

Chapter 4 Organizer

Population Biology

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 4.1 Population Dynamics National Science Education Standards UCP.1-3; A.1, A.2; C.4, C.5; F.2, F.4, F.5, F.6; G.1, G.2 (3 sessions, 1 block)	<ol style="list-style-type: none"> Compare and contrast exponential and linear population growth. Relate the reproductive patterns of different populations of organisms to models of population growth. Predict effects of environmental factors on population growth. 	MiniLab 4-1: Fruit Fly Population Growth, p. 96 Inside Story: Population Growth, p. 98 Problem-Solving Lab 4-1, p. 99 Investigate BioLab: How can you determine the size of an animal population? p. 108 Chemistry Connection: Polystyrene: Friend or Foe? p. 110
Section 4.2 Human Population Growth National Science Education Standards UCP.1-3; A.1, A.2; C.4, C.5, C.6; F.4, F.5; G.1, G.3 (2 sessions, 1 block)	<ol style="list-style-type: none"> Relate population characteristics to population growth rates. Compare the age structure of rapidly growing, slow-growing, and no-growth countries. Hypothesize about problems that can be caused by immigration and emigration. 	MiniLab 4-2: Doubling Time, p. 105 Problem-Solving Lab 4-2, p. 106

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at <http://www.carolina.com>

MATERIALS LIST

BioLab

p. 108 paper bag, beans (175), magic marker, paper, pencil, calculator (optional)

MiniLabs

p. 96 banana, glass jar, rubber band, fine cloth or wire mesh, paper, pencil
p. 105 paper, pencil, calculator (optional)


Alternative Lab

p. 100 petri dish (2), radish seeds, paper napkins, wax paper, pipette, water, paper, pencil

Quick Demos

p. 101 overhead projector, cardboard, checkers
p. 106 none

Key to Teaching Strategies

- L1** Level 1 activities should be appropriate for students with learning difficulties.
- L2** Level 2 activities should be within the ability range of all students.
- L3** Level 3 activities are designed for above-average students.
- ELL** ELL activities should be within the ability range of English Language Learners.
- COOP LEARN** Cooperative Learning activities are designed for small group work.
- P** These strategies represent student products that can be placed into a best-work portfolio.
-  These strategies are useful in a block scheduling format.

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 4.1 Population Dynamics	Reinforcement and Study Guide, pp. 15-16 L2 Concept Mapping, p. 4 L3 ELL Critical Thinking/Problem Solving, p. 4 L3 BioLab and MiniLab Worksheets, p. 17 L2 Laboratory Manual, pp. 23-30 L2 Content Mastery, pp. 17-18, 20 L1	Section Focus Transparency 8 L1 ELL Reteaching Skills Transparency 6 L1 ELL
Section 4.2 Human Population Growth	Reinforcement and Study Guide, pp. 17-18 L2 BioLab and MiniLab Worksheets, pp. 18-20 L1 Content Mastery, pp. 17, 19-20 L1	Section Focus Transparency 9 L1 ELL
Assessment Resources		Additional Resources
Chapter Assessment, pp. 19-24 MindLogger Videoquizzes Performance Assessment in the Biology Classroom Alternate Assessment in the Science Classroom Computer Test Bank L1 BDOL Interactive CD-ROM, Chapter 4 quiz		Spanish Resources ELL English/Spanish Audiocassettes ELL Cooperative Learning in the Science Classroom COOP LEARN Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC

Teacher's Corner

Products Available From Glencoe
 To order the following products, call Glencoe at 1-800-334-7344:
Videodisc
 GTV: Planetary Manager

Index to National Geographic Magazine
 The following articles may be used for research relating to this chapter.
 "Feeding the Planet," by T. R. Reid, October 1998.
 "Human Migration," by Michael



Parfit, October 1998.
 "Population," by Joel L. Swerdlow, October 1998.
 "Making Sense of the Millennium," by Joel L. Swerdlow, January 1998.
 "The World's Food Supply at Risk," by Robert E. Rhoades, April 1991.
 "Beyond Supermouse: Changing Life's Genetic Blueprint," by Robert F. Weaver, December 1984.
 "World's Urban Explosion," by Robert W. Fox, August 1984.


GLENCOE TECHNOLOGY




The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life
 CD-ROM **ELL**

 BioQuest: *Antarctic Food Web*
 Animation: *Carrying Capacity*

Videodisc Program 
 *Carrying Capacity*

The Infinite Voyage
 *The Keepers of Eden*

The Secret of Life Series
 *Competition*
 *Predator-Prey*
 *Gone Before You Know It: The Biodiversity Crisis*

4 Population Biology

GETTING STARTED DEMO

Logical-Mathematical Have the class calculate and graph the growth of a population of 10 bacteria that doubles every two hours. Help them visualize the growth by using poker chips for the first five two-hour periods. Every two hours, the numbers double: 10, 20, 40, 80, 160, 320, 640, 1280, 2560, 5120, 10 240, to 20 480. Ask students to explain why bacteria don't take over the world. *They run out of food, space, or other needs.* Discuss the walrus shown in the photograph, and ask why their population doesn't grow as quickly. *They have fewer offspring less often.* Ask what problems people experience as a result of population growth. Establish that crowding makes life more stressful and can spread disease.

Theme Development

The theme of **systems and interactions** is illustrated as changes in populations (the system) result from interactions occurring within the population.

0:00 OUT OF TIME?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Resource Manager

Section Focus Transparency 8 and Master **LI ELL**

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.



Kinesthetic Project, p. 96



Linguistic Biology Journal, pp. 97, 99; Portfolio, p. 104; Activity, p. 107



Visual-Spatial Project, p. 98; Portfolio, p. 98; Meeting Individual Needs, p. 102



Logical-Mathematical Enrichment, p. 97; Activity, p. 103; Tech Prep, p. 104

What You'll Learn

- You will explain how populations grow.
- You will identify factors that inhibit the growth of populations.
- You will summarize forces behind and issues in human population growth.

Why It's Important

How a population grows is critical to its niche. A population that becomes too large too quickly may run out of food and space, and diseases spread more easily through large populations; a population that grows too slowly may become extinct.

GETTING STARTED

Population Plot

Assume you started with ten bacteria, and the population doubled every two hours. Chart the growth of this bacterial colony over a 24-hour period. *How has the population size changed?*

interNET CONNECTION To find out more about population biology, visit the Glencoe Science Web Site. www.glencoe.com/sec/science



The walrus (*Odobenus rosmarus*) in this large group make up one population.

Section

4.1 Population Dynamics

Weeds! You've probably observed a scene like this before. What was recently a clean, grass-filled lawn is now crowded with hundreds, perhaps thousands, of bright yellow dandelions. Why do these plants appear so quickly and in such large numbers? Each season a dandelion plant produces hundreds of seeds. In contrast, the lion produces only two to four cubs when it successfully mates. Despite the different reproductive modes, dandelion populations and lion populations have lived in their habitats for thousands of years.



Dandelions (above) and a lioness with cub (inset)

Principles of Population Growth

How and why do populations grow? Population growth is defined as an increase in the size of a population over time. Scientists use a variety of methods to investigate population growth in organisms, as shown in **Figure 4.1**. One method involves placing microorganisms, such as bacteria or yeast cells, into a tube or bottle of nutrient solution and observing how rapidly the population grows. Another method involves introducing

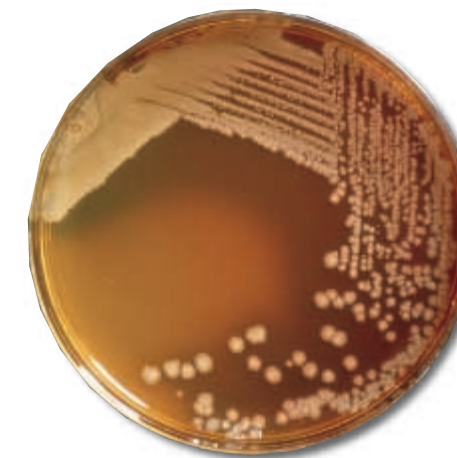


Figure 4.1 Ecologists can study population growth by inoculating a petri dish containing a nutrient medium with a few organisms and watching their growth.

SECTION PREVIEW

Objectives

Compare and contrast exponential and linear population growth.

Relate the reproductive patterns of different populations of organisms to models of population growth.

Predict effects of environmental factors on population growth.

Vocabulary

exponential growth
carrying capacity
density-dependent factor
density-independent factor

Section 4.1

Prepare

Key Concepts

Population growth is the increase in population size over time. Students learn that population growth, while exponential at times, is controlled by limiting factors that determine the carrying capacity of the environment. Such limits to population growth may result from predator-prey interactions or overcrowding.

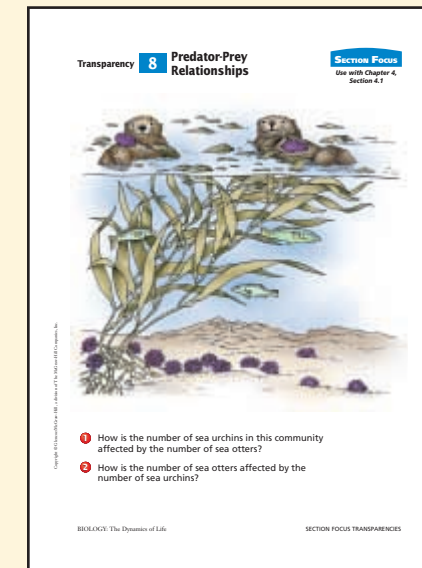
Planning

- Purchase bananas and gather jars and mesh for MiniLab 4-1.
- Purchase radish seeds. Gather petri dishes and napkins for the Alternative Lab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 8** on the overhead projector and have the students answer the accompanying questions. **LI ELL**



Assessment Planner

Portfolio Assessment

Portfolio, TWE, pp. 98, 104
Problem-Solving Lab, TWE, p. 99
Assessment, TWE, p. 103
MiniLab, TWE, p. 105

Performance Assessment

MiniLab, SE, pp. 96, 105
Assessment, TWE, pp. 100, 107
Alternative Lab, TWE, pp. 100-101
BioLab, SE, p. 109

Knowledge Assessment

Section Assessment, SE, pp. 103, 107
Problem-Solving Lab, TWE, p. 106
Chapter Assessment, SE, pp. 111-113

Skill Assessment

MiniLab, TWE, p. 96
Assessment, TWE, pp. 102, 105
BioLab, TWE, p. 109

2 Teach

MiniLab 4-1

Purpose

Students will learn that food is a factor in population growth.

Process Skills

observe and infer, interpret data

Safety Precautions

Have students wash their hands after each observation.

Teaching Strategies

■ If temperatures are warm enough, fruit flies should be attracted quickly to the bananas.

■ You can order wingless fruit flies from a biological supply company.

■ Have students record their data and observations in a table.

Expected results

Fruit flies will arrive and quickly reproduce. Larvae will be evident on the jar and the banana. In a few weeks, the jar will be full of flies. Soon the population will decline because the food supply is limited.

Analysis

- Answers will vary.
- lack of food due to overcrowding
- The population quickly increased and then quickly decreased.

Assessment

Skill Have students describe how they could determine whether food type affects the type of animal attracted. Use the Performance Task Assessment List for Designing an Experiment in PASC, p. 23. **L2**

MiniLab 4-1 Making and Using Tables

Fruit Fly Population Growth Fruit flies (*Drosophila melanogaster*) and similar insects have rapid rates of reproduction. Fruit flies are frequently used in biological research because they reproduce quickly and are easy to keep and count. In this activity you will observe the growth of a fruit fly population as it exploits a food supply.



Procedure

- Place half of a banana in a jar and allow it to sit outside in a warm shaded area, or put it in a warm area in your classroom.
- Leave the jar for one day or until you have at least three fruit flies in it. Put the mesh on top of the jar and fasten with the rubber band.
- Each day record how many adult fruit flies are alive in the jar. Record for at least three weeks. Put your data into table form. **CAUTION: Return the fruit flies to your teacher for proper disposal.**

Analysis

- How many fruit flies did you start with? On what day were there the most fruit flies? How many were there?
- Why did the number of fruit flies decrease?
- Based on this investigation, why are insects considered to display a rapid reproduction pattern?

a plant or animal species into a new environment that contains abundant resources and then observing the population growth of that species.

Use the *MiniLab* on this page to demonstrate this method of measuring population growth. Through studies such as these, scientists have identified clear patterns showing how and why populations grow.

How fast do populations grow?

What's interesting about the growth of populations is that it is unlike the growth of some other familiar things. Consider, for example, the growth of a weekly paycheck for an after-school job. Suppose you are working for a company that pays you \$5 per hour. You know if you work for two hours, you will be paid \$10; if you work for four hours, you will be paid \$20; if you work for eight hours, you will be paid \$40; and so on. When you plot this rate of increase on a graph, as shown in *Figure 4.2*, you can see that the result is a steady, linear increase; that is, growth occurs in a straight line when graphed.

Populations of organisms do not experience this linear growth. Rather, the resulting graph of a growing population first resembles a J-shaped curve. Whether the population is one

of weeds in a field, frogs in a pond, or humans in a city, the initial increase in the number of organisms is slow because the number of reproducing organisms is small. Soon, however, the rate of population growth increases rapidly because the total number of potentially reproducing organisms increases. This pattern illustrates the exponential nature of population growth. **Exponential growth** means that as a population gets larger, it also grows faster. Exponential growth, as illustrated in *Figure 4.3*, results in a population explosion.

Limits of the environment

Can a population of organisms grow indefinitely? What prevents the world from being overrun with all kinds of living things? Through population experiments, scientists have found that, fortunately, population growth does have limits. Eventually, limiting factors, such as availability of food and space, will cause a population to stop increasing. In time, this leveling-off of population size results in an S-shaped growth curve.

The number of organisms of one species that an environment can support is its **carrying capacity**. When populations are under the carrying capacity of a particular environment, births exceed deaths until the carrying capacity is reached. If the population temporarily overshoots the carrying capacity, deaths exceed births until population levels are once again below carrying capacity. Thus, the number of organisms in a population is sometimes more than the carrying capacity and sometimes less. Learn how to determine population size by completing the *BioLab* at the end of this chapter. When the population falls below the carrying capacity, the population tends to increase; when it is above the carrying capacity, the

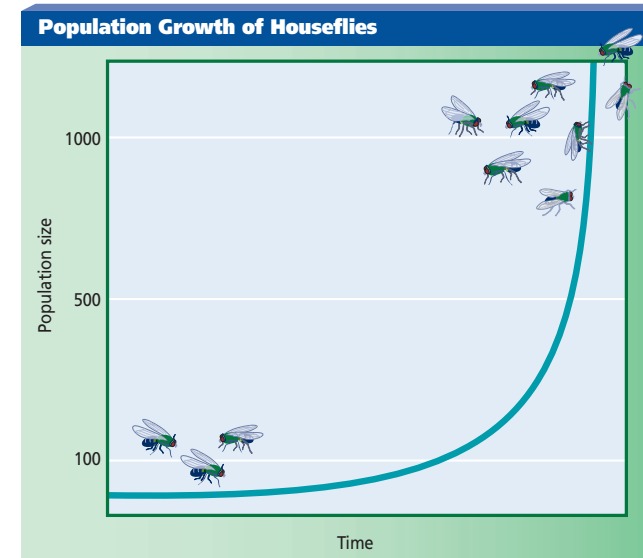


Figure 4.3 Because they grow exponentially, populations such as houseflies have the potential for explosive growth.

population tends to decrease. Do all populations follow the same growth pattern? Find out in the *Inside Story* on the next page.

Patterns of population growth

In nature, many animal and plant populations change in size. Why, for example, does it seem like mosquitoes are more numerous at certain times of the year? Why don't populations reach carrying capacity and become stable? To answer these questions, population biologists study the most important factor that determines population growth—an organism's reproductive pattern.

A range of population growth patterns are possible in nature. The two extremes of this range are demonstrated by the population growth rates of both mosquitoes and elephants. Mosquitoes reproduce very rapidly and produce many offspring in a short period of time. Elephants have a slow rate of reproduction and produce relatively few young over their lifetimes. What causes species to have different life-history patterns?

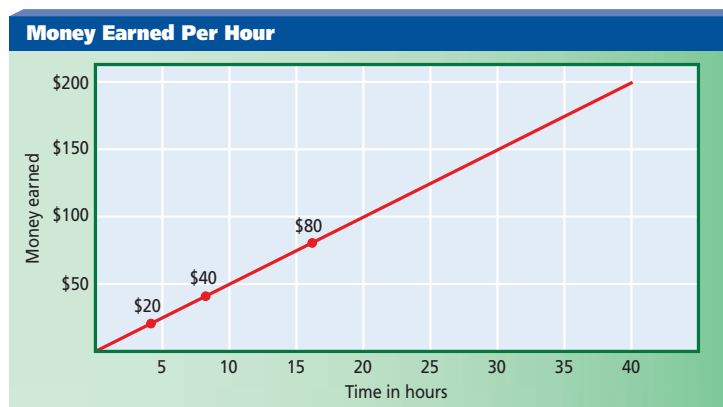


Figure 4.2 The way you earn money at an hourly rate is a straight line graph. Other examples might include the growth of your weekly allowance or the number of cars produced by an assembly line each month.

Reinforcement

Explain that while linear growth may be shown by height increases in children, it does not reflect the growth pattern of most populations.

Chalkboard Example

Graph two lines onto the same axis using different colors of chalk. Have one line show linear growth, and the other line show exponential growth. Ask students to describe how the patterns differ. Point out that when the curves begin, differences are smaller than at the end points.

Enrichment

Logical-Mathematical Have students make the calculations needed to decide if they would rather be paid a linear salary of \$5.00 per hour for a 40-hour week or an exponential salary that starts at 1 cent the first hour and doubles each hour up to 40 hours. *The exponential salary will exceed the linear salary many times over.* **L2**

The BioLab at the end of the chapter can be used at this point in the lesson.



GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Carrying Capacity*
Disc 1

VIDEODISC
Biology: The Dynamics of Life
Carrying Capacity (Ch. 13)
Disc 1, Side 1
17 sec.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
BioQuest: *Antarctic Food Web*,
Disc 1

MEETING INDIVIDUAL NEEDS

Learning Disabled

Review the proper construction of a graph with students and/or refer them to the **Skill Handbook**. Assign students to cooperative groups of mixed ability levels. Have them prepare graphs from data that you supply to illustrate linear and exponential changes. **L1**

PROJECT

Fruit Fly Demographics

Kinesthetic Fruit flies are easy to maintain in captivity. Allow students to carry out an experiment that will compare a population of fruit flies kept in balance with their environment with one not kept in balance. Students will first have to determine how this balance will be maintained. **L3**

BIOLOGY JOURNAL

Evaluating Population Growth

Linguistic Have students write a scenario that depicts what life in the United States might be like if the population doubled. Have them consider available recreational space, demands made on natural resources, and food and housing needs. **L2**

Resource Manager

BioLab and MiniLab Worksheets,
p. 17 **L2**
Laboratory Manual, pp. 23-30 **L2**

Purpose

Students study the general pattern of population growth in stable environments.

Teaching Strategies

■ Have students write a one-paragraph summary of how a population grows, including why the population levels off. **L1**

■ Have students become one of the original animals in a population that grows quickly. Ask them to write a fictional account of what happens from the animal's perspective.

■ The Project Wild simulation "Oh, Deer!" is an excellent method of simulating that fluctuations above and below the carrying capacity are normal.

■ Give each group of students a die. For time period 1, they roll the die and record the number that shows up as a population size. Do the same for time period 2, 3, all the way to 10. On the *x*-axis, plot the time periods 1 to 10. On the *y*-axis, plot the population size. Have them find the average population size for the 10 time periods and draw a straight line to reflect this average. Relate this line to carrying capacity.

Critical Thinking

The population begins exponential growth. This resembles the letter **J**. Eventually growth slows down and the population levels off. After it levels off, it fluctuates above and below the carrying capacity.

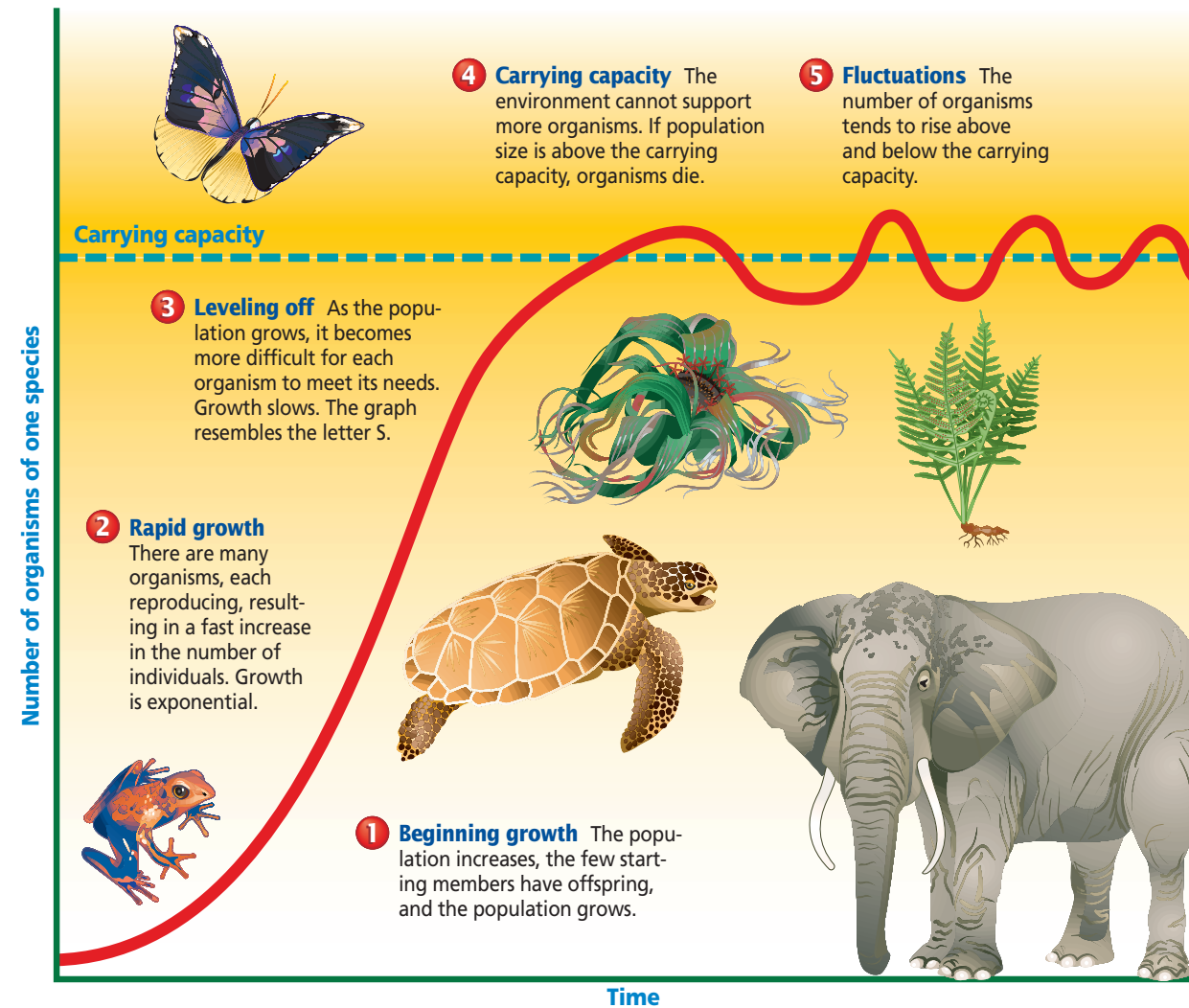
Population Growth

When organisms are in an optimal environment, they flourish. From a few pioneers, the population increases. Ecologists have discovered that these population increases show a pattern. Whether it is a plant or animal, whether on land or in the ocean, populations grow in predictable manners.

Critical Thinking Why does the population fluctuate once it reaches carrying capacity?



Humpback whales have a long life-history, living up to thirty years.



The kind of reproductive pattern a species has depends mainly on environmental conditions. For example, species such as mosquitoes are successful in environments that are unpredictable and change rapidly. Rapid life-history patterns are found in organisms from unpredictable environments. Typically, these organisms have a small body size, mature rapidly, reproduce early, and have a short life span. Populations of these organisms increase rapidly, then decline rapidly as environmental conditions suddenly change and become unsuitable. The small surviving population will begin reproducing exponentially when conditions are again favorable. The *Problem-Solving Lab* on this page will allow you to observe an organism with this type of a life-history pattern, bacteria.

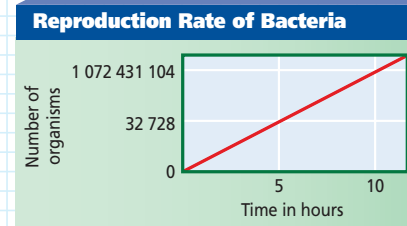
Species that live in more stable environments, such as elephants, often have a different life-history pattern. Elephants, humans, bears, whales, and long-lived plants, such as cacti and bristlecone pine shown in *Figure 4.4*, are large, reproduce and mature slowly, and are long-lived. These organisms maintain population sizes near the carrying capacities of their environments.

Although populations could display a variety of life-histories, under

Problem-Solving Lab 4-1 Predicting

How rapidly can bacteria reproduce? The faster an organism reproduces, the quicker you can see population increases. Bacteria are examples of rapidly reproducing organisms.

Thus, they are often used in experiments that deal with population studies or trends.



Analysis

Here are some facts regarding unchecked bacterial reproduction:

1. A single bacterium can reproduce to yield two bacteria under ideal conditions every 20 minutes.
2. Ideal conditions for bacterial reproduction include proper temperature, unlimited food, space to grow, and dispersion of waste materials.

Thinking Critically

1. Suppose you start with one bacterium under ideal conditions. If no bacteria die, compute the number of bacteria present after 1 hour, 5 hours, and 10 hours.
2. What environmental factors might affect a bacterial population's reproduction?
3. The above graph is an example of one group's data:
 - a. What error did they make in the *y*-axis of the graph?
 - b. Redraw the graph correctly.
4. An elephant reproduces once every four to six years. Why are elephants not likely to be used in laboratory population studies?



Figure 4.4 This bristlecone pine is an example of a long-lived species with a slow life-history pattern.

Problem-Solving Lab 4-1

Purpose

Students will calculate the change in number of individuals present in a bacterial population.

Process Skills

calculate, think critically, predict, apply concepts, make and use graphs, organize data

Teaching Strategies

■ Allow students to use calculators.

■ Suggest that they prepare their own data table to record the number of bacteria present during each time period.

Example:

Time (in minutes)	Number Present
0	1
20	2
40	4
60 (1 hour)	8
80	16

Thinking Critically

1. 8; 32 728; 1 072 431 104
2. Answers may include temperature, light, and pollution.
3. a. The *y*-axis is not properly scaled.
b. Check students' graphs for accuracy.
4. Answers may include the long time period between generations and the size of the animals.

Assessment

Portfolio Ask students to write a paragraph for their portfolios, evaluating the use of yeast, mice, and primates in population studies. Use the Performance Task Assessment List for Writing in Science in PASC, p. 87. **L3 P**

PROJECT

Population Growth in Pictures

Visual-Spatial Have students create flipbooks that show population growth. Draw scenes on the right sides of index cards. On the first cards, show a few organisms, then exponential growth. Show competition for resources. Then show a constant population size. A line on a graph can advance in each scene. **L1 ELL**

Portfolio

Interpreting Graphs

Visual-Spatial Ask students to draw an S-shaped curve. Have them identify the following: slow growth phase, exponential growth phase, plateau, point where carrying capacity (*K*) is reached. Ask how this graph might change with a sudden increase or decrease in food supply. **L2 P**

BIOLOGY JOURNAL

Life as a Mosquito

Linguistic Have students imagine they are breeding mosquitoes. Tell them to describe the conditions that make their environment unpredictable and subject to rapid change. Students will have to research life stages and breeding habits of mosquitoes to complete this task. **L2**

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage: The Keepers of Eden, Extinction and the National Zoo's Tamarin Monkey Project (Ch. 4) 13 min. 30 sec.
The Cheetah: Using DNA Profiles to Research Reproduction (Ch. 5) 9 min.

Resource Manager

Reteaching Skills Transparency 6 and Master **L1 ELL**

Revealing Misconceptions

Exponential growth may be misunderstood. Some students may think that (1) the growth rate must be very fast and (2) the growth rate increases. Use this analogy to help. You put \$100 in the bank and get 10% interest a year. How much will you have after the first five years? \$110, \$121, \$133, \$146, \$161

The big idea is that although the account grows only at a slow and constant 10% a year, growth builds upon growth. This is what exponential growth is all about.

Revealing Misconceptions

Help students realize that most organisms fall in a continuum between rapid life-histories and slow life-histories. These are the extremes of the scale.

Assessment

Performance Assessment in the Biology Classroom, p. 53, *Estimating Populations*. Have students carry out the activity to show their knowledge of how population size is determined. **L2**

NATIONAL GEOGRAPHIC

VIDEODISC
GTV: Planetary Manager
Agriculture, Side 2



Figure 4.5 Wild mustard plants taking over an abandoned field represent a species with a rapid life-history pattern (a). Organisms that have a slow life-history pattern, such as these Canada geese, provide much parental care for their young in order to ensure species survival (b).



uncrowded conditions, such as the pioneer stage in succession, rapid population growth seems to be most common. **Figure 4.5** shows organisms that represent both extremes in life-history patterns. Which of these organisms would be most successful in a rapidly changing environment?

Environmental limits to population growth

Limiting factors, you may remember, include biotic or abiotic factors that determine whether or not an organism can live in a particular environment. Limiting factors also regulate the size of a population. Limited food supply, extreme temperatures, and even storms can affect population size. Ecologists have identified two kinds of limiting factors: density-dependent and density-independent factors.

Density-dependent factors include disease, competition, parasites, and food. These have an increasing effect as the population increases. Disease, for example, spreads more quickly in a population with members that live close together, as indicated in **Figure 4.6**, than in smaller populations with members that live farther apart. In very dense populations, disease may quickly wipe out an entire population. In crops such as corn or soybeans in which large numbers of the same plant are grown together, a disease can spread rapidly throughout the

Figure 4.6 Corn smut is a fungus that produces large, deformed growths on the ears of corn. To prevent it from spreading through a cornfield, affected plants must be burned or buried before the fungus reproduces.



whole crop. In less dense populations, fewer individuals may be affected.

Density-independent factors affect all populations, regardless of their density. Most density-independent factors are abiotic factors, such as temperature, storms, floods, drought, and habitat disruption, shown in **Figure 4.7**. No matter how many earthworms live in a field, they will drown in a flood. It doesn't matter if there are many or few mosquitoes; a cold winter will kill them. Another example of a density-independent factor is pollution. How does pollution affect a habitat? Find out in the *Chemistry Connection* at the end of this chapter.

Organism Interactions Limit Population Size

Population sizes are limited not only by abiotic factors, but also are controlled by various interactions among organisms that share a community.

Predation affects population size

A barn owl kills and eats a mouse. A swarm of locusts eats and destroys acres of lettuce on a farm. When the brown tree snake was introduced in Guam, an island in the South Pacific, it wiped out most of the birds on the island. These examples demonstrate how predation can affect population sizes in both minor and major ways. When a predator consumes prey, it can affect the population size of the prey population. For this reason, predation may be a limiting factor of population size.

Populations of predators and prey experience changes in their numbers over a period of years. Predator-prey relationships often show a cycle of population increases and decreases over time. One classic example of this has been demonstrated by graphing 90 years of data concerning the populations of the Canadian lynx and the snowshoe hare. A member of the cat family, the lynx stalks, attacks,



Figure 4.7 Populations are affected by both density-dependent and density-independent factors.

A Hurricane Mitch, which hit south Florida in 1998, did extensive damage to both heavily populated areas and less populated ones. Catastrophic weather patterns are density-independent factors.

B As a population of foxes increases, competition for the available food also increases. Food becomes a density-dependent factor and population growth slows.

Alternative Lab

Germinating Radishes

Purpose

Students will study the percent of germination of radish seeds.

Safety Precautions

Have students wash their hands after handling the seeds.

Materials per group

two petri dishes, radish seeds, napkins, pipette

Procedure

Model the method of germination: Cut a napkin into two circles that will fit into a petri dish. Place one circle into the dish, put some seeds on top, and place the other circle on top of the seeds. Add a pipette or two of water. Cover the dish. Then give students these instructions

1. With your group, choose one variable to

change, such as the amount or type of solution used for watering. You could also investigate the effects of heat, light, or music.

2. Complete this problem statement: What is the effect of _____ on the germination of a radish seed? Write a hypothesis to answer this question.
3. Write out your procedures before starting. Plan for a control and an experimental group.

4. Set up your experiments and wait 48 hours. Then report your results. Was your hypothesis correct?

Analysis

1. Why do plants produce so many seeds? *Not all seeds germinate.*
2. Was your variable a biotic or abiotic factor? *Most will be abiotic factors.*
3. What was your conclusion for your experiment? *Answers will vary.*

Assessment

Performance Have students write a lab report describing the procedure they followed and their conclusions. Use the Performance Task Assessment List for Lab Report in **PASC**, p. 47. **L1**

Quick Demo

Cut out a cardboard frame that is a little smaller than the size of the glass of the overhead projector. Put three checkers into the frame. Move the frame and cause the checkers to move about. Stop. If any checkers are within one cm of another, they die. Repeat, adding more checkers. Students will realize that the more crowded it gets, the greater the number of checkers that die. Have them relate this to density-dependent factors.

Visual Learning

Ask students to study **Figure 4.7B** and explain what will happen to prey populations of mice and rabbits as the predator fox population increases. *The rabbit and mice populations will decline.*

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Competition



Predator-Prey



Resource Manager

Critical Thinking/Problem Solving 4, p. 4 **L3**
Concept Mapping, p. 4 **L3**

ELL

Tying to Previous Knowledge

Explain how the decrease in available energy at the top trophic level of a food chain serves as a limiting factor on predator population size.

Visual Learning

Ask students to study the graph in Figure 4.8 and identify the point at which the numbers of snowshoe hare and lynx began to increase. Have them also indicate where decreasing numbers occur. Use the graph to point out the cyclic nature of these events. Elicit from students why these events are cyclic.

Assessment

Skill Have students examine Figure 4.8 and answer these questions: In what approximate year were there the most hares? 1865 In what year were there the most lynxes? 1935 After the hare population spikes, how many years pass until it crashes? *approximately 5 years*

3 Assess

Check for Understanding

Ask students to explain the difference between the words in each of the following pairs. **L1 ELL**

- linear growth—exponential growth
- carrying capacity—population size
- density-dependent factors—density-independent factors
- predation—competition

and eats the snowshoe hare as a primary source of food.

The data in **Figure 4.8** show the lynx and hare populations rise and fall almost together. When the hare population increases, there is more food for the lynx population, and the lynx population increases. When the lynx population rises, predation on the hares increases, and the hare population decreases. With fewer hares available for food, the lynx population also declines. With fewer predators, the hare population increases, and the cycle continues. This example shows how predator populations affect the size of the prey populations. At the same time, prey populations affect the size of the predator populations. As the snowshoe hare's food supply of grasses and herbs dwindles during the fall and winter months, the hare population decreases. Because there are now fewer hares to hunt, the lynx population also decreases. With the return of spring, the hare's food supply and

its population recover. This leads to more hares, allowing the lynx population to increase as well.

Predator-prey relationships are important for the health of natural populations. Usually, in prey populations, the young, old, or injured members are caught. Predation helps improve the odds that there will be sufficient resources for the healthiest individuals in a population.

The effects of competition

Organisms within a population constantly compete for resources. When population numbers are low, resources are plentiful. However, as population size increases, competition for resources such as food, water, and territory can become fierce. Competition is a density-dependent factor. When only a few individuals compete for resources, no problem arises. When a population increases to the point at which demand for

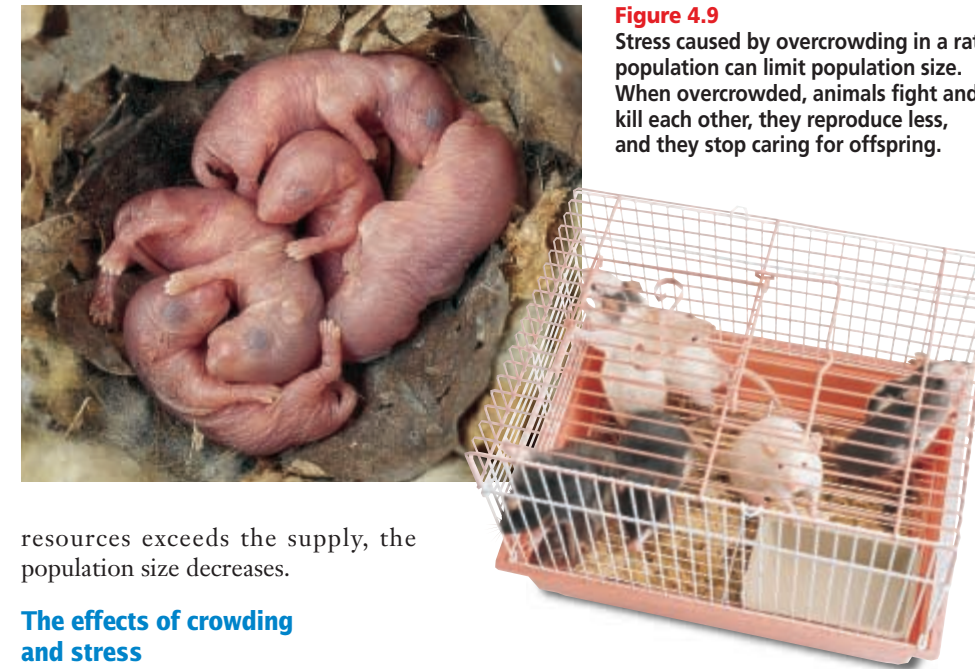


Figure 4.9 Stress caused by overcrowding in a rat population can limit population size. When overcrowded, animals fight and kill each other, they reproduce less, and they stop caring for offspring.

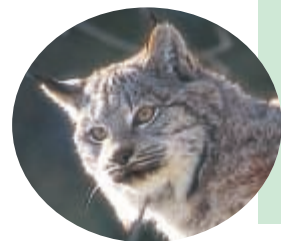
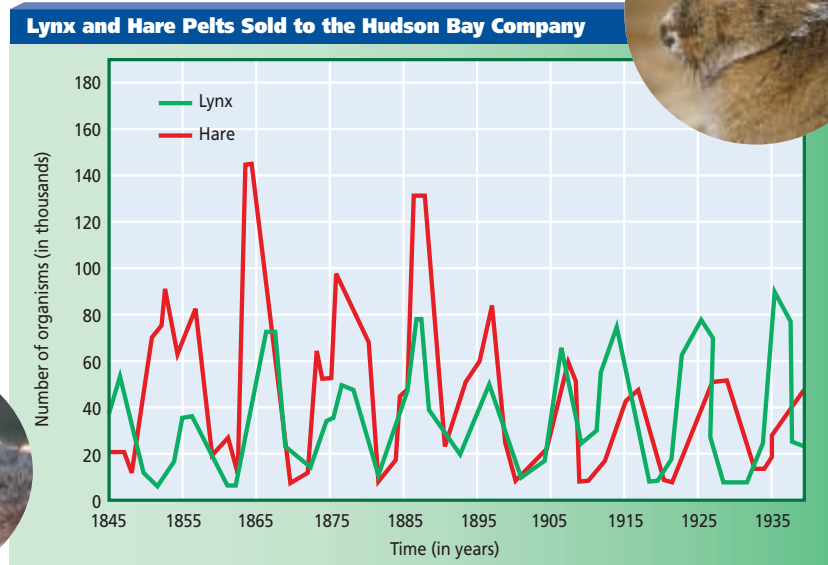
resources exceeds the supply, the population size decreases.

The effects of crowding and stress

When populations of organisms become crowded, individuals may exhibit stress. The factors that create stress are not well understood, but the effects have been documented experimentally in populations of rats and mice, as shown in **Figure 4.9**. As

populations increase in size, individual animals begin to exhibit a variety of symptoms, including aggression, decrease in parental care, decreased fertility, and decreased resistance to disease. All of these symptoms can lead to a decrease in population size.

Figure 4.8 The data in this graph reflect the number of hare and lynx pelts sold to the Hudson Bay Company in northern Canada. Notice that as the number of hares increased, so did the number of lynx.



Section Assessment

Understanding Main Ideas

- How are graphs of exponential growth and linear growth different?
- Explain how short and long life-history patterns differ.
- Describe how density-dependent and density-independent factors regulate population growth.
- How can a density-independent factor, such as a flood, influence carrying capacity?

Thinking Critically

- An organic farmer does not use pesticides on her farm. Instead of growing one crop on her farm, as many farmers do, she grows ten different crops. Explain how this may decrease insect damage to her plants.

SKILL REVIEW

- Making and Using Graphs** Graph the following population growth for the unknown organism shown in **Table 4.1** and state whether the organism has a population growth pattern closer to a rapid or slow life-history pattern. For more help, refer to *Organizing Information* in the **Skill Handbook**.

Year	Spring	Summer	Autumn	Winter
1995	564	14 598	25 762	127
1996	750	16 422	42 511	102
1997	365	14 106	36 562	136

Reteach

Have students provide an example that shows an understanding of the meaning of each vocabulary word in this section. **L1 ELL**

Extension

Have students research the terms *r-strategists* and *K-strategists*. Have them provide characteristics and examples for both groups and correlate this information with what they have studied in this chapter. **L3**

Assessment

Portfolio Have students outline the concepts in this section. **L2**

4 Close

Activity

Logical-Mathematical Ask students to count the potential offspring (the number of seeds) in one green pepper. **Caution:** *Have them wash their hands after handling seeds.* Ask why the world is not covered with green pepper plants. **L2**

Resource Manager

Content Mastery, p. 18 **L1**
Reinforcement and Study Guide, pp. 15-16 **L2**

MEETING INDIVIDUAL NEEDS

Learning Disabled

Visual-Spatial Have students tape the outlines of two squares, measuring 10 cm per side. Ask them to use pennies to illustrate a dense population in one square and a less dense population in the other square. Ask them to predict which population is more vulnerable to disease. *the dense population* **L1**

GLENCOE TECHNOLOGY

VIDEOTAPE
The Secret of Life
Gone Before You Know It: The Biodiversity Crisis

Section Assessment

- Linear growth graphs form a straight line, and exponential graphs form a curved line described as J-shaped.
- Short life-history organisms show a rapid increase and rapid decline caused by their unpredictable environments. Long life-history organisms show a slow population change within stable environments and usually maintain

- sizes near the carrying capacity of the environment.
- Density-dependent factors have an increasing effect as population size increases. Density-independent factors affect a population no matter what its size.
- The flood could damage a habitat, thus lowering its carrying capacity.

- Each kind of insect usually damages specific crops. When a farmer grows ten crops, an infestation of one kind of insect is unlikely to affect all of her crops.
- The graphs should show a rapid life-history pattern. The organism reproduces rapidly and declines rapidly.

Prepare

Key Concepts

Population growth is the increase in population size over time. Students learn that population growth, while exponential at times, is controlled by limiting factors that determine the carrying capacity of the environment. Such limits to population growth may result from predator-prey interactions or overcrowding.

Planning

- Purchase beans, markers, and bags for the BioLab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 9** on the overhead projector and have the students answer the accompanying questions. **L1 ELL**

SECTION PREVIEW

Objectives

Relate population characteristics to population growth rates.

Compare the age structure of rapidly growing, slow-growing, and no-growth countries.

Hypothesize about problems that can be caused by immigration and emigration.

Vocabulary

demography
age structure
immigration
emigration

Section

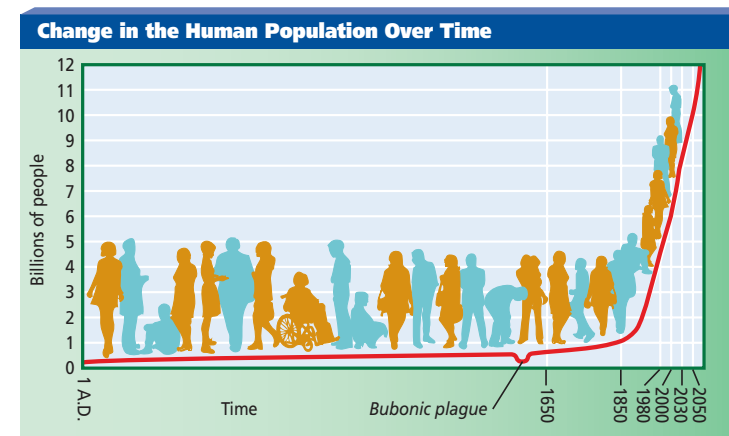
4.2 Human Population Growth

Does Earth have a carrying capacity for the human population? How many people can live on Earth? No one knows how many people Earth can support, and it is presently impossible to tell when the human population will stop growing. However, demographers suggest that food production will not always keep pace with the population increase.



Earth from space

Figure 4.10 Ten thousand years ago, approximately 10 million people inhabited Earth. Today, there are more than 6 billion, and scientists estimate that by the year 2050, there will be more than 10 billion people on Earth.



104 POPULATION BIOLOGY

Demographic Trends

A good way to predict the future of the human population is to look at past population trends. For example, are there observable patterns in the growth of populations? That is, are there any similarities among the population growths of different countries—similarities that might help

scientists predict, and therefore control, future population catastrophes? As you have seen, some populations tend to increase until the environment cannot support any additional growth. **Demography** (dem AH graf ee) is the study of human population growth characteristics. Demographers study such population characteristics as growth rate, age structure, and geographic distribution.

What is the history of population growth for humans? Although local human populations often show fluctuations, the worldwide human population has increased exponentially over the past several hundred years, as shown in **Figure 4.10**. Unlike other organisms, humans are able to reduce environmental effects by eliminating competing organisms, increasing food production, and controlling disease organisms.

Effects of birthrates and death rates

How can you tell if a population is growing? A population's growth rate is the difference between the birthrate and the death rate. One way of calculating a population's growth rate is by calculating its doubling rate. Learn how to calculate doubling rates in the *MiniLab* on this page. In many industrialized countries, such as the United States, declining death rates have a greater effect on total population growth than increasing birthrates. For example, in the United States, life expectancy increases almost every year. This means that you are more likely to live slightly longer than students who are presently in college.

Although people in the United States are living longer, the fertility rate is decreasing. This is because more people are waiting until their thirties to have children. Today's families also have fewer children than they did in previous decades. Fertility rate is the number of offspring a female produces during her reproductive years. When fertility rates are high, populations grow more rapidly unless the death rate is also high. **Table 4.2** shows the birthrate, death rate, and fertility rate of some rapidly

MiniLab 4-2 Using Numbers

Doubling Time The time needed for any population to double its size is known as its "doubling time." For example, if a population grows slowly, its doubling time will be long. If it is growing rapidly, its doubling time will be short.

Procedure

- 1 The following formula is used to calculate a population's doubling time:
$$\text{Doubling time (in years)} = \frac{70}{\text{annual percent growth rate}}$$
- 2 Copy the data table below.
- 3 Complete the table by calculating the doubling time of human populations for the listed geographic regions.

Geographic region	Annual percent growth rate	Doubling time
Africa	2.8	
Latin America	2.2	
Asia	1.9	
North America	0.7	
Europe	0.3	

Analysis

1. Which region has the fastest doubling time? Slowest doubling time?
2. How might this type of information be useful to governments of these regions?
3. What are some of the ecological implications for an area with a fast doubling time?

	Birthrate (per 1000)	Death Rate (per 1000)	Fertility (per woman)	Population increase (percent)
Rapid Growth Countries				
Jordan	38.8	5.5	3.3	3.3
Uganda	50.8	21.8	7.1	2.9
Zimbabwe	34.3	9.4	5.2	2.5
Slow Growth Countries				
Germany	9.4	10.8	1.2	-1.5
Italy	9.4	9.7	1.2	-0.5
Sweden	10.8	10.6	1.5	0.1
North American Countries				
Mexico	27.0	5.2	3.1	2.2
United States	14.8	8.8	2.0	0.6

2 Teach

MiniLab 4-2

Purpose Students will learn the concept of "doubling time" and use a formula to calculate this value.

Process Skills

use numbers, acquire information, analyze information, compare and contrast, predict, recognize cause and effect

Teaching Strategies

- Organize the class into small groups. Place students with poorer math skills with those who are more skilled.
- Allow students to use calculators.
- The value of "70" used in the formula is a constant.

Expected Results

Africa = 25 years, Latin America = 31.8 years, Asia = 36.8 years, N. America = 100 years, Europe = 233 years

Analysis

1. Africa; Europe
2. Answers may vary, but students may mention the planning of roads, homes, and other needed structures.
3. Students may list the high potential for disease, problem with waste disposal, and lack of space.

Assessment

Portfolio Have students prepare a bar graph using their calculated values for doubling time. Use the Performance Assessment List for Graph from Data in PASC, p. 39. **L2**

Assessment

Skill Ask students to use Table 4.2 to identify the factors that contribute to a high population growth rate. Responses may include high birthrates, low death rates, and high fertility rates. **L2**

TECHPREP

Graphing Population Growth

Logical-Mathematical Have students make a bar graph that shows the population growth of each country in Table 4.2, from highest to lowest percentage. **L2**

Portfolio

Interpreting Graphs

Linguistic Ask students to work with partners to write a true and a false statement that are both based on Table 4.2. Have partners exchange statements and identify which is true and which is false. **L2**

Cultural Diversity

Fertile Grounds

Have the class discuss reasons why developing countries have high fertility rates. Cultural reasons could include (a) people prefer large families; (b) large families may have more prestige; and (c) religions may ban the use of birth control. There could be socioeconomic reasons as well. Statistics

suggest that there tend to be more babies per woman in economically depressed countries. Reasons might include (a) higher infant mortality may encourage people to have more children; (b) families may have more children to help earn money; and (c) families don't have access to medical services or birth control.

Quick Demo

If the information is available, help students construct an age structure graph for an aquarium of fish or cage of mice that you have in your classroom. Discuss what the graph may reveal about expected population growth. **L2**

Problem-Solving Lab 4-2

Purpose

Students will analyze trends in human population changes.

Process Skills

think critically, apply concepts, analyze information, use numbers, draw a conclusion, make and use graphs

Teaching Strategies

- Review the meanings of density-dependent factors, density-independent factors, and carrying capacity.
- Explain doubling time and annual percent growth if students did not complete or discuss MiniLab 4-2.
- Allow students to use calculators.

Thinking Critically

- Density-dependent: disease, war, immigration, emigration, birth rate, death rate, availability of food or water. Density-independent: pollutants in water, soil, or air.
- No. Humans are able to provide food and water, remove wastes, and prevent disease.
- over 7 billion
- 200 years; 70 years; 55 years
- It is taking less and less time for the human population to double in size.
- The values show an annual percent growth rate ranging from 0.35% (1650–1850) to 1.27% (1920–1975). The trend is one of higher growth

Problem-Solving Lab 4-2

Applying Concepts

What trends are seen in the human population? Human population trends present some interesting ideas and concepts. Because of our intelligence, we are better able to control our population size, regulate our food supply, and remove waste products from our environment. Thus, human population trends may differ from those of other organisms.



A human population

Analysis

Figure 4.10 shows human population changes over time. Study this graph and answer the questions below.

Thinking Critically

- What density-dependent factors can influence human population growth? What density-independent factors can influence human population growth?
- Has the human population reached its carrying capacity? Explain why.
- Based on the graph in Figure 4.10, what will be Earth's population in the year 2010?
- Determine the human population's doubling time as it increases from half a billion to one billion, from one to two billion, and from two to four billion.
- Explain the significance of the trend shown in question 4.
- Using the values for doubling time provided in question 4, calculate the human population's annual percent growth rate using the method described in the *MiniLab* on the previous page. Use the formula below:

$$\text{Doubling time (in years)} = \frac{70}{\text{annual percent growth rate}}$$
- Explain the significance of the trend shown by your answer to question 6.

growing and slower growing countries. Some countries, such as Uganda, have high death rates among children because of disease and malnutrition. However, these countries have high birthrates, and their populations are growing rapidly. Some other countries, such as Sweden and Italy, have low death rates, but their birthrates are also low, so these coun-

- rate for each period of time. (Note: The annual percent growth rate is actually for a span of many years rather than only one year.)
- The human population continues to show an increase in its annual growth rate and has not yet reached its carrying capacity.

tries' populations are growing slowly, if at all.

As you can see, different combinations of birthrates and death rates have different effects on populations. The birthrate, death rate, and fertility rate of a country provide clues to that country's rate of population growth. Learn more about human population trends in the *Problem-Solving Lab* on this page.

Does age affect population growth?

Imagine a country filled mostly with teenagers. Does it make a difference to population growth if the largest proportion of the population is in one age group? In order to make predictions about populations of the future, demographers must know the age structure of a population. Age structure refers to the proportions of a population that are at different age levels. **Age structure** can be visualized by the use of graphs, as shown in *Figure 4.11*, and can help predict if a population is growing rapidly, growing slowly, or not growing at all. Rapid growth countries have an age structure with a wide base because a large percentage of the population is teenagers and children. These young people are likely to mature into adults and have their own children. If the percentage of people in each category is fairly equal, this indicates the population is stable, neither increasing nor decreasing.

Mobility has an effect on population size

Humans can move in and out of different communities. The effects of human migrations can make it difficult for a demographer to make predictions, but patterns do exist. Movement of individuals into a population is **immigration**.

Population Distribution Per Age Range for Several Countries

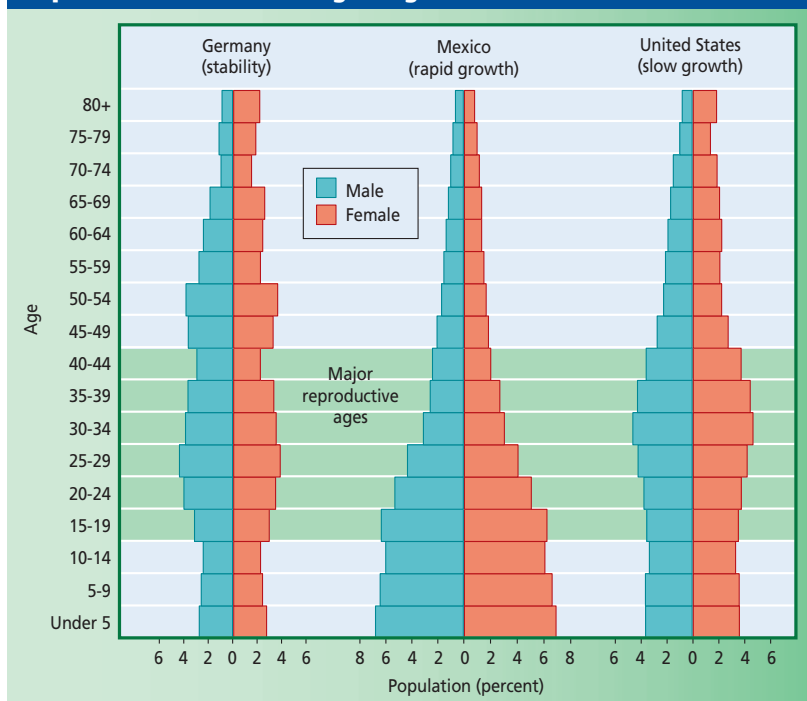


Figure 4.11 Notice that in a rapidly developing country such as Mexico, the large number of individuals in their pre-reproductive years will add significantly to the population when they reach reproductive age. Populations that are not growing, such as Germany's, have an almost even distribution of ages among the population.

WORD ORIGIN

emigration From the Latin words *e*, meaning "out," and *migrate*, meaning "to migrate." People emigrate when they move out of a country.

Movement from a population is **emigration**. Obviously, movement of people between countries has no effect on total world population, but it does affect national population growth rates. Local populations can

also feel the effects of a moving population. Many suburbs of large cities are expanding rapidly. This places stress on schools, roads, and police and fire services. What other problems result from suburban growth?

Section Assessment

Understanding Main Ideas

- What characteristics of populations do demographers study?
- How does life expectancy affect death rate?
- What clues can an age structure graph provide about a country's population growth?
- Discuss some possible problems for local populations caused by immigration and emigration of people.

Thinking Critically

- Using the age structure graph for the United States in *Figure 4.11*, explain which gender

has a higher life expectancy and then suggest a hypothesis for why this difference exists.

SKILL REVIEW

- Making and Using Graphs** Construct a bar graph showing the age structure of Kenya using the following data: pre-reproductive years (0-14)—42 percent; reproductive years (15-44)—39 percent; post-reproductive years (45-85+)—19 percent. For more help, refer to *Organizing Information* in the *Skill Handbook*.

Section Assessment

- Demographers study growth rate, age structure, and geographic distribution.
- If life expectancies rise, death rates will decrease.
- It can determine if a population is growing rapidly, slowly, or not at all.
- Answers will vary. Immigration can increase the need for schools, medical

- facilities, and public transportation. Emigration may result in unused facilities and vacant homes.
- Female; hypotheses will vary, but may include a healthier life style or different hormone concentrations.
- Evaluate students' graphs for logic and accuracy.

3 Assess

Check for Understanding

Have students explain the relationship between the words in each of the following pairs. **L1**

ELL

- population growth—birth and death rate
- age of population—population growth

Reteach

Ask students to explain how a high fertility rate with low death rate will influence a population's size. *Population will increase.* **L2**

Extension

Have students research the pros and cons of allowing large numbers of immigrants to enter the United States. **L3**

Assessment

Performance Have students write a paragraph that expresses their opinion as to whether the future size of human population should be controlled.

4 Close

Activity

Linguistic Have students list changes that can increase and decrease a population's size. **L1**

Resource Manager

Section Focus Transparency 9 and Master **L1 ELL**
 BioLab and MiniLab Worksheets, p. 18 **L2**
 Content Mastery, p. 17, 19-20 **L1**
 Reinforcement and Study Guide, pp. 17-18 **L2**

Time Allotment

One class period

Process Skills

apply concepts, collect data, experiment, formulate models, interpret data, predict, use numbers, write about biology

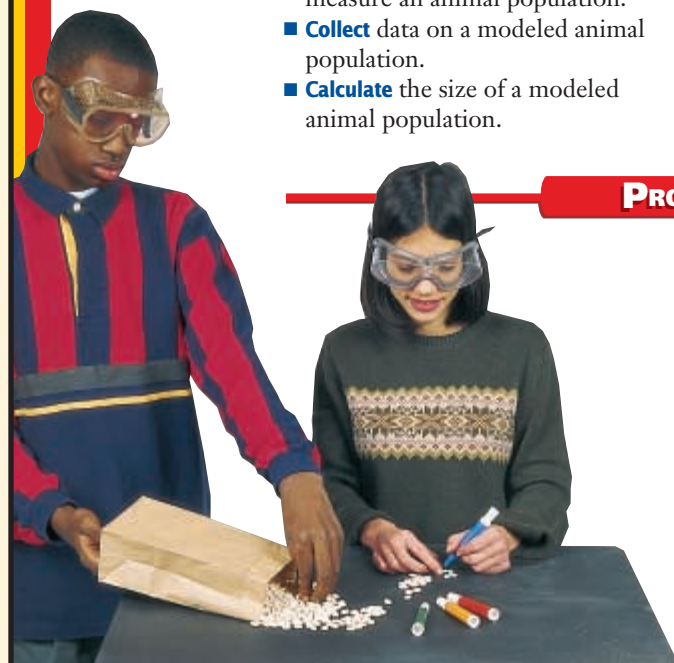
Safety Precautions

Have students wash their hands after handling the bean seeds.

PREPARATION

- Prepare bags in advance. Place 150-175 beans in each bag.
- Shortcut to counting beans—count out 165 beans. Then determine the volume of this number of beans by placing them into a graduated cylinder. Read the volume and use this as a guide in preparing the other bags. All bags DO NOT have to have the same number of beans.
- Remove all marked beans from the bag at the end of each class and replace with unmarked beans.

Resource Manager
BioLab and MiniLab Worksheets, p. 19 **L2**



How can you determine the size of an animal population?

Scientists can determine the number of animals in a large population by using a sampling technique. Here is how it works. They trap and mark a few animals in a specified area. The animals are released and the traps are reset. Among the animals caught this second time, some are marked and some are unmarked. Scientists then calculate the total population for their specified area based on the ratio of marked animals to unmarked animals.

In this activity, a bag represents the area of land where the population study is being conducted. Beans will represent animals. All the beans in the bag represent the total animal population being studied.

PREPARATION

Problem

How can you model a measuring technique to determine the size of an animal population?

Objectives

In this BioLab, you will:

- **Model** the procedure used to measure an animal population.
- **Collect** data on a modeled animal population.
- **Calculate** the size of a modeled animal population.

Materials

paper bag containing beans
magic marker
calculator (optional)

Safety Precautions

Always wear goggles in the lab. Wash hands after working with plant material.

Skill Handbook

Use the Skill Handbook if you need additional help with this lab.

PROCEDURE

1. Copy the data table.
2. Reach into your bag and remove 20 beans.
3. Use a dark magic marker to color these beans. These will represent your caught and marked animals.
4. When the ink has dried, return the beans to the bag.

PROCEDURE

Teaching Strategies

- Do not tell students the total number of beans in each bag.
- Any type of marker is suitable. Make sure the color contrasts with the bean color. Make sure all sides of the bean are colored.
- The number of beans removed in step 5 does not have to be exactly 30 but should be close.

- Review the technique for calculating an average.

Data and Observations

Sample data may appear as shown on page 109.

5. Shake the bag. Without looking into the bag, reach in and remove 30 beans.
6. Record the number of marked beans (recaptured and marked) and the number of unmarked beans (caught and unmarked) in your data table as trial 1.
7. Return all the beans to the bag.
8. Repeat steps 5 to 7 four more times for trials 2 to 5.
9. Calculate averages for each of the columns.
10. Using average values, calculate the original size of the bean population in the bag by using the following formula:
M = number initially marked
CwM = average number caught during the trials with marks
Cw/oM = average number caught during the trials without marks

$$\text{Population Size} = \frac{M \times (CwM + Cw/oM)}{CwM}$$

Data Table

Trial	Total caught	Number caught with marks	Number caught without marks
1	30		
2	30		
3	30		
4	30		
5	30		
Averages	30		

Calculated population size = _____

Actual population size = _____

11. Record the calculated population size in the data table.
12. To verify the actual population size, count the total number of beans in the bag and record this value in the data table.

ANALYZE AND CONCLUDE

1. **Thinking Critically** This experiment is a simulation. Explain why this type of activity is best done as a simulation.
2. **Applying Concepts** Give an example of how this technique could actually be used by a scientist.
3. **Analyzing Data** Compare the calculated to the actual population size. Explain why they may not agree exactly. What changes to the procedure would improve the accuracy of the activity?
4. **Making Inferences** Explain why this technique is used more often with animals than with plants when calculating population size.
5. **Making Predictions** Assume you were doing this experiment with living animals. What would you be doing in step 2? Step 3? Step 5?

Going Further

Writing about Biology Assume that you are a field biologist on Mackinaw Island, Michigan. Explain in detail how you would go about determining the deer population on the island. Include a data table that could be used in your procedure.

interNET CONNECTION To find out more about populations of organisms, visit the Glencoe Science Web Site. www.glencoe.com/sec/science

ANALYZE AND CONCLUDE

1. Students may note that it's difficult to obtain enough traps, find a suitable site for study, and work with trapped animals.
2. Possible answers: to determine the size of a population in a specific area, such as a national park, or to measure a change in a population size over time
3. The calculated value is based on counting a representation of the population, not every individual in the population. To increase the accuracy of the activity, one could increase the number of trials, the number of animals recaptured, or the number of animals caught and marked.
4. Plants do not move about and so are easier to count.
5. Step 2, capture animals in cages; step 3, tag or mark the animals in some manner; step 5, reset traps and capture more animals

Assessment

Skill Provide students with raw data and have them calculate the size of a population. Use the Performance Task Assessment List for Using Math in Science in PASC, p. 29. **L3**

Going Further

Have students design a long-term experiment that would determine the effectiveness of a "roach motel" on reducing the size of a cockroach population.

Data Table

Trial	Total caught	Number caught with marks	Number caught without marks
1	30	3	27
2	30	2	28
3	30	5	25
4	30	4	26
5	30	6	24
Totals	150	20	130
Average	30	4	26

Calculated population size = 150

Actual population size = 160

(This number will vary per bag.)

Purpose

Students will find out some advantages and disadvantages of a commonly used plastic called polystyrene.

Teaching Strategies

■ Use a dozen colored, plastic-coated paper clips to demonstrate how monomers link to form polymers. Make a chain with two alternating colors. Have a volunteer identify the monomers. If time allows, have students consult basic chemistry books to make models of complex plastic polymers.

■ Have students survey plastic containers at home or at stores to determine some of the many uses of polystyrene. Inform them that plastics labeled with the number “6” are polystyrene. Compile a master list of uses, which might include yogurt, cottage cheese, and sour cream containers; audiocassette boxes; frozen dinner trays; toy parts; picnic tableware; and others. **L1 ELL**

■ Have students suggest several situations in which disposable tableware would benefit those using it. *Answers might include in hospitals, where the transmission of pathogens can be a problem to patients, especially those with immunodeficiency diseases, or in school cafeterias, where cleaning reusable dishes, glasses, and cutlery might be cost prohibitive.* **L2**

Connection to Biology

Many environmentalists in this nation, as well as people in other Western cultures, view Americans as a “throw-away” society based on their widespread use of plastics and dependence on single-use containers and tableware items. The advantage of polystyrene being nondegradable is that harmful substances are kept from entering the environment. The disadvantage is that this material takes up valuable space in landfills.

Polystyrene: Friend or Foe?

Polymerization is a process in which single molecules known as monomers are joined to form long chains called polymers. Polystyrene is a petrochemical polymer. Manufacturers of this plastic argue that it has revolutionized many industries, especially those related to food service. Environmentalists contend that this plastic, like many others, is a dangerous substance that harms Earth and its inhabitants.



The basic chemical unit, or monomer, of polystyrene is styrene. Pure polystyrene is brittle, but by combining styrene with other monomers, an impact-resistant plastic is formed. Polystyrene is commonly used as building insulation and flotation devices, as packaging materials, and to make a wide assortment of disposable cups, plates, bowls, containers, and cutlery.

Foamed plastics Foamed plastics, often used in food packaging, are made by blowing tiny holes into a polymer. Polystyrene was the first foamed plastic developed. Initially, chlorofluorocarbons, or CFCs, were used as blowing agents to produce this closed-cell foam in which gas cells are completely isolated from each other by thin walls of plastic. Today, most foamed polystyrene is made using pentane or carbon dioxide as the blowing agent. Unlike CFCs, these gases do not destroy Earth’s ozone layer.

Polystyrene products Foam beverage cups and plates, plastic forks, some packaging “peanuts,” and the jewel cases that house compact discs are a few of the many polystyrene products on the market today. In the food service industry, polystyrene products are touted for their safety because they are used only once and thrown away. Because of its insulating properties, foamed polystyrene keeps hot foods hot and cold foods cold, thus reducing the risk of contamination

by bacteria. Foam packaging peanuts and polystyrene blocks protect electronics and other fragile items during shipping.

The perils of polystyrene Despite its convenience and popularity in various industries, polystyrene poses its share of environmental concerns. The main monomer in this plastic—styrene—is classified as a neurotoxin, as it impairs the central and peripheral nervous systems. Long-term exposure to even small amounts of styrene can also cause abnormal hematological, lymphatic, and cytogenetic effects. People do not eat plastic containers, but studies have shown that styrene is common in human fat tissue because it is often leached from foods and beverages stored, eaten, and drunk from such containers.

CONNECTION TO BIOLOGY

Polystyrene makes up less than 1 percent of our waste by weight, yet it constitutes 25–30 percent by volume. What does this say about the average consumer in this country? Also, polystyrene does not degrade in landfills. Suggest two reasons why this is both a good thing and a bad thing.

interNET CONNECTION To find out more about plastics, visit the Glencoe Science Web Site. www.glencoe.com/sec/science

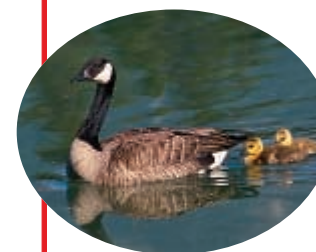
Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

SUMMARY

Section 4.1

Population Dynamics



Main Ideas

- Some populations grow exponentially until they reach the carrying capacity of the environment. Populations may exhibit slow growth that tends to approach the carrying capacity with minor fluctuations, rapid growth that tends to expand exponentially and then experiences massive diebacks, or fall somewhere in between.
- Density-dependent factors such as disease and food supply, and density-independent factors such as weather, have effects on population size. Interactions among organisms such as predation, competition, stress, and crowding also limit population size.

Vocabulary

carrying capacity (p. 97)
density-dependent factor (p. 100)
density-independent factor (p. 101)
exponential growth (p. 97)

Section 4.2

Human Population Growth

Main Ideas

- Demography is the study of population characteristics, such as growth rate, age structure, and movement of individuals. Birthrate, death rate, and fertility differ considerably among different countries, resulting in uneven population growth patterns across the world.

Vocabulary

age structure (p. 106)
demography (p. 104)
emigration (p. 107)
immigration (p. 106)

UNDERSTANDING MAIN IDEAS

- Which of the following factors is density-dependent?
 - a. drought
 - b. flood
 - c. food
 - d. wind speed
- When populations increase, resource depletion may result in _____.
 - a. exponential growth
 - b. straight-line growth
 - c. competition
 - d. increase in predators
- Storms, cold temperatures, and drought are all _____.
 - a. density dependent
 - b. biotic factors
 - c. exponential
 - d. density independent
- Between A.D. 1 and A.D. 1650, the world’s population had a major dip because of _____.
 - a. fertility
 - b. decreased death rate
 - c. density-independent factors
 - d. bubonic plague
- Which of the following environments would be more likely to have organisms that exhibit fast growth?
 - a. hot deserts
 - b. large, deep lakes
 - c. prairies that often flood
 - d. tropical rain forests
- A female’s fertility rate is the number of offspring she produces _____.
 - a. in a year
 - b. in a decade
 - c. by age 50
 - d. over her lifetime

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site. www.glencoe.com/sec/science



All Chapter Assessment

questions and answers have been validated for accuracy and suitability by The Princeton Review.

UNDERSTANDING MAIN IDEAS

- c
- c
- d
- d
- c
- d

GLENCOE TECHNOLOGY

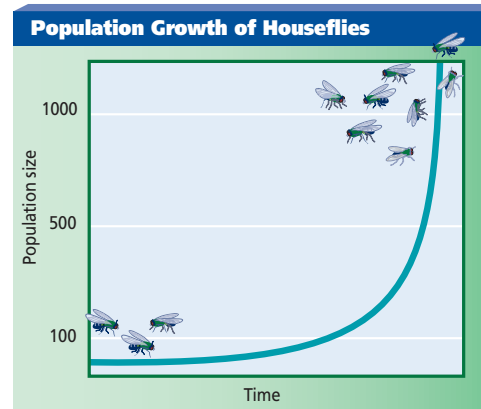
VIDEOTAPE
MindJogger Videoquizzes
Chapter 4: Population Biology
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 19–24
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 4 quiz

- 7. c
- 8. a
- 9. b
- 10. c
- 11. exponential growth
- 12. carrying capacity
- 13. birth, death, emigration
- 14. limiting factor
- 15. Jordan, Uganda
- 16. carrying capacity
- 17. demographer
- 18. 4, 8
- 19. life expectancy, increases
- 20. exponential growth

7. According to the graph, the growth rate of a house fly population _____.
- a. increases, then drops suddenly
 - b. increases, at a steady rate
 - c. increases rapidly
 - d. levels off after a certain amount of time

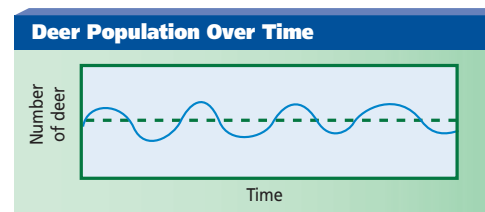


8. A person breeds rabbits in a cage. After a few generations, she observes that the rabbits are more aggressive towards each other, the young are less healthy, and more young rabbits die. This population is:
- a. under stress
 - b. under the carrying capacity
 - c. density independent
 - d. both choices a and c
9. A life-history pattern that tends to approach carrying capacity with minor fluctuations is _____.
- a. population dependent
 - b. slow growth
 - c. fast growth
 - d. exhibited by most insects

THE PRINCETON REVIEW TEST-TAKING TIP

Pace Yourself
Many test questions look more complicated than they really are. If you find yourself having to do a great deal of work to answer a question, take a second look and consider whether there might be a simpler way to find the answer.

10. What can be said about the growth of a country with an age structure graph that approximates a rectangle?
- a. It is decreasing.
 - b. It is increasing slowly.
 - c. It is stable.
 - d. It is increasing rapidly.
11. A J-shaped growth curve indicates a population is experiencing _____.
12. The highest level at which a population can be sustained is its _____.
13. Population growth rates are affected by _____ and _____ rates. It is also influenced by immigration and _____.
14. Predators that help control the size of a population represent a _____.
15. From *Table 4.2*, the fastest growing country is _____. The women of _____ give birth to the most children.
16. The solid-line graph below shows the changes in deer population over time. The dotted line represents the _____ for the deer population.



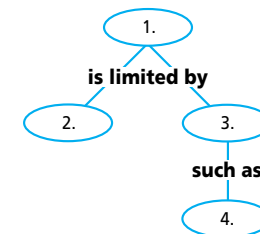
17. A person who studies human population growth characteristics is a _____.
18. A bacterial cell divides every 30 minutes and produces two cells. Starting with one cell, after 30 minutes there would be two cells, after 60 minutes _____ cells, and after 90 minutes, _____ cells.
19. A demographic estimate of how long a person of a particular age will live is called his/her _____. In the United States, this estimate _____ every year.
20. Populations that grow without restriction are experiencing _____.

APPLYING MAIN IDEAS

21. Which environmental factors would most affect the populations of developing countries?
22. As human populations grow, what might happen to the populations of other species? Discuss the causes for your hypotheses.
23. Assume that a female black rat gives birth every month and produces eight young. In each litter, four are female and four are male. Starting in month zero with one newborn litter of four males and four females for a total population of eight, calculate the total population size at months 1, 2, and 3.

THINKING CRITICALLY

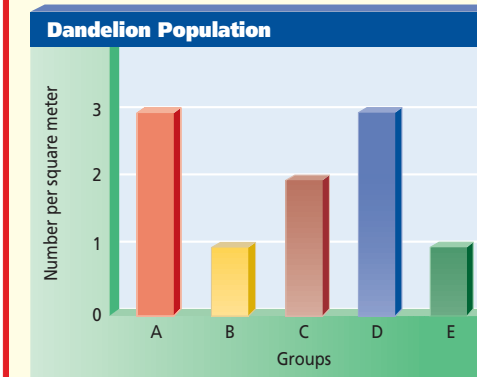
24. **Observing and Inferring** Why are short life-history species, such as mosquitoes and some weeds, successful even though they often experience massive population declines?
25. **Comparing and Contrasting** Compare and contrast the characteristics of species having long life-history patterns with those that have short life-history patterns.
26. **Concept Mapping** Complete the concept map by using the following vocabulary terms: density-dependent factors, density-independent factors, exponential growth, immigration.



CD-ROM
For additional review, use the assessment options for this chapter found on the *Biology: The Dynamics of Life Interactive CD-ROM* and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

ASSESSING KNOWLEDGE & SKILLS

The following bar graph indicates the number of dandelions counted by five groups of students (groups A-E) on school grounds. Assume that the school grounds have 21 950 square meters planted in grass.



Interpreting Data Use the graph to answer the following questions.

1. How many dandelions per square meter did group A count?
- a. one
 - b. two
 - c. three
 - d. four
2. On average, how many dandelions did the students count per square meter?
- a. one
 - b. two
 - c. three
 - d. four
3. Using the average number of dandelions per square meter, what is the estimated number of dandelions on the school grounds?
- a. 21 950
 - b. 43 900
 - c. 50 485
 - d. 65 850
4. **Interpreting Data** The study is repeated two months later and now the average is five dandelions per square meter. Now, what is the estimated size of the population?

APPLYING MAIN IDEAS

21. density-dependent factors such as limited food or water and increased chances for disease to spread
22. The populations of other species may decrease. Humans may disrupt the habitats of other species, so that they do not have enough space for mating, rearing offspring, or finding shelter and food.
23. Month one = 8 parents + (4 females times 8 offspring) = 40. Month two = 40 parents + (20 females times 8 offspring) = 200. Month three = 200 parents + (100 females times 8 offspring) = 1000.

THINKING CRITICALLY

24. Short life-history species provide enough potential offspring in the form of seeds, eggs, or larvae to produce the next generation, even when there are massive die-offs.
25. Species with long life-histories usually have few young that take a long time to mature, while those species with short life-histories have many offspring that mature quickly.
26. 1. Exponential growth; 2. Density-independent factors; 3. Density-dependent factors; 4. Immigration

ASSESSING KNOWLEDGE & SKILLS

- 1. c
- 2. b
- 3. b
- 4. 109 750