SCIENCE

Order & Design

Second Edition

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SCIENCE / HEALTH SERIES

Science: Order and Design

Second Edition

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Backyard Scientist

Science Investigation

How to Use This Text

Science: Order & Design has many features designed to make your study of life science interesting and beneficial.

Interesting Content

The Table of Contents gives you an overview of what you will study this year. After learning basic principles about life science and the methods scientists use to discover facts about nature, you will study the plants that grow abundantly in parks, gardens, yards, and meadows. You will then learn about the intricate design that God placed into your body systems and how you can glorify God by taking care of your body. You will see that the evidence from nature supports the biblical account of Creation and that the similarities between man and animals are the result of a common Designer. Next, you will study the major animal groups and the multitude of microscopic living things. Finally, you will learn how the relationships between living things and their environments demonstrate God's providential design.

Study Aids

Throughout the text, the most important terms and concepts are marked using bold or italic text.

Mastering key terms in bold will help you understand concepts and prepare for quizzes and tests.

A sentence or phrase in italics is an important concept or definition of which to take particular note.

Italic terms guide you in following the logic of the text or highlight connections to previous chapters.

Pronunciations of unusual or unfamiliar words are given at first use; a pronunciation key is on p. 496.

Illustrations enhance interest and understanding.

Pronunciations are also given for many terms. In the back of the book, you will find a **Glossary** of key terms and definitions (p. 496) and an **Index** listing all references to the major topics (p. 519).

Feature Articles

This text includes many articles that will enhance your study of science. "A Closer Look" articles present detailed information of various interesting topics to aid your understanding of the text. "Creation Clip" boxes present specific and interesting examples of God's design in nature.

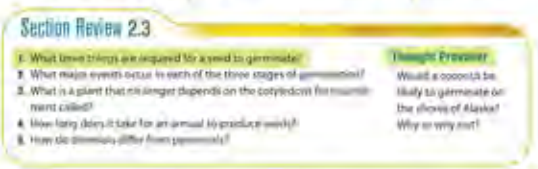
There are also activities throughout the book. "Check It Out" and "Science Investigation" activities can be completed during the lesson to illustrate concepts from the text. "Nature Explorer" and "Backyard Scientist" are activities and projects that can be completed outside the lesson to help you learn about nature by exploring it.

Section and Chapter Reviews

Section reviews will be useful as you read the text and prepare for quizzes. **Chapter reviews** will help you study for tests. Each chapter review consists of four sections: Define, Identify, Explain, and Apply.

Comprehension questions check understanding.

Thought Provokers help you develop thinking skills and make connections.


Section Review 2.3

Thought Provoker

Would a coconut be likely to germinate on the shores of Alaska? Why or why not?

Define key terms.

Identify important characteristics and lists.

Explain terms and concepts.

Apply material to answer thinking questions.


Chapter 1 Review

Accurate, Detailed Illustrations

Every photograph and diagram in this book was chosen to enhance your interest in and understanding of the written text. As you read the text, pay close attention to the illustrations; match them with the text material and read the captions and labels. If the illustration is showing a process, trace the process as you read the text.

Christian Perspective

The most important feature of this life science textbook is its Christian perspective. The authors believe that the world and all things in it were created exactly as explained in the Bible (Gen. 1, 2) and that the order found in creation is the result of God's wonderful design (Psa. 104). Most of the world's greatest scientists—men like Galileo, Sir Isaac Newton, Robert Boyle, Lord Kelvin, Michael Faraday, Gregor Mendel, Louis Pasteur, Johannes Kepler, and Joseph Lister—worked from this perspective. It is the authors' desire that as you gain a deeper knowledge of the living creation, you will be drawn closer in a personal relationship with the Creator.

Study Tips for Science

- Do your homework right after school, while what you learned is still fresh in your mind.
- Review daily.
- Note key terms and ideas by highlighting them or by recording them in a notebook.
- Summarize or outline the text in your own words.
- Make flashcards of terms and definitions.
- Have a friend help you review. Take turns "teaching" the material to each other and asking questions about it.

Chapter 1
Invitation to Science

KEY CONCEPTS

- *introduction to life science*
- *how to observe nature*
- *overview of environments*
- *taxonomy*
- *scientific method*
- *scientific reasoning*

1.1 Studying God's Living Creation

Through science, man has greatly increased his knowledge of God's creation and used that knowledge to benefit mankind. In fact, many early modern scientists who believed in God—great men like Sir Isaac Newton, Galileo Galilei, Sir Francis Bacon, and Robert Boyle—wrote of God's infinite wisdom and design, evidenced in their studies of creation. These men established that *the purpose of science is carefully observing nature, discovering the laws of creation, and using those laws for mankind's benefit.* This purpose fulfills God's first command to Adam and Eve:

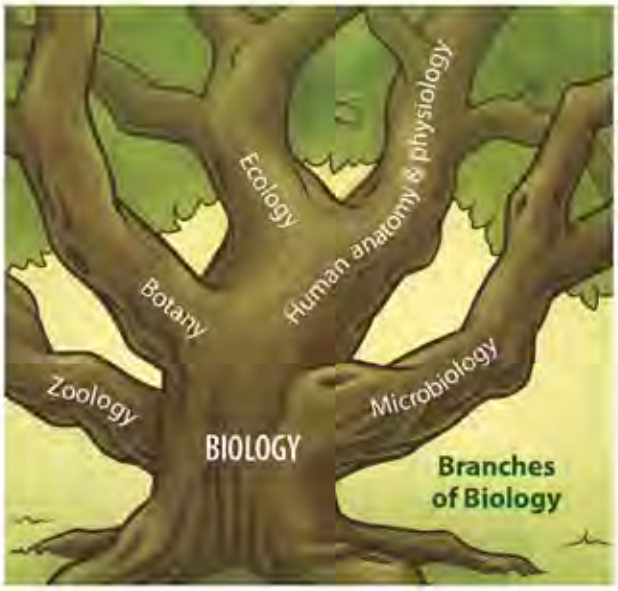
> *Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth. —Gen. 1:28*

The study of living things, called life science or **biology**, began with this command to Adam and Eve to subdue the earth and use it for their benefit. From the beginning, man has been naming, using, and studying living things. Scientists who study living things are called *biologists.*

In this chapter, you will study what **organisms** (living things) need for survival and where they live. You will learn about how scientists classify organisms for study. And you will learn how to study and think about nature like a scientist. Using these skills throughout the remaining chapters will enable you to make fascinating discoveries and will give you a greater knowledge of God's amazing creation.

Branching Out

Because there is a great diversity of living things to study, scientists divide biology into different branches. The study of animals and how they live is called **zoology** [zō·ŏl′ə·jē]. In zoology, scientists also discover new species and breed healthier, stronger animals. **Botany** [bŏt′n·ē] is the study of plants. Many scientists who study plants use their knowledge to help farmers grow larger, better crops and to change plant characteristics, including flower color and design. **Microbiology** [mī′krō·bī·ŏl′ə·jē], the study of organisms that are too small to see without a microscope, encompasses zoology and botany because some animals and plants are microscopic. The study of organisms interacting with their surroundings and each other is called



ecology [ĭ·kŏl′ə·jē]. Ecology links all the other branches of biology together by showing how one organism relates to another.

The fifth main branch of biology is **human anatomy** [ə·nät′ə·mē] **and physiology** [fĭz ē·ŏl′ə·jē]. *Anatomy* is the study of an organism's shape and structure; while *physiology* is the study of how an organism's structure functions. When studying anatomy, a scientist may analyze a leg muscle's size, shape, and location; but in physiology, he would study how the leg muscles function in movement. Using anatomy and physiology, scientists can understand how our bodies work and can help medical doctors repair injuries or cure diseases.

The Meaning of Life

God created a great variety of living things: giant whales and miniature aquatic plants; high-flying birds and deep-sea fish; cheetahs that run at over 100 km/hr (60 mi/hr) and snails that take over 12 min to travel 1 m (39 in). Despite this diversity, *all living things have five main characteristics in common:* they have an organized structure, grow, respond to changes in and around themselves, reproduce, and carry out the life processes of metabolism.

Organized structure. The more scientists study living things, the more it becomes evident that *God made all living things with an orderly and carefully designed structure.* Every organism consists of one or more cells; a **cell** is the smallest unit of living things that can be said to be alive. In even the simplest cell, many different components must work in perfect harmony for the cell to carry on its life processes. (We will study some of the cell's complex structure and function in chapter 11.)

A **unicellular** [yo͞o′nĭ·sĕl′yə·lər] **organism** consists of a single cell that performs all of the organism's functions; but a **multicellular** [mŭl′tē·sĕl′yə·lər] **organism** like an animal or plant contains many different types of cells, each with a different purpose. Most multicellular organisms have cells arranged into *tissues*, groups of different types of cells working together to perform a single function. A large structure made of several types of tissues, like the brain of a person or animal or a leaf of a plant, is an *organ*; a group of organs that together perform some large function for the organism, like digestion or distribution of substances, is a *system*.


snail


cheetah

Growth. Another characteristic of living things is that *all living things grow*. Unicellular organisms grow by increasing cell size as they absorb water and other substances. Although the individual cells of multicellular organisms also increase in size, most growth in multicellular organisms occurs by increasing the number of cells through cell division, not by increasing the size of the cells. Every time a cell divides, it is replaced by two new cells (its "daughters"); throughout an organism's life, this process of cell division repeats many times to form the numerous cells in the fully grown organism from a single cell.

Response to changes. *All living things respond to changes both within themselves and outside themselves.* To survive, an organism or cell must maintain a stable internal condition called **homeostasis** [hō′mē•ō•stā′sĭs]. For example, your body needs oxygen from the air to function; if the level of oxygen in your body decreases (as when you are exercising), your body responds to the change by breathing harder and faster to take in more oxygen and maintain homeostasis. Unicellular organisms and the individual cells of multicellular organisms must also maintain homeostasis by responding to changes in their internal chemical composition.

Organisms also respond to changes outside themselves. Your body responds to hot weather by sweating to keep cool and responds to cold weather by shivering to keep warm; this allows your internal temperature to stay constant (about 37°C or 98.6°F) for proper body function. Many plants respond to changes in sunlight by turning their leaves toward the sun. Some animals, such as snowshoe hares and arctic foxes, respond to shorter days in autumn and winter by changing their coat color to blend with snow. Most unicellular organisms find food by detecting slight changes in the amount of certain chemicals, much as you may find a favorite dessert by detecting in which direction the smell is strongest. The white blood cells that protect your body from disease use a similar technique to hunt invading microorganisms.

Reproduction. When God created living things, He commanded them to multiply and fill the earth (Gen. 1:22); He repeated this command after the Flood of Noah's day (Gen. 8:17). To carry out this command, *all living things reproduce.* **Reproduction** is the process by which life continues through the generation of new organisms. As you study life science, you will learn the great variety of ways that God has designed for organisms to reproduce. No matter how organisms reproduce, *heredity*, the transmission of characteristics from parent to offspring, ensures that the offspring are the same kind of organism as the parents and have many other similarities to their parents. (We will study heredity in more detail in chapter 11.)

Metabolism. *All living things perform* ***metabolism****,* the sum of all the chemical processes of life. Although God designed metabolism to be more complex than any processes that occur in nonliving things, it still follows the same laws of science as the nonliving creation. One of the most fundamental laws of science is the *law of conservation of energy*, which states that energy can neither be created nor destroyed but can only change form. Because of this law, all the energy required by metabolism must come from **nutrients**, substances in food that provide organisms with energy or serve other essential purposes. Plants use available water, air, and sunlight to make their own food through *photosynthesis*. Animals and people cannot make their own food; but because all organisms need the same basic types of nutrients, they can get the nutrients they need by *ingesting*, or eating, plants and other organisms.

The first step in metabolism is converting the energy from nutrients into a form the cells can use, a chemical called *ATP.* In humans and many other organisms, the cells produce ATP by combining nutrients with oxygen in the process of **cellular respiration**. Without oxygen, these organisms cannot obtain the energy they need. Some organisms, most of which are unicellular, can use other processes to

produce ATP without using oxygen. No matter how the ATP is produced, the remainder of metabolism uses the ATP energy for growth, movement, and other body activities. After metabolism is completed, unneeded substances are removed through *excretion* to prevent accumulation that could poison the organism.

To perform metabolism, an organism needs adequate water. For example, about 70% of your body's mass is water, and your body must maintain that percentage of water to survive. Too much or too little water could stop your body's functions. You can survive over a week without food, but you cannot survive more than a few days without drinking water. All organisms, not just humans, need water for their metabolism to function.

A Closer Look

Word Puzzles

Life science is an exciting subject with many unfamiliar words. Although these words may seem long or hard to memorize, most of them use the same prefixes and suffixes. By familiarizing yourself with the meanings of the most common suffixes and prefixes, you can easily learn new words in biology.

For example, you are already familiar with the prefix *zoo-*. Most people know that a *zoo* is a place where animals are kept for the public to see and that a *zookeeper* is someone who takes care of those animals. Using this knowledge, you would guess that *zoology* has to do with animals. Look at its suffix: *-logy*. This suffix means "the study of." If you put together the meanings of the prefix and suffix, you have "animals, the study of." By rearranging the two definitions for easier reading, you can see that *zoology* means "the study of animals."

Using the chart provided, determine the general meaning of each word. Write down the possible definition and then look up each word in a dictionary.

1. **epidermis**
2. **chloroplast**
3. **autotroph**
4. **thermometry**
5. **phagocyte**
6. **cardiology**
7. **arthropod**
8. **hypothermia**

PREFIX	MEANING
arthro-	joint, jointed
auto-	self
bio-	life
cardio-	refers to the heart
chloro-	green
cyto-	cell
eco-	environment
epi-	on, above
exo-	outside
hypo-	under, below
macro-	large
micro-	small
phago-	eat, eater
photo-	light
syn-	together
thermo-	heat
zoo-	animal

SUFFIX	MEANING
-cyte	cell
-derm	skin
-ia, -iasis	disease, condition
-logy	study of
-metry	measurement
-plast	small body or cell
-pod	foot
-troph	food, nutrition

Les. 1 end

Section Review 1.1

1. What is the purpose of science?
2. Define *biology*.
3. What term refers to living things?
4. What is the study of the shape and structure of organisms?
5. List the five main characteristics found in all living things.
6. Define *homeostasis*.
7. What process, which combines nutrients with oxygen to produce ATP, is the first step in metabolism in humans and many other organisms?

Thought Provoker

List three specific ways in which botany affects how you live.

1.2 Begin in Your Own Backyard

Whenever you step outdoors, you walk into a laboratory similar to where men like Sir Francis Bacon and Sir Isaac Newton studied science. They used the meadows, woods, and waters around them to study God's creation. You can also use the outdoors to study nature; even your own backyard can provide a place for you to observe and study organisms. By observing the outdoors, you are, in a small way, following in the footsteps of these great scientists.

Preparing to Observe

Because there is so much to learn about nature, the great scientists of the past kept carefully written records of what they learned, allowing them to share this knowledge with others. Like these scientists, *you should keep a notebook of your observations about nature.*

In your notebook, write detailed descriptions of any **flora** (plant life) and **fauna** (animal life) that you observe. For plants, note the shape and arrangement of the leaves. Do you see any flowers or seeds on the plant? Is it in the shade or in full sunlight? Also, do you see any animals that live or feed on it? Make sure you record them with your plant's description. When observing an animal, record details about its appearance such as color, shape, size, or number of legs. Did it make any songs, calls, or noises? If so, try to describe how it sounded.

Record ways in which animals and plants show God's design for things like where they live, what they eat, and how they act. Note any special body structures and consider how they relate to the organism's physiology. Also record the relationships between organisms and how they help or hurt each other.

Include the date, time, and location of all entries. When observing outside, you should also record the type of weather. If possible, sketch or photograph what you observe. Sketches or photographs do not replace a written description but can include details or colors that are hard to describe. Place any sketches and photographs into your notebook.

A Closer Look

Mirror Images

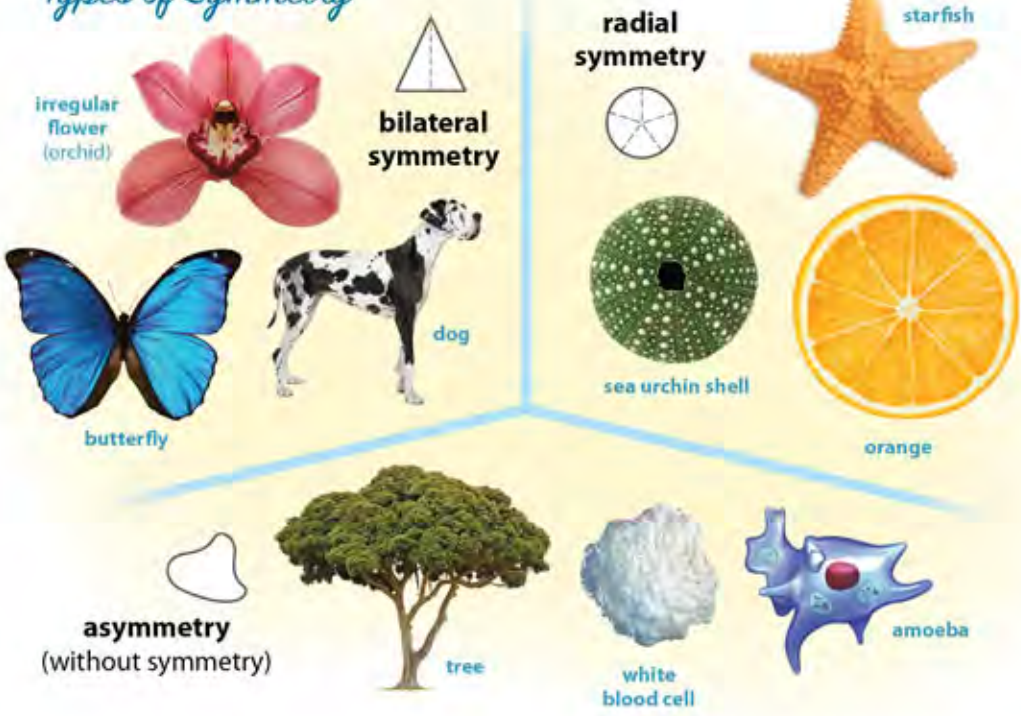
Most organisms can be categorized into three groups based on **symmetry**. Symmetry is the ability of an object to be cut into equal halves that are mirror images of each other. Biological symmetry is approximate and based on external similarities. As you observe God's creation, try to identify the symmetry of each organism you find.

The simplest symmetry is **bilateral symmetry**. Organisms with bilateral symmetry can be cut only one way to create similar right and left halves. Think of a leaf folded in half down the center; only one fold can create equal halves. Humans and most animals, including fish, insects, and birds, have bilateral symmetry, possessing paired limbs and one eye on each side of the head. A few flowers and fruits, like orchids and bananas, also have bilateral symmetry.

Organisms with **radial symmetry** can be cut multiple ways to create mirror halves. Like a pie, an organism with radial symmetry has a top and bottom but not right and left sides. You can cut a pie in half any way that you want and always get identical halves. Most flowers and fruits possess radial symmetry. Only a few animals, including starfish, jellyfish, and sea urchins, have radial symmetry.

Asymmetrical organisms cannot be cut into equal halves. Organisms like amoebas that constantly change shape are considered asymmetrical. Trees, which have great variety in their branch structure, are also considered asymmetrical.

Types of Symmetry



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A Handy Environment for Study

If you study life science in your backyard, you will probably be studying organisms in a meadow **environment** [ĕn·vī′rən·mənt]. An environment is everything surrounding the organism being studied. Environments on land, like meadows, are called **terrestrial** [tə·rĕs′trē·əl]. Other terrestrial environments include deserts, mountains, savannas, and jungles; each one has its own unique flora and fauna.

The home of an organism is its **habitat**. Soil is one of the habitats in your backyard. If you dug up the soil, you would discover ants, beetle grubs, and other insects. The ground may also be home to burrowing mammals like chipmunks, woodchucks, and moles. Many common snakes also live in underground burrows. *The ground beneath your backyard is teeming with life,* even though you do not normally see it or think about it.

A different set of animals will be found above ground in a meadow environment. Usually, you can immediately observe bees, butterflies, grasshoppers, and other insects. Whether you look in the sky or on the ground, you will see a variety of birds. With enough patience, you may also observe several other types of animals, including mice, rabbits, lizards, and squirrels.

NATURE EXPLORER

Snail Tracking

Snails will often return to the same place every night. Try placing a flowerpot on its side in your yard. Several days later, go out during the day, count all the snails on the flowerpot, and mark them with a dab of nail polish while wearing gloves. Count and record the number of snails that return to the flowerpot each day. Try moving the pot or placing others nearby and record your observations.

Seasons of Change

To every thing there is a season, and a time to every purpose under the heaven. —Eccles. 3:1

Changes in the environment will change the types of organisms that can be observed. The amount of light is the most frequent of these changes. Most familiar terrestrial organisms are **diurnal** [dī·ûr′nəl], or active mainly during the day. Other organisms are **nocturnal** [nŏk·tûr′nəl], or active mainly at night. Some common nocturnal animals are raccoons, garden toads, fireflies, and moths. Although most flowers bloom during the day, the evening primrose and the night-flowering catchfly bloom at night.

Most of the animals found in your backyard are active during dry weather but seek shelter during wet weather. Some animals, however, are easier to find during wet weather. Burrowing animals like earthworms and certain snakes will emerge during a rainstorm if water begins to fill their tunnels.

Seasonal changes also affect the activity of plants and animals. During the spring, new plants sprout and trees start to grow new leaves. Some of the most vividly colored flowers bloom during this time of year. Animals begin nesting and raising young. While observing, you may even catch a glimpse of baby deer or rabbits. Summer is also a busy time as flowers continue to bloom and animals rapidly grow in size. Most of the plants that you observed flowering in the spring have begun developing fruits on their branches.

When the weather cools and autumn approaches, many animals prepare for the upcoming winter by storing food. Some animals store food in burrows or holes in trees. Other animals eat constantly to build energy reserves, allowing them to sleep through most of the winter.

Seasons

Chapter 2
PLANTS
PROVISION FOR LIFE

KEY CONCEPTS

- *flower parts*
- *pollination and fertilization*
- *seed dispersal*
- *germination*
- *familiar flower families*
- *monocots and dicots*
- *leaf structure and arrangement*
- *photosynthesis and cellular respiration*
- *vascular system*
- *non-flowering plants*

2.1 The Purpose and Design of Flowers

On the third day of Creation, God commanded, "Let the earth bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so" (Gen. 1:11). *Green plants are among the most important of God's provisions for life on Earth.* Every green plant is a factory that collects solar energy and uses it to manufacture food for itself, people, and animals. The branch of science that studies plants is *botany*, and scientists who specialize in plants are called *botanists*.

The Discoveries of Christian Konrad Sprengel

In 1787, after studying a wild geranium in great detail, **Christian Konrad Sprengel** [shprĕng′əl] exclaimed: "The wise Author of Nature has not made even a single hair without a definite design!"[1] Sprengel recognized that flowers are organs intricately designed for plant reproduction and was the first to point out the role of insects in pollination.

Sprengel was born in Germany in 1750. Although he studied theology and languages in school, he was an enthusiastic amateur naturalist (one who studies nature). After working as a schoolmaster and school administrator, he decided to devote his life to studying the wonders of God's plant creation.

Through careful observation and experimentation, Sprengel discovered that each flower's nectar-producing organs have special colors designed to attract various insects. Sprengel also discovered that insects transport pollen grains from one flower to another. He observed and outlined many complex details of plant reproduction and plant and insect interaction. Sprengel published his botanical studies and theories in his book, *The Newly Revealed Mystery of Nature in the Structure and Fertilization of Flowers*.

In all his studies, Sprengel intended to bring glory to God for the wise design, purpose, and provision He

[1] Quoted in Neltje Blanchan, *Nature's Garden* (New York: Doubleday, 1901), vi.

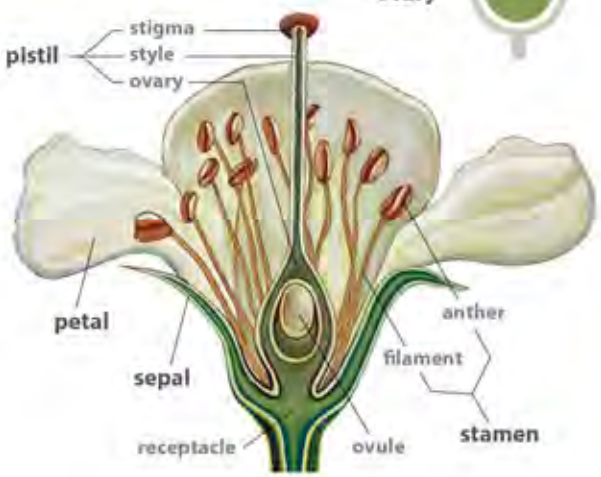
placed into His living creation. Twenty-five years after Sprengel's death in 1816, scientists began to study his long-neglected records and came to recognize the significance of this Christian botanist's work.

Look Closely

As we study the plant kingdom, we discover that *God created an incredible variety of design in flowering plants.* The combinations of colors, shapes, and sizes seem to be infinite. This diversity shows the remarkable ingenuity of the Creator.

Despite their differences, all flowers generally have one basic design. *All of a flower's parts are involved in its primary function: the reproduction of the plant.* In the center of the flower is a vase-shaped structure called the **pistil**. The sticky top of the pistil is called the *stigma*; the large, rounded bottom is called the **ovary**. In most flowering plants the ovary is *superior*, attached above the other flower parts (petals, etc.); but in some plants the ovary is *inferior*, attached below the other flower parts. The stalk that connects the stigma to the ovary is the *style*. The ovary holds the **ovules** [ŏv′yo͞olz], which are the plant's future seeds.

Parts of a Flower (plum)




cactus flower


Japanese iris


dahlia

One or more **stamens** [stā′mənz] surround the pistil. A stamen consists of an *anther* on top of a thin stalk called a *filament*. The anther produces pollen grains. As you examine flowers, you will find that not all flowers have both stamens and pistils. Flowers having only stamens are called *staminate* [stā′mə·nĭt], and those having only pistils are called *pistillate* [pĭs′tə·lāt′].

Surrounding the pistil and stamens are the **petals**, which often serve to attract insects or birds that pollinate the plant. **Sepals** [sē′pəlz] are leaf-like structures that surround the base of the petals. The sepals enclose and protect the developing flower *bud* until it opens as a fully formed flower. The pistil, stamens, petals, and sepals are attached to the **receptacle**, the enlarged upper portion of a flower's stem.


squash staminate flower


squash pistillate flower

Science Investigation

ADULT SUPERVISION REQUIRED!

A Careful "Cutup"

A good way to learn the various parts of a flower is to dissect [dĭ•sĕkt′: cut apart] a complete flower and mount its parts. Answer the Questions at the end of this Science Investigation as you work.

Materials

- Large flower (like a lily, hibiscus, or gladiolus)
- Two sheets of white paper
- Hand lens
- Scalpel or sharp knife
- Tape
- Black construction paper
- Scissors (for cutting labels)

STEP 1 Place a large flower on a sheet of white paper and lay it flat so you can see the outside of the petals and the sepals.

STEP 2 Carefully remove all of your flower's petals and examine the remaining reproductive structures. Use a hand lens to observe the stigma and anthers.

STEP 3 Poke a scalpel or sharp knife into the receptacle and carefully pull the blade up the center of the flower to the tip of the pistil, splitting the flower in half.

Caution: Always hold the cutting edge of a blade away from your body.

STEP 4 Observe the pistil with a hand lens. Notice the bead-like ovules within the base of the pistil. If your flower has already been pollinated, you may be able to see a pollen tube running through the middle of the pistil.

STEP 5 Use tape to mount each part of the flower on black construction paper, and attach labels (cut from a second sheet of white paper) to identify the flower's individual structures.

Questions

1. How would you describe the stamen?
2. Does the stigma feel sticky?
3. Is the flower's ovary inferior or superior?
4. Which structure(s) would be missing if this were a pistillate flower?
5. How many ovules does your flower have?

Section Review 2.1

1. What are the most important of God's provisions for life on earth?
2. What was Sprengel's goal with his botanical studies?
3. What is the primary purpose of a flower?
4. Name the four main parts of a flower.
5. List and define the three parts of a pistil.
6. What part of the flower produces pollen?

Thought Provokers

1. Does the plum flower have an inferior ovary or a superior ovary? Refer to the illustration on p. 35.
2. Can a staminate flower produce seeds? Why or why not?

Chapter 6
MAMMALS



KEY CONCEPTS

- *characteristics of mammals*
- *orders of placental mammals*
- *marsupials*
- *oviparous mammals*

6.1 Introduction to Mammals

God created plants to remain in one place and to be producers (organisms that make their own food). In contrast, He created animals in almost the opposite way; **animals** are *multicellular* organisms (organisms with more than one cell) that can move and are *consumers* (organisms that do not make their own food). Movement is probably the most notable characteristic of animals. Although a few animals, like sponges, spend much of their life attached to a surface, these animals still have motion; instead of moving themselves, they move the environment around them. Movement is essential to animals' survival as consumers. Since animals cannot produce their own food, they must either move to where the food is or bring the food to themselves.

By their body structure, animals are separated into two main groups: vertebrates [vûr′tə•brĭts] and invertebrates. **Vertebrates** are animals with a backbone (vertebral column). All vertebrates have an internal skeleton, or **endoskeleton** [ĕn′dō•skĕl′ĭ•tn], made of bone or cartilage; complex body systems, organs, and tissues; and bilateral symmetry. Although vertebrates make up less than one-tenth of the entire animal population, they are the animals that we are most familiar with: mammals, birds, fish, reptiles, and amphibians. The vertebrates were traditionally classified in phylum *Vertebrata* [vĕr•tĕ′brā′tə], but they are now usually classified in phylum *Chordata* [kôr•dā′tə], which includes a few invertebrates that possess structures similar to backbones.

Most animals are **invertebrates**, animals without a backbone. There is a wide assortment of invertebrates, including insects, worms, snails, starfish, and sponges. Because of the great variety of invertebrates, they are classified in many different phyla; we will study some of this variety in later chapters.

Furry Friends

Have you ever seen a cheetah running at 100 km/hr (60 mi/hr) or a bat flying and diving through the air to catch its dinner? Perhaps you have gone to an aquarium and have seen dolphins or whales. Maybe you have a pet dog or cat for which you are responsible. Although all of these animals live in various environments and move in different ways, they all have characteristics that place them in the vertebrate class *Mammalia* [mă•mā′lē•ə]. *These characteristics include an ability to regulate their body temperature internally, an endoskeleton, mammary* [măm′ə•rē] *glands, hair, a four-chambered heart, and a respiratory system with lungs and a diaphragm.*

Class Mammalia actually makes up a very small portion of the animal kingdom, yet it is the group of animals with which we are the most familiar. This is probably because **mammals** appear to be the most intelligent of God's creatures, so we enjoy watching them at play, teaching them to do tricks, or using them to assist in accomplishing work.

Diverse Design

All land-dwelling mammals were created on the sixth day of Creation; but aquatic mammals like whales and manatees were created on day five. God gave mammals the ability to control their body temperature. Since this ability allows them to survive in many different places, mammals are found from the African deserts to the Arctic Circle. God has also given mammals tremendous size variation. The *Kitti's hog-nosed bat* has the distinction of being the smallest mammal by overall body size; it is about 3 cm (1.2 in) long and weighs less than a dime! The *blue whale* is the largest mammal and the largest animal that has ever existed. The 33 m (110 ft) blue whale weighs over 180,000 kg (175 tons).

One scientist estimated that the aorta of a blue whale has a 23 cm (9 in) diameter, large enough that a small dog could run through it!

Studying mammals provides an appreciation for the incredible complexity of design in God's creation. We see evidences of our Creator as we study these incredible animals.

Characteristics of Mammals

Previously, you learned about the way scientists classify the different animals. *Animals found in class Mammalia have several characteristics that set them apart as a uniquely created group.*

Warming up. Mammals do not rely on their surroundings to determine their body temperature; instead, they are **warm-blooded**, meaning they regulate their body temperature by internal mechanisms like panting, shivering, and sweating. Mammals have a fairly constant, warm body temperature year round.

Some mammals cannot find enough food in the winter to maintain a high body temperature; God designed them to enter a state of *dormancy*. While in a dormant state, an organism will temporarily slow all metabolic activity and development in order to survive the winter months. Winter dormancy in mammals is called **hibernation** [hī′bər·nā′shŭn]. Before hibernation, the mammal will eat more food to store extra fat for energy during hibernation. Smaller mammals, like badgers, chipmunks, and some bats and squirrels, hibernate by reducing their body temperature close to the freezing point.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