Demographics Habitable Planet Lab

Purpose: To examine the interrelationships between organisms in the environment.

Directions:

1. Read ALL Instructions and the introduction section BEFORE doing the lab.
2. Go to: http://www.learner.org/courses/envsci/interactives/demographics/index.php
3. Click on "Open Simulator"
4. Download the instruction power point from Ms. Rodela's AP Biology 2015-2016 webpage. Review this power point and refer to it as necessary to complete the lab.
5. Print our and complete this paper by hand.
6. Write a lab report (instructions are on Ms. Rodela's web page).
7. Upload your report to Turnitin.com
8. Keep this paper with your raw data and notes to include in your binder check.

Introduction:

Before civilization began to impact the human life cycle approximately 10,000 years ago, human beings had high birth and death rates. Today the world is in the midst of a demographic transition — a transition to low birth and death rates — as the ability to control both disease and reproduction increases. Along the way, between these extremes, populations go through an intermediate period of continued high birth rates, combined with low death rates, resulting in a population explosion (Figure 1).

Because countries span a continuum along this transition, looking at the present demographics of countries around the world provides an opportunity to look forward or backwards in time: a post-transition country can get a glimpse of a situation resembling its own past from countries still in transition, and a transitional country may get a hint of its demographic future from countries that are further along the continuum.

At the most basic level, the increase or decrease in population can be calculated by following the simple formula:

(BIRTH RATE - DEATH RATE) + (IMMIGRATION – EMMIGRATION) = GROWTH RATE

Please note that the model in this lab does not take immigration or emigration into account, so we are looking at birth and death rates only.

Birth and death rates are expressed in a number of different ways. Overall rates are often expressed as the number of births per woman over her whole life, and deaths per year. But for use in predicting population growth, population models use birth and death rates specific to each age group, over a step of 5 years.

The overall population growth rate is only one of the differences among countries in different stages of the transition. The age-based population structure is also greatly affected. The Population by Age Group graph is a standard representation of population structure, called an age-structure diagram, or population pyramid. The age structure of a population is key to its population growth because the more young people, who either are or will reach child bearing age, the faster the population will grow.

The age structure diagram varies in shape. For example, the United States has a house-shaped "pyramid". Nigeria has a young-heavy wide base. Indonesia looks like an onion dome in 2015. Decreasing populations progress into an "inverted pyramid", where the top is wider than the base (Figure 1).

Population momentum is the time lag between a change in birth/death rates and the slowing of population growth (figure 1). This lag time leads to an increase in the overall size of the population.

The term "demographic transition" was originally based on the model of Western European countries, although it is now applied to every country in the world. While useful, the demographic transition model do not, usually, include immigration and emigration rates, which can affect population growth and vary for a variety of reasons. Likewise, does not include cultural variables which might influence the birth and death rates of a population. Issues of culture, religion, government, economy, and natural resources, among others, affect this transition. You might find that where a country stands in the demographic transition may give you some idea of the problems it is currently facing and those that it has overcome in the past.

The distinction of "first," "second," and "third world" countries is purely fictional and subjective, but disease, famine, and war are more endemic to those countries categorized as "third world" than the more highly developed countries in the "first world." "First world" countries are plagued by urbanization, pollution, higher energy needs due to higher standards of living, drug and alcohol abuse and social disorders. Although the "first world" countries are now, for the most part, either approaching a zero population growth or heading toward a negative population growth, the overall effect has been an exponential population boom that occurred after the Industrial Revolution.

AP Biology Essential Knowledge Standards addressed:

4.A.5 Communities are composed of populations of organisms that interact in complex ways

Key vocabulary: demographic transition, age structure diagram, replacement level fertility

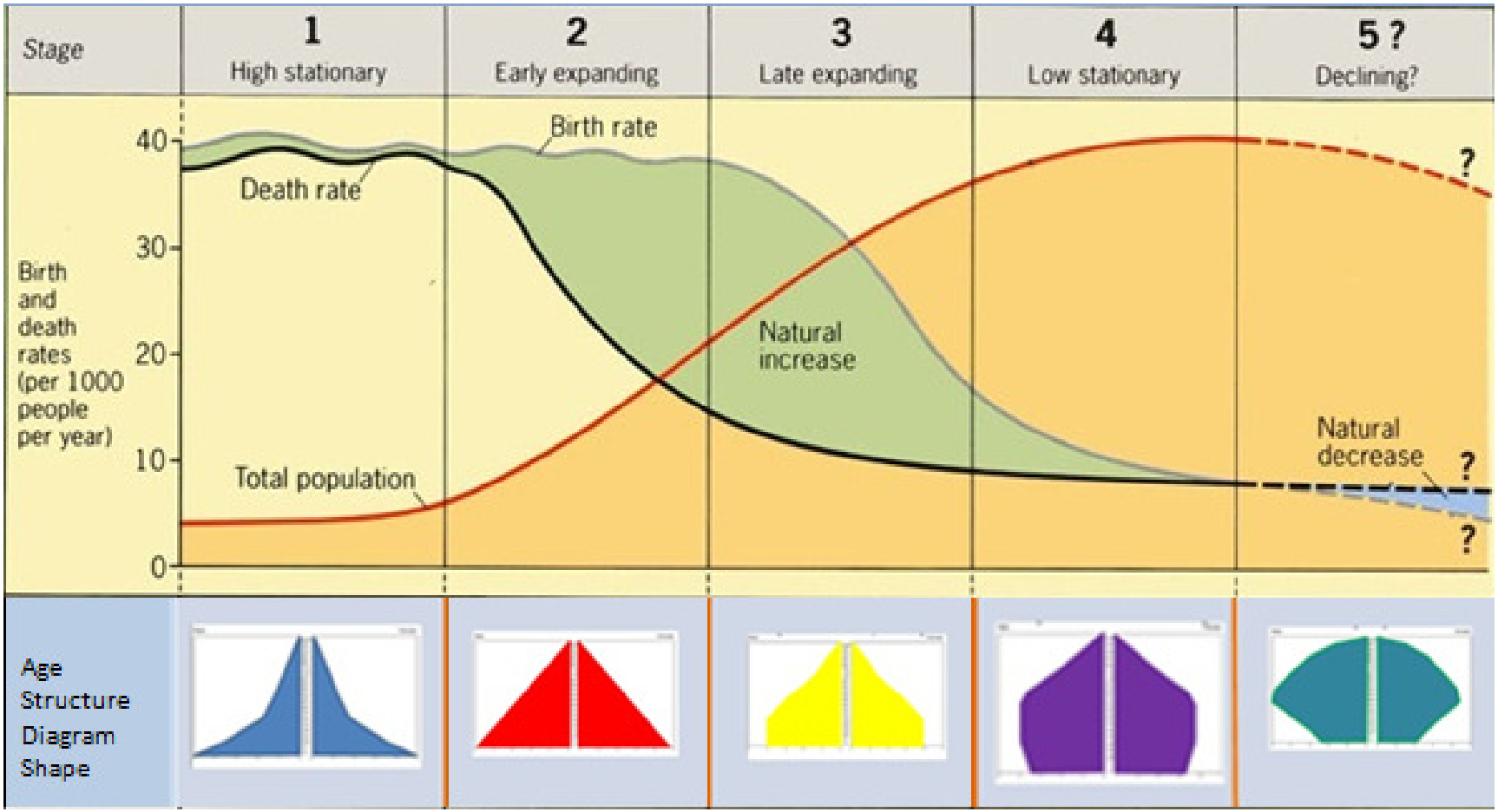

Figure 1. Demographic Transitions. Demographic transition graph showing 5 stages (top). And age structure diagrams (bottom).

Stage	1 High stationary	2 Early expanding	3 Late expanding	4 Low stationary	5 ? Declining?
Examples	A few remote groups	Egypt, Kenya, India	Brazil	USA, Japan France, UK	Germany
Birth rate	High	High	Falling	Low	Very low
Death rate	High	Falls rapidly	Falls more slowly	Low	Low
Natural increase	Stable or slow increase	Very rapid increase	Increase slows down	Stable or slow increase	Slow decrease
Reasons for changes in birth rate	Many children needed for farming. Many children die at an early age. Religious/social encouragement. No family planning.		Improved medical care and diet. Fewer children needed.	Family planning. Good health. Improving status of women. Later marriages.	
Reasons for changes in death rate	Disease, famine. Poor medical knowledge so many children die.	Improvements in medical care, water supply and sanitation. Fewer children die.		Good health care. Reliable food supply.	

Figure 2. Stages of Demographic Transition vs. Birth Rates, Death Rates, Population Growth Rate (Natural increase), Reasons for changes. With examples.

Lesson 1: Demographic Transition

Step 1 Challenge: Determine the growth rates of populations of different countries.

Instructions:

1. To get a sense of the demographic transition continuum, start by running the simulator to 2050 for all nine countries).
2. Record their population growth rates at the end of the simulated period in the Data Tables.
   -Use figures 1 and 2 above to fill out the relative place in transition and social factors.

Lesson 1: Step 1				
Country	Birthrate	Death Rate	Population Growth 2015	Population Growth 2050
USA				
Brazil				
China				
India				
Indonesia				
Iraq				
Italy				
Japan				
Nigeria				

Lesson 1: Step 1				
Country	Relative place in Transition	Social Factors 1	Social Factors 2	Social Factors 3
USA				
Brazil				
China				
India				
Indonesia				
Iraq				
Italy				
Japan				
Nigeria				

3. Number the countries by growth rate from highest (earliest in the demographic transition) to lowest (farthest along the transition).

4. Take screen shots of the age structure diagrams in 2015 and in 2050 and take screen shots of the graphs in 2050. Include all these in your report.

5. Then answer the following questions.
    i. How do you suppose living conditions differ between the country furthest along in the demographic transition compared to the country earliest in the transition?

    ii. How would living conditions in these two countries affect both birth and death rates?

    iii. Think of three social factors that contribute to lower birth rates in the countries farther along. How might these social conditions be encouraged to emerge in less developed countries?

    iv. In general, how do the concepts of "early, middle, and late demographic transition" map to the concepts of "first, second, and third world countries"?

Step 2 Challenge: Determine how age structure diagrams in the different countries compare to their population growth graphs.

Instructions:

1. Look at the shape of age structure diagram for all of the countries you took in the screen shots from step 1.
2. Compare the pyramid shape of the countries that you found to be late in the transition to those that are earlier in the transition.
3. Compare the shapes of the age structure diagrams in 2015 to the shape in 2050.

Lesson 1: Step 2			
Country	Stage of Demographic Transition	Shape of Pyramid (2015)	Shape of Pyramid (2050)
USA			
Brazil			
China			
India			
Indonesia			
Iraq			
Italy			
Japan			
Nigeria			

4. Answer the following questions:
    i. How does the shape of the age structure diagram differ from most developed to least developed country?

    ii. How does the shape of the age structure diagram differ between 2015 and 2050?

Lesson 1 Review Questions:

1. People in the "prime of life" (aged roughly 20-60, depending on local conditions), support the populations younger and older than themselves. How might this impact the quality of life in countries with the various shapes of demographic pyramids?

2. Countries that are now "late" in the demographic transition, generally began it earlier than other countries, or, as with China, pursued the transition more aggressively. The USA is fairly late in the transition.
    a. What do you suppose its demographic pattern was like 100 years ago?

    b. What about China 100 years ago?

    c. Based on what you know of these and other countries, consider what factors prompt women to have fewer children, later in life.

Lesson 2: **Population Momentum**

Step 1 Challenge:
You will consider the human and ecological impacts of unchecked population growth as well as the human cost of China's successful attempt to curb its own growth.

Instructions:

1. Select Nigeria from the Country pull down menu, run the simulator with the default settings to 2050, and record the results in your Data Table under the "original" column.
2. Predict what will happen when the average age of childbearing women is increased by 5 years (fewer teenage pregnancies) and record your prediction (rise, fall, similar).
3. Run the simulator, increasing the childbearing age by 5 years, then 15 years, and then decreasing it by 5 years, and record your results. Use the Reset button at the bottom of the dialog to restore the original rates between each different treatment.

Lesson 2: Step 1					
Nigeria	Original	Prediction	+ 5 years	+15 years	-5 years
Birth rate					
Death rate					
Population growth					

4. What if Nigeria suddenly had the same birth and death rates as the USA?
    a. In the simulator, click on the birth rates button, choose "USA" from the pull-down menu, and click "Apply."
    b. Do the same for death rates.
    c. Then, run the simulator to year 2150 (hit the Run button three times).
    d. While doing so, watch the *shape* of the age structure diagram (the graph by age group).
5. Sketch the pyramid shape at the end of the 150 years.

6. Answer the following questions:
    i. How and why does the pyramid shape change?

    ii. How does an increase or decrease in the average childbearing age group change the population?

    iii. Why do “first world” countries tend to have older childbearing women than “third world” countries?

Step 2 Challenge:
Now let's look at Japan, a country with a population structure almost the opposite to that of Nigeria. Make a prediction about how this difference in population structure might affect the growth of the population, given what you know about the ages at which people are able to bear children and the ages at which people are likely to die.

Instructions:
1. Apply the process laid out in Step 1 to Japan.
    a. Select Japan from the Country pull down menu
    b. Rrun the simulator with the default settings to 2050
    c. Record the results in your Data Table.

Lesson 2: Step 2				
Japan	Prediction	+ 5 years	+15 years	-5 years
Birth rate				
Death rate				
Population growth				

2. Predict what will happen when the average age of childbearing women is increased by 5 years (fewer teenage pregnancies) and record your prediction. Run the simulator, increasing the childbearing age by 5 years, then 15 years, and then decreasing it by 5 years, and record your results. Remember to Reset between each treatment.

3. Return to the simulator and change the birth and death rates to those of the USA. Again, run the simulator to year 2150, observing what happens to Japan's age structure diagram.

4. Draw Japan’s age structure diagram below:

5. Answer the following questions:
    i. Did the pattern of population change match your prediction? If not, why not?

    ii. Compare the final age structure diagram for Japan to the one you sketched of Nigeria. How do they compare, and why are they similar or different?

    iii. How are Japan's numbers different from Nigeria's? What do you think accounts for the difference?

    iv. Many Western European countries are giving monetary incentives to employees who have multiple children. Why would they do this?

    v. How would a baby boom change Japan's demographics?

Lesson 2 Review Questions:

1. If two countries with the same birth and death rates by age group, what will their population structure (age structure diagram shape) eventually look like?

2. In the short term, a population structure has a momentum of its own. Even with extreme measures such as China's "one-child" laws, a population growth rate cannot be changed quickly. China's population control policies began in earnest around 1975.
    a. How long is the delay between that, and when China's population crests?

    b. How many people were added during that delay?

Lesson 3: Social Impacts

Step 1 Challenge: How does the population in a country like Iraq, where the culture promotes larger families, become stabilized? Determine what needs to be done to make that happen.

Instructions:

1. Predict what the average death rate and the average birth rate would have to be in order for the Iraqi population to stabilize or achieve a 0% growth rate by 2050.
2. Record your prediction
3. Run the simulator with varying parameters until you find a zero growth rate.
4. Record your findings in the table.
5.

Lesson 3: Step 1				
Iraq	Prediction	Simulated 1	Simulated 2	Simulated 3
Birth rate				
Death rate				
Population Growth	0%			0%

6. Answer the following:
    i. How close was your prediction to the actual model parameters that gave you a 0% growth rate?

    ii. What factors did you use to make your prediction?

    iii. What would Iraq have to do in order to reach a zero growth rate?

    iv. What kinds of challenges might the Iraqi government face in trying to implement these measures?

v. Faced with mounting population pressure and the resultant drain on natural resources, many growing populations wish to migrate, and other dwindling nations import labor. Where are the major sources and destinations of this population growth differential in the world today?

vi. What issues do the immigrants bring with them?

vii. What is the expected result of a nation whose population is outstripping its resources and ability to feed its people, if its people cannot migrate peaceably?

Step 2 Challenge: Now, we'll look at Brazil and Indonesia.

Instructions:

1. Predict the shape of each pyramid and record it in your Data Table.
2. Predict the birth and death rates as well as the percentage of population growth in 2050 and record your prediction.
3. Run the simulations for each country and record your data.

Lesson 3: Step 2 – Brazil		
	Prediction	Simulation
Pyramid		
Birthrate		
Death Rate		
Population Growth		

Lesson 3: Step 2 – Indonesia		
	Prediction	Simulation
Pyramid		
Birthrate		
Death Rate		
Population Growth		

4. Answer the following:
    i. What are the most obvious similarities and differences between these two countries?

    ii. What might account for the differences?

    iii. Brazil and Indonesia are home to the greatest tropical rainforests on Earth. In what ways might their population stories affect the rest of the world?

Lesson 3 Review Questions:

1. In "third world" countries, what could be done to slow population growth? How might that be enforced? What are the more effective ways of maintaining a near zero population growth?

2. Due to population momentum, any policy change is slow to effect population growth rates. With this in mind, how do you imagine population pressures will shape relationships between countries in the 21st century?

3. How might the culture of an aging population differ from that of a culture more highly populated by children? What kinds of issues do both cultures have in common, and what might be done to attend to these issues?