DOCUMENT RESUME

ED 300 240 SE 049 755

TITLE	Biological Science: An Ecological Approach. BSCS Green Version. Student Study Guide. A Resource Book of Learning Skills Activities. Teacher's Edition. Sixth Edition.
INSTITUTION	Biological Sciences Curriculum Study, Colorado Springs.
REPORT NO	ISBN-0-8403-4447-3
PUB DATE	87
NOTE	149p.; For Teacher's Edition, see SE 049 756; Teacher's Resource Book, see SE 049 757. Drawings may not reproduce well.
AVAILABLE FROM	Kendall/Hunt Publishing Company, 2640 Kerper Blvd., Dubuque, IA 52001 ($5.90).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Biological Sciences; Course Organization; Critical Thinking; *Instructional Materials; Problem Solving; Science Activities; Science Education; Secondary Education; *Secondary School Science; *Study Guides; *Study Skills; Teaching Methods; *Textbooks
IDENTIFIERS	*Biological Sciences Curr Study Green Version

ABSTRACT

This study guide is designed to help students learn to use science skills to solve biological problems, learn to apply knowledge about biology in their own lives, and learn to communicate with others about biology. The activities in this guide use information related to each chapter in the 1987 BSCS Green Version textbook. Students can use the activities before, during, or after their study of the chapter. There are 99 activities and exercises related to the 25 chapters of the textbook. These paper-and-pencil activities direct students to make observations, collect data from research sources, draw models and diagrams, and interpret and draw graphs. This teacher's edition provides possible student responses. (CW)

DOCUMENT RESUME

ED 300 240 SE 049 755

TITLE	Biological Science: An Ecological Approach. BSCS Green Version. Student Study Guide. A Resource Book of Learning Skills Activities. Teacher's Edition. Sixth Edition.
INSTITUTION	Biological Sciences Curriculum Study, Colorado Springs.
REPORT NO	ISBN-0-8403-4447-3
PUB DATE	87
NOTE	149p.; For Teacher's Edition, see SE 049 756; Teacher's Resource Book, see SE 049 757. Drawings may not reproduce well.
AVAILABLE FROM	Kendall/Hunt Publishing Company, 2640 Kerper Blvd., Dubuque, IA 52001 ($5.90).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051) -- Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Biological Sciences; Course Organization; Critical Thinking; *Instructional Materials; Problem Solving; Science Activities; Science Education; Secondary Education; *Secondary School Science; *Study Guides; *Study Skills; Teaching Methods; *Textbooks
IDENTIFIERS	*Biological Sciences Curr Study Green Version

ABSTRACT

This study guide is designed to help students learn to use science skills to solve biological problems, learn to apply knowledge about biology in their own lives, and learn to communicate with others about biology. The activities in this guide use information related to each chapter in the 1987 BSCS Green Version textbook. Students can use the activities before, during, or after their study of the chapter. There are 99 activities and exercises related to the 25 chapters of the textbook. These paper-and-pencil activities direct students to make observations, collect data from research sources, draw models and diagrams, and interpret and draw graphs. This teacher's edition provides possible student responses. (CW)

Student Study Guide
Biological Science
An Ecological Approach
Sixth Edition

A Resource Book of Learning Skills Activities

BSCS Green Version

BSCS
The Colorado College
Colorado Springs, CO 80903

Jean P. Milani, BSCS, Green Version Revision Coordinator
Carol Leth Stone, Science Writer, Alameda, California, Principal Author
Edward Drexler, Pius XI High School, Milwaukee
Richard R. Tolman, Brigham Young University, Provo, Utah

Teacher's Edition

Kendall/Hunt
Publishing Company
Dubuque, Iowa

BSCS Production Staff

Douglas J. Robert
Katherine A. Winternitz

Artist

Carl J. Bandy

BSCS Administrative Staff

Jane Butler Kahle, Chair, Board of Directors
Joseph D. McInerney, Director

ISBN 0-8403-4447-3

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

Contents

To the Student

Your textbook presents the major ideas of biology, many specific facts, and a large new vocabulary. At times, this information may seem overwhelming. However, you can take charge of your learning and be successful in biology. This study guide will help you do so.

The study guide will help you in three ways. First, it will help you learn to use science skills to solve biological problems. By doing such things as hypothesizing, using data, and making inferences, you will understand why and how scientists use those skills.

Second, you will learn to apply your new knowledge about biology to the world around you. Memorizing the words or even the ideas of biology is useless unless you can apply biology to your own life.

Third, you will learn to communicate with others about biology. You will learn how to find out what others have written, and how to talk and write about biology yourself.

We hope the study guide will help you to master other learning, as well as biology. We want to know if it helps you, and if you can suggest changes for the next edition. Please send your comments to BSCS, the Colorado College, Colorado Springs, Colorado 80903, Attn: GV6.

Preface to the Teacher

The Student Study Guide is designed to enhance students' abilities in three specific areas: communication skills, science skills, and general cognition or combined skills. Activities use information related to each chapter to develop those skills. The type of skill is identified at the beginning of each activity.

Students can use the activities before, during, or after their study of the chapter. The appropriate timing is indicated at the beginning of each activity.

In many cases, space has been provided for student responses. In other cases, however, responses are best made in a binder, on scratch paper, or on index cards. Those situations are indicated in the student directions.

Possible student responses may be suggested, but are not meant to be taken as the only correct answers. Students should be encouraged to be creative and thoughtful in responding to questions and problems presented in the guide.

We hope you and your students will find the Student Study Guide a helpful learning tool. We would appreciate any suggests you have concerning this guide. Please send them to BSCS, The Colorado College, Colorado Springs, Colorado 80903, Attn: GV6.

Introductory Activity

Introductory Activity

Combined Skill: Predicting
This activity can be carried out during the first days of the school year.

PREDICTING YOUR FUTURE

Many of the things you will learn in biology are related to your own life and to your immediate surroundings. They also are related to what your life may be like in the future.

What do you think your future will be? As a science fiction writer does, you can use your knowledge of the present to make predictions. Be creative with your predictions, but make them realistic. Based on what you know and can guess, write your answers to the following questions. There are no right answers yet; you can check your work in twenty years.

Twenty years from now, where in the world (or the solar system) do you think you will live?

Will you live in a city or a rural area?

Will you be married?

How many children will you have?

How will you care for your children?

Will your parents live with you?

What sorts of foods will you eat? Where will they come from? Will you grow any of your own food?

What sort of work will you do? Where will you do it?

What sort of exercise will you get? Where will you go for it?

How healthy do you expect to be?

What will your surroundings be like? Crowded and polluted, or spacious and clean?

Can you make any other predictions about your future?

This activity is continued at the end of the guide, as "Review Activity." Students are asked to reevaluate their predictions in light of what they have learned during their year of biology.

Chapter 1

Activity 1.1

Combined Skill: Reviewing background information (or, in cognitive psychology terms, "activating schemata")
Students can use this activity before beginning the chapter.

GETTING READY TO READ

If you read a book written for a young child, you can finish it quickly. No words or ideas will seem strange to you. Reading a book written for high school students is more difficult. Perhaps the authors use some words you do not understand or refer to ideas you have forgotten since you first learned them. If you try to read the book without enough background information, you will waste time, and you may misunderstand what you are reading.

Your teacher may spend some class time reviewing words or ideas that will help the entire class. However, it is up to you to make sure that you are ready to read the chapter and understand it.

To get ready, skim the chapter. Do the authors refer to some things without explaining them, assuming you already understand them? For example, do you know the meanings of the words "venture" and "microorganism"? Do you know how to use a stereomicroscope? In the space below, list a few things you probably need to look up or learn before reading chapter 1 thoroughly:

You will, of course, try to fill in any obvious gaps in your students' backgrounds. However, one of the purposes of this guide is to make students monitor their own learning and take responsibility for finding out what they need to know.

Activity 1.2

Communication Skill: Notetaking
Students can use this activity before or during the chapter.

TAKING HELPFUL NOTES

What you learn in biology class will come from several sou ces, such as laboratory work, the textbook, and your outside reading. One important source of information is your teacher. This activity will help you to write down information your teacher gives you and to use it later.

The following example is taken from one biology student's class notes. Notice what the student did while taking the notes—underlining, sketching something the teacher drew on the chalkboard, and so on.

Oct. 1

Food chains + webs

* Food chain - series of steps in passage of food from one organism to another. Always a plant, may have several animals.

arrow - eaten by or gives food to

How many?

plant → animal → animal → decomposers (rots)
grass → rabbit → coyote → maggots yuck!

* Interrelationships - ways orgs affect each other. Can link chains to make web.

* Food web

grass → rabbit → coyote → decomposers
grass → ewe → lamb → coyote
decomposers ?

play tryouts Oct. 15!

Quiz on Monday!

Why do you think the student added stars to some terms?

The teacher probably emphasized them or said they would reappear on tests.

After class, the student and some friends looked over their notes together. They helped each other understand the material. They looked up some words in the textbook and a dictionary. After that, the student typed the notes and put them in a permanent biology notebook. (The notes about the quiz and the play tryouts went into a little reminder book.) The typed notes looked like this:

Oct. 1

Food chains and webs

*Interrelationships—ways organisms affect each other. Includes eating and other relationships.

*Food chain--series of steps in the passage of food from one organism to another. Always includes one plant; may include one animal or several, as well as decomposers.

*Decomposer--anything that decomposes (rots) tissue, such as bacteria or mold.

General food chain:

plant —> animal —> animal —> decomposer

Examples:

grass —> rabbit —> coyote —> maggots

grass —> ewe —> lamb —> coyote

(Arrow = eaten by, or gives milk or other food to)

*Food web--two or more food chains with some shared organisms, such as:

```
grass —> rabbit —> coyote —> maggots
    \—> ewe —> lamb —/
```

Reviewing and copying your notes may seem like a lot of work. But most students who do it find that they save time later in studying for tests. Try it on your notes from the next biology class.

No space is provided here for response by the student, it is hoped that he or she already has a spiral-bound notebook for taking notes in class. Encourage students to type and hand in a copy of their notes from at least one class period; if possible, have them continue the practice throughout the year and save their notes in a permanent notebook. Help them also by emphasizing that cooperating in reviewing and copying notes is not "cheating" unless someone uses it as a substitute for class attendance.

Activity 1.3

Science Skill: Observing

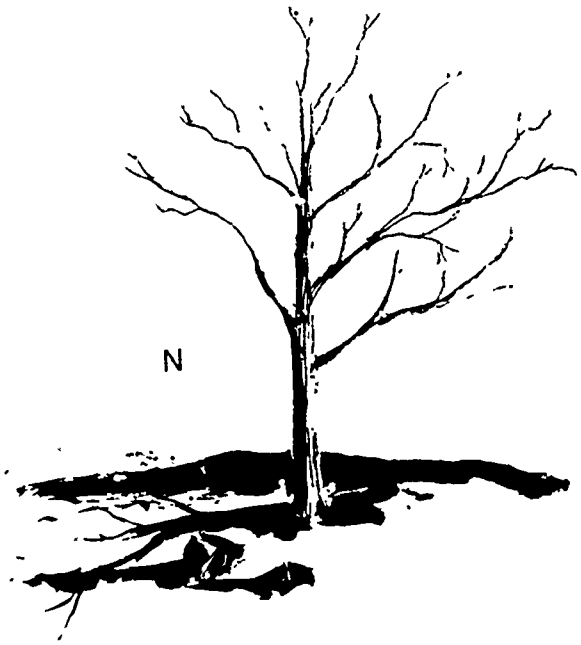
Students can carry out this activity before or during the chapter.

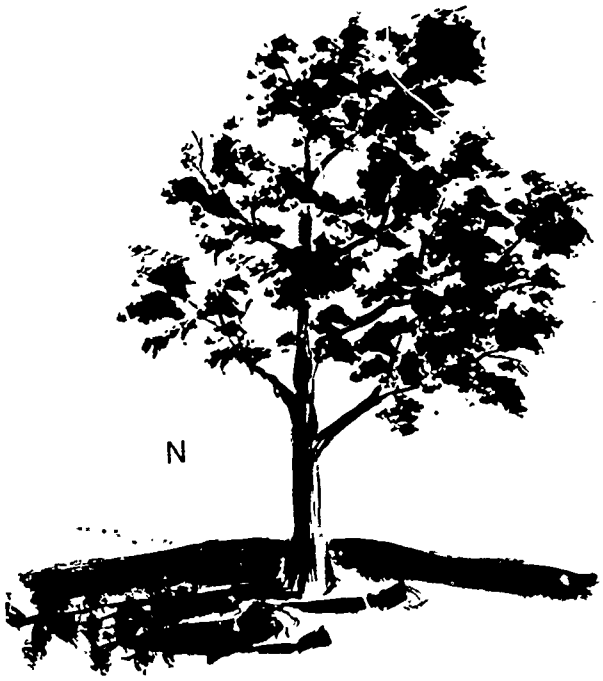
SEEING WITH A PURPOSE

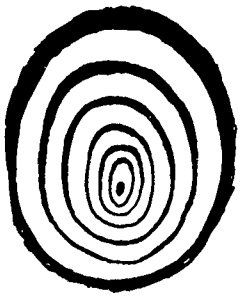
When you have some understanding of how living things grow and behave, you can more easily orient yourself in your surroundings. This was very useful to the Native Americans, who had no compasses. In the words of an 18th-century French priest, Père Lafitau, who spent five years with the Iroquois tribe, the Iroquois "pay great heed to their 'star' compass [the Pole Star] in the woods and in the vast prairies. . . . But when the sun or stars are not visible they have a natural compass in the trees of the forest from which they know the north by almost infallible signs.

"The first is that of their tips, which always lean toward the South, to which they are attracted by the sun. The second is that of their bark, which is more dull and dark on the north side [where there is less evaporation, and the moist bark looks darker]. If they wish to be sure they only have to give the tree a few cuts with their axe; the various tree rings which are formed in the trunk of the tree are thicker on the north side." (From Harold Gatty, 1958, *Nature is Your Guide* (New York: Penguin Books).)

Using Iroquois methods, label the north side of each of the following pictures:







These methods are not always reliable. What might cause a tree to grow toward the north, or to be moister on the south side?

Shade may be cast by buildings or by natural surroundings. Wind direction also affects growth.

Activity 1.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can use this activity after completing chapter 1.

DISAPPEARING MARSHLANDS

San Francisco Bay was surrounded by marshes when the Spanish explorer Gaspar de Portolo arrived in 1769. He found the Ohlone Indians hunting deer, rabbits, and other game in the tall marsh grasses.

In the years since, many of the marshes have been drained for various human purposes. Many persons see the marshes as wet, smelly places that hurt property values. However, many animals and plants can live only there, and many others depend on organisms that live there.

About three dozen kinds of birds live there year-round. These include ducks, grebes, coots, killdeer, avocets, stilts, and clapper rails. They feed on small animals that live in the mud—worms, snails, and shellfish (clams, mussels, oysters, and shrimp). Those small animals in turn eat very small marsh producers such as diatoms and algae. They also eat detritus (decaying plant and animal matter).

Much detritus comes from plants that can tolerate high concentrations of salt, such as cordgrass, salt grass, marsh rosemary, alkali heath, picklewood, and Australian saltbush. (In addition to providing material as detritus, the pickleweed performs the role of host to a parasitic plant called salt marsh dodder, and the leaves of the Australian saltbush are the food of the caterpillars of pygmy blue butterflies, the smallest butterflies in North America.)

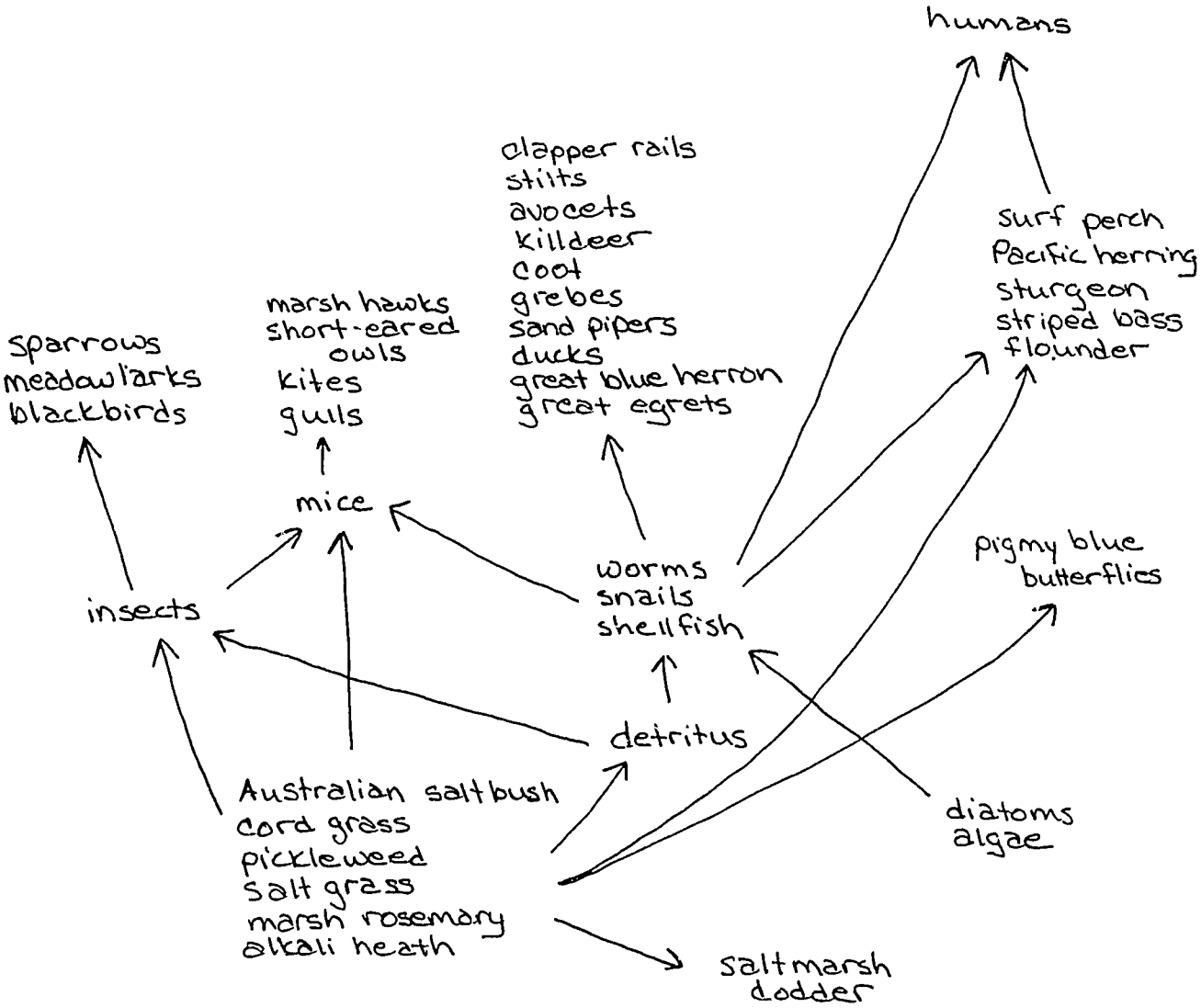
Land birds such as sparrows, meadowlarks, and blackbirds may come to the marsh to feed on insects, and they may become food for larger birds such as kites, short-eared owls, and marsh hawks.

In the mud along the water's edge, crabs and shrimp provide food for migratory birds: among them, sandpipers, ducks of many kinds, great blue herons, and great egrets. These last two also feed on mice.

One kind of mouse, the red-bellied salt marsh harvest mouse, is an endangered species. It lives nowhere else. It is fed on by hawks, owls, herons, and gulls.

Humans fish for striped bass, surfperch, Pacific herring, sturgeon, and flounder in the bay. We also use its shellfish. Fish feed on plants, snails, and small shellfish.

In the space provided on the following page, draw a food web based on the information above.


humans
clapper rails
stilts
avocets
killdeer
coot
grebes
sand pipers
ducks
great blue herron
great egrets
surf perch
Pacific herring
sturgeon
striped bass
flounder
marsh hawks
short-eared owls
kites
gulls
sparrows
meadowlarks
blackbirds
mice
worms
snails
shellfish
pigmy blue butterflies
insects
detritus
Australian saltbush
cord grass
pickleweed
salt grass
marsh rosemary
alkali heath
diatoms
algae
saltmarsh dodder

The marshes are now restricted to 51 square miles of open space. Many persons using the area would like to drain some of the areas that remain, making them usable for such purposes as airport runways. Comment on the possible effects of such drainage.

Species restricted to the marsh, notably the salt harvest mouse, would disappear. As the plants, detritus, and invertebrates disappeared, so would the larger shellfish and fish used by humans.

Chapter 2

Activity 2.1

Communication Skill: Freewriting

Students can do this before reading the chapter. It gives them an opportunity to write about science without the distraction of worrying about whether their ideas are "correct;" in addition, you can use their questions as a basis of discussion.

WRITING ABOUT POPULATIONS

Before beginning this activity, get out a pen or pencil and several sheets of scratch paper. Then glance through chapter 2 in your textbook for a minute or two.

Now, close the book. For five minutes, write down what you know about populations. You can include topics from the textbook and topics you may know about from other sources. Don't worry about spelling or grammar; just write freely, getting your ideas down on paper. Don't worry about whether your ideas are right, either.

You probably have some questions about populations. Write those on a separate sheet of paper or underline them, so they stand out from the rest of what you have written.

When the time is up, go back and organize what you have written. Write at least three paragraphs to show your teacher. These should be corrected for grammar and spelling. Write your questions in the space below. Your teacher may ask to see the questions now, or you may want to bring them up in class discussions.

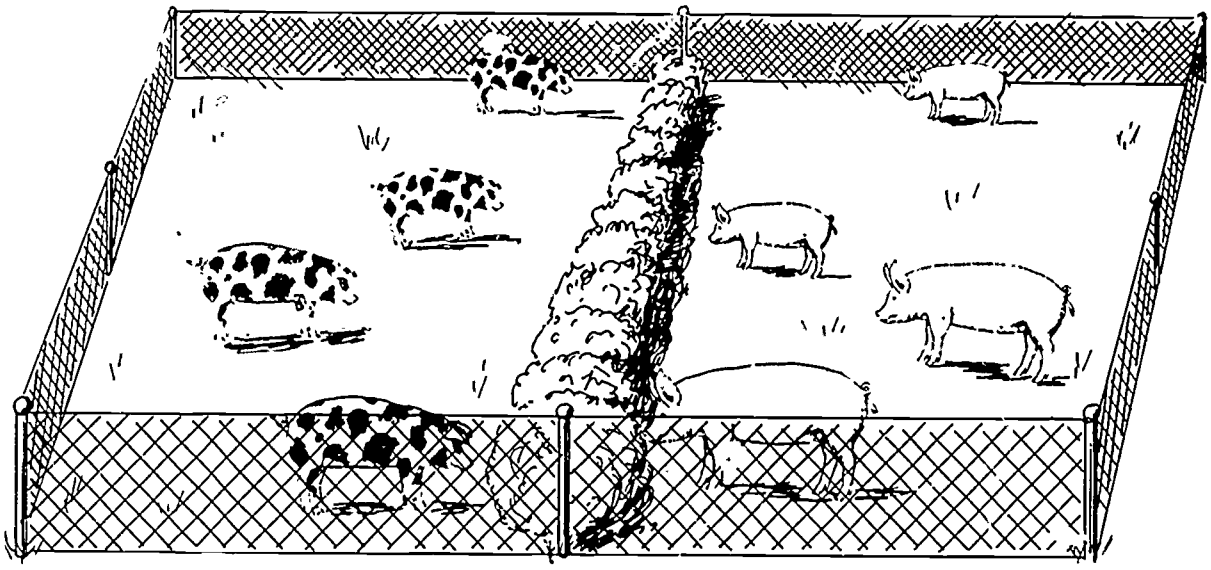
My questions about populations:

Activty 2.2

Science Skill: Describing properties and changes
Students can do this after reading the chapter.

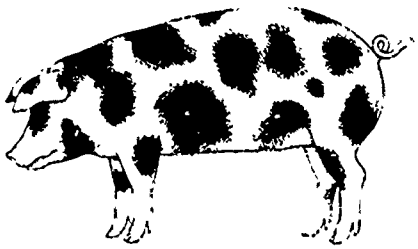
PIG POPULATIONS

Two groups of pigs were kept in adjacent pens. The fences around the pens were high and strong, but the hedge separating the two groups of pigs was not strong enough. Sometimes pigs were able to get through the hedge.



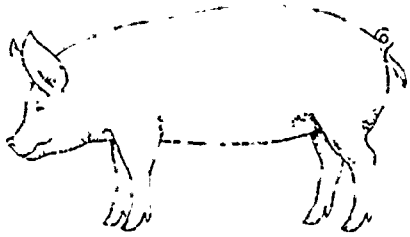
Area A Area B

At the beginning of Year 1, all the pigs in Area A were of the Spot breed, which looked like this:



SPOT

All the pigs in Area B were of the Yorkshire breed, which looked like this:



YORKSHIRE

Events during Year 1 are shown in the following table:

	Area A	Area B
Year 1 starting population size	6	9
Number of births	18	21
Number of deaths	6	9
Number of emigrations	9	11
Number of immigrations	11	9

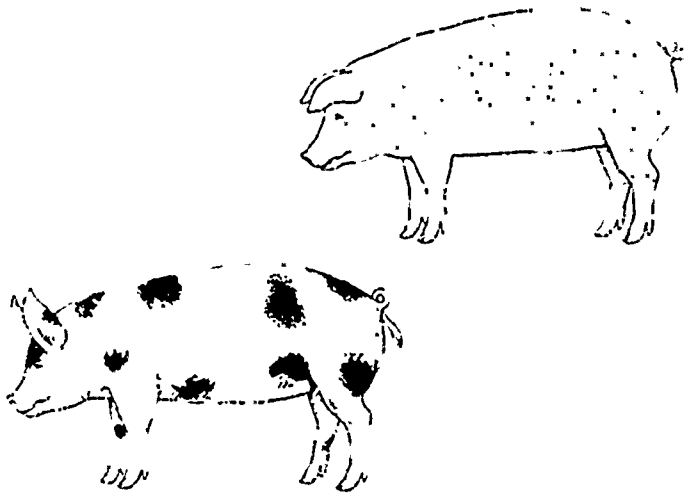
At the end of Year 1, how many pigs were in each area?

	Area A	Area B
Spot	9	9
Yorkshire	11	10
Total	20	19

Events during Year 2 are shown in the following table:

	Area A	Area B
Year 2 starting population size	20	19
Number of births	55	47
Number of deaths	20	19
Number of emigrations	25	27
Number of immigrations	27	25

At the beginning of Year 3, none of the pigs looked like those shown above. M((them looked more like these pigs:



Events during Year 3 are shown in the following table:

	Area A	Area B
Year 3 starting population size	57	45
Number of births	285	225
Number of deaths	70	60
Number of emigrations	100	50
Number of immigrations	50	100

How many pigs were in Area A at the end of Year 3? 222

In [illegible] B? 260

What rate was primarily responsible for the changes in both population sizes during Year 3? Natality

Try to account for this.

Students should observe that the pigs appear different and calculate that the birth rate has about doubled. Though they may not be familiar with the "hybrid vigor" that is responsible, they should relate the increased birth rate to the changes in the pigs.

Activity 2.3

Combined Skill: Planning how to study
Students can do this while reading the chapter.

PLANNING TO STUDY BIOLOGY

By now, you have some idea of what to expect from your biology course. How can you take charge of your work, so that you will learn as much as you can?

It goes without saying that you need to know what the assignments are and when they are due. Your teacher will tell you about the reading assignments and the tests, as well as any other work that is expected of you. From that point, it is up to you.

One thing that will help you is planning ahead. You need to estimate the time needed for reading the assignments, doing problems, studying for tests, and so on. Based on what has happened so far this year, fill out this tentative weekly schedule:

Activity	Amount of time	Day and time
Reading biology assignments		
Reviewing biology assignments		
Studying for biology tests		
Other (extra projects, etc.)		

The amount of time and its scheduling will vary from person to person. For example, if you are a slow reader, you may have to plan to spend more time on the assignments than a faster reader would. If you can do math problems easily, that will help you in doing some of the work that lies ahead. If you have a job or extracurricular activities after school, you will have to juggle your time accordingly. Set up a schedule that you think will work for you. For two or three weeks, keep track of the time you actually spend. Then revise the schedule if you need to.

In addition to planning your time, you need to plan your approach. In the space below, write a short paragraph about how you plan to read a chapter to find and remember the major ideas in it.

Researchers at Stanford University found that many students, especially the poorer achievers, have no idea of how to approach studying a textbook. Help them think about clues and study aids such as headings, boldface terms, pictures, and review questions

Activity 2.4

Science Skill: Inferring from Data
Students can do this activity after completing the chapter.

POPULATION PROFILES

Some observations are direct. For example, you can look at a pig and see whether it is white or black, spotted or unspotted. Other people will probably make the same observation.

Other observations are indirect, and may leave more room for disagreement. Such indirect observations are called inferences. By observing something, you infer that something else is true. (If you observed that the lock on your front door was broken, you might infer that a burglar had entered the house.)

Biologists and others often use population data to infer other things about a population. Here are some data about three human populations, arranged by age group only:

Age Group	Population 1	Population 2	Population 3
0–10	30%	20%	5%
10–20	25%	15%	5%
20–45	30%	35%	35%
45–65	10%	20%	35%
65+	5%	10%	20%
Total	100%	100%	100%

Which population is most likely to grow rapidly in size over the next 20 years, and why?

population 1, because of the high proportion of the population in the reproductive years (55%)

Which population probably has the greatest number of men between the ages of 45 and 65?

population 3 (17.5%), inferring equal numbers of men and women.

Make at least one inference from the table. See if others in the class agree with your inference. If you disagree, how can you find out who is right?

Be sure that students make inferences rather than restating data.

Chapter 3

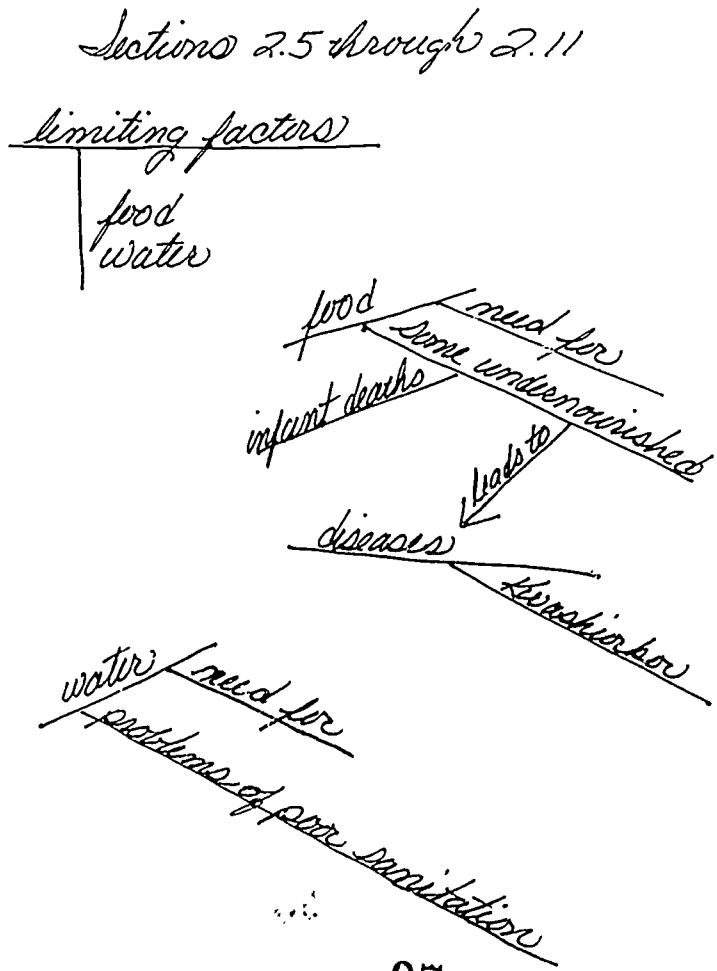
Activity 3.1

Communication Skill: Skimming before reading
Students can do this activity before beginning chapter 3.

GETTING AN OVERVIEW

How do you begin reading an assignment in the textbook or in an outside source of information? If you just begin reading from the beginning, and plod through the assignment to the end, you may lose the "plot" somewhere in the middle. In reading textbooks and similar material, you will read faster and learn more if you skim the assignment first to get a rough idea of the topics covered in it. By looking at each page for just three or four seconds, you will get a broad overview, as if you were flying over an area in a plane.

You will probably also forget your overview quickly unless you write down what you remember. It is not necessary to write it down in complete sentences or to worry about spelling; the important thing is to jot down everything you can recall immediately. Here is an example of what one person wrote down after skimming sections 2.5 through 2.11 in this textbook:



Notice that connecting lines and an arrow were used to link related words. The student recalled that several limiting factors, including food and water, were listed; to show that, the .t was started at the top left. Also illustrations could have been sketched, or color pencils used, to emphasize things. There is no one way to do this, and each reader can use whatever seems appropriate at the time.

This is only a small part of what is covered in those sections. It might not even be an important part. The reader might want to skim the material a few more times, adding to the notes each time, before actually reading the assignment.

Try skimming chapter 3 in your textbook now. Look at each page for about three or four seconds. Remember that you are going to write down what you can recall. There are no "right" or "wrong" answers; if you make mistakes, you can revise your ideas as you read the chapter more thoroughly.

Write your notes in the space below.

You may want to use a stopwatch to time the students for this activity. There is a natural tendency to slow down and spend more than the allotted time on skimming, which defeats the idea of getting a quick overview of the material. Student will probably be pleasantly surprised at how much they can remember. That will give them self-confidence in approaching assignments and help them master large amounts of material efficiently.

Activity 3.2

Science Skill: Observing. Here, observing is for the purposes of comparing two populations and seeing the ranges of two characteristics in each population. It will help students prepare for later studies of variation in populations.
Students can do this activity during the chapter.

A SHELL GAME

The following picture shows the shells of two populations of aquatic mollusks (the soft-bodied animals, which includes snails and slugs). Each population has a characteristic shell shape. The shells also vary in two other ways. What are they? Size and number of lines.

To keep track of each group of shells, put a number on each one. Then list the same numbers in a column on a piece of scratch paper. Add two more columns to the right of that column:

Shell	A	B
1		
2		
3		
(etc.)		

Work with another student. Decide what units to use, and how to measure characteristics A and B.

The students must decide on which dimension of the shells to measure and be consistent in using that dimension. Centimeters or millimeters can be used as the units.

Now fill in the two columns. What was the smallest number in column A? _____

The largest? _____

The smallest number in Column B? _____

The largest? _____

For the longer, conical shells, the number of lines ranges from 3 to 5; for the other shells, from 1 to 7.

Those two pairs of numbers represent the range of each characteristic for the first kind of mollusk. Repeat your measurements for the second population. In the space below, describe each population as fully as possible.

They should include the shapes and ranges of size and number of lines for each population.

Activity 3.3

Science Skill: Inferring. While the activities of hypothesizing and experimenting are referred to, they are not named. If your students are already quite scientifically literate, you may want to extend the activity to those concepts.
This activity can be carried out while the chapter is being read.

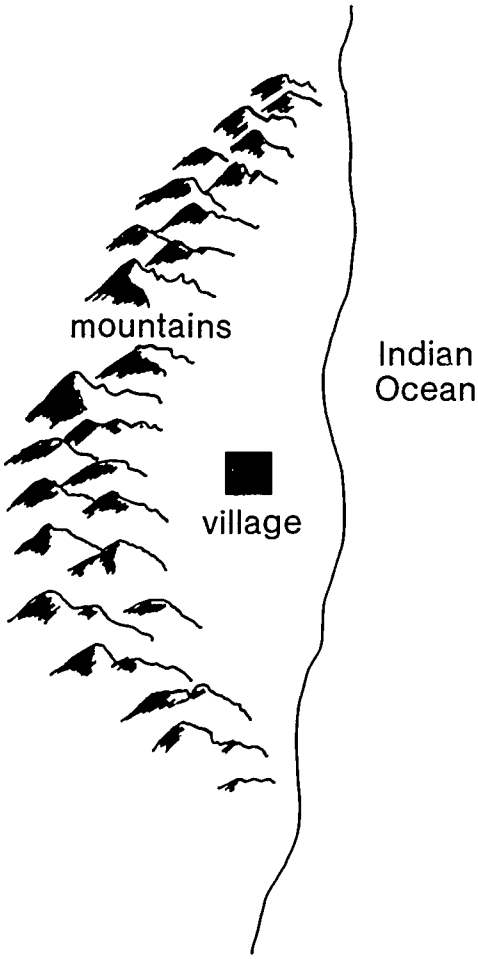
A PROBLEM OF IMMUNITY

A scientist read a magazine article about a village near the east coast of Africa. A parasite that is found in 70% of Africans is never found in the villagers. The people there are very fond of drinking a root beer that they make from a local plant. The plant grows only there.

The scientist made a tentative inference about the villagers' immnity to the parasite. What was it?

The root beer might somehow protect them.

Another scientist read another article about the disease. That article said nothing about the root beer, but with the article was a rough map of the village and the surrounding area.



That scientist also made a tentative inference about the villagers' immunity to the parasite. What was it?

The mountain range might prevent contact between the villagers and other Africans, so that they would not be exposed to the parasite.

The two scientists met each other at a conference. They happened to talk about their inferences about the village, and decided to travel there together to find the real cause of the villagers' immunity.

What preliminary study might they do in Africa?

They could try the root beer on non-villagers who did not yet have the parasite. Taking some of the villagers into infested areas, while possibly providing useful information, would obviously be an unethical practice.

(If you want to carry this discussion further, you can have students consider appropriate hypotheses and experimental design, but it is not necessary.)

Activity 3.4

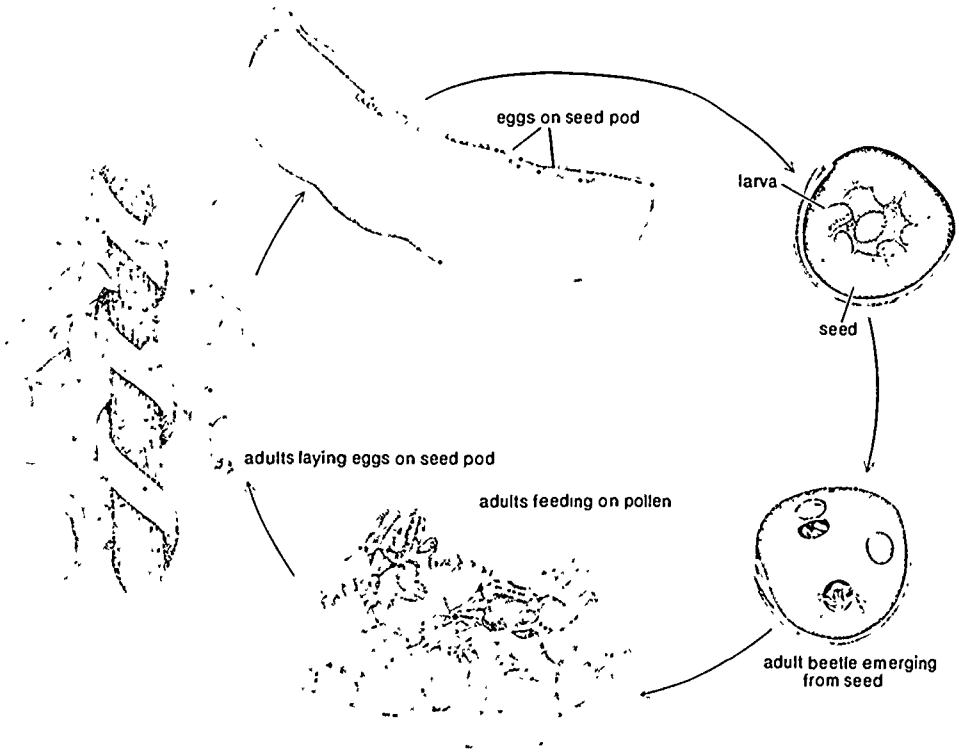
Combined Skill: Generalizing a concept from the chapter to new instances. The main concept here is *niche;* food chains and webs also are reviewed:

Students can carry out this activity after completing the chapter.

FINDING A NICHE

The plant *Dioclea* grows in Kentucky. It is a legume, or pod-bearing plant; unlike peas or beans, however, it is poisonous to most insects. To most insects, but not to all. A certain beetle, *Caryedes,* eats nothing else.

The beetle's life cycle is completely dependent on *Dioclea.* The immature beetles, or larvae, grow inside the plant's seeds. When they become adults, the beetles emerge from the seeds and feed on the plant's pollen. Then they lay their eggs on the seed pods. The eggs hatch into larvae, which burrow into the seeds; and the cycle repeats.



Another insect in Kentucky is the tobacco hornworm. It cannot eat *Dioclea*, but it feeds on tomatoes, tobacco, and other plants.

Draw the food chains described above.

Dioclea → *Caryedes*
tobacco → tobacco hornworm
tomato → tobacco hornworm
other plants → tobacco hornworm

Note that a separate food chain must be drawn for *Dioclea* and *Caryedes*, while the other organisms are links in a large food web, only a small part of which is shown here.

Describe the niches occupied by *Dioclea* and *Caryedes*.

The plant is protected from being eaten by most insects. The insect has no competition for the plant, but can eat nothing else.

What advantages and disadvantages are there to this arrangement for *Dioclea?*

Advantages: Protection from most insects
Disadvantages: No obvious ones (Most legumes do not depend on insects for pollination, so the disadvantage of specialization is probably not a problem here.)

What advantages and disadvantages are there to this arrangement for *Caryedes?*

Advantages: Lack of competition
Disadvantages: Dependence on one plant for food

Chapter 4

Activity 4.1

Communication Skill: Outline writing
This activity can precede the chapter.

WRITING AN OUTLINE

Outlines are useful for two main purposes: summarizing what someone else has written, and planning what you are going to write.

Outlining what others have written is especially useful if you want to criticize their writing. Scientists often exchange rough drafts of their papers before sending them to publishers. If you are asked to criticize someone's rough draft, you can help him or her organize the paper by outlining it yourself.

Outlining a paper you are planning is useful for self-criticism, also. By using an outline before writing, you can make sure that you include all the major points you want to cover. You also can check to see whether you have included topics that are unimportant for the paper you are planning. If you have, you can take them out of the outline; that will save time later in writing and revising.

The following outline is based on chapter 3 in your textbook.

COMMUNITIES AND ECOSYSTEMS

A. Introduction
B. Life in a Community
   3.1 Many interactions are indirect.
   3.2 The Florida river community has many interacting populations.
   3.3 A niche represents all the activities of an organism.
   3.4 Organisms can benefit from or be harmed by other organisms.
C. Ecosystem Structure
   3.5 The boundary of an ecosystem is difficult to determine.
   3.6 A change in the abiotic environment causes many changes in the biotic community.
   3.7 Within a community there are generally more producers than consumers.
D. Ecosystem Stability and Human Influence
   3.8 An ecosystem with many organisms is usually stable.
   3.9 Humans upset the stability of ecosystems.
   3.10 Human activity creates biocide-resistant organisms.
   3.11 Humans cause the extinction of many species.
   3.12 Humans can preserve natural areas for the future.

Do any of the numbered headings seem out of place? Which one?

3.7, judged only by its title, seems to belong in part A, rather than B.

Look at the paragraphs in that section. Can you understand its placement now?

It includes material on the abiotic environment, and so it does belong in part B, Ecosystem Structure.

If you were writing an outline for a textbook and came across such a problem, how would you solve it?

In a case like this, the title could be rewritten. If the section actually belonged somewhere else, the chapter should be reorganized.

Why do you think the section headings are written in the form of complete sentences?

The authors stated important principles in the section headings. Take this opportunity to point out that section headings can be useful clues to the main ideas in a chapter.

Activity 4.2

Combined Skill: Vocabulary
This activity can be carried out at any time.

THE LANGUAGE OF SCIENCE

You probably think that you speak only one or two languages. But if you use BASIC or some other computer language, that is another language, just as French or German is. You may use different "languages" with your friends, your teachers, and your family.

Science has a language of its own, too. You will learn as many new words in biology this year as you would learn in the first year of a foreign language. Fortunately, there are some things you can do to learn the special language of science quickly, without just memorizing each new term.

1. Many prefixes and suffixes are added to "root words" in science to show variations from the root word. If you know what a prefix or suffix means, you can recognize it in combination with any root word. For example, you probably know that the prefix *bio-* means "life" or "living" and that the suffix *-ology* means "the study of." List some other words that begin with *bio-*, and write their definitions.

List some other words that end with *-ology*, and give their definitions.

Look through the glossary and index at the end of your textbook. Pick out some of the prefixes and suffixes that appear more than once. See if you can figure out what they mean. Check your answers in a dictionary.

List them below.

Prefix	Meaning

Suffix	Meaning

Here are some "made-up" words. If you found them in a science article, how would you define them?

Erythrophyll Red matter in plants

Anthrovore Man-eater

Neozoic Referring to new animals

Oxymolecular Molecule containing oxygen

Make up some words yourself. See if other students can translate them.

2. Knowing the original meaning of a mysterious scientific word can help you remember its present meaning. Using an unabridged dictionary, look up and write down the derivations of the following terms:

Epidemic Greek: *epi*, upon, + *demos*, the people

Vector Latin: carrier

Niche Late Latin: *nidiculare*, to make a nest

Opiate Medieval Latin: *opiatus*, bringing sleep

3. Try to study in a place where you can use a dictionary. Looking up an unfamiliar word immediately will help you understand what you are reading. If you have no dictionary available, write the word down so you will remember to look it up later.

Activity 4.3

Science Skill: Using data tables
This activity can be carried out during the chapter.

USING TABLES OF DATA

Most science articles, and many newspaper articles, contain tables of data, or information. They may appear at first to be mainly confusing columns of numbers. If you learn to use such tables, however, you can acquire and use a large amount of information quickly. If the information were written out in paragraph form, it would take up a great deal of space and could not be used as easily.

The simple table below shows the results of growing maple seedlings in different solutions. The left column shows the original dry weight of each seedling. The other columns show what each seedling weighed after two months of growth on sphagnum moss, water, and other nutrients.

Dry weight (grams) after growth in solutions containing:

Original dry weight in grams	Water only	Phosphorus (P) and potassium (K) but no nitrogen (N)	N and K but No P	N and P but No K	N and P and K
0.038	0.077	0.071	0.077	0.490	0.423

Which element(s) contributed greatly to seedling growth? N and P

Which element(s) is/are not essential to seedling growth? K

The table below is more complex. It shows the average weight (in 1979) of Americans according to age, height, and gender.

Average Weight of Americans by Height and Age

The figures represent weights in ordinary indoor clothing and shoes, and heights with shoes.

Men							Women						
Height	20–24	25–29	30–39	40–49	50–59	60–69	Height	20–24	25–29	30–39	40–49	50–59	60–69
5′2″	130	134	138	140	141	140	4′10″	105	110	113	118	121	123
5′3″	136	140	143	144	145	144	4′11″	110	112	115	121	125	127
5′4″	139	143	147	149	150	149	5′0″	112	114	118	123	127	130
5′5″	143	147	151	154	155	153	5′1″	116	119	121	127	131	133
5′6″	148	152	156	158	159	158	5′2″	120	121	124	129	133	136
5′7″	153	156	160	163	164	163	5′3″	124	125	128	133	137	140
5′8″	157	161	165	167	168	167	5′4″	127	128	131	136	141	143
5′9″	163	166	170	172	173	172	5′5″	130	132	134	139	144	147
5′10″	167	171	174	176	177	176	5′6″	133	134	137	143	147	150
5′11″	171	175	179	181	182	181	5′7″	137	138	141	147	152	155
6′0″	176	181	184	186	187	186	5′8″	141	142	145	150	156	158
6′1″	182	186	190	192	193	191	5′9″	146	148	150	155	159	161
6′2″	187	191	195	197	198	196	5′10″	149	150	153	158	162	163
6′3″	193	197	201	203	204	200	5′11″	155	156	159	162	166	167
6′4″	198	202	206	208	209	207	6′0″	157	159	164	168	171	172

Who is likely to weigh more, a 5′9″ man of 45 or a 6′9″ women of the same age? The man.

Is there a general trend in weight according to age in women? It increases.

In men? _____

It increases until the age of 60, then falls. Probably men who do not lose weight during middle age are more likely to die before the age of 60, and the average weight is based on the survivors.

What is the general trend in weight according to height in men? It increases.

What is the general trend in weight according to height in women? It increases.

Use the following paragraphs to make a data table of your own.

A research analyst at the Population Council did a study of death rates owing to fatal heart attacks in women aged 40 to 44. He found that for American and British women in that age range, the annual death rate for women who neither smoked nor used oral contraceptives was 7.4 per 100,000. On the other hand, women aged 40 to 44 who did not smoke but who did use "the pill" had a death rate of 10.7 per 100,000. For women who smoked but did not use the pill, the rate was 15.9. The death rate was 62 per 100,000 in women who both smoked and used the pill.

Death Rates Per 100,000 Women Aged 40–44

	Non-smokers	Smokers
Non-pill-users	7.4	15.9
Pill-users	10.7	62

Activity 4.4

Science Skill: Identifying variables
Students can carry out this activity after completing the chapter.

VARIABLES

A variable is anything that changes. Scientists study some things that vary naturally, such as population size or the pH of water. When they plan experiments, they control variables and see how changing each variable changes the outcome of the experiment.

Many natural variables can be seen in chapter 4 of your textbook. For example, every molecule varies in the atoms that make it up. For each of the following things, what may vary?

Adenosine phosphates Number of phosphates

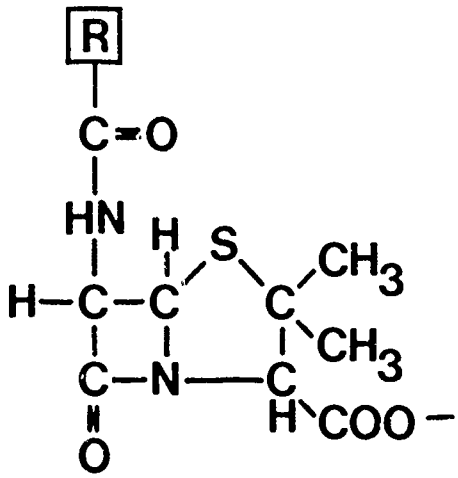
Carbohydrates Number and type of sugar units

Proteins Amino acids or peptides

Enzyme activity Temperature and pH

The variable that changes first in a system is called the *independent* variable. If something else changes because it depends on the independent variable, that is a *dependent* variable. During the growth of a population, for example, the population size is a dependent variable, and time is an independent variable.

In testing new drugs for effectiveness, chemists for drug companies may vary portions of drug molecules. For example, here is the molecular formula for penicillin:



The portion labeled "R" can be modified to form other penicillins, such as staphcillin or ampicillin. Write a paragraph describing how new penicillins might be tested for effectiveness against a new strain of bacteria. Correctly use the terms "independent variable" and "dependent variable" in the paragraph.

The paragraph should include the use of "independent variable" for the portion of the penicillin molecule that is substituted, and "dependent variable" for effectiveness against the bacteria.

Chapter 5

Activity 5.1

Communication Skills: Finding the main idea in a paragraph and Identifying the method of paragraph development
Students can do this activity before chapter 5.

THE MAIN IDEA

In well-written science material, each paragraph has a main idea. Usually that idea is stated in one sentence, called the topic sentence. The topic sentence is often the first sentence in the paragraph.

The rest of the paragraph develops the main idea further. Development may take the form of providing examples, making comparisons, giving details, or adding information to the topic sentence in other ways.

Read the following paragraph, written in 1674 by van Leeuwenhoek:

> About two hours distant from this Town there lies an inland lake, called the Berkelse Mere, whose bottom in many places is very marshy, or boggy. Its water is in winter very clear, but at the beginning or in the middle of summer it becomes whitish, and there are then little green clouds floating through it; which, according to the saying of the country folk dwelling thereabout, is caused by the dew, which happens to fall at that time, and which they call honey-dew. This water is abounding in fish, which is very good and savoury. Passing just lately over this lake, at a time when the wind blew pretty hard, and seeing the water as above described, I took up a little of it in a glass phial; and examining this water next day, I found floating therein divers earthy particles, and some green streaks, spirally wound serpentwise, and orderly arranged, after the manner of the copper or tin worms, which distillers use to cool their liquors as they distil over. The whole circumference of each of these streaks was about the thickness of a hair of one's head. Other particles had but the beginning of the foresaid streak; but all consisted of very small green globules joined together: and there were very many small green globules as well. Among these there were, besides, very many little animalcules, whereof some were roundish while others, a bit bigger, consisted of an oval. On these last I saw two little legs near the head, and two little fins at the hindmost end of the body. Others were somewhat longer than an oval, and these were very slow a-moving, and few in number. These animalcules had divers colours, some being whitish and transparent; others with green and very glittering little scales; others again were green in the middle, and before and behind white; others yet were ashen grey. And the motion of most of these animalcules in the water was so swift, and so various, upwards, downwards, and round about, that 'twas wonderful to see. and I judge that some of these little creatures were above a thousand times smaller than the smallest ones I have ever yet seen, upon the rind of cheese, in wheaten flour, mould, and the like. (From Clifford Dobell, 1958, *Antony van Leeuwenhoek and His 'Little Animals'* (New York: Russell and Russell).)

What is the main idea in the paragraph?

Van Leeuwenhoek took some water from a lake in summer and found microscopic organisms in it.

If the paragraph has a topic sentence, underline it.
How is the paragraph developed?

Details about the organisms are provided.

Activity 5.2

Science Skill: Identifying a hypothesis
Students can do this activity during the chapter.

IDENTIFYING A HYPOTHESIS

A hypothesis is sometimes called an "educated guess." All of us make informal hypotheses, based on our past experiences and knowledge. For example, if you observed a great many sparrows, and each of them had white crossbars on its wings, you might hypothesize that all sparrows have them. Each time you observe another sparrow, you test that hypothesis.

Suppose a biology student makes these observations:

1. White blood cells have nuclei, though they may vary in size and shape.
2. Paramecia contain contractile vacuoles, nuclei, and food vacuoles.
3. A textbook illustration of a "typical cell" shows mitochondria, a nucleus, an endoplasmic reticulum, and other structures.
4. In plant leaf cells, chloroplasts nearly fill the cells, almost hiding the nuclei from view.
5. A description of viruses states that viruses invade their hosts' nuclei.

What hypothesis is the student likely to make concerning the parts of a cell?

All cells have nuclei.

Suppose he or she continued making observations. For each of the following observations, state whether it would support or disprove the hypothesis.

human kidney cells: support

slide of cat brain cells: support

human red blood cells: do not support

organisms in pond water: support

What might the student do as a result of these tests of the hypothesis?

Modify it to "nearly all cells have nuclei."

Activity 5.3

Combined Skill: Writing questions and answers about written material
Students can do this activity after completing the chapter.

LEARNING BY QUESTIONING

One of the fastest ways to discover whether you understand written material is to try to write a quiz covering it.

Review sections 5.10 through 5.13 in the textbook and write a quiz covering the sections. Write at least 10 questions. You may want to provide some sketches to be labeled, or write questions beginning, "Draw the following. . . ." Emphasize questions on the topics you think are important, not trivial details. Write an answer key, also.

Help students to focus on broad ideas and to write integrative questions.

Close your textbook and try taking the test yourself. When you can answer the questions, exchange your test with another student. Take each other's tests and mark each other's answers. If you disagree on some test items, look them up in the textbook.

Activity 5.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this activity after completing the chapter.

DIFFUSION

A "typical" human body cell contains these proportions of substances:

70% water
1% inorganic ions (such as sodium, potassium, calcium, and magnesium)
15% proteins
7% nucleic acids
3% carbohydrates (2% sugar and 1% starch)
2% lipids
2% other substances

Assume for this activity that water, inorganic ions, sugar, and "other substances" can pass through cell membranes; and that proteins, nucleic acids, starch, and lipids cannot. Assume also that diffusion is based on the percentage composition of substances. (For example, an increase in percentage of CO_2 inside a cell will have the same effect as an increase in the concentration of CO_2, regardless of what happens to the other substances in the cell.)

Suppose that each column in the table below represents a test tube containing the percentages of substances listed, and the cell at the top is a body cell placed in the test tube. Using colored pencils, draw arrows to show the movements of substances across the cell membrane. Key them as shown in the table.

Percentage Composition of Solution in Test Tube

	Test-tube Number							
	1	2	3	4	5	6	7	8
Substance								
water	65	75	68	68	70	73	70	65
(blue arrows)	out	in	out	out		in		out
inorganic ions	5	1	2	1	1	0.5	1	1
(red arrows)	in		in			out		
proteins	18	10	10	10	13	17	18	15
(yellow arrows)	no movement							
nucleic acids	7	2	10	7	5	5	7	5
(green arrows)	no movement							
sugar	3	3	3	3	5	0	1	0
(purple arrows)	in	in	in	in	in	out	out	out
starch	0	1	2	1	1	2	1	4
(orange arrows)	no movement							
lipids	1	1	3	1	2	2	1	1
(pink arrows)	no movement							
other substances	1	7	2	9	3	0.5	1	9
(black arrows)	out	in		in	in	out	out	in

Chapter 6

Activity 6.1

Communication Skill: Using the library
Students can do this activity before reading chapter 6.

LIBRARY RESEARCH

An essential part of any scientific investigation and one of the first steps in the process is a search of the literature. Once a problem has been clearly defined, the investigator or a member of the investigative team spends many hours in the library searching out as much information about the problem as can be found.

This information is valuable in many ways: questions about the problem are answered, it prevents the duplication of research already done, and data gathered is useful in the development of hypotheses. Knowing how to do a search of the literature is a valuable tool, not only for scientific investigations but for any academic endeavor and even for use in recreational and leisure reading.

The goal of this activity is to learn how to locate the books, magazines, or newspapers in a library that contain the information you are seeking. The information search begins with the card catalog, an index of a library's holdings. It is most often filed in drawers in alphabetical order. In large, modern libraries, the card catalog may be on film or computer files.

Each item in the library usually has more than one entry in the card catalog. The title of the source will be on one card, the author on a second card, and often the subject will be on a third card.

Listed below are three major topics discussed in chapter 6. Select one of these topics and use the subject headings in a library's card catalog to determine how many books that library has on the particular topic. List the books by title, author, date of publication, city of publication, and publisher.

Topic	Possible subject headings
Reproduction	Science
	Zoology
	Biology
Meiosis	Life science
	Fetus
	Embryology
Fertilization	Pregnancy
	Reproductive system
	Reproduction
	Fertilization
	Cell division
	Genetics
	Fertility

In looking through the card catalog, you may see directions to "see also" other subject headings. If you find other useful subject headings in that way, list them below.

The goal of this activity is to become familiar with the card catalog, so nothing is said about locating the books, magazines, or newspapers in the library. If you feel such experience would be valuable at this time you can add it to the activity.

Some valuable references are:

M. G. Cook, 1975, *The New Library Key* (New York: The H. W. Wilson Co.).

C. C. Kuhlthau, 1985, *Teaching the Library Research Process* (West Nyack, NY: The Center for Applied Research in Education, Inc.).

C. Wolf and R. Wolf, 1986, *Basic Library Skills* (Jefferson, NC: McFarland and Company, Inc.).

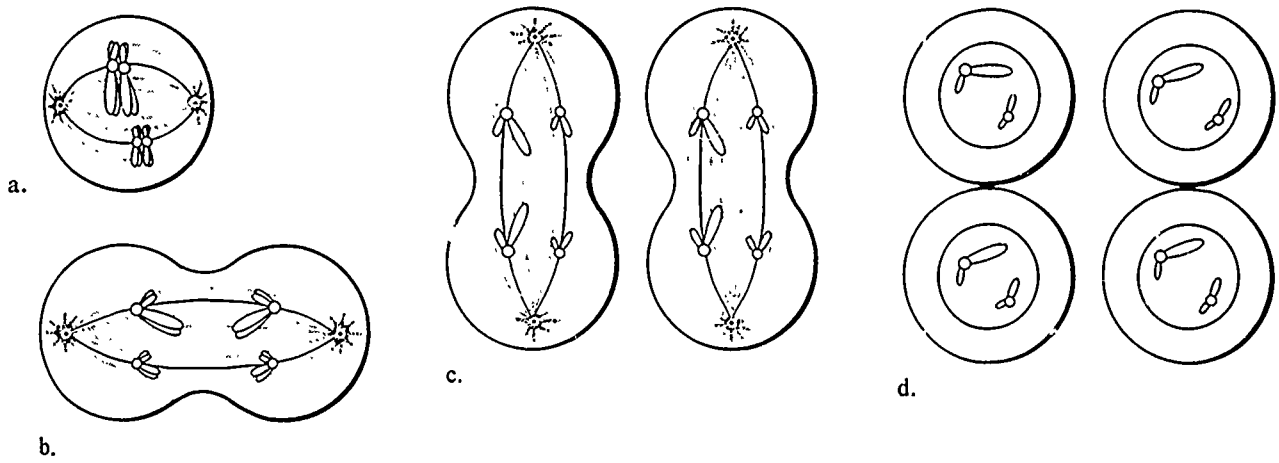
Activity 6.2

Science Skill: Describing properties and changes
Students can do this activity during or after the chapter.

PICTURING MEIOSIS

Sometimes in science writing, pictures can accompany the text, making long explanations unnecessary. At other times, pictures are not available or cannot be used. So, it is important to be able to describe objects, events, and changes accurately in words.

Examine the four drawings of meiotic stages shown below. Describe the cell and its contents at each stage as thoroughly as possible. Try to make the description so complete that someone reading it could picture everything that is shown in the drawing.



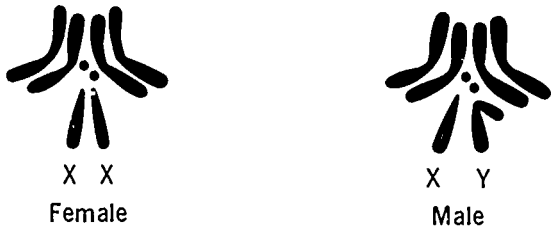
The description should include the chromosomes and chromatin, the splitting of the cell into two, then into four; the movements of the chromosomes to the equatorial plate and to the ends of the cell; and so on. Be sure students do not add inferences to their descriptions.

Activity 6.3

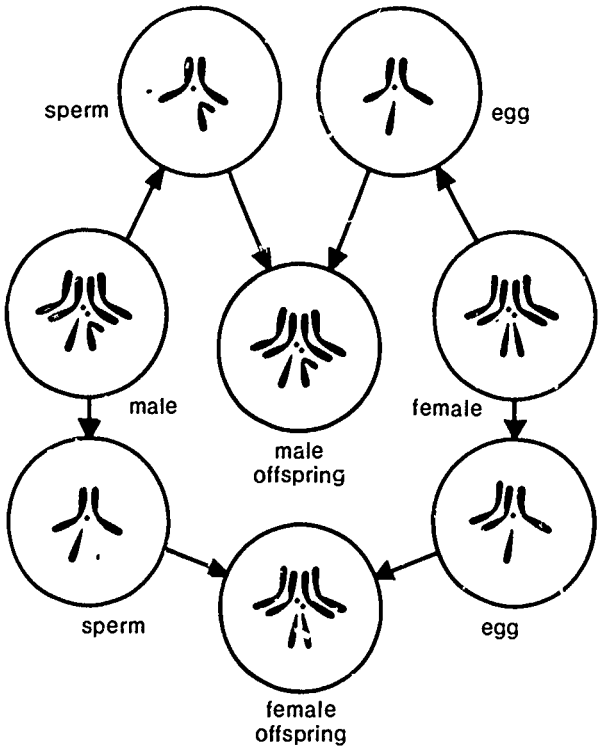
Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this during or after the chapter.

THE *Drosophila* LIFE CYCLE

The pictures below show the diploid chromosomes of *Drosophila melanogaster.*



In the circles below, draw the chromosomes as they would appear at each stage.



Activity 6.4

Science Skill: Making predictions from hypotheses
Students can do this activity after completing the chapter.

PANGENESIS

The English biologist Charles Darwin knew nothing of chromosomes or meiosis. These were discovered after his death, when microscopes and staining techniques led to new knowledge of cellular events.

In trying to explain how inheritance took place, Darwin resorted to the idea of pangenesis, which originated with the Greeks about 2,000 years ago. Darwin thought that gemmules, representative particles, came from all parts of the body and entered the gametes. In this way the parents' characteristics were transmitted to the offspring.

The test of any hypothesis is whether the predictions from it are supported by evidence. Make some predictions from the pangenesis hypothesis. (For example, what would you predict about the offspring of two brown-eyed parents? What would you predict about the chromosomes in body cells and sex cells? If a man and woman had lost limbs in accidents before having children, would their children have normal limbs?) Compare the predictions with evidence from everyday observations or from studies of cells. If the predictions do not agree with the evidence, the hypothesis is disproved (you have shown it to be false).

Encourage students to see why the theory as well as the fallacies in it endured for so long.

On the other hand, if the evidence agrees with the hypothesis, that does not prove the hypothesis is true. For example, you might make a hypothesis that the tooth fairy leaves money when you leave an extracted tooth under your pillow, and produce evidence that seems to support your hypothesis. However, other explanations that are less entertaining but more accurate are possible. It is seldom possible to prove conclusively that a hypothesis is true; in most cases all you can do is to make rigorous tests of it. If the tests cannot disprove the hypothesis, then it is *probably* true.

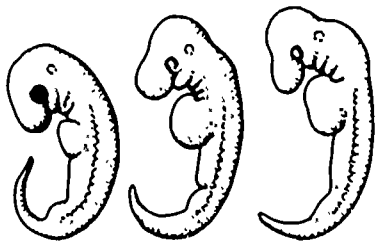
Chapter 7

Activity 7.1

Science Skill: Observing and describing properties and changes
Students can do this activity before starting the chapter.

EMBRYONIC DEVELOPMENT

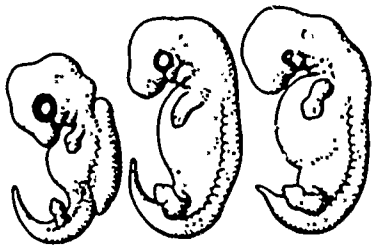
The early stages of embryonic development are similar for different kinds of organisms. Look at the three embryos below.



In the space below, describe what you see in common for all three embryos. Observe the embryos carefully as you write your observations.

Responses will vary, as will terminology, but they should describe a head, tail, and eyespot that are in common. They also should recognize the general similarity in overall shape. Some may mention the eyespot and the beginnings of an ear. The gill slits and what they might call forelimb buds should also be included.

After a short time has passed, the three embryos have changed considerably. Observe the three embryos below. In the space below, describe how each embryo has changed from the first observations that you made.

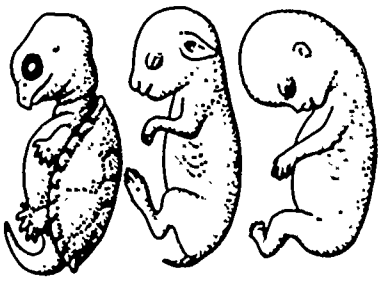


Each of the organisms is larger and has forelimb and hindlimb buds. The tails are shorter. The stomach region is larger for all three embryos. The eyespot is larger for the two embryos on the left.

Now describe any differences that you see between the three embryos. Write your observations in the space below.

The eyespot is larger on the embryo at the left, next largest in the center embryo, and smallest on the embryo at the right. The embryo on the left is developing some kind of structure on its dorsal surface. It also has more bumps on its head than the other two. The gill slits are much reduced in the embryo on the right. The embryo in the center has a smaller bulge in the stomach region than the other two. The forelimb buds are longest on the center embryo, and widest on the embryo on the right. The hindlimb buds are smallest on the embryo on the left.

Observe below the same embryos after more time has passed. They still are not ready to be born, but they are increasing in their maturity.



In the space below, describe each of the embryos. If you think you have enough information, write the kind of animal each will become.

No descriptions are included here. The students should describe the general characteristics of each of the three embryos. The embryos are, from left to right, a tortoise, a rabbit, and a human. The students should probably get the tortoise (or turtle) and the human, but they might not guess the rabbit. The correct response is not important, but the observations and descriptions should be complete.

As you continue in your biology class, keep trying to make more and better observations. Continual practice will help you improve with this important science skill.

Activity 7.2

Communication Skill: SQ3R method
Students can do this activity before or during the chapter.

UNDERSTANDING EMBRYONIC DEVELOPMENT

The SQ3R method is a tool that can help you understand what you read. These are the steps to follow:

1. S: *Skim* the passage quickly.
2. Q: Note the major *questions* that you think are answered by the passage. Watch for clues in the printing, such as headings and boldface type. The authors used these to emphasize major ideas or vocabulary.
3. R: *Read* the passage carefully.
4. R: *Recite* the answers to the questions.
5. R: *Review* the passage. Find any answers you missed earlier.

Try this method on sections 7.1 through 7.4. These sections deal with one of the true miracles of nature, the development of a living organism from a single cell to a complex mass of cells functioning smoothly together. Use the space below to formulate your questions and to write your responses to the questions you raised.

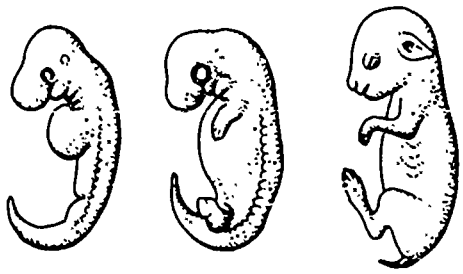
Questions	Answers

Activity 7.3

Science Skill: Formulating hypotheses
Students can do this activity during the chapter.

DEVELOPMENT OF A HYPOTHESIS

In Activity 7.1 of this Study Guide you observed and described the development of three different embryos. At the conclusion of Activity 7.1 you were asked to guess what kinds of animals were represented in the illustrations. You probably guessed correctly for the organism on the left side of the page (go back and look at it again, if you would like to). If you guessed tortoise, you were correct. If you guessed turtle, you were very close, but not completely correct. You probably also guessed correctly for the organism on the right side of the page. If you guessed human, you were correct. What did you guess for the organism in the center of the illustration? The three stages of embryonic development for the organism are repeated below. Observe the sequence carefully.



In the space below, write the characteristics that might help you decide what the organism is.

The students will probably list many things here, but the ears, face structure, tail, and hind limb structure are the most important.

A hypothesis is an educated guess that is based on some data. The observations that you listed above are your data. A hypothesis is usually written in an "if . . ., then . . ." format. For example, the following could be a hypothesis about the first organism: "If the first organism in Activity 7.1 has a shell on its back, a shell on its stomach, and a tail, then it is probably a turtle." Using your data from above, write in the space below a hypothesis about what you think organism 2 might be. Make certain that you use the "if . . ., then . . ." format.

Biologists are formulating hypotheses during much of the time they are conducting their research. Carefully formulated hypotheses can be used easily to set up and design an experiment. Find out if your hypothesis is correct. Your teacher will tell you what the organism is. If you were correct, write in the space below the data that were most important for you in developing your hypothesis. If you were not correct, go back and observe the illustration again. What structures give you the most important clues about what the organism is? Write the names of those structures in the space below.

You will have more opportunities to develop hypotheses in other study guide activities. Remember, it is not important whether you were wrong or right with your hypothesis. Biologists find evidence that supports and refutes their hypotheses all the time. The point of this activity is to learn how to phrase a hypothesis. This is one of the important skills in science.

Activity 7.4

Combined Skill: Defending a thesis with evidence
Students can do this activity after the chapter.

SECOND-HAND CIGARETTE SMOKE

The Surgeon General of the United States has issued two separate warnings about the dangers associated with cigarette smoking. Smokers are more likely to develop lung and other cancers as well as cardiovascular disease. In addition, smoking by pregnant women has been associated with possible damage to the embryo. Among the effects observed are low birth weight and premature birth.

Recently, new findings have been published in the United States and in Japan that indicate that people who breathe the smoke from other people's cigarettes are also at risk for lung cancer and other respiratory disorders. Deeply imbedded in this issue are the rights of individual persons. Smokers claim the right to smoke and to take into their bodies anything they desire. Non-smokers claim they have the right to breathe pure air without being exposed to the hazards of second-hand cigarette smoke. "Your right to smoke ends where my nose begins," is a common phrase used by non-smokers.

Take a stand on this issue and support your stand with data. You may use material from your text, the school library, public libraries, or from the popular media such as newspapers and magazines. Try to keep in mind three important questions as you read. First, what are the data? You should ask yourself whether the author is presenting data or simply opinions. Second, what do the data mean? Is the author interpreting the data correctly or "twisting" the data to make it fit some particular position? Third, what are the professional credentials of the author? Is the author a recognized professional, or someone who is simply expressing opinions that are not backed up by any kind of professional training or academic degrees? Sort through the sources carefully and submit your written report to your teacher.

You may want to take a few days in class to listen to oral reports on this issue. If you desire, you can expand the topics to air pollution in general and allow the students to report on different types of pollution and their effects on the human body.

Chapter 8

Activity 8.1

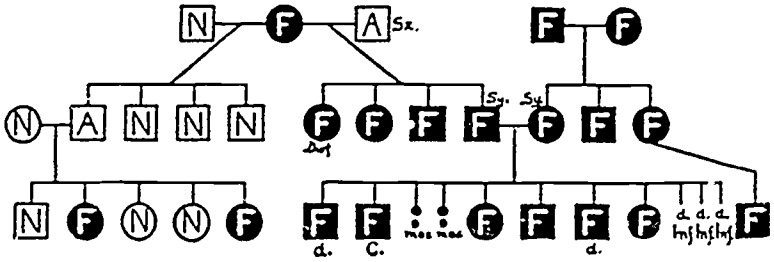
Combined Skill: Identifying fact v. opinion
Students can do this activity before beginning chapter 8.

TEXTBOOKS AREN'T PERFECT

You probably think of science textbooks as being filled with facts and being free of opinions. However, even the authors of science textbooks are sometimes guilty of presenting opinion as fact.

Early in this century, there was a biological and social movement called eugenics. The goal of eugenics was to improve the genetics of the American population. It took the forms of restricting immigration from some foreign countries and forbidding the marriage of anyone considered genetically inferior. Some of what the eugenecists taught was factual, but some was opinion or misinterpretation. For example, they sometimes labeled as "feeble-minded" people who could not speak English or who were physically ill from hookworms or other causes.

A textbook writer named George Hunter wrote biology textbooks that were used all over the country. The following illustration and quote are from a page in his 1914 textbook.



This chart shows that feeble-mindedness is a characteristic sure to be handed down in a family where it exists. The feeble-minded woman at the top left of the chart married twice. The first children from a normal father are all normal, but the other children from an alcoholic father are all feeble-minded. The right-hand side of the chart shows a terrible record of feeble-mindedness. Should feeble-minded people be allowed to marry? (After Davenport.)

The evidence and the moral speak for themselves!

Parasitism and its Cost to Society.—Hundreds of families such as those described above exist today, spreading disease, immorality, and crime to all parts of this country. The cost to society of such families is very severe. Just as certain animals or plants become parasitic on other plants or animals, these families have become parasitic on society. They not only do harm to others by corrupting, stealing, or spreading disease, but they are actually protected and cared for by the state out of public money. Largely for them the poorhouse and the asylum exist. They take from society, but they give nothing in return. They are true parasites.

The Remedy.—If such people were lower animals, we would probably kill them off to prevent them from spreading. Humanity will not allow this, but we do have the remedy of separating the sexes in

asylums or other places and in various ways preventing intermarriage and the possibilities of perpetuating such a low and degenerate race. Remedies of this sort have been tried successfully in Europe and are now meeting with success in this country. (George Hunter, 1914, *A Civic Biology*, (New York: American Book Company). Reprinted by permission of D. C. Heath and Company.)

What was Hunger advocating? Write a criticism of his argument.

Hunter wanted to forbid marriage, and thus childbirth, among the "feeble-minded." The pedigree appears authoritative, but note that the term "feeble-minded" is not defined. Note also the implication that alcoholism is equal to "feeble-mindedness." In addition, lack of normal intelligence is linked to diseases, immorality and crime; and there is no indication of what the family's environment was like.

No convincing evidence is presented here for Hunter's opinion, which was shared by many biologists and others. Eugenics persisted in biology textbooks until World War II, when Hitler's attempt to exterminate Jews was seen as the ultimate example of eugenics.

Activity 8.2

Science Skill: Interpreting data to test a hypothesis

Combined Skill: Generalizing a concept from the chapter to new instances.

Students can do this activity during or after reading chapter 8

THE LYON HYPOTHESIS

For many years, geneticists wrestled with a puzzle involving the X chromosome. Mutant genes on the X chromosome can cause genetic disorders. The geneticists questioned why a female who was homozygous for a mutant gene on her two X chromosomes was no more seriously affected by a particular disorder than a male, who had only one such gene on his single X chromosome. In 1961 Mary F. Lyon, a British geneticist, proposed a possible explanation of this puzzle.

The Lyon hypothesis is as follows. In each of the body cells of a normal female, one of the X chromosomes is inactivated. Inactivation occurs in the embryo about 16 days after conception. Either the maternal or the paternal X chromosome is inactivated, apparently by chance, in any given cell. Once inactivation occurs in a cell of a developing embryo, the same X chromosome will be inactivated in all cells that descend from that cell.

Listed below are some data resulting from observations of natural events. Indicate in the space following the data whether it supports or does not support the Lyon Hypothesis.

Below is some information you will need to help you make your decisions.

1. The genes for fur color in mice and cats are carried on the X chromosome.
2. Barr bodies are darkly stained masses that can be seen in the nucleus of certain cells of XX females.
3. Hemophilia is a recessive, X-linked trait that produces severe symptoms in males.

OBSERVATIONS

1. Female mice that were heterozygous for X-linked genes for coat color had fur that was made up of patches of the different color. supports
2. Male mice do not exhibit the patchy coat color seen in females. supports
3. Female mice with a single X chromosome (XO) do not show the patches of different color as seen in the XX females. supports
4. A Barr body appears to be an X chromosome which has been wound up on itself. supports
5. An enzyme called G6PD is produced by an X-linked gene in humans. There is no difference between normal females and males in the amount of enzyme produced. supports
6. The amount of G6PD in individuals with 3 or more X chromosomes is the same as that found in XX females. supports
7. The gene responsible for the production of an enzyme called steroid sulfatase is X-linked. Females normally produce twice the amount of this enzyme as males. does not support
8. Cells from heterozygous females who have two different alleles for different forms of G6PD on each X chromosome produce only one form of the enzyme. supports
9. Males with Klinefelter syndrome (XXY) have one Barr body in each cell. supports
10. Female carriers of hemophilia may be as severely affected as males, not affected at all, or have symptoms somewhere in between. supports
11. In kangaroos the inactivated X chromosome is always the paternal X. does not support
12. Calico cats are heterozygous for a coat color gene (black or yellow). An XXY male cat is calico (black and yellow patches of fur). supports

Activity 8.3

Communication Skill: Editing a paragraph
Students can do this activity after completing chapter 8.

EDITING A PARAGRAPH

Examine the following paragraph closely. Each sentence has at least one mistake in content, grammar, or usage. Circle the mistake and try to suggest a way of improving the sentence.

1 Crossing over occurs at the stage of mitosis where two homologous chromosomes specifically
2 attract each other to form pairs. The mechanism of this attraction (*pairing*) remain's a great
3 mystery. It is clearly a very specific process, since it occurs only among chromosomes containing
4 the same genes. Following the formation of pairs, both chromosomes occasionally brake at the same point and rejoin crossways. This allows the formation of recombinant chromosomes con-
5 taining some genes derived from the paternal chromosome and some genes derived from the maternal chromosome. Crossing over greatly increases the amount of genetic recombination and,
6 accept in highly specialized cases, is universally observed. The frequency of crossing over, however,
7, 8 varies greatly with the particular specie involved. On the average one, to several crossovers occur every time chromosomes pair. (Adapted from J. D. Watson, 1970, *Molecular Biology of the Gene*, 2nd edition (New York: W. A. Benjamin, Inc.): 187).

1. Pairing of homologous chromosomes occurs only in meiosis.
2. There is no apostrophe in "remains." Take this opportunity to point out also that apostrophes are not used for indicating plurals or the possessive form of pronouns (of "it," for example).
3. "Among" is used for three or more; "between" is used for pairs.
4. "Break" is misspelled.
5. Wordy and repetitious.
6. "Except" is misspelled.
7. The singular of "species" is also "species."
8. Misplaced comma.

The original paragraph is printed below.

Crossing over occurs at the stage of meiosis where two homologous chromosomes specifically attract each other to form pairs. The mechanism of this attraction (*pairing*) remains a great mystery. It is clearly a very specific process, since it occurs only between chromosomes containing the same genes. Following the formation of pairs, both chromosomes occasionally break at the same point and rejoin crossways This allows the formation of recombinant chromosomes containing some genes derived from the paternal chromosome and some from the maternal one. Crossing over greatly increases the amount of genetic recombination and, except in highly specialized cases, is universally observed. The frequency of crossing over, however, varies greatly with the particular species involved. On the average, one to several crossovers occur every time chromosomes pair. (From J. D. Watson, 1970, *Molecular Biology of the Gene*, 2nd edition (New York: W. A. Benjamin, Inc.): 187).

Chapter 9

Activity 9.1

Communication Skill: Outline some writing
Students can use this activity before or during the chapter.

OUTLINING THE THEORY OF EVOLUTION BY NATURAL SELECTION

The theory of evolution by natural selection unifies the entire field of biology. It is important that you understand the basic premises and ideas that constitute the theory. One way of identifying the important parts of the theory is to outline a section of the text that deals with evolution by natural selection. Section 9.3 provides an overview of how Darwin synthesized the theory of natural selection. Read this section of the text carefully, then return to the Study Guide. As you answer the following questions, use a sheet of notebook paper to write a structured outline of section 9.3. What is the title of section 9.3? Write your answer here and at the top center of your sheet of notebook paper.

Darwin Formulated the Theory of Natural Selection

Read the first two paragraphs of the section. What is the major, overall idea that is presented in these two paragraphs? Write a roman numeral I on the left side of your notebook paper just below the title of section 9.3. Write the main idea after the roman numeral I. Also, write your answer in the space below.

Responses will vary but should include something about Darwin's background.

Read the next five paragraphs (through the paragraph about the finches). Write a roman numeral II below roman numeral I on your sheet of paper. Next to the roman numeral II, and in the space below, write the main idea covered in the five paragraphs.

Darwin in South America and the Galápagos Islands

Under roman numeral II, add the capital letters A through E. Write the main idea of each of the five paragraphs next to these letters on your paper.

A. Darwin in Brazil and Chile
B. Darwin's writings
C. Current species descend from ancestral species
D. Galápagos Islands
E. Finches

Continue outlining the rest of section 9.3 in the same manner that you have completed the first few paragraphs. After you have completed the outline, go back and reread the section and compare it to your outline. Make any changes that you think are necessary.

Activity 9.2

Combined Skill: Using the library
Students can do this activity before or during the chapter.

EVOLUTION SEARCH

Books do not contain all the available information about a given topic. Current information is more likely to be found in journals and periodicals, especially in the area of science. It is important to know how to access such information.

Go to the library (either your school library or the local public library) to begin a search for current articles about evolution. The *Reader's Guide to Periodical Literature* contains references for all articles printed in popular periodicals for each year. It is the best place to start your search. The *Reader's Guide* is usually found in the reference section of the library, or with the magazines.

Look up the word evolution. There will be listings of articles in a number of periodicals and also a list of other categories under which you can look for more information. Write down all the articles listed under evolution, and also all the other topics to which you are referred by the *Reader's Guide.*

Find at least one of the current articles listed. Read the article and write down what you think are the main ideas and what new information is presented by the authors.

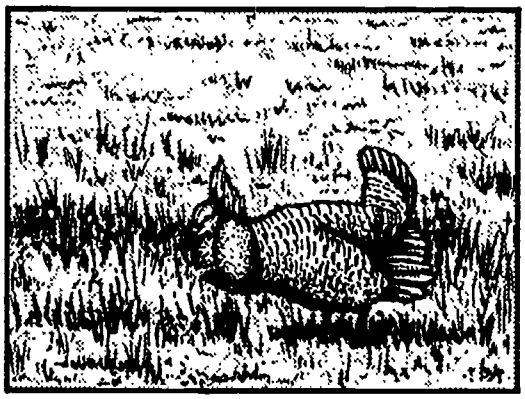
Activity 9.3

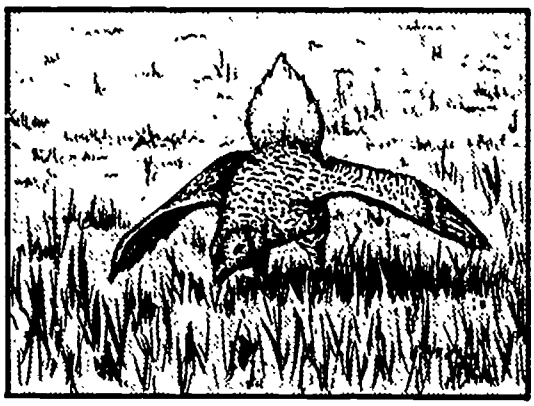
Science Skill: Revising a hypothesis
Students can do this activity before or during the chapter. If you have the BSCS film loop "Grouse: A Species Problem," it could be substituted for this written exercise. This film is now available in videotape form from Media Design Associates, P. O. Box 3189, Boulder, CO 80307

GROUSE: A SPECIES PROBLEM

The greater prairie chicken (*Tympanuchus cupido*) and the sharptail grouse (*Pedioecetes phasianellus*) are both members of the order Galliformes. Both birds have interesting reproductive behavior and have been studied intensively by biologists. The prairie chickens gather on "booming grounds" where the males inflate air sacs in their necks and make the characteristic "booming" sound. Each male establishes and defends a territory in which he displays for females that have gathered. Each male displays independent of all other males. The sharptail grouse also gather on "booming grounds," but the males display in unison. The sharptails appear to have a hidden "conductor" that tells the males to move together to display to the females. Both species exhibit foot stomping, lowered heads, and extended wings in their displays.

The prairie chicken has a fan-shaped tail that is white underneath and that has a banded pattern on the top. The sharptail has a pointed tail that is white underneath but lacks the banded pattern present on the prairie chicken. The air sac of the prairie chicken is orange. The air sac of the sharptail grouse is purple, and it is smaller. The male prairie chicken erects some feathers behind its head during the courtship displays. Whereas the body feathers of the prairie chicken have a distinct barred pattern, the sharptail grouse has a rather mottled appearance. Observe the two birds in the following illustration.





Biologists have long hypothesized that these birds are in different genera. What is the genus of the prairie chicken? *Tympanuchus*

What is the genus of the sharptail grouse? *Pedioecetes*

The prairie chicken prefers open grassland habitats. The sharptail prefers open woodlands. Both of these types of habitats occur together in the central part of Wisconsin, and both birds are found in this small area.

What could you do to determine the genetic relationship between these two birds? Write down as many ideas as you can in the space below.

Ideas will be diverse, but could include responses such as, put them together in pens and see if they will breed, construct a karyotype to determine if their chromosome number is the same, study the blood proteins to determine how similar they are.

Select one of your hypotheses. In the space below, tell how you would set up an experiment to test your hypothesis. What results would confirm that the birds are in separate genera? What results would indicate that the birds are more closely related?

The responses will vary, depending on the students' hypotheses.

As biologists studied the two birds in Wisconsin, they found a third bird that had a large air sac like the prairie chicken, but it was purple in color like the sharptail grouse. Its tail feathers were intermediate in color and shape between those of the sharptail and the prairie chicken, as was the color pattern on its body feathers. Many other characteristics were intermediate between the two birds. How do these data affect the hypothesis that the two birds are in different genera?

The students may say that this proves that they are in the same genus or species, but fertility of offspring still needs to be determined.

After much observation these new birds were observed mating among themselves and with the sharptail and the prairie chicken. Young birds resulted from these matings, so the new bird is not sterile. How do these data affect the hypothesis that the two birds are in different genera?

These data would indicate that they are probably of the same species.

Explain the genetic relationship between the sharptail grouse and the prairie chicken, assuming that both birds have a common ancestor. Explain the processes involved that show how the two birds may have evolved.

The common ancestor must have been divided into two separate populations by a barrier of some kind (reproductive, geographic, or some other). After time had passed, the isolated populations diverged enough that their physical and behavioral characteristics became quite different.)

In your own words, write a hypothesis that explains the genetic relationship between the sharptail grouse and the prairie chicken, in light of the new evidence that has been gathered. Use the "if . . ., then . . ." format for your hypothesis.

If a fertile hybrid has been produced between the prairie chicken and the sharptail grouse, then the birds must be in the same species. Perhaps they are different subspecies of the same species

Activity 9.4

Combined Skill: Criticizing a statement
Students can do this activity after finishing the chapter.

FINDING FALLACIES

The paragraph below was taken from a children's science book. Based on your knowledge of evolution, genetics, and scientific methods, write a paragraph with the most vigorous criticism you can of the ideas in the statement. Watch out especially for fallacies (misconceptions or illogical reasoning).

> Biologists often try to explain how things work before they have done their experiments. Their explanations are called theories. Theories have to be tested by doing the right experiments. If a scientist proves a theory is correct, the theory becomes a fact. . . . No one has been able to prove that [evolution] is the way life on Earth developed. . . . It will continue to be a theory until someone performs experiments to prove it. (From *Life on Earth: Biology Today* (New York: Random House, 1983).)

Some critiques your students might develop are:
Biologists try to explain "how things work" by forming hypotheses.
Hypotheses help in the design of experiments.
Experiments are performed to gather data, which are used to evaluate hypotheses.
A theory is a large and important explanation of some related group of natural phenomena.
Evolution is a theory, because it is a large and important explanation of natural phenomena. Evolution (change) is also a fact, because it has happened and is continuing to happen.

The goal of science is not to "prove" a theory, but to get as much information as possible about each hypothesis. In that way a decision can be made about whether the hypothesis constitutes a useful and reasonable explanation of natural phenomena.

Chapter 10

Activity 10.1

Science Skill: Statistics
Students can do this before beginning chapter 10.

HOW MANY ROBINS?

In studying the evolution of populations, it often is important to calculate the mean (average) value of a characteristic in two or more populations for comparison. Suppose you are studying the brood size (number of young per mating season) of Robins. Here is the data you collect:

Brood	Number of young		
	Group A 28° N latitude	Group B 48° N latitude	Group C 62° N latitude
1	4	5	6
2	2	2	6
3	3	6	7
4	4	5	7
5	5	6	6
6	4	6	6
7	4	6	7
8	5	5	6
9	2	4	7
10	3	7	5
11	5	6	7
12	3	6	6
13	3	5	7
14	4	6	5
15	3	5	7
16	4	6	7
17	4	5	5
18	5	6	6
19	3	7	7
20	2	4	6
Mean	3.6	5.6	6.3
Standard deviation	0.99	0.82	0.73

Calculate the mean value for each group by adding the brood sizes and dividing by 20. Fill in those spaces in the table.

Notice that there is overlapping in the three groups. Also, many values deviate (differ) from the mean for that group. The first brood in Group A consisted of 4 young, whereas the mean was 3.6. The deviation from the mean for that brood was 0.4. You can calculate the standard deviation from the mean by adding all the separate deviations and averaging them. Calculate the standard deviation for the first three broods for Group A, just to be sure you understand how it works. What is the standard deviation for those 3 broods?

0.87 (Some calculators will round off the value to 1.)

Knowing whether the standard deviation is large or small tells you how the characteristic is distributed. If the standard deviation is large, many values will be far from the mean; if it is small, most values will be very near the mean value.

To calculate the standard deviation for a larger group, use a calculator. Fill in the standard deviation values for the three groups.

Depending on the backgrounds of your students, you may want to extend this activity to the topics of variance, probability values, and the t test. The activity here is intended to make beginning students comfortable with the first step in statistics.

Activity 10.2

Communication Skill: Making and using self-review materials
Students can begin this activity during the chapter and complete it after finishing the chapter.

CLASSIFICATION BINGO

Reviewing can be fun if you make a game of it. Work with some friends to set up a bingo-like game for reviewing classification.

Instead of letters, use at least three kinds of criteria for classification (such as nuclei and nutrition). Assign numbers to specific characteristics. For each of the five kingdoms, make about four cards or chips for each player.

Here is a game card designed by one team of students:

	1 Pro.	2 Eu.	3 Auto.	4 Het.	5 Asex.	6 Sex.
A. Nutrition						
B. Nuclei						
C. Reproduction						

One of you can call out letter/number combinations, produced by throwing dice or spinning a wheel. The others should put correct cards or chips on their playing cards. The first to fill squares correctly is the winner.

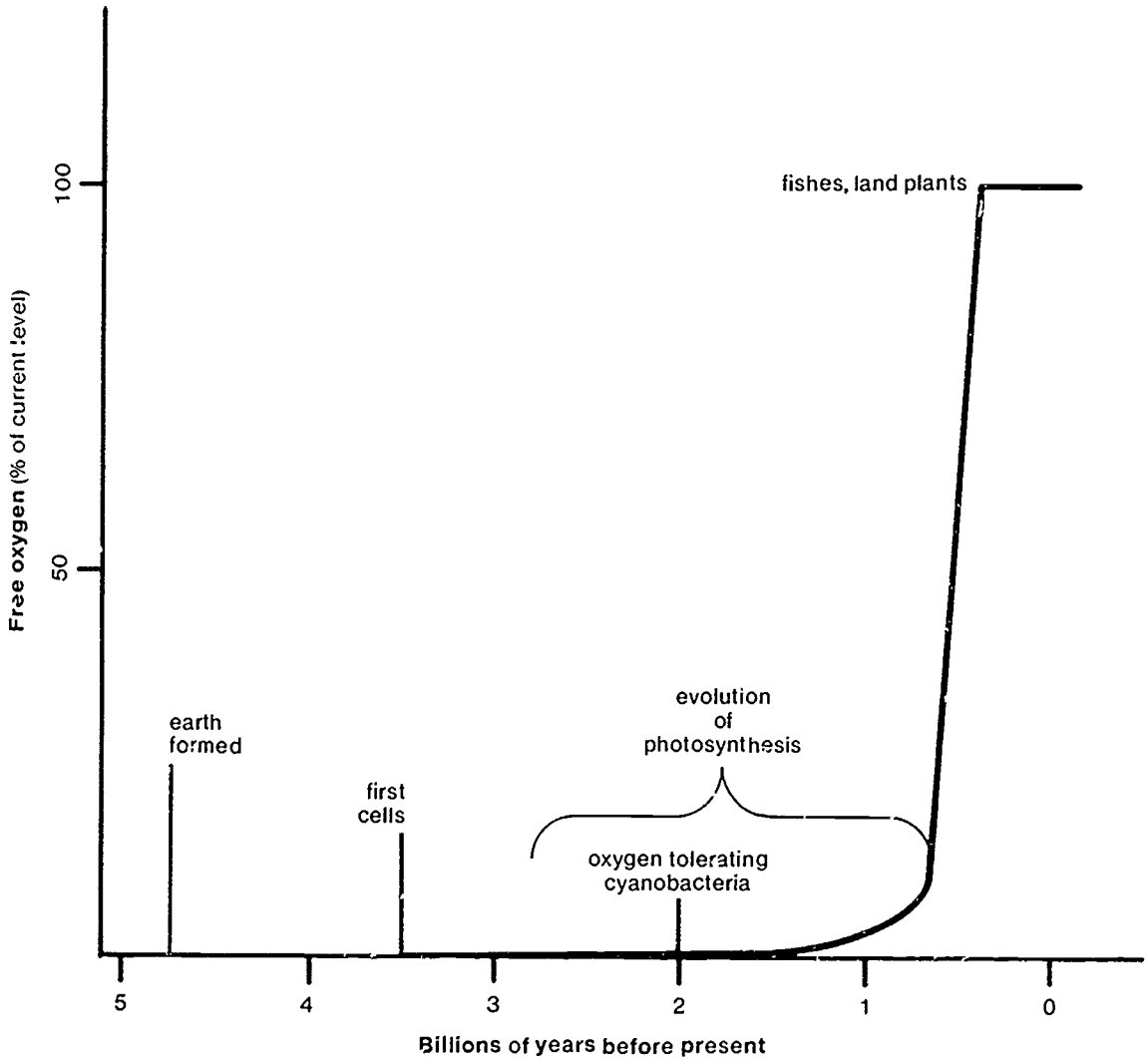
Activity 10.3

Science Skill: Making a graph
This activity can follow the chapter.

WHY WE HAVE OXYGEN

In sections 10.12 and 10.13 of your textbook, there is a description of how changes in organisms changed the atmosphere. Scientists have studied evidence of oxygen in the rocks. They have found that the atmosphere's current level of free oxygen was reached about 0.4 billion (400 million) years ago, when large fishes and the first land plants evolved. Oxygen-producing cyanobacteria evolved about 2 billion years ago, and probably the first living compounds were formed about 4 billion years ago, when there was no free oxygen in the atmosphere. Perhaps modern photosynthesis began about 1.5 billion years ago.

Draw a rough graph showing the change in free oxygen (from 0 to 100% of the current level) over the last 4 billion years. Label important events along the curve.



Activity 10.4

Communication Skills: Giving instructions and Using teamwork
Students can do this activity after completing chapter 10.

WORKING AS A TEAM

For this activity, work in teams of four. Work together to collect a group of at least 20 different pictures of similar animals or plants (such as 20 snakes, 20 evergreen trees, or 20 dogs).

Now, work as separate team members. Member 1 should decide what characteristics to use for classifying the organisms in the pictures and explain the decisions to Member 2 only.

Member 2 should make a dichotomous key, based on Member 1's instructions, and tell only Member 3 how to use the key with the pictures.

Member 3 should follow Member 2's instructions to use the key. Based on the results, Member 3 should tell Member 4 only how the key should be changed.

Member 4 should revise the key and explain the changes, and the reasons, to Member 1.

Chapter 11

Activity 11.1

Communication Skills: Skimming for meaning and Learning the function of paragraph structure
Students can do this activity before beginning chapter 11.

SKIMMING PARAGRAPHS

In Activity 3.1, you tried skimming a passage. You may have been surprised at how much you remembered.

Another approach to skimming makes use of paragraphs. In most science writing, the first paragraph states a problem or introduces a topic. The last paragraph sums up the results or reaches a conclusion. Each of the paragraphs in between has a main point, in most cases stated in the first sentence of the paragraph.

Try looking through chapter 11. Read the introductory and summary paragraphs thoroughly. Read only the first sentence of each of the remaining paragraphs. Try to understand what the chapter is about from reading only those paragraphs and sentences. When you finish, turn the page in this book.

Now, try answering these questions:

Are all diseases caused by microorganisms?

Name some organisms involved in the nitrogen cycle.

In a bacterial infection, what is a "host"?

Write a few sentences below summarizing what you can remember from skimming the chapter.

Activity 11.2

Science Skill: Describing properties
This activity can be done during the chapter.

IDENTIFYING BACTERIA

In medical laboratories, cultures of bacteria are grown for diagnosis of bacterial diseases. The bacteria are then classified by size, shape, and staining characteristics. The sizes and shapes of some common pathogens are shown below.

Sizes of Common Bacteria

Name of organism	Size of individual cells
Staphylococcus aureus (boils, etc.)	0.8– 1.0 μm in diameter
Streptococcus pyogenes (sore throat, etc.)	0.4– 0.75 μm in diameter
Pneumococcus (pneumonia)	0.8– 1.2 μm in diameter
Gonococcus (gonorrhea)	0.8– 0.6 μm in diameter
Meningococcus (meningitis)	0.8– 0.6 μm in diameter
Corynebacterium diphtheriae (diphtheria)	1.5– 6.5 μm long, 0.3–1.0 μm wide
Mycobacterium tuberculosis (tuberculosis)	2 – 4 μm long, 0.3–0.5 μm wide
Salmonella typhosa (typhoid fever)	1 – 3 μm long, 0.8–1.0 μm wide
Clostridum tetani (tetanus)	2 – 3 μm long, 0.3–0.5 μm wide
Vibrio comma (cholera)	1 – 2 μm long, about 0.4 μm wide
Treponema pallidum (syphilis)	8 –14 μm long, about 0.2 μm wide

The Gram stain is a common tool for diagnosis. The stains gentian violet and safranine are used. Some bacteria retain the purple color of gentian violet. Others lose the purple color but are stained pink by safranine. The purple bacteria are called Gram-positive, and the pink bacteria are called Gram-negative. This chart shows how some important bacteria react to the Gram stain.

Gram-positive Bacteria		Gram-negative Bacteria	
Organism	**Disease with which associated**	**Organism**	**Disease with which associated**
Staphylococci (all pathogenic species)	—Furunculosis, etc.	Gonococcus	—Gonorrhea
Streptococci (all important pathogenic species)	—Erysipelas, tonsilliltis, scarlet fever, etc.	Meningococcus	—Epidemic meningitis
Pneumococci	—Lobar pneumonia, etc.	*Salmonella typhosa*	—Typhoid fever
Cor. diphtheriae	—Diphtheria	*S. paratyphi*	—Paratyphoid fever, food poisoning
Mycobacterium tuberculosis	—Tuberculosis	*Shigrella dysenteriae*	—Dysentery
Bacillus anthracis	—Anthrax	*Haemophilus influenzae*	—Influenza, etc.
Clostridium tetani	—Tetanus	*Bordetella pertussis*	—Whooping cough
C. perfringens	—Wound infection, gas gangrene	*Pseudomonas mallei*	—Glanders
C. botulinum	—Botulism	*Yersinia pestis*	—Plague
Actinomyces	—Actinomycosis	Fusiform bacilli	—Vincent's angina, etc.
		Brucella group	—Undulant fever
		Vibrio comma	—Cholera
		Spirochetes	—Syphilis, relapsing fever, etc.

Assume you are a bacteriologist who has just discovered the syphilis bacterium in a culture grown from patient's blood. In a short paragraph, describe what the bacteria looked like and how you reached your conclusion.

The paragraph should include descriptions of these characteristics—spiral-shaped, 8–14 μm long, 0.2 μm wide, Gram-negative.

Activity 11.3

Science Skill: Organizing data in graphs or tables
Students can do this during the chapter.

ORGANIZING INFORMATION

In chapter 11, there is much information on various living and nonliving forms. You can help yourself learn and remember the main points by organizing the information in table form.

Make a table showing the various groups and their characteristics. Someone reading the table should be able to tell whether a characteristic refers to one group or several, and whether a group is a part of another group. If you include the names of specific organisms, use them as examples of groups. If the chapter does not provide information for some parts of the table, put a question mark in that section or look it up elsewhere (and record the source you use).

		Structure of cell wall	Habitat	Role in food web
Archae-bacteria	Thermoacidophiles	non-polysaccharides	hot, acidic	?
	Halophiles		salt water	?
	Methanogens		anaerobic	consumers
Eubacteria	Cyanobacteria	polysaccharides and amino acids	hot or cold/fresh or salt water	producers
	Green bacteria			
	Purple bacteria		anaerobic depths of bodies of water	
	Chemoautotrophic bacteria		in soil or root nodules	use inorganic molecules as energy source
	Pathogens, decay bacteria		in or on other organisms	consumers (parasites) or decomposers
Other groups	Viruses	protein coat	inside living cells	consumers (parasites)
	Viroids	none		
	Prions	none		

Students might also use such characteristics as living or nonliving, role in the nitrogen or oxygen cycle, and so on in their tables.

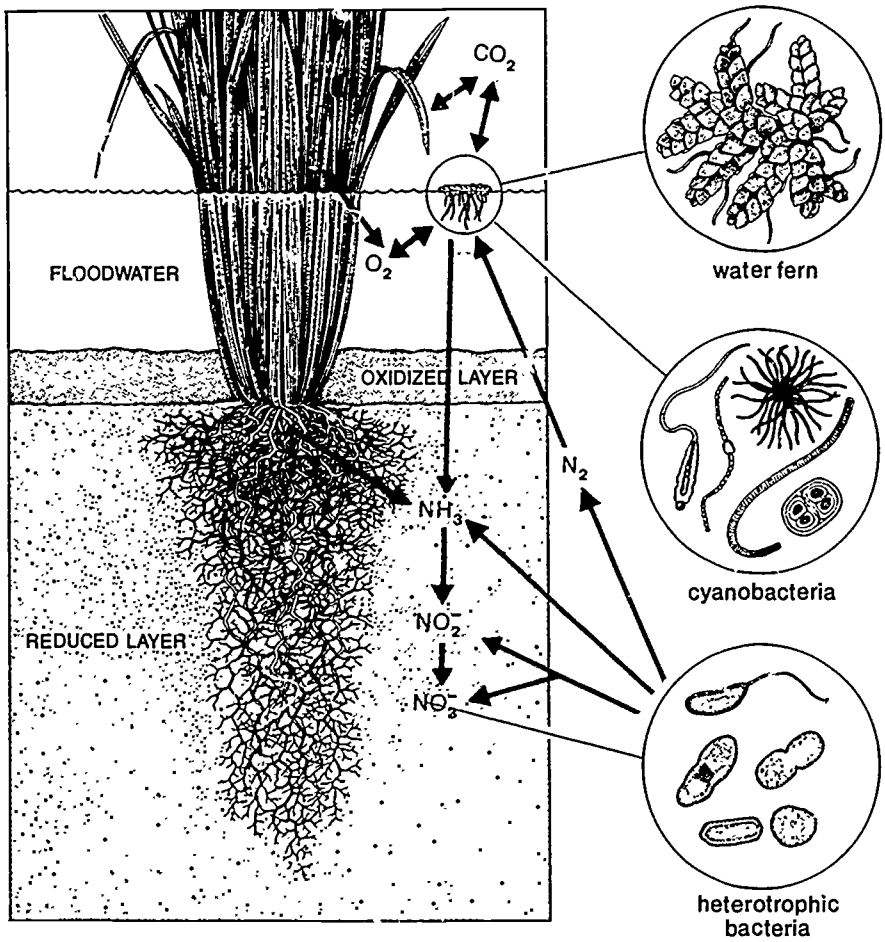
Activity 11.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this after completing chapter 11.

RICE

Rice is often grown in flooded fields, where other plants cannot grow, because of the lack of oxygen around their roots. This is possible because rice plants have an efficient system of air passages. Air travels from the leaves to the roots, providing oxygen to the tissues.

Rice plants get usable nitrogen from the flooded soil. The nitrogen is fixed by a mutualistic relationship of water fern and cyanobacteria. Bacteria taking part in the nitrogen cycle are found both in the oxidized soil layer and in the reduced (without oxygen) soil layer. They act on the nitrogen compounds that are released as plants above them die and decay.



Using the above information, label the diagram to show the cycling of oxygen and nitrogen.

Chapter 12

Activity 12.1

Communication Skill: Finding the main idea in a paragraph
Students can do this before beginning chapter 12.

FINDING THE NUCLEUS OF AN IDEA

The word "nucleus" can be used in many connections, but it always refers to something central. Most cells have nuclei, and so do most paragraphs.

Read the following paragraphs and try to pick out the central idea in each one.

(1) I was raised in the belief that organelles were obscure little engines inside my cells, owned and operated by me or my cellular delegates, private, submicroscopic bits of my intelligent flesh. Now, it appears, some of them, and the most important ones at that, are total strangers.

(2) The evidence is strong, and direct. The membranes lining the inner compartment of mitochondria are unlike other animal cell membranes, and resemble most closely the membranes of bacteria. The DNA of mitochondria is qualitatively different from the DNA of animal cell nuclei and strikingly similar to bacterial DNA; moreover, like microbial DNA, it is closely associated with membranes. The RNA of mitochondria matches the organelles' DNA, but not that of the nucleus. The ribosomes inside the mitochondria are similar to bacterial ribosomes, and different from animal ribosomes. The mitochondria do not arise *de novo* in cells; they are always there, replicating on their own, independently of the replication of the cell. They travel down from egg to newborn; a few come in with the sperm, but most are maternal passengers.

(3) The chloroplasts in all plants are, similarly, independent and self-replicating lodgers, with their own DNA and RNA and ribosomes. In structure and pigment content they are the images of prokaryotic blue-green algae. It has recently been reported that the nucleic acid of chloroplasts is, in fact, homologous with that of certain photosynthetic microorganisms.

(4) There may be more. It has been suggested that flagellae and cilia were once spirochetes that joined up with the other prokaryotes when nucleated cells were being pieced together. The centrioles and basal bodies are believed in some quarters to be semiautonomous organisms with their own separate genomes. Perhaps there are others, still unrecognized.

(5) I only hope I can retain title to my nuclei.

What is the main idea in paragraph 1?

The author's established ideas about cell structure are being challenged by modern research.

In paragraph 2?

The DNA and RNA of mitochondria are unlike those of the nucleus, this is a major bit of evidence that mitochondria are invaders.

In paragraph 3?

Chloroplasts provide similar evidence.

In paragraph 4?

Other organelles apparently also arose independently of the cells they inhabit.

In paragraph 5?

The author ruefully comments that he hopes his nuclei, at least, are his own. Notice how this paragraph is made more dramatic by consisting of only one sentence.

Lewis Thomas is a master of popular science writing. Help students to appreciate how he presents complex ideas in understandable form, as well as how carefully constructed his paragraphs are. Many high school students would enjoy reading *The Lives of a Cell* and other books by Thomas—and you certainly would.

Activity 12.2

Combined Skills: Using the library and Preparing a bibliography
Students can do this during chapter 12.

WRITING A SHORT BIBLIOGRAPHY

At the end of nearly every science paper is a bibliography. (It may be called by other names—References, Sources, Literature Cited, and so on.) A bibliography is a list of books and papers used as references by the author. It is the last thing written, but the first thing used by the writer.

Suppose you are going to write a paper or do a research project on protists or fungi. Go to the library and find any five books or articles on one of those topics. Then write a bibliography of those five references, using the format shown, which is the one recommended by the *American National Standard for Bibliographic References.*

Follow the format below for articles:
Author's last name, author's first name or initials. Year of publication. Title of article. Name of journal or magazine, volume, pages.

Example:

de Duve, Christian. 1983. Microbodies in the living cell. Scientific American 248: 74–84.

Follow this format for books:
Author's last name, author's first name or initials. Year of publication. Title of book. Place of publication, publisher.

Example:

Taber, W. and R. Taber. 1967. The Impact of Fungi on Man. Chicago: Rand McNally & Co.

Usually a bibliography is arranged alphabetically, according to the authors' last names.

Though you can find references anywhere, you should be careful to verify them (be sure they are accurate) by checking the original article or book. Bibliographies often contain mistakes, and sometimes even a library card catalog can be wrong.

Students may notice that the format given here differs from that used in their textbook. Explain to them that journals vary in their style requirements and that even style manuals do not agree. The most important thing is to be consistent in whatever style is adopted.

Activity 12.3

Science Skill: Identifying a hypothesis

Students can do this activity after completing the chapter.

READING TO FIND HYPOTHESES

Read the following paragraphs and try to find the hypothesis. Information in chapter 12 of your textbook may be helpful.

Bordeaux mixture, a chemical mixture that is used for controlling plant diseases, was developed by a French botany professor, Alexis Millardet. Millardet was working with some grape growers in the 19th century.

The growers had imported grape seedlings from the United States and were growing them with some success. However, they were plagued with two problems: grape thieves and a plant disease. The disease, called downy mildew of grapes, was spreading from the American seedlings throughout the vineyards.

In an effort to curb the grape thieves, the growers put a foul-tasting mixture of copper sulfate and lime on the grapes. Millardet noticed that the grapes having that mixture on them did not become diseased.

What was Millardet's hypothesis?

That the chemical mixture was poisonous to a fungus that causes downy mildew.

Activity 12.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this activity after completing the chapter.

WHODUNIT?

See if you can solve this murder mystery:

In 1932, a healthy person travelling in Wales died in a locked hotel room. Not only was the door locked, but the windows were nailed shut.

For some reason, the hotel maids were superstitious about the room and insisted that the room itself was capable of killing people. While skeptical of that idea, the police were baffled as to the cause of death, and so they began an investigation of the room itself.

It looked like a room for murder, all right—dark and damp, it was papered with a dark green velvety paper that added to the gloom. The wallpaper looked normal, but the police found that it contained arsenic. However, the victim was scarcely likely to have eaten the wallpaper. Only if converted to a gas might it have poisoned the victim; and even then, a high concentration of the toxic gas would have been needed.

In reading up on arsenic compounds, one of the police detectives discovered that a fungus, *Scopulariopis brevicaulis,* can convert arsenic to a gas, trimethylarsine.

Can you explain the murder?

Aided by the dark, damp environment, the fungus grew undetected on the fuzzy green wallpaper. Eventually it produced enough trimethylarsine to be fatal in a room having no fresh air.

Chapter 13

Activity 13.1

Communication Skill: Using the library

Students can do this before beginning chapter 13. Encourage each student to choose a different plant or group.

FINDING INFORMATION ON PLANTS

Before reading chapter 13, look through the chapter, noting the pictures especially. Find a plant or group of plants that interests you—perhaps one that grows in your area, or that you have seen when traveling or living elsewhere.

Go to the library and gather enough information on your plant so that you can give a five-minute class report on it. Find out such things as what unusual characteristics it has, where it lives, what animals eat it, how humans use it, and so on. Write a bibliography of the references you use. At the top of the paper, write the name of the plant and your name.

Activity 13.2

Communication Skill: Giving a class report

Students can give their reports during chapter 13.

REPORTING ON PLANTS

Using your notes from the last activity, prepare a five-minute class report on your plant. Try to use only a few notes for your talk, so that you can talk naturally rather than reading every word.

If possible, bring the plant or a picture or slide to illustrate the talk.

Give your teacher a copy of the bibliography you prepared.

You may want to assemble the bibliographies for distribution or save them for future class projects.

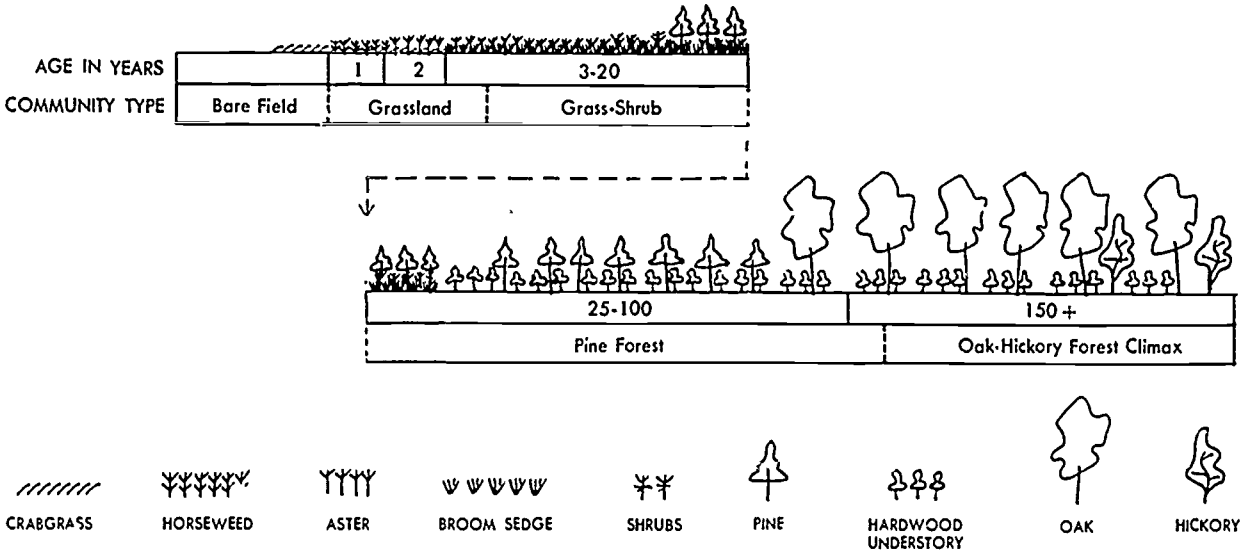
Activity 13.3

Science Skill: Formulating a hypothesis.
This activity can be carried out during the chapter.

TENTATIVE EXPLANATIONS

Chlorophyll may be found in many forms that have different characteristics. Two of the most important forms are chlorophyll *a* and chlorophyll *b*. Both types may be involved in photosynthesis, but chlorophyll *b* absorbs more light in blue wavelengths than chlorophyll *a* does. So, it is more efficient in allowing photosynthesis in shady places.

The following diagram shows how the plants changed on an abandoned farm in the Midwest during about 150 years.



Notice that oak seedlings can grow beneath pine trees, but that pine seedlings are not found under oak trees. Eventually, as a result, the area became a forest of oaks and other hardwoods, with few or no pines.

Based on the above information, write a hypothesis about the chlorophyll in oaks and pines.

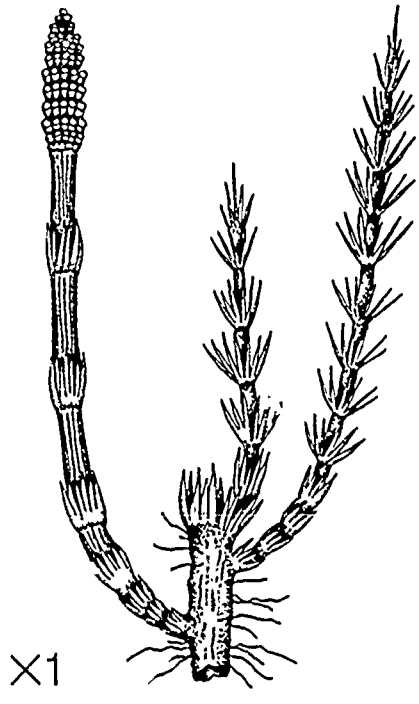
Hypothesis: oaks contain more chlorophyll *b* than pines do.

Activity 13.4

Combined Skill: Generalizing a concept fro[illegible] to new instances
This activity should be carried out after the chap[illegible]pleted.

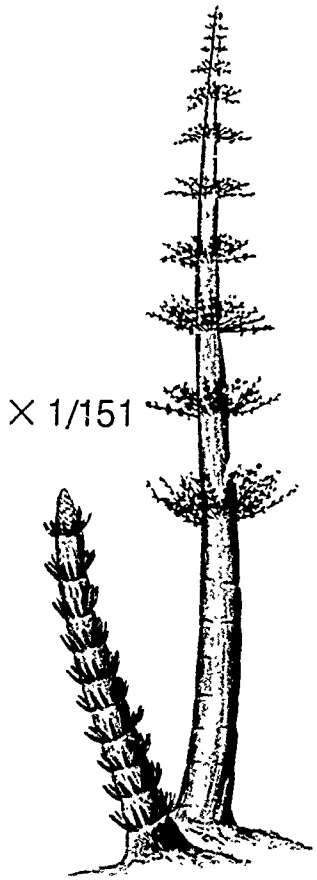
PRIMITIVE PLANTS

The plants shown below are horsetails, or *Equisetum*. Their stems are hollow, jointed branches of underground stems. In most areas they are less than 2 m high, though in the tropics one species grows as high as 12 m.



Equisetum

In the Carboniferous Era, giant plants related to modern horsetails grew in many parts of the earth. They thrived in the warm, swampy environment. An example is *Calamites,* shown below.



Calamites

As the earth became drier, the swamps receded, and the habitat of the giant plants disappeared. The plants themselves also disappeared.

Modern horsetails have the same requirements as their ancient relatives, yet they thrive in many areas. In the space below, write your explanation of how you think this is possible.

As the habitat diminished, patches of suitable moist environments remained. The plants were able to survive by becoming smaller and exploiting these small areas.

Chapter 14

Activity 14.1

Science Skill: Classifying
Students can do this activity before starting chapter 14.

INDOOR BIRDWATCHING

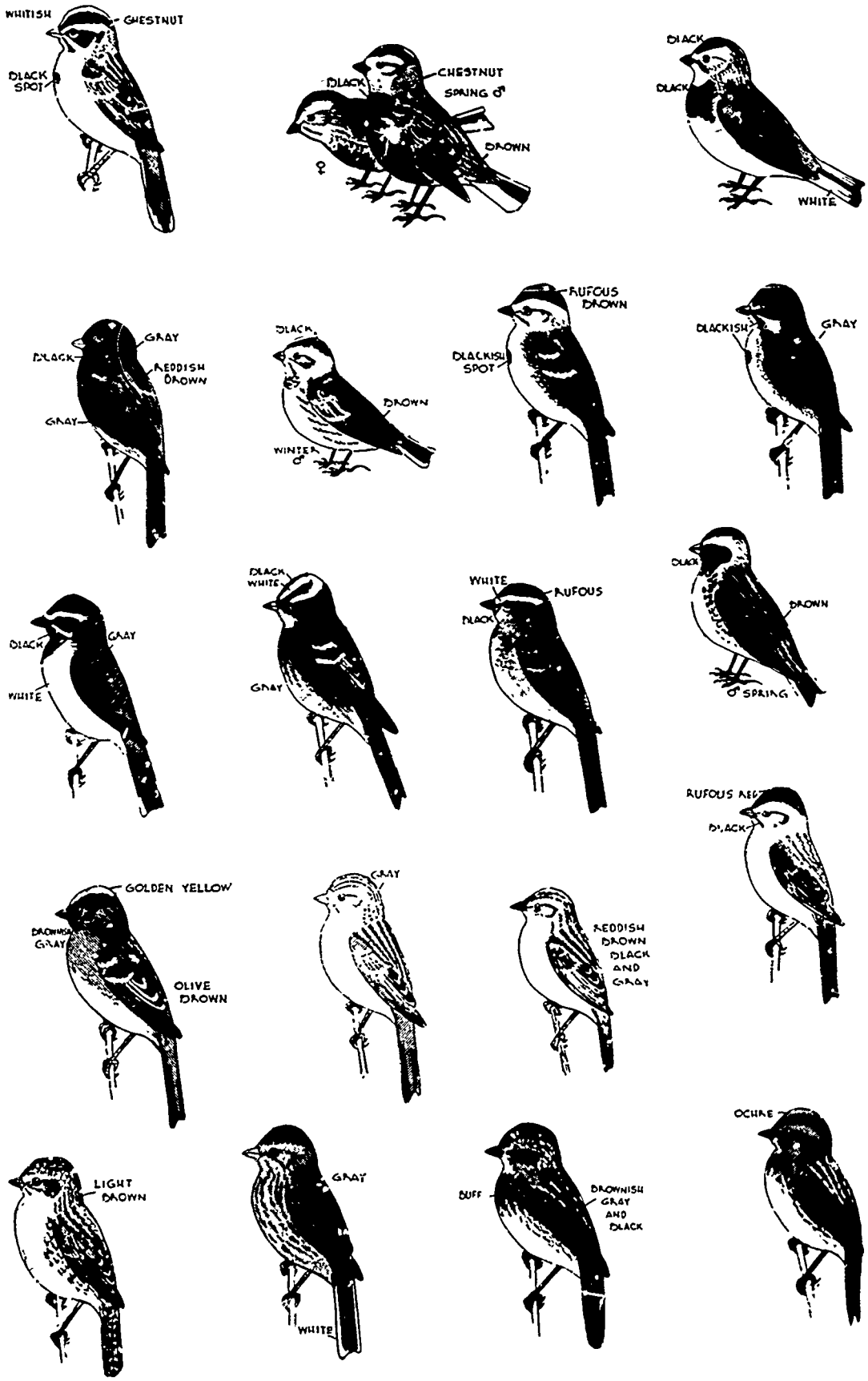
Birdwatchers use many characteristics for identifying birds. What might they use for identifying birds at a distance?

General shape and size, song, characteristic movement. Habitat is useful for eliminating some species.

What characteristics would be useful for identifying birds at close range?

Color; markings; shapes of bill, tail, neck, and feet.

The following illustrations show a variety of sparrows found in the United States (excluding Hawaii and Alaska) west of about 100° longitude.



From *How to Know the Land Birds* by H. E. Jaques.

In what states would you be most likely to see these sparrows?

Washington, Oregon, Montana, Idaho, Wyoming, California, Nevada, Utah, Colorado, Arizona, New Mexico; and in the western portions of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

Use the characteristics shown in the pictures to construct a dichotomous key for identifying these species.

The possibilities are enormous. Help students begin the keys by classifying the birds according to the presence or absence of a characteristic that divides the group approximately in half, such as spotted or streaked breasts vs. plain breasts. Characteristics found only in one or two species, such as ochre head stripings, should be left for the final step in the key. By dividing each group about in half at each step, the students will produce the most efficient key.

Activity 14.2

Communication Skill: Editing a passage for clarity and correct usage.
Students can do this activity during the chapter

A WHALE OF A TALE

In the passage below, look for misused terms, repetitive words or phrases, bad sentence construction, and other mistakes that interfere with clarity. Number each one with a colored pencil. Correct the mistake or make whatever changes are needed to increase clarity.

Because of their fishlike shape and aquatic habitat, whales were once thought to be large
1, 2 fish. Actually they are mammals and, as with humans, they have lungs and give birth to live young,
3, 4 and they nurse thier young. The few hairs to be found on a whale are on its muzzle. Whales probably descended from terrestrial animals that became adapted to aquatic life, which might
5 explain there resemblance to fish.

Whales are well-adapted to their life in the world's oceans. Beneath their skin they have a
6 layer of blubber, or fat. It provides a source of stored energy and helps conserve heat.
7 Their very, very streamlined bodies enable each and every species of whale to swim and dive
8, 9 in all of the oceans of the world. The whale cannot move it's head separately from its body, because
10 the neck vertebrae are compressed into a short area.

A whale's flippers are small in proportion to its body, making the tail the main organ for
11 locomotion.

Their lungs are huge, even in proportion to their body size. Both the lungs and the heart are adapted to those conditions and help the whales take in and conserve large amounts of oxygen.
12 Whales need powerful lungs and circulatory systems, because they dive to great depths and may stay down for as much as an hour.

1. Redundant.
2. Incorrect inference: the implication is that only humans are mammals.
3. Misspelled word.
4. Redundant.
5. Misspelled word.
6. Antecedent of "it" unclear; recasting of sentence and combining with previous sentence improves clarity.
7. Redundant.
8. Excessive wordiness.
9. Incorrect use of an apostrophe in a possessive.
10. Redundant.
11. Dangling sentence; should have been included in previous paragraph.
12. By moving this sentence to the beginning of the paragraph it becomes a topic sentence, which this paragraph lacks.

One possible way of rewriting the passage follows. The reasons for the changes are keyed to the circled words or sentences in the passage above.

Because of their shape and aquatic habitat, whales were once thought to be large fish. Actually they are mammals and, as with other mammals, they have lungs and give birth to live young, whom they nurse. The few hairs to be found on a whale are on its muzzle. Whales probably descended from terrestrial animals that became adapted to aquatic life, which might explain their resemblance to fish.

Whales are well-adapted to their life in the world's oceans. Beneath their skin they have a layer of blubber, or fat, which provides a source of stored energy and helps conserve heat.

Their streamlined bodies enable whales to swim easily. The whale cannot move its head separately from its body, because the neck vertebrae are compressed. In addition, a whale's flippers are small in proportion to its body, making the tail the main organ for locomotion.

Whales need powerful lungs and circulatory systems, because they dive to great depths and may stay down for as much as an hour. Their lungs are huge, even in proportion to their body size. Both the lungs and the heart are adapted to those conditions and help the whales take in and conserve large amounts of oxygen.

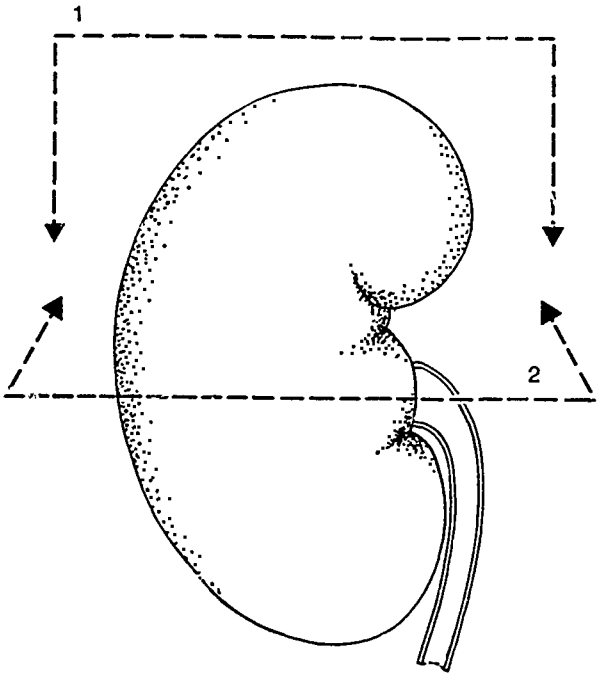
Activity 14.3

Combined Skill: Visualizing in three dimensions
This activity can be done during the chapter.

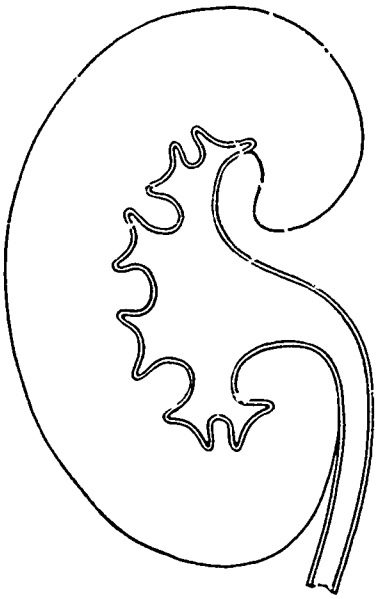
SEEING FROM ALL SIDES

In studying animals, biologists often make use of prepared slides. Tissues are cut at various angles, and they are studied as "cross sections," "longitudinal sections," etc.

The picture below shows the human kidney from the side.

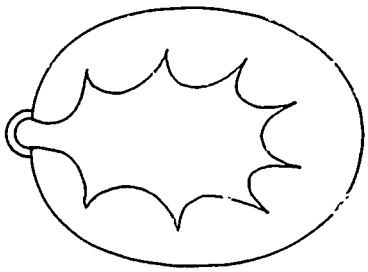


The next picture shows what a section of the kidney would look like if cut in the plane indicated by the dotted lines (1) at the top.



In the space below, draw what the section indicated by the dotted lines (2) would look like.

Be sure students draw the cross section approximately as shown. They should realize that a cross section taken above or below the one shown would not show the ureter.



Activity 14.4

Science Skill: Generalizing a concept from the chapter to new instances
Communication Skill: Developing a paragraph by means of analogy
Students can do this activity after completing the chapter.

ON BEING THICK-SKINNED

An insect or other arthropod is covered with a cuticle, which lines many body cavities, forms the exoskeleton, and may form the wings. In addition to supporting the animal, the cuticle provides an anchoring place for muscles and provides a barrier between the animal and its environment. One of its roles as a barrier is to protect the animal from water loss. The chitin of which the cuticle is made is a polysaccharide similar to cellulose.

Write a paragraph describing insect cuticles by comparing them to the cell walls of plant cells. Begin the paragraph with a topic sentence that states the main idea.

Be sure students point out the likenesses but that they do not carry the analogy too far. The cell wall provides protection and support, but not attachment for organs, for example.

Chapter 15

Activity 15.1

Communication Skills: Planning study, Skimming, and Giving instructions
Students can do this activity before beginning chapter 15.

GIVING INSTRUCTIONS

Studying Section Three should have given you an idea of the problems organisms must solve in order to survive in their environments. If you skim Section Four now, you will see what body systems make it possible for the organisms to solve those problems.

Assume that you are tutoring a student in biology. Draw a chart for your student to use in studying chapters 15–17. The rows should show the problems of survival humans must solve; the columns should show the human body systems discussed in Section Four. Give instructions for filling in the chart, but do not fill it in. (You may want to fill it in yourself as you study and review the next few chapters.)

Rows: movement, obtaining energy and oxygen, removing wastes, transporting substances, coordinating activities, reproducing.
Columns: digestive system, skeletal and muscular systems, circulatory system, respiratory system, nervous and endocrine systems, reproductive system. Instructions should include telling the student that each space should refer to how a human system solves a human problem.

Activity 15.2

Science Skill: Refuting a hypothesis by testing
Students can do this activity during or after the chapter.

ANIMAL PROTEIN: HOW ESSENTIAL?

For each kilogram of your ideal body weight, you need about 0.5–0.8 g of protein per day. For example, a person of your age weighing 54 kg would need an average of 35.1 g of protein per day. You could get that much protein by eating 85 g of cooked beef or chicken (24 g), 50 g of broccoli (3 g), 6 g of peanut butter (4 g), and 50 g of cooked dried beans (8 g).

For many years, athletes were fed huge amounts of steak, eggs, and other high-protein foods from animal sources. It was thought that the animal protein would help the athletes build muscle tissue and have stamina. Recently, however, studies have shown that most proteins from animal sources also contain large amounts of cholesterol, which may contribute to cardiovascular diseases. Athletes today eat less protein from animal sources; some even are vegetarians. They seem healthy, are good athletes, and have low levels of cholesterol in their blood.

Protein from plant sources often is "incomplete"—that is, some of the essential amino acids are missing. For example, corn has little of the essential amino acid lysine, and beans have lysine but little methionine. If a person tried to live on just corn or beans, eventually he or she would suffer from a deficiency of protein.

State a hypothesis about the need for animal protein. List any assumptions on which the hypothesis is based. (For example, someone might assume that "only muscle tissue can be used to make muscle tissue.") From the information above and in chapter 15, refute the hypothesis by making at least one prediction from the hypothesis and showing that the prediction does not agree with the evidence.

Hypothesis:

The hypothesis might be stated as, "Protein from animal sources is needed to provide essential amino acids for nutrition of humans."

Assumptions:

Assumptions might include: all the essential amino acids must be provided in each source of protein; in the body, proteins are built up from proteins, rather than from the molecular fragments of the Krebs cycle; and humans today need meat because our ancestors were carnivorous.

Prediction(s):

If the hypothesis is true, then vegetarians cannot manufacture the proteins they need for health, and food from plant sources cannot provide all the essential amino acids.

EVIDENCE:

Healthy vegetarian athletes and others do not bear out the first prediction, which disproves the hypothesis. Also, vegetables in combination can provide all the essential amino acids.

Be sure students understand that a healthy vegetarian needs to eat complementary sources of plant protein (such as corn and beans, or peanut butter and whole wheat bread) together, because proteins are quickly metabolized. Because of the problems involved in ensuring complementarity, and although the hypothesis can be disproved, students should not be encouraged to abandon animal protein entirely unless they know how to get all the essential amino acids from plant sources. Furthermore, people who are opposed to killing animals for food can still get animal protein by eating eggs and milk products.

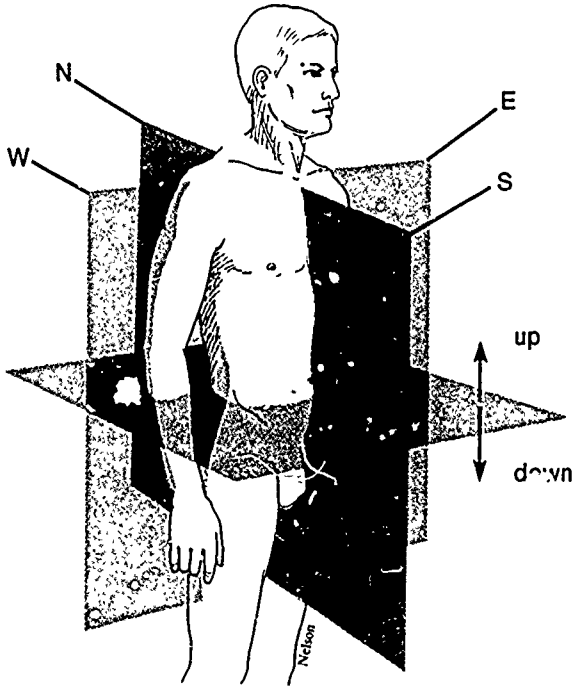
Activity 15.3

Combined Skill: Visualizing a concept in three dimensions
Students can carry out this activity during chapter 15.

MAPPING THE DIGESTIVE TRACT

Anyone can memorize the parts of the digestive tract. But can you actually visualize how the parts are arranged?

Use the drawing below to orient yourself and fill in the chart with the organs of the digestive tract and the directions in which food travels as it moves through the canal. For some organs, you may need to use several directions as the organ itself turns.



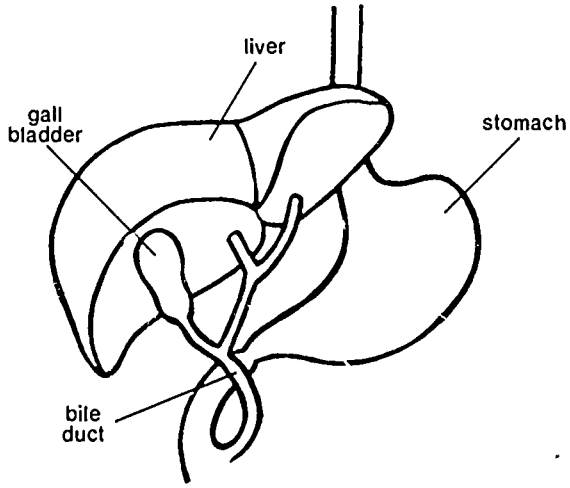
Direction	Into or through which organ
1. North	into mouth
2. North	through pharynx
3. Down	through esophagus
4. Down and southeast	into stomach
5. Down and southwest	through stomach
6. West	into small intestine (duodenum)
7. Down, east, up, south	through small intestine (duodenum)
8. North, south, east, west, up, and down	through small intestine
9. West	into large intestine
10. Up	through large intestine
11. South	through large intestine
12. East	through large intestine
13. Down	through large intestine
14. Up and north	through large intestine
15. Down and north	rectum

Activity 15.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can carry out this activity after completing the chapter.

SOME MEDICAL DETECTIVE WORK

The liver secretes bile, a mixture of substances that includes pigments and salts. The salts are responsible for breaking down fat droplets in the small intestine. Many blood vessels pass through the liver, and a large vein from the liver travels in the direction of the heart.



A patient had a severe case of jaundice (yellowing of the skin and, especially, in the whites of the eyes). The physician ruled out several causes of this symptom, and eventually discovered that the patient had a large tumor in the upper portion of the small intestine.

Explain how the tumor could cause jaundice.

The tumor was blocking the duct through which bile flows from the liver and gall bladder into the small intestine. The bile backed up into the liver, and the pigments entered the circulatory system. Eventually they traveled throughout the body, and were especially visible in the whites of the patient's eyes.

Chapter 16

Activity 16.1

Communication Skill: Using the SQ3R technique
Students should do this activity as preparation for apter 16.

APPROACHING CHAPTER 16

You used the SQ3R technique in activity 7.2. Try it again now to prepare for studying chapter 16. Write your questions and answers in the space below.

Questions	Answers

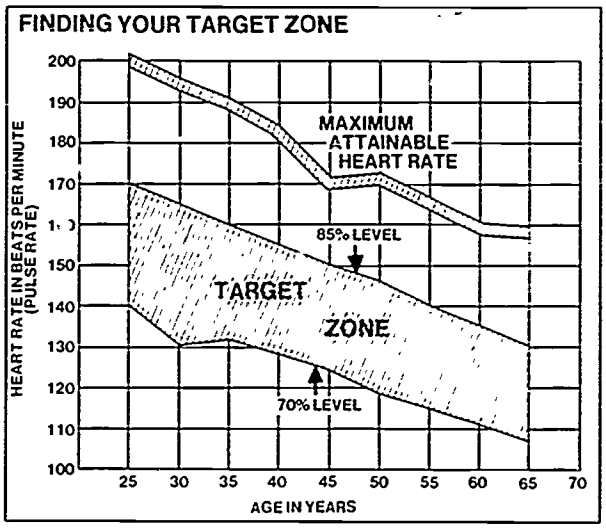
Activity 16.2

Science Skill: Using graphs and tables
Students can do this during the chapter.

GETTING IN SHAPE

Use the table and the graph below to do this activity.

Energy range (Approx. calories used per hour)	Activity
72–84	Sitting Conversing
120–150	Strolling, 1 mph Walking, 2 mph
150–240	Golf using power cart
240–300	Cleaning windows Mopping floors Vacuuming
	Bowling
	Walking, 3 mph Cycling, 6 mph
	Golf, pulling cart
300–360	Scrubbing floors
	Walking, 3.5 mph Cycling, 8 mph
	Table Tennis Badminton Volleyball
	Tennis, doubles
	Man calisthenics Ballet exercises
350–420	Walking, 4 mph Cycling, 10 mph Ice or roller skating
420–480	Walking, 5 mph Cycling, 11 mph
	Tennis, singles
	Water skiing
480–600	Jogging, 5 mph Cycling, 12 mph
	Downhill skiing
	Paddleball
600–650	Running, 5.5 mph Cycling, 13 mph
Above 660	Running, 6 or more mph
	Handball Squash



The heart rate you should maintain during conditioning exercise is between 70 and 85 percent of the maximum attainable heart rate for your age.

A 25-year-old woman decided to begin a walking program to build up her endurance and to help her lose weight. She began her program with the hope that she could meet her goals by walking an hour a day with her dog.

To condition her cardiovascular system, her doctor advised that she increase her heart rate to about 75% of its maximum attainable rate for 20 minutes at least 3 times a week. That much exercise would cause her to breathe deeply, also. The capacity of her heart and lungs to deliver oxygen to her body cells would gradually increase.

During the first week on the program, she discovered that her small, stubborn dog would not walk more than 1.5 miles per hour. (During that time, the woman's heart rate was 125 beats per minute.) However, she lost two pounds, which encouraged her. Was she also meeting her conditioning goal? Explain.

No. Even though she walked for a longer period than the 20 minutes her doctor advised, she was not getting a conditioning effect.

How might she change her program to meet her goals?

She might warm up by walking her dog for 20 minutes, then walk rapidly alone for 20 minutes. Walking 3.5 miles an hour would enable her to reach the target zone for her age.

How might a man of 40 condition his cardiovascular system and burn off 350–420 kcal a week?

Cycle at [illegible] mph for 20 minutes 3 times a week.

What is his heart rate target zone?

130–155 beats/minute.

A woman of 65 wanted to begin a safe conditioning program. What is the maximum heart rate she should attain during exercise?

130 beats/minute.

A man of 50 was interested in losing a little weight, but his heart was already in good condition. How could he burn up 200 kcal/day?

He could either cut down on nonessential food or choose some exercise that is not necessarily aerobic, such as doing housework or playing golf, for at least half an hour per day.

Activity 16.3

Combined Skill: Writing questions and answers about a chapter
Students can do this after reading chapter 16.

REVIEWING

Now that you have studied chapter 16, you will probably find that your ideas about what is in the chapter are a little different from when you used the SQ3R technique. To prepare for your next test, write a series of questions covering the chapter in the space below. For each heading listed, write at least three questions that you think are important.

Circulation

Immunity

Blood

Respiration

Excretion

Homeostasis

Reproduction

Activity 16.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this activity after completing the chapter.

VITAMIN C

Kidney stones are painful accumulations of mineral compounds in the collecting ducts of the kidney. The cause of kidney stones is not completely understood, but they often are associated with a high intake of sulfa drugs, vitamin C, or other compounds.

Vitamin C (ascorbic acid) is important for the strength of the skin and mucous membranes. The vitamin C molecule itself is composed of atoms of oxygen, hydrogen, and carbon. It contributes to the formation of compounds that also may contain nitrogen and minerals.

Persons who are deficient in vitamin C may have such symptoms as bleeding gums and bruised skin. A water-soluble crystalline substance usually taken in tablet form, the vitamin is often considered harmless because it is filtered out of the blood and excreted. Thus it cannot build up to toxic levels in the blood or body.

From what you know of several human body systems, explain how vitamin C enters the body, is distributed, and is excreted.

Students should include:

oral ingestion;
absorption from the small intestine;
circulation through intestinal veins, heart, and arteries to arterial capillaries;
passage of some of the vitamin from capillaries to cells in skin and mucous membranes;
passage of some of the vitamin from renal capillaries to Bowman's capsules, and loss of that part of the vitamin through the renal tubules, ureters, and urethra.

Some students also may speculate that vitamin C contributes to the formation of the mineral compounds that form kidney stones. Encourage their hypothesizing but emphasize that the metabolism and possible side effects of this vitamin are not yet completely understood.

Chapter 17

Activity 17.1

Communication Skill. Skimming a passage. The activity also serves to review students' current knowledge about marijuana

Students can carry out this activity before beginning the chapter.

SKIMMING FOR MEANING

In chapter 17, you will learn about the effects of drugs on the human nervous system. Those effects bring about changes in surface behavior. Read the following passage quickly, then close the book and write down as much as you can remember of the passage on a piece of paper.

Brain Effects of Marijuana

Immediate effects on the brain are the least controversial and best defined of marijuana's hazards. Like alcohol, marijuana is intoxicating. A marijuana high interferes with memory, learning, speech, reading comprehension, arithmetic problem solving, and the ability to think. Driving skills are impaired, as is general intellectual performance. Long-term intellectual effects are not known.

Some researchers have described what they called amotivational syndrome among young marijuana smokers, who, with frequent use of the drug, tend to lose interest in school, friends, and sexual intercourse. However, it is not known whether marijuana use is a direct cause or merely one symptom of a general underlying problem. Persistent brain abnormalities and changes in emotion and behavior have been demonstrated in monkeys given large doses of marijuana.

Like alcohol, marijuana interferes with psychomotor functions such as reaction time, coordination, visual perception, and other skills important for driving and operating machinery safely. Actual tests of marijuana-intoxicated drivers have clearly shown that their driving is impaired, yet they tend to think they are driving better than usual. In several surveys 60 to 80 percent of marijuana users said they sometimes drive while high.

Marijuana is not physically addicting, but people can become psychologically hooked on the drug. Marijuana may aggravate existing emotional problems. The most common adverse emotional effect is an acute panic reaction, in which the user may become terrified and paranoid and require hospital treatment. In 1978 some 10,000 people were treated in hospital emergency rooms for adverse marijuana reactions. (From Jane Brody, 1982, *The New York Times Guide to Personal Health* (New York: New York Times Books).

The passage above provided information on marijuana's effects on the brain. What other organs are affected by the drug?

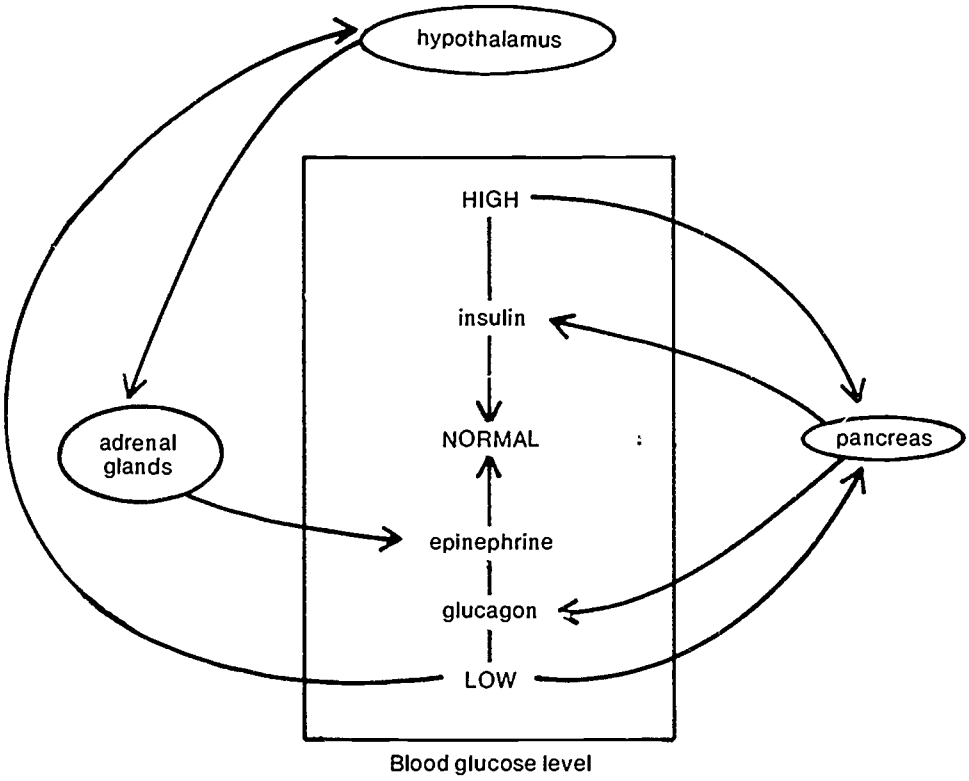
Lungs, heart, reproductive organs.

Activity 17.2

Science Skill: Forming and using scientific models
Students can carry out this activity during or after the chapter.

THE CONTROL OF BLOOD SUGAR LEVEL

Using your textbook as a source of information, plan a model of how the endocrine system controls the level of glucose in the blood. Draw your finished model in the space below.



A tumor of the hypothalamus caused a decrease in secretion of its hormones. Use your model to predict the effect of that decrease on blood glucose level.

The secretion of epinephrine would be diminished, resulting in a lowered level of blood glucose.

What would be the secondary effects of that change on the body?

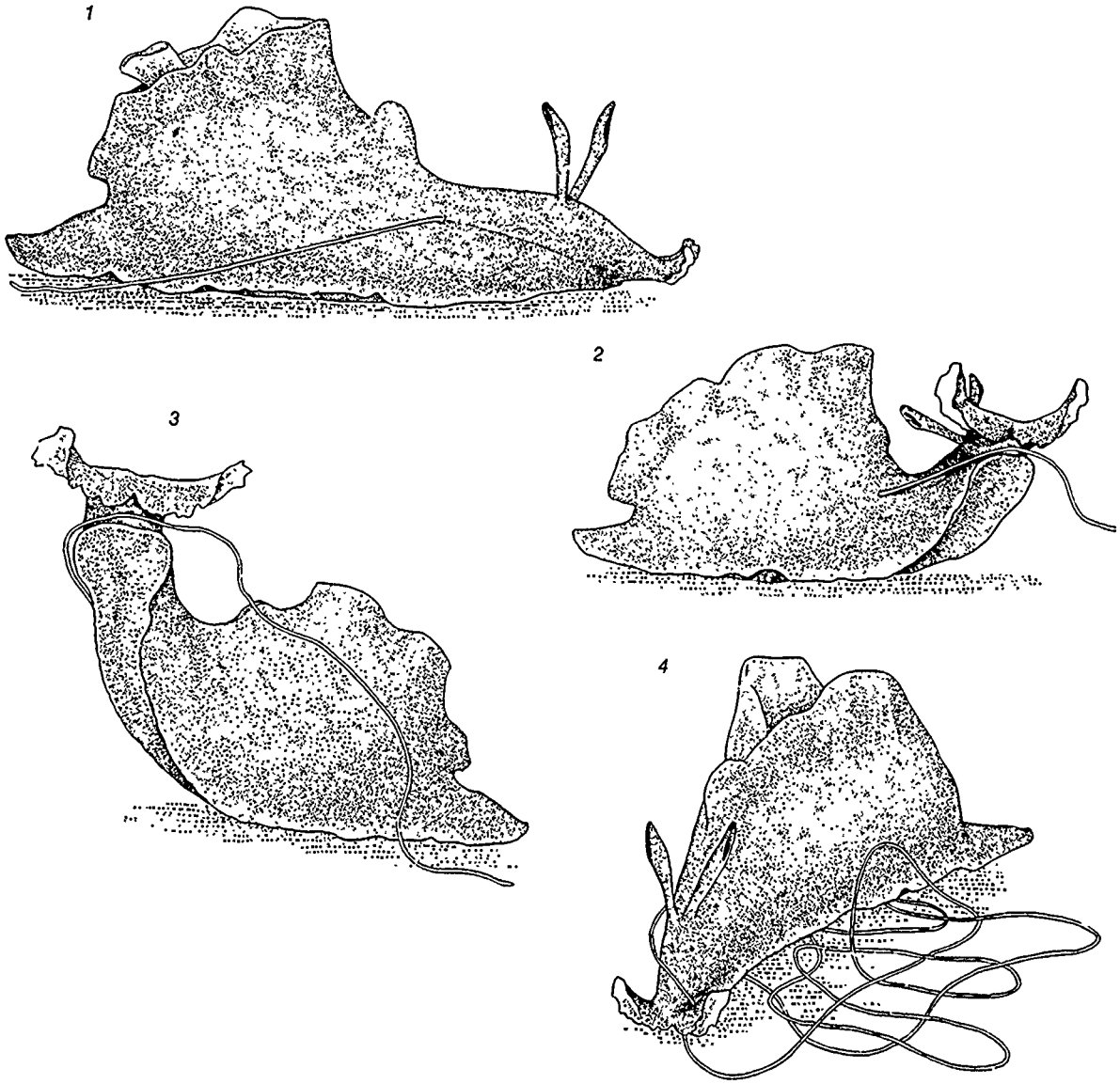
Too little glucose would be supplied to the body cells, including those in the brain. Temporary fatigue or permanent damage to the organs would result.

Activity 17.3

Combined Skill: Generalizing a concept from the chapter to new instances
Students can carry out this activity during or after the chapter.

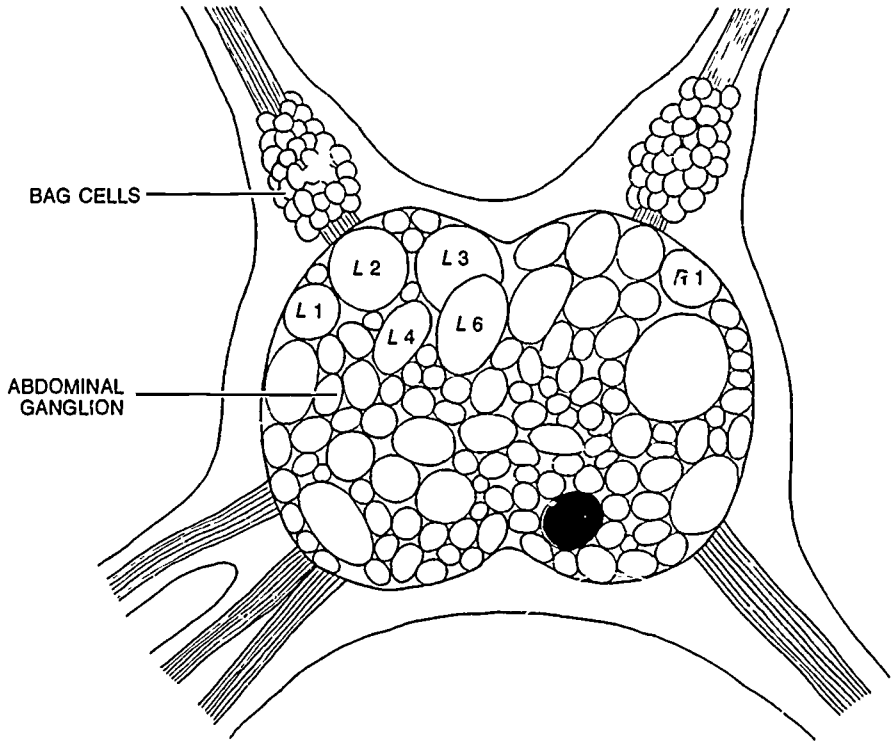
A PATTERN OF BEHAVIOR

The marine snail lays its eggs according to a rigid pattern of behavior. The actions are determined by a set of genes.



1. The muscles of the reproductive tract contract, expelling a string of egg cases.
2. The animal takes the string in its mouth.
3. At the same time, it waves its head, which pulls the rest of the string out of the reproductive duct.
4. When an entire string has emerged, the snail attaches it to a solid surface.

These behaviors can be brought about in the laboratory by injecting the snail with a set of peptides. The peptides are ordinarily produced by "bag cells" in the snail's "brain" (abdominal ganglion). As the peptides are produced, they act as neurotransmitters, affecting neurons within the brain.



Gene A provides the information that causes bag cells to produce peptide A. Peptide A excites the neurons labelled L1 and R1 in the drawing. Similarly, gene B brings about the production of peptide B, which inhibits neurons L2, L3, L4, and L6. Gene C controls peptide C, exciting neuron R15; peptide C also acts as a hormone that causes contraction of the reproductive duct. Exactly how the peptides control the rest of the behavior pattern is not known.

Make some assumptions about the control of the behavior pattern. Then assume a mutation in the snail's DNA that adds a new step to the behavior pattern, or omits a step. In two or three paragraphs, list your assumptions and explain what must happen between the mutation and any change in the snail's behavior.

Students should link each peptide to part of the behavior pattern. In addition, they should show that the mutation would probably lead to the production of another peptide in the bag cells, and that it would excite or inhibit some neuron in the brain. The change in that neuron would lead to muscle movement, observable as part of the behavior pattern.

Activity 17.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can carry out this activity after completing the chapter.

COCAINE

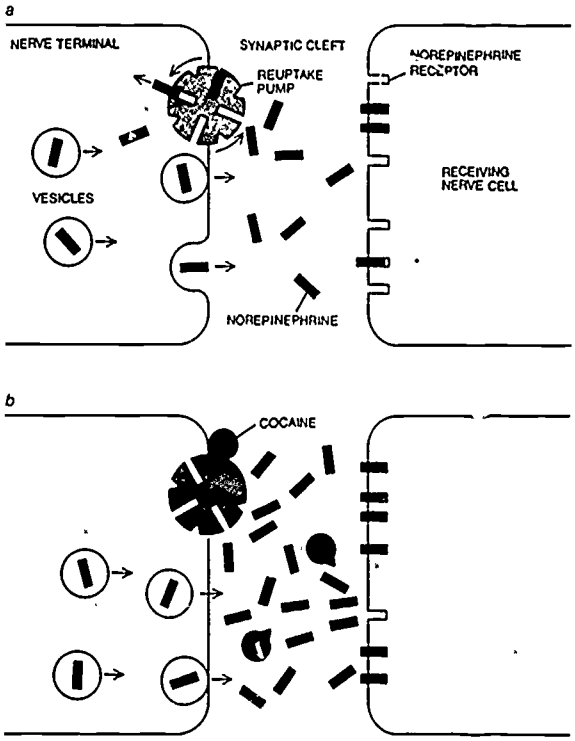
Cocaine affects the user through its chemical action on sensory neurons. Cocaine molecules block the channels through which sodium ions move in and out of axons.

Explain why that has an anesthetic effect on the cocaine user.

For normal transmission of neural impulses, sodium ions must move in and out of neurons. When cocaine blocks the channels, the usual wave of depolarization followed by repolarization is blocked. The parts of the brain that "feel" pain thus receive no stimulation from the sensory neurons.

Cocaine also affects surface behavior for chemical reasons. The cocaine molecules move into the synapses of neurons in the sympathetic nervous system. The axons of these neurons, like those of other neurons, release neurotransmitters such as norepinephrine into the synapses. Ordinarily, the neurotransmitters are reabsorbed into the axon. Cocaine interferes with that reabsorption.

Explain what that interference would do to transmission of an impulse across the synapse, and what the effects on the person's muscles and glands would be. (You can refer to your textbook as well as the art below.)



From "Cocaine" by Craig Van Dyke and Robert Byck. Copyright

The norepinephrine would continue to accumulate and to stimulate the adjacent nerve cell. As indicated in Figure 17.22 in the textbook, the final effects are dilation of the pupils, increased respiration, increased heart rate and blood pressure, and increased supply of glucose to muscle tissue.

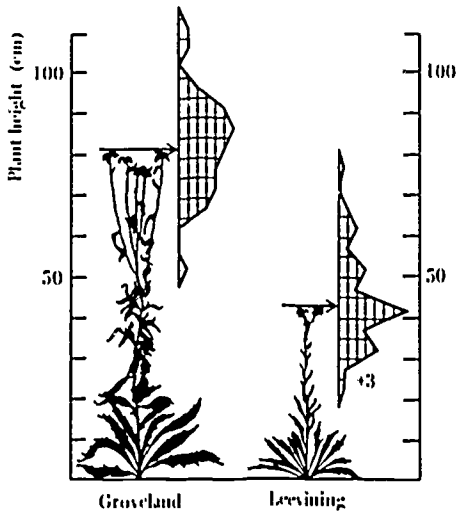
Chapter 18

Activity 18.1

Science Skill: Interpreting graphs and tables
Students can do this activity before beginning chapter 18. For the associated activity (activity 18.4), wait until chapter 18 is underway or completed.

YARROW GROWTH

Graphs and tables may be presented in many ways, and you need to learn to be flexible in reading them. Look at the pictures and graph below:



J. Clausen, D. D. Keck, and W. M. Hiesey. *Experimental Studies on the Nature of Species. III. Environmental Responses of Climatic Races of Achillea.* Carnegie Institution of Washington publication 581(1948).

Each plant in the picture represents 60 specimens of yarrow plants, *Achillea lanulosa.* The plants were all grown under controlled conditions at Stanford University, but there were differences between the Groveland and Leevining populations that resulted in the different heights.

The arrows across the tops of the plants represent the mean height of each population, as shown on the Y axis. What was the mean height of plants in the Groveland population? About 82 cm

What was the mean height of plants in the Leevining population? About 44 cm

The graph at the right of each plant picture shows the range of heights in each population. (These graphs may be easier to understand if you turn the page 90° counterclockwise.) Each square represents about 2 individuals of a given height. For example, for the Groveland population there were about 8 individuals of 70 cm height. (Of course, "about 8 individuals" makes no sense. These graphs were created by connecting peaks on bar graphs. They are useful mainly for comparative purposes.)

What height did the greatest number of individuals in the Leevining population have?

42 cm

The range of height (that is, the largest and smallest heights) for the Leevining population was about 19 cm to about 82 cm. What was the total range of height for the Groveland population?

About 48 to more than 110 cm

If the two populations had been plotted on a single graph, what would the curve have looked like?

The groups would have overlapped but there would have been 2 definite peaks at 85 cm and 42 cm.

Activity 18.2

Communication Skill: Finding topic sentences and rewriting for clarity
Students can do this activity during or after chapter 18.

PLANT GROWTH

The following paragraph is taken from an article about the development of plant leaves.

> Plant development is quite unlike animal development. With most animals the formation of new organs is confined to the earliest phases of embryonic growth. With plants the process is a continuous one. New organs arise from perpetually embryonic growth centers: undifferentiated tissues consisting of cells capable of transformation into a variety of plant organs. The growth centers, at the extremities of the plant, are embryonic tissue at the apex of the root and shoot. Such tissue is termed the apical meristem. (From D. Kaplan, "The Development of Palm Leaves" *Scientific American* (July 1983): 98.)

Does the paragraph have a topic sentence? If so, underline it.

At first glance, the paragraph appears disorgnaized. Students may well say that it has none. Careful study, however, will show that the first sentence *is* a topic sentence, and that the rest of the paragraph is developed by comparing plant and animal growth, and by giving some details of plant growth.

How is the paragraph developed?

If there is no topic sentence, write the main idea of the paragraph in the space below.

In struggling with the various ideas in the paragraph, students should gradually realize that the first sentence actually is the main idea.

Can you suggest any way of making this paragraph clearer?

Encourage students to use various ways of rewriting the paragraph. Whatever method they use, the goal should be increased clarity. For example, the fourth sentence causes a number of problems. It is redundant in mentioning both the occurrence of new organs and the capability of producing them. The sentence could be split to separate the two ideas. Moreover the description of the embryonic growth centers is out of place. It defines the type of tissue capable of producing organs. As such, it belongs to the animal as well as to the plant discussion. However, the information would be redundant there as well. The only way to incorporate it is to position it as a new topic sentence, replacing the original. One of the topics must be removed. This points up the main problem with understanding the paragraph: it contains too many apparent topics.

Activity 18.3

Combined Skill: Refuting an argument using evidence and logic
Students can do this activity during the chapter.

SALES RESISTANCE

A farmer's apple orchard was not doing well: many of the leaves were small. Hoping to improve the orchard, he asked a traveling salesman to do some soil tests and recommend a product that might help the trees.

The salesman reported that the soil was deficient in zinc, and that the farmer should purchase an additive that contained zinc. It was, incidentally, quite expensive.

Based on table 18.1 in your textbook, what advice would you give the farmer?

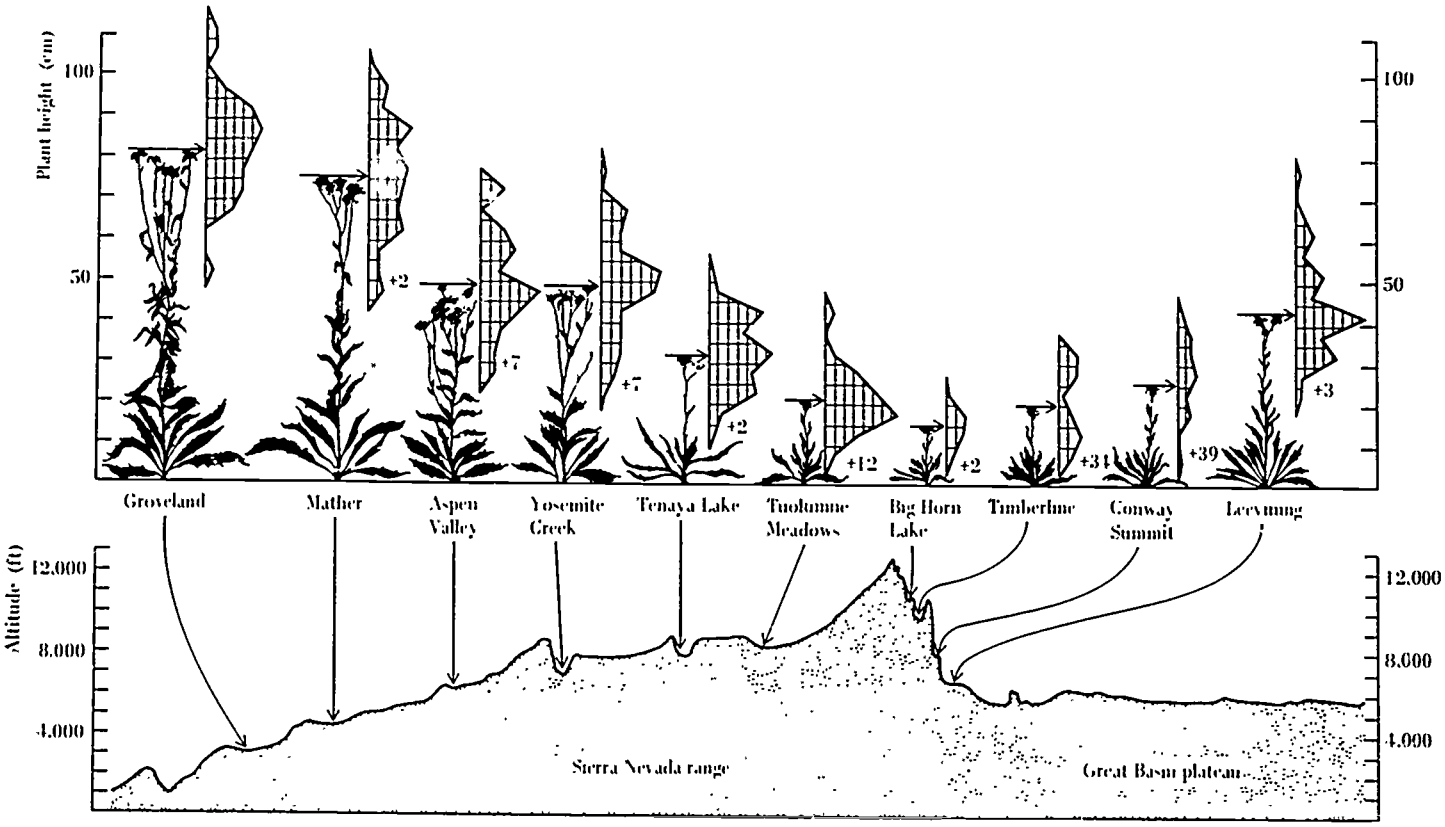
(This pertains to "mineral elements required by plants.") Farmers should always be suspicious of traveling salesmen, even if they have no daughters. As the table shows, a zinc deficiency could be the problem, but a chlorine deficiency also might cause small leaves. In addition, short internodes would be seen if a lack of zinc were involved. A soil test by a university extension service or other unbiased source would help the farmer determine the problem and know what sort of product would be most helpful.

Activity 18.4

Combined Skill: Generalizing a concept from the chapter to new instances
Students can do this activity after completing chapter 18.

WHY DO YARROW PLANTS VARY?

Recall the yarrow plants graphed in Activity 18.1. The pictures and graphs there were taken from the following:



J Clausen, D D Keck, and W M Hiesey, *Experimental Studies on the Nature of Species. III. Environmental Responses of Climatic Races of Achillea*, Carnegie Institution of Washington publication 581(1948).

Like the Groveland and Leevining populations you saw earlier, all these populations were grown under the same conditions at Stanford University (altitude 100 ft). Biologists grew seeds there in an effort to find out whether variation in plant populations was caused by genetic factors or by environmental factors. The lower graph shows the altitude and approximate geographic location from which each population originated. All the locations were at about 38° N latitude.

Based on this graph, do genetic factors or environmental factors seem more likely to determine plant height?

Genetic factors seem more likely here, as all the plants were grown in the same environment at Stanford.

Now examine the table below, showing the growth and survival of plants from the same populations at three different locations. The altitude at Stanford is 100 ft, at Mather 4600 ft, and at Timberline 10,000 ft.

Growth and survival of ecotypes of *A. lanulosa* grown in experimental plots at Stanford (100 ft elevation), Mather (4600 ft), and Timberline (10,000 ft) in California for 3 years.

	Longest stems (cm)			Survival* (%)		
Origin of plants	**Stanford**	**Mather**	**Timberline**	**Stanford**	**Mather**	**Timberline**
Groveland	83.6	58.2	15.5	100	93	40
Mather	79.6	82.4	34.3	93	90	39
Aspen Valley	47.4	56.8	25.3	93	100	73
Yosemite Creek	42.6	56.2	30.1	97	97	90
Tenaya Lake	33.9	33.7	33.4	100	97	97
Tuolumne Meadows	24.5	32.7	28.4	90	97	93
Timberline	21.2	31.6	23.7	90	67	90
Big Horn Lake	15.4	19.5	23.6	83	67	91

*Based on samples of 30 plants (except Big Horn Lake, 12 plants).
J. Clausen, D. D. Keck, and W. M. Hiesey. *Experimental Studies on the Nature of Species. III. Environmental Responses of Climatic Races of Achillea.* Carnegie Institution of Washington publication 581(1948).

What can you conclude about genetic and environmental factors now?

Though the graph clearly showed there must be a genetic difference, the table shows there must be environmental influences on variation as well.

Write a paragraph describing the variation shown here as an adaptation to selective forces. What are those forces?

The paragraph should mention that at higher altitudes, shorter plants have an adaptive advantage. The selective forces are probably temperature, moisture, and wind.

Chapter 19

Activity 19.1

Communication Skill: Identifying a main idea in a paragraph
Students can use this activity before or during the chapter.

IDENTIFYING A MAIN IDEA

Chemists must be included among the garlic and onion lovers. For them the reasons are professional: chemists have long been attracted to substances that have strong odors, sharp tastes and marked physiological effects. Investigations made by chemists over more than a century establish that cutting an onion or a garlic bulb releases a number of low-molecular-weight organic molecules that incorporate sulfur atoms in bonding forms rarely encountered in nature. The molecules are highly reactive: they change spontaneously into other organic sulfur compounds, which take part in further transformations. Moreover, the molecules display a remarkable range of biological effects. The lacrimatory, or tear-inducing, quality of an onion is only one example. Certain extracts of garlic and onions are antibacterial and antifungal. Other extracts are antithrombotic, that is, they inhibit blood platelets from forming thrombi (aggregations of themselves and the protein fibrin). In short, they act to keep blood from clotting. (From E. Block, "The Chemistry of Garlic and Onions" *Scientific American* (March, 1985): 114.)

Read the paragraph above again and decide what the main ideas is. Write the main idea in the space below.

Garlic and onions have some sulfur-containing chemicals that have a variety of biological effects, such as tear-inducing, antibacterial, antifungal, and antithrombotic.)

Now that you have written what you think is the main idea, go back and reread the paragraph. Do you agree that your main idea is the main idea of the paragraph? If you do, congratulations. If you don't, rewrite your main idea. Reread the paragraph and determine if your new main idea covers the idea in the paragraph.

Activity 19.2

Science Skill: Interpreting data in charts and graphs
Students can use this activity during the chapter.

EFFECT OF GIBBERELLIC ACID

A class of biology students conducted an experiment on the effect of gibberellic acid on the growth of two varieties of peas, Alaska and Little Marvel. The table below contains the measurements for five plants in each of four treatment groups. Study the data carefully.

Growth of Two Varieties of Pea Plants with and without Gibberellic Acid Treatment

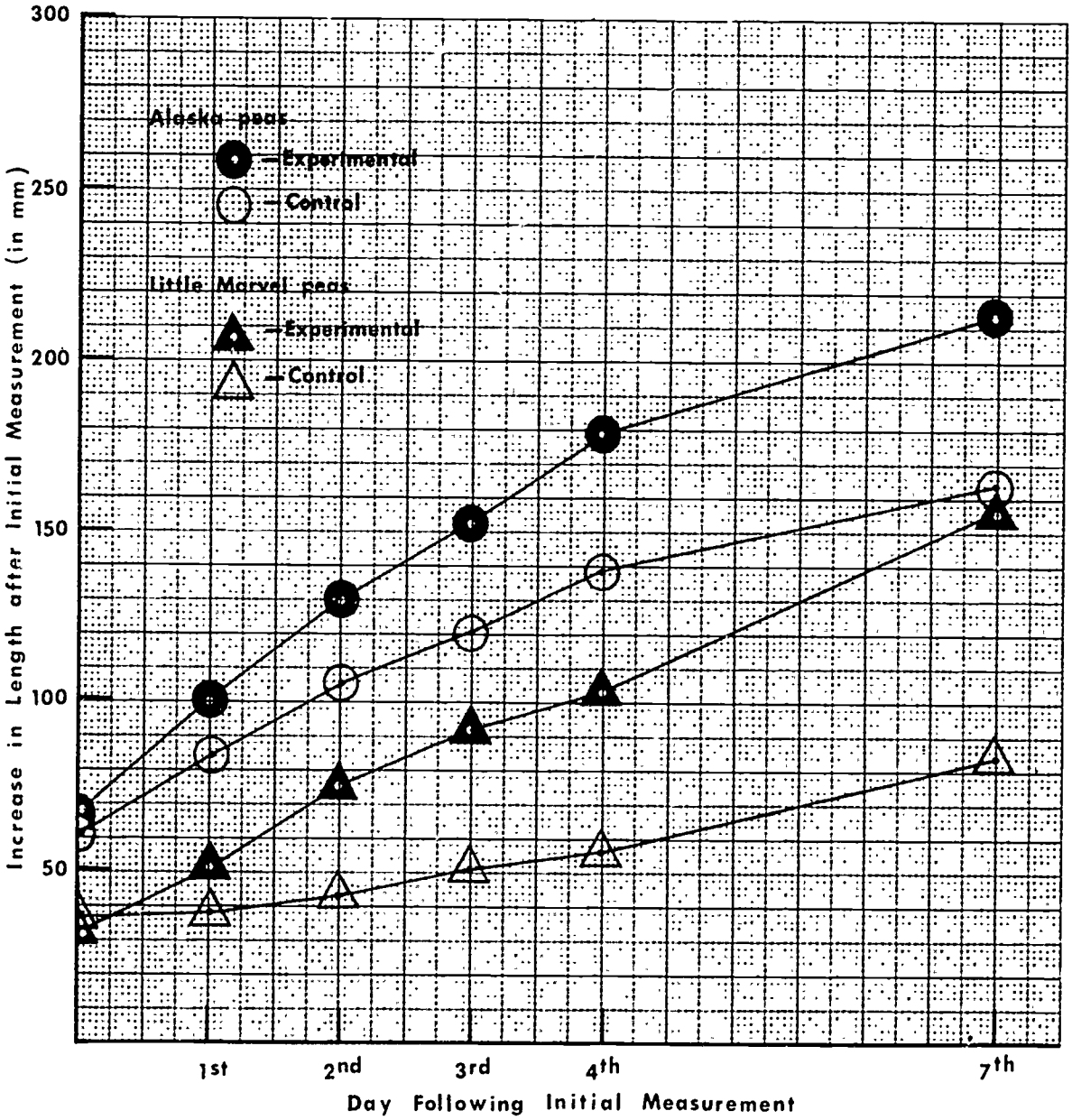
Pea variety	Treatment	Individual plants	Length (mm) initial measurement	Length (in mm) on days following initial measurement				
				1st	2nd	3rd	4th	7th
Alaska	Sprayed with gibberellic acid (Experimental)	1						
		2						
		3						
		4						
		5						
		Average	67	101	130	153	179	214
	Sprayed with water (Control)	1						
		2						
		3						
		4						
		5						
		Average	61	84	105	121	139	163
Little Marvel	Sprayed with gibberellic acid (Experimental)	1						
		2						
		3						
		4						
		5						
		Average	35	51	76	93	103	156
	Sprayed with water (Control)	1						
		2						
		3						
		4						
		5						
		Average	32	38	43	51	56	79

From Addison E. Lee, 1968, *Plant Growth and Development* (Lexington, MA: D. C. Heath and Company). Copyright © BSCS.

What can be concluded from the results of the experiment?

Students should see that peas treated with gibberellic acid grew longer than those not treated.

The graph below was constructed by the students using the data from the table on the previous page. Observe the graph carefully.



From Addison E. Lee, 1968, *Plant Growth and Development* (Lexington, MA. D. C. Heath and Company). Copyright © BSCS.

What can be concluded from the results of the experiment?

Conclusions are the same as from the table.

Which format is easiest to interpret—the table or the graph?

Students should say that the graph is easier.

Explain why one is easier to interpret than the other.

Responses will vary, but should center around the visual representation of the growth in the graph versus no visual representation in the table.

Activity 19.3

Combined Skill: Generalizing a concept from the chapter to new instances
Students can use this activity during the chapter.

TRANSPLANTING PHOTOSYNTHESIS

Chapter 19 contains many of the details of photosynthesis. From previous chapters you know that many of the organisms in the various kingdoms cannot produce their own food by photosynthesis. What important chemical compound are these organisms lacking? chlorophyll

What are the structures in which this photosynthetic compound is located? chloroplasts

Review the section of chapter 19 that deals with photosynthesis. Make certain that you understand all of the raw materials that are needed to carry out this important process.

Genetic engineers have been working for several years trying to isolate the genes that control photosynthesis. Imagine, for a moment, that the genes have been located and the nucleotide sequences identified. Your task now is to select a nonphotosynthetic organism in which to implant the engineered photosynthesis genes. Think carefully about which organism you would like to use and your reasons for choosing this organism. In the space below, identify the organism you have selected and tell why you selected it. Explain the benefits that can be derived from enabling this organism to carry out photosyn-

thesis. Explain how this organism is going to obtain all of the necessary raw materials to conduct photosynthesis in its cells. Try to counter any arguments you think you might encounter from persons who do not know anything about genetic engineering techniques.

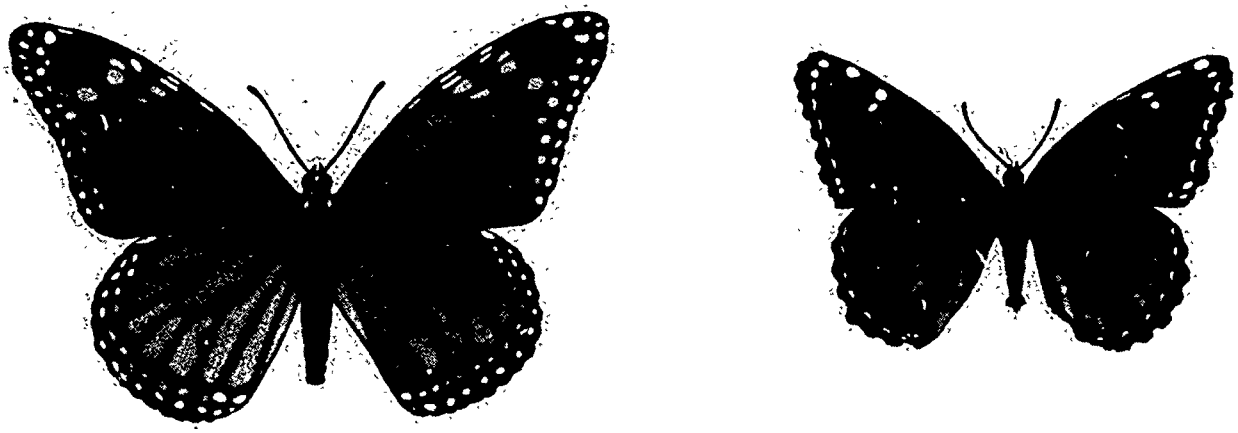
Activity 19.4

Science Skill: Testing a hypothesis
Students can use this activity during or after the chapter.

MIMICRY HYPOTHESIS

Monarch butterflies lay their eggs on milkweed plants. When the larvae emerge, they feed almost exclusively on the milkweed plant. The milkweed manufactures several different alkaloid chemicals that produce a bitter taste. The monarch larvae consume large amounts of this chemical and it is incorporated in their bodies. When the adult butterflies emerge, they still contain the bitter tasting chemical. Biologists have observed birds feeding on the monarch butterflies. Soon after eating one, the bird regurgitates violently and expels the butterfly from its mouth. It is assumed that the bitter tasting chemical is the cause of the bird's regurgitation.

Biologists also have noticed that the viceroy butterfly looks a lot like the monarch. One very popular hypothesis is that birds who have eaten monarch butterflies learn to avoid viceroy butterflies because they look like the monarch. The viceroy butterfly, however, does not contain the bitter tasting alkaloids the monarch does. The two butterflies are shown in the illustration below.



Your task is to design an experiment that could determine the reason why birds avoid eating the viceroy. Is it because it mimics the appearance of the monarch? Or, is there some other bad-tasting molecule in the viceroy's body? In the space below, describe how such an experiment could be conducted. Identify the variables in the experiment and how you would control variables that might have an influence on the outcome of the experiment. State what results you would expect to find that would support the mimicry hypothesis. State what results you would expect to find that would not support the mimicry hypothesis.

There are various ways to set this up, but exposing birds to viceroy butterflies should be done before they eat monarchs. If the birds like the viceroys, and don't avoid them, then the noxious chemical hypothesis could be ruled out. After the birds have fed on many viceroys, switch to monarchs and observe the birds' behavior until they completely avoid the monarchs. Now, reintroduce viceroys and observe the behavior of the birds. Students may recognize that several species of birds should be tried in order to generalize to a larger population.

Chapter 20

Activity 20.1

Communication Skill: Freewriting. Here, freewriting is used to activate the students' current knowledge about material in Section Five and to stimulate questions about it.
Students should do this activity before beginning Section Five.

LOOKING AHEAD

Before you lies the last section of the Green Version textbook. Perhaps you already know something about the ideas in this section. In the space below, write continuously for five minutes about what you know, think you know, or would like to know, about these topics: natural selection and survival; world ecosystems on land and in water; and human ecology.

This serves two purposes—activating the students' current knowledge of these topics, and bringing forth possible topics for class discussions and reports.

Activity 20.2

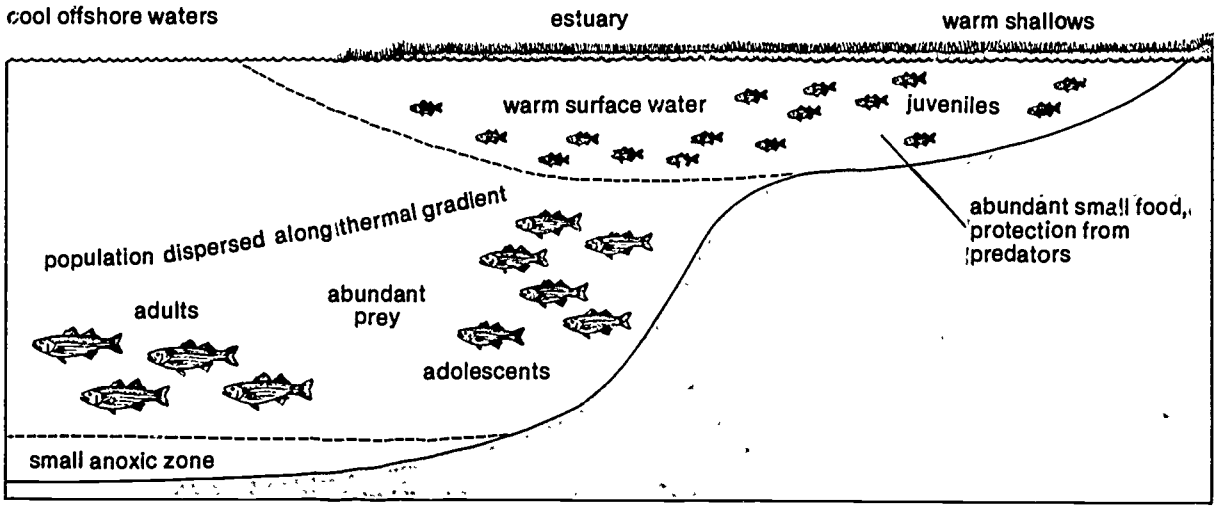
Science Skill: Forming and using models
Students can do this activity during the chapter.

A FISH MODEL

Striped bass normally live in ocean waters and estuaries. They can also live in fresh water; in fact, they are used to stock rivers and ponds.

Biologists are conducting many studies on striped bass, in part because these fish are prized as human food. The fish are tagged with temperature-sensing transmitters. A transmitter sends information about a fish's location and the temperature of the surrounding water.

Such studies have shown that striped bass of different ages prefer different ranges of environmental temperatures. Juveniles prefer to be in water between 22 and 27° C; adults, between 16 and 25° C. This preference is so strong that a starving bass will not follow prey into water that is too warm or too cool. As the drawing shows, this causes a coastal population of fish to disperse. Males reach reproductive maturity at 2 years, and females at about 4 years. Adults return to shallow water to spawn.



The season also affects the water temperature. Eggs are laid and hatch in the spring, when water is cooler. The hatchlings reach the juvenile stage by summer, when the water is warmer. Meanwhile, the adults move out to deeper, cooler waters. Space and food resources are thus available to all members of the population.

The bass also are limited to areas having desirable concentrations of oxygen. They must have a minimum of 2 ml of oxygen per liter of water. The drawing shows that in the deepest waters, too little oxygen is available. In inland ponds, the anoxic (low oxygen) area extends higher in the summer, because of the greater decomposition of organic material in warm weather. The decomposition uses up oxygen.

Form and use a model of growth for a striped bass population, similar to the models in the textbook investigations. Include assumptions about initial population size, depth of the oxygenated zone, geographic area (including coastal or inland), temperatures at various depths, time of year, and changes of temperature from seasonal changes. Decide whether the fish are free to migrate to warmer or cooler areas, or if they die when the water is too warm or cool. Whatever your model is like, the resulting "output" should be the numbers of adults and juveniles in a specified area at a specified time of the year.

Students may form various models, and should be encouraged to do so. Some might assume a coastal location, similar to San Francisco Bay or Chesapeake Bay; others, an inland pond or river with a nearby warm spring. They must decide on an air temperature at which the bottom water zone has too little oxygen for the fish. In any case, they will see that the niche for adults shrinks during summer, with the fish squeezed between too warm water and too little oxygen. In winter, the surface water may become too cold for juveniles.

Write up your model clearly so that another person can use it without asking you any questions. Try it out on some classmates.

Here is another opportunity for students to see the consequences of muddy science writing. Unclear instructions will make it impossible for another person to use the model successfully.

Activity 20.3

Combined Skill: Using the library to plan and outline a science paper
This activity can be carried out during or after chapter 20.

FINDING SCIENCE INFORMATION

Chapter 20 is only the "tip of the iceberg" of information about selection and survival. As you read the chapter, make a list of questions that puzzle you. Here are some questions that one student asked:

How have the populations in African countries changed since 1900?
What are lemmings, and what sort of niche do they have?
Have human immigrants to the United States settled in places that remind them of their homelands?
How many kinds of *Drosophila* are there, and how do they differ?
What insects have become resistant to insecticides, and how?

These sample questions suggest the level of question that students might ask—not so specific that they can be answered after one trip to a dictionary or almanac, yet not so general that a dissertation would be the only appropriate discussion paper.

Write your questions below.

Choose one question that especially interests you. Pick out key words in the question to use for getting information. For the first question above, for example, you would need to look for information under the heading "Africa," and then under subheadings such as "human populations" or "population growth." Write the key words for your question below.

Take a package of 3" × 5" index cards to the library, and look for information that will help you answer your question. As you look, you may find other helpful key words. Add these to the list you made.

Encyclopedias and almanacs are helpful for some topics. The card catalog will lead you to books on your topic. If you have *Biology Digest* or *Science Digest*, you may find information on your topic there. Your teacher or librarian can suggest other sources for your particular library.

Each time you find an article that helps you, fill out an index card with this information:

Author Year

Title of article

Book or other source in which the article was found

Your notes about the answer to your question

If possible, make a photocopy of the article.

Keep your cards and copies together in a folder or envelope. When you think you could write a short paper answering the question, stop gathering information. (If you cannot find anything on the topic, you may want to use one of your other questions instead.)

Before you start writing, make an outline. It might take the following form:

United States Immigrants

A. The question: Do immigrants tend to settle in areas reminding them of their homelands? (Reasons why they might do so)
B. Example: Scandinavians
C. Example: Mexicans
D. Example: Russians
E. My answer and summary of paper

Notice that this outline is very simple. As you plan your paper, you may want to add subheadings, but a short, simple outline will give you a clearer beginning picture of what you want to accomplish.

Another thing to notice about this outline is its five-part structure. This is sometimes called a "spool" outline, because the top and bottom sections are broader than the center sections—like an old-fashioned spool of thread, or a spool of wire. The top (first) section is a broad introduction to the topic and includes the question you want to answer. The center sections are specific points you want to make. The bottom (last) section summarizes your answer and may relate your topic to broader issues in ecology.

An outline with this basic structure can be used for any subject and for any length of paper. You will find it useful for science and for any other nonfiction writing you do.

Write your basic outline below.

Now, take out your cards and copies. Use a colored pen or pencil to classify them A, B, and so on, according to how they fit into your outline. You should have at least one source of information for each of the center sections of the outline. The first and last sections may be entirely your own question and conclusions, or they may include references to outside sources. Use paper clips to fasten these related materials together. Save them; you will need to use them during the next chapter.

Chapter 21

Activity 21.1

Communication Skill: Writing from an outline
Students can use this activity before beginning chapter 21.

WRITING A SCIENCE PAPER

While reading chapter 20, you outlined a paper to be written for the purpose of answering a question about selection and survival. Take out that outline and your notes now, and begin writing the paper. It should be one to three pages long. Write only a first rough draft—that is, get your main ideas down on paper without worrying about spelling, punctuation, or grammar.

You may want to start by expanding your outline to organize your ideas better. Or you may want to begin writing from your simple outline. Do whichever you think will help you more.

When you finish your rough draft, rewrite the outline. Expand it or revise it, based on your rough draft. (To expand it, add headings and subheadings.) The outline should make sense by itself, so that anyone reading it would know what the main points of your paper are.

Write your revised outline in the space below.

Activity 21.2

Science Skill: Using a data table
This activity can be used during the chapter.

ANIMAL FAMILIES THROUGH TIME

Much science data is summarized in tables. This saves space and makes it easy to do further calculations based on the data.

You need to be able to read a data table and interpret it. Like graphs, data tables are usually arranged along vertical and horizontal axes. At the top of a data table is a labelled horizontal row of one or more variables. At the side is a labelled vertical column of one or more variables. For example, the simple data table below has one variable in the horizontal row, and two in the vertical column:

Gender	Number of students
Boys	16
Girls	18

By reading the labels and numbers, you learn that 16 students are boys, and 18 are girls.

Most tables are more complicated and need more interpretation. In the following table, the results of four experiments are summarized. For each experiment, four results (A–D) are recorded. Notice that there is also a horizontal row for the average of each result for all four experiments.

	Results			
Experiment	A	B	C	D
1	4	5	20	0.9
2	2	6	25	0.4
3	3	5	27	0.5
4	2	7	24	0.6
Average	2.75	5.75	24	0.6

Construct a data table yourself, showing the number of animal families that have lived in past eras. Base the table on the information below, but use the names of eras and periods instead of (or in addition to) number of years. Also, show the types of animals that lived in each period.

Number of families	Million years ago	Number of families	M..ion years ago
850	0.011	300	310
810	5	310	320
620	63	320	345
510	106	320	365
360	135	290	390
320	148	280	405
310	157	270	411
280	180	250	418
270	187	230	425
240	192	210	431
300	200	180	487
310	256	100	500
300	280	80	533
300	290	60	566
295	300		

Students will have to decide how to fit more than one point in each era, and how to set up a useful table. Probably they will need 5 columns: era, epoch, kinds of animals, years before the present, and number of families.

You could also show the information as a graph. What are the advantages of using a data table over using a graph?

More precise numbers can be given; it is easier to make further calculations.

What are the advantages of using a graph over using a data table?

The picture is seen immediately, especially events such as the Permo-Triassic crisis, predictions (extrapolations) are easier; events at various lengths of time can be shown better.

Activity 21.3

Science Skill: Inferring
Students can do this activity during or after chapter 21.

IN SEARCH OF EARLY ARTISTS

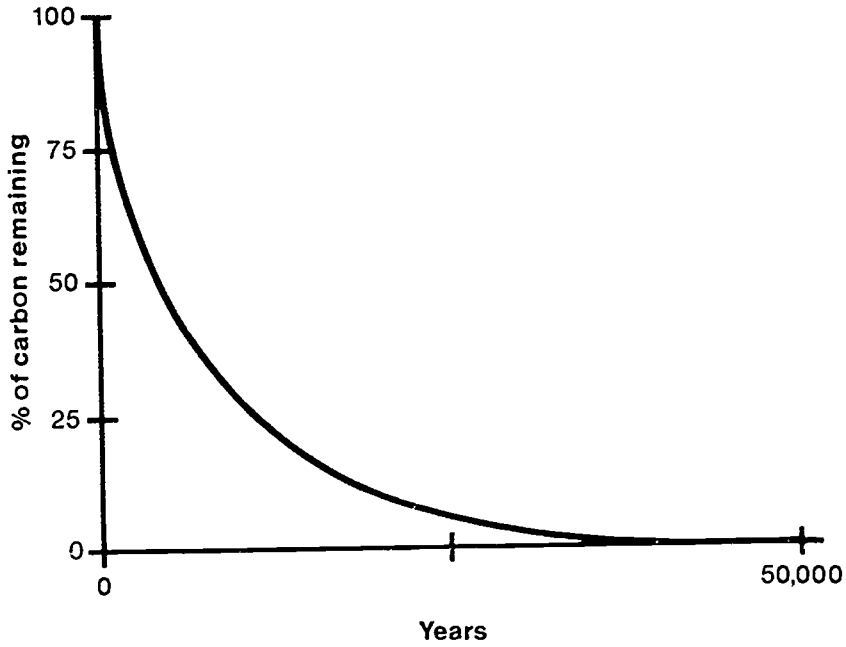
On the walls and ceilings of a cave near Lascaux, France, are magnificent paintings. Some are far below the ground. In a great chamber, the "Hall of Bulls," the paintings are of gigantic bulls. In adjoining passages are paintings of horses, deer, wild cattle, and bison. Paintings in other parts of the cave show a man, a rhinoceros, cats, and other animals.

To determine who the artists were and when they lived, scientists began by studying the things the artists left behind. Stone palettes and lumps of pigments were some evidence they left, as well as the remains of meals. Because they had to paint in the dark, they used lamps. The lamps they left were made of stone. Probably tallow was the fuel, and the wicks were made of lichen or twigs of juniper.

Ashes and soot found with the lamps have provided carbon for radiocarbon dating. As any organism takes in carbon during its lifetime, it takes in a certain proportion of carbon-14 (^{14}C), a radioactive element that is formed in the air. When the organism dies, the ^{14}C begins breaking down to nitrogen. The decay is at a definite rate: about every 5730 years, half of the ^{14}C originally present has been converted to nitrogen. (In other words, the half-life of ^{14}C is 5730 years.)

By measuring the amount of ^{14}C in a fossil and comparing it to the amount that would be expected (based on the amount of ordinary carbon that is present), a scientist can determine the fossil's age.

Draw a graph showing the breakdown of ^{14}C that occurs over the years.



After how many years is less than 1% of the original ^{14}C left in a fossil? 40,000

The charcoal found with the lamps contained about 13% of the ^{14}C that was in the original fuel.

How old are the paintings? 17,000 years

Activity 21.4

Communication Skill: Expanding science vocabulary
Students can do this activity at any time.

AN ANTHROPOLOGY SONG

In 1931 a skeleton of a 15-year-old girl was unearthed in Minnesota. The skeleton was 10,000 to 15,000 years old. With it were found a bone dagger, a clam shell, a conch-shell pendant, pieces of turtle shell, bits of antler, bird bones, and a wolf's tooth.

Someone wrote the following song about the girl:

Minnesota Clementine
or
A Threnody for the First Lady of the Land

On a lake shore, near a glacier
In a Minnesota clime,
Dwelt a Pleistocene old-timer
And his daughter, Clementine.

Chorus:
Oh my darling, oh my darling,
Minnesota Clementine
Parts of you are gone forever,
Dreadful sorry, Clementine.

Oh, her teeth were big as tombstones
And her nose was platyrrhine.
Mighty spacious and prognathous
Were the jaws of Clementine.

Drove she mammoths to the water
Every morning just at nine,
Stubbed her toe upon an esker,
Fell into the freezing brine.

Blubber lips among the cracked ice
Blowing steam and spouting slime,
But, alas, she was no whale cow,
So subsided Clementine.

On a highway, with a scraper,
Planing bumps raised by the rime,
Up they brought her, Asia's daughter,
Pleistocenic Clementine.

Counting varves and sifting gravel,
Bones and beads, one at a time,
Papa Jenks got her together,
Fossil flapper, Clementine.

(Reprinted with permission from *Earth Science* (winter 1985, p. 19); published by the American Geological Institute).

"Clementine" can be pictured better if you understand all the words. In the space below, define the following words:

threnody

glacier

Pleistocene

platyrrhine

prognathous

esker

rime

varves

Why was she called "Asia's daughter"?

Like other early Americans, she was descended from Asians.

Activity 21.5

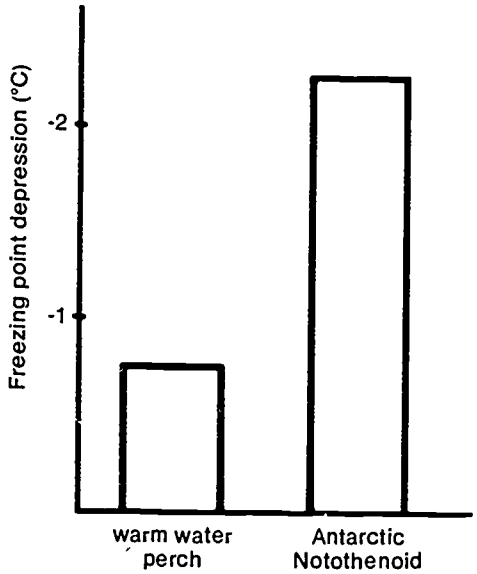
Combined Skill: Generalizing a concept from the chapter to new instances
This activity should be done following completion of chapter 21.

SURVIVING THE COLD

The Antarctic is too cold today for most fish; in the Southern Ocean, the temperature rarely rises above 2° C. However, a group of perchlike fishes called notothenioids live there.

Antarctica was once part of Gondwanaland. About 80 million years ago, that mass began to break apart. For the next 40 million years or so, the area that is now Antarctica was probably surrounded with fairly warm water. Fossils of sharks, rays, catfish, and other fish now found only in temperate waters have been found on Seymour Island. When Antarctica separated from Australia, a pattern of ocean currents caused enormous cooling of the new Southern Ocean.

The notothenioids have two adaptations that help them survive cold water temperatures. One is the ability to make substances that act as antifreeze in their blood. Because the notothenioids' kidneys lack glomeruli, the substances are not lost in the urine, but stay in the blood. Related fish that live in warm water have kidneys with glomeruli.



The histogram above compares the antifreeze ability, measured in terms of freezing-point depression, of notothenioids and warm-water perches.

Most notothenioids are bottom-dwellers. But at least two species of them have another helpful adaptation—buoyancy that lifts them to middle levels, where water is warmer than at deep levels. Their buoyancy is surprising, for, like their bottom-dwelling relatives, these notothenioids have no swim bladders. However, their skeletons contain a high proportion of cartilage, which is lighter than bone tissue. In addition, their vertebrae are hollow.

Write a paragraph about what you think happened to Antarctic fish around 30 million years ago.

The paragraph should include the idea that rapid cooling acted to select fish that could withstand cold temperatures and exploit the resources at the middle level. The specific adaptations allowing the notothenioids to survive were lack of glomeruli, ability to form antifreeze substances, and light skeletons.

Chapter 22

Activity 22.1

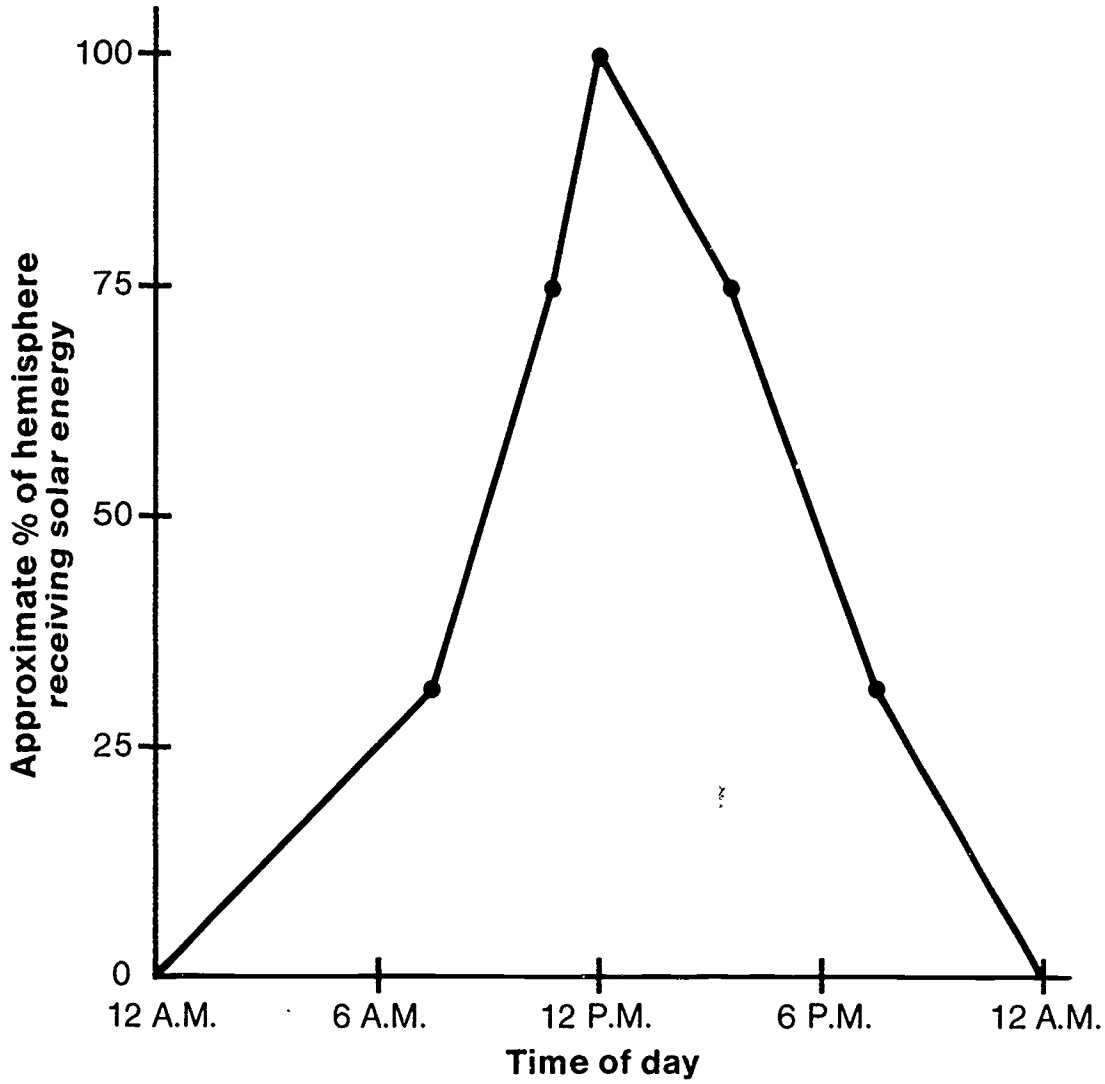
Science Skill: Interpreting or using graphs and maps
Students can do this before reading the chapter.

SOLAR RADIATION

Each day the earth rotates once on its axis, and, depending on the season, most or all of the earth goes through a cycle of daylight and darkness. These photos taken from satellites show the western hemisphere at various times of the day.

NASA

With the photos as a reference, use the space below to construct a line graph showing the approximate percent of the western hemisphere receiving solar energy at midnight, 7:30 A.M., 10:30 A.M., noon, 3:30 P.M., and 7:30 P.M.



Would this graph differ in winter and summer? Discuss.

No, the graph for the *western* hemisphere would not change. However, the amount of light reaching the *northern* and *southern* hemispheres would vary with the seasons.

Relate the seasonal difference in sunlight to the plants found in the grassland biome.

Grassland plants must be able to withstand both hot summers and cold winters, owing in part to the differing amounts of solar radiation in winter and summer.

Activity 22.2

Communication Skill: SQ3R method
Students can do this while reading the chapter.

READING ABOUT BIOMES

In mastering this chapter, as in other reading, you may find the SQ3R method helpful. These are the steps to follow:

1. S: *Skim* the passage quickly.
2. Q: Note the major *questions* that you think are answered by the passage. Watch for clues in the printing, such as headings and boldface type. The authors used these to emphasize major ideas or vocabulary.
3. R: *Read* the passage carefully.
4. R: *Recite* the answers to the questions.
5. R: *Review* the passage. Find any answers you missed earlier.

For example, one student wrote these questions about section 22.1:

1. What is climate?
2. Why is it important to ecosystems?
3. How does climate change in different seasons?
4. What is a climatogram?
5. What is a biome?

Try the method yourself on one of these sections: 22.2, 22.3, 22.5, or 22.8. After steps 2 and 4, fill in the spaces below.

Questions	Answers

You may want to use this method for studying other books. Some people find it a good way to study for tests. Is the SQ3R method helpful to you?

Why or why not?

Activity 22.3

Combined Skill: Visualizing in 3 dimensions
Students can do this while reading the chapter.

BIOMES IN 3 DIMENSIONS

The solar radiation and precipitation an area receives depends on where on the globe it is located—on its latitude, its longitude, and its altitude. The drawing below shows a mythical continent that has characteristics of Eurasia and Africa. Mt. Echo, at 25 degrees of longitude and 40 degrees of latitude, is 5000 m high. For each 1000 m above sea level, the vegetation on the mountain changes as if it were 10 degrees of latitude farther north. For example, at 1000 m of elevation, the vegetation changes from grassland to deciduous forest.

For the questions below, use your textbook and the map. List at least five organisms in answer to each question.

What organisms would you find at sea level, 10 degrees north and 0 degrees east?

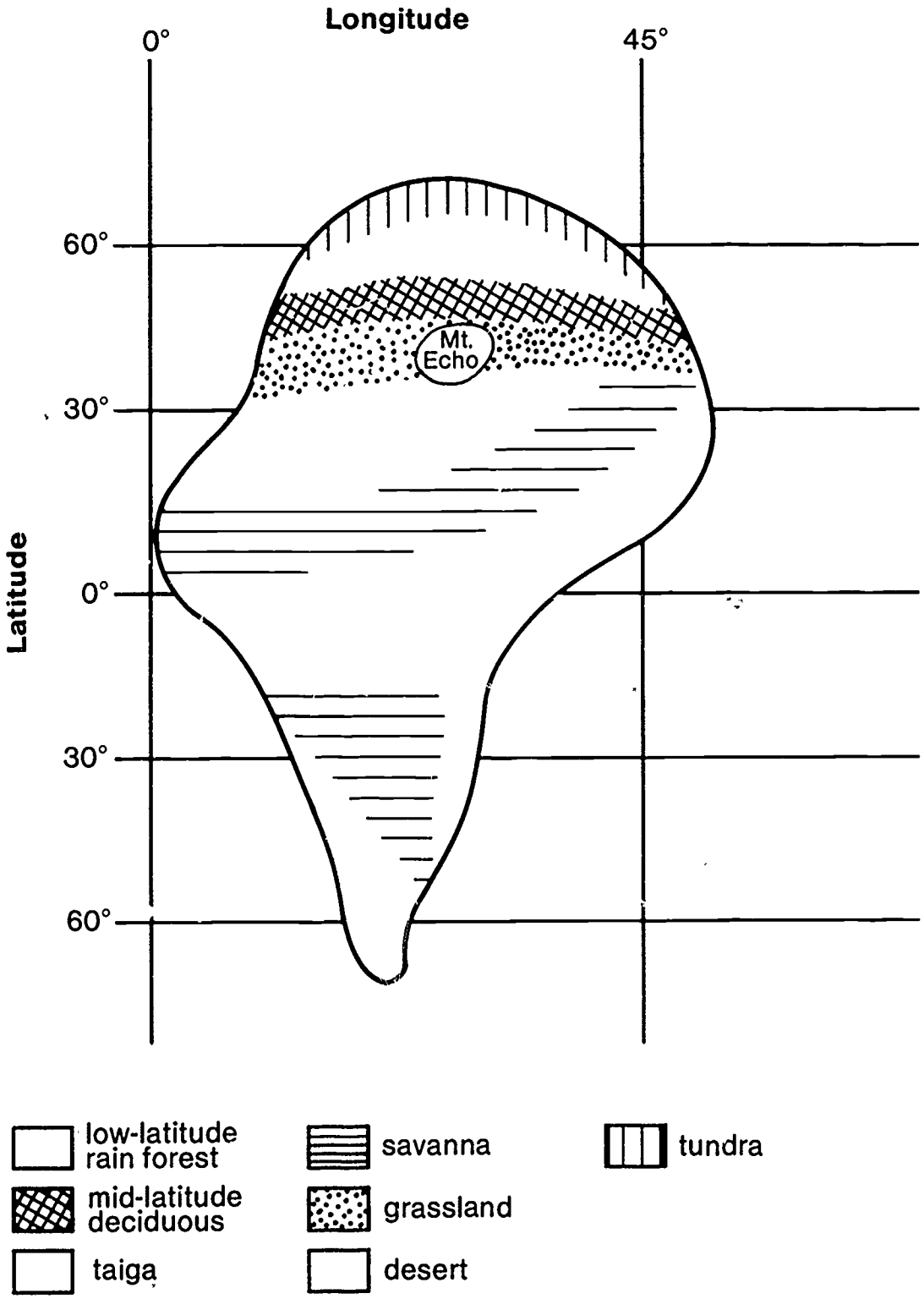
savanna organisms

What organisms would you find at sea level, 0 degrees north and 25 degrees east?

rainforest organisms

What organisms would you find at 3000 m of elevation, 40 degrees north and 25 degrees east?

tundra organisms



Activity 22.4

Combined Skill: Generalizing a concept to a new example
Students can do this after reading the chapter.

WHERE BIOMES MEET

Three biomes overlap in central Wisconsin. At that latitude and longitude, climatic factors are such that on the sunny side of a hill, the vegetation may be different from the vegetation on the shady side. The difference in temperature or precipitation can be just enough to tip the balance from one biome to another.

Some areas can be described as follows:

1. In summer, herbs and grasses grow on the gently rolling hills. Bur oak trees may be seen here and there, but they grow mainly in valleys, along streams. Other trees are rare. Rabbits and grasshoppers are common. The winters are cold, with an average temperature of −6° C in January; in July, the average temperature is 21° C. The greatest precipitation falls from April through June.

What biome is described here? grassland

2. In other areas, the greatest precipitation falls between June and September. The temperature also is highest then, the average ranging from 10 to 15° C. The winters are bitter cold, with the average temperature well below −18° C in January. Most trees are adapted to conserve water, their leaves being needles. Evergreen forests of spruce, fir, pine, and hemlock surround lakes carved out by glaciers. Some non-evergreen trees also may be seen here—among them, beech and aspen. Deer and black bears live here.

What biome is described here? taiga

3. Describing Wisconsin's third biome is up to you. Write a paragraph like those above, naming the biome and including information about the climate, plants, and animals. Use your textbook and (if you wish) other references.

Chapter 23

Activity 23.1

Communication Skill: Editing a paragraph
Students can do this activity before beginning chapter 23.

A MUDDY SEA AROUND US

To be clear and communicative, science writing must obey the rules of spelling, punctuation, and grammar. Some mistakes may actually change the meaning of a sentence. For example, consider these sentences:

> Sewage greatly effects nearby ecosystems.

The word *effect* means "bring about." The author meant to say *affect*.

> Being polluted, the biologist studied the fish in the stream.

Presumably the stream, not the biologist, was polluted.

> The hydrosphere absorbs stores, and circulates heat.

This is a case of a missing comma. The hydrosphere does not "absorb stores"; it absorbs, stores, and circulates heat.

The examples could go on and on. The point is that in science writing, each sentence is something like a chemical or mathematical equation; its meaning must be perfectly clear to the reader.

The selection below is adapted from the book *The Sea Around Us,* by Rachel Carson. Try to find and correct the errors we have introduced into the selection.

> Between the sunlight surface, waters of the open sea and the hidden hills and valleys of the ocean floor lie the least well-known region of the sea. these deep, dark waters, with all their mysteries, and there unsolved problems. Cover a vary considerable part of the Earth. The hole world ocean extends over about three-forths of the surface of the globe. If we subtract the shallow areas of the continental shelves and the scattered banks and shoals, where at least the pail ghost of sunlight moves over the underlying bottom, there still remain about half the earth that is covered by miles-deep, lightless water, that has been dark since the world began.

Carson's book is a model of good science writing. Encourage students to look up the original passage, the first paragraph in the section The Sunless Sea. (They may be led to read more.) With the mistakes corrected, the passage appears as

> Between the sunlit surface waters of the open sea and the hidden hills and valleys of the ocean floor lies the least-known region of the sea. These deep, dark waters, with all their mysteries and their unsolved problems, cover a very considerable part of the earth. The whole world ocean extends over about three-fourths of the surface of the globe. If we subtract the shallow areas of the continental shelves and the scattered banks and shoals, where at least the pale ghost of sunlight moves over the underlying bottom, there still remains about half the earth that is covered by miles-deep, lightless water, that has been dark since the world began.

From Rachel Carson, 1961, *The Sea Around Us* (New York: The New American Library, p. 48).

Activity 23.2

Science Skill: Identifying variables
This activity can be done at any time during the chapter.

AQUATIC VARIABLES

In reading newspaper articles, you may come across descriptions of surveys or experiments in which variables are measured. Read the article below, which was released by United Press International in 1985, and look for variables.

State, MWD Widen Water Pollution Tests

SACRAMENTO (UPI)—The Department of Water Resources is widening the scope of its tests of Northern California water shipped to Southern California via the State Water Project to check for pollutants.

The Metropolitan Water District of Southern California, which serves most of the Southland's urban area, is also increasing scrutiny of its water, most of which comes from the Colorado River. Los Angeles uses some MWD water, but relies mostly on its own supply.

A water quality engineer for the Department of Water Resources said Friday that sediments in storage reservoirs will be checked for "pesticides, other organic materials and minerals, including selenium."

He said tissue samples will be taken from fish in the California Aqueduct and in the department's reservoirs in Southern California. "We want an assurance that things in fish tissue are not approaching official-action levels," Mitchell said.

The crisis over the selenium-tainted Kesterson Wildlife Refuge in Merced County has raised concern over the Northern California water supplied by the State Water Project.

Part of the water comes from the San Joaquin River, which flows into the Sacramento-San Joaquin River Delta. A director of the San Francisco Bay Institute said Friday that farm waste water from about 77,000 acres of land on the western side of the San Joaquin Valley drains into the river. He said selenium probably had been entering the San Joaquin for many years before the Kesterson crisis arose.

The MWD gets a relatively small portion of its water from this source.

In Los Angeles, an MWD spokeswoman said Friday that selenium content of the Colorado River water also is a matter of concern.

She said tests of MWD water supplied from the Colorado in January showed selenium contents of 4 to 6 parts per billion, while tests of water coming in from the north at the same time showed no detectable selenium content.

She emphasized that tests for selenium of both water from the north and water from the Colorado have always been below the federal government's action level of 10 parts per billion. (Reprinted with permission of United Press International, copyright 1985.)

What agency has carried out a study involving variables?

MWD of Southern California

What is the independent variable?

Source of MWD water

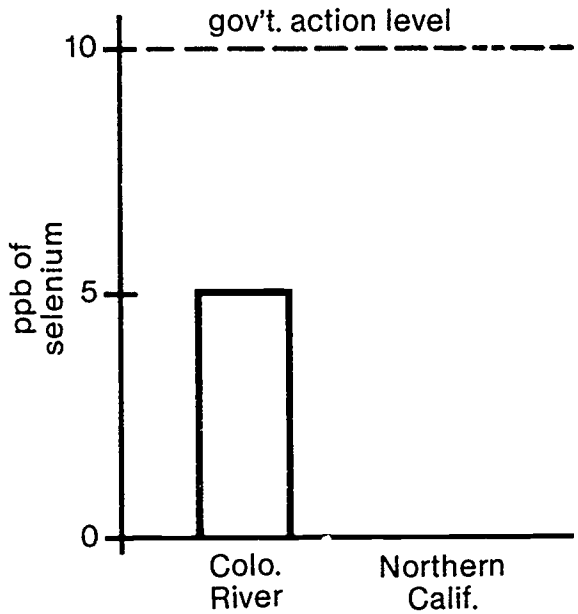
How does the independent variable vary?

Colorado River or Northern California (State Water Project)

What is the dependent variable?

Amount of selenium

Draw a histogram below to show the results of the study, and indicate how the results compare with a government standard.



Activity 23.3

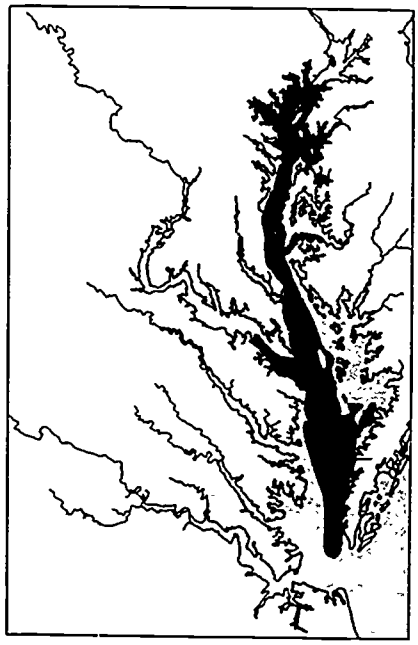
Combined Skills: Generalizing a concept from the chapter to new instances, and Understanding the social aspects

Students can carry out this activity after finishing chapter 23.

CHESAPEAKE BAY

Chesapeake Bay has been an important source of seafood since the first Americans arrived there. The food web depended on submerged grasses, and included crabs, oysters, ducks, striped bass, and other organisms. Farms and large cities grew up along the bay.

Now the grasses are gone from Chesapeake Bay, and some of the fish and other living things are disappearing also. The water near Cambridge, which was clear 25 years ago, is filled with mud. Large mats of algae float in the water all over the bay, cutting off light to the water below. Decomposers of dead algae contribute to the further depletion of oxygen. Human waste can sometimes be seen in the water. Amounts of nitrogen and phosphorus have greatly increased, especially in the parts of the bay near the Susquehanna, Potomac, and James rivers. In the areas shown in black on the map, the oxygen has decreased greatly.



Write a paragraph describing the probable sources of these changes in the bay, and how they made the changes.

The sources should include the runoff of fertilizer from farms, sewage, wastes from the large cities, and erosion from areas where trees have been removed for construction. The nitrogen and phosphorus contribute to the algae growth that decreases the oxygen.

Chapter 24

Activity 24.1

Communication Skill: Rewriting a passage
Students can do this activity before the chapter.

CLOUDY WRITING

Since about 1750, the mean surface temperature of the earth has gradually risen. During the same time, the carbon dioxide in the atmosphere has increased. Scientists have naturally tended to associate the two trends.

The warming trend has been spotty, not distributed evenly over the planet. Computer simulations, however, have predicted an even warming trend in all areas.

Scientists who developed some of the models commented on the contradiction as follows: "While we are witnessing a warming of the terrestrial climate, we cannot identify its cause. Even if it is of anthropogenic origin, it need not be due only to increased CO_2. But if it's due predominately to CO_2, then our present climate models require work to reconcile them with observational data on patterns of surface temperature change."

Rewrite their statement for clarity and correct any mistakes in spelling you find.

"Anthropogenic origin" is redundant.
"Predominantly" is misspelled.
The last clause is cloudy, perhaps deliberately so. A more forthright statement would be. "our models of climate are wrong and must be revised to account for the evidence of surface temperature change."

Activity 24.2

Science Skill: Inferring
Students can do this activity during the chapter.

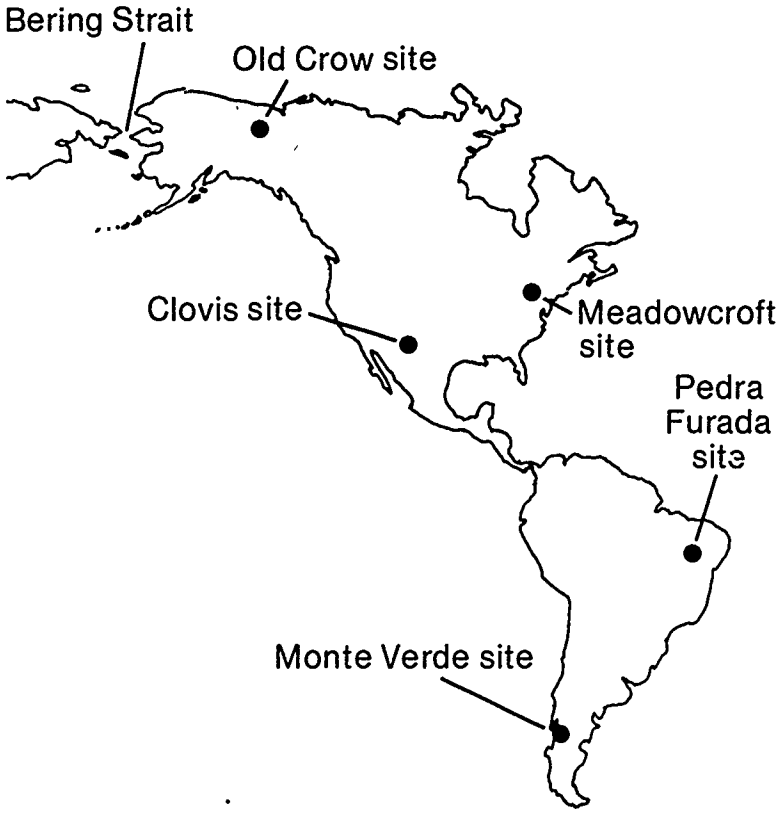
THE EARLIEST AMERICANS

On the basis of evidence at scattered sites, anthropologists have built up a picture of how humans first migrated to this hemisphere. The established picture is that during the late Pleistocene ice age, there was a land bridge connecting Siberia to Alaska. Across that bridge came mammoths. Asian hunters followed them and eventually hunted them to extinction. Following the mammoths, the earliest Americans moved from Alaska eastward and southwestward into the rest of North America and eventually into South America. About 14,000 years ago, the ice age ended. As the glaciers melted, they released water that covered the land bridge, and Asia was no longer connected to North America.

One of the findings that supported this hypothesis was the site called Old Crow, in the Yukon Territory. Radiocarbon dating of bone tools found there indicated that the site was 27,000 years old. Other sites in the Americas were younger, as would be expected. For example, the Meadowcroft site in Pennsylvania is about 19,000 years old, and the Clovis site in New Mexico is about 11,500 years old.

Lately, however, some new work has called the established picture into question. First, a scientist who re-examined the bones at the Old Crow site reports that a mistake was made in the original radiocarbon dating. He says the site is only 13,500 years old. Other recent findings show that two sites in South America (Pedra-Furada, in Brazil; and Monte Verde, in Chile) are at least 32,000 years old—much older than any sites yet discovered in North America.

Using a colored pencil, draw the "established" route of human migration on the map below.



In the space below, speculate on where the first Americans came from and how and when they got here. Use all the available evidence to support your hypothesis. Consider the possibility that some of the findings may be inaccurate. By the time you do this activity, new evidence may have appeared. If you know of such evidence, include it in your hypothesis.

If the South American sites pre-date any in North America, it is possible that humans reached South America first (sometime before 32,000 years ago), then migrated up into Central and North America. They might have come across the Pacific from the Solomon Islands, or north from Australia by way of Antarctica.

Perhaps still older sites are yet to be discovered in North America. If so, the original hypothesis could be retained.

Or, there might have been a mistake in the dating of the South American sites, as there apparently was of the Old Crow site. They might not be as old as reported. Acrimonious debate on this topic is currently taking place. Students may find newspaper articles that illustrate the excitement of scientific argument.

Activity 24.3

Combined Skills: Generalizing a concept from the chapter to new instances and Seeing its social aspect

This activity can be carried out after chapter 24 is completed.

RECONSTRUCTING VILLAGE LIFE

Discoveries in archaeology and anthropology have led to a fairly good picture of what cities and villages in the Middle East were like about 3500 to 4000 years ago. Such cultural advances as writing and metallurgy (metalworking with alloys or heated metal) made it possible to make many kinds of tools and to trade goods over long distances. Workers were specialized, as butchers, potters, bead-makers, and so on. Artists created paintings and sculpture, and people wore jewelry to decorate themselves. There were several social classes, based on wealth. Walled cities were for defense during war and for protecting assets.

In contrast, around the time of the agricultural revolution (8,000 to 10,000 years ago), early farmers must have lived very simply. Probably any trading was done within a small community, and tools were made with flint or shaped from cold metal. Buildings were constructed of stone, bones, and other unworked materials.

But what happened during the time of transition, from about 8000 to 4000 B.C.? Our picture of that period has been based largely on a village site in Iraq called Jarmo. It was excavated during the 1940s and 1950s.

Jarmo existed around 7000 B.C. The people lived a simple life, farming the land around them. Each family was fairly independent, living in its own house, making its own tools, and raising its own livestock. No evidence was found in Jarmo of specialization of workers. Apparently there were no social classes and no trade with outsiders.

Since 1960, however, other sites have been found, dating from 6000 to 8000 B.C., that seem to indicate that Jarmo was not typical. Here is some evidence from sites in Turkey, Jordan, and Iraq:

Wall painting of hunter carrying bow.

Possible inference: Art.

Large storage area with animals' bones, hunting equipment, and scraping tools; these remains are associated with large-scale leather-tanning.

Possible inference: Trade of leather for other goods over wide area.

Buildings containing different kinds of craft tools—one having a butcher's tools, another a beadmaker's, and so on.

Possible inference: Specialization of workers and work areas.

Awls, pins, reamers, hooks, and sheets made of copper that had been heated and shaped.

Possible inference: Metallurgy like that occurring in later eras.

Large, sophisticated pottery kilns that could have provided many more pots than the local area could have used.

Possible inference: Manufacture of pots and Trade over wide area.

Pots containing trace elements indicating that the pots had been made elsewhere.

Possible inference: Trading of pots.

Obsidian (a volcanic glass) found hundreds of miles from any volcano.

Possible inference: Trading of obsidian.

Cities surrounded with walls and fortifications.

Possible inference: Defense during war or in times of stiff economic competition.

Differences among burial chambers. Some appear to be those of wealthier persons, some of poorer persons.

Possible inference: Social Hierarchy.

In a village in Turkey, a huge blood-stained stone slab surrounded with hundreds of human skulls.

Possible inference: Religious Sacrifice or slaying of opponents after a victory.

Cosmetics in homes. Also, murals and figurines showing people with elaborate hairdos and wearing jewelry.

Possible inference: attention to body Ornamentation.

Sculpture of head. Found in Jericho. Eyes of head made with shells that probably came from the southern coast of Israel (at least 100 km away).

Possible inference: Trade.

Lumps of iron that had been heated.

Possible inference: attempt at Metallurgy.

Using your imagination, what can you infer from the evidence presented above? Write a short essay (having at least three paragraphs) about your own mental reconstruction of a "typical" village or city in 6500 B.C. in the Middle East.

Chapter 25

Activity 25.1

Communication Skill: Rewriting a passage
Students can do this activity before beginning chapter 25.

REWRITING YOUR ROUGH DRAFTS

In most cases, even a good rough draft can be improved. Some things to look for in rewriting are:

Topic sentences. Does each paragraph begin or end with a sentence or question stating the main topic of that paragraph? Usually a topic sentence in each paragraph will help the reader understand what you are saying.

Transitions. Is there some obvious connection between each paragraph and the one before it? Writing good transitions is difficult, but it improves science writing considerably.

Useless words. Do some words merely repeat what has already been said, or fill up space unnecessarily? Cross those words out.

Paragraph development. What do you do after writing the topic sentence? Expand on it by giving details, citing examples, comparing or contrasting, showing analogies to other situations, or developing the topic in other ways.

Your individual problem areas. What mistakes do you make most often? For instance, do you use certain words too often, or do you always misspell some common words? Watch for these mistakes and correct them.

Get out the rough draft you wrote during chapter 21, or the essay you wrote for chapter 24 (whichever interests you more). Revise it, using the above suggestions.

Activity 25.2

Combined Skills: Generalizing a concept from the chapter to new instances and Editing a passage
Students can do this during or after the chapter.

BUSINESS AND RECOMBINANT DNA

There are 12 errors in grammar, punctuation, or spelling in the following article. Read the article once to understand the idea being presented. Then read it a second time to locate and correct the various errors. After you have corrected the mistakes, read the article a third time. Do you think it is more understandable now?

BUSINESS AND RECOMBINANT DNA

1, 2 Their is an estimated 5,750,000 diabetics in the United States. The research and development that led to the discovery of recombinant DNA that allowed for bacterial production of human
3 insulin required an investment of millions of dollars. Investors in this project expect to regain his
4 investment plus a reasonable profet. Because of the large numbers of people who will purchase the genetic-engineered human insulin, the expectations of these investors will probably be realized.

5 Lets look at another similarly produced produced product, human growth hormone. The
6 prime group for this product is children who's pituitary glands are not producing the normal amount of growth hormone. If not treated, these children will only be at the height of a three or four year
7 old when they reach adulthood treatment with human growth hormone will allow them to grow to a normal adult height.

There are an estimated 2500 to 5000 children with this disorder in the United States. This
8 is far to small a number of potential users for any kind of profit to be realized by investors, so producers of human growth hormone will look for other markets. One group of potential buyers
9 is athletes who, if they were able to grow taller and heavier than they're genes dictate, might become more proficient at their particular sport. Another group might be parents who, for a variety of reasons, want their children to be taller. If the producers of this hormone begin to market
10, 11 their product to these types of groups it could raise many legal and ethical issues. Whom should
12 make decisions about issues of this type The developers of the hormone, the purchasers and users, the government?

As research and development produce more and more genetic-engineered products, many scientific, legal, economic, and ethical issues are going to place heavy demands on decision makers of the future. You could be one of them. What can you do to be ready for this responsibility?

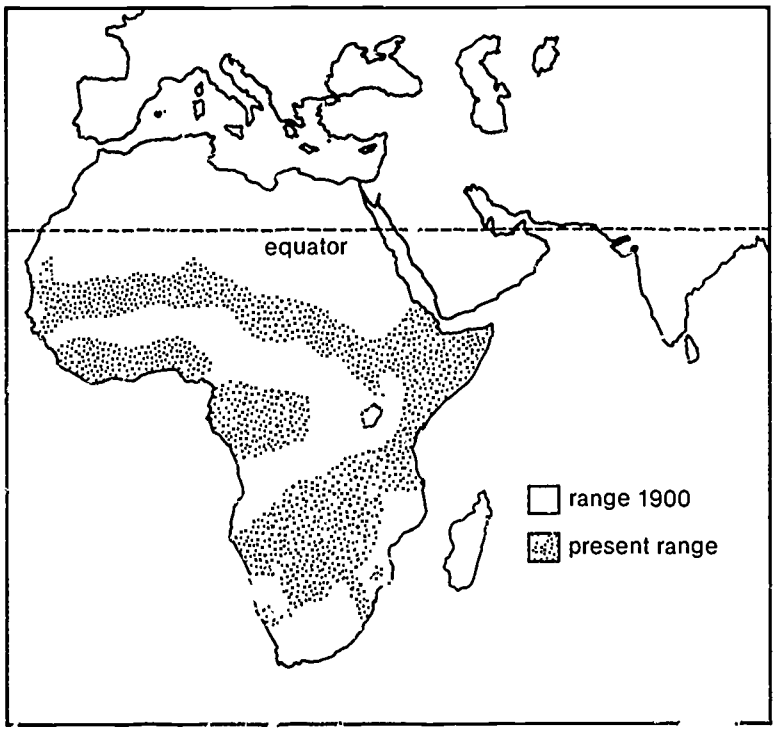
1. there—spelling—indefinite subject
2. are—plural to agree with diabetics
3. their—plural to agree with investors
4. profit—spelling
5. let's—spelling—contraction for let us
6. whose—spelling—possessive
7. run-on sentence—period after adulthood + capital T in Treatment
8. too—spelling—adverb of degree
9. their—spelling—possessive
10. sentence fragment—comma after groups + small i in it
11. who—spelling—subject form of pronoun
12. question mark instead of period.

Activity 25.3

Science Skill: Making a prediction
Students can do this activity during or after the chapter.

PREDICTION—EXTINCTION?

Cheetahs, the fastest animals in the world, seem to be on the fast track to extinction. Once they were found throughout the world, but now they live only in the parts of Africa shown on the map below. All living cheetahs are virtually identical genetically. Apparently at some time in the Pleistocene, the population size was reduced severely, and this was followed by inbreeding that reduced genetic variation among individuals.



Write a paragraph about what you predict will happen to the remaining cheetahs during the next 50 years. Consider the possible effects of genetic uniformity, climatic variation, changing ecosystems, disease, and protective legislation before making your prediction.

Though the cheetahs' outlook appears gloomy, protective legislation might allow them to come back from the brink of extinction. In northern California, elephant seals were similarly endangered, but protection has allowed them to thrive. Students might argue the case either way, but should consider the various possibilities.

Review Activity

These questions refer back to the introductory activity in the student study guide.

PREDICTING YOUR FUTURE—PART II

Several months ago you made some predictions about your future. Look at those predictions now. After taking this class in biology, would you change any of those predictions? _____

Which one(s)?

Why?

List a few things you can do to help ensure having the kind of future you want to have.

Concluding Activity

Communication Skill: Proposing and defending a thesis

Students can do this activity after finishing the textbook, but you may want them to develop it as they do Section Five, using the writing techniques emphasized in earlier activities.

ARGUING YOUR IDEAS

Some scholarly articles appear to be just factual. Underlying most scholarly papers, however, is a thesis. A thesis is the writer's main statement, which he or she defends by producing evidence to support it. Usually the central thesis of a paper can be stated in one or two sentences. For example, Darwin presented his thesis—that evolution has occurred as a result of natural selection—in his book *The Origin of Species by Natural Selection.* The book contains the evidence he had gathered and examined during a 20-year process of thinking and writing. Most theses are proposed and defended in considerably less time, but few are so thoroughly supported.

Try writing a biological thesis of your own. Use the entire textbook, your lab and field work, and any other sources you wish as the sources of evidence to support the thesis.

Encourage students to examine the photographs in the textbook, as well as the text, for evidence.

Some examples of theses proposed by students are the following:

If the organisms in an area are removed, the same organisms will eventually return.

Competition is usually beneficial to both competitors.

Or, take someone else's thesis (from discussion in the textbook or from a magazine or newspaper article) and present evidence that falsifies it.

Examples of theses you might argue against are:

The "population problem" is entirely a problem of distributing resources fairly.

Intelligence is determined entirely by genes.

Intelligence is determined entirely by environmental factors.

Your paper should be at least two pages long. The activities you completed earlier should help you in doing the research, writing your outline and rough draft, and finishing the paper.