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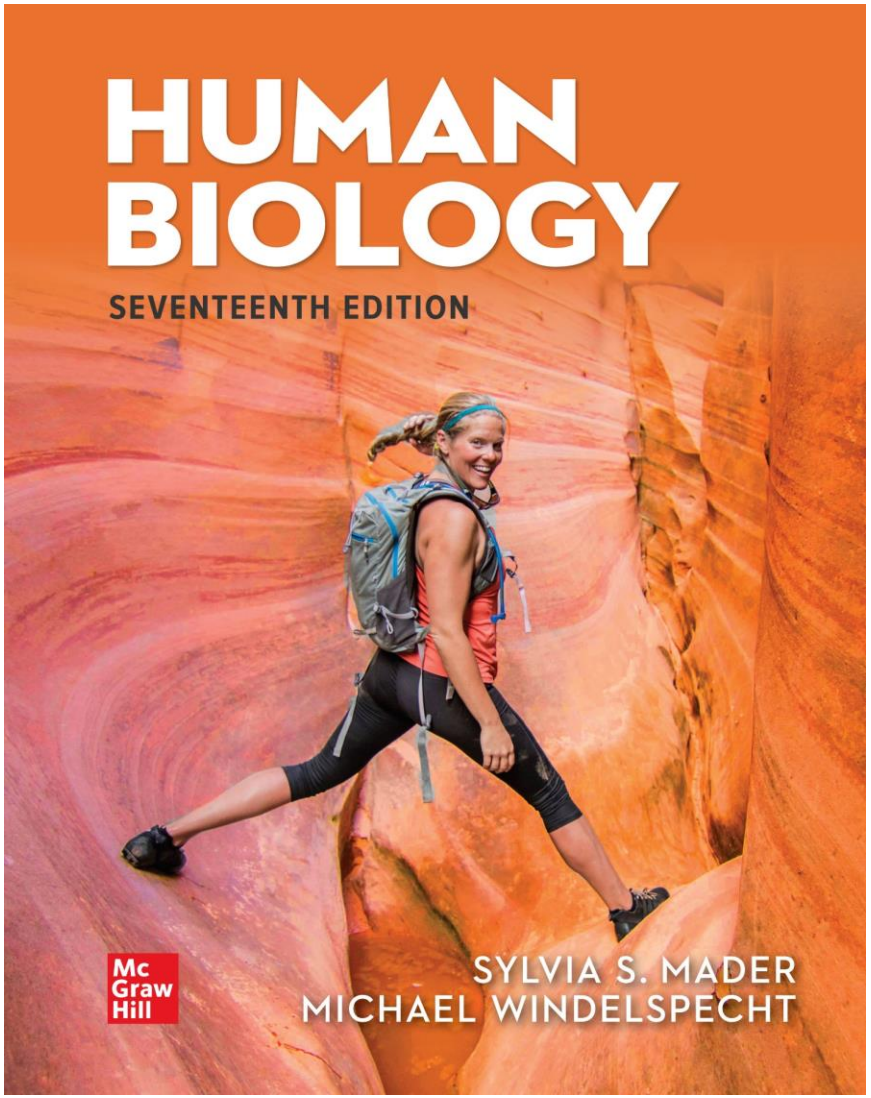

HUMAN BIOLOGY

Seventeenth Edition

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Chapter 1
Exploring Life and Science

1.1 The Characteristics of Life 1

Learning Outcomes:

- Explain the basic characteristics common to all living organisms.
- Describe the levels of organization of life.
- Explain why the study of evolution is important in understanding life.

1.1 The Characteristics of Life 2

The science of **biology** is the study of living organisms and the environments they live in.

All living organisms:

(1) are organized.

(2) acquire materials and energy.

(3) are homeostatic.

(4) respond to stimuli.

(5) reproduce and have the potential for growth.

(6) have an evolutionary history.

Life Is Organized 1

Levels of biological organization:

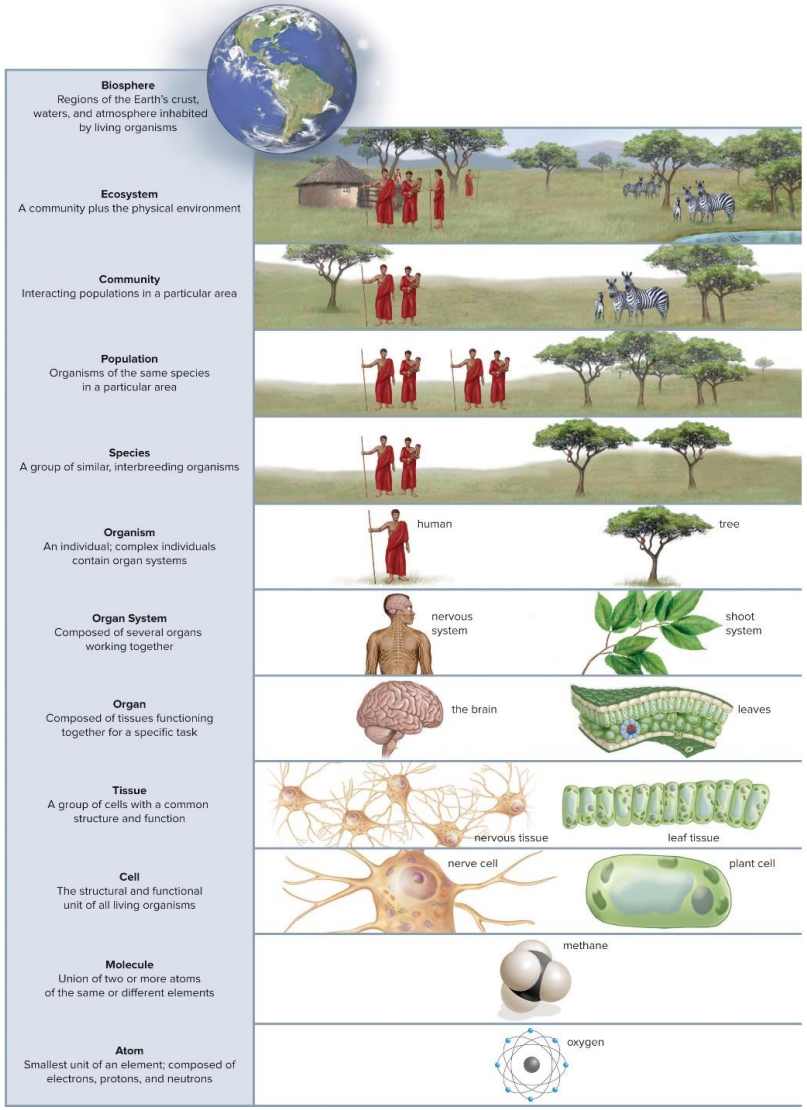
Atoms join together to form **molecules.**

Cell—smallest structural and functional unit of an organism.

- Some organisms are single-celled; some, like humans, are **multicellular** (composed of many cells).

Tissue—group of similar cells that perform a particular function.

Levels of Biological Organization (Figure 1.2)



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Life Is Organized 2

Levels of biological organization, continued:

- **Organ**—composed of several tissue types.
- **Organ system**—group of organs that work together for a common purpose.
- **Organism**—collection of organ systems.
- **Species**—a group of interbreeding organisms.
- **Population**—the members of one species in a particular area.
- **Community**—interacting populations.

Life Is Organized 3

Levels of biological organization, continued:

- **Ecosystem**—community of populations interacting with the physical environment.
- **Biosphere**—all of the Earth's ecosystems.

Life Requires Materials and Energy 1

Energy—the capacity to do work.

- Humans acquire materials and energy by eating.
- Food provides nutrients, which are used for building blocks and energy.

Life Requires Materials and Energy 2

Metabolism—the sum of all the chemical reactions that occur within a cell or organism.

The ultimate source of energy for life on Earth is the sun.

Photosynthesis—used by plants, algae, and some bacteria.

- Harvests energy from the sun and converts it to chemical energy.
- Produces sugars, which serve as the basis for the food chain for other organisms.

Living Organisms Maintain an Internal Environment

Homeostasis—a constant internal environment.

- Most organ systems strive to maintain homeostasis.
- That is, body temperature is maintained within a narrow range of values.

Living Organisms Respond

Homeostasis would be impossible to maintain without the ability to respond to stimuli.

- That is, external stimuli: remove one's hand from a hot stove.
- That is, internal stimuli: adjustments to blood pressure in response to values outside of normal.

Living Organisms Reproduce and Develop 1

When organisms **reproduce**, they pass on their genetic information to the next generation.

Growth—increase in size and in the number of cells.

Development—all changes that occur from fertilization until death.

- Includes changes occurring in childhood, adolescence, and adulthood; also repair after injury.

Living Organisms Reproduce and Develop 2

DNA (deoxyribonucleic acid)—the genetic information of all life.

Contains hereditary information that directs the structure and function of all cells.

Contains **genes**—short segments that specify traits.

Mutations—variations in genes.

- Can be beneficial and make organism better suited for its environment (this is the basis for evolution).

Organisms Have an Evolutionary History

Evolution—how a population changes over time.

Natural selection—the process by which evolution occurs.

- When a new variation occurs that allows organisms to capture more resources, those individuals have more offspring.

Adaptation—over time, population has more individuals with this advantageous variation.

Check Your Progress 1.1

List the basic characteristics of life.

Summarize the levels of biological organization.

Explain the relationship between adaptations and evolutionary change.

1.2 Humans Are Related to Other Animals 1

Learning Outcomes:

- Summarize the place of humans in the overall classification of living organisms.
- Understand that humans have a cultural heritage.
- Describe the relationship between humans and the biosphere.

1.2 Humans Are Related to Other Animals 2

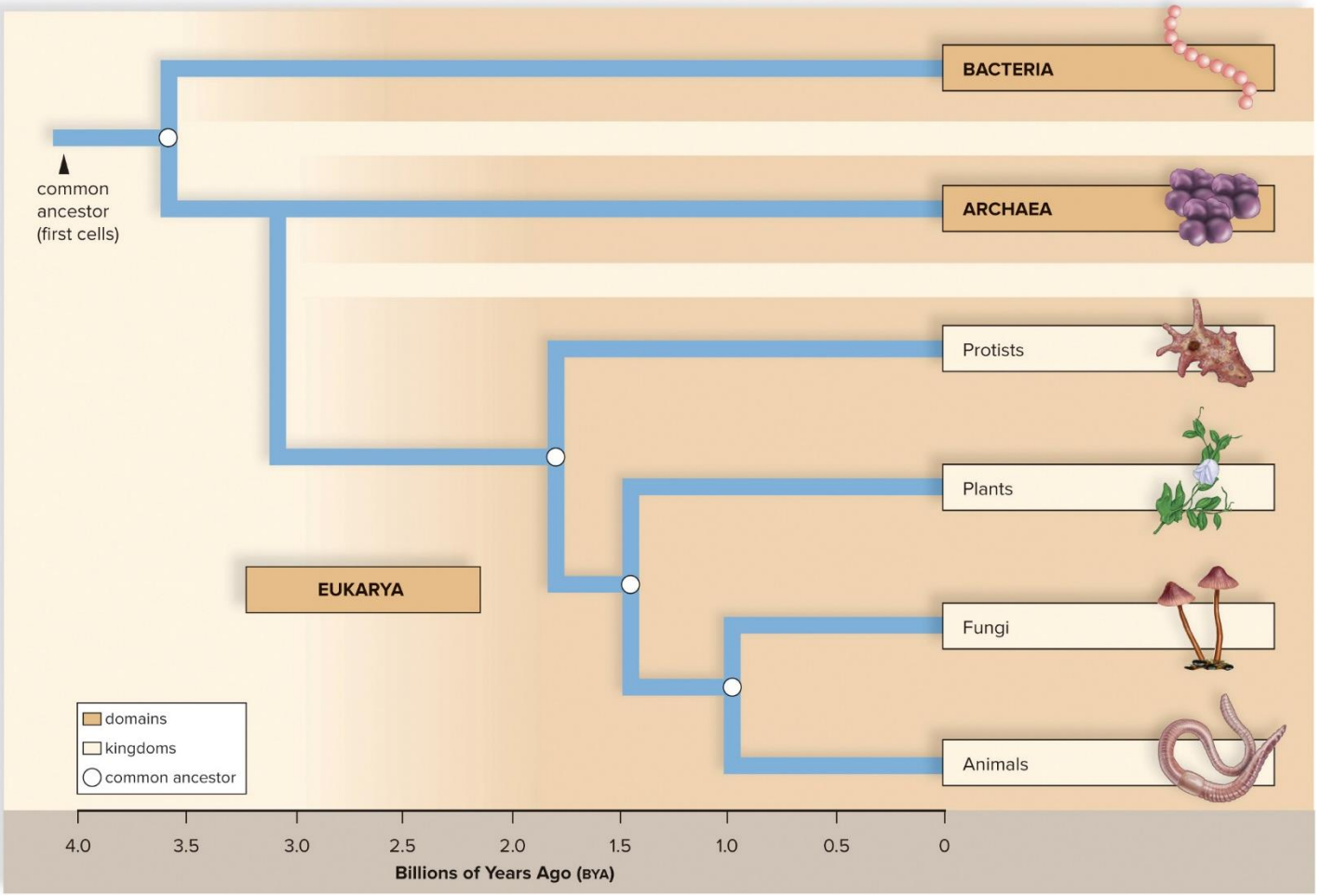
All life is classified into one of three **domains**: **Bacteria, Archaea, Eukarya.**

Bacteria and Archaea contain prokaryotes—single-celled organisms that lack a nucleus.

Eukaryotic cells contain a nucleus.

- Some eukaryotes are single-celled, some are multicellular (like humans).

The Evolutionary Relationships of the Three Domains of Life (Figure 1.5)



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1.2 Humans Are Related to Other Animals 3

The domain Eukarya is divided into four **kingdoms** and 6 **supergroups**:

Plants (Plantae).

Fungi (Fungi).

Animals (Animalia).

Protists (Protista).

- This group of eukaryotic organisms has organisms belonging to different supergroups.

The Classification of Life (Figure 1.6, Archaea and Bacteria)

Domain Archaea

Sulfolobus, an archaean

- Prokaryotic cells of various shapes.
- Adaptations to extreme environments.
- Absorb or chemosynthesize food.
- Unique chemical characteristics.

Domain Bacteria

Escherichia coli, a bacterium

- Prokaryotic cells of various shapes.
- Adaptations to all environments.
- Absorb, photosynthesize, or chemosynthesize food.
- Unique chemical characteristics.

(archaea): Eye of Science/Science Source; (bacteria): A. Barry Dowsett/Science Source

The Classification of Life (Figure 1.6, Protista and Plantae)

Domain Eukarya; Kingdom Protista

Paramecium, a single-celled protozoan

- Algae, protozoans, slime molds, and water molds.
- Complex single cell (sometimes filaments, colonies, or even multicellular).
- Absorb, photosynthesize, or ingest food.

Domain Eukarya: Kingdom Plantae

Ophrys apifera, bee orchid

- Certain algae, mosses, ferns, conifers, and flowering plants.
- Multicellular, usually with specialized tissues, containing complex cells.
- Photosynthesize food.

(paramecium): M.I. Walker/Science Source; (orchids): CreativeNature_nl/iStock/Getty Images

The Classification of Life (Figure 1.6, Fungi and Animalia)

Domain Eukarya: Kingdom Fungi

Amanita muscaria, a mushroom

- Molds, mushrooms, yeasts, and ringworms.
- Mostly multicellular filaments with specialized, complex cells.
- Absorb food.

Domain Eukarya: Kingdom Animalia

Buteo jamaicensis, red-tailed hawk

- Sponges, worms, insects, fishes, frogs, turtles, birds, and mammals.
- Multicellular with specialized tissues containing complex cells.
- Ingest food.

(mushrooms): Ingram Publishing/Getty Images; (hawk): Keneva Photography/Shutterstock

Kingdom Animalia

Most animals are **invertebrates.**

Lack internal skeletal support structure—vertebrae.

- That is, earthworms, insects, mollusks.

Vertebrates.

Have a nerve cord protected by a vertebral column.

- That is, fish, reptiles, amphibians, birds.

Vertebrates with hair or fur and mammary glands are called **mammals.**

- That is, humans, raccoons, seals.

Humans

Humans are primate mammals and most closely related to apes, but are distinguished from apes by:

- Highly developed brains.
- Completely upright stance.
- Creative language skills.
- Ability to use a wide variety of tools.

Humans and apes have a common ancestor.

Humans Have a Cultural Heritage

Culture—activities and items passed down from one generation to the next.

- Beliefs, values, and skills.
- Arts and sciences.

Humans Are Members of the Biosphere

The biosphere spans the surface of the Earth, into the atmosphere, and down into the soil and seas.

Check Your Progress 1.2

Define the term *biosphere.*

Define *culture.*

Explain why humans belong to the domain Eukarya and kingdom Animalia.

1.3 Science as a Process 1

Learning outcomes:

- Describe the general process of the scientific method.
- Distinguish between a control group and an experimental group in a scientific test.
- Recognize the importance of scientific journals in the reporting of scientific information.
- Recognize the importance of statistical analysis to the study of science.

1.3 Science as a Process 2

Science—a way of knowing about the natural world.

Scientists should be objective (factual), not subjective (involves judgment).

The scientific process uses the **scientific method.**

- A standard series of logical steps.

Start with an Observation

Observation is a formal way of watching the natural world.

Made with:

- the senses (sight, smell).
- the help of instruments like microscopes.
- through research.

Develop a Hypothesis

A **hypothesis** is a possible explanation for the observation of a natural event.

Inductive reasoning—when someone uses creative thinking to combine facts into a cohesive whole.

Scientists make a testable **prediction** based on a hypothesis.

Test the Hypothesis

Scientists use **deductive reasoning** to test the hypothesis (“if, then” logic).

Experiments are designed with **experimental variables** and responding (dependent) **variables.**

Test groups and a **control groups** are also used.

Model organisms (like mice) are also used.

Collect and Analyze the Data 1

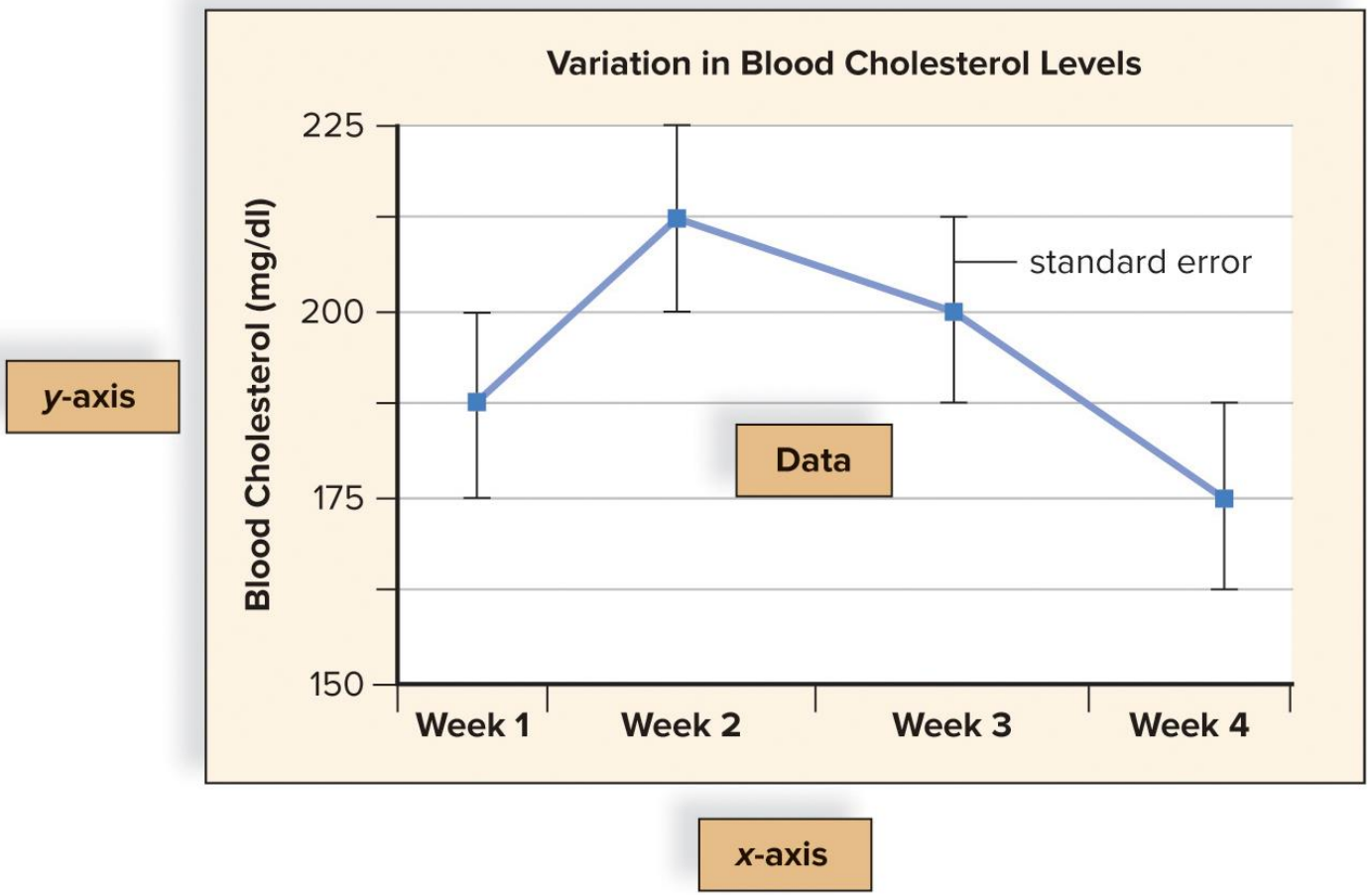
Results are derived from experiments.

Results, in the form of **data**, may be presented in a variety of formats.

Graphs are useful tools to summarize data.

- Line graphs, bar graphs.

The Presentation of Scientific Data (Figure 1.9)



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Collect and Analyze the Data 2

Statistics are used to interpret data.

Statistical data include a standard error (standard deviation) to show how uncertain a value is.

Statistical significance is determined to evaluate the probability that the results are due to chance or some other experimental variable.

Studies can be published in **scientific publications**.

Develop a Conclusion

Scientists analyze the data in order to reach a **conclusion** about whether a hypothesis is supported or not.

The conclusion of one experiment can lead to the hypothesis for another experiment.

Scientific Theory

Scientific theory—accepted explanations for how the world works.

- That is, cell theory—all organisms are made of cells.

Law, or **principle**—accepted by an overwhelming majority of scientists.

- That is, evolution.

An Example of a Controlled Study

Hypothesis: antibiotic B is better than the currently used antibiotic A.

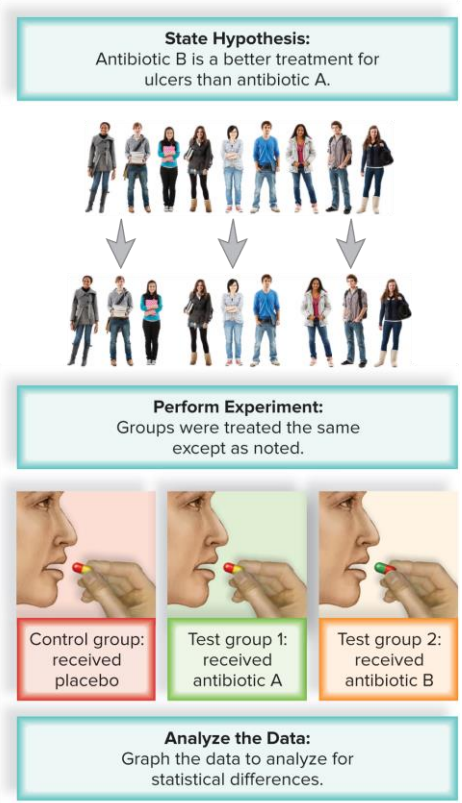
Control group: subjects with ulcers receive a **placebo** (a pill that contains no medication).

The two test groups each receive one of the antibiotics.

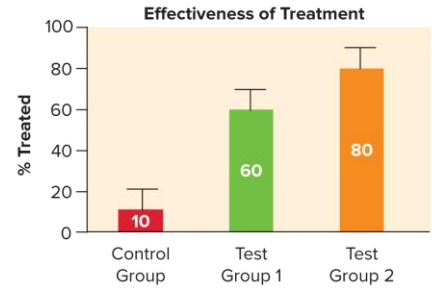
Double-blind study—neither the doctors nor the patients know which group they are in.

Conclusion—antibiotic B had better results.

Example of a Controlled Study (Figure 1.10)



a. Experimental design



b. Experimental data

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(students, all photos): René Mansi/E+/Getty Images

Check Your Progress 1.3

Describe each step of the scientific method.

Explain why a controlled study is an important part of the experimental design.

List a few pros and cons of using a scientific journal versus other sources of information.

Summarize how the use of graphs and statistics aids in data analysis.

1.4 Science and the Challenges Facing Society 1

Learning Outcomes:

- Distinguish between science and technology.
- Summarize some of the major challenges facing science.

1.4 Science and the Challenges Facing Society 2

Science—a systematic way of acquiring knowledge about the natural world.

Technology—the application of scientific knowledge to the interests of humans.

Scientific investigations are the basis for the majority of our technological advances.

- Such as the cell phone or a new drug.

Climate Change

Climate change—changes in the normal cycles of the Earth's climate due to human activity.

- Imbalance in chemical cycling of carbon.

Global warming—an increase in temperature due to increasing CO_2 levels in the atmosphere.

Scientific consensus: climate change and global warming are causing significant changes in Earth's ecosystems.

Biodiversity and Habitat Loss

Technology—the application of scientific knowledge to human interests.

Biodiversity—the total number and relative abundance of species, the variability of their genes, and the different ecosystems in which they live.

Extinction—the death of a species.

- Many biologists are alarmed at the current high rate of extinction.

Loss of Biodiversity (Figure 1.12)

Gudkov Andrey/Shutterstock

Emerging and Reemerging Diseases

Emerging diseases—relatively new.

Examples: avian influenza (H5N1, H7N9), swine flu (H1N1), severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and COVID-19 caused by a new form of SARS virus named SARS-CoV-2.

Reemerging diseases—known for some time and considered low risk but for occasional outbreaks. Example: Ebola.

Some come from new or increased exposure to certain animals.

Some come from globalization (they spread more easily).

Some come when disease vectors mutate and change hosts.

Check Your Progress 1.4

Explain how a new technology differs from a scientific discovery.

Explain why the conservation of biodiversity is important to human society.

Summarize how emerging diseases and climate change have the potential to influence the entire human population.

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