

**Unit 3 Study Guide: Population Growth**

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1. Define the term "population". Define the following terms/abbreviations related to population growth: N, per-capita birth rate, per-capita death rate,  $r$ ,  $r_{\max}$ , G. For what values of  $r$  will populations be growing? For what values of  $r$  will populations be declining?
2. What does the pattern of human population growth look like? Be specific and detailed. When did our populations begin to increase rapidly? How has population doubling time changed in the last 400 years? What is world population size now? What is this pattern of population growth called?
3. Under what general conditions will populations grow exponentially? Draw a graph of population size vs. time for a population growing exponentially and write the equation that describes G during exponential growth. Under these conditions, what is the relationship between  $r$  and  $r_{\max}$ ? Over time, what is happening to the population size? What is happening to population growth rate?
4. In nature, what specific conditions might lead to exponential growth? Give examples.
5. Under what general conditions will populations grow logistically? Draw a graph of population size vs. time for a population growing logistically and write the equation that characterizes G during logistic growth, being sure to define all terms used in the equation. In biological terms (rather than in "math" terms), how is this equation different from the equation that describes exponential growth (hint: this is a question about the concept of environmental resistance and carrying capacity)? What is the relationship between  $r$  and  $r_{\max}$ ? Over time, what is happening to population size (N)? What is happening to the per-capita rate of increase ( $r$ )? What is happening to population growth rate (G)? When is population growth rate the greatest?
6. What general evidence do we have that we are already at least nearing the earth's carrying capacity for humans? Describe the "ecological footprint" model for determining carrying capacity, including the different categories of land considered. What patterns emerge from the the 1997 study of ecological footprints presented in your text and in class? What does this study tell us about the importance of consumption patterns vs. population size when considering ecological footprint (support your answer with specific information about consumption patterns of the top and bottom 20% of the population)? What does this study tell us about the footprint of individuals from developed vs. developing countries? Of the world as a whole?

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7. How do age structure and age at first reproduction affect long-term human population growth? Describe the differences in age structure between a developing country and the U.S. and discuss the long-term implications of those differences for population growth in each country and for the social issues each country is likely to face as a consequence. In general, under what conditions will women world wide increase their age at first reproduction and limit the number of children they have? Why are these conditions sometimes difficult to meet?
8. Describe the four UN population projections we examined in class. Under what conditions will human population growth continue to rise exponentially (at least for the next 50 years)? Under what conditions will it stabilize the most quickly? What will the global human population size be under that scenario?
9. Does age at first reproduction affect population growth rates in non-human organisms? If so, give examples of the kinds of species with late age at first reproduction and discuss how that feature (and others related to it) affect the species' vulnerability to overexploitation.
10. In natural populations, what kinds of factors limit population growth? In general, do biotic and abiotic factors differ in their effects on population growth? Can they interact? Give examples to illustrate your answer, including experimental studies as appropriate.