3rd EDITION

CHAPTER 1

# The Science of Biology

## CHAPTER OVERVIEW

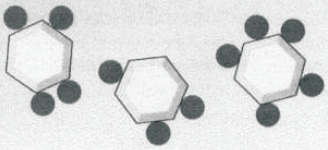
### Biology and the Living World

1.1 The Diversity of Life
1.2 Properties of Life
1.3 The Organization of Life
1.4 Biological Themes

- All living things share eight fundamental properties:
  *complexity*
  *movement*
  *response to stimulation*
  *cellular organization*
  *metabolism*
  *homeostasis*
  *reproduction*
  *heredity*
- There are many ways to study biology. Five general themes often used to organize the study of biology are
  *evolution*
  *the flow of energy*
  *cooperation*
  *structure determines function*
  *homeostasis*

**Pre-Reading**

Read over the chapter overview to identify the main concepts of this section and to set a purpose for reading. Take note of key vocabulary terms.



- The discovery of how CFCs are reducing levels of ozone in the atmosphere is a good example of science in action.
- The scientific process is founded on careful observation.
- In a control experiment, only one variable is allowed to change.
- Scientific progress is made by rejecting hypotheses that are inconsistent with observation.

### Using Science to Make Decisions

1.8 Theory and Certainty

- The acceptance of a hypothesis is always provisional.
- Well-tested hypotheses are often combined into general statements called theories.
- There is no surefire way to do science and no foolproof "method."
- One of the most creative aspects of scientific investigation is the formulation of novel hypotheses.

## 1.5 The Nature of Science

### Deductive Reasoning

Science is a particular way of inv
all investigations are scie
want to know how to get to
not conduct a scientific inv
a map to determine a route.
applying a "map" of accepte
**deductive reasoning.** Deduct
of mathematics, philosophy, p
reasoning is also the way a co
on deductive reasoning to make
general principles as the basis fo
these decisions.

### Inductive Reasoning

Where do general principles come
gious and ethical principles often have a religious foundation; political principles reflect social systems. Some general principles, however, are not derived from religion or politics but from observation of the physical world around us. If you drop an apple, it will fall, whether or not you wish it to and despite any laws you may pass forbidding it to do so. Science i
voted to discovering the general princip
operation of the physical w

How do scientist
entists are, above all,
derstand how it works
entists determine the
physical world.

This way of disco
examination of specific
(figure 1.10). Inductive r
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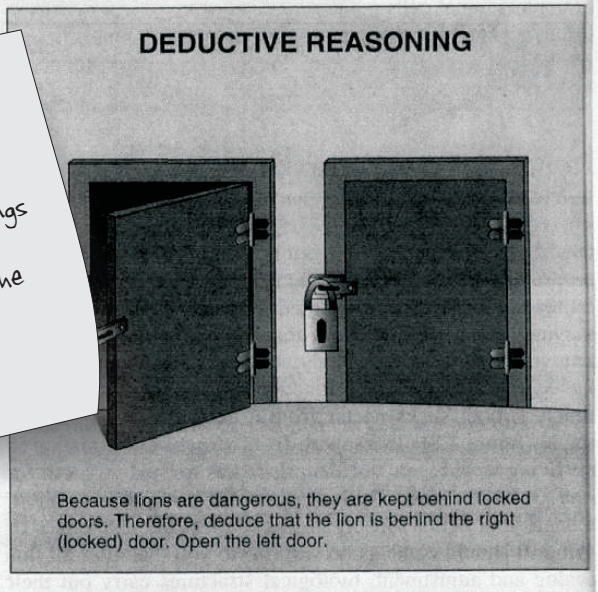
ers began to conduct expe
general principles about
ments were sometimes q
simply of releasing an app
fall to the ground. This sim
watching it
ation is the stuff of science. From a host of particular observations, each no more complicated than the falling of an apple, Newton inferred a general principle—that all objects fall toward the center of the earth. This principle was a possible explanation, or **hypothesis,** about how the world works. Like Newton, scientists today formulate hypotheses, and observations are the materials on which they build them.

**1.5** Science uses inductive reasoning to infer general principles from detailed observation.



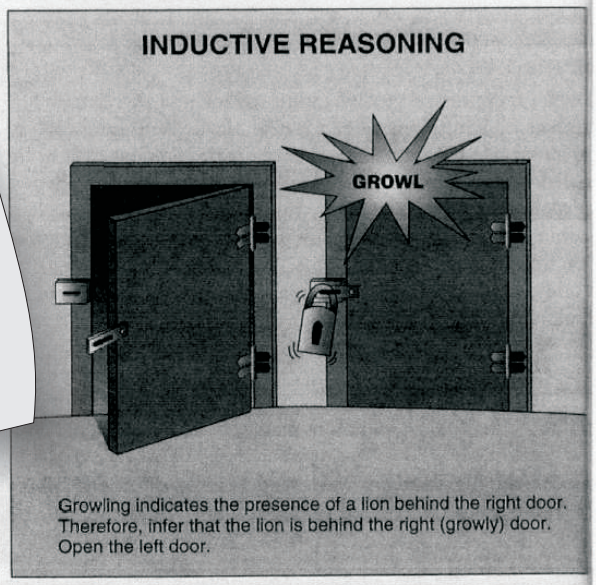




**Figure 1.10 Deductive and inductive reasoning.**
A deduction is a conclusion drawn from general principles. An inference is a conclusion drawn from specific observations. In this hypothetical example, a gladiator is forced to choose between two doors in a coliseum. Behind one of the doors is a deadly lion; behind the other door is freedom. How can the gladiator make the choice? He can use either deductive or inductive reasoning.



**Chapter and Section Headings**

**Before** reading the entire section, read all of the headings to become familiar with the topics to be learned. Turn the headings into questions.

**Figure Numbers**

These indicate visuals, graphics, charts and/or diagrams that support the text. (Ex: Fig. 1.10 is the tenth figure in the chapter)

**Concept Statement**

**After** reading the section, take note of the one-sentence summary to review the main idea.

## 1.6 Science in Action: A Case Study

In 1985 Joseph Farman, a British earth scientist working in Antarctica, made an alarming discovery. Scanning the Antarctic sky, he found less ozone ($O_3$, a form of oxygen gas) than should be there—not a slight depletion but a 30% drop from a reading recorded five years earlier in the Antarctic!

At first it was argued that this "ozone hole" was an as-yet-unexplained weather phenomenon. Evidence soon mounted, however, implicating synthetic chemicals as the culprit. Detailed analysis of chemicals in the Antarctic atmosphere revealed a surprisingly high concentration of chlorine, a chemical known to destroy ozone. The source of the chlorine was a class of chemicals called **chlorofluorocarbons (CFCs).** CFCs have been manufactured in large amounts since they were invented in the 1920s, largely for use as coolants in air conditioners, propellants in aerosols, and foaming agents in making Styrofoam. CFCs were widely regarded as harmless because they were chemically unreactive under normal conditions. But in the thin atmosphere over Antarctica, CFCs condense onto tiny ice crystals; warmed by the sun in the spring, they attack and destroy ozone without being used up (figure

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the earth is a serious
the harmful ultra-
l the earth continu-
layer filters out

age the DNA in skin
% drop in the atmo-
to lead to a 6% in-
imately 3% that has
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t 1 million tons of
United States and
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since they were in-
vented are still in use in air conditioners and aerosols and have not yet reached the atmosphere. As these CFCs, as well as CFCs still being manufactured, move slowly upward through the atmosphere, the problem can be expected to grow worse. Ozone depletion has now been reported over the North Pole as well, and there is serious concern that the Arctic ozone hole will soon extend over densely populated northern Europe and the northeastern United States. Elevated levels of chlorine were reported over northern Europe in 1992, a warning of ozone destruction to come.

**1.6** Industrially produced CFCs catalytically destroy ozone in the upper atmosphere.

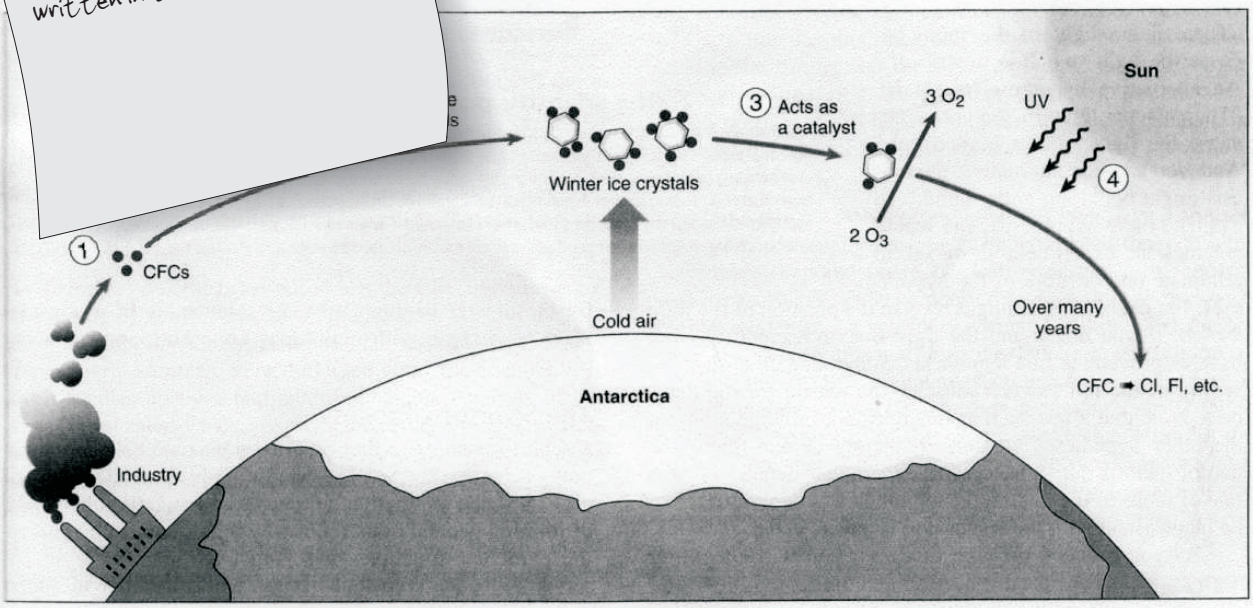


**Figure 1.11 How CFCs attack and destroy ozone.**

CFCs are stable chemicals that accumulate in the atmosphere as a by-product of industrial society (*1*). In the intense cold of the Antarctic, these CFCs adhere to tiny ice crystals in the upper atmosphere (*2*), where they catalytically destroy ozone (*3*). As a result, more harmful UV radiation reaches the earth's surface (*4*).



**Bolded Words**

Definitions for the key vocabulary words will be located within the text usually directly before the bolded word. The definition can also be found in the glossary.

**Figures and Visuals**

Graphic information that is used to explain and clarify what is written in the text.

## CONCEPT REVIEW

1. Metabolism refers to an organism's ability to
   a. reproduce.
   b. use energy.
   c. pass on genes.
   d. move.

2. Key terms for homeostasis are
   a. external environment, stable.
   b. internal environment, unstable.
   c. internal environment, stable.
   d. external environment, unstable.

3. Select the smallest level of organization among the following.
   a. cell
   b. organ
   c. organ system
   d. tissue

4. The change in a species through time is
   a. cooperation.
   b. evolution.
   c. homeostasis.
   d. metabolism.

5. A guess in a scientific process is called a(n)
   a. hypothesis.
   b. observation.
   c. prediction.
   d. theory.

6. A collection of hypotheses that have been repeatedly tested without rejection is called a(n)
   a. control.
   b. observation.
   c. test.
   d. theory.

7. Factors that influence a process in a scientific study are
   a. controls.
   b. tests.
   c. theories.
   d. variables.

8. List the six kingdoms of life.

9. List the five fundamental properties that are shared by all living organisms on earth and that are not exhibited by nonliving things.

10. _____ is the complex linear molecule responsible for heredity.

11. A _____ is a tiny living compartment covered with a membrane.

12. At each level of organization, _____ determines function.

13. Any good scientific i
    _____.

14. A _____ is
    variable is not all

**Chapter Review**

Read over the concept review questions **before** reading the lesson to set a purpose for your reading. **After** reading, reread the vocabulary and answer the questions to check your understanding.

## CHALLENGE YOURSELF

1. What is the difference between theory and certainty to a scientist? How does the word *hypothesis* fit in with a theory?

2. How does the human heart show all of the general themes of life: levels of organization, homeostasis, etc.?

3. How do you think that the connection between structure and function is the result of evolution?

4. Why is it correct to state that the process of science does not work to discover truth?

5. Imagine that you are a
   ing hypothesis: The d
   species of fish from a l
   States is due to acid ra
   pollution. What alterna
   formulate? What experiments would you conduct to test these hypotheses? How would you use control experiments to isolate the influence of acid rain from that of other variables?