Objective:
The purpose of this activity is to analyze human population growth and the influences of density dependent controls (diseases/epidemics) on a large population.

As an educated nation, we should be aware of the global problems associated with overpopulation. Yet in 1995 we spent only $600 million on international population assistance. To put this figure in perspective, the Pentagon spends about that amount in two days, and American consumers $1.5 billion on Halloween costumes each year. The overall consequences of our rapidly increasing global population are:

1. environmental degradation
2. habitat destruction
3. extinction of many species.

In the 1800s, Thomas Malthus predicted that, because of environmental limitations, the human population could not continue to grow without limits. According to Malthus, one of the factors, that serve to curb the exponential growth of humankind, is disease.

Large high-density populations found in urban areas often provide ideal conditions for the spread of disease. Throughout history, epidemics have decimated the human population. The black plague, influenza, and now AIDS (Acquired Immune Deficiency Syndrome).

Human immunodeficiency virus, HIV, is the pathogen that causes AIDS. Despite humanity’s growing arsenal of medical treatment, many diseases (especially viruses) still remain deadly and virtually untreatable. HIV most frequently is transmitted through intimate sexual contact. AIDS is one of many Sexually Transmitted Diseases (STDs).

Unfortunately, STDs are epidemic on this planet. Some can make life miserable, others can cause sterility, and some can kill. Every year in the U.S., there are millions of new cases (in addition to the millions of existing untreated or treatable old cases.) There are many factors in our modern-day lives that contribute to this epidemic: 1) Pathogens have mutated, which makes them more difficult to eradicate. 2) World travel allows an infected individual to transmit the pathogen anywhere on the planet within hours or days. 3) Casual sexual relationships increase the spread of disease. Without a doubt, the single most important risk factor is multiple sex partners. Despite the fact that these are pathogenic diseases, our attitudes of denial and shame regarding a sexually transmitted disease often prevents us from seeking out effective treatments.

A. Population Growth
Every hour, our planet has a net increase of 10,625 people. The rate of change for the size of a population is the difference between natality and mortality.

\[
\text{Global growth rate (\%) } = \frac{\text{births} - \text{deaths}}{\text{total population}} \times 100
\]

When looking at the population for a specific area of the planet, immigration and emigration must also be considered.

\[
\text{Global growth rate (\%) } = \frac{\text{births} = \text{immigrants} - \text{deaths} - \text{emigrants}}{\text{total population}} \times 100
\]
We often express the change in births or deaths as a percentage (number/100) or rate. For example, if 6 offspring were born per 100 people annually (6% birth rate) and 4 people died per 100 people (4% death rate), the annual growth rate would be 2%. For human populations we usually express these rates per 1000 individuals. In this case, the above data would be expressed as: 60/1000 – birth rate, 40/1000 – death rate, and the growth rate as 20/1000 or 2%.

At the present time, the world population is approximately 5.8 billion. The birth rate is 2.4% and the death rate is 0.9%. Remember that migration is not a factor when dealing with global population growth. Another way to calculate the global growth rate is to simply find the difference between the birth and death rates.

Global growth rate (%) = Birth rate (%) – Death rate (%)

Use the data in the following tables to construct graphs showing the world’s and Orange County’s population growth. Answer the following questions.

Table 1: World Population

<table>
<thead>
<tr>
<th>Years</th>
<th>Population size</th>
<th>Number of years to increase by one billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,000 B.C.</td>
<td>5 million</td>
<td></td>
</tr>
<tr>
<td>1650 A.D.</td>
<td>500 million</td>
<td></td>
</tr>
<tr>
<td>1800 A.D.</td>
<td>1 billion</td>
<td>All of human history</td>
</tr>
<tr>
<td>1930 A.D.</td>
<td>2 billion</td>
<td>_____ years</td>
</tr>
<tr>
<td>1960 A.D.</td>
<td>3 billion</td>
<td>_____ years</td>
</tr>
<tr>
<td>1975 A.D.</td>
<td>4 billion</td>
<td>_____ years</td>
</tr>
<tr>
<td>1987 A.D.</td>
<td>5 billion</td>
<td>_____ years</td>
</tr>
<tr>
<td>1997 A.D.</td>
<td>5.8 billion</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Orange County Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Population Size</th>
<th>Birth Rate / 1000</th>
<th>Death Rate / 1000</th>
<th>Growth Rate / 1000</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>19,696</td>
<td>-----</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1910</td>
<td>35,011</td>
<td>12.40</td>
<td>11.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1920</td>
<td>62,757</td>
<td>24.01</td>
<td>14.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>118,611</td>
<td>16.50</td>
<td>10.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1940</td>
<td>130,760</td>
<td>16.89</td>
<td>11.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>216,224</td>
<td>19.40</td>
<td>9.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>727,550</td>
<td>21.28</td>
<td>5.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>1,420,386</td>
<td>16.13</td>
<td>5.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>1,934,462</td>
<td>16.30</td>
<td>6.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>2,410,556</td>
<td>21.10</td>
<td>6.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Look at your world population graph; how would you describe its shape? ____________________________

2. What are some reasons it took so much time for the world population to reach 1 billion, but it took only 12 years to increase from 4 to 5 billion? ____________________________

3. What do you think caused the dip in the Orange County population, between 1930 and 1940?

4. Using the Orange County data and graph, answer the following:
   a. When was the birth rate highest? ____________________________
   b. Why was it so high during those years? ____________________________
   c. What is happening to the death rate? Why? ____________________________

5. List some measures that our government could take to reduce population growth in the United States. ____________________________

6. If there were access to free family planning throughout the world, what affect would this have on global population growth and worldwide abortion rates? ____________________________
B. Doubling Time

The concept of doubling time clearly illustrates the concept of positive feedback that occurs with exponential population growth. Positive feedback occurs when an initial event sets in motion a chain of events, which further magnifies the initial effect. Every time the population doubles, a bigger number is doubled and the time for it to double decreases. Study the following table and the answer the following questions. The formula for allowing you to calculate the doubling time for any population is:

\[
\text{Doubling Time} = \frac{70}{\% \text{ growth rate}} \quad (70 = \text{demographic constant})
\]

(birth rate \% – death rate \%)

Table 3: Doubling Time as a Function of Growth Rate

<table>
<thead>
<tr>
<th>Rate of Increase</th>
<th>Doubling Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5%</td>
<td>140 years</td>
</tr>
<tr>
<td>0.8%</td>
<td>87.5 years</td>
</tr>
<tr>
<td>1.0%</td>
<td>70 years</td>
</tr>
<tr>
<td>2.0%</td>
<td>35 years</td>
</tr>
<tr>
<td>3.0%</td>
<td>23 years</td>
</tr>
<tr>
<td>4.0%</td>
<td>17.5 years</td>
</tr>
<tr>
<td>5.0%</td>
<td>14 years</td>
</tr>
</tbody>
</table>

1. What is the present growth rate of the world population? ________________________ (show work)

2. Calculate how many years it will take to double using the formula. ________________ (show work)
3. What would the world population be if doubling occurred? __________________________
   (show work)

4. What would some of the logical consequences of a world population of that size?
   ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________

5. Use the % data in table 2 to calculate the expected Orange County doubling time.

6. Use the two graphs you constructed to estimate what the actual doubling time was for each population to get its present population size. (How many years ago was the population half of its current size?)
   A. The world ______________________________
   B. Orange County __________________________

7. Compare the rate of increase and the actual doubling time for Orange County and the world. How can you explain the discrepancy between the Orange County growth rate and the doubling time indicated in Table 3 or found utilizing the doubling time formula?
   ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________
C. Population Growth and Disease:

This is an activity to demonstrate the affect that population size has on the spread of diseases. It also demonstrates what can happen when you have unprotected sex with multiple partners. **Remember that this is only a simulation of STD transmission and does not reflect on you or your morals. So have fun with it.**

**Scenario**
You are going to a swinging singles resort, where you will have five sexual encounters, without the use of condoms or any other protective device. Be sure to introduce yourself before each encounter, and try to remember the sequence of individuals with whom you have had “simulated sex”. The liquid in the test tube represents body fluids, which you will exchange via the dropper. You should try to exchange **the same amount** as your partner, so the volume of body fluids remains relatively constant in your test tube.

**Procedure:**
A. Select a tube with a dropper from the rack provided by the instructor. **Walk around, mingle, and exchange bodily fluids with 5 different partners.** Be sure to move around the room and not just exchange fluids with the people next to you. Afterwards return to your seat.

B. Once you are back from your singles resort vacation, you decide to go in for an HIV test. The doctor (instructor) will put 3 drops of “Solution X” in your test tube. After the entire group has been tested, we will interpret the test results and calculate the percentage of infected people.

C. Since this is a very deadly disease, we need to find out from whom the disease was originally transmitted. As a group we will analyze the transmission process as the disease spread through the class.

D. Answer the following questions.

1. How many students are in your class today? ________________________________
   How many had positive results? ________________________________
   Calculate the % infection rate: ________________________________

2. How did you feel while waiting to get your test results? ________________________________

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
3. Were you positive or negative?

If you were positive:
   A. Use 6 adjectives to describe how you felt when you got your test results.

   B. How did you feel when others who participated in the same behaviors remained disease free?

If you were negative:
   A. Use 6 adjectives to describe how you felt when you got your test results, and realized you “escaped” infection.

   B. How did you feel when others who participated in the same behaviors became infected?

4. When engaging in this activity, could you tell an “infected” tube (individual) just by looking?