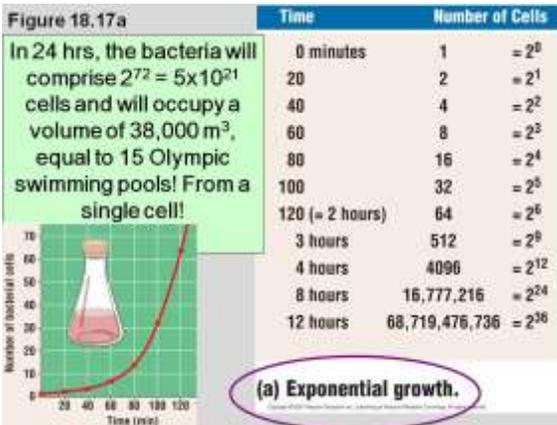


# Population Dynamics

ECOLOGY

## Question of the Day

- In the absence of predators and with infinite resources, a bacteria begins reproducing at time = 0 hours. The bacteria divides every 20 minutes. The bacteria divides every 20 minutes.
- After how long will the bacteria's population reach one million?
  - A. 6 – 8 hours
  - B. 1 – 2 days
  - C. 3 – 4 days
  - D. One week



## New Terms

- Exponential growth (J-curve)
- Logistic growth (S-curve)
- Carrying capacity
- Density dependence / independence
- Intra/interspecific competition

## Why Study Populations?

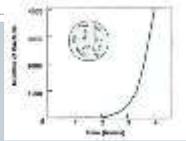
- Studying populations can give us information about:
  - The health of ecosystems
  - Endangered species
  - Invasive species
  - Diseases
  - Human beings
  - Sustainability

## Population Growth Curves

- Represented as the number of individuals over time
- Exponential (J-shaped)
- Logistic (S-shaped)

### J- Shaped Curve: Exponential growth

- Exponential growth: unrestricted population growth
- No predators



In a Petri dish, bacteria grow exponentially until nutrients are depleted.

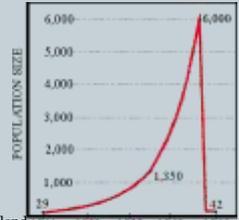


Darwin estimated that a single pair of elephants would become a population of 17 billion in 700 years.

“There is no exception to the rule that every organic being naturally increases at so high a rate, that, if not destroyed, the earth would soon be covered by the progeny of a single pair”. – Charles Darwin

### Exponential Growth Can Result in Population Crash

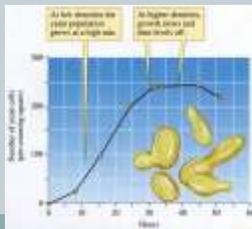
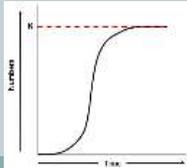
- Explosion in population → exhaustion of local resources
- Can result in local extinction
- The ecosystem *may* recover and the J-curve will repeat



St. Matthew's island reindeer example  
Assumed population of the St. Matthew Island reindeer Herd. Actual counts are indicated on the population curve.

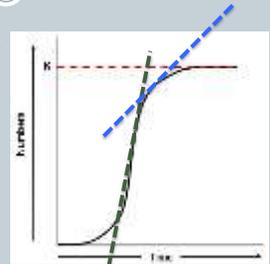
### Logistic Growth (S-Shaped Curve)

- Alternative to spike and crash of J-curve
- Observed in natural ecosystems
- Exponential growth initially, then growth slows and stops



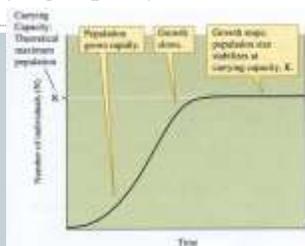
### Understanding the Graph

- Slope = rate of change
- Steeper slope = faster rate of (pop.) change
- More gradual = slower rate of (pop.) change
- No slope = no change
- Logistic growth changes from steep slope to gradual, to no slope at all
- Rapid rate of population change → slow rate of population change → no change at all



### Carrying Capacity

- Eventually growth slows down and stops at the **carrying capacity, K**
- Carrying capacity:** maximum number of individuals that the environment can support

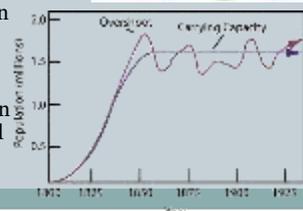
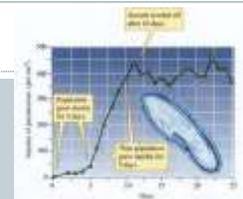


What factors influence carrying capacity?



### Dynamic Balance

- Population may overshoot carrying capacity and then decline as a result
- Results in **dynamic balance:** population fluctuates around a median.
- Births and deaths occur, but population will fluctuate around carrying capacity



### Factors Influencing Carrying Capacity

- Carrying capacity occurs due to:
  - Density-dependent factors
  - Density-independent factors
- Population Density: # of individuals occurring in a given area



### Density Dependence

- **Density dependent factor:** A factor that limits growth, with an effect that increases as population increases.
  - Simplified definition: Fewer organisms survive and reproduce as it gets more crowded.
- **Examples:**
  - Limited resources (food, places to live/nest)
  - Parasites, disease, predators are more effective at high population density



### Density Independent Factor

- Factors that are not effected by population density
- Can affect high density and low density populations equally
- **Examples:**
  - Catastrophic events (severe weather, etc.)
  - Temperature
  - Human activity



### What Causes Equilibrium?

- Population curves reach an equilibrium
  - Some fluctuations, but overall steady population
  - For this to occur, populations must be controlled (unable to grow exponentially) by other factors
  - **Bottom up:**
    - Competition (scarcity of resources)
  - **Top down:**
    - Predation
- NEXT CLASS: competition + predation



### Sticker Question

- What is the carrying capacity for barnacles in the graph below?

