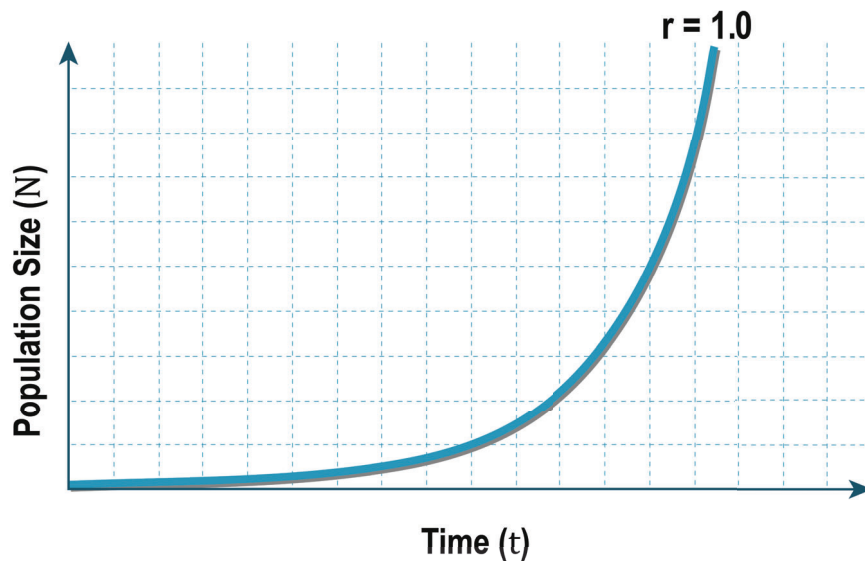


TOPIC: EXPONENTIAL POPULATION GROWTH

Exponential Growth in an Ideal, Unlimited Environment

- ◆ If the *per capita* population growth rate (r) is *positive & constant*, the population will grow _____.
- ◆ **Exponential Growth:** uninhibited population growth, increasing _____ with population size.
 - Therefore, as population size (N) increases, population growth rate ($\frac{\Delta N}{\Delta t}$) continuously _____.
 - *Impossible* in nature for long periods because resources are _____.



Exponential growth produces an ___-shaped curve.

EXAMPLE

A population will grow exponentially under which of the following conditions?

- a) Unlimited food.
- b) Unlimited space.
- c) No competition from other species.
- d) No density-dependent factors.

PRACTICE

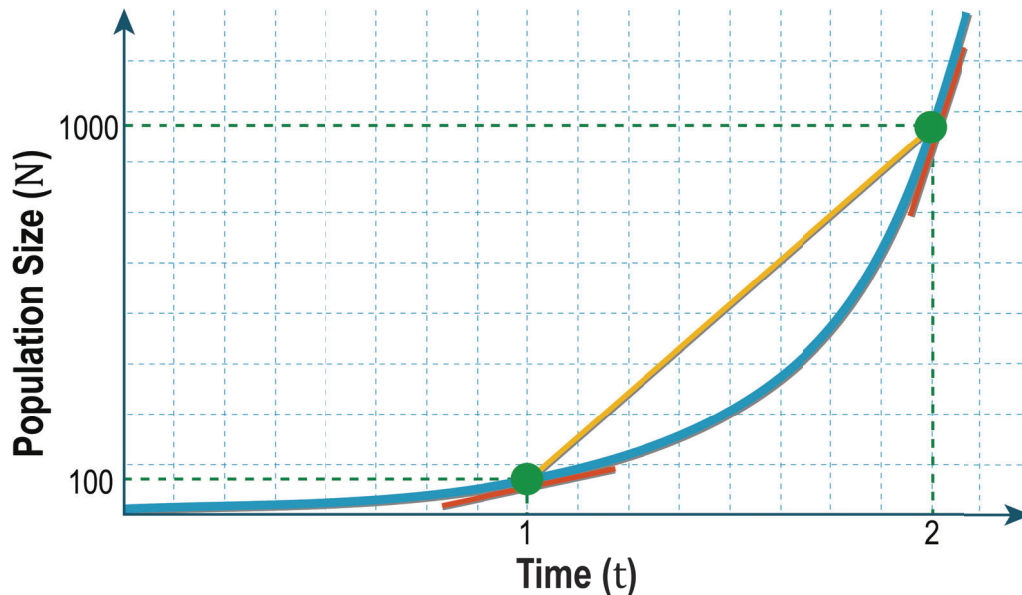
You're studying 2 different populations of the same bacteria in the lab; both in the same unlimited, ideal conditions. Population-A starts with 2,000 individuals, while Population-B starts with 20,000 individuals. Assuming both populations grow exponentially, which population will have a higher population growth rate & why?

- a) Population-A because it has fewer individuals & therefore has more space to grow.
- b) Population-A because populations in ideal environments have a higher growth rate when N is smaller.
- c) Population-B because it can utilize resources more efficiently.
- d) Population-B because with exponential growth, larger populations have a higher growth rate.

TOPIC: EXPONENTIAL POPULATION GROWTH

Exponential Population Growth Equations

◆ These are the equations for exponential growth:



$$N_t = N_0 e^{rt}$$

Describes the exponential **curve**.

N_t = final population size.

N_0 = initial population size.

$e \approx 2.71828$

r = per capita population growth rate.

t = elapsed time.

$$\frac{dN}{dt} = rN$$

Describes slope of **line tangent** to any **single point** on **curve**.

$\frac{dN}{dt}$ = instantaneous population growth rate at any time instant.

r = per capita population growth rate.

N = population size at that time instant.

$$\frac{\Delta N}{\Delta t} = r_{\Delta t} N$$

Describes slope of **line** connecting any **2 points** on **curve**.

$\frac{\Delta N}{\Delta t}$ = average population growth rate over a discrete time interval.

$r_{\Delta t}$ = *apparent* per capita population growth rate in that time interval.

N = initial population size.

NOTE: r is assumed _____ in the exponential growth model.

TOPIC: EXPONENTIAL POPULATION GROWTH

EXAMPLE

PART 1: Calculate the population size at $t = 3$ years using the initial population size of 100 and a constant per capita population growth rate (r) of 2.303 individuals per year per individual.

PART 2: Given the slope of the line between two points (1, 100) and (2, 1000) on an exponential growth curve described by the equation, calculate the average per capita growth rate ($r_{\Delta t}$) between $t = 1$ and $t = 2$.

PART 3: Given the slopes of the lines tangent to the exponential growth curves at the points (1, 100) and (2, 1000), which are described by the equation $dN/dt = rN$, calculate the instantaneous population growth rate at $t = 1$ and $t = 2$.

TOPIC: EXPONENTIAL POPULATION GROWTH

PRACTICE

If a bacterial population starts with 100 cells and has a per capita population growth rate (r) of 0.1 cells per hour per cell, what would be the population size after 5 hours?

- a) 165 individuals.
- b) 111 individuals.
- c) 272 individuals.
- d) 150 individuals.

PRACTICE

Imagine a regional population of Atlantic Bluefin Tuna has an annual intrinsic growth rate (r) of 0.45. Their population (N) at the beginning of year 1 is 1,500. Calculate the regional population of Atlantic Bluefin Tuna at the end of year 1.

- a) 2,175 Tuna.
- b) 4,077 Tuna.
- c) 1,835 Tuna.
- d) 2,352 Tuna.



TOPIC: EXPONENTIAL POPULATION GROWTH

PRACTICE

Using the same data as the previous question, calculate the regional population of Atlantic Bluefin Tuna at the end of year 2 & at the end of year 3.

- a) 3,689 Tuna; 5,786 Tuna. c) 3,204 Tuna; 4,056 Tuna.
b) 3,670 Tuna; 5,505 Tuna. d) 4,085 Tuna; 5,963 Tuna.



PRACTICE

A chameleon population (N) in a shrubland in Cyprus has an intrinsic growth rate (r_{max}) of 0.38. You estimate the total population to be 550. Assuming this population has experienced uninhibited exponential growth, what was the chameleon population 3 years ago?

- a) 376 chameleons. c) 176 chameleons.
b) 257 chameleons. d) 202 chameleons.

