

b. Enter your data into L1, L2, and L3.
c. Turn your graphs on by using the STAT PLOTS. Press [2nd] [Y=] and then [ENTER] to see plot one. It must be on and you want the first plot of L1 ([2nd] [1] and L2, choose a mark you want.
d. Repeat for plot 2 by using the [▲] until it is highlighted and pressing [ENTER]. You now want L1 and L3 with a different mark.
e. Press the [GRAPH] to see both graphs. If you do not see the graphs appear you can auto scale the graphs using [ZOOM] [9].

Analysis

1. Compare the two graphs.
2. Apply the Exponential Regression to both graphs
   a. Press [STAT] then [▶] to choose the Calc menu.
   b. Select 0 for the ExpReg
   c. Press [2nd] [1] [,] [2nd] [2] [,] [VARS] [▶] [ENTER] [▼] [ENTER] [ENTER] so that your screen will say ExpReg L1,L2,Y1
   d. Repeat step 2 but use it for L1 and L3 and store it into Y2.
   e. Press [GRAPH] to see your graphs.

3. Which set of data best fits this model?

4. Apply the Logistic Regression (select B in the CALC menu) the same way to both sets of data.

5. Which data does this best fit?

6. Explain why the data tapers off at the end.

7. Gather your data from the class transparency, when were you infected, if you where.

Your Data Table 3

Encounter Partner	pH	Conductivity
0		
1		
2		
3		
4		
5		
6		

8. Looking at the class data, and can you tell who started it all?

9. If a buffer were used at some point, like a vaccination, what would you predict the results would be as far as pH?

Class Data Sheet

Student	Case1	Case 2	Case 3	Case 4	Case 5	Case 6
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
Total infected						

Created by Jacklyn Bonneau

TEACHER NOTES

Each student should be given a test tube containing 5-mL of distilled water. In one of the test tubes, place 5-mL of a concentrated salt solution and sodium hydroxide instead of the distilled water. Note which student the infected water is given to. A concentrated salt solution can be made by adding 5 teaspoons of NaCl and 1 M NaOH and enough distilled water to bring the volume to 100 mL.
Instruct the students that they need to select a different classmate each time they make an exchange.

If probes are not available you can still do this lab just use the solution, have students interact and donate a couple of drops to the wax paper you have up front with the chart below under it. They donate after each "encounter". After the lab is complete you move the sheets, so numbers are not necessarily available, and add the phenolphthalein and count the number of "pink" solutions at the end of each iteration. This data is then posted as class data. Run off as many as iterations.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Created by Jacklyn Bonneau

PRE-LAB QUESTIONS

1. If it is assumed that no individual will be infected more than once, then the data would have an exponential relationship. It is likely that in each exchange, an infected individual will exchange with another infected individual. Because of this, the number infected after each exchange will be fewer than would be expected in an exponential relationship.

Predicted Data

Table 1

Exchange	# infected
1	2
2	4
3	8
4	16
5	32
6	64

2. If the data were exponential, then in the 7^{th} exchange 128 individuals would be infected. Since some exchanges will not yield newly infected individuals, the data is not truly exponential, resulting in no less than 8 exchanges to infect all 120 individuals.

SAMPLE DATA

Table 2

Name	Exchange 1 Conductivity	Exchange 1 Conductivity	Exchange 1 Conductivity	Exchange 1 Conductivity	Exchange 1 Conductivity	Exchange 1 Conductivity
Jamie	1	2	3	2000	1500	1200
Wynn	1	2	3	4	1600	1650
Anna	1	1	2700	2710	2600	2500
Mary	3000	3000	3000	3000	3000	3000
Bob	1	2	2	3	4	300
Sharon	2	2	3	2000	1950	1800
Don	3	4	700	800	690	700
John	1	2	2	2	400	700
Cindy	0	3000	2500	2400	1600	2200
Krystina	2	3	3	3	300	260

Madison	2	4	4	4	5	530
Randy	3500	2700	2500	1700	2200	1800
Andy	3	3	600	800	1000	1000
Jacob	2	2100	1900	2100	1900	1700
Jennifer	1	1	2	2	400	400
Charles	2	3	3	600	690	400
Total	2	4	7	10	14	16

ANALYSIS

1. In the predicted data, the disease spread more rapidly. The predicted data will likely be exponential while the actual data more closely matches a logistic fit.
3. The predicted data from Table 1 more closely matches the exponential regression.
5. The actual class data more closely matches the logistic regression rather than the exponential regression.
6. In a closed population, the likelihood that an exchange will result in a newly infected individual decreases with each passing exchange. Since the population total is fixed, there becomes a point where the number of infected individual exceeds the number of uninfected. At that point, the odds of exchanging randomly with another infected individual are greater than the odds of exchanging with an uninfected individual. This results in a tapering effect which can be seen on the scatter plot of Infected Individuals *vs*. Exchange.