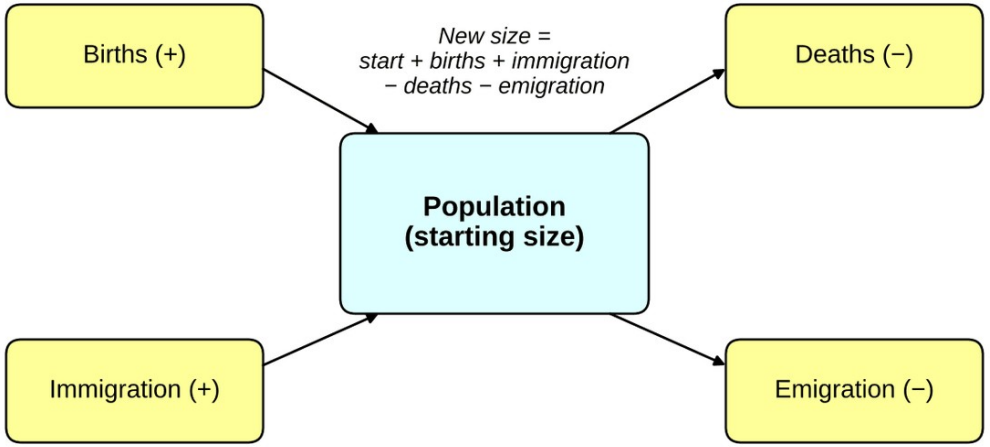
Essential Question

Why do populations stop growing exponentially?

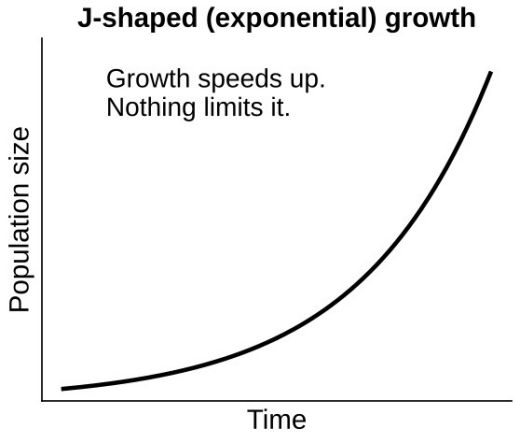
How Populations Change

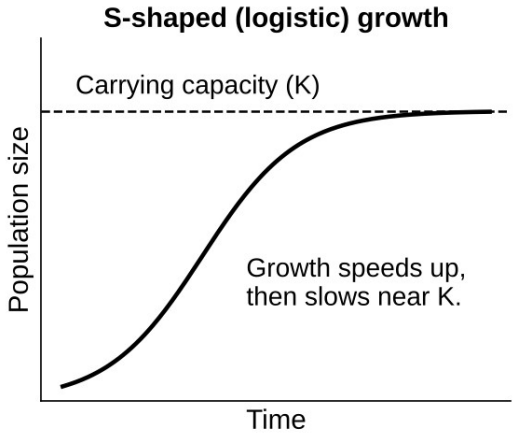
- Births and immigration add individuals
- Deaths and emigration remove individuals
- New size = start + births + immigration − deaths − emigration
- Growth means the population gets larger over time



Exponential Growth

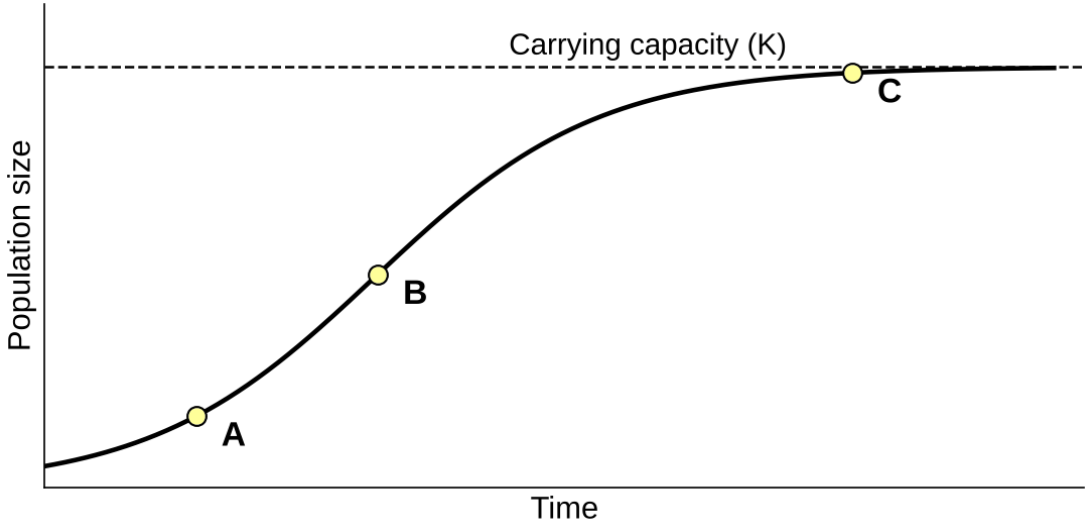
- Each generation adds more individuals than the last
- Growth speeds up over time
- Graph is J-shaped
- Possible only when resources are plentiful and nothing limits growth





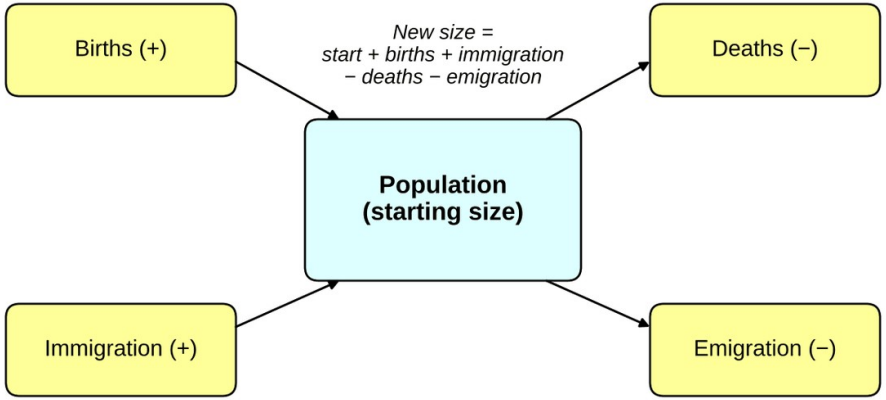
Logistic Growth and Carrying Capacity

- Growth slows as resources become limited
- Graph is S-shaped
- Carrying capacity (K): the largest population an environment can support
- Population levels off near K



Example: Change in a Population

500 mice start the year. 80 are born, 20 move in, 30 die, and 10 move out. Find the new population size and the percent change.

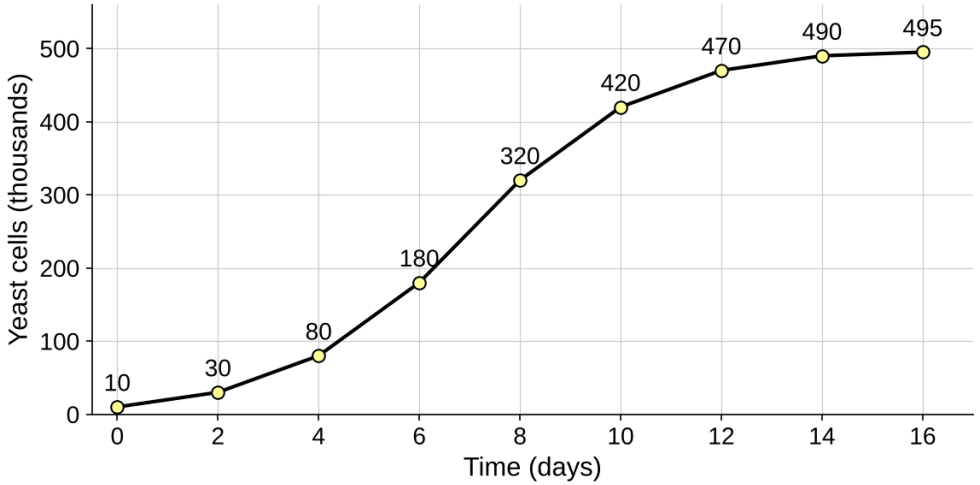


Solution: Change in a Population

- Add what comes in: 80 births + 20 immigrants = 100 mice
- Add what goes out: 30 deaths + 10 emigrants = 40 mice
- New size: 500 + 100 − 40 = 560 mice
- Change: 560 − 500 = 60 mice
- Percent change: 60 mice ÷ 500 mice × 100 = 12%
- Reasoning: more mice were added than removed, so the population grew.

Example: Yeast in a Flask

Yeast grown in a flask with a fixed amount of sugar (sample data). Describe the shape, estimate the carrying capacity, and find the interval of fastest growth.

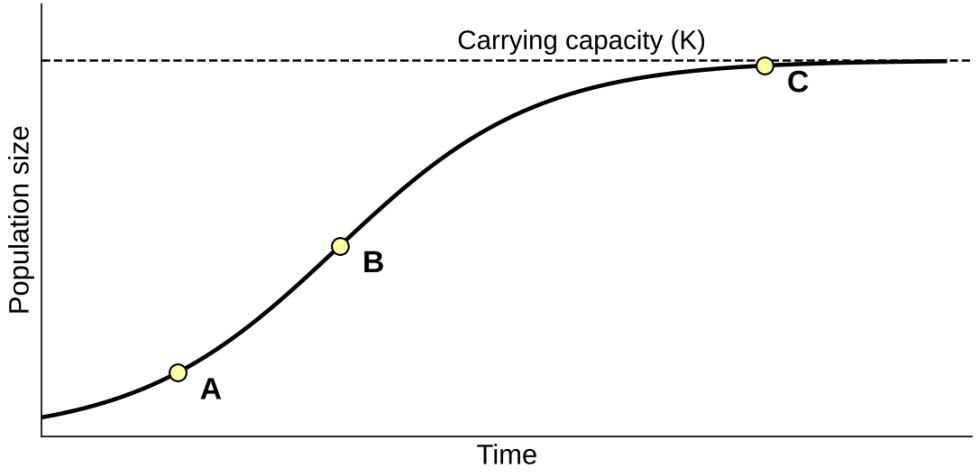


Solution: Yeast in a Flask

- Shape: the graph is S-shaped. It rises slowly, then steeply, then levels off.
- Carrying capacity: the population levels off at about 500 thousand cells, so K is about 500 thousand cells.
- Change in each interval: 20, 50, 100, 140, 100, 50, 20, and 5 thousand cells.
- Fastest growth: 140 thousand cells, between day 6 and day 8.
- Reasoning: as the yeast used up the sugar, growth slowed and the population leveled off near K.

Example: Using the Logistic Model

Logistic growth graph with points A, B, and C. Which point has the fastest growth? Which has the slowest? Why is growth slow at C?



Solution: Using the Logistic Model

- Fastest: point B, where the curve is steepest.
- Slowest: point C, where the curve is nearly flat. (Point A is also slow, but the curve is steeper there than at C.)
- Reasoning: at C the population is near the carrying capacity. Resources are limited, so few offspring survive and the number added is about equal to the number lost.
- Answer: B is fastest and C is slowest. At C the population is near K, where limited resources slow growth.

2.3 Exponential and Logistic Growth

Big Ideas

- Population change = births + immigration − deaths − emigration
- Exponential growth is J-shaped and needs unlimited resources
- Logistic growth is S-shaped and levels off
- Carrying capacity (K) is the largest population the environment can support
- Growth is fastest at the steepest part of the S-curve